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

McAlester Army Ammunition Plant, Oklahoma

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

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Preliminary Assessment and Site Inspection of Per- and Polyfluoroalkyl Substances

McAlester Army Ammunition Plant
Oklahoma

Tim Derstine
Site Inspection Project Manager, Arcadis U.S., Inc.

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

Amol Keskar
Technical Expert, Arcadis U.S., Inc.

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Prepared by:

Arcadis U.S., Inc.

7550 Teague Road

Suite 210

Hanover

Maryland 21076

Arcadis Ref.:

30001995

Date:

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EXECUTIVE SUMMARY

The United States Army (Army) is performing preliminary assessments (PAs) and site inspections (SIs) on the current or potential historical use of per- and polyfluoroalkyl substances (PFAS), with a focus on perfluorooctane sulfonate (PFOS), perfluorooctanoic acid (PFOA), and perfluorobutanesulfonic acid (PFBS), at Army installations (installations) nationwide. The PA identifies areas of potential interest (AOPIs) where PFAS-containing materials were used, stored, and/or disposed, or areas where known or suspected releases to the environment occurred. The SI includes multi-media sampling at AOPIs to determine whether or not a release has occurred. The SI may conclude further investigation is warranted, a removal action is required to address immediate threats, or no further action is required. This McAlester Army Ammunition Plant (MCAAP) PA/SI was completed in accordance with the Comprehensive Environmental Response, Compensation, and Liability Act of 1980 (CERCLA), National Oil and Hazardous Substances Pollution Contingency Plan, and Army/Department of Defense (DoD) policy and guidance.

MCAAP is the DoD's largest explosive storage facility and is the technology center for bomb assembling, loading, packing, manufacturing, engineering, product assurance, and production support. The installation occupies 44,965 acres in Pittsburg County, Oklahoma. The two primary land uses at MCAAP are magazines (approximately 7,000 acres) and the buffer areas around magazines, which are classified as natural wildlife areas (approximately 30,000 acres). At MCAAP, there are approximately 1,900 civilian personnel and 30 military personnel, including area veterans, Army Reserve and National Guard. The land designated for housing and administrative use occupies roughly 45 acres and is located in the northeastern portion of the installation.

The MCAAP PA identified seven AOPIs, of which six were selected for investigation during the SI. SI field activities were conducted in two phases. Phase I included soil, sediment, surface water, and groundwater grab sampling from 22 to 25 June 2020. Phase II included additional groundwater, soil, and surface water sampling from 01 to 02 December 2020.SI sampling results from these six AOPIs were compared to risk-based screening levels calculated by the Office of the Secretary of Defense (OSD) for PFOS, PFOA, and PFBS. PFOS, PFOA, and/or PFBS were detected in soil, surface water, sediment, and/or groundwater at five AOPIs; however, three of the six sampled AOPIs had PFOS, PFOA, and/or PFBS present at concentrations greater than the risk-based screening levels. The MCAAP PA/SI identified the need for further study in a CERCLA remedial investigation.

Table ES-1 below summarizes the PA/SI sampling results and provides recommendations for further study in a remedial investigation or no action at this time for each AOPI.

Table ES-1. Summary of AOPIs Identified During the PA, PFOS, PFOA, and PFBS Sampling at MCAAP, and Recommendations

AOPI Name	PFOS, PFOA, and/or PFBS Detected Greater than OSD Risk Screening Levels? (Yes/No/ND/NS)				Recommendation
	Groundwater	Soil	Surface Water	Sediment	
Firefighter Training Area	Yes	No	No	ND	Further study in a remedial investigation
AFFF Fire Response Site	ND	ND	No	NS	No action at this time
Former Navy Fire Department	ND	No	Yes	NS	Further study in a remedial investigation
Current Fire Department	Yes	No	NS	No	Further study in a remedial investigation
Former Fire Department	No	No	NS	NS	No action at this time
Former Naval Special Weapons Facility Shop (MCAAP-023/HQAES 40520.1023)	NS	NS	NS	ND	No action at this time
Missile Production Facility*	NS	NS	NS	NS	No action at this time

Notes:
* The AOPI was not sampled during the SI but may be sampled during future investigations.
Light gray shading – detection greater than the OSD risk screening level
AFFF – aqueous film-forming foam
ND – non-detect
NS – not sampled

1 INTRODUCTION

The United States (U.S.) Army (Army) is performing preliminary assessments (PAs) and site inspections (SIs) on the current or potential historical use of per- and polyfluoroalkyl substances (PFAS), with a focus on perfluorooctane sulfonate (PFOS), perfluorooctanoic acid (PFOA), and perfluorobutanesulfonic acid (PFBS), at Army installations (installations) nationwide. The Army is the lead agency under the Comprehensive Environmental Response, Compensation, and Liability Act of 1980 (CERCLA) and Executive Order 12580 and is conducting the PAs/SIs consistent with its authority under CERCLA, 42 United States Code §§ 9600, et seq. (as amended), and the Defense Environmental Restoration Program, 10 United States Code §§ 2701, et seq.

The McAlester Army Ammunition Plant (MCAAP) PFAS PA/SI included two distinct efforts. The PA identified locations that are areas of potential interest (AOPIs) at MCAAP based on the use, storage, and/or disposal of PFAS-containing materials, in accordance with the 2018 Army Guidance for Addressing Releases of Per-and Polyfluoroalkyl Substances (Army 2018). The SI included multi-media sampling at AOPIs to determine whether a release has occurred, and the PFOS, PFOA, and PFBS results were compared to the Office of the Secretary of Defense (OSD) PFOS, PFOA, and PFBS risk screening levels to determine whether further investigation is warranted. This report provides the PA/SI for MCAAP and was completed in accordance with CERCLA and the National Oil and Hazardous Substances Pollution Contingency Plan.

1.1 Project Background

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

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

and 600 ng/L for PFBS. The PFOS and PFOA soil screening levels for the residential and industrial/commercial scenarios are 0.13 milligrams per kilogram (mg/kg) (residential) and 1.6 mg/kg (industrial/commercial). The soil screening levels for PFBS are 1.9 mg/kg (residential) and 25 mg/kg (industrial/commercial). These screening criteria are discussed further in **Section 6.5**.

1.2 PA/SI Objectives

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

1.2.1 PA Objectives

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

1.2.2 SI Objectives

An SI is conducted when the PA determines an AOPI exists based on probable use, storage, and/or disposal of PFAS-containing materials. The SI includes multi-media sampling at AOPIs to determine whether or not a release has occurred. The SI may conclude further investigation is warranted, a removal action is required to address immediate threats, or no further action is required.

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

1.3 PA/SI Process Description

For MCAAP, PA/SI development followed a similar process as described below. **Section 3** provides a summary of the PA activities completed, and **Section 6** provides a summary of the SI activities completed for MCAAP. The PA and SI processes are documented in the PA/SI Quality Control Checklist included as **Appendix B**.

1.3.1 Pre-Site Visit

First, an installation kickoff teleconference was held among applicable points of contact (POCs) from United States Army Environmental Command (USAEC), United States Army Corps of Engineers (USACE), MCAAP, and Arcadis U.S., Inc. (Arcadis). The kickoff call occurred on 01 May 2018, five weeks before the site visit, to discuss the goals and scope of the PA, project scheduling, installation access, timeline for the site visit, and access to installation-specific databases, and to request available records.

A records review was conducted before the site visit to obtain electronically available documents from the installation and external sources for review. The purpose of the records research was to identify any area

on the installation that may have been a location where PFAS-containing materials were used, stored, and/or disposed, as well as to gather information on the physical setting and site history at MCAAP.

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

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

1.3.2 Preliminary Assessment Site Visit

The site visit was conducted from 04 to 07 June 2018. An in-brief meeting was held to provide installation staff with the objectives of the site visit and team introductions. **Section 3** includes information regarding personnel interviewed.

Personnel interviews were conducted with individuals having significant historical knowledge of MCAAP. The interviews focused on confirming information discussed in historical documents, collecting information that may have not been included in historical documents, and corroborating other interviewees' information.

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

An exit briefing was offered to installation personnel at the conclusion of the site visit to discuss any items identified during the site visit, discuss any follow-up items, and review the schedule for submitting deliverables. The exit briefing was conducted on 07 June 2018 with the installation, USAEC, and USACE to discuss preliminary findings of the PA site visit.

1.3.3 Post-Site Visit

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

1.3.4 Site Inspection Planning and Field Work

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

The objectives of the SI kickoff teleconference were to:

- Discuss the AOPIs selected for sampling and the proposed sampling plan for each AOPI
- Gauge regulatory involvement, requirements, or preferences
- Identify overlapping unexploded ordnance or cultural resource areas
- Identify specific installation access requirements and potential schedule conflicts
- Discuss general SI deliverable and field work schedule information and logistics.

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

- AOPIs selected for sampling and an updated proposed sampling plan for each AOPI
- An updated SI deliverable and field work schedule.

A Programmatic Uniform Federal Policy-Quality Assurance Project Plan (PQAPP) was developed and finalized in October 2019 for the USAEC PFAS PA/SI (Arcadis 2019). The PQAPP details general planning processes for collecting data and describes the implementation of quality assurance (QA) and quality control (QC) activities for the SI portion for Army installations nationwide. Additionally, an installation-specific QAPP Addendum was developed to define the DQOs, present the sampling design and rationale, and provide qualifications for project personnel. The SI field work was completed in accordance with the PQAPP (Arcadis 2019) and the approved installation-specific QAPP Addendum (Arcadis 2020a). A Site Safety and Health Plan (SSHP) was also developed as an attachment to the QAPP Addendum to identify specific health and safety hazards that may be encountered at the installation during sampling. The SSHP was designed to supplement the Accident Prevention Plan

(Arcadis 2018), which was developed for Army installations nationwide. The QAPP Addendum (Arcadis 2020a) and SSHP (Arcadis 2020b) were submitted to the installation and finalized before commencement of field work.

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

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

1.3.5 Data Analysis, Validation, and Reporting

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

2 INSTALLATION OVERVIEW

The following subsections provide general information about MCAAP, including the location and layout, the installation mission(s) over time, a brief site 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

MCAAP is located 9 miles southwest of the city of McAlester in southeastern Oklahoma (**Figure 2-1**). Tulsa, Oklahoma is 113 miles north of the installation; Oklahoma City, Oklahoma is 120 miles northwest; and Dallas, Texas is 180 miles southwest. The installation occupies 44,965 acres in Pittsburg County (MCAAP 2016). A site layout is presented on **Figure 2-2**. The county population in 2019 was reported as being 43,654.

2.2 Mission and Brief Site History

MCAAP is the DoD's largest explosive storage facility and is the technology center for bomb assembling, loading, packing, manufacturing, engineering, product assurance, and production support. Since 1998, it has been the headquarters for the U.S. Army Defense Ammunition Center (MCAAP 2016).

The primary mission of MCAAP is to produce and renovate quality conventional missile ammunition and ammunition-related components, including performing engineering and product assurance in support of producing, receiving, storing, shipping, demilitarizing, and disposing of conventional and missile ammunition and related items (MCAAP 2016).

Established during World War II as the McAlester Naval Ammunition Depot, it was chosen as an ammunition depot site and began production in 1943. The depot has produced ammunition, rockets, mines, and depth charges. The workforce has fluctuated between 632 and 15,000 employees throughout the site's history. In 1977, the DoD designated the Department of Army as the single manager of conventional ammunition. On 01 October 1977, the plant's name was changed to McAlester Army Ammunition Plant as it was transferred to the Army (MCAAP 2016).

2.3 Current and Projected Land Use

Currently, MCAAP conducts ammunition production, storage, and demilitarization operations (MCAAP 2016). The two primary land uses at MCAAP are magazines (approximately 7,000 acres) and the buffer areas around magazines, which are classified as natural wildlife areas (approximately 30,000 acres). Other land uses include administrative and housing areas, leased hay meadow production areas, wildfowl wildlife areas and their food plots, industrial areas, production buildings, and recreational facilities that include picnic areas and athletic fields.

MCAAP utilizes two Resource Conservation and Recovery Act-permitted open burn/open detonation areas, which are used for the demolition of produced and stored munitions when they are deemed in excess, outdated, or unserviceable. The areas encompass 673.09 acres (EA Engineering, Science and Technology, Inc., PBC [EA] 2015).

Brown Lake is host to fishing tournaments and outdoor recreation. Boat docks and recreational cabins are stationed on the lake, and outdoor recreational equipment is available to rent and use. Fish stocking has occurred across the installation, including Brown Lake, since 1945. Brown Lake was stocked with largemouth bass, bluegill, channel catfish, and crappie. Presently, the installation conducts an agricultural outlease program, which includes five outlease tracts totaling approximately 21,000 acres. These areas are managed for native grass hay production, food plots, and brush hogging. MCAAP also has a mineral lease program. There are ten active mineral leases active and nine gas-producing wells on the installation.

Land use is expected to remain the same for the foreseeable future (MCAAP 2011).

According to the 2011 Integration Natural Resources Management Plan, tenant activities at MCAAP include:

- U.S. Army Occupational Health Clinic
- U.S. Army Defense Ammunition Center and School
- U.S. Army Test, Measurement, and Diagnostic Support Center
- Naval Surface Waters Center, Indian Head Division, Detachment McAlester
- Defense Reutilization and Marketing Office
- Army Air Force Exchange
- Federal Credit Union
- Defense Automated Printing Service
- Air Force Reserve Ammunition Team
- U.S. Army Reserves
- Oklahoma National Guard.

MCAAP's Reserve Component program supports mobilization training for ammunition and other units. MCAAP provides year-round training to multiple units, including ordnance, maintenance, transportation, engineering, and infantry.

2.4 Climate

MCAAP has a warm, moist, and temperate to subtropical climate. The average annual high temperature is 83 degrees Fahrenheit in July and August with an average annual low temperature of 39 degrees Fahrenheit in January. Snowfall occurs at MCAAP about two to five times per year but does not typically last longer than two days. Average annual precipitation is about 45 inches and is well distributed throughout the year with peak rainfall occurring in May. Annual evaporation rates exceed precipitation rates by approximately 9 inches, creating a dry environment (EA 2015). Tornadoes are known to occur in March, April, and May (MCAAP 2011).

2.5 Topography

The mean elevation of MCAAP is 717 feet above mean sea level with gently sloping land (75 percent of the installation) and rolling sandstone hills (25 percent of the installation). The elevation ranges between 700 and 900 feet above mean sea level (**Figure 2-3**). This topography is typical across southeastern Oklahoma (MCAAP 2011).

2.6 Geology

MCAAP is on the boundary between the Interior Plain and Ouachita Mountain physiography provinces, in a sub-province referred to as McAlester-Marginal Hill Belt (MCAAP 2011). MCAAP is located within the Arkoma Basin geologic province and is situated within the Krebs syncline (EA 2015). The Krebs syncline is bounded to the north by the McAlester anticline and to the south by the Savanna anticline. As a result, numerous cuesta and hogback ridges exist.

Unconsolidated deposits include terrace deposits as well as windblown sand and colluvium from hillsides. Within the immediate vicinity of local creeks and rivers are alluvial deposits consisting of gravel, sand, silt, and clay. Gertie Sand is the dominant unconsolidated deposit, covering approximately 40 percent of the facility. This sand is approximately 25 to 50 feet thick (EA 2015).

The unconsolidated deposits overlay bedrock consisting of Pennsylvanian-aged sandstone and shale. Thurman Sandstone comprises the upper bedrock and is made up of brown, fine- to coarse- grained sandstone, and dark gray shale beds. It forms a narrow concentric band near the central portion of the installation and is also found in isolated remnants near the west-central portion of the installation. A 50-foot-thick chert conglomerate unit, consisting of angular-to-rounded fragments, is contained within the Thurman Sandstone (EA 2015).

Thurman Sandstone overlays the Boggy Formation, which exists in the southern, northwestern, and northeastern portions of the installation, including north of Brown Lake. It consists of alternating beds of fine- to coarse-grained sandstone and blue-gray shale. The upper limit of the Boggy Formation consists of Bluejacket Sandstone, which has been eroded to an escarpment. This sandstone unit is tan, with fine to coarse grains. Near the base of the formation is a coal bed. The Boggy Formation is between 1,470 and 2,000 feet thick in total (EA 2015).

The oldest exposed rocks at MCAAP belong to the Savanna Formation and are located along the southeastern boundary of the installation. The Savanna Formation consists of shale with fine to coarse sandstone units. It is up to 2,800 feet thick and contains coal beds 600 to 800 feet below the top of the formation (MCAAP 2011 and EA 2015).

2.7 Hydrogeology

Groundwater infiltration and water storage are limited by the county's geology. Groundwater on MCAAP is not commonly present in large quantities, except in some terrace gravel deposits. Bedding planes between the layers of sandstone and the partings between laminae of shale in bedrock formations are exposed to direct precipitation, which is the primary avenue of groundwater recharge and movement. These bedding planes exist in the Savanna, Boggy, and Thurman bedrock formations south and east of MCAAP (EA 2008). The limited existing groundwater flows through bedrock fractures and joints. Because

these bedrocks vary in depth and density, water availability is also variable. Low permeability of the bedrock and thin surface soil limit groundwater recharge to less than 1 percent of total precipitation (EA 2015). Therefore, most of the precipitation becomes surface water runoff or is evaporated. Due to the limited amount of groundwater beneath MCAAP, the groundwater flow direction has not been determined (EA 2008).

The groundwater that is available is limited to the fractures within the Savanna, Boggy, and Thurman formations along the south and east of the installation. The area adjacent to Bull Creek and eastern Brown Lake overlies Quaternary alluvium. Groundwater within the near-surface deposits and adjacent to these water bodies likely flows toward areas of topographic lows and then ultimately toward the northeast, parallel with Bull Creek.

2.8 Surface Water Hydrology

Five major watersheds and eight major watershed lakes occur at MCAAP. The two predominant surface water bodies are Brown Lake and Rocket Lake. Brown Lake, the largest, is located on the eastern portion of the installation. It occupies 550 acres and provides potable water to the installation and surrounding area (MCAAP 2011; EA 2008). Rocket Lake occupies 10 acres and is located 1 mile west of Brown Lake. Bull Creek connects Rocket and Brown Lakes, flowing east through Brown Lake and then eventually off-post and into Chun Creek. Wetlands comprise a significant portion of the surface water system at MCAAP, draining into Brown Lake, especially during storm events (MCAAP 2011).

The beneficial uses for Brown Lake and the surrounding watershed include public and private water supply, Class I irrigation, and primary recreation. Recreation activities include kayaking, canoeing, fishing, and boating. The Community and Family Activities Directorate administers a fishing tournament at Brown Lake (MCAAP 2011). Bull Creek is noted as a primary recreational resource.

Surface runoff at the installation drains into seven creeks: Hominy, Bull, Deer, Chun, North Boggy, Sassafras, and Caney Boggy Creeks. Sassafras and North Boggy Creeks drain off-post toward the south into the Red River. Deer, Bull, Hominy, and Chun Creeks drain into Eufaula Lake, approximately 20 miles north of the installation. Eufaula Lake is used as a potable water source for surrounding cities (MCAAP 2011).

2.9 Relevant Utility Infrastructure

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

2.9.1 Stormwater Management System

Stormwater flows into the small streams that are tributaries to Bull Creek, Rocket Lake, and Brown Lake. All stormwater from the central and eastern portions of MCAAP drains to various ditches and streams and eventually into Brown Lake. MCAAP's industrial area exists upstream of Brown Lake. However, the number of discharges into Brown Lake have been reduced to decrease pollutant loading. These discharges are connected into the sewage treatment plant, which discharges treated water into Bull

Creek downstream from Brown Lake. Brown Lake's primary outfall is Bull Creek, which flows northeast and eventually off-post. No stormwater collection system exists in production areas of the installation.

2.9.2 Sewer System

The wastewater treatment plant (WWTP) was constructed in 1943 and is located east of Brown Lake. The headworks flow to either a grit chamber or equalization ponds. Following a grit chamber, flow is to a primary clarifier and to a sludge drying bed with a 3,000-gallon capacity. Liquid waste flows from the primary clarifier to the equalization ponds, which then flows to the trickle filters (made up of rocks), to a secondary clarifier, and is given ultraviolet disinfection.

Sludge produced in the treatment plant is tested for toxicity characteristic leaching procedure and paint filters before being taken to the landfills at the installation and used as a cover. Approximately 24,000 gallons of sludge are generated each year, with three annual hauls to the landfill. Treated water from the WWTP discharges to Bull Creek, which is southeast of the treatment works. The treatment works collects domestic wastewater, industrial wastewater, laundering facility wastewater, pre-treated wastewater from perchlorate production, washdown water, and pinkwater (generated during the handling and demilitarization of conventional explosives containing dissolved trinitrotoluene [TNT] and cyclotrimethylene trinitramine [RDX], as well as some byproducts). The pinkwater treatment plant does not discharge directly to the environment, but instead is piped to the sewage treatment plant for further treatment and then disposal. Fourteen surface water impoundments are regulated by the Oklahoma Department of Environmental Quality for the treatment of wastewater and stormwater runoff.

2.10 Potable Water Supply and Drinking Water Receptors

Brown Lake is the primary drinking water source for the installation and surrounding towns of Savanna and Haywood. The surface water supply intake for this public water system (PWS) is located on the eastern boundary of Brown Lake where intake water is pumped through the WWTP. The PWS identifier for this site is OK1020605. MCAAP is the primary consumer of potable water obtained from Brown Lake, using almost 200 million gallons annually. Savanna and Haywood consume approximately 24 and 3 million gallons, respectively, annually (MCAAP 2011).

The groundwater that is available is limited to the fractures within the Savanna, Boggy, and Thurman formations along the south and east of the installation. There are no supply wells located within MCAAP boundaries (EA 2008). An Environmental Data Resources, Inc. (EDR) report includes search results from a variety of environmental, state, city, and other publicly available databases for a referenced property. An EDR report was generated for MCAAP, which along with state and county GIS data provided by the installation, identified several off-post public and private wells within 5 miles of the installation boundary (**Figure 2-4**). The EDR report providing well search results is included as **Appendix E**. There is one domestic well registered on the installation (**Table 2-1**). The domestic well was identified through state water well records, which list an incorrect address for MCAAP and do not identify the Federal Government as the owner. Additionally, the well location has not been confirmed by MCAAP personnel and is assumed to not be present on the installation.

2.11 Ecological Receptors

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

MCAAP is located in the transition zone between western grasslands and eastern forests where grassland, timber, and brushland can be found. The predominant habitat is grassland, making up 14,437 acres of the installation. Big bluestem, little bluestem, Indian grass, and switch grass are the dominant flora here (MCAAP 2011).

Brushland comprises 10,731 acres of the installation. Surveys indicate that this habitat is home to the federal- and state-listed American burying beetle and Indiana bat. However, the Indiana bat has not been observed at MCAAP. Native bluestem grasses are found here with shrub species such as sumac, hawthorn, persimmon, and Osage orange (MCAAP 2011).

Timberland comprises 10,400 acres of MCAAP land. Stands consist mostly of post oak, blackjack oak, red oak, and hickory (EA 2015).

MCAAP includes 1,030 acres of wetlands, streams, ponds, and marsh areas within its boundaries. Between 2011 and 2015, 20 acres of shallow-water wetlands developed as a result of beaver activity (MCAAP 2011).

According to surveys, MCAAP hosts 25 species of mammals, 163 species of birds, 20 species of fish, 12 species of reptiles, and nine species of amphibians. Mammals found on MCAAP include white-tailed deer, eastern cottontail, raccoon, eastern gray squirrel, eastern fox squirrel, gray fox, red fox, bobcat, beaver, skunk, opossum, and feral hogs (EA 2015).

Bird species at the installation include eastern wild turkey, northern bobwhite quail, red wing blackbird, great blue heron, American crow, brown-headed cowbird, common grackle, European starling, American robin, and scissor-tailed flycatcher. Migratory birds transient to MCAAP include Canadian goose, wood duck, mallard, blue-winged teal, and mourning dove (EA 2015).

Twenty fish species and 22 herpetofauna species exist on the installation. Invertebrates have not been inventoried.

Game species on the installation include white-tailed deer, eastern wild turkey, bobwhite quail, cottontail, swamp rabbits, fox, gray squirrels, mourning doves, woodcocks, feral hogs, largemouth bass, and flathead catfish. MCAAP is divided into four areas for deer and turkey hunting (MCAAP 2011).

Special-status flora on the installation includes sandgrass, pipewort, xeric oak-hickory-pine forest communities, and bristly locust (MCAAP 2011).

There is one known special-status species on the installation. The American burying beetle is federally listed as a threatened species. On 15 October 2020, it was downlisted by the U.S. Fish and Wildlife Service from endangered to threatened on the Federal List of Endangered and Threatened Wildlife (U.S. Fish and Wildlife Service 2020). Other special-status fauna in Pittsburg County and surrounding counties includes the interior least terns, prairie mole cricket, alligator snapping turtle, Texas horned lizard, long-tailed weasel, Bachman's sparrow, desert shrew, southeastern myotis, Mexican free-tailed bat, eastern

harvest mouse, marsh rice rat, woodchuck, Indiana bat, and river otter. Aside from the American burying beetle, none of these species have been observed on the installation (MCAAP 2011).

MCAAP hosts approximately 275 acres of agricultural land used for food plots. These food plots are managed for winter rye grass to support wildlife (MCAAP 2011).

2.12 Previous PFAS Investigations

Previous (i.e., pre-PA) PFAS investigations relative to MCAAP, including those conducted and not conducted by the Army, are summarized to provide full context of available PFAS data for MCAAP. However, only data collected by the Army are used to make recommendations for further investigation.

In response to the USEPA's Third Unregulated Contaminant Monitoring Rule (UCMR3), PWSs across the United States were sampled for select PFAS compounds, including PFOS, PFOA, and PFBS. The laboratory that analyzed samples under UCMR3 met the USEPA's UCMR3 Laboratory Approval Program application and Proficiency Testing criteria for USEPA Method 537 Version 1.1. The UCMR3 efforts were conducted by the USEPA (i.e., not the Army). Two of these PWSs are adjacent to MCAAP. The McAlester Public Works Administration Public Water Authority (PWS identifier OK1020609), located approximately 7 miles north of the installation, was sampled in August 2014, November 2014, February 2015, and May 2015. The Adamson Rural Water District PWS (PWS identifier OK3006112), located approximately 5 to 12 miles northeast, east, and southeast of the installation, was sampled in February, May, August, and November 2015. The Adamson Rural Water District PWS is supplied by purchased water from Eufaula Lake, which is approximately 14 miles northeast of Brown Lake. The reporting limit at the time of UCMR3 sampling was 40 ng/L for PFOS, 20 ng/L for PFOA, and 90 ng/L for PFBS, less than or equal to the OSD risk screening levels for tap water. Samples were collected at the entry points of the distribution systems. PFOS, PFOA, and PFBS were not detected in any of these samples.

In 2015 and 2016, an evaluation of 23 Army Materiel Command installations, including MCAAP, was conducted. Drinking water samples were collected from the drinking water supply systems. As part of the Army Materiel Command investigation, two drinking water samples were collected at MCAAP's drinking water system (PWS identifier OK1020605). These samples were collected from the pre-treated water (pre-granular-activated carbon treatment system) source and from finished water. PFOS and PFOA were not detected at concentrations greater than the minimum reportable level (40 ng/L and 20 ng/L, respectively; Tetrahedron, Inc. 2018). PFBS was not sampled for as part of this investigation. The analysis method utilized for this investigation was USEPA Method 537.

In 2016, the Army Materiel Command identified MCAAP as one of 13 installations that may have had past operational activities that involved the use of aqueous film-forming foam (AFFF) and implemented a sampling program to determine if PFOS and/or PFOA were present as a result. A historical investigation identified two locations where AFFF has been used for firefighter training. In 2017, two soil samples were collected from these two areas. One sample was collected at the Current Fire Department, which had an AFFF tank testing area. The other sample was taken at the Firefighter Training Area, where the fire department conducted training exercises with old, gelled AFFF. Results from the sample collected at the Current Fire Department indicated PFOS was present at a concentration of 0.051 mg/kg and PFOA at 0.0012 mg/kg. Results from the sample collected at the Firefighter Training Area indicated PFOS was

present at 0.062 mg/kg; PFOA was not detected above the minimum detection level (0.0012 mg/kg) (Tetrahedron, Inc. 2017). The analysis method utilized for this investigation was USEPA Method 537.

Results from each of the previous PFAS investigations are provided in **Table 2-2**.

3 SUMMARY OF PA ACTIVITIES

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

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

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

3.1 Records Review

The records reviewed for this PA included, but were not limited to, various Installation Restoration Program (IRP) administrative record documents, compliance documents, MCAAP fire department documents, MCAAP directorate of public works documents, and GIS files. Internet searches were also conducted to identify publicly available and other relevant information. A list of the specific documents reviewed for MCAAP is provided in **Appendix F**.

3.2 Personnel Interviews

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

A list of roles for the installation personnel interviewed during the PA process for MCAAP (affiliation is with MCAAP unless otherwise noted) is presented below:

- IRP Manager
- Director, Environmental Management
- Fire Chief
- Former Fire Chief (1994 to 2013)
- Master Planner
- Environmental Physical Scientist

- Integrated Pesticide Management Coordinator
- Support Agreement Manager
- Water Program Manager
- Water Treatment Plant Facility Manager
- Industrial Hygiene Supervisor
- Electronic Systems Mechanic
- Supervisor (Oklahoma National Guard)
- Shop Supervisor (Former Naval Special Weapons Facility).

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

3.3 Site Reconnaissance

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

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

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

MCAAP was evaluated for potential current and historical use, storage, and/or disposal of PFAS-containing materials. There are a variety of PFAS-containing materials used in relation to current and historical Army operations. However, the use, storage, and/or disposal of AFFF is the most prevalent potential source of PFAS chemicals at DoD facilities. As such, this section is organized to summarize the AFFF-related uses first, and remaining potential PFAS-containing materials in the subsequent sections.

4.1 AFFF Use, Storage, and Disposal Areas

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

AFFF inventory data were not available from USAEC or the installation. However, interviews conducted and safety data sheets provided during the PA site visit were used to develop an understanding of the AFFF use and storage at this installation. AFFF products were reported to have been stored in the fire station storage building, which is located just south of the fire station. During the 2018 PA site visit, 5-gallon buckets of 1 to 3% and 3 to 6% AFFF were identified here. There were 11 and 24 buckets of each, respectively. Fire trucks on the installation have the capacity to carry between 5 and 10 gallons of concentrate.

Approximately 15 years ago, the MCAAP Fire Department began using U.S. Foam Technologies-manufactured AFFF, which included First Strike 3%-6% alcohol-type foam concentrate (ATC)/AFFF, First Strike 1%-3% ATC/AFFF, and First Strike Class A foam. Class A foam is formulated for use on solid combustibles such as paper, wood, cloth, and some plastics. ATC/AFFF is used on petroleum fires and generally contains PFAS.

Before 2016, gelled AFFF would be used for training along with First Strike TF-1170 Training Foam Super Concentrate. Since 2006, First Strike TF-1170 Training Foam (which does not contain fluorinated surfactants) has been the only foam used for training.

For emergency preparedness, fire department personnel were trained to perform nozzle testing with AFFF to ensure optimal flow and use of the AFFF mixture. Nozzle testing involved spraying AFFF through fire equipment. Nozzle testing was known to have been conducted at the Current Fire Department to ensure proper equipment function.

Additional firefighting training activities were conducted at the Firefighter Training Area. The Firefighter Training Area was established by the MCAAP Fire Department around 1992 to assist in fire familiarization training with state and Army National Guard units. Burn pans were used for wood and diesel fires. An estimated 2 gallons of foam concentrate were used to extinguish each fire. With each training exercise, 20 gallons of AFFF concentrate were used per truck. Overall, an estimated 50 to 100 gallons of concentrate a year were released to the area during these cross-training events. The area was bermed to mitigate foam migration to the surrounding area, and personnel from the Environmental Office monitored training to further prevent direct discharge to the adjacent Bull Creek.

Two former fire department buildings (Former Fire Department and Former Navy Fire Department) were identified at MCAAP during the PA site visit; however, documentation of AFFF use or storage at these areas was not available. Given their periods of operation (discussed in **Section 5.2**), it is likely that AFFF may have been used or stored at these locations as well.

The MCAAP Fire Department provided a report that included response narratives describing incidences where foam was used in response to fires. These records, along with personnel interviews, comprise the information available on fire responses at the installation. In these narratives, the deployed foam type and/or exact deployment location was often missing or unspecific. These events are not associated with petroleum fires and as a result were not anticipated to be responded to using AFFF unless noted. These events are summarized below:

- AFFF was deployed in response to a fire at the AFFF Fire Response Site in 2005 or 2006. Here, 9,000 pounds of asphalt caught fire near a TNT production facility. Two full trucks of AFFF and reserves were required to extinguish the fire.
- In January 2015, a fire at a building known as the “DRMS Complex” had a hydraulic hose break and hydraulic fluid sprayed over equipment. The hydraulic fluid caught fire, and two extinguishers equipped with foam were used to extinguish and wash down remaining hydraulic fluid. The class and volume of foam used, as well as the exact location of this fire, are unknown.
- In June 2015, a roll-off dumpster fire at the building grounds was extinguished with 20 gallons of foam, which was sprayed into the dumpster. The dumpster was taken to a landfill offsite soon thereafter. The class and volume of foam used, exact location of this fire, and disposal location of the dumpster are unknown.
- In August 2015, a grass fire at the demolition range rekindled after an initial water response. This second response required the application of foam to the fire. The class and volume of foam used, as well as the exact location of this fire, are unknown.
- In December 2015, a dumpster fire next to a general-purpose storage building required use of several buckets of foam to extinguish. This dumpster was removed from the site soon thereafter. The class and volume of foam used, as well as disposal location of the dumpster, are unknown.
- In March 2016, an equipment fire at a maintenance shop required response with foam. The class and volume of foam used are unknown.
- In January 2018, foam was used in response to a dumpster fire by the high explosives filling plant. The class and volume of foam used, exact location of this fire, and disposal location of the dumpster are unknown.

A mutual aid agreement exists among the MCAAP Fire Department and fire departments in the cities of Savanna, Haywood, and McAlester. MCAAP often held classes for volunteer firefighters from surrounding areas to practice and learn foam application techniques for wildland fire training.

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

Following document research, personnel interviews, and site reconnaissance activities at MCAAP, metal plating operations, pesticide storage areas, photo-processing areas, X-ray processing facilities, missile production facilities, and landfills were also identified as preliminary locations for use, storage, and/or disposal of PFAS-containing materials. The information gathered in the PA for each of these preliminary locations is summarized below. Areas not retained for further investigation are discussed in **Section 5.1** and areas retained as AOPIs are discussed in **Section 5.2**.

Potential PFAS use associated with metal plating activities may be relevant to Army installations. During metal plating operations, a metal surface may be treated with a layer of electrochemically deposited metals in an acid bath. PFAS, specifically PFOS, have been used in metal plating operations as surface tension-reducing wetting agents to mitigate the release of aerosolized chemicals into a working environment. Hard chromium plating is one type of metal plating operation where PFAS-containing mist suppressants were commonly used. Historically, it was common for spent plating baths from metal plating operations to be disposed of in a lined or unlined pit or into a sanitary or storm sewer. Therefore, PFAS present in mist suppressants during the metal plating process could be released to the environment.

The Former Naval Special Weapons Facility Shop was historically used for electroplating and anodizing activities as early as the 1970s in the “Pot Room” (MCAAP 1984 and 2001). The Navy leased and maintained the building for general maintenance and fabrication of weapon support elements (e.g., bomb racks). The equipment was removed by 1988. The Navy vacated the building in 2018. In March 2018, while preparing to move, plating equipment and chromic acid iridate, constituents possibly associated with chromium plating, were found. Similar chemicals were noted in a 1984 industrial hygiene review (MCAAP 1984).

During a telephonic interview with the IMCOM Pest Management Consultant, it was noted that products containing Sulfluramid (i.e., associated with insecticides) may have contained PFAS and were phased out in 1996. During the PA records review, the IMCOM Pest Management Consultant provided records of potentially PFAS-containing pesticides and insecticides used at and/or stored at Army installations, and did not identify MCAAP as an installation having used or stored PFAS-containing pesticides/insecticides. Additionally, the PA team reviewed available pesticide use inventory documentation provided by the installation and did not identify PFAS-containing pesticide use, storage, or disposal.

X-ray facilities and photograph laboratories, which have the potential to utilize PFAS-containing materials, were identified in the initial building inventory review at the installation. The documents reviewed regarding these buildings did not provide evidence that PFAS-containing materials were used, stored, or disposed of in any of these buildings.

Since 2013, removal of hydraulic fluids from model AB and early O Maverick AGM 65 missiles has occurred at the Missile Production Facility located southwest of Brown Lake. The hydraulic fluid is a phosphate ether blend that contains PFAS. Workers flush out 15 ounces of hydraulic fluids from each of

these missiles and store the removed fluids in 55-gallon drums. It takes approximately two years to fill these drums. These drums are kept on containment pallets inside the facility and are disposed of offsite.

There are 12 landfill locations at MCAAP. There is currently only one active non-hazardous industrial waste landfill at MCAAP, which is permitted by the Oklahoma Department of Environmental Quality. The active landfill onsite contains asbestos, boxes, and sludge from the WWTP. The sludge from the WWTP is taken first to drying beds. This sludge is then sampled for toxicity characteristic leaching procedure metals, undergoes a paint filter test, and is dewatered when necessary before being taken to the landfill. There were no records indicating that the WWTP or these landfills received impacted media from the AOPIs.

4.3 Readily Identifiable Off-Post PFAS Sources

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

There are no apparent industrial operations or municipal fire stations bounding the installation.

A mutual aid agreement exists among the MCAAP Fire Department and fire departments in the cities of Savanna, Haywood, and McAlester. As part of the mutual aid agreement, the MCAAP Fire Department responded to a diesel trailer that caught fire off-post, on Highway 69. A small amount of AFFF was used to extinguish the fire. Although the exact date and location of this specific response are unknown, MCAAP frequently responds to vehicle fires on Highway 69.

5 SUMMARY AND DISCUSSION OF PA RESULTS

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

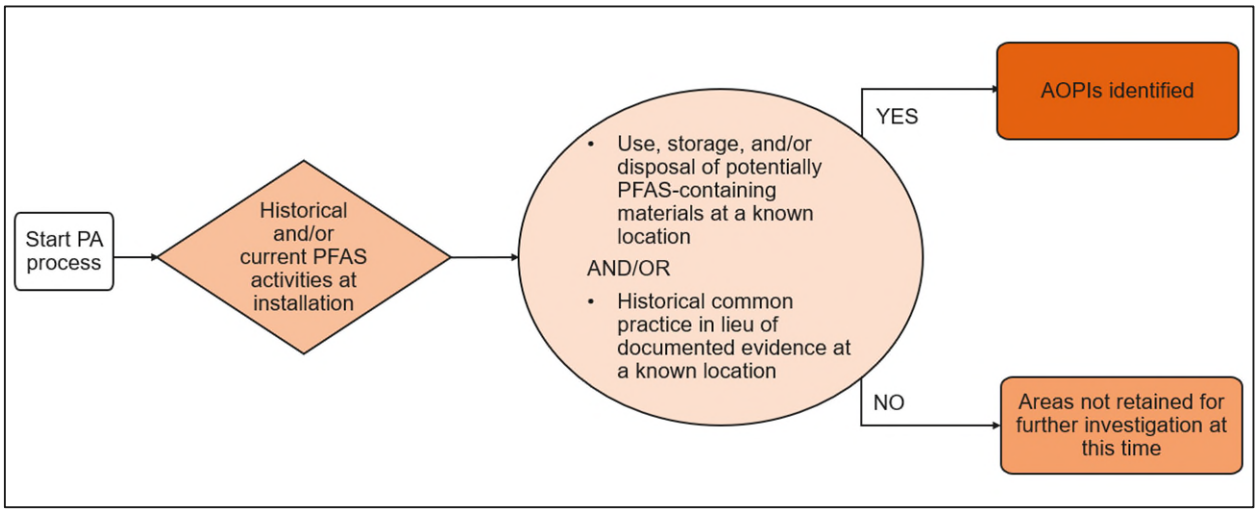

Figure 5-1. AOPI Decision Flowchart

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

Data limitations for the PA/SI at MCAAP are presented in **Section 9**.

5.1 Areas Not Retained for Further Investigation

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

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

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

Area Description	Dates of Operation	Relevant Site History	Rationale
Pesticide Control Shop	Currently	Building is a pesticide-mixing and chemical storage area. MCAAP personnel mix large quantities of pesticides outside using a field stand but all waste streams are recaptured and re-mixed or disposed of offsite. The collection "trap" was described as not likely as ever having been full.	MCAAP was not identified as an installation to have used PFAS-containing pesticides.
X-Ray Facility	1943 – Unknown	Constructed in 1943, the facility was used to develop x-ray imagery until an unconfirmed time.	Interviews and document research did not provide evidence that use, storage, or disposal of PFAS-containing materials occurred here.
X-Ray Facility	1945 – Unknown	Constructed in 1945, the facility was used to develop x-ray imagery until an unconfirmed time.	Interviews and document research did not provide evidence that use, storage, or disposal of PFAS-containing materials occurred here.
X-Ray Facility	1943 – Unknown	An x-ray unit was moved to this facility. Presently, there is now a silver recovery machine. The x-ray unit was used for medical x-rays and was in use since 1943.	Interviews and document research did not provide evidence that use, storage, or disposal of PFAS-containing materials occurred here.
Photo Lab	1943 – Unknown	A photograph laboratory was known to have existed here at some point, developing film. The building was constructed in 1943.	Interviews and document research did not provide evidence that use, storage, or disposal of PFAS-containing materials occurred here.
Photo Lab	1943 – Unknown	A photograph laboratory was known to have existed here at some point, developing film. The building was constructed in 1943.	Interviews and document research did not provide evidence that use, storage, or disposal of PFAS-containing materials occurred here.
Photo Lab	1990 – Unknown	A photograph laboratory was known to have existed here at some point, developing film. The building was constructed in 1990.	Interviews and document research did not provide evidence that use, storage, or disposal of PFAS-containing materials occurred here.

5.2 AOPIs

Overviews of each AOPI identified during the PA process are presented in this section. One of the AOPIs overlaps with installation-named IRP sites and/or Headquarters Army Environmental System (HQAES) sites**.** The AOPI, overlapping IRP site identifier, HQAES number, and current site status are discussed within each AOPI subsection presented below. At the time of this PA, none of the installation-named IRP sites have historically been investigated or are currently being investigated for the possible presence of PFAS.

The AOPI locations are shown on **Figure 5-2**. Aerial photographs of each AOPI that also show the approximate extent of AFFF use (if applicable) are presented on **Figures 5-3** through **5-9** and include active monitoring wells in the vicinity of each AOPI.

5.2.1 Firefighter Training Area (FTA)

The Firefighter Training Area (FTA) is identified as an AOPI following records research, personnel interviews, and site reconnaissance activities due to the area being used for firefighting training and known AFFF use. The FTA was originally established by the MCAAP Fire Department to assist in familiarization training with state and Army National Guard units. The area is flat, circular, vegetated, and surrounded by an earthen berm and gravel road. The portion of Bull Creek that is downgradient of Brown Lake lies approximately 60 feet to the east of the FTA. The earthen berm was created around the outer road so that foam and water could be retained in the center of the site, as general surface flow is toward the creek. Burn pans, placed in varying locations within the circular FTA, were used for wood and diesel fires. Annually, approximately 50 to 100 gallons of AFFF was used in firefighter training exercises. Environmental Office representatives monitored firefighter activities to prevent direct discharge to Bull Creek (**Figure 5-3**). An incineration building was formerly located in this area. However, this building was demolished in 2019.

5.2.2 AFFF Fire Response Site (AFRS)

The AFFF Fire Response Site (AFRS) is identified as an AOPI following personnel interviews due to a fire occurring here that required the application of 100 gallons of AFFF concentrate.

This fire occurred in approximately 2005 when 9,000 pounds of asphalt caught fire inside the building. The exact fire location within the building, and subsequently where the AFFF was applied, is not known. Most of the foam deployed here was reported to have been mopped or broomed outside through doors or into drains. The drain discharge location has not been identified. Foam residuals would have evaporated. The area is predominantly paved on the northern portion and vegetated with manicured grass on the southern portion. The southern portion of the AOPI also has earthen conveyance ditches flowing to the southeast. The earthen stormwater conveyance ditches on the northern portion of the AOPI convey water to the east (**Figure 5-4**). Both stormwater conveyance ditches lead toward Rocket Lake, which discharges into Brown Lake.

5.2.3 Former Navy Fire Department (FNFD)

The Former Navy Fire Department (FNFD) is identified as an AOPI following personnel interviews due to the area being used by the Navy as a fire department facility until the transfer of the installation to the Army in 1977. Specific activities by the Navy Fire Department are unknown but it is likely that vehicle washout and AFFF storage occurred at this location. The Army continued to use this building until the early 2000s, when the building was condemned due to black mold. The station is still currently only in use as a storage building for fire apparatuses. The area is predominantly gravel, with undeveloped vegetated land to the north, south, and east of the buildings (**Figure 5-5**). There are steam utility pipes to the south, north, and northeast of the building. Site topography is relatively flat, with surface water flowing away from the building to the northeast.

5.2.4 Current Fire Department (CFD)

The Current Fire Department (CFD) is identified as an AOPI following personnel interviews and site reconnaissance activities due to the area being used for AFFF storage and nozzle testing.

The area was originally constructed in 2001 for use as the primary fire station at the installation. Prior to this time, it was a wooded area. It is estimated that between 2001 and 2007, nozzle testing was completed weekly on the south side of the building (**Figure 5-6**). AFFF was stored along with Class A foams. During the 2018 site visit, 5-gallon buckets of 1 to 3% and 3 to 6% AFFF were identified in the storage building at the CFD. There were 11 and 24 buckets of each, respectively. Fire trucks on the installation have the capacity to carry between 5 and 10 gallons of concentrate.

To the south of the building, the area slopes steeply toward Bull Creek and Brown Lake.

5.2.5 Former Fire Department (FFD)

The Former Fire Department (FFD) is identified as an AOPI following document research, personnel interviews, and site reconnaissance activities due to the area potentially being used for AFFF storage and nozzle testing.

This was the original fire station for the installation. It was constructed in 1943 and used until 2001 when the CFD building was constructed. In 2001 it became an administrative building. There are no records indicating AFFF storage, accidental releases, or nozzle testing occurred at this location; however, personnel interviewed only had knowledge of fire operations at this building between 1994 and 2001 and thus were not able to provide the full historical use of this building. After the CFD was put in service, the FFD building was repurposed into an office facility currently housing the Directorate of Public Works. The area is predominantly paved, with grassy areas directly east and west of the former vehicle ramp on the south side of the building. Brown Lake is located approximately 500 feet to the southwest; an unlined conveyance ditch carries stormwater to the west **(Figure 5-7**).

5.2.6 Former Naval Special Weapons Facility Shop (MCAAP-023 / HQAES 40520.1023)

The Former Naval Special Weapons Shop is identified as an AOPI following document research, personnel interviews, and site reconnaissance activities due to the area being potentially used for

chromium plating. The Navy leased and maintained this building for its use until late 2018 when the building was vacated. The building was used for general maintenance and fabrication of weapon support elements (e.g., bomb racks). The “Pot Room,” located on the east-central side of the building, was known to have limited electroplating and anodizing activities in the 1980s, or possibly earlier. The plating equipment was removed in 1988. This building created discharge to two unlined lagoons until 1991. In March 2018, during preparations for moving, plating equipment and chromic acid iridate, constituents possibly associated with chromium plating, were found.

Discharge from this building was directed via piping to two unlined lagoons located to the northeast (**Figure 5-8**). The Special Weapons Lagoons were identified as MCAAP-023, a potential waste disposal area, during the installation’s evaluation of solid waste management units (SWMUs) in 1991. The site consists of one unlined earthen impoundment, separated into two sections, measuring 60 feet by 120 feet in total area (United States Army Environmental Hygiene Agency 1992). The SWMU evaluation noted the lagoons received and retained domestic sewage from the Former Naval Special Weapons Shop prior to discharge to a drainage leading to Rocket Lake. The system was used from the 1970s through November 1991, when the discharge system was tied to the sewer and the piping to the lagoons was capped and abandoned. The report (United States Army Environmental Hygiene Agency 1992) notes that some industrial wastes may have been conveyed to the lagoons, including small quantities (less than 50 gallons per year) of cyanide and cadmium for electroplating operations, chromates from anodizing, sulfuric acid from a chemical treatment solution, and nitric acid. The SWMU evaluation concluded that there was no evidence of a release of chemicals, and while migration of constituents via surface water to Rocket Lake was possible, the exposure potential to receptors was low. Therefore, the document concluded that no further evaluation was needed at that time.

It could not be confirmed that the plating and chemicals were used in hard chromium plating operations.

5.2.7 Missile Production Facility

The Missile Production Facility is identified as an AOPI following document research, personnel interviews, and site reconnaissance activities due to the storage and disposal of PFAS-containing materials. Since 2013, removal of hydraulic fluids from model AB and early O Maverick AGM 65 missiles has occurred here. The hydraulic fluid is a phosphate ether blend that contains PFAS. Workers flush out 15 ounces from each of these missiles and store them in 55-gallon drums. It takes approximately two years to fill these drums. These drums are kept on containment pallets inside the facility and are disposed of offsite. The facility is located southwest of Brown Lake (**Figure 5-9**). There have not been any reported spills.

6 SUMMARY OF SI ACTIVITIES

Based on the results of the PA at MCAAP, an SI for PFOS, PFOA, and PFBS was conducted in accordance with CERCLA. SI sampling was completed at MCAAP at six of the seven AOPIs to evaluate the presence or absence of PFOS, PFOA, and PFBS in comparison to the OSD risk screening levels.

Sampling was not conducted at one AOPI, the Missile Production Facility, because there was no media available to sample. Production using PFAS-containing material began in 2014 and has not resulted in any related record of spills. Waste has been stored only within secondary containment and the total volume of waste produced is less than 28 gallons per year. The waste is disposed of offsite.

An installation-specific QAPP Addendum (Arcadis 2020a) was developed to supplement the general programmatic information provided in the PQAPP (Arcadis 2019) and to detail the site-specific proposed scopes of work for the SI. A preliminary CSM was prepared for each of the installation's AOPIs in accordance with the USACE Engineer Manual 200-1-12 on Conceptual Site Models (USACE 2012). The preliminary CSMs identified potential human receptors and chemical exposure pathways based on current and/or reasonably anticipated future land uses. The preliminary CSMs identified soil, groundwater, surface water, and/or sediment pathways as potentially complete, which guided the SI sampling. The QAPP Addendum details the sampling design and rationale based on each AOPI's preliminary CSM. The SI scope of work was completed in two phases, conducted in June and December 2020, through the collection of field data and analytical samples.

The SI field work was completed in accordance with the standard operating procedures (SOPs), technical guidance instructions (TGIs), sampling design, and QA/QC requirements as detailed in the QAPP Addendum (Arcadis 2020a) and PQAPP (Arcadis 2019). The subsections below summarize the DQOs, sampling design and rationale, sampling methods and procedures, and data analysis procedures for the SI phase at MCAAP. Non-conformances to the prescribed procedures in the PQAPP and QAPP Addendum are described in **Section 6.3.4**. Analytical results obtained through SI field activities are summarized in **Section 7**.

6.1 Data Quality Objectives

As identified during the DQO process and outlined in the site-specific QAPP Addendum (Arcadis 2020a), the objective of the SI is to identify whether there has been a release to the environment at the AOPIs identified in the PA and to determine if further investigation is warranted. This SI evaluated groundwater, soil, surface water, and sediment for PFOS, PFOA, and PFBS presence or absence at each of the sampled AOPIs.

6.2 Sampling Design and Rationale

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

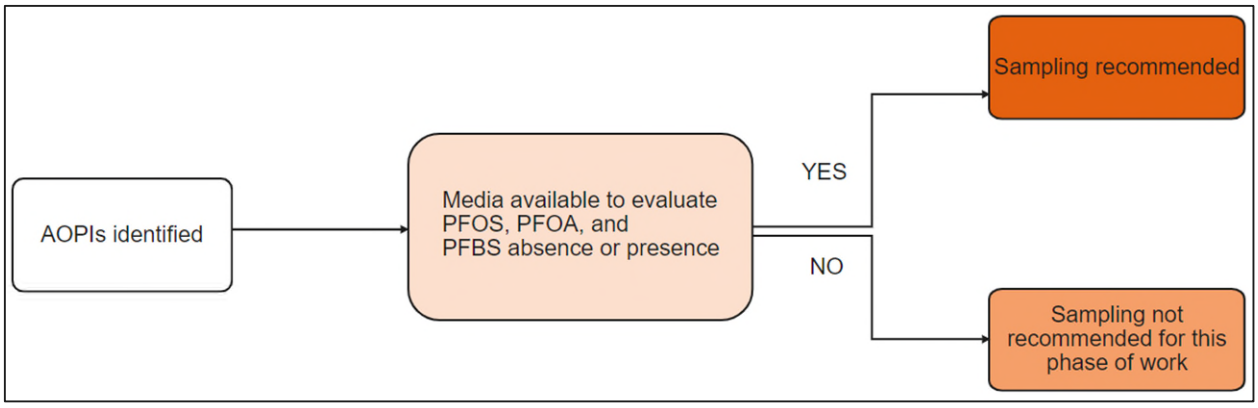

Figure 6-1. AOPI Sampling Decision Tree

The sampling design for SI Phase I sampling activities at MCAAP is detailed in Worksheet #17 of the QAPP Addendum (Arcadis 2020a).

Groundwater, soil, surface water, and/or sediment samples were collected at or downgradient of six AOPIs with known or suspected PFAS use/storage/disposal to identify PFOS, PFOA, and PFBS presence and concentrations. The targeted sampling areas are believed to have the potential for the greatest PFAS concentrations closest to known or suspected use of AFFF, and/or storage/disposal of potential PFAS-containing materials. Sampling was not conducted at one AOPI, the Missile Production Facility, because there was no media available to sample.

SI field activities were conducted in two phases. Phase I included soil, sediment, surface water, and groundwater sampling from 22 to 25 June 2020. During the Phase I investigation, elevated PFOS concentrations were detected in soil at the Former Navy Fire Department and in groundwater at the Firefighter Training Area. Soil and groundwater PFOS detections did not exceed OSD risk screening levels; the OSD tap water risk screening level prior to October 2019 for PFBS (40,000 ng/L) was higher than the groundwater detections at the Firefighter Training Area (1,700 ng/L). Although the 2019 OSD risk screening levels were not exceeded at these AOPIs, because the detection level was approaching the OSD risk screening level, the USAEC requested that additional sampling be conducted. Phase II included additional groundwater, soil, and surface water sampling from 01 to 02 December 2020.

Groundwater was collected from existing monitoring wells or from temporary wells set downgradient of or in the suspected release area of AOPIs. Shallow soil samples were collected to evaluate PFOS, PFOA, and PFBS presence or absence and concentrations at potential release areas and to evaluate the potential for those areas to be sources of PFAS to surface water and groundwater as an influence to drinking water. Total organic carbon (TOC), pH, and grain size data were collected for potential use in future fate and transport studies.

Samples were collected from the top 6 inches of sediment at the Current Fire Department, Firefighter Training Area, and Former Naval Special Weapons Facility Shop to evaluate PFAS presence or absence, type, and concentrations from where AFFF or PFAS-containing metal plating components may have been released.

Surface water samples were collected from downgradient locations at the Firefighter Training Area, Former Navy Fire Department, and AFFF Fire Response Site. Surface water samples were also collected

at upgradient and downgradient locations from the FTA to evaluate whether downgradient PFOS, PFOA, and PFBS concentrations were solely attributable to the Firefighter Training Area.

Sampling depths noted on figures for existing monitoring wells represent approximately the center of the saturated screened interval. **Table 6-1** includes the monitoring well construction details for the wells sampled during the SI (when available).

6.3 Sampling Methods and Procedures

Environmental data were collected and analyzed in accordance with the PQAPP (Arcadis 2019), including the SOPs and TGIs in Appendix A of the PQAPP and the QA/QC requirements identified in Worksheet #20 of the PQAPP; the approved scope and sampling methods outlined in the site-specific QAPP Addendum (Arcadis 2020a); and the safety procedures specified in the Accident Prevention Plan (Arcadis 2018) and SSHP (Arcadis 2020b). The sampling methods described in the SOPs and TGIs establish equipment requirements, procedures for preparing equipment and containers before sampling, sampling procedures under various conditions, and procedures for storing samples to prevent contamination during collection and transport. In general, sampling techniques used in the SI were consistent with conventional sampling techniques used in the environmental industry, although special considerations were made regarding PFAS-containing materials and equipment and cross-contamination potential.

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

6.3.1 Field Methods

Groundwater samples were collected using low-flow purging methods from approximately the center of the saturated screened interval at existing monitoring wells. At sampling locations where boreholes were advanced using direct-push technology (DPT), temporary wells were set. Groundwater recovery was not sufficient for low-purge methods at any of these locations. Thus, disposable bailers were employed, capturing groundwater from the bottom of each temporary well. Surface soil samples were collected from the top 2 feet of native soil and composited. They were collected using the DPT equipment when paired with a groundwater sample. Otherwise, they were collected using a shovel or hand auger. Sediment samples were collected from the upper 6 inches using a hand auger and decanted before bottling for laboratory analysis. Surface water samples were collected using a peristaltic pump just below the water column.

Decontamination procedures for non-dedicated equipment used during sampling are described in **Section 6.3.5**.

6.3.2 Quality Assurance/Quality Control

Worksheet #20 of the PQAPP (Arcadis 2019) and QAPP Addendum (Arcadis 2020a) provide QA/QC requirements for field duplicates, matrix spike/matrix spike duplicates (MS/MSDs), equipment blanks

(EBs), source blanks for water used in the initial decontamination step for drill tooling, and field blanks for laboratory-supplied water used in the final decontamination step.

QA/QC samples were collected at the frequencies specified in the QAPP Addendum (Arcadis 2020a), typically at a rate of 1 per 20 parent samples. Field duplicates and MS/MSD samples were collected for media sampled for PFOS, PFOA, PFBS, and TOC only. EBs were collected for media sampled for PFOS, PFOA, and PFBS at a frequency of one per piece of relevant equipment for each sampling event, as specified in the QAPP Addendum (Arcadis 2020a). The decontaminated reusable equipment from which EBs were collected include tubing, tubing weights, screen-point samplers, drill casing and cutting shoes, hand augers, water-level meters, acetate liners, bailers, and stainless-steel trowels as applicable to the sampled media. Source blanks were collected from the water used to pressure-wash drill tooling. Analytical results for blank samples are discussed in **Section 7.**

6.3.3 Dedicated Equipment Background

Dedicated equipment background (DEB) samples were collected at a frequency of one DEB per AOPI at AOPIs where groundwater sampling was conducted at existing monitoring wells that contained dedicated, down-hole equipment. Dedicated high-density polyethylene tubing was located in MW-194S at the Current Fire Department. Two water samples were collected from this well. One DEB sample was collected from the first water produced through the pump and tubing. The DEB was used to evaluate whether the dedicated equipment may be impacting the PFOS, PFOA, and/or PFBS results. It is unknown whether the dedicated equipment consisted of PFAS-containing components. PFOS, PFOA, and/or PFBS concentrations in the DEBs reflect concentrations of stagnant groundwater, and may be biased high by contributions from equipment that contains PFOS, PFOA, and/or PFBS components. The parent sample was collected after the well was purged until the field parameters stabilized. DEB samples are discussed further in **Section 7.7**.

6.3.4 Field Change Reports

No instances of major scope modifications or non-conformances (i.e., those that may have had a significant impact on the project scope and/or data usability/quality, or required stop-work, and warranted discussion with USACE) occurred during the SI field work at MCAAP. In some cases, clarifications to the established scope of work were needed but did not constitute a non-conformance from the sampling plans described in the MCAAP QAPP Addendum (Arcadis 2020a). The minor modifications and clarifications to the procedures and scope of work detailed in the QAPP Addendum and PQAPP (Arcadis 2019) that did not affect DQOs are documented in Field Change Reports (FCRs) included as **Appendix M** and are summarized below:

- FCR-MCAAP- 01: Since MCAAP-AFRS-2-GW was unable to accumulate a sufficient amount of groundwater for sampling, a surface water sample was collected approximately 50 feet away instead.
- FCR-MCAAP-02: Sediment samples were collected from the top 6 inches of overburden rather than the top 4 inches.
- FCR-MCAAP-03: EB samples were changed to reflect the equipment used during the field event.

- FCR-MCAAP-04: MS/MSD analytes were analyzed from sample MCAAP-FNFD-1-GW instead of prescribed MCAAP-AFRS-1-GW due to insufficient sample volume.
- FCR-MCAAP-05: EBs 1 through 4 and 6 through 10 were mistakenly dated in the chain-of-custody documentation as having been collected on 22 June 2020.
- FCR-MCAAP-06: In response to some PFOS, PFOA, and PFBS detections observed as part of the Phase I sampling event, the USAEC requested that additional sampling be conducted at the Firefighter Training Area and the AFFF Fire Response Site.
- FCR-MCAAP-07: There was an insufficient amount of groundwater in the planned Phase II Former Naval Fire Department groundwater boring; therefore, a surface water sample was collected approximately 50 feet to the northeast instead.

Following Operations Security (OPSEC) review in November 2021, building numbers were removed from the PA/SI report. AOPI names and sample IDs were updated accordingly.

6.3.5 Decontamination

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

6.3.6 Investigation-Derived Waste

Investigation-derived waste, including soil cuttings, excess sediment, groundwater, surface water, decontamination fluids, and disposable equipment, was drummed, characterized, and picked up from the site on 07 April 2021, and disposed of offsite at Chemical Waste Management Emelle Landfill (Emelle, Alabama) on 09 April 2021 under an approved permit. Equipment investigation-derived waste includes personal protective equipment and other disposable materials (e.g., gloves, plastic sheeting, Lexan tubes, and high density polyethylene and silicon tubing) that may come in contact with sampling media.

6.4 Data Analysis

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

6.4.1 Laboratory Analytical Methods

Analytical samples collected during the SI were submitted to Pace South Carolina (formerly Shealy Environmental Services, Inc.), an ELAP-accredited laboratory, for PFAS analysis, including PFOS, PFOA, and PFBS, by liquid chromatography with tandem mass spectrometry. Laboratory analyses associated with the SI were completed in accordance with Worksheets #12.1 through #12.5 of the PQAPP (Arcadis 2019). Eighteen PFAS-related compounds, including PFOS, PFOA, and PFBS, were analyzed for in

groundwater, soil, surface water, and sediment samples using an analytical method that is ELAP-accredited and compliant with QSM 5.3 (DoD and Department of Energy 2019), Table B-15.

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

- TOC by Solid Waste Test Method 846 9060A
- Grain size analysis by ASTM International D422-63
- pH by Solid Waste Test Method 846 9045D.

These data were collected for potential use in future fate and transport studies.

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

6.4.2 Data Validation

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

6.4.3 Data Usability Assessment and Summary

A data usability assessment was completed for all analytical data associated with SI sampling at MCAAP. Documentation generated during the data usability assessment, which was compiled into a DUSR (**Appendix N**), was prepared in accordance with the USACE Engineer Manual 200-1-10 (USACE 2005), the Final DoD General Data Validation Guidelines (DoD 2019), and the Final DoD Data Validation Guidelines Module 3: Data Validation Procedure for Per-and Polyfluoroalkyl Substances Analysis by QSM Table B-15 (DoD 2020). This documentation reviewed precision, accuracy, completeness, representativeness, comparability, and sensitivity. A statement of overall data usability is included in the DUSR.

Based on the final data usability assessment, the environmental data collected at MCAAP during the SI were found to be acceptable and usable for this SI evaluation with the qualifications documented in the DUSR and its associated data validation reports (**Appendix N**), and as indicated in the full analytical

tables (**Appendix O**) provided for the SI results. These data are of sufficient quality to meet the objectives and requirements of the PQAPP (Arcadis 2019) and QAPP Addendum (Arcadis 2020a). Data qualifiers applied to laboratory analytical results for samples collected during the SI at MCAAP are provided in the data tables, data validation reports, and the Data Usability Summary Table at the end of DUSR. Qualifiers for data shown on figures are defined in the notes of figures.

6.5 Office of the Secretary of Defense Risk Screening Levels

The OSD risk screening levels for PFOS, PFOA, and PFBS in groundwater (tap water) and soil were calculated using the USEPA's RSL calculator for residential and industrial/commercial worker receptor scenarios and current toxicity values. These risk screening levels are shown in **Table 6-2**.

Table 6-2. OSD Risk Screening Levels Calculated for PFOS, PFOA, and PFBS in Tap Water and Soil Using USEPA's Regional Screening Level Calculator

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

Notes:
[1] Risk screening levels for tap water and soil provided by the OSD, 2021 Memorandum: Investigating Per- and Polyfluoroalkyl Substances within the Department of Defense Cleanup Program. September 15 (**Appendix A**).
[2] All soil and/or sediment data are screened against both the Residential Scenario and Industrial/Commercial risk screening levels (if collected from less than 2 feet below ground surface), regardless of the current and projected land use of the AOPI.
mg/kg = milligram per kilogram
ng/L = nanograms per liter
ppm = parts per million
ppt = parts per trillion

The OSD residential tap water risk screening levels will be used to compare all groundwater and surface water data (as the surface water is used as a drinking water source nearby) for this PFAS PA/SI. While the current and most likely future land uses of the AOPIs at MCAAP are industrial/commercial, both residential and industrial/commercial soil risk screening levels for PFOS, PFOA, and PFBS will be used to evaluate detected concentrations in soil and sediment samples collected from dry streambeds at the Current Fire Department. The data from the SI sampling event are compared to the relevant OSD risk screening levels in **Section 7**. If concentrations of PFOS, PFOA, or PFBS are detected greater than the applicable OSD risk screening levels, further study in a remedial investigation is recommended in **Section 9**.

7 SUMMARY AND DISCUSSION OF SI RESULTS

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

Groundwater, soil, surface water, and sediment analytical results for PFOS, PFOA, and PFBS are summarized in **Tables 7-1** through **7-4**, respectively. A summary of the AOPIs and whether their SI results exceed the OSD risk screening levels is presented in **Table 7-5**. **Appendix O** includes the full suite of analytical results for these media, as well as for the QA/QC samples. An overview of AOPIs at MCAAP with OSD risk screening level exceedances is depicted on **Figure 7-1**. **Figures 7-2** through **7-7** show the PFOS, PFOA, and PFBS analytical results for groundwater, soil, surface water, and sediment for each AOPI. Non-detected results are reported as less than the LOQ. Detections of PFOS, PFOA, and/or PFBS greater than the applicable OSD risk screening levels are highlighted in summary tables and on figures. Final qualifiers applied to the data by the laboratory and the project chemist (as defined in **Section 6.4.3**) are presented in the analytical tables. Groundwater and surface water data collected during the SI are reported in ng/L, or parts per trillion; soil and sediment data are reported in mg/kg, or parts per million.

Field parameters measured for groundwater during low-flow purging and sample collection and for surface water during sample collection are provided on the field forms in **Appendix K**. Soil and sediment descriptions are also provided on the field forms in **Appendix K**. The results of the SI are grouped by AOPI and discussed for each medium as applicable.

Table 7-5. AOPIs and OSD Risk Screening Level Exceedances

AOPI Name	OSD Exceedances (Yes/No)
Firefighter Training Area	Yes
AFFF Fire Response Site	No
Former Navy Fire Department	Yes
Current Fire Department	Yes
Former Fire Department	No
Former Naval Special Weapons Facility Shop (MCAAP-023/HQAES 40520.1023)	No
Missile Production Facility*	NA

Note:
NA – Not applicable
*The AOPI was not sampled during this SI because there was no media to sample as described in **Section 6.2**.

7.1 Firefighter Training Area (FTA)

The subsections below summarize the groundwater, soil, surface water, and sediment analytical results for PFOS, PFOA, and PFBS associated with samples collected from the Firefighter Training Area in the Phase I and Phase II SI. This AOPI is located in the northeastern portion of the installation, northeast of Brown Lake and upgradient from several off-post domestic wells. Due to the quaternary alluvium present and the local topography, groundwater in this area is suspected to flow to the north and northeast. **Figure 7-2** shows analytical results for media sampled during the SI.

7.1.1 Groundwater

All three groundwater samples were collected using DPT at or downgradient of the potential source area where runoff from firefighter training would have accumulated. Groundwater generally occurred between 4.6 and 6.3 feet below ground surface (bgs).

During Phase I sampling, one groundwater sample was collected (MCAAP-FTA-1-GW; **Table 7-1**). PFOS was detected at 30 ng/L, PFOA was detected at 8.8 ng/L, and PFBS was detected at 1,700 ng/L. PFBS exceeded the current OSD residential tap water risk screening level (600 ng/L) but did not exceed the OSD risk screening level that existed at the time (40,000 ng/L). PFOS and PFOA did not exceed the OSD residential tap water risk screening level (40 ng/L).

During Phase II sampling, two groundwater samples were collected (MCAAP-FTA-2-GW and MCAAP-FTA-3-GW). PFOS was detected in MCAAP-FTA-2-GW (170,000 ng/L) and MCAAP-FTA-3-GW (460 J ng/L). The J indicates that the analyte is an estimated concentration. PFOA was detected in MCAAP-FTA-2-GW (3,300 J ng/L) and MCAAP-FTA-3-GW (130 J+ ng/L). The J+ indicates the result is an estimated quantity and may be biased high. PFBS was detected in MCAAP-FTA-2-GW (4,800 ng/L) and MCAAP-FTA-3-GW (270 ng/L). PFOS and PFOA detections exceeded the OSD residential tap water risk screening level (40 ng/L) in both samples. PFBS detections exceeded the OSD residential tap water risk screening level (600 ng/L) in one sample (MCAAP-FTA-2-GW).

7.1.2 Soil

During the Phase I and Phase II sampling events, three surface soil samples were collected from the top 2 feet of native soil in areas where runoff from firefighter training likely would have drained. The OSD residential and commercial/industrial risk screening levels were not exceeded for PFOS, PFOA, or PFBS in any sample.

During Phase I sampling, one soil sample was collected (MCAAP-FTA-1-SO). PFOS and PFOA concentrations were 0.027 mg/kg and 0.00057 J mg/kg, respectively. PFBS was not detected. **Table 7-2** presents the analytical results.

During Phase II sampling, two soil samples were collected (MCAAP-FTA-2-SO and MCAAP-FTA-3-SO). PFOS was detected in MCAAP-FTA-2-SO (0.072 J mg/kg) and MCAAP-FTA-3-SO (0.060 mg/kg). PFOA was detected in MCAAP-FTA-2-SO (0.00063 J mg/kg). PFBS was not detected in either sample.

As noted in **Section 2.12**, a soil sample from the Firefighter Training Area was analyzed in 2017 to determine PFOS/PFOA presence at the site and resulted in detections of 0.062 mg/kg and 0.0012 mg/kg, respectively. The 2017 soil sample location is approximate (**Figure 7-2**).

7.1.3 Surface Water and Sediment

Three surface water samples were collected from Bull Creek, east and southwest of the Firefighter Training Area, over both Phase I and Phase II sampling events (**Figure 7-2**). Samples were collected from both upgradient and downgradient locations from the AOPI. One of these samples (MCAAP-FTA-1-SW) was co-located with a sediment sample (MCAAP-FTA-1-SE). The third surface water sample (MCAAP-FTA-3-SW) was collected to inform whether PFOS, PFOA, or PFBS from upgradient locations was contributing to the surface water detections at or downgradient of the FTA. **Tables 7-3** and **7-4** present the analytical results for the surface water and sediment samples, respectively. The tap water OSD risk screening levels were not exceeded for PFOS, PFOA, or PFBS in any of the surface water samples.

During Phase I sampling, one surface water sample was collected (MCAAP-FTA-1-SW). PFOS, PFOA, and PFBS concentrations were 7.5 ng/L, 2.5 J ng/L, and 2.6 ng/L, respectively.

During Phase I sampling, one sediment sample was collected (MCAAP-FTA-1-SE). PFOS, PFOA, and PFBS were not detected.

During Phase II sampling, two surface water samples were collected (MCAAP-FTA-2-SW and MCAAP-FTA-3-SW). PFOS was detected in the MCAAP-FTA-2-SW (4.5 ng/L) and MCAAP-FTA-3-SW (2.5 J ng/L) parent and duplicate surface water samples. PFOA was not detected in either surface water sample. PFBS was detected in the MCAAP-FTA-2-SW field duplicate sample (1.8 J ng/L). It was not detected in the parent sample.

7.2 AFFF Fire Response Site (AFRS)

The subsections below summarize the groundwater, soil, and surface water PFOS, PFOA, and PFBS analytical results associated with the AFFF Fire Response Site. Samples were collected from this site only during the Phase I sampling event. This AOPI is located in the central portion of the installation, west of Rocket Lake. Due to the local topography, groundwater in this area is suspected to flow to the north and northeast. **Figure 7-3** shows analytical results for media collected during the SI.

7.2.1 Groundwater

DPT drilling was used to collect one groundwater sample (MCAAP-AFRS-1-GW) downgradient of the AOPI. Groundwater was encountered at approximately 6 feet bgs. PFOS, PFOA, and PFBS were not detected. **Table 7-1** presents the analytical results. An additional groundwater sample was attempted at MCAAP-AFRS-2-GW; however, an insufficient amount of groundwater was available for collection.

7.2.2 Soil

Two surface soil samples (MCAAP-AFRS-1-SO and MCAAP-AFRS-2-SO) were collected from the top 2 feet of native soil in areas where runoff from the AFFF release likely would have drained. PFOS, PFOA, and PFBS were not detected in either soil sample. **Table 7-2** presents the analytical results.

7.2.3 Surface Water

One surface water sample (MCAAP-AFRS-1-SW) was collected from a nearby stormwater drainage ditch after MCAAP-AFRS-2-GW (the original planned second groundwater sample) was unable to accumulate a sufficient amount of groundwater for sampling and a surface water sample was collected instead (see FCR in **Appendix M**). The surface water sample was collected from a location just south of the building (**Figure 7-3**). PFOS, PFOA, and PFBS detections were 3.4 ng/L, 2.5 J ng/L, and 2.0 J ng/L, respectively. **Table 7-3** presents the analytical results for surface water samples. The OSD residential tap water risk screening levels were not exceeded for PFOS, PFOA, or PFBS.

7.3 Former Navy Fire Department (FNFD)

The subsections below summarize the groundwater, soil, and surface water PFOS, PFOA, and PFBS analytical results associated with samples collected from the Former Navy Fire Department in the Phase I and Phase II SI. This AOPI is in the central portion of the installation, west of Rocket Lake and north of the AFFF Fire Response Site. Due to the local topography, groundwater in this area is suspected to flow to the north and northeast. **Figure 7-4** shows analytical results for media collected during the SI.

7.3.1 Groundwater

DPT drilling was used to collect one groundwater sample downgradient of the potential source area during the Phase I sampling event. Groundwater occurred at approximately 16 feet bgs. PFOS, PFOA, and PFBS were not detected. **Table 7-1** presents the analytical results. An additional groundwater sample was planned during Phase II in an area northeast of the AOPI boundary; however, an insufficient amount of groundwater was available for collection.

7.3.2 Soil

During the Phase I sampling event, three surface soil samples were collected from the top 2 feet of native soil in areas where runoff from nozzle testing likely would have drained. PFOS was detected in MCAAP-FNFD-1-SO (0.066 mg/kg), MCAAP-FNFD-2-SO (0.024 mg/kg), and MCAAP-FNFD-3-SO (0.026 mg/kg). PFOA was detected in MCAAP-FNFD-2-SO (0.015 mg/kg). PFBS was not detected in any of the three soil samples. The OSD residential and commercial/industrial risk screening levels were not exceeded for PFOS, PFOA, or PFBS in any of the three soil samples. **Table 7-2** presents the analytical results for soil.

7.3.3 Surface Water

Due to detectable concentrations of PFOS on the western portion of the AOPI, a second phase of SI sampling was conducted. One surface water sample was collected from a nearby stormwater drainage area after the original DPT boring did not recover groundwater (see FCR in **Appendix M**). This sample (MCAAP-FNFD-1-SW) was collected from a location just northeast of the building (**Figure 7-4**). PFOS, PFOA, and PFBS were detected at 69 ng/L, 5.6 ng/L, and 10 ng/L, respectively. PFOS exceeded the OSD risk screening level (40 ng/L). **Table 7-3** presents the analytical results for surface water samples.

7.4 Current Fire Department (CFD)

The subsections below summarize the groundwater, soil, and sediment PFOS, PFOA, and PFBS analytical results associated with the Current Fire Department. Samples were collected from this site only during the Phase I sampling event. Due to the local topography, groundwater in this area is suspected to flow to the southeast. **Figure 7-5** shows analytical results for media collected during the SI.

7.4.1 Groundwater

Groundwater samples were collected from two existing monitoring wells positioned downgradient and cross-gradient of the AOPI. Groundwater generally occurred at approximately 7.5 feet bgs and had a sample intake at 18 feet bgs (MCAAP-MW-192S and MCAAP-MW-194S).

PFOS, PFOA, and PFBS were detected in MCAAP-MW-192S (210 ng/L, 66 ng/L, and 300 ng/L, respectively). PFOS, PFOA, and PFBS were not detected in MCAAP-MW-194S. PFOS and PFOA exceeded the OSD residential tap water risk screening level (40 ng/L) in MCAAP-MW-192S. **Table 7-1** presents the analytical results.

7.4.2 Soil

One surface soil sample was collected from the top 2 feet of native soil in areas where runoff from nozzle testing likely would have drained (MCAAP-CFD-1-SO). PFOS and PFOA were detected in MCAAP-CFD-1-SO (0.0077 mg/kg and 0.00097 J mg/kg, respectively). The OSD residential and commercial/industrial risk screening levels were not exceeded for PFOS, PFOA, or PFBS. **Table 7-2** presents the analytical results.

As noted in **Section 2.12**, a soil sample from the Current Fire Department was analyzed in 2017 to determine PFOS/PFOA presence at the site and resulted in detections of 0.051 mg/kg and 0.0012 mg/kg, respectively. The 2017 soil sample location is approximate (**Figure 7-5**).

7.4.3 Sediment

One sediment sample was collected from a dry streambed downgradient of the inferred area of AFFF use or release (MCAAP-CFD-1-SE). The OSD residential and commercial/industrial risk screening levels were not exceeded for PFOS, PFOA, or PFBS. PFOS was detected at 0.0040 mg/kg. A qualifier of S indicates that there was an MS/MSD failure, as further discussed in **Appendix M**. PFOA and PFBS were not detected. **Table 7-4** presents the analytical results.

7.5 Former Fire Department (FFD)

The subsections below summarize the groundwater and soil PFOS, PFOA, and PFBS analytical results associated with the Former Fire Department. Samples were collected from this site only during the Phase I sampling event. This AOPI is located north of Brown Lake. Due to the local topography, groundwater in this area is suspected to flow to the south. **Figure 7-6** shows analytical results for media collected during the SI.

7.5.1 Groundwater

DPT drilling was used to collect one groundwater sample downgradient of the AOPI (MCAAP-FFD-1-GW). Groundwater occurred at approximately 5.13 feet bgs. PFOS, PFOA, and PFBS were detected at concentrations of 5.0 ng/L, 2.7 J ng/L, and 7.5 ng/L, respectively. The OSD residential risk screening levels were not exceeded for PFOS, PFOA, or PFBS. **Table 7-1** presents the analytical results.

7.5.2 Soil

Two surface soil samples were collected from the top 2 feet of native soil. Sample MCAAP-FFD-1-SO was collected from the inferred area of use and sample MCAAP-FFD-2-SO was collected from a ditch downgradient from where runoff from potential AFFF releases likely would have drained. The ditch is an intermittent stream and is not always saturated. At the time of the sampling event, the drainage ditch was dry and the sample was identified as soil rather than sediment. PFOS was detected in MCAAP-FFD-1-SO (0.0012 mg/kg) and MCAAP-FFD-2-SO (0.00089 J mg/kg). PFOA and PFBS were not detected in either sample. The OSD residential and commercial/industrial risk screening levels were not exceeded for PFOS, PFOA, or PFBS. **Table 7-2** presents the analytical results.

7.6 Former Naval Special Weapons Facility Shop (FNSWFS)

The subsections below summarize the sediment PFOS, PFOA, and PFBS analytical results associated with the Former Naval Special Weapons Facility Shop. Samples were collected from this site only during the Phase I sampling event. This AOPI is located to the southwest of Brown Lake. Due to the local topography, groundwater in this area is suspected to flow to the northeast. **Figure 7-7** shows analytical results for media collected during the SI.

7.6.1 Sediment

Two sediment samples were collected where fluid discharge from the Former Naval Special Weapons Facility Shop was released into the lagoons. Samples were collected from the top 6 inches of sediment. PFOS, PFOA, and PFBS were not detected in either sample. **Table 7-4** presents the analytical results.

7.7 Dedicated Equipment Background Samples

One DEB sample was collected. The parent sample and DEB pair (MCAAP-MW-194S-0625020 and MCAAP-CFD-DEB-1-062520) did not have detections for PFOS, PFOA, or PFBS constituents (**Table 7-1**). The results of the DEB sample pair collected at MCAAP suggest that sampling using the dedicated downhole sampling equipment did not bias the PFOS, PFOA, and/or PFBS results.

7.8 TOC, pH, and Grain Size

In addition to sampling soil for PFOS, PFOA, and PFBS, one soil sample per AOPI was analyzed for TOC, pH, moisture content, and grain size data for potential use in future fate and transport studies. TOC concentrations in the soil samples ranged from 5,590 to 15,800 J- mg/kg, which are within the range of what is typically observed in topsoil: 5,000 to 30,000 mg/kg. The combined percentage of fines (i.e., silt and clay) in soils at MCAAP ranged from 33 to 68.2% with an average of 52.6%. In general, PFAS

constituents tend to be more mobile in soils with less than 20% fines (silt and clay) and lower TOC. The pH of the soil was slightly alkaline (7 to 9 standard units). Based on these geochemical and physical soil characteristics (i.e., high percentage of fines and TOC) observed underlying the installation during the SI, PFAS constituents are expected to be relatively less mobile at MCAAP than in soils with lower percentages of fines and TOC.

7.9 Blank Samples

Most concentrations of PFOS, PFOA, and PFBS constituents detected in blank samples were low-level. Other than those noted below, concentrations of PFOS, PFOA, PFBS were not detected in other blank samples.

PFOS was detected at 7.5 ng/L in the sample barrel equipment blank collected on 24 June 2020 at the Former Navy Fire Department after the groundwater sample was collected (MCAAP-EB-7-062420).

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

7.10 Conceptual Site Models

The preliminary CSMs presented in the QAPP Addendum (Arcadis 2020a) were re-evaluated and updated, if necessary, based on the SI sampling results. The CSMs presented on **Figure 7-8** through **Figure 7-12** and discussed in this section therefore represent the current understanding of the potential for human exposure. For some AOPIs, the CSM is the same and thus shown on the same figure.

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

Based on the use, storage, and/or disposal of PFAS-containing materials at the AOPIs, affected media are likely to consist of soil, groundwater, surface water, and sediment.

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

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

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

- There are no residences in the vicinity of the AOPIs, and the AOPIs are not likely to be regularly accessed by on-installation residents and recreational users, or by off-installation receptors. Therefore, the soil exposure pathways for these receptors are incomplete.
- Recreational users are not likely to contact groundwater during outdoor recreational activities; therefore, the groundwater exposure pathway for on-installation recreational users is incomplete.

Additional exposure pathway descriptions for each CSM are provided below by figure.

Figure 7-8 shows the CSM for the Firefighter Training Area. This AOPI has a potential for PFOS, PFOA, and/or PFBS presence due to AFFF releases during firefighter training activities.

- PFOS and PFOA were detected in soil at the Firefighter Training Area and site workers could contact constituents in soil via incidental ingestion, dermal contact, and inhalation of dust. Therefore, the soil exposure pathway for on-installation site workers is complete.
- PFOS, PFOA, and PFBS were detected in groundwater at this AOPI. There are currently no on-post drinking water wells. However, the groundwater exposure pathways (via drinking water ingestion and dermal contact) for on-installation site workers and residents are potentially complete to account for potential future use of the on-post downgradient groundwater.
- Groundwater originating at this AOPI is suspected to flow off-post through the installation’s northeastern boundary. Due to the absence of land use controls preventing potable use of groundwater in this area, the groundwater exposure pathway (via drinking water ingestion and dermal contact) for off-installation receptors is potentially complete.
- PFOS, PFOA, and PFBS were detected in surface water samples collected from Bull Creek, east of the Firefighter Training Area. PFOS, PFOA, and PFBS were not detected in the single sediment sample collected, but given the presence in surface water, there is a potential for PFOS, PFOA, and/or PFBS to be present in sediment in other nearby locations. Bull Creek is noted as a primary recreational resource by MCAAP in its Integrated Natural Resources Management Plan and Environmental Assessment (MCAAP 2011). Recreational users could contact constituents in Bull Creek through incidental ingestion and dermal contact; therefore, the surface water and sediment exposure pathways for on-installation recreational users are potentially complete.
- Bull Creek downgradient of this AOPI is not used for drinking water. On-installation site workers and residents are not likely to otherwise contact surface water or sediment in on-post surface water bodies; therefore, these exposure pathways are incomplete.

- Bull Creek flows off-post through the installation's northeastern boundary. Recreational users off-post could contact constituents in Bull Creek through incidental ingestion and dermal contact; therefore, the surface water and sediment exposure pathways for off-installation recreational users are potentially complete.

Figure 7-9 shows the CSM for the AFFF Fire Response Site. This AOPI has a potential for PFOS, PFOA, and/or PFBS presence due to the release of AFFF during a response to a fire that occurred in 2005. Residuals would have drained to a sump or possibly flushed from the building. The area is predominantly paved.

- PFOS, PFOA, and PFBS were not detected in soil or groundwater at this AOPI. Therefore, the soil and groundwater exposure pathways for all receptors are incomplete.
- PFOS, PFOA, and PFBS were detected in surface water from a nearby stormwater drainage ditch at this AOPI. Surface water can flow from unnamed intermittent tributaries and drainage ditches toward Rocket Lake, which feeds Brown Lake, the primary drinking water source for the installation. Therefore, the surface water exposure pathways (via drinking water ingestion and dermal contact) for on-installation site workers and residents are potentially complete.
- On-installation site workers may contact sediment in nearby drainage ditches. Therefore, the sediment exposure pathways for site workers are potentially complete. However, residents are not likely to contact sediment in on-post surface water bodies; therefore, the sediment exposure pathways for residents are incomplete.
- Recreational users could contact constituents in Brown Lake through incidental ingestion and dermal contact; therefore, the surface water and sediment exposure pathways for on-installation recreational users are potentially complete.
- Brown Lake also provides drinking water for the surrounding communities of Savanna and Haywood. Therefore, the surface water exposure pathway (via drinking water ingestion and dermal contact) for off-installation drinking water receptors is potentially complete.
- Surface water at this AOPI flows more than 5 miles before reaching the installation boundary. Therefore, it is unlikely that recreational users off-post could contact constituents in Bull Creek and downstream water bodies through incidental ingestion and dermal contact. Therefore, the sediment exposure pathway for off-installation receptors is incomplete.

Figure 7-10 shows the CSM for the Former Navy Fire Department. This AOPI has a potential for PFOS, PFOA, and/or PFBS presence due to fire station activities.

- PFOS and PFOA were detected in soil at the Former Navy Fire Department and site workers could contact constituents in soil via incidental ingestion, dermal contact, and inhalation of dust. Therefore, the soil exposure pathway for on-installation site workers is complete.
- PFOS, PFOA, and PFBS were detected in surface water from a nearby stormwater drainage ditch at this AOPI. Surface water can flow from unnamed intermittent tributaries and drainage ditches toward Rocket Lake, which feeds Brown Lake, the primary drinking water source for the installation. Therefore, the surface water exposure pathways (via drinking water ingestion and dermal contact) for on-installation site workers and residents are potentially complete.
- On-installation site workers and residents are not likely to contact sediment in on-post surface water bodies; therefore, the sediment exposure pathways for these receptors are incomplete.

- Recreational users could contact constituents in Brown Lake through incidental ingestion and dermal contact; therefore, the surface water and sediment exposure pathways for on-installation recreational users are potentially complete.
- Brown Lake also provides drinking water for the surrounding communities of Savanna and Haywood. Therefore, the surface water exposure pathway (via drinking water ingestion and dermal contact) for off-installation drinking water receptors is potentially complete.
- Surface water from this AOPI flows more than 5 miles before reaching the installation boundary. Therefore, it is unlikely that recreational users off-post could contact constituents in Bull Creek and downstream water bodies through incidental ingestion and dermal contact. Therefore, the sediment exposure pathway for off-installation receptors is incomplete.
- PFOS, PFOA, and PFBS were not detected in groundwater at this AOPI. Additionally, there are currently no on-post drinking water wells. However, because PFOS, PFOA, and/or PFBS were detected in surface water and soil, and to account for potential future use of the downgradient on-post groundwater, the groundwater exposure pathways (via drinking water ingestion and dermal contact) for on-installation site workers and residents are potentially complete.
- Groundwater from this AOPI is suspected to potentially flow more than 5 miles before reaching the installation boundary. Therefore, it is unlikely that off-post users could contact groundwater via drinking water ingestion and dermal contact, and the groundwater exposure pathway for off-installation receptors is incomplete.

Figure 7-11 shows the CSM for the Current Fire Department and Former Fire Department. These AOPIs have a potential for PFOS, PFOA, and/or PFBS presence due to release of AFFF during fire station activities.

- PFOS and/or PFOA were detected in soil at these AOPIs, and site workers could contact constituents in soil via incidental ingestion, dermal contact, and inhalation of dust. Therefore, the soil exposure pathway for on-installation site workers is complete.
- PFOS, PFOA, and PFBS were detected in groundwater at these AOPIs. There are currently no on-post drinking water wells. However, the groundwater exposure pathways (via drinking water ingestion and dermal contact) for on-installation site workers and residents are potentially complete to account for potential future use of the downgradient on-post groundwater.
- Groundwater originating at this AOPI is suspected to flow off-post through the installation's northeastern boundary. Due to the absence of land use controls preventing potable use of groundwater in this area, the groundwater exposure pathway (via drinking water ingestion and dermal contact) for off-installation receptors is potentially complete.
- PFOS was detected in sediment collected near Brown Lake, downgradient of the inferred area of AFFF use or release at the Current Fire Department and from dry sediment (soil) downgradient of the inferred area of AFFF use or release at the Former Fire Department. Surface water samples were not collected; however, the potential for PFOS, PFOA, and/or PFBS presence in surface water is inferred from the sediment sample results. Brown Lake is the primary drinking water source for the installation. Therefore, the surface water exposure pathways (via drinking water ingestion and dermal contact) for on-installation site workers and residents are potentially complete.
- On-installation site workers and residents are not likely to contact sediment in on-post surface water bodies; therefore, the sediment exposure pathways for these receptors are incomplete.

- Recreational users could contact constituents in Brown Lake through incidental ingestion and dermal contact; therefore, the surface water and sediment exposure pathways for on-installation recreational users are potentially complete.
- Brown Lake also provides drinking water for the surrounding communities of Savanna and Haywood. Therefore, the surface water exposure pathway (via drinking water ingestion and dermal contact) for off-installation drinking water receptors is potentially complete.
- Surface water bodies flow off-post to the northeast through Bull Creek. Recreational users off-post could contact constituents in Bull Creek through incidental ingestion and dermal contact; therefore, the surface water and sediment exposure pathways for off-installation recreational users are potentially complete.

Figure 7-12 shows the CSM for the Former Naval Special Weapons Facility Shop. Electroplating and possible metal plating discharge (containing PFOS, PFOA, and/or PFBS) from the building was routed to discharge in the unlined lagoons sitting to the northeast of the building. This AOPI has the potential for PFOS, PFOA, and/or PFBS presence due to those disposal activities.

- PFOS, PFOA, and PFBS were not detected in the former lagoon sediment at this AOPI. Therefore, the former lagoon sediment exposure pathways for all receptors are incomplete.
- Based on the SI sampling results and unconfirmed use of PFOS, PFOA, and/or PFBS in historical plating activities at this AOPI, the presence of PFOS, PFOA, and/or PFBS in other environmental media (groundwater, surface water, and sediment) is not expected. Therefore, the groundwater, surface water, and sediment exposure pathways for all receptors are incomplete.

Following the SI sampling, five of the six sampled AOPIs were considered to have complete or potentially complete exposure pathways. Although the CSMs indicate complete or potentially complete exposure pathways may exist, the recommendation for remedial investigation is based on the comparison of analytical results for PFOS, PFOA, and PFBS to the OSD risk screening levels (**Table 6-2**).

8 OFF-POST PRIVATE POTABLE WELL INVESTIGATION

PFOS and PFOA concentrations were detected at concentrations greater than the USEPA lifetime health advisory in groundwater downgradient of the Firefighter Training Area. Because of this, off-post private potable wells may be identified for potential future sampling. An off-post well survey has been completed for an area specified by the Army using readily available information from the online Oklahoma Water Resources Database. Relevant parcels will be reviewed to compile a list of property owners. Finally, available groundwater modeling reports (i.e., U.S. Geological Survey reports) will be reviewed for the area. Thereafter, select off-post private potable wells may be recommended for future sampling based on the understanding of the relationship between on- and off-post hydrogeological conditions. If such wells are identified for future sampling, community outreach and notification will be coordinated among Arcadis, MCAAP, Headquarters of the Department of the Army, and USAEC Divisions. If off-post private potable well sampling occurs, the results of the event will be discussed in a subsequent addendum.

9 CONCLUSIONS AND RECOMMENDATIONS

The PFAS PA/SI included two distinct efforts. The PA identified AOPIs at MCAAP based on the use, storage, and/or disposal of PFAS-containing materials, in accordance with the 2018 Army Guidance for Addressing Releases of Per-and Polyfluoroalkyl Substances (Army 2018). The SI included multi-media sampling at AOPIs to determine whether a release of PFOS, PFOA, and PFBS to the environment occurred.

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

Brown Lake provides potable surface water for the installation and nearby municipalities (PWS identifier OK1020605). A public water supply intake is located on the eastern boundary of Brown Lake. In response to UCMR3, pre- and post-treatment samples were collected from this drinking water system in 2016 (**Table 2-2**). Analyses for these samples followed USEPA Method 537. PFOS and PFOA were not detected greater than the minimum reportable level (40 ng/L and 20 ng/L, respectively: Tetrahedron, Inc. 2018). Brown Lake was not sampled during this SI.

Six of the seven AOPIs were sampled during the SI at MCAAP to identify the presence or absence of PFOS, PFOA, and PFBS at each AOPI sampled. Sampling was not conducted at one AOPI, the Missile Production Facility, because there was no media available to sample. The SI scope of work was completed in accordance with the Final PQAPP (Arcadis 2019) and the MCAAP QAPP Addendum (Arcadis 2020a).

Five of the six sampled AOPIs had detections of PFOS, PFOA, and/or PFBS in soil, groundwater, sediment, and/or surface water. Of these five AOPIs, three had exceedances of OSD risk screening levels. The three AOPIs (Firefighter Training Area, Current Fire Department, and Former Navy Fire Department) had exceedances of the residential tap water risk screening levels for PFOS and/or PFOA (40 ng/L) in groundwater or surface water.

The maximum concentrations of PFOS, PFOA, and PFBS in groundwater were observed at the Firefighter Training Area (170,000 ng/L, 3,300 ng/L, and 4,800 ng/L, respectively). Each exceeded their respective OSD tap water risk screening level (40 ng/L, 40 ng/L, and 600 ng/L). The Current Fire Department was also found to have groundwater detections of PFOS (210 ng/L) and PFOA (66 ng/L) above the OSD residential tap water risk screening levels (40 ng/L). PFBS was detected at a concentration of 300 ng/L at this AOPI, which is less than the OSD residential tap water risk screening level of 600 ng/L.

Maximum concentrations of PFOS, PFOA, and PFBS in surface water were detected at the Former Navy Fire Department. PFOS (69 ng/L) was detected above the OSD residential tap water risk screening level (40 ng/L). PFOA (5.6 ng/L) and PFBS (10 ng/L) concentrations were less than the OSD residential tap water risk screening levels (40 ng/L and 600 ng/L, respectively).

PFOS, PFOA, and PFBS were not detected in soil samples at concentrations above the OSD residential or commercial/industrial risk screening levels. Maximum PFOS (0.072 mg/kg) and PFOA (0.0015 mg/kg) detections occurred at the Firefighter Training Area and the Former Navy Fire Department, respectively. There were no detections of PFBS in any soil sample.

Maximum PFOS concentrations in sediment were detected at the Current Fire Department in MCAAP-CFD-1-SE (0.0047 mg/kg in the field duplicate and 0.0040 mg/kg in the parent sample). These detections did not exceed OSD residential or commercial/industrial risk screening levels. PFOA and PFBS were not detected in MCAAP-CFD-1-SE. PFOS, PFOA, and PFBS were not detected in the three sediment samples collected from the Former Naval Special Weapons Facility Shop or Firefighter Training Area.

The preliminary CSMs prepared for the PA were re-evaluated and updated, if necessary, as part of the SI. Following the SI sampling, five of the six sampled AOPIs were considered to have complete or potentially complete exposure pathways. Soil exposure pathways for on-installation site workers are complete at four AOPIs. Although there are currently no drinking water wells on-post, the groundwater exposure pathways for on-installation site workers and residents are potentially complete at four AOPIs to account for potential future potable use of the on-post groundwater. Groundwater exposure pathways for off-installation drinking water receptors are potentially complete at three AOPIs. The surface water (drinking water) exposure pathways for on-installation and off-installation receptors are potentially complete at four AOPIs located upgradient of the existing surface water intake on Brown Lake. Surface water and sediment exposure pathways for on-installation recreational users are potentially complete at five AOPIs. Surface water and sediment exposure pathways for off-installation recreational users are potentially complete for three AOPIs located closer to the installation's northeastern boundary.

Although the CSMs indicate complete or potentially complete exposure pathways may exist, the recommendation for future study in a remedial investigation or no action at this time is based on the comparison of analytical results for PFOS, PFOA, and PFBS to the OSD risk screening levels (**Table 6-2**). **Table 9-1** below summarizes the AOPIs identified at MCAAP and PFOS, PFOA, and PFBS sampling results and recommendations for each AOPI. Further investigation is warranted at MCAAP. In accordance with CERCLA, site-specific risk will be assessed during a future phase to evaluate whether remedial actions are required.

Table 9-1. Summary of AOPIs Identified During the PA, PFOS, PFOA, and PFBS Sampling at MCAAP, and Recommendations

AOPI Name	PFOS, PFOA, and/or PFBS Detected Greater than OSD Risk Screening Levels? (Yes/No/ND/NS)				Recommendation
	Groundwater	Soil	Surface Water	Sediment	
Firefighter Training Area	Yes	No	No	ND	Further study in a remedial investigation
AFFF Fire Response Site	ND	ND	No	NS	No action at this time
Former Navy Fire Department	ND	No	Yes	NS	Further study in a remedial investigation
Current Fire Department	Yes	No	NS	No	Further study in a remedial investigation
Former Fire Department	No	No	NS	NS	No action at this time
Former Naval Special Weapons Facility Shop (MCAAP-023/HQAES 40520.1023)	NS	NS	NS	ND	No action at this time
Missile Production Facility*	NS	NS	NS	NS	No action at this time

Notes:
* The AOPI was not sampled during this SI but may be sampled during future investigations.
Light gray shading – detection greater than the OSD risk screening level
ND – non-detect
NS – not sampled

Data collected during the PA (**Section 3** through **Section 5**) and SI (**Section 6** through **Section 8**) were sufficient to draw the conclusions and recommendations summarized above. The data limitations relevant to the development of this PA/SI for PFOS, PFOA, and PFBS at MCAAP are discussed below.

Records gathered for the use, storage, and/or disposal of PFAS-containing materials were reviewed during the PA process. Documentation specific to AFFF may have been limited (e.g., each AFFF use, procurement records, documentation of AFFF used during crash responses or firefighter training activities) due to lack of recordkeeping requirements for the full timeline of common AFFF practices. Anecdotal accounts of AFFF use (and therefore likely PFOS, PFOA, and PFBS use) were limited to available installation personnel, whose knowledge of AFFF use may have been restricted by their time spent at the installation or previous roles held that limited their relevant knowledge of potential AFFF (or other PFAS-containing material) use. For example, the fire response document provided by the fire department did indicate foam use in response to fires but did not specify whether foam was Class A (typically formulated without PFAS) or Class B (typically formulated with PFAS).

Although metal plating was known to occur, a comprehensive list of the materials and equipment used for this plating operation was not present in the available records during the document research, and interviewees did not have specific information to describe the materials used. As a result, confirming whether PFAS-containing materials were used in the metal plating activities onsite was not possible.

A comprehensive well survey was not completed as part of the PA; therefore, the information reviewed regarding off-post wells is limited to what is contained in the off-post well search results (**Appendix E**).

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

A public water supply intake is located on the eastern boundary of Brown Lake and is within a mile downgradient of the Former Fire Department and Current Fire Department AOPIs. As stated, the extent of PFOS, PFOA, and PFBS impacts was not delineated as part of this PA/SI. Thus, Brown Lake was not sampled during the SI. In 2016, the public water system (PWS identifier OK1020605) was sampled for PFOA and PFOS. Data from this sampling event is included in **Table 2-2**. PFOS and PFOA were not detected at concentrations greater than the minimum reportable level (40 ng/L and 20 ng/L, respectively: Tetrahedron, Inc. 2018). It is not known whether further sampling of the water system for PFAS has been conducted. Available data, including PFOS, PFOA, and PFBS results, which were analyzed per the selected analytical method, are provided in **Appendix O**.

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

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ACRONYMS AND ABBREVIATIONS

%	percent
AFFF	aqueous film-forming foam
AFRS	AFFF Fire Response Site
AOPI	area of potential interest
Arcadis	Arcadis U.S., Inc.
Army	United States Army
ATC	alcohol-type foam concentrate
bgs	below ground surface
CERCLA	Comprehensive Environmental Response, Compensation, and Liability Act of 1980
CFD	Current Fire Department
CSM	conceptual site model
DEB	dedicated equipment background
DoD	Department of Defense
DPT	direct-push technology
DQO	data quality objective
DUSR	Data Usability Summary Report
EA	EA Engineering, Science and Technology, Inc., PBC
EB	equipment blank
EDR	Environmental Data Resources, Inc.
ELAP	Environmental Laboratory Accreditation Program
FCR	Field Change Report
FFD	Former Fire Department
FNFD	Former Navy Fire Department
FTA	Firefighter Training Area
GIS	geographic information system
GW	groundwater
HQAES	Headquarters Army Environmental System
IMCOM	Installation Management Command
installation	United States Army or Reserve installation

IRP	Installation Restoration Program
LOD	limit of detection
LOQ	limit of quantitation
MCAAP	McAlester Army Ammunition Plant
mg/kg	milligrams per kilogram (parts per million)
MS/MSD	matrix spike/matrix spike duplicate
N	no
NA	not available
ng/L	nanograms per liter (parts per trillion)
NS	not sampled
OSD	Office of the Secretary of Defense
PA	preliminary assessment
PFAS	per- and polyfluoroalkyl substances
PFBS	perfluorobutanesulfonic acid
PFOA	perfluorooctanoic acid
PFOS	perfluorooctane sulfonate
POC	point of contact
ppm	parts per million
ppt	parts per trillion
PQAPP	Programmatic Uniform Federal Policy-Quality Assurance Project Plan
PWS	public water system
QA	quality assurance
QAPP	Quality Assurance Project Plan
QC	quality control
QSM	Quality Systems Manual
RSL	Regional Screening Level
SE	sediment
SI	site inspection
SO	soil
SOP	standard operating procedure
SSHP	Site Safety and Health Plan

SW	surface water
SWMU	solid waste management unit
TGI	technical guidance instruction
TNT	trinitrotoluene
TOC	total organic carbon
U.S.	United States
UCMR3	Third Unregulated Contaminant Monitoring Rule
USACE	United States Army Corps of Engineers
USAEC	United States Army Environmental Command
USEPA	United States Environmental Protection Agency
WWTP	wastewater treatment plant
Y	yes

TABLES

Table 2-1
On-Post Potable Well Construction Details
USAEC PFAS Preliminary Assessment/Site Inspection
McAlester Army Ammunition Plant, Oklahoma

Well ID	Well Type	Total Well Depth (ft bgs)	Well Casing Diameter (inches)	Top of Screen Depth (ft bgs)	Completion Date	Estimated Well Yield (gpm)	Geologic Material/Unit	Well Status	First Water Zone (ft bgs)
50542	Domestic	35	10	--	9/8/1999	--	--	Used	19

Notes:
Records found in the Oklahoma Water Resources Board database
-- = no record

Abbreviations:
bgs = below ground surface
ft = feet
gpm = gallons per minute

Table 2-2
Historical PFOS, PFOA, and PFBS Analytical Results
USAEC PFAS Preliminary Assessment/Site Inspection
McAlester Army Ammunition Plant, Oklahoma

		Location	Well 01 before GAC (OK1020605)		Well 01 after GAC (OK1020605)		Firefighter Training Area (MCAAP-FTA)	Current Fire Department (MCAAP-CFD)
		Sample ID	MCAAP-SW-BLDG67-PG	MCAAP-SW-BLDG67-PG	MCAAP-SW-BLDG40-FW	MCAAP-SW-BLDG40-FW	MCAAP-SO-B34	MCAAP-SO-B408
		Sample Date	11/1/2016	11/1/2016	11/1/2016	11/1/2016	4/25/2017	4/25/2017
Chemical name	OSD risk screening level* (ng/L)	OSD risk screening level** (mg/kg)	ng/L	ng/L	ng/L	ng/L	mg/kg	mg/kg
Perfluorooctanoic acid (PFOA)	40	0.13	ND	ND	ND	ND	ND	0.0012 J
Perfluorobutanesulfonic acid (PFBS)	600	1.9	NA	NA	NA	NA	NA	NA
Perfluorooctane sulfonate (PFOS)	40	0.13	ND	ND	ND	ND	0.051	0.062

Table 2-2
Historical PFOS, PFOA, and PFBS Analytical Results
USAEC PFAS Preliminary Assessment/Site Inspection
McAlester Army Ammunition Plant, Oklahoma

		Location	McAlester PWS (OK1020609)				Adamson Rural Water District #8 (OK3006112)			
		Sample ID	4K04049-01	5B04020-01	5E05052-01	4H13126-01	112208Q	113258Q	114808P	116073P
		Sample Date	11/4/2014	2/4/2015	5/5/2015	8/13/2014	2/3/2015	5/5/2015	8/3/2015	11/2/2015
Chemical name	OSD risk screening level* (ng/L)	OSD risk screening level** (mg/kg)	ng/L	ng/L	ng/L	ng/L	ng/L	ng/L	ng/L	ng/L
Perfluorooctanoic acid (PFOA)	40	0.13	ND	ND	ND	ND	ND	ND	ND	ND
Perfluorobutanesulfonic acid (PFBS)	600	1.9	ND	ND	ND	ND	ND	ND	ND	ND
Perfluorooctane sulfonate (PFOS)	40	0.13	ND	ND	ND	ND	ND	ND	ND	ND

Table 2-2
Historical PFOS, PFOA, and PFBS Analytical Results
USAEC PFAS Preliminary Assessment/Site Inspection
McAlester Army Ammunition Plant, Oklahoma

Notes:
Shading = units are provided in nanograms per liter
* risk screening level for tap water. To be conservative, the OSD tap water risk screening levels will be used to compare all groundwater and potable-use surface water for this Army PFAS PA/SI program.

** risk screening level for soil. To be conservative, the OSD residential risk screening level for soil will be used to compare soil and sediment for this Army PFAS PA/SI program.

Acronyms and Abbreviations:
GAC = granular activated carbon
mg/kg = milligrams per kilogram
ng/L = nanograms per liter
NA = not available
ND = not detected
OSD = Office of the Secretary of Defense
PWS = public water system

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

Table 6-1
Monitoring Well Construction Details
USAEC PFAS Preliminary Assessment/Site Inspection
McAlester Army Ammunition Plant, Oklahoma

Area of Potential Interest	Sampling Location ID[1]	Total Well Depth (ft/bgs)	Measuring Point Elevation (ft ags)	Measuring Point	2020 Depth to Groundwater from MP (ft)	2020 Groundwater Elevation (ft amsl)	Screened Interval (ft bgs)	Casing Diameter (inches)	Dedicated Bladder Pump (Y/N)
Current Fire Department	MCAAP-MW-192S-062520	19.16	NM	TOC	7.0	NC	NM	2	Y
	MCAAP-MW-194S-062520	21.74	NM	TOC	8.5	NC	NM	2	Y
Firefighter Training Area	MCAAP-FTA-1-GW	16.05	0.75	TOC	6.3	NC	10-15	2	N
	MCAAP-FTA-2-GW-120220	10.26	2.24	TOC	4.6	NC	NM	2	N
	MCAAP-FTA-3-GW-120120	7.67	2.13	TOC	5.2	NC	5-10	2	N
AFFF Fire Response Site	MCAAP-AFRS-1-GW	29.29	2.17	TOC	6.0	NC	20-30	2	N
Former Navy Fire Department	MCAAP-FNFD-1-GW	25.13	0	TOC	15.9	NC	15-25	2	N
Former Fire Department	MCAAP-FFD-1-GW	15.11	0.66	TOC	5.1	NC	5-15	2	N

Notes:
1. Permanent wells were not installed at the DPT sampling locations. The total depth listed indicates the total depth of the temporary borehole; the screened interval listed for DPT sampling points indicates the interval at which the drill casing was retracted for collection of a grab groundwater sample through a decontaminated screen-point sampler.

Acronyms and Abbreviations:
AFFF = aqueous film-forming foam
ags = above ground surface
amsl = above mean sea level
bgs = below ground surface
DPT = direct push technology
ft = feet
ID = identification
MP = measuring point
TOC = top of casing
Y/N = Yes/No

Qualifiers:
NC - not calculated
NM = not measured (not surveyed)

Table 7-1
Groundwater PFOS, PFOA, and PFBS Analytical Results
USAEC PFAS Preliminary Assessment/Site Inspection
McAlester Army Ammunition Plant, Oklahoma

AOPI	Location	Sample/ Parent ID	Sample Date	Analyte	PFOS (ng/L)		PFOA (ng/L)		PFBS (ng/L)	
				OSD Tapwater Risk Screening Level	40		40		600	
				Sample Type	Result	Qual	Result	Qual	Result	Qual
AFFF Fire Response Site	MCAAP-AFRS-1	MCAAP-AFRS-1-GW	06/25/2020	N	3.5	U	3.5	U	3.5	U
Former Navy Fire Department	MCAAP-FNFD-1	MCAAP-FD-1-GW-06242	06/24/2020	FD	3.4	U	3.4	U	3.4	U
		MCAAP-FNFD-1-GW	06/24/2020	N	3.7	U	3.7	U	3.7	U
Firefighter Training Area	MCAAP-FTA-1	MCAAP-FTA-1-GW	06/24/2020	N	**30**		**8.8**		**1700**	
	MCAAP-FTA-2	MCAAP-FTA-2-GW-120220	12/02/2020	N	**170000**	J	**3300**	J	**4800**	J
	MCAAP-FTA-3	MCAAP-FTA-3-GW-120120	12/01/2020	N	**460**	J	**130**	J+	**270**	
		MCAAP-FD-2-GW120120	12/01/2020	FD	**330**	J	**130**		**270**	
Current Fire Department	MCAAP-MW-192S	MCAAP-MW-192S-062520	06/25/2020	N	**210**		**66**		**300**	
	MCAAP-MW-194S	MCAAP-CFD-DEB-1-062520	06/25/2020	DEB	1.7	U	1.7	U	1.7	U
		MCAAP-MW-194S-062520	06/25/2020	N	3.5	U	3.5	U	3.5	U
Former Fire Department	MCAAP-FFD-1	MCAAP-FFD-1-GW	06/24/2020	N	**5.0**		**2.7**	J	**7.5**	

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

Acronyms/Abbreviations:
AFFF = aqueous film-forming foam
AOPI = Area of Potential Interest
DEB = dedicated equipment blank
FD = field duplicate sample
ID = identification
N = primary sample
ng/L = nanograms per liter (parts per trillion)
OSD = Office of the Secretary of Defense
PFBS = perfluorobutane sulfonic acid
PFOA = perfluorooctanoic acid
PFOS = perfluorooctane sulfonic acid

Qualifiers (Qual):
J = The analyte was positively identified; however, the associated numerical value is an estimated concentration only.
J+ = The result is an estimated quantity; the result may be biased high.
U = The analyte was analyzed for but the result was not detected above the limit of quantitation.

Table 7-2
Soil PFOS, PFOA, and PFBS Analytical Results
USAEC PFAS Preliminary Assessment/Site Inspection
McAlester Army Ammunition Plant, Oklahoma

AOPI	Location	Sample/Parent ID	Sample Date	Analyte	PFOS (mg/kg)		PFOA (mg/kg)		PFBS (mg/kg)	
				OSD Industrial/Commercial Risk Screening Levels	1.6		1.6		25	
				OSD Residential Risk Screening Levels	0.13		0.13		1.9	
				Sample Type	Result	Qual	Result	Qual	Result	Qual
AFFF Fire Response Site	MCAAP-AFRS-1	MCAAP-AFRS-1-SO	06/25/2020	N	0.0011	U	0.0011	U	0.0011	U
	MCAAP-AFRS-2	MCAAP-AFRS-2-SO	06/24/2020	N	0.0013	U	0.0013	U	0.0013	U
Former Navy Fire Department	MCAAP-FNFD-1	MCAAP-FNFD-1-SO	06/25/2020	N	**0.066**		0.0013	U	0.0013	U
	MCAAP-FNFD-2	MCAAP-FNFD-2-SO	06/25/2020	N	**0.024**		**0.0015**		0.0011	U
	MCAAP-FNFD-3	MCAAP-FNFD-3-SO	06/25/2020	N	**0.026**		0.0012	U	0.0012	U
Firefighter Training Area	MCAAP-FTA-1	MCAAP-FTA-1-SO	06/22/2020	N	**0.019**		0.0011	U	0.0011	U
		MCAAP-FD-1-SO-062220	06/22/2020	FD	**0.027**		**0.00057**	J	0.0011	U
	MCAAP-FTA-2	MCAAP-FTA-2-SO-120120	12/01/2020	N	**0.072**	J	**0.00063**	J	0.0011	U
		MCAAP-FD-2-SO-120120	12/01/2020	FD	**0.059**	J	0.0011	U	0.0011	U
	MCAAP-FTA-3	MCAAP-FTA-3-SO-120120	12/01/2020	N	**0.06**		0.001	U	0.001	U
Current Fire Department	MCAAP-CFD-1	MCAAP-CFD-1-SO	06/22/2020	N	**0.0077**		**0.00097**	J	0.0011	U
Former Fire Department	MCAAP-FFD-1	MCAAP-FFD-1-SO	06/22/2020	N	**0.0012**		0.0011	U	0.0011	U
		MCAAP-FFD-2-SO	06/22/2020	N	**0.00089**	J	0.0011	U	0.0011	U

Notes:
1. **Bolded** values indicate the result was detected greater than the limit of detection.
2. Data are compared to the Office of the Secretary of Defense (OSD) risk screening levels for the residential and commerical/industrial scenario (OSD. 2021. Memorandum: Investigating Per- and Polyfluoroalkyl Substances within the Department of Defense Cleanup Program. September.).

Acronyms/Abbreviations:
AFFF = aqueous film-forming foam
AOPI = Area of Potential Interest
FD = field duplicate sample
ID = identification
mg/kg = milligrams per kilogram (parts per million)
N = primary sample
OSD = Office of the Secretary of Defense
PFBS = perfluorobutane sulfonic acid
PFOA = perfluorooctanoic acid
PFOS = perfluorooctane sulfonic acid

Qualifiers (Qual):
J = The analyte was positively identified; however, the associated numerical value is an estimated concentration only.
U = The analyte was analyzed for, but the result was not detected above the limit of quantitation.

Table 7-3
Surface Water PFOS, PFOA, and PFBS Analytical Results
USAEC PFAS Preliminary Assessment/Site Inspection
McAlester Army Ammunition Plant, Oklahoma

AOPI	Location	Sample/Parent ID	Sample Date	Analyte	PFOS (ng/L)		PFOA (ng/L)		PFBS (ng/L)	
				OSD Tapwater RiskScreening Level	40		40		600	
				Sample Type	Result	Qual	Result	Qual	Result	Qual
AFFF Fire Response Site	MCAAP-AFRS-1	MCAAP-AFRS-1-SW	06/25/2020	N	**3.4**		**2.5**	J	**2.0**	J
Former Navy Fire Department	MCAAP-FNFD-1	MCAAP-FNFD-1-SW-120220	12/02/2020	N	**69**		**5.6**		**10**	
Firefighter Training Area	MCAAP-FTA-1	MCAAP-FTA-1-SW	06/22/2020	N	**7.4**		**2.5**	J	**2.5**	J
		MCAAP-FD-1-SW-062220	06/22/2020	FD	**7.5**		**2.5**	J	**2.6**	J
	MCAAP-FTA-2	MCAAP-FTA-2-SW-120120	12/01/2020	N	**4.5**		3.5	U	3.5	U
		MCAAP-FD-2-SW-120120	12/01/2020	FD	**4.3**		3.6	U	**1.8**	J
	MCAAP-FTA-3	MCAAP-FTA-3-SW-120120	12/01/2020	N	**2.5**	J	3.4	U	3.4	U

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

Acronyms/Abbreviations:
AFFF = aqueous film-forming foam
AOPI = Area of Potential Interest
FD = field duplicate sample
ID = identification
N = primary sample
ng/L = nanograms per liter (parts per trillion)
OSD = Office of the Secretary of Defense
PFBS = perfluorobutane sulfonic acid
PFOA = perfluorooctanoic acid
PFOS = perfluorooctane sulfonic acid

Qualifiers (Qual):
J = The analyte was positively identified; however, the associated numerical value is an estimated concentration only.
U = The analyte was analyzed for, but the result was not detected above the limit of quantitation.

Table 7-4
Sediment PFOS, PFOA, and PFBS Analytical Results
USAEC PFAS Preliminary Assessment/Site Inspection
McAlester Army Ammunition Plant, Oklahoma

AOPI	Location	Sample/Parent ID	Sample Date	Analyte	PFOS (mg/kg)		PFOA (mg/kg)		PFBS (mg/kg)	
				OSD Industrial/Commercial Risk Screening Level	1.6		1.6		25	
				OSD Residential Risk Screening Level	0.13		0.13		1.9	
				Sample Type	Result	Qual	Result	Qual	Result	Qual
Firefighter Training Area	MCAAP-FTA-1	MCAAP-FTA-1-SE	06/22/2020	N	0.0012	U	0.0012	U	0.0012	U
Current Fire Department	MCAAP-CFD-1	MCAAP-CFD-1-SE	06/25/2020	N	**0.004**		0.0014	U	0.0014	U
		MCAAP-FD-1-SE	06/25/2020	FD	**0.0047**		0.0015	U	0.0015	U
Former Naval Special Weapons Facility Shop	MCAAP-FNSWFS-1	MCAAP-FNSWFS-1-SE	06/25/2020	N	0.0011	U	0.0011	U	0.0011	U
	MCAAP-FNSWFS-2	MCAAP-FNSWFS-2-SE	06/25/2020	N	0.0012	U	0.0012	U	0.0012	U

Notes:
1. **Bolded** values indicate the result was detected greater than the limit of detection.
2. All laboratory reported results in nanograms per gram were converted to milligrams per kilogram.
3. Data from the Current Fire Department (CFD) are compared to the Office of the Secretary of Defense (OSD) risk screening levels for the residential and commerical/industrial scenario (OSD. 2021. Memorandum: Investigating Per- and Polyfluoroalkyl Substances within the Department of Defense Cleanup Program. September.). The CFD streambed was dry and therefore appropriate for this OSD comparison.

Acronyms/Abbreviations:
AOPI = Area of Potential Interest
FD = field duplicate sample
ID = identification
mg/kg = milligrams per kilogram
N = primary sample
OSD = Office of the Secretary of Defense
PFBS = perfluorobutane sulfonic acid
PFOA = perfluorooctanoic acid
PFOS = perfluorooctane sulfonic acid

Qualifier (Qual):
U = The analyte was analyzed for, but the result was not detected above the limit of quantitation.

FIGURES

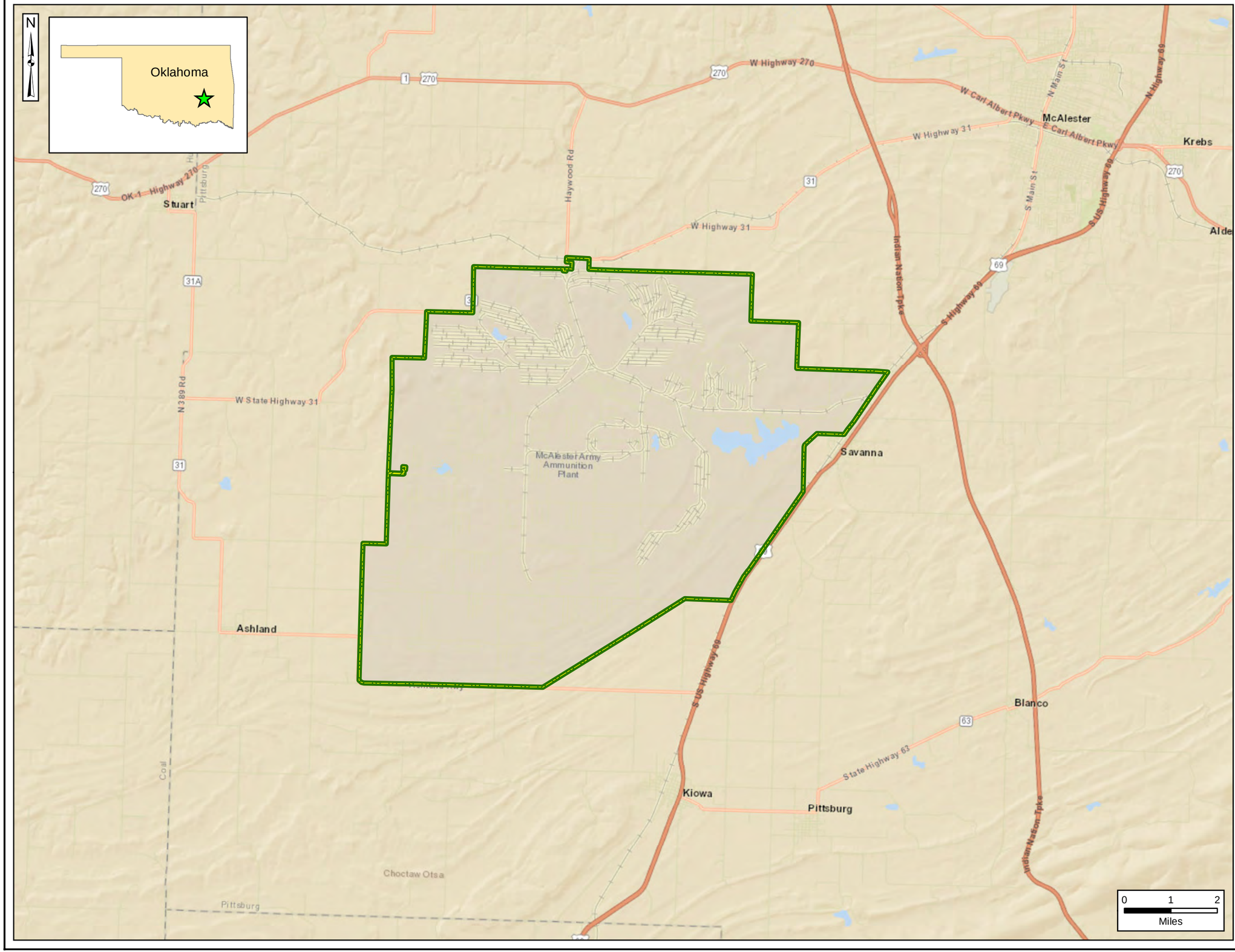
USAEC PFAS Preliminary Assessment / Site Inspection McAlester AAP, OK

ARCADIS

Figure 2-1
Site Location

Legend

Installation Boundary



Data Sources:
McAlester AAP, GIS Data, 2018
ESRI ArcGIS Online, Street Map Data

Coordinate System:
WGS 1984, UTM Zone 15 North

USAEC PFAS Preliminary Assessment / Site Inspection McAlester AAP, OK

ARCADIS

Figure 2-2 Site Layout

Legend

- Installation Boundary
- River/Stream
- Water Body
- Surface Water Flow Direction
- Surface Water Supply Inlet
- Agricultural Well
- Domestic Well
- Monitoring Well
- Outfall

Data Sources:
McAlester AAP, GIS Data, 2018
EDR, Well Data, 2019
OWRB, Well Data, 2019
ESRI ArcGIS Online, Aerial Imagery

Coordinate System:
WGS 1984, UTM Zone 15 North

USAEC PFAS
Preliminary Assessment / Site Inspection
McAlester AAP, OK

ARCADIS

Figure 2-3
Topographic Map

Legend

- Installation Boundary
- River/Stream
- Water Body

Data Sources:
McAlester AAP, GIS Data, 2018
ESRI ArcGIS Online, USA Topo Maps

Coordinate System:
WGS 1984, UTM Zone 15 North

USAEC PFAS Preliminary Assessment / Site Inspection McAlester AAP, OK

ARCADIS

Figure 2-4
Off-Post Potable Wells

Legend

- Installation Boundary
- 5-Mile Radius
- Public Water Supply System Well
- Agricultural Well
- Domestic Well
- Irrigation Well

RWD = Rural Water District

Rural Water District #2
Hughes County RWD #2
Hughes Co RWD #2
Gail Capehart
Gail Capehart

McAlester Army Ammunition Plant

McAlester
Krebs
Savanna
Ashland
Kiowa
Pittsburg
Choctaw Otsa
Coal
Hughes

W Highway 270
W Highway 31
W State Highway 31
OK-1 Highway 270
Haywood Rd
N 369 Rd
W Carl Albert Pkwy
E Carl Albert Pkwy
N Main St
S Main St
N Highway 69
S US Highway 69
S State Highway 69
Indian Nation Tpke

0 1 2
Miles

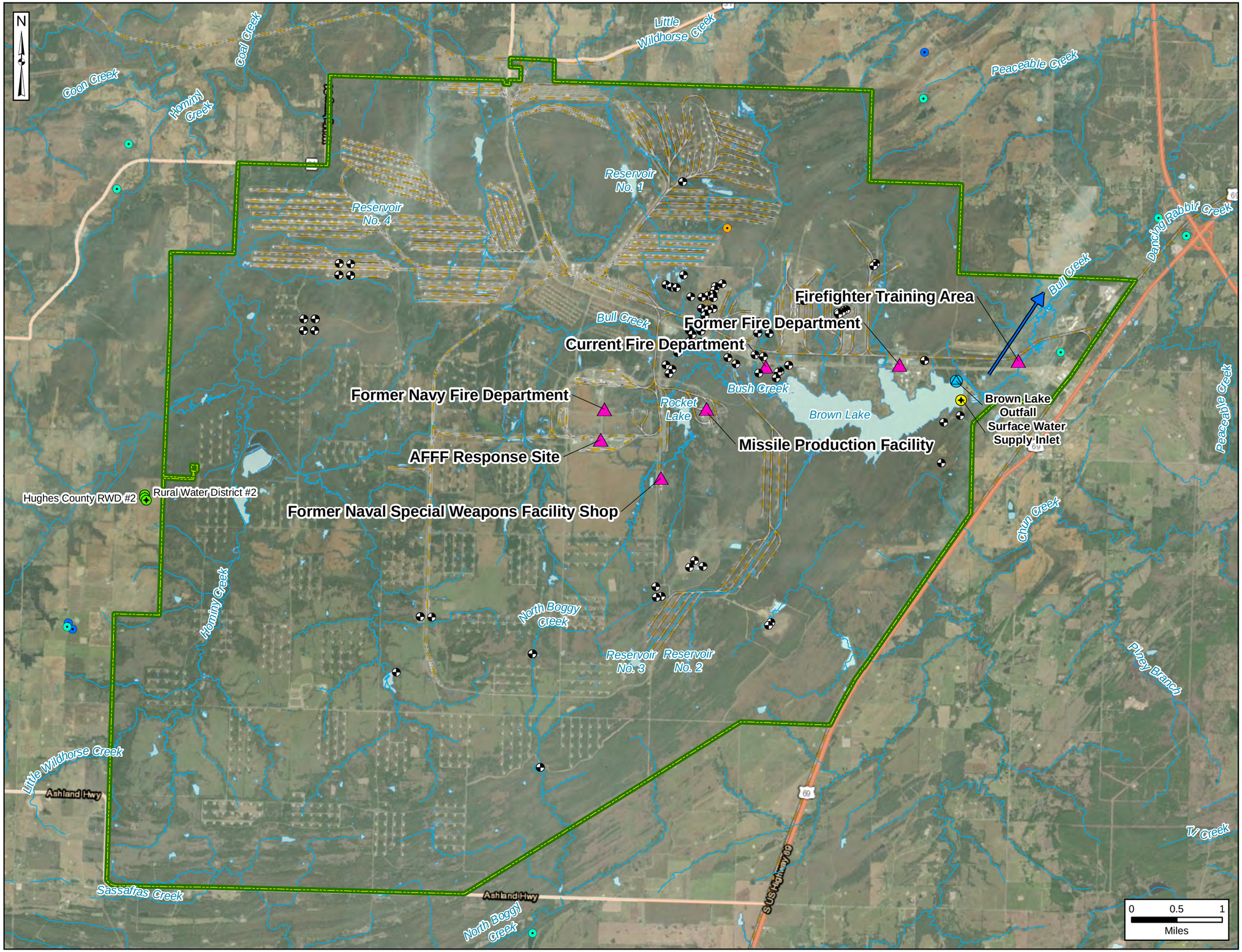
Data Sources:
McAlester AAP, GIS Data, 2018
EDR, Well Data, 2019
OWRB, Well Data, 2019
ESRI ArcGIS Online, Aerial Imagery

Coordinate System:
WGS 1984, UTM Zone 15 North

USAEC PFAS Preliminary Assessment / Site Inspection McAlester AAP, OK

ARCADIS

Figure 5-2
AOPI Locations



Legend

- Installation Boundary
- AOPI
- River/Stream
- Water Body
- Surface Water Flow Direction
- Surface Water Supply Inlet
- Off-Post Public Supply Well
- Agricultural Well
- Domestic Well
- Irrigation Well
- Monitoring Well
- Outfall

AFFF = aqueous film-forming foam
AOPI = area of potential interest
RWD = rural water district

Data Sources:
McAlester AAP, GIS Data, 2018
EDR, Well Data, 2019
OWRB, Well Data, 2019
ESRI ArcGIS Online, Aerial Imagery

Coordinate System:
WGS 1984, UTM Zone 15 North

USAEC PFAS
Preliminary Assessment / Site Inspection
McAlester AAP, OK

ARCADIS

Figure 5-3
Aerial Photo of Firefighter Training Area

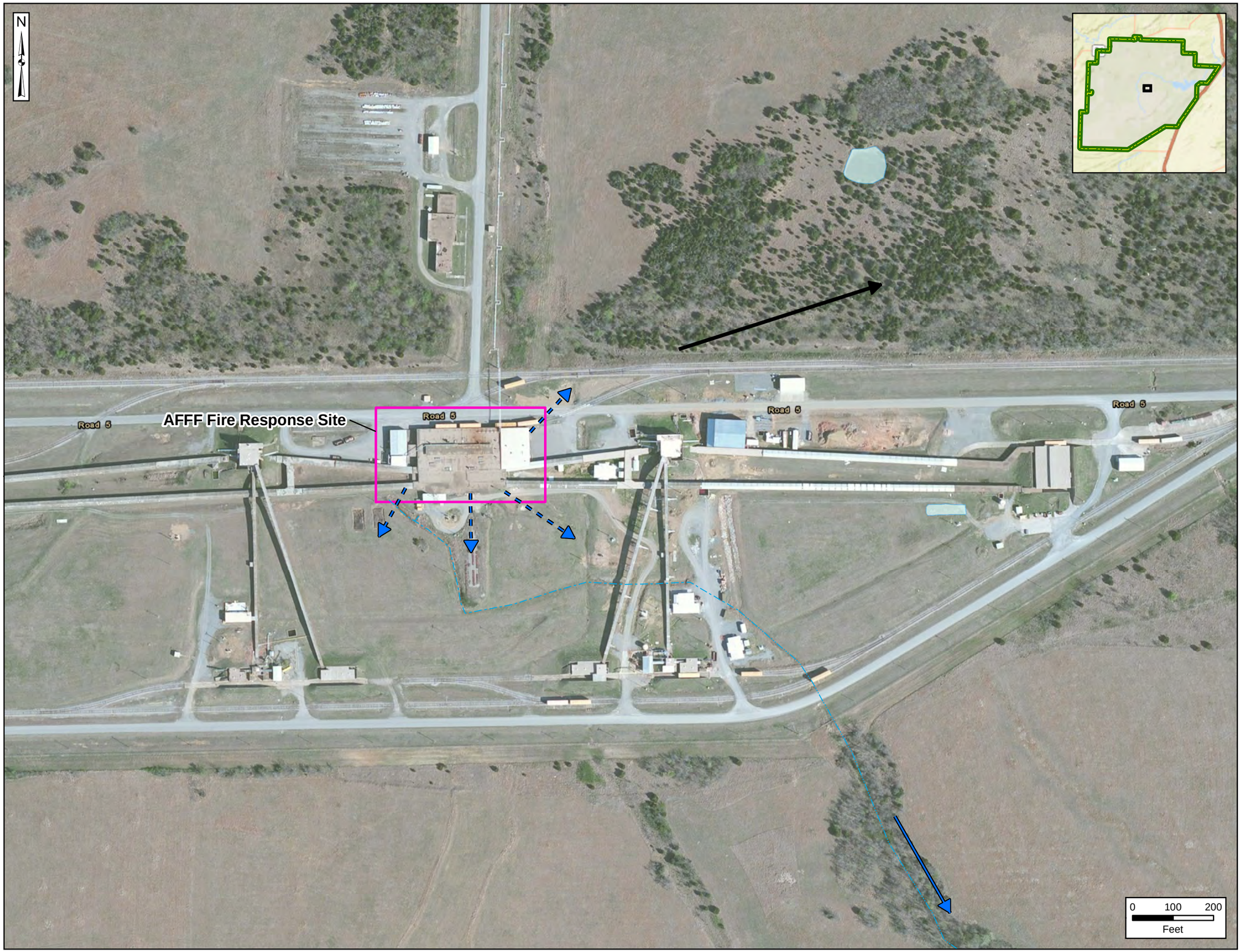
Legend

- Installation Boundary
- AOPI
- Water Body
- Inferred Groundwater Flow Direction
- Surface Runoff Flow Direction
- 2017 Soil Sampling Location (approximate)

AOPI = area of potential interest

Data Sources:
McAlester AAP, GIS Data, 2018
ESRI ArcGIS Online, Aerial Imagery

Coordinate System:
WGS 1984, UTM Zone 15 North



USAEC PFAS
Preliminary Assessment / Site Inspection
McAlester AAP, OK

ARCADIS

Figure 5-4
Aerial Photo of
AFFF Fire Response Site

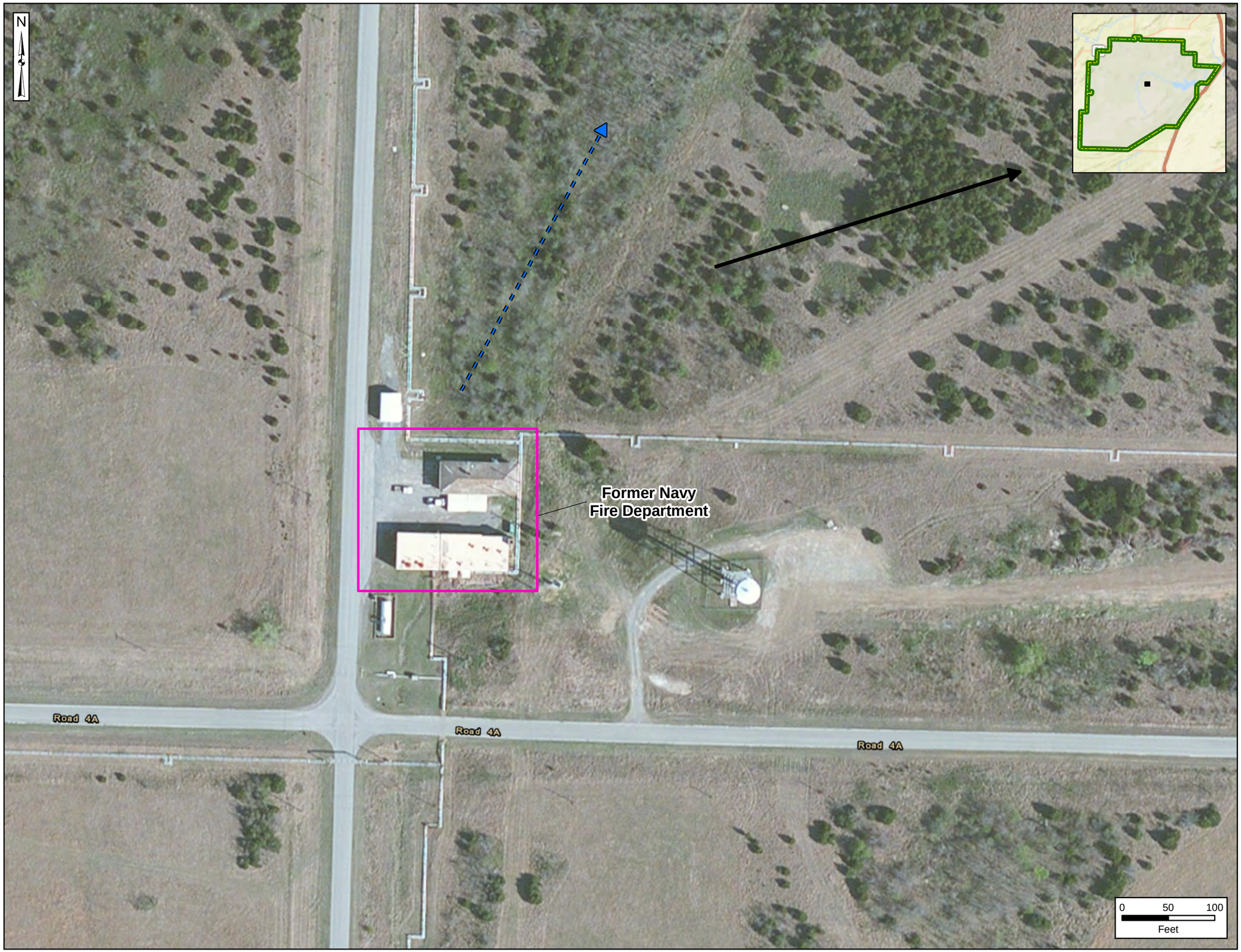
Legend

- Installation Boundary
- AOPI
- Stream (Intermittent)
- Ditch
- Water Body
- Groundwater Flow Direction
- Surface Runoff Flow Direction
- Surface Water Flow Direction

AFFF = aqueous film-forming foam
AOPI = area of potential interest

Data Sources:
McAlester AAP, GIS Data, 2018
ESRI ArcGIS Online, Aerial Imagery

Coordinate System:
WGS 1984, UTM Zone 15 North



USAEC PFAS
Preliminary Assessment /
Site Inspection
McAlester AAP, OK

Figure 5-5
Aerial Photo of
Former Navy Fire Department

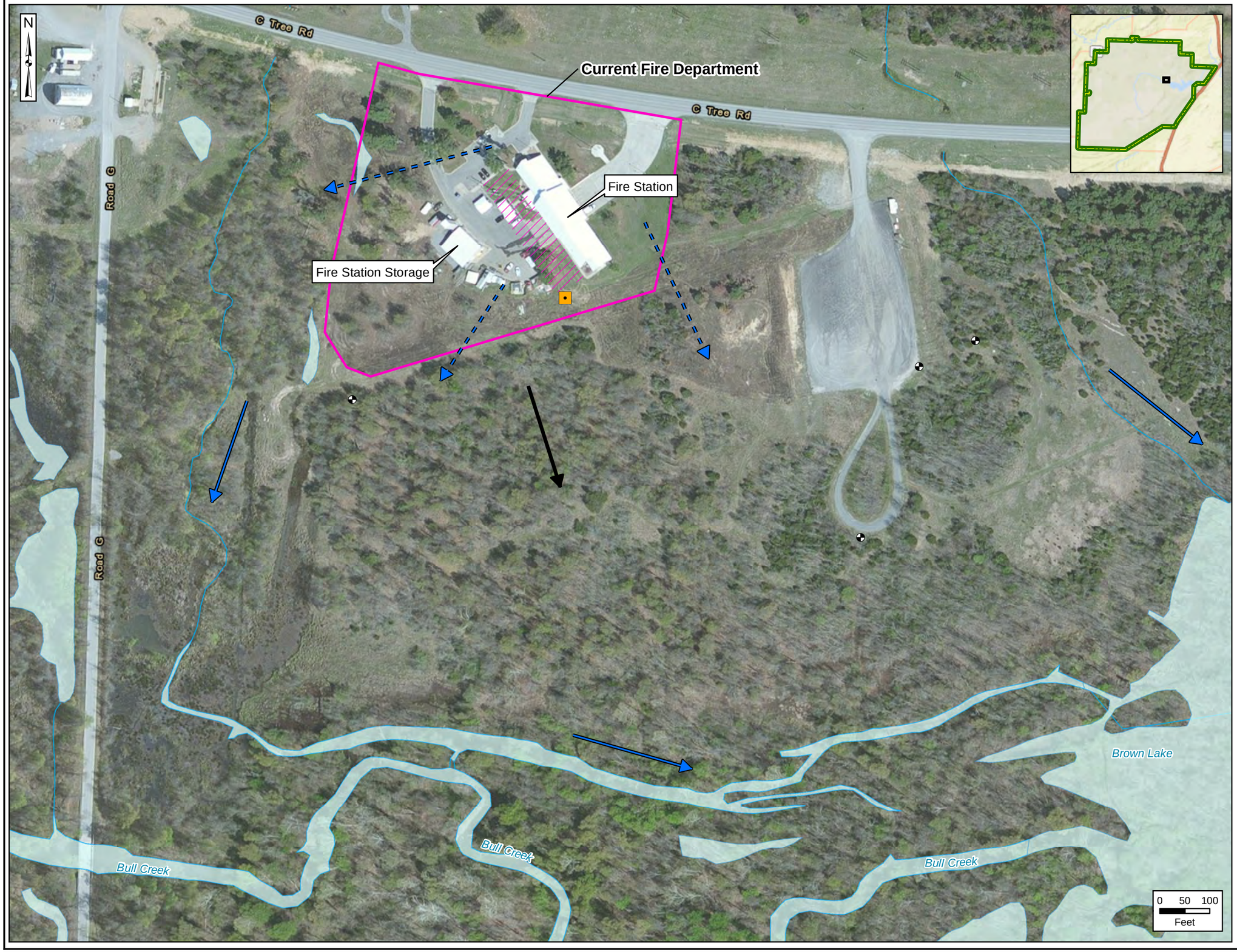
Legend

- Installation Boundary
- AOPI
- Groundwater Flow Direction
- Surface Runoff Flow Direction

AOPI = area of potential interest

Data Sources:
McAlester AAP, GIS Data, 2018
ESRI ArcGIS Online, Aerial Imagery

Coordinate System:
WGS 1984, UTM Zone 15 North



USAEC PFAS
Preliminary Assessment / Site Inspection
McAlester AAP, OK

ARCADIS

Figure 5-6
Aerial Photo of Current Fire Department

Legend

- Installation Boundary
- AOPI
- AFFF Application Area
- 2017 Soil Sampling Location (approximate)
- River/Stream
- Water Body
- Groundwater Flow Direction
- Surface Runoff Flow Direction
- Surface Water Flow Direction
- Monitoring Well

AFFF = aqueous film-forming foam
AOPI = area of potential interest

Data Sources:
McAlester AAP, GIS Data, 2018
ESRI ArcGIS Online, Aerial Imagery

Coordinate System:
WGS 1984, UTM Zone 15 North

USAEC PFAS
Preliminary Assessment / Site Inspection
McAlester AAP, OK

ARCADIS

Figure 5-7
Aerial Photo of
Former Fire Department

Legend

- Installation Boundary
- AOPI
- River/Stream
- Stream (Intermittent)
- Groundwater Flow Direction
- Surface Runoff Flow Direction
- Surface Water Flow Direction

AOPI = area of potential interest

Data Sources:
McAlester AAP, GIS Data, 2018
ESRI ArcGIS Online, Aerial Imagery

Coordinate System:
WGS 1984, UTM Zone 15 North

N

Road F

Road F

Road F

1330

Former Naval Special
Weapons Facility Shop

0 100 200
Feet

USAEC PFAS
Preliminary Assessment /
Site Inspection
McAlester AAP, OK

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Figure 5-8
Aerial Photo of
Former Naval Special Weapons
Facility Shop

Legend

- Installation Boundary
- AOPI
- River/Stream
- Water Body
- Groundwater Flow Direction
- Surface Water Flow Direction

AOPI = area of potential interest

Data Sources:
McAlester AAP, GIS Data, 2018
ESRI ArcGIS Online, Aerial Imagery

Coordinate System:
WGS 1984, UTM Zone 15 North

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McAlester AAP, OK

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Figure 5-9
Aerial Photo of Missile Production Facility

Legend

- Installation Boundary
- AOPI
- Groundwater Flow Direction

AOPI = area of potential interest

Data Sources:
McAlester AAP, GIS Data, 2018
ESRI ArcGIS Online, Aerial Imagery

Coordinate System:
WGS 1984, UTM Zone 15 North

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Figure 7-1
AOPI Locations and OSD Risk Screening Level Exceedances

Legend

- Installation Boundary
- Sampled AOPI
- AOPI Not Sampled
- AOPI with Risk Screening Level Exceedance
- River/Stream
- Water Body
- Surface Water Flow Direction
- Surface Water Supply Inlet
- Off-Post Public Supply Well
- Agricultural Well
- Domestic Well
- Irrigation Well
- Monitoring Well
- Outfall

AFFF = aqueous film-forming foam
AOPI = area of potential interest
OSD = Office of the Secretary of Defense
RWD = Rural Water District

Data Sources:
McAlester AAP, GIS Data, 2018
EDR, Well Data, 2019
OWRB, Well Data, 2019
ESRI ArcGIS Online, Aerial Imagery

Coordinate System:
WGS 1984, UTM Zone 15 North

N

Coon Creek
Coal Creek
Little Widhorse Creek
Hominy Creek
Peaceable Creek
Reservoir No. 1
Reservoir No. 4
Dancing Rabbit Creek
Bull Creek
Firefighter Training Area
Former Fire Department
Current Fire Department
Bush Creek
Brown Lake
Brown Lake Outfall
Surface Water Supply Inlet
Former Navy Fire Department
Rocket Lake
Missile Production Facility
AFFF Response Site
Former Naval Special Weapons Facility Shop
Hughes County RWD #2
Rural Water District #2
Hominy Creek
North Boggy Creek
Reservoir No. 3
Reservoir No. 2
Chun Creek
Piney Branch
Little Widhorse Creek
Ashland Hwy
Sassafras Creek
Ashland Hwy
North Boggy Creek
S US Highway 69
Ti Creek
69
0 0.5 1
Miles

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Figure 7-2
Firefighter Training Area PFOS, PFOA, and PFBS Analytical Results

MCAAP-FTA-2-SO	
Date	12/1/2020
Depth	0-2 ft
PFOS	**0.072 J [0.059 J]**
PFOA	**0.00063 J** [0.0011 U]
PFBS	0.0011 U [0.0011 U]

MCAAP-FTA-2-GW	
Date	12/2/2020
Depth	10.26 ft
PFOS	**170,000 J**
PFOA	**3,300 J**
PFBS	**4,800**

MCAAP-FTA-1-SW	
Date	6/22/2020
Depth	0.25 ft
PFOS	**7.4 [7.5]**
PFOA	**2.5 J [2.5 J]**
PFBS	**2.5 J [2.6 J]**

MCAAP-FTA-2-SW	
Date	12/1/2020
Depth	0.25 ft
PFOS	**4.5 [4.3]**
PFOA	3.5 U [3.6 U]
PFBS	3.5 U [**1.8 J**]

MCAAP-FTA-1-SO	
Date	6/22/2020
Depth	0-2 ft
PFOS	**0.019 [0.027]**
PFOA	**0.0011 U [0.00057 J]**
PFBS	0.0011 U [0.0011 U]

MCAAP-FTA-1-SE	
Date	6/22/2020
Depth	0-0.5 ft
PFOS	0.0012 U
PFOA	0.0012 U
PFBS	0.0012 U

MCAAP-FTA-1-GW	
Date	6/24/2020
Depth	15 ft
PFOS	**30**
PFOA	**8.8**
PFBS	**1,700**

Firefighter Training Area

Bull Creek

MCAAP-FTA-3-SO	
Date	12/1/2020
Depth	0-2 ft
PFOS	**0.060**
PFOA	0.0010 U
PFBS	0.0010 U

MCAAP-FTA-3-GW	
Date	12/1/2020
Depth	7.67 ft
PFOS	**460 J [330 J]**
PFOA	**130 J+ [130]**
PFBS	**270 [270]**

MCAAP-FTA-3-SW	
Date	12/1/2020
Depth	0.25 ft
PFOS	**2.5 J**
PFOA	3.4 U
PFBS	3.4 U

Tree Rd

N

0 50 100 Feet

0 200 400 Feet

Legend

- Installation Boundary
- AOPI
- River/Stream
- Water Body
- Inferred Groundwater Flow Direction
- Surface Runoff Flow Direction
- 2017 Soil Sampling Location (Approximate)
- Soil Sampling Location
- Sediment Sampling Location
- Groundwater Boring Location
- Soil/Groundwater Boring Location
- Surface Water Sampling Location

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

Notes:
1. Groundwater results (shown in light blue) and surface water results (shown in dark blue) are reported in nanograms per liter (ng/L).
2. Soil results (shown in green) and sediment results (shown in brown) are reported in milligrams per kilogram (mg/kg).
3. Duplicate sample results are shown in brackets.
4. Bolded values indicate detections.
5. Concentrations of PFOS and PFOA that exceed the Office of the Secretary of Defense (OSD) residential tap water risk screening level of 40 ng/L (OSD 2021) are highlighted gray.
6. Concentrations of PFBS in groundwater that exceed the residential tap water risk screening level of 600 ng/L are highlighted gray.
7. J flag indicates the analyte was positively identified; however, the associated numerical value is an estimated concentration only.
8. J+ flag indicates the result is an estimated quantity and may be biased high.
9. U flag indicates the analyte was analyzed for, but was not detected above the limit of quantitation (LOQ).

Data Sources:
McAlester AAP, GIS Data, 2018
ESRI ArcGIS Online, Aerial Imagery

Coordinate System:
WGS 1984, UTM Zone 15 North

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Figure 7-3
AFFF Fire Response Site PFOS, PFOA, and PFBS Analytical Results

MCAAP-AFRS-1-SO	
Date	6/25/2020
Depth	0-2 ft
PFOS	0.0011 U
PFOA	0.0011 U
PFBS	0.0011 U

MCAAP-AFRS-1-GW	
Date	6/25/2020
Depth	30 ft
PFOS	3.5 U
PFOA	3.5 U
PFBS	3.5 U

MCAAP-AFRS-2-SO	
Date	6/24/2020
Depth	0-2 ft
PFOS	0.0013 U
PFOA	0.0013 U
PFBS	0.0013 U

MCAAP-AFRS-1-SW	
Date	6/25/2020
Depth	0.25 ft
PFOS	**3.4**
PFOA	**2.5 J**
PFBS	**2.0 J**

AFFF Fire Response Site

Road 5

0 100 200
Feet

Legend

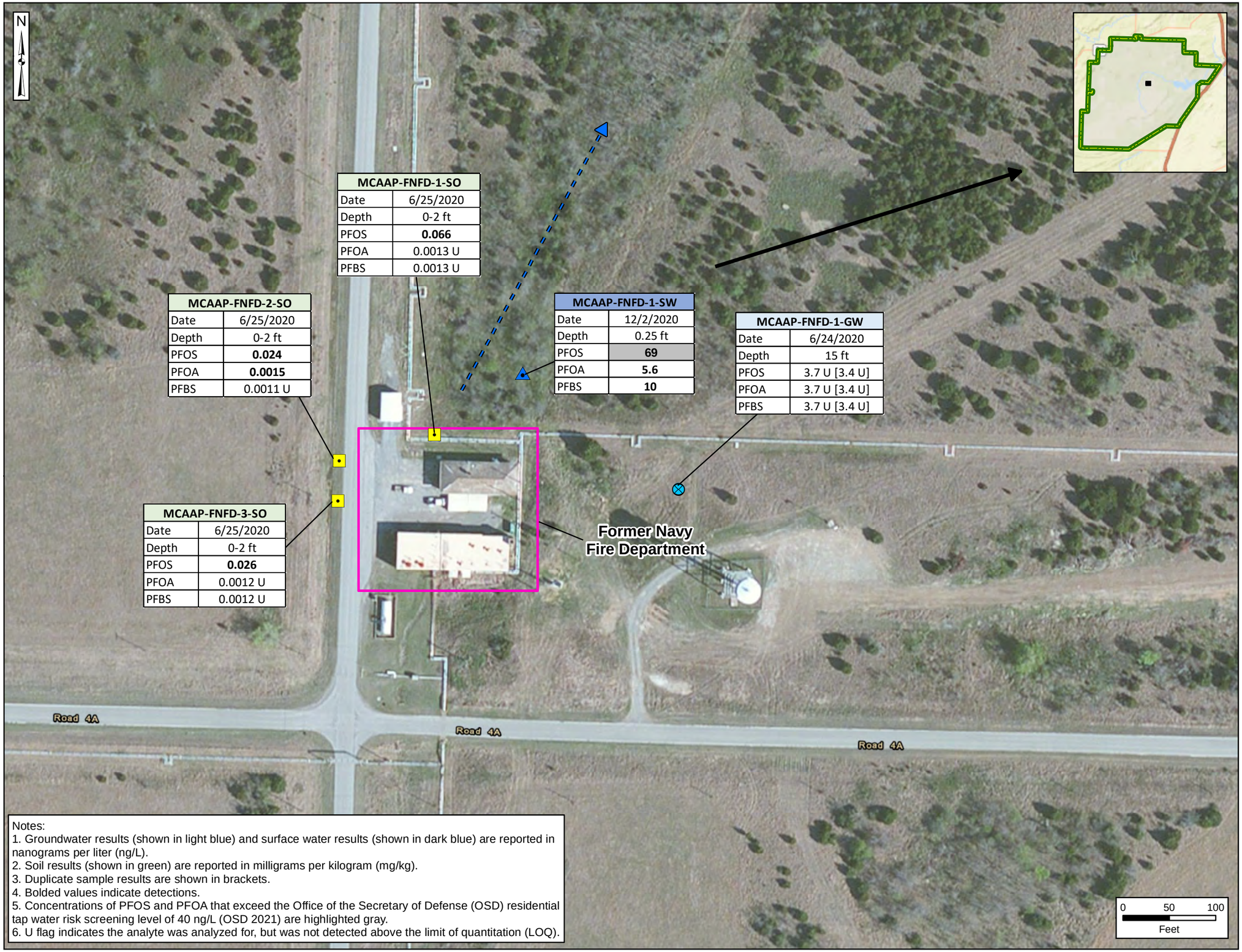
- Installation Boundary
- AOPI
- Stream (Intermittent)
- Ditch
- Water Body
- Groundwater Flow Direction
- Surface Runoff Flow Direction
- Surface Water Flow Direction
- Surface Water Sampling Location
- Groundwater Boring Location
- Soil Sampling Location

AFFF = aqueous film-forming foam
AOPI = area of potential interest
ft = feet
PFBS = perfluorobutanesulfonic acid
PFOA = perfluorooctanoic acid
PFOS = perfluorooctane sulfonate

Notes:
1. Groundwater results (shown in light blue) and surface water results (shown in dark blue) are reported in nanograms per liter (ng/L).
2. Soil results (shown in green) are reported in milligrams per kilogram (mg/kg).
3. Bolded values indicate detections.
4. J flag indicates the analyte was positively identified; however, the associated numerical value is an estimated concentration only.
5. U flag indicates the analyte was analyzed for, but was not detected above the limit of quantitation (LOQ).

Data Sources:
McAlester AAP, GIS Data, 2018
ESRI ArcGIS Online, Aerial Imagery

Coordinate System:
WGS 1984, UTM Zone 15 North



Notes:
1. Groundwater results (shown in light blue) and surface water results (shown in dark blue) are reported in nanograms per liter (ng/L).
2. Soil results (shown in green) are reported in milligrams per kilogram (mg/kg).
3. Duplicate sample results are shown in brackets.
4. Bolded values indicate detections.
5. Concentrations of PFOS and PFOA that exceed the Office of the Secretary of Defense (OSD) residential tap water risk screening level of 40 ng/L (OSD 2021) are highlighted gray.
6. U flag indicates the analyte was analyzed for, but was not detected above the limit of quantitation (LOQ).

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Figure 7-4
Former Navy Fire Department PFOS, PFOA, and PFBS Analytical Results

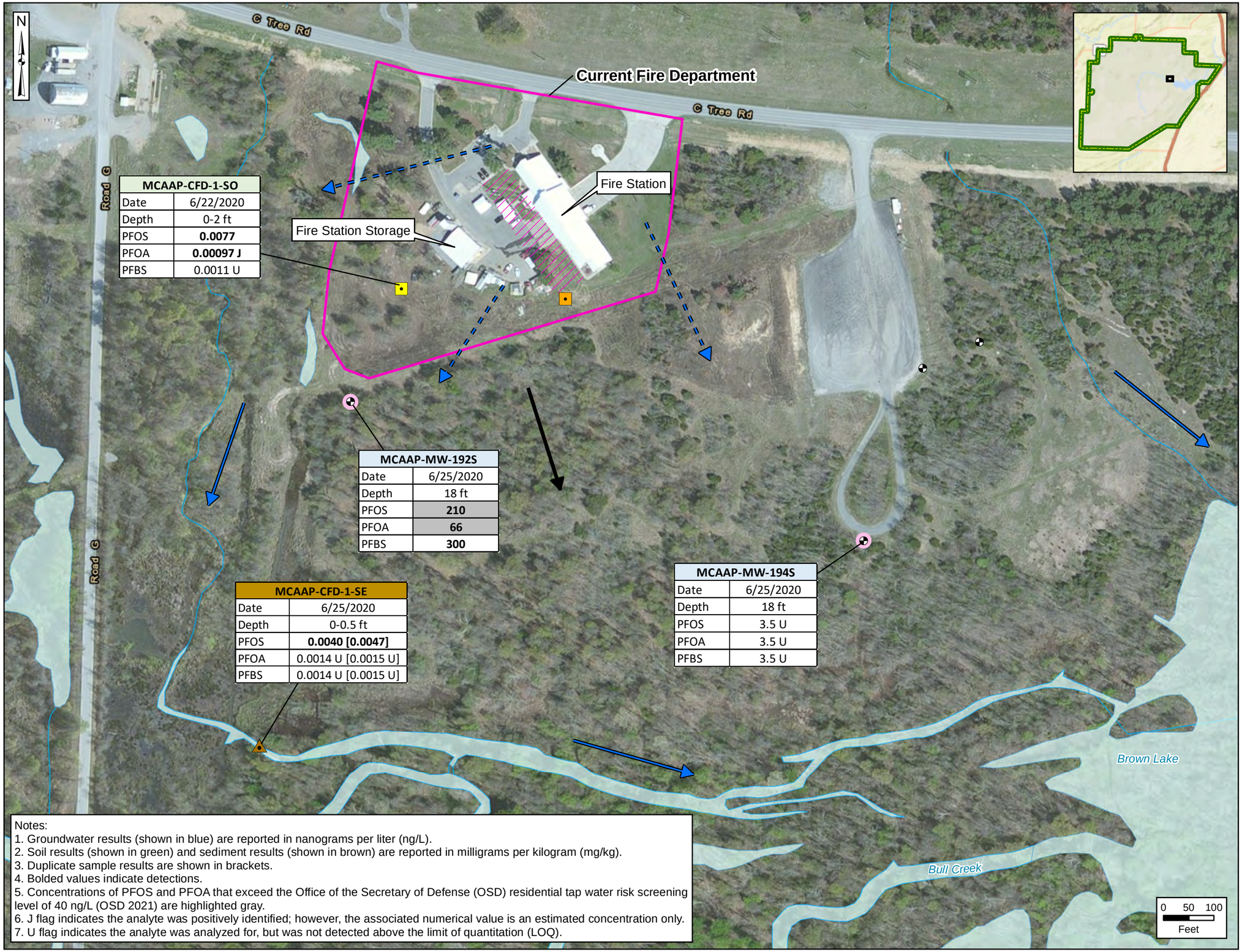
Legend

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

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

Data Sources:
McAlester AAP, GIS Data, 2018
ESRI ArcGIS Online, Aerial Imagery

Coordinate System:
WGS 1984, UTM Zone 15 North



Notes:
1. Groundwater results (shown in blue) are reported in nanograms per liter (ng/L).
2. Soil results (shown in green) and sediment results (shown in brown) are reported in milligrams per kilogram (mg/kg).
3. Duplicate sample results are shown in brackets.
4. Bolded values indicate detections.
5. Concentrations of PFOS and PFOA that exceed the Office of the Secretary of Defense (OSD) residential tap water risk screening level of 40 ng/L (OSD 2021) are highlighted gray.
6. J flag indicates the analyte was positively identified; however, the associated numerical value is an estimated concentration only.
7. U flag indicates the analyte was analyzed for, but was not detected above the limit of quantitation (LOQ).

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Figure 7-5
Current Fire Department PFOS, PFOA, and PFBS Analytical Results

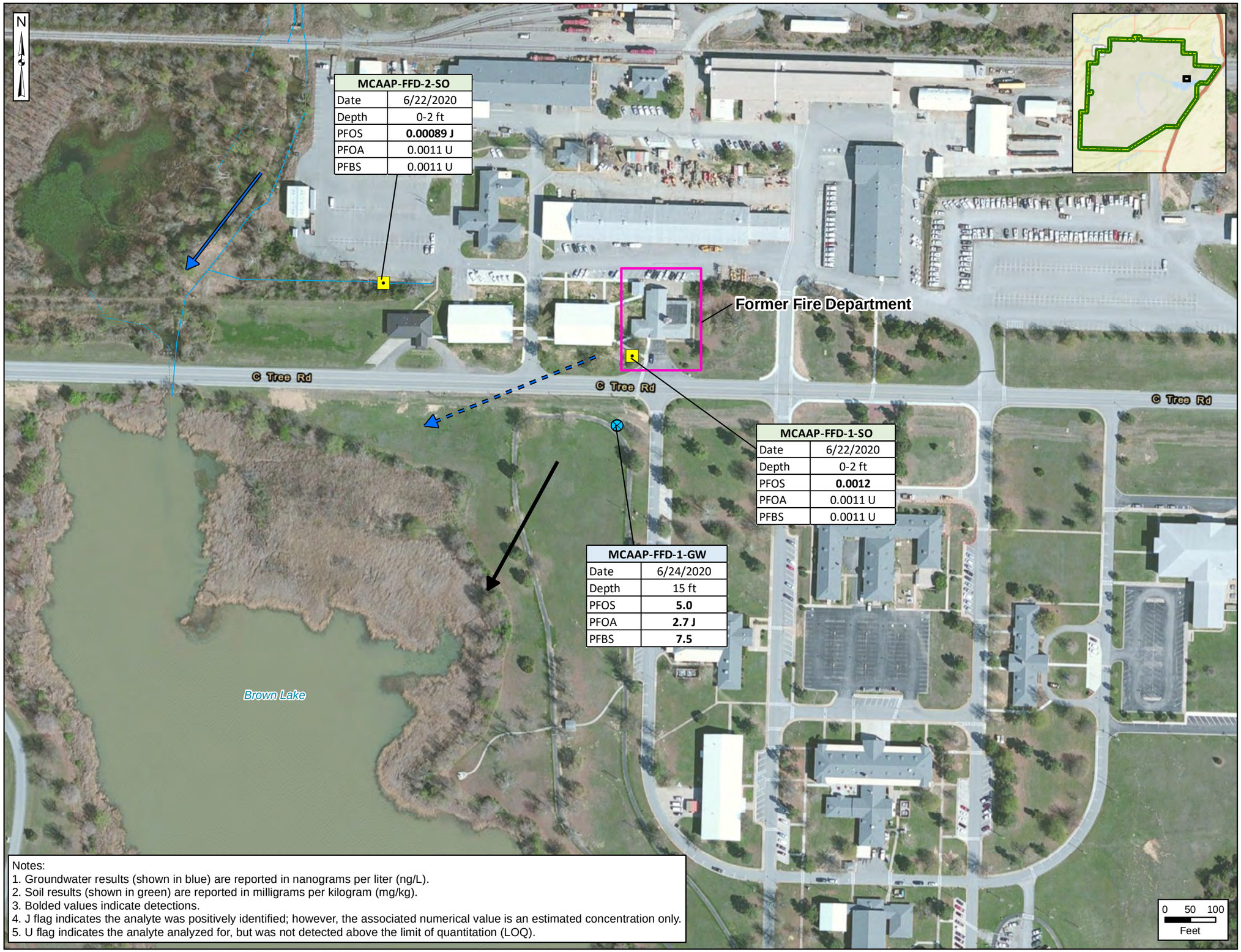
Legend

- Installation Boundary
- AOPI
- AFFF Application Area
- River/Stream
- Water Body
- Groundwater Flow Direction
- Surface Runoff Flow Direction
- Surface Water Flow Direction
- Monitoring Well
- Sediment Sampling Location
- Soil Sampling Location
- 2017 Soil Sampling Location (approximate)
- Groundwater Sampling Location (Existing Monitoring Well)

AFFF = aqueous film-forming foam
AOPI = area of potential interest
ft = feet
PFBS = perfluorobutanesulfonic acid
PFOA = perfluorooctanoic acid
PFOS = perfluorooctane sulfonate

Data Sources:
McAlester AAP, GIS Data, 2018
OWRB, Well Data, 2019
ESRI ArcGIS Online, Aerial Imagery

Coordinate System:
WGS 1984, UTM Zone 15 North



Notes:
1. Groundwater results (shown in blue) are reported in nanograms per liter (ng/L).
2. Soil results (shown in green) are reported in milligrams per kilogram (mg/kg).
3. Bolded values indicate detections.
4. J flag indicates the analyte was positively identified; however, the associated numerical value is an estimated concentration only.
5. U flag indicates the analyte analyzed for, but was not detected above the limit of quantitation (LOQ).

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Figure 7-6
Former Fire Department PFOS, PFOA, and PFBS Analytical Results

Legend

- Installation Boundary
- AOPI
- River/Stream
- Stream (Intermittent)
- Groundwater Flow Direction
- Surface Runoff Flow Direction
- Surface Water Flow Direction
- Groundwater Boring Location
- Soil Sampling Location

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

Data Sources:
McAlester AAP, GIS Data, 2018
ESRI ArcGIS Online, Aerial Imagery

Coordinate System:
WGS 1984, UTM Zone 15 North

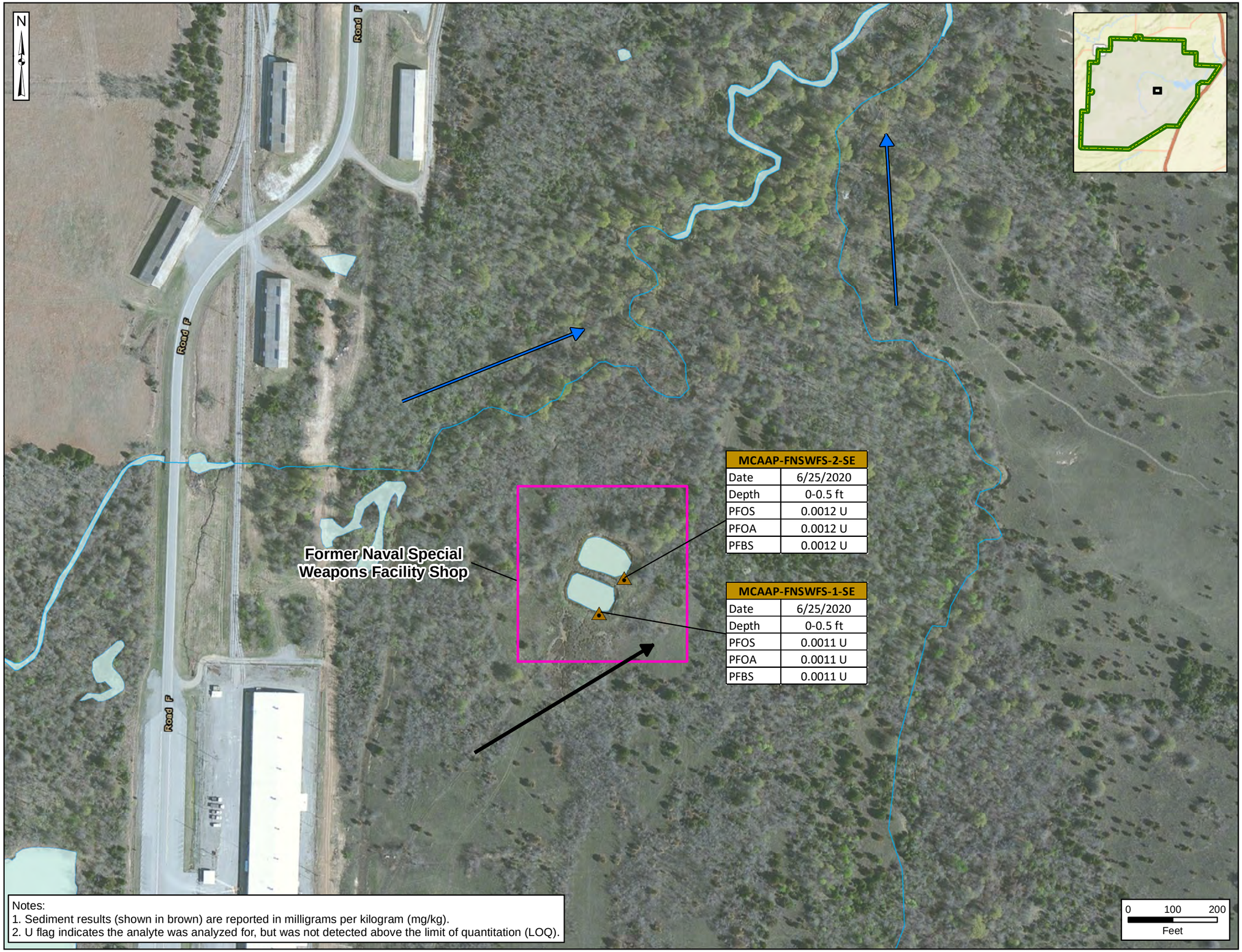

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Figure 7-7
Former Naval Special Weapons Facility Shop
PFOS, PFOA, and PFBS Analytical Results

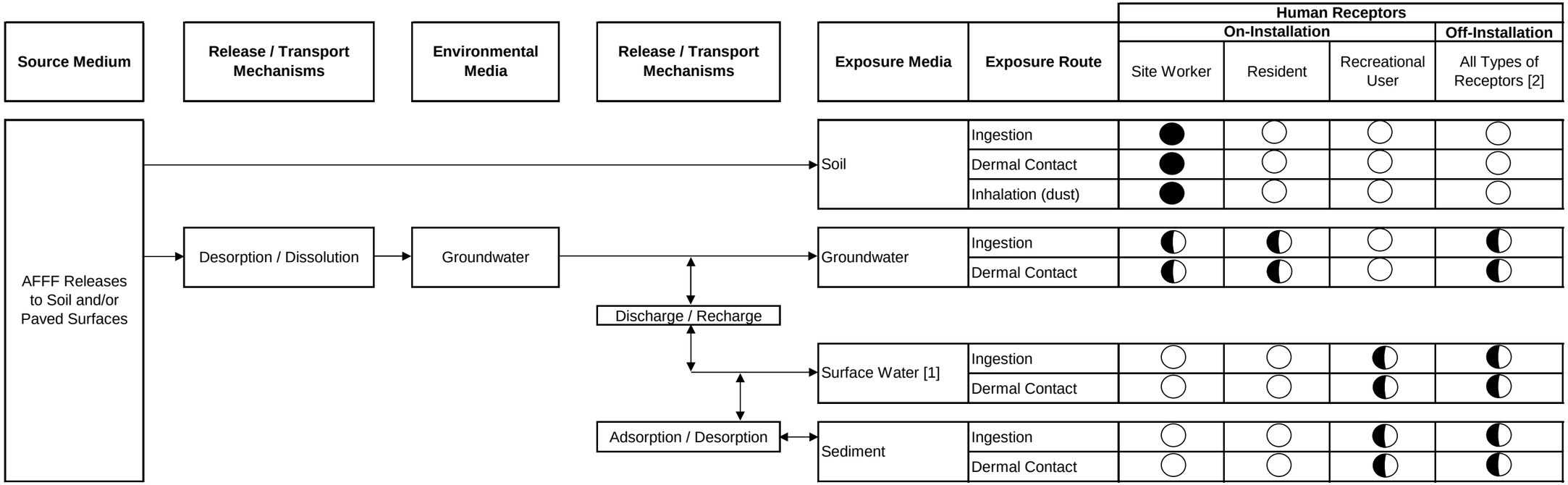
Legend

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

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

Data Sources:
McAlester AAP, GIS Data, 2018
ESRI ArcGIS Online, Aerial Imagery

Coordinate System:
WGS 1984, UTM Zone 15 North



Legend:

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

Notes:
[1] The AOPI is located downgradient of the surface water supply inlet on Brown Lake. In this CSM, the surface water and sediment exposure pathways for Recreational Users describe incidental ingestion and dermal contact during outdoor recreational activities.
[2] All types of off-installation human receptors include drinking water receptors and recreational users.
.
AOPI - area of potential interest
AFFF - aqueous film-forming foam

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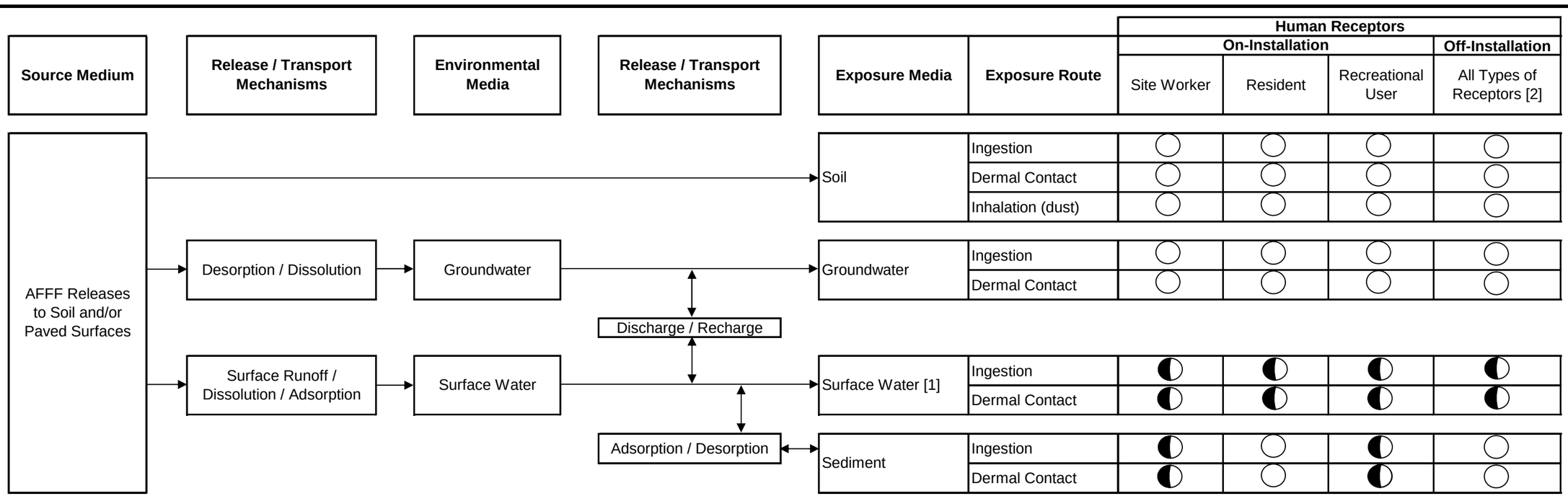
Conceptual Site Model - Firefighter Training Area
USAEC PFAS Preliminary Assessment / Site Inspection
McAlester Army Ammuntion Plant, Oklahoma

Figure 7-8



Legend:

= Complete Exposure Pathway

= Potentially Complete Exposure Pathway

= Incomplete Exposure Pathway

Notes:
[1] The AOPI is potentially upgradient of the surface water supply inlet on Brown Lake. The surface water exposure pathway for Site Workers and Residents describes drinking water ingestion and dermal contact. The surface water and sediment exposure pathways for Recreational Users describe incidental ingestion and dermal contact during outdoor recreational activities.
[2] All types of off-installation human receptors include drinking water receptors and recreational users

AOPI - area of potential interest
AFFF - aqueous film-forming foam

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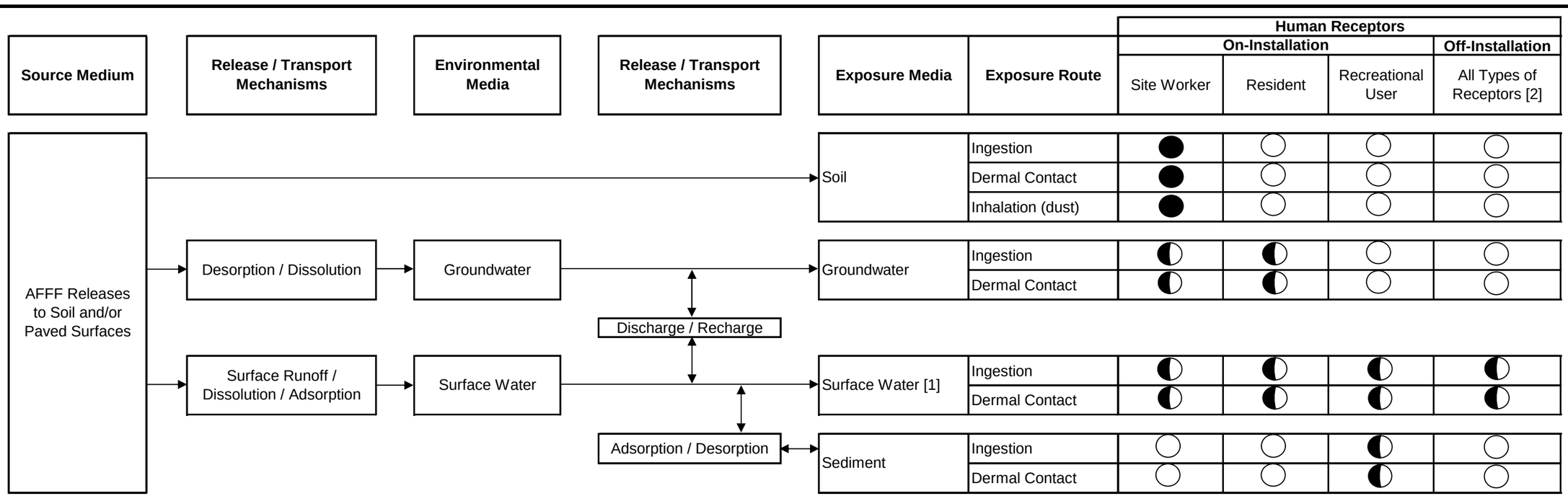
Conceptual Site Model - AFFF Fire Response Site
USAEC PFAS Preliminary Assessment / Site Inspection
McAlester Army Ammuntion Plant, Oklahoma

Figure 7-9



Legend:

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

Notes:
[1] The AOPI is potentially upgradient of the surface water supply inlet on Brown Lake. The surface water exposure pathway for Site Workers and Residents describes drinking water ingestion and dermal contact. The surface water and sediment exposure pathways for Recreational Users describe incidental ingestion and dermal contact during outdoor recreational activities.
[2] All types of off-installation human receptors include drinking water receptors and recreational users.

AOPI - area of potential interest
AFFF - aqueous film-forming foam

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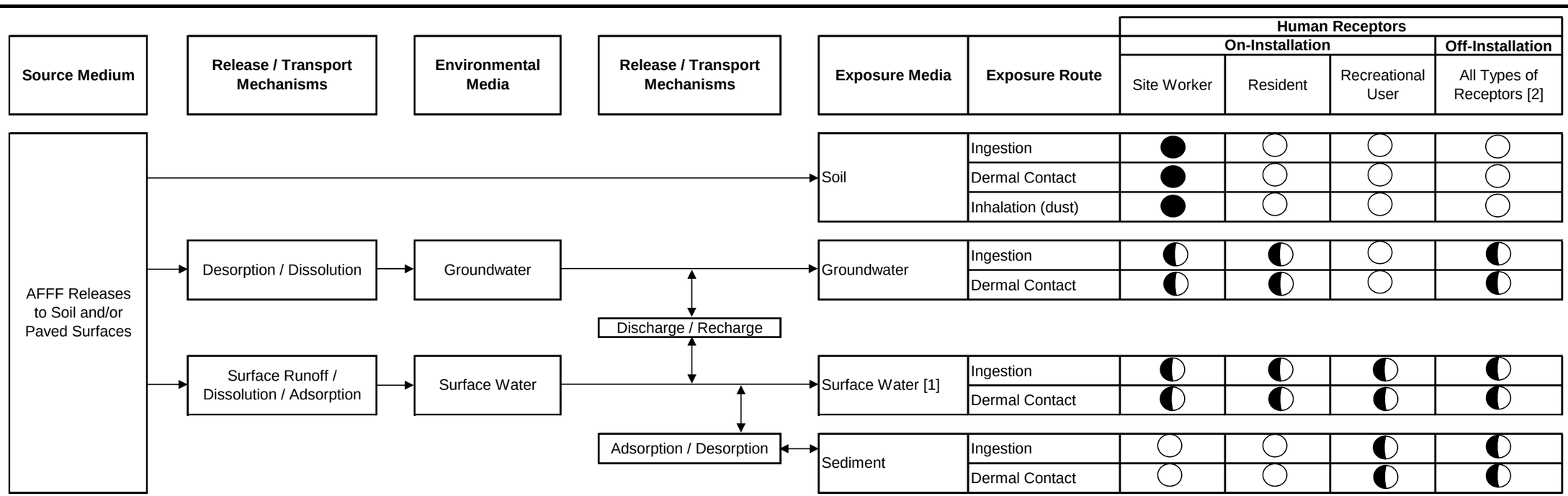
Conceptual Site Model - Former Navy Fire Department
USAEC PFAS Preliminary Assessment / Site Inspection
McAlester Army Ammuntion Plant, Oklahoma

Figure 7-10



Legend:

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

Notes:
[1] The AOPIs are potentially upgradient of the surface water supply inlet on Brown Lake. The surface water exposure pathway for Site Workers and Residents describes drinking water ingestion and dermal contact. The surface water and sediment exposure pathways for Recreational Users describe incidental ingestion and dermal contact during outdoor recreational activities.
[2] All types of off-installation human receptors include drinking water receptors and recreational users.

AOPI - area of potential interest
AFFF - aqueous film-forming foam

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Conceptual Site Model - Current Fire Department and Former Fire Department
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McAlester Army Ammuntion Plant, Oklahoma

Figure 7-11

Source Medium	Release / Transport Mechanisms	Environmental Media	Release / Transport Mechanisms	Exposure Media	Exposure Route	Human Receptors: On-Installation: Site Worker	On-Installation: Resident	On-Installation: Recreational User	Off-Installation: All Types of Receptors [2]
Potentially PFAS-containing waste products released to former Special Weapons Lagoons				Former Lagoon Sediment	Ingestion	○	○	○	○
					Dermal Contact	○	○	○	○
					Inhalation (dust)	○	○	○	○
	Desorption / Dissolution	Groundwater		Groundwater	Ingestion	○	○	○	○
					Dermal Contact	○	○	○	○
			Discharge / Recharge						
				Surface Water [1]	Ingestion	○	○	○	○
					Dermal Contact	○	○	○	○
			Adsorption / Desorption	Sediment	Ingestion	○	○	○	○
					Dermal Contact	○	○	○	○

Legend:

● = Complete Exposure Pathway

◐ = Potentially Complete Exposure Pathway

○ = Incomplete Exposure Pathway

Notes:
[1] The AOPI is potentially upgradient of the surface water supply inlet on Brown Lake. The surface water exposure pathway for Site Workers and Residents describes drinking water ingestion and dermal contact. The surface water and sediment exposure pathways for Recreational Users describe incidental ingestion and dermal contact during outdoor recreational activities.
[2] All types of off-installation human receptors include drinking water receptors and recreational users.

AOPI - area of potential interest
AFFF - aqueous film-forming foam

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Conceptual Site Model - Former Naval Special Weapons Facility Shop
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McAlester Army Ammuntion Plant, Oklahoma

Figure 7-12

Arcadis U.S., Inc.

7550 Teague Road

Suite 210

Hanover, Maryland 21076

Tel 410 987 0032

Fax 410 987 4392

www.arcadis.com