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

White Sands Missile Range, New Mexico

Prepared For:
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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 White Sands Missile Range (WSMR) 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.

WSMR encompasses five counties in New Mexico (Doña Ana, Socorro, Lincoln, Otero, and Sierra) It is comprised of 2,048,000 acres and spans approximately 100 miles from north to south. WSMR is used primarily for rocket and missile testing. The main cantonment area (known as Main Post) and headquarters borders the south and southwest portion of the installation. The Stallion Range Center (SRC) is located on the northern portion of the installation and conducts other cantonment activities there.

The WSMR PA identified 19 AOPIs for investigation during the SI phase. SI sampling results from the 19 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 and groundwater at 15 AOPIs; 7 of the 19 AOPIs had PFOS, PFOA, and/or PFBS present at concentrations greater than the risk-based screening levels. The WSMR PA/SI identified the need for further study in a CERCLA remedial investigation. **Table ES-1** below summarizes the PA/SI sampling results and provides recommendations for further study in a remedial investigation or no action at this time at each AOPI.

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

AOPI Name	PFOS, PFOA, and/or PFBS detected greater than OSD Risk Screening Levels? (Yes/No/ND/NS)		Recommendation
	GW	SO	
Fire Station 1 (FS1) (Building 155)	NS	No	No action at this time
Former Firefighting Training Area Pit (SWMU-21)	NS	Yes	Further study in remedial investigation
Former Firefighting Training Area Waste Pile (SWMU-22)	NS	Yes	Further study in remedial investigation
Former Firefighting Training Area at Martin Luther King Ave and Hughes St (FFTAMLK)	No	Yes	Further study in remedial investigation
Vehicle Maintenance Shop (VMS) (Building 21095)	NS	No	No action at this time
Photo Processing Lab (PPL) (SWMUs 1-7) (Building 1621)	No	No	No action at this time
Fire Department Storage Building (Building 1812)	NS	No	No action at this time
Former Fire Department Storage Building (Building 1713)	NS	Yes	Further study in remedial investigation
Sewage Treatment Plant Percolation Ditches and Impoundment Area	NS	No	No action at this time
WSMR Landfill (SWMUs 86-87)	No	NS	No action at this time
Current Firefighting Training Area (CFTA) (Building 21612)	NS	No	No action at this time
Fire Station 2 Launch Complex (FS2) (Building 23480)	NS	Yes	Further study in remedial investigation
Fire Station 4 High Energy Laser System Test Facility (FS4) (Building 26020)	Yes	No	Further study in remedial investigation

AOPI Name	PFOS, PFOA, and/or PFBS detected greater than OSD Risk Screening Levels? (Yes/No/ND/NS)		Recommendation
	GW	SO	
Fire Station 3 Stallion Range Center (FS3) (Building 34228)	NS	No	No action at this time
Stallion Range Center Firefighting Training Area (SWMU-162)	NS	Yes	Further study in remedial investigation
Stallion Range Center Landfill	ND	NS	No action at this time
Camp Tumbleweed Fire Training Area (FTA)	NS	ND	No action at this time
Hazardous Storage Waste Building (Building 22895)	NS	ND	No action at this time
Electromagnetic Analysis Facility (Building 23638)	NS	No	No action at this time

Notes:
Light gray shading – detection greater than the OSD risk screening level
GW – groundwater
ND – non-detect
NS – not sampled
SO – soil

1 INTRODUCTION

The United States (U.S.) Army (Army) is performing preliminary assessments (PAs) and site inspections (SIs) on the current or potential historical use of per- and polyfluoroalkyl substances (PFAS) with a focus on perfluorooctane sulfonate (PFOS), perfluorooctanoic acid (PFOA), and perfluorobutanesulfonic acid (PFBS), at Army installations (installations) nationwide. The Army is the lead agency under the Comprehensive Environmental Response, Compensation, and Liability Act of 1980 (CERCLA) and Executive Order 12580 and is conducting the PA/SI consistent with its authority under CERCLA, 42 United States Code §§ 9600, et seq. (as amended), and the Defense Environmental Restoration Program, 10 United States Code §§ 2701, et seq. The PFAS PA/SI included two distinct efforts. The PA identified locations that are areas of potential interest (AOPIs) at White Sands Missile Range (WSMR) based on the use, storage and/or disposal of PFAS-containing materials, in accordance with the 2018 Army Guidance for Addressing Releases of Per-and Polyfluoroalkyl Substances (Army 2018). The SI included multi-media sampling at AOPIs to determine whether or not a release 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 WSMR 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. Due to industry and regulatory concerns about the potential health effects and adverse environmental impacts, there has been a reduction in the manufacture and use of PFAS worldwide. In the U.S., significant reductions in the production, importation, and use of PFOS and PFOA (two individual compounds in the PFAS class) occurred between 2001 and 2015 (Interstate Technology Regulatory Council 2017). PFBS replaced PFOS in some applications and is currently used and manufactured in the U.S.

In 2016, the United States Environmental Protection Agency (USEPA) established a lifetime health advisory of 70 nanograms per liter (ng/L) in drinking water for PFOS or PFOA and for the sum of PFOS and PFOA when both are present (USEPA 2016). On 15 October 2019, the OSD provided guidance on the investigation of PFOS, PFOA, and PFBS at Department of Defense (DoD) restoration sites (OSD 2019). The DoD guidance provides risk screening levels for PFOS, PFOA, and PFBS in tap water 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 memo, on 08 April 2021, USEPA published an updated toxicity assessment for PFBS (USEPA 2021). Based on the updated toxicity assessment for PFBS, the OSD issued a memorandum on 15 September 2021 to include updated PFBS risk screening levels (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 WSMR, PA/SI development followed the 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 WSMR. 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 between applicable points of contact (POCs) from United States Army Environmental Command (USAEC), United States Army Corps of Engineers (USACE), WSMR, and Arcadis U.S., Inc. (Arcadis). The kickoff call occurred 05 September 2018, 7 weeks before the site visit to discuss the goals and scope of the PA, project scheduling, installation access, timeline for the site visit, access to installation-specific databases, and to request available records.

Records review was conducted before the site visit to obtain electronically available documents from the installation and external sources for review. The purpose of the records 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 WSMR.

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 Installation Management Command (IMCOM) operation order
- The Army PA Operations Security requirements package, which includes the antiterrorism/operations security review cover sheet.
- 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 on 23 to 26 October 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 at WSMR. The interviews focused on confirming information discussed in historical documents, collecting information that may have not been in historical documents, corroborating other interviewees' information.

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

An exit briefing was offered to installation personnel at the conclusion of the site visit to raise 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 26 October 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 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 serve 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 the WSMR.

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 (UXO) or cultural resource areas
- confirm the plan for investigation derived waste (IDW) handling and disposal
- identify specific installation access requirements and potential schedule conflicts
- discuss general SI deliverable and field work schedule information and logistics

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

- regulatory involvement requirements or preferences
- providing 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 2020). A Site Safety and Health Plan (SSHP) was also developed as an attachment to the QAPP Addendum to identify specific health and safety hazards that may be encountered at the installation during sampling. The SSHP was designed to supplement the Accident Prevention Plan (Arcadis 2018), which was developed for Army installations nationwide. The QAPP Addendum and SSHP were submitted

to the installation and finalized before commencement of the field work that occurred in July and November of 2020 and May and July of 2022.

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

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

1.3.5 Data Analysis, Validation, and Reporting

Environmental samples collected during the SI were submitted to a laboratory which 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) 5.1.1 (DoD 2018) / 5.3 (DoD and Department of Energy 2019). Method QSM 5.1.1 (DoD 2018) was used in July 2020 and November 2020 sampling events, while method QSM 5.3 DoD and Department of Energy 2019) was used in May 2022 and July 2022 sampling events. 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 WSMR, 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

WSMR is the largest military installation in the country. It spans across five counties in New Mexico (Dona Ana, Socorro, Lincoln, Otero, and Sierra) and is comprised of 2,048,000 acres. The headquarters area of the main installation is located approximately 20 miles east of Las Cruces, New Mexico, 45 miles north of El Paso, Texas, and 50 miles southwest of Alamogordo, New Mexico (**Figure 2-1**). In addition to the primary installation area, there are two extension areas on the northern and western boundaries, as well as several joint-use land areas. The acreages of these areas are an additional 3.8 million acres (WSMR 2016). To the east of the installation is Holloman Air Force Base and to the south is Fort Bliss Military Reservation. The Doña Ana Range borders the installation to the south (WSMR 2009) (**Figure 2-2**).

2.2 Mission and Brief Site History

The following description of WSMR's mission and site history is excerpted from the 2016 Installation Action Plan (WSMR 2016). The installation mission is to provide the Army, the U.S. Navy, the U.S. Air Force, the DoD, and other customers with high quality services for experimentation, testing, research, assessment, development, and training (WSMR 2016).

Originally established as White Sands Proving Ground (WSPG) in 1945, the range was originally established to develop a missile defense program, testing captured German V-2 rockets. The area was formed from privately held grazing land or land condemned for government use (WSMR 2016).

In 1952, DoD moved control of the Alamogordo Bombing Range from the Air Force to WSPG as part of the development plan for creating an integrated range. WSPG inherited the Trinity Site, the location of the first nuclear missile test, in 1953 (WSMR 2016).

In 1958, WSPG was designated as WSMR. Off-range launch sites and launch corridors were established in 1963 as far away as 400 miles. Green River Test Site (GRTS) was identified as a primary sub-installation for WSMR. In 1961, GRTS was acquired by the government to provide support for the Advanced Ballistic Re-Entry System and the Air Force Systems Command. Athena and Pershing 1A missiles were tested here between 1962 and 1975 (Chemical Systems Lab 1982). Since this time, very little military activity has occurred here (WSMR 2014). An overview of the GRTS information reviewed as part of this PA can be found in **Appendix D.**

2.3 Current and Projected Land Use

The WSMR is an active installation and serves as the U.S. Army's largest rocket and missile development, firing and testing facility. The installation performs applied research, conducts field trials of new missile types, and finds new applications for existing missile systems (WSMR 2016).

Currently, WSMR is comprised of instrumentation sites, impact areas, support facilities, and launch sites. It is designated as a National Range that focuses on the support of missile development and test programs for the Army, Navy, Air Force, National Aeronautics and Space Administration (NASA), and other governmental agencies (WSMR 2016). The southern portion of the range is more densely populated and developed, with facilities that include the NASA White Sands Test Facility (WSTF), Launch Complexes, High Energy Laser Systems Test Facility (HELSTF), and others. The northern portion of the facility is much less densely developed and has fewer regularly inhabited facilities, which include the Stallion Range Center (SRC).

The NASA WSTF is a 60,800-acre facility used to conduct research to support the space mission (WSMR 2009). It was established in 1963 and is permitted by its co-use agreement with WSMR to make modifications within the industrial area without WSMR approval. NASA WSTF operates with its own Resource Conservation and Recovery Act (RCRA) permit and environmental management division and is responsible for its own environmental releases. As a result, the NASA WSTF will not be evaluated as part of this PA/SI.

2.4 Climate

WSMR is characterized as having a mild, arid to semiarid continental climate. December and January are the coldest months, with average daytime highs of about 57 degrees Fahrenheit (°F) and nighttime lows of 30°F. Summertime highs are experienced in June with an average temperature of 95°F. Atmospheric moisture comes from the Pacific Ocean and Gulf of Mexico. Average relative humidity is lower in the valleys, ranging from 65% at sunrise to 30% in the mid-afternoon. Warmer months have characteristically low humidity. February to May is the windy season in the area, causing soil erosion and particulate dust during dry spells. Southerly wind gusts between 35 to 57 miles per hour may also be generated. Average monthly precipitation is greatest in June and July, and average annual rainfall is about 10 inches. The monsoon season is between July and August, when thunderstorms and flash flooding are common. Snowfall is uncommon but can occur (WSMR 2009).

2.5 Topography

Southern Desertic Basins, Plains, and Mountains comprise 82% of WSMR. The intermontane desert basins and broad valleys are bordered by hills, which range from gently to strongly sloped. Alluvial fans and terraces are also found here. They have steep mountain ranges and trend north to south on the western portion of the installation (**Figure 2-3**). Comprising 18% of WSMR are Central New Mexico Highlands, which are characterized by tilted block-faulted ranges separated by intermountain basins. These blocks form longitudinal, asymmetric ranges and mountains. The Tularosa Basin makes up the southern and eastern portions of the installation. It is bounded on the west by the Organ and San Andres Mountains, which are separated by the St. Augustine Pass (U.S. Highway 70). The Organ Mountains reach elevations of 8,917 feet above mean sea level. The San Andres Mountains reach a peak of 8,956 feet above mean sea level (WSMR 2009; WSMR 2017).

2.6 Geology

The geology of WSMR consists of linear and isolated mountain ranges which are composed of folded and eroded volcanic rock (i.e. basalt, rhyolite, gabbro, andesite). The oldest exposed rocks at WSMR are Precambrian granitic and metamorphic units. The valley floors at WSMR are characterized by alluvial fans which extend from mountain bases and thick marine sediments (WSMR 2009). Soils on the installation overlay sands, rock fragments, and minor amounts of silt and clay that become coarser with depth.

The majority of WSMR lays atop the Tularosa Basin, which is an elongated, depressed crustal unit bounded by faults on its long sides. Tularosa Basin is a graben formed by block faulting. It extends from beyond the southern boundary of the installation towards the northwest. The Main Post and the HELSTF both lay within this basin, while the SRC lies outside of the basin in the far northern areas of WSMR. The basin is comprised of lacustrine deposits (made of sands, silts, and clays several hundred feet thick) formed by sediment transported from nearby mountains and deposited. Tularosa Basin contains many ephemeral playa lakes, alkali gypsum flats, and gypsum dunes. Thick deposits of gypsum form much of the underlying bedrock here. Certain locations of forming playas trap surface water and may form sinkholes (WSMR 2009; WSMR 2017).

The San Andres Mountain Range to the west of the installation can be divided into two groups based on rock type. The Organ Mountains are known for their serrate and rugged topography which was produced by the weathering of intrusive monzonite, extrusive rhyolite, and intrusive quartz. There are several faults in this mountain range which expose limestone, andesite, and shale. On the east side of these mountains is a north-south fault which forms the western limit of the graben (WSMR 2009). On the east side of the San Andres Mountains are slopes comprised of Precambrian metamorphosed rocks. They form a sharper slope than the west side of the San Andres Mountains, which are comprised of limestone with sandstone and shale. These date back to the Pennsylvanian and Mississippian Ages (WSMR 2017).

The Oscura Mountains, located in the north central portions of WSMR (east of SRC) are composed of Permian sandy shale, limestone, shale, Pennsylvanian conglomerate, and Precambrian metamorphic rocks.

A tertiary lava flow forms the badlands of WSMR, extending from the northeast boundary to the southwest nearly four miles and varying in thickness between 33 to 49 feet (WSMR 1978). The badlands are east of the Oscura Mountains and SRC.

Although the installation is adjacent to a fault block, earthquake activity is not characteristic and WSMR is not located in an area of frequent seismic events (WSMR 2009).

2.7 Hydrogeology

The installation lies primarily within three watersheds: Jornada del Muerto, Tularosa Valley, and Jornada Draw. These are closed basins, with no outlet for surface water flow. Ephemeral arroyos and washes drain from the mountain range eastward toward the Tularosa Valley watershed and westward into the Jornada del Muerto watershed (WSMR 1978). The majority of WSMR drains into the Tularosa Valley watershed. A third of this watershed's acreage lies within the boundaries of the installation. It receives recharge from the mountain front with loss to evaporation occurring in the lowest portion of the basin at

Lake Lucero (WSMR 1978). Generally, groundwater flows away from the mountain ranges. Water quality and availability depletes as distance from these mountain ranges grows.

Groundwater flow in the Main Post area is generally to the southeast but is influenced by the pumping from local water supply wells (Environmental Science and Engineering, Inc. [ESE] 1996). Within the western portion of the Tularosa Valley bolson, groundwater is presumed to flow to the south (MEVATEC Corporation 2002). At HELSTF, perched groundwater flow is to the southeast. Regional groundwater flow is toward the south. Finally, at the SRC, groundwater flow is to the south-southeast (ESE 1996). Shallow perched aquifers are present throughout the Tularosa Basin aquifer. However, they are not used for potable water supply due to poor water quality.

The SRC, at the northern portion of the installation, lies on top of aquifer systems of the Rio Grande Region. This region is comprised of thin Upper Quaternary fluvial deposits of the inner Rio Grande Valley and thick sedimentary fill of intermontane basins, which includes bolson-fill deposits within the Jornada del Muerto Basin. The Upper Cenozoic Santa Fe Group forms the majority of the latter unit. Groundwater flow in this area is controlled by the lithofacies and stratigraphic subdivisions as well as associated rift of basin and range structures. This structural framework also heavily influences the quality of groundwater and surface water in the area. The majority of groundwater recharge to this bolson aquifer occurs through the unconsolidated Tertiary/Quaternary alluvial fan deposits and arroyos along the eastern flank of the San Andres, San Augustin, and Organ Mountains (Arcadis 2011). At the SRC, groundwater flow is also influenced by the pumping from local water supply wells and can vary in direction towards them (ESE 1996).

2.8 Surface Water Hydrology

Natural, perennial surface water resources on the installation are nonexistent (WSMR 1978). The soil on the installation is highly absorbic and the evaporation rate in the area is high, resulting in minimal surface water retention. The only perennial surface water at WSMR once was the sewage effluent treatment ditches. The effluent infiltrated the ground after flowing on the surface for about 3,300 feet (WSMR 1978). Recently, the installation has converted to new sewer lines to convey the effluent towards Davies Tank, southeast of the Main Post area. The lowest part of the installation is Lake Lucero which is on the western edge of the White Sands National Monument. Local drainage courses toward the center of the Tularosa basin but ultimately drains to the south.

Salt Creek originates at the Oscura Mountains on their southern edge. It empties into the Alkali Flats. Three Rivers Creek originates in the Sacramento Mountains, east of WSMR, and terminates into the Alkali Flats. Malpais Spring is located on the southwest edge of the lava flow and discharges into the basin floor (WSMR 1978).

The Village of Tularosa has surface water rights to Tularosa Creek and relies on these diverted surface water flows for drinking water and irrigation water for 2,000 acres of land. Water is also diverted upstream from Tularosa and the Mescalero Apache Reservation (WSMR 2009).

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 WSMR.

2.9.1 Stormwater Management System Description

The Main Post area of the installation has a large area of impervious surfaces. Structural stormwater management features include man-made open ditches, natural ditches, culverts, and underground storm sewer lines with grated storm drains. All drainage flows eastward on the site toward the desert valley. Along the western edge of the Main Post is a levee, which was built in 1968 to divert the stormwater drainage to the north and south. Currently, there are three major drainage outfalls. They exist on the east side of Hughes Road and are south of Watertown Avenue. Modeling results from a 2009 investigation determined that much of the Main Post had inadequate structural stormwater management features (WSMR 2009).

2.9.2 Sewer System Description

Sanitary wastewater generated at Main Post is treated in the sewage treatment plant. The effluent is conveyed via underground sewer pipes to the southeast of the main cantonment and infiltrates near Davies Tank.

Sanitary wastewater generated at SRC is collected into septic tanks and then flowed to evaporation lagoons. The small amount of sludge from these lagoons is placed in drying beds (WSMR 1978).

There are approximately 60 septic tank and drainage field systems at outlying areas where other methods of wastewater disposal are not feasible. Septic tanks are pumped out periodically for treatment at the sewage treatment plant.

2.10 Potable Water Supply and Drinking Water Receptors

The source of potable water for WSMR is from groundwater in alluvial aprons. Each area of the installation has its own distribution system. There are 18 raw water supply wells throughout the installation which provide drinking water. Of these wells, 11 can be found within the Main Post area, where water is withdrawn from the Tularosa Valley basin. The Main Post has a closed-loop system with one water line extending to the southeast corner of the installation. Well depths average approximately 770 feet below ground surface (bgs). The static water level in these wells rises to between 305 and 400 feet bgs. The water-bearing zone is up to 1,700 feet thick on the western edge of the Tularosa Valley basin, and it pinches out to the west of the Dona Ana-Otero County boundary (Coastal and Hydraulics Laboratory 2016).

Four other wells can be found 6 to 10 miles southeast of Main Post in the Soledad Canyon area. These wells withdraw water from the Tularosa Basin and is conveyed to the Main Post water treatment plant (WTP). Treated water is stored in two 400,000-gallon storage tanks (Coastal and Hydraulics Laboratory 2016). However, two of these four wells are not currently in service due to sand production. The other

two wells are not in service because the booster pump to the water treatment plant is out of service due to sand production.

In the northwestern portion of the installation, two wells at the SRC (SRC-02 and SRC-03) withdraw brackish water from the Quarternary/Tertiary alluvial and upper bolson-fill deposits within the Jordana del Muerto Basin. These wells supply water to a reverse osmosis plant, which desalinates the water and produces about 50,000 gallons of potable water per day. In addition to supplying the SRC with potable water, treated water from the two wells at the SRC is conveyed using trucks to remote sites for drinking water and construction purposes (Coastal and Hydraulics Laboratory 2016).

In addition to the 15 potable water supply wells, there are approximately 18 older wells on the installation that each withdraw up to 200 gallons per day for wildlife. (Coastal and Hydraulics Laboratory 2016).

As part of the PA, a search was conducted for other domestic and public potable water supply wells within 5 miles of the installation boundary. 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 WSMR, which along with state and county GIS 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 provided as **Appendix E.**

2.11 Ecological Receptors

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

WSMR is in the Bolson sub-section, Mexican Highlands section of the Basin and Range physiographic province. Higher elevations support limited ponderosa pine forest and woodlands. Valleys and slopes of mid-elevations support Plains-Mesa Foothill grasslands, Chihuahuan Desert shrublands, and Chihuahuan Desert grasslands. Grasslands make up the most abundant vegetative communities. Vegetation classification of WSMR resulted in 71 major plant associations. Twenty-two of these are considered imperiled and 41 are vulnerable. The two most abundant communities are Lowland Basin Grassland and Mixed Foothill-Piedmont Desert Grassland (WSMR 2009).

A large portion of the installation is patchy with large intercanopy spaces and scarce vegetation. Mesquite shrublands make up the majority of the patchy areas, which are mostly dune fields. Shrublands make up 22% of the installation. Ten plant associations are associated with shrubland here, ranging from dense to sparse shrub canopy to sparse to moderate grassy understory (WSMR 2009).

On WSMR, 73 mammal species occur, as well as 291 bird species, seven amphibian species, and 47 reptile species. Large mammals include mule deer, elk, collared peccary, pronghorn antelope, bighorn sheep, feral horse, oryx, barbary sheep, coyotes, bobcats, mountain lions and badgers. Small mammals include a variety of rabbits, shrew, rodents and bats. Big game species include oryx and pronghorn antelope (WSMR 2009).

The avian species on the installation are raptors, game birds, and songbirds. Game birds include Gambel's quail, scaled quail, white-winged dove, and mourning dove. Songbirds include black-throated

sparrow, pyrrhuloxia, and horned larks. Raptors include northern harriers, Swainson's hawk, and red-tailed hawks (WSMR 2009).

The singular native fish species on WSMR is the White Sands pupfish (WSMR 2009).

Of the seven amphibian and 47 reptile species on the installation, there are six toad species, one salamander, one turtle, 19 lizard, and 27 snake species. Five of these snake species have potentially lethal bites (WSMR 2009).

Although a complete inventory of invertebrate species for WSMR has not been documented, beetles, true bugs, ants, bees, wasps, butterflies, moths, and flies have all been documented. Other invertebrates found on the installation include centipedes, vinegaroons, scorpions, and spiders. Land snails have been identified, including the endemic Tularosa springsnail (WSMR 2009).

Desert Bighorn Sheep are listed as an endangered species by the State of New Mexico. There are 61 federal and/or state sensitive species of flora and fauna known to occur, or potentially occurring on WSMR. Species listed as endangered both federally and in New Mexico include the least tern, northern Aplomado falcon, southwestern willow flycatcher, and the Todsen's pennyroyal. Species which are listed as endangered only in the state of New Mexico include the brown pelican, the desert night-blooming cactus, the Mescalero milkwort, and the Organ Mountain pincushion cactus (WSMR 2009).

2.12 Previous PFAS Investigations

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

In response to the third Unregulated Contaminant Monitoring Rule (UCMR3) 15 samples were collected from two Alamogordo domestic water system facilities which are approximately 50 miles to the northeast from WSMR in 2013 and 2014. They were analyzed according to USEPA Method 537, which included PFOS, PFOA and PFBS. Analytical results indicated that PFOS, PFOA and PFBS were not detected in the samples; the limits of detection were 40 ng/L, 20 ng/L and 90 ng/L, respectively. The analytical results from these PFAS samples are included in **Table 2-1**.

In October 2016, under the IMCOM Operations Order 16-088, 12 samples were collected from components of three water systems at WSMR, including several wells and points of entry **(Appendix F).** They were analyzed according to USEPA Method 537, which included PFOS, PFOA and PFBS. Analytical results indicated that PFOS, PFOA and PFBS were not detected in the samples; the limits of detection for these analytes varied between 51-57 ng/L, 26-28 ng/L, and 12-130 ng/L, respectively. The analytical results from these PFAS samples are included in **Table 2-1**.

In 2019, one point of entry sample was collected from WSMR. It was analyzed according to USEPA Method 537 Version 1, which included PFOS, PFOA and PFBS. Analytical results indicated that PFOS, PFOA and PFBS were not detected in the samples; the limits of detection were 0.53 ng/L, 0.31 ng/L and 0.27 ng/L, respectively. The analytical results from this PFAS sample is included in **Table 2-1**.

In 2020, eight drinking water samples were collected from WSMR. They were analyzed according to USEPA Method 537 Version 1, which included PFOS, PFOA and PFBS. Analytical results indicated that PFOA was detected in two samples and PFBS was detected in three samples. The limit of detection for

each of these analytes varied between the ranges of 0.33 ng/L and 0.37 ng/L. The analytical results from these PFAS samples are included in **Table 2-1**.

3 SUMMARY OF PA ACTIVITIES

To document areas where any potential current and/or historical PFAS-containing materials were used, stored and/or disposed at WSMR, 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 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 G**), installation personnel interviews (**Appendix H**), site reconnaissance photos (**Appendix I**) and site reconnaissance logs (**Appendix J**) during the PA process for WSMR is presented in **Section 4**. Further discussion regarding rationale for not retaining areas for further investigation is presented in **Section 5.1**, and further discussion regarding categorizing areas as AOPIs is presented in **Section 5.2**.

3.1 Records Review

The records reviewed for this PA included, but were not limited to, various Installation Restoration Program (IRP) administrative record documents, compliance documents, WSMR fire department documents, WSMR directorate of public works (DPW) 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 WSMR is provided in **Appendix G**.

3.2 Personnel Interviews

Interviews were conducted during the 2018 PA site visit. The list of roles for the installation personnel interviewed during the PA process for WSMR is presented below (affiliation is with WSMR unless otherwise noted).

- Stallion Branch Chief DPW
- General Engineer - Master Planning
- IRP Manager
- Senior Archaeologist
- Environmental Chief
- Current Fire Chief

- Senior GIS Analyst
- (G-3) Environmental Engineer
- Supervisor for Grounds
- Environmental Engineer
- Conservation Branch Chief
- Aviation Manager
- Water Resources Program Manager
- Deputy Fire Chief
- Pest Control Technician
- Work Leader - Pest Control
- Director of Installation Safety Office
- Hazardous Waste Program Manager
- Safety Coordinator
- Acting Chief of Utilities
- Garrison Chief Site Safety Officer
- (G-3) Archaeologist of Cultural Resources
- NASA Environmental Project Manager
- NASA Fire Chief

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

3.3 Site Reconnaissance

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

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

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

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

4.1 AFFF Use, Storage, and Disposal Areas

AFFF was developed in the mid-1960s in response to a need for firefighting foams better suited to extinguish Class B, fuel-based fires. AFFF formulations consist of water, an organic solvent, up to 5 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.

As identified in the current assets file and confirmed during 2018 PA site visit interviews with fire department personnel, AFFF was stored at Former Fire Department Storage (FFDSTG) building. In 2008, AFFF began being stored in the current Fire Department Storage (FDSTG). Not only does this building store drums of Class A and B foam, it also stores apparatuses and vehicles that have the potential to contain AFFF, including a Striker and other aircraft rescue and firefighting vehicles.

Additional AFFF storage buildings include those at Fire Station 4 HELSTF and Fire Station 3 SRC. The Fire Station 4 HELSTF storage building is estimated to have stored AFFF since 1987. During the 2018 PA site visit, the Fire Station 4 HELSTF storage building housed 17, 5-gallon containers of Silv-ex® Class A foam concentrate, one 55-gallon drum of Ansulite™ 3% AFFF (Class B foam) concentrate, and one 5-gallon bucket of Chemguard® 6% (Milspec Class B foam) concentrate. The Fire Station 3 SRC storage building has been used for AFFF storage since 2003, when it was converted from a gym facility and theater. No evidence of spills or leaks from the AFFF containers was observed or reported during the site visit.

In February 2017, AFFF from the WSMR Fire Department was received by the Hazardous Waste Program at Building 1817. According to installation personnel, the turn-in of materials included three 55-gallon drums, five pallets of 5-gallon buckets, and another two 5-gallon buckets of AFFF. The total weight of material turned in to the Hazardous Waste Program was 5,975 pounds. The volume is estimated to be approximately 675 gallons. As of November 2017, the installation housed 110, 5-gallon containers and three 55-gallon containers for a calculated total of 715 gallons of AFFF concentrate.

Fire station personnel provided their accounts of fire station use, spill response, and firefighting training. Fire Station 1 is located at Main Post. It has a wash pad located northwest of the building. Historical washout and nozzle testing is suspected in this area but could not be confirmed by current Fire Department staff. Runoff from this wash pad would be conveyed to the stormwater swale to the south.

Fire Station 2 Launch Complex (LC) has been in commission since 1967. A 1982 article reviewed from the installation archives shows a 1,500-gallon water and foam tanker at the station which would have been capable of spraying AFFF.

Fire Station 3 SRC has been in commission since before 1960. It houses Striker and P19 vehicles on location which carry Class B AFFF.

Fire Station 4 HELSTF has been in commission since 1987. A Heavy Expanded Mobility Tactical Truck based water tender HEWATT vehicle is located outside the fire station. The vehicle has a 50-gallon tank that carries Class A foam concentrate according to WSMR fire department staff.

According to interviews and document review, AFFF releases have not occurred at any of the WSMR fire stations. However, it is possible that releases may have occurred and not been reported. According to site personnel, the Hazardous Waste Storage (Building 22985) was reportedly sprayed down with an unidentified foam in 2008 in response to a collapsed drum to reduce static.

The Current Firefighting Training Area (CFTA) has been active since 2013. Historical satellite imaging dating back to 1996 shows fence lines and structures within the current boundaries. The current Fire Department staff indicate no use of AFFF at this site, although there is potential for its use prior to their arrival. According to Fire Department staff, only water and propane have been used here for firefighting training purposes.

The FFTA at Martin Luther King Avenue and Hughes Avenue (FFTAMLK) is estimated to have been constructed sometime between 1998 and 2003 according to satellite imagery. No documentation was available to review. WSMR Fire Department personnel indicated the site was never used for firefighting training. During the 2018 PA site visit, training equipment and a full 5-gallon container of 3M Light Water™ AFFF was identified. This container was weathered and cracked. It was later removed by the DPW-Environment to the hazardous waste yard to be disposed of with other AFFF material.

For emergency preparedness, WSMR fire department personnel were trained to performed nozzle testing with AFFF to ensure optimal flow and release of the AFFF mixture. Nozzle testing involved spraying AFFF through fire equipment, which could release AFFF to the environment if the mixture was not fully contained. There were no installation reports where nozzle testing was performed. Fire equipment training also included arc training to maximize the arc, reach, and distance covered by AFFF in an emergency response.

The FFTA Pit was used until 1982. It is located at the southern fringe of the Main Post. During its operation, waste oils and fuels were used to simulate fire emergencies for training purposes. It is believed that AFFF was used during this training. According to a 1978 newspaper article from the Missile Ranger, foam was utilized to extinguish a fuel fire at these fire pits (Missile Ranger 1978). The IRP site was excavated to a depth of 8 feet to address oil-contaminated soils and placed in stockpile. The stockpile area contained soils removed from a 50-foot by 50-foot area which was scraped to a depth of 1-foot bgs and was known as FFTA Waste Pile. The excavated soil was disposed of at the WSMR landfill. Remaining soils stored onsite in roll off containers were used as backfill at the excavation. In a 01

October 1976 article of the installation newspaper, Missile Ranger, firefighting training was shown to occur with foam at an unidentified location (Missile Ranger 1976). According to the site history, this is likely to have occurred at the FFTA Pit.

A 2014 Missile Ranger newspaper article indicated that a firefighting training exercise was conducted near Main Post on a mock helicopter crash. The article shows a photo of an unidentified aqueous material being used to extinguish the flames at Camp Tumbleweed. Neither the exact location of this training nor the aqueous material used in this training could be confirmed by installation personnel.

The SRC FFTA was reportedly used before the 1980s based on previous reports and fire department staff. Firefighting activities included setting small, controlled fires for firefighters to practice extinguishing. Typically, flammable liquids such as diesel and gasoline were used to start the fire. Although no WSMR personnel interviews indicated AFFF was used in this training, the time period of operation of the training area makes AFFF usage likely. In 2010 a revised RCRA Facility Investigation (RFI) report was developed and included a Human Health Risk Assessment and an Ecological Risk Assessment for the SRC FFTA (Arcadis 2011). In 2011, an additional investigation was performed on a small area of soils affected by firefighting training at the SRC FFTA. An area of about 8 feet wide by 16 feet long was excavated due to exceedances of arsenic and diesel-range organics. The excavation ranged from 2 to 10 feet bgs in depth. Approximately 60 cubic yards of soil were removed from the site and disposed offsite. WSMR has submitted a Correction Action Closure Petition to the NMED.

The WSMR Fire Department responds to vehicle accidents along U.S. Highway 70 and U.S. Highway 380. A 2014 newspaper article from the Missile Ranger describes the WSMR Fire Department as having responded to 31 major vehicle accidents in that area. Information regarding whether AFFF was used in these responses and the exact locations was not available during the PA.

According to installation interviews and record review, an aircraft crash occurred in the Red Rio Bombing Range at WSMR in June 2018. Records on the exact location of this crash and whether AFFF was utilized in this response have not been identified.

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

Following document research, personnel interviews, and site reconnaissance at WSMR, sewage treatment plants and associated percolations ditches/impoundments, landfills, photo processing labs, and vehicle maintenance shops were also identified as preliminary locations for use, storage, and/or disposal of PFAS-containing materials. A summary of information gathered in the PA for each of these preliminary locations is described below. Specific discussion regarding areas not retained for further investigation is presented in **Section 5.1** and specific discussion regarding areas retained as AOPIs is presented in **Section 5.2**.

An accidental release of six gallons of AFFF occurred at the Vehicle Maintenance Shop in 2016 during a routine maintenance operation. The AFFF was released onto the concrete when an incorrect valve control handle was pulled. The AFFF was washed to the east of the concrete into the drainage area.

The Sewage Treatment Plant, located on Main Post, received sewage from the installation until its closure in 1996. Between 1958 and 1986, wastewater which was potentially impacted by PFAS was routed here from the PPL. Treated wastewater was released to the east through two unlined drainage ditches into an impoundment area. The ditches were previously listed as two separate SWMUs (82 and

83) but have since been combined as SWMU-82. The ditches and bed were excavated in the 1990s. Approximately 4,000 cubic yards of excavated soil were taken to the WSMR Landfill.

In the 1990s, excavated soil was taken to the WSMR Landfill from the sewage treatment plant percolation ditches (STPPD) and evaporation area, which may have had soil impacted by PFAS (Radian International, LLC. 1997).

During closure in the 1980s, an area of soil 50 feet by 100 feet in size was excavated to a 4-foot depth. The excavated soil was aerated to remediate fuel hydrocarbons and used as clean fill for the SRC Landfill. No record of a written report documenting this cleanup has been discovered.

Excavated soil from the FFTA Pit was transported to WSMR Landfill on 10 April 1996 to be used as daily cover. This soil may have also been impacted by PFAS. WSMR Landfill has been capped and is under post closure care. Sanitary and Construction Landfills (SWMUs 86 and 87, respectively), are cells that make up the landfill.

Electromagnetic Analysis Facility Building was destroyed during a fire according to personnel interviews. The date is unknown, and the foam typed used to suppress the fire was not identified.

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 WSMR 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 pesticides use, storage, or disposal.

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 WSMR) is not part of the PA/SI program. 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. These potential PFAS sources include White Sands National Monument, Fort Bliss, and Holloman Air Force Base (AFB) releases.

According to news articles, in April 2016, a drone crash at the White Sands National Monument reportedly released a significant amount of jet fuel to the soil. It is unknown whether AFFF was used in any response to this crash.

Fort Bliss borders the installation to the south. Three potable wells which supply WSMR are located within the installation boundary of Fort Bliss. Any releases of PFAS within proximity to these wells have the possibility to impact the drinking water supply at WSMR.

Holloman AFB is located 40 miles east of the central portion of WSMR. Personnel interviews conducted at WSMR during the PA indicated that in 2003 and 2018, plane crashes occurred at Holloman AFB. According to personnel interviews, the WSMR Fire Department has also responded to some of these crashes. The exact locations of these crashes and responses are unknown. An SI performed at Holloman AFB in 2016 identified PFAS in soil, groundwater and surface water above the risk screening levels used in the investigation. Therefore, Holloman AFB is a source of PFAS to the east of WSMR.

5 SUMMARY AND DISCUSSION OF PA RESULTS

The preliminary locations evaluated for potential use, storage, and/or disposal of PFAS-containing materials at WSMR, 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, 19 areas have been identified as AOPIs. The process used for refining these areas is presented on **Figure 5-1**, below.

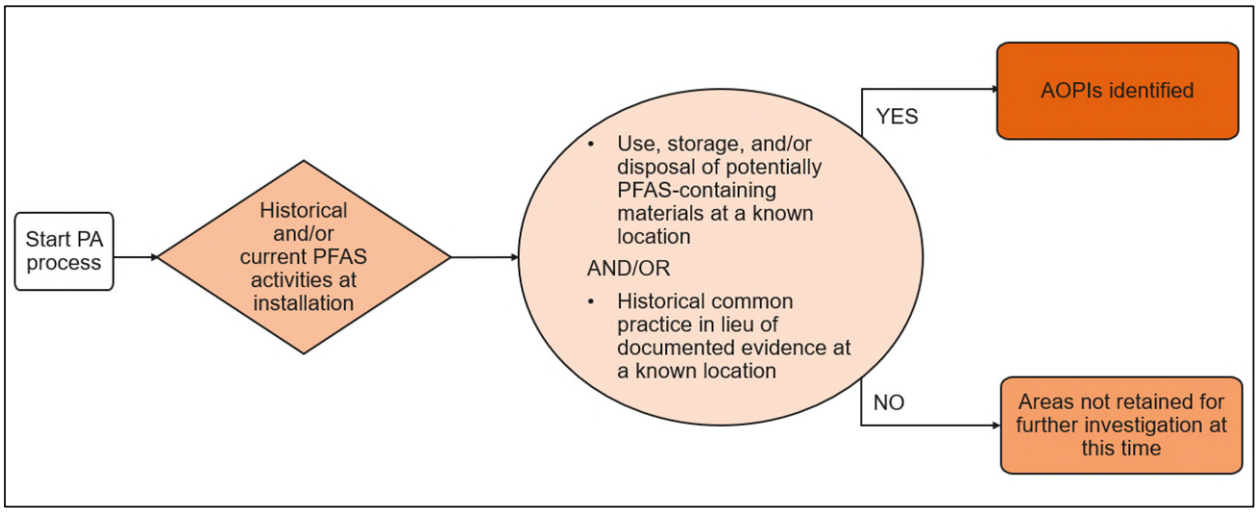

Figure 5-1: AOPI Decision Flowchart

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

Data limitations for this PA/SI at WSMR are presented in **Section 8**.

5.1 Areas Not Retained for Further Investigation

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

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

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

Area Description	Dates of Operation	Relevant Site History	Rationale
Temporary Building 1348 – Temporary Pesticide Storage	1960s to 1992	No known history of burial or unauthorized dumping. No known use of PFAS-containing pesticides. Past IRP investigation with removal actions performed.	No evidence of PFAS-containing materials used, stored, or disposed at this location.
Building 1708-Current Pesticide Storage	1992 to Present	Currently used for pesticide storage and mixing. Mixing is completed over a catch basin. No known use of PFAS-containing pesticides. Expired products are delivered to DPW Hazardous Waste Yard for disposal.	No evidence of PFAS-containing materials used, stored, or disposed at this location.
SWMU-62 – Former Sewage Treatment	1940 to 1958	This unit was a former sanitary WWTP located east of the Main Post area. The area has been regraded and no visible signs of the plant exist. It is unknown if PFAS-containing wastes were sent through the sewer system to this WWTP.	No evidence of PFAS-containing materials used, stored, or disposed at this location.
Building 34280 – Electronic Equipment Facility	1985 to 1986	Photo processing was reported as having taken place. Building is under tenant operation currently; no access was given to facility. No chemical lists were available for this site.	No evidence of PFAS-containing materials used, stored, or disposed at this location.
Vehicle accidents along U.S. Highway 70 and U.S. Highway 380	Ongoing	WSMR Fire Department responds to vehicle accidents along U.S. Highway 70 and U.S. Highway 380. Information regarding whether AFFF was used in these responses and the exact locations was not available during the PA.	No confirmed AFFF use and no confirmed locations.
Aircraft Crash Site in Red Rio Bombing Range	2018	An aircraft crash was reported to have occurred in the Red Rio Bombing Range at WSMR in June 2018. Records on the exact location of this crash and whether AFFF was utilized in this response have not been identified.	No confirmed AFFF use and no confirmed location.

5.2 AOPIs

Overviews for each AOPI identified during the PA process are presented in this section. Of the 19 AOPIs, seven overlap with WSMR IRP sites and/or Headquarters Army Environmental System (HQAES) sites (**Figure 5-2**). 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 WSMR 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 **5-17** and include active monitoring wells in the vicinity of each AOPI.

5.2.1 Fire Station 1 (FS1) (Building 155)

The Fire Station 1 is identified as an AOPI following records research, personnel interviews, and site reconnaissance due to the area potentially being used for AFFF storage and nozzle testing. This fire station has been in use since the 1950s and is the first fire station constructed at WSMR. A wash pad is located on the northwest side of the building, where fire truck tank washout and nozzle testing with AFFF is suspected to have occurred. Runoff is conveyed to a stormwater swale to the south across Aberdeen Avenue.

An aerial photograph of Fire Station 1 is provided on **Figure 5-3**. The AOPI is located on a paved area with a grassy area on the northeast corner.

5.2.2 Former Firefighting Training Area Pit (FFTAP/SWMU-21)

The FFTAP (SWMU-21) is identified as an AOPI following records research, personnel interviews, and site reconnaissance due to historical firefighting training activities. The AOPI is located at the southern fringe of the Main Post. The site was originally used beginning in the early 1960s until its closure in 1982 (International Technology Corporation [ITC] 1992). Three waste oil above-ground storage tanks were formerly present onsite. During the operation of firefighting training area, waste oils and fuels were used to simulate fire emergencies, and AFFF may have been used to extinguish the fires. The unit was reportedly excavated to a maximum depth of 8 feet to address oil-contaminated soils. Excavated soils were placed in six roll-off containers. The soil from five of these roll-off containers was determined to be non-hazardous and returned to the excavation as backfill. The sixth container was transported to WSMR Landfill on 10 April 1996 to be used as daily cover.

An aerial photograph of FFTAP (SWMU-21) is provided on **Figure 5-4**. This AOPI had three tanks used for waste oil present at the time of use, although they have since been removed. The area currently has no pavement or structures present.

5.2.3 Former Firefighting Training Area Waste Pile (FFTAWP/SWMU-22)

The FFTAWP (SWMU-22) is identified as an AOPI following records research, personnel interviews, and site reconnaissance due to the area being used to store potential PFAS-impacted soil excavated from the FFTAP (SWMU-21). The FFTAWP was located at the southern end of Main Post, south of the FFTAP (SWMU-21). The soil removed from the FFTAP during remediation activities in the 1990s was stored at the FFTAWP area before being disposed of in the WSMR Landfill (ITC 1992). To move the soil from the staging area to the WSMR Landfill, a 250 square foot area was excavated to a depth of 1 foot. A Corrective Action Closure Petition is currently in progress with NMED. Supplemental sampling for petroleum hydrocarbons associated with waste oil is currently being conducted under the work plan with NMED.

An aerial photograph of FFTAP (SWMU-22) is provided on **Figure 5-4**. There are no structures at this AOPI. The area is vegetated with patchy shrubbery.

5.2.4 Former Firefighting Training Area at Martin Luther King Avenue and Hughes Avenue (FFTAMLK)

The FFTAMLK is identified as an AOPI following records research, personnel interviews, and 2018 PA site reconnaissance due to the presence of a full 5-gallon container of AFFF along with firefighting training equipment, including a fuselage, multiple propane tanks, control panels, turret, and drainage features (riprap and ponding area). The AFFF container was weathered and cracked. This training area first appears on historical aerials in 2003. The most recent addition of training equipment occurred in 2013. According to Fire Department personnel, this FFTA was never used.

An aerial photograph of FFTAMLK is provided on **Figure 5-5**. The AOPI is located on a predominantly unpaved area. There are three areas of metal structures, two of which are paved. Water nozzles are located throughout the area. A crushed gravel road passes through the center of the AOPI.

5.2.5 Vehicle Maintenance Shop (VMS) (Building 21095)

The VMS at Building 21095 is identified as an AOPI following records research, personnel interviews, and site reconnaissance due to an accidental AFFF release in 2016. During a routine maintenance operation, an individual pulled the wrong lever on a fire truck, and approximately 5 gallons of AFFF concentrate were released onto the concrete. The spill was then washed off to the east into the drainage area.

An aerial photograph of the Vehicle Maintenance Shop is provided on **Figure 5-6**. The AOPI is located on a predominately paved area. Vegetated soil cover surrounds the AOPI.

5.2.6 Photo Processing Lab (SWMUs 1-7) (Building 1621)

The Photo Processing Lab (SWMUs 1-7) is identified as an AOPI following records research, personnel interviews, and site reconnaissance due to the occurrence of electroplating in the building. WSMR reportedly had the second most active photograph processing laboratory nationwide during peak building utilization. On floor plans, electroplating was indicated in several rooms, including those with floor drains. These floor drains lead to the Sewage Treatment Plant (ITC 1992). Additionally, three sinks in the photo processing area were used for weekly scrubbing on photo-processing racks, which were in direct contact with photo chemicals such as metallic cyanides and silver. These sinks also drain to the Sewage Treatment Plant. Historical documents reviewed as part of the PA state that electroplating took place in this building, and that the waste derived from it included silver. This silver was removed from the electroplating waste by SWMU-7, a recovery unit tailing tank. Approximately 30 gallons of waste were generated each month during operation. Electroplating operations may have potentially utilized chemicals containing PFAS, but the exact type of electroplating is unknown. SWMU-7 was a recovery unit tailing tank that removed silver from the waste generated by electroplating and conveyed the waste to an internal drum. The site is currently undergoing corrective action under a RCRA permit.

An aerial photograph of the PPL (SWMUs 1-7) is provided on **Figure 5-7**. The AOPI is a building located in a flat, unpaved area. Immediately adjacent and to the east is a paved parking lot.

5.2.7 Fire Department Storage (FDSTG) (Building 1812)

The FDSTG is identified as an AOPI following records research, personnel interviews, and site reconnaissance. The AOPI is located at the northeastern portion of Main Post. The site was used beginning in 2008 by the WSMR Fire Department. A striker vehicle and aircraft rescue and firefighting vehicle are stored here. The area is known to store AFFF-related apparatus and vehicles, as well as both AFFF and Class A foams. No reported spills occurred at this storage facility.

An aerial photograph of FDSTG is provided on **Figure 5-8**. The area is paved with the storage area still intact.

5.2.8 Former Fire Department Storage (FFDSTG) Building (Building 1713)

The FFDSTG Building is identified as an AOPI following personnel interviews. The AOPI is located at the southern portion of the Main Post, west of the VMS and east of the FFTAP. Based on fire department staff interviews the building was used to store firefighting related materials before the storage was moved to Fire Department Storage Building. These materials may have included AFFF, AFFF-related vehicles, and AFFF-related apparatuses.

An aerial photograph of FFDSTG is provided on **Figure 5-9**. The area is paved with the storage area still intact.

5.2.9 Sewage Treatment Plant Percolation Ditches and Impoundment Area (STPPD) (SWMU-82)

The STPPD received sewage from the installation until the sewage treatment plant was closed in 1986. Between 1958 and 1986, wastewater which was potentially impacted by PFAS was routed to the sewage treatment plant from the PPL. Treated wastewater was released to the east through two unlined drainage ditches into an impoundment area. The ditches were previously listed as two separate SWMUs (82 and 83) but have since been combined as SWMU-82. The ditches and impoundment area were excavated in the 1990s, and the excavated soil was taken to the WSMR Landfill.

An aerial photograph of STPPD is provided on **Figure 5-10**. The area is lightly vegetated without any pavement present.

5.2.10 WSMR Landfill (SWMUs 86-87)

In the 1990s, approximately 4,000 cubic yards of soil excavated from the STPPD were taken to the WSMR Landfill. Some or all of these soils may have had soil impacted by PFAS (Radian International, LLC. 1997). In 1996, excavated soil from the FFTAP and FFTAWP was transported to WSMR Landfill to be used as daily cover. This soil may have also been impacted by PFAS. The WSMR Landfill has been capped and is under post closure care.

An aerial photograph of WSMR Landfill is provided on **Figure 5-11**. The area is lightly vegetated without any pavement present.

5.2.11 Current Firefighting Training Area (CFTA) (Building 21612)

The CFTA at Building 21612 is identified as an AOPI following records research, personnel interviews, and site reconnaissance due to historical firefighting training activities. Personnel interviews indicate that firefighting training has occurred here since 2013 using water and propane only. However, there is potential for historical AFFF use here prior to the employment of the current fire department staff. Historical imaging from 1996 shows fence lines and structures related to training operations.

An aerial photograph of the CFTA is provided on **Figure 5-12**. The AOPI is located on a flat, paved surface surrounded by unpaved, lightly vegetated areas.

5.2.12 Fire Station 2 Launch Complex (FS2) (Building 23480)

The Fire Station 2 at Building 23480 is identified as an AOPI following records research, personnel interviews, and site reconnaissance due to a 1982 Missile Ranger article showing a tanker capable of spraying AFFF present at this station (Missile Ranger 1982). Firefighters may have conducted vehicle washing and maintenance or nozzle testing here, resulting in the release of PFAS-containing AFFF.

An aerial photograph of Fire Station 2 LC is provided on **Figure 5-13**. The AOPI is located on a flat, paved area surrounded by grass and dirt areas.

5.2.13 Fire Station 4 High Energy Laser System Test Facility (FS4) (Building 26020)

The Fire Station 4 at Building 26020 is identified as an AOPI following records research, personnel interviews, and site reconnaissance due to AFFF use and storage. The fire station has been used from 1987 to present, and nozzle testing and maintenance of vehicles containing AFFF is performed at this location. Additionally, a HEWATT vehicle is located outside this fire station. This vehicle has a 50-gallon tank that carries only Class A foam according to fire department personnel. The storage building, located on the premises, was used to store AFFF. During the PA site visit, Chemguard® 6% milspec was observed being stored here.

An aerial photograph of Fire Station 4 is provided on **Figure 5-14**. The AOPI is located on a flat-paved area surrounded by typical desert landscape.

5.2.14 Fire Station 3 Stallion Range Center (FS3) (Building 34228)

Fire Station 3, located at Building 34228, is identified as an AOPI following records research, personnel interviews, and site reconnaissance due to the fire station housing striker and P-19 vehicles (which carry Class B AFFF). It is suspected that training and nozzle testing with AFFF may have been conducted at this location. The building was constructed in 1960 and is still in use. The storage building, located on the premises, may have been used to store AFFF.

An aerial photograph of Fire Station 3 is provided on **Figure 5-15**. The AOPI is located on a flat, unpaved area. Immediately adjacent to the northeast is a parking lot.

5.2.15 Stallion Range Center (SRC) FFTA (SWMU-162)

The SRC FFTA (SWMU-162) is identified as an AOPI following records research, personnel interviews, and site reconnaissance due to the use of the area as a firefighting training area where small diesel fuel or gasoline fires were ignited. The date that the firefighting training area was used first is unknown; however, it is known that it was used until the 1980s. A Corrective Action Closure Petition submitted to NMED is currently in progress for the site. In 2011, an area 50 feet by 100 feet was excavated to a 4-foot depth. The excavated soil was aerated in the sun and used as clean fill for the SRC landfill. Approximately 60 cubic yards of material was profiled, manifested and removed from site as non-hazardous waste.

An aerial photograph of SRC FFTA (SWMU-162) is provided on **Figure 5-16**. The AOPI is located on a flat, unpaved surface without structures present.

5.2.16 Stallion Range Center Landfill (SWMUs 119-120)

During closure of the SRC FFTA in the 1980s, an area of soil 50 by 100 feet in size was excavated to a 4-foot depth, aerated in the sun, and used as clean fill for the SRC Landfill. Approximately 60 cubic yards of material was profiled, manifested and disposed at the SRC Landfill as non-hazardous waste. This possibly impacted soil may have contributed to PFAS constituents migrating through desorption or dissolution to groundwater in the area around the SRC Landfill, which is still active.

An aerial photograph of SRC Landfill is provided on **Figure 5-17**. The area is lightly vegetated without any pavement present.

5.2.17 Camp Tumbleweed Fire Training Area (FTA)

The Camp Tumbleweed FTA is identified as an AOPI following records research, personnel interviews and site reconnaissance due to the use of the area as a firefighting training area where the historical fire response training potentially used AFFF. In 2013, a newspaper article from the Missile Ranger indicated that firefighters put out a mock helicopter fire near Main Post during a training exercise. No evidence that Class B foam was used during training was found, and the location of this camp could not be confirmed. Further investigations located the camp on the south side of the investigated area by using newspaper description and former images.

An aerial photograph of Camp Tumbleweed FTA is provided on **Figure 5-18**. The area is lightly vegetated without any pavement present and a covered picnic area.

5.2.18 Hazardous Storage Waste Building (Building 22895)

The Hazardous Storage Waste Building is identified as an AOPI following records research, personnel interviews and site reconnaissance due to the spill of an unknown chemical. In 2008, a Collapsed drum resulted in a flammable spill (unknown chemical). To suppress vapors, the entire building was reportedly sprayed down with foam. The AFFF used in response is unknown.

An aerial photograph of Hazardous Storage Waste Building is provided on **Figure 5-19**. The AOPI is located on a flat, paved area surrounded by grass and dirt areas.

5.2.19 Electromagnetic Analysis Facility (Building 23638)

The Electromagnetic Analysis Facility is identified as an AOPI following personnel interviews due to an historical fire response which used foam. The date and type of foam used is unknown. The was potential AFFF runoff from the foam used to suppress the fire. The building was destroyed during the fire.

An aerial photograph of the former footprint of the Electromagnetic Analysis Facility is provided on **Figure 5-20**. The AOPI is located on a flat, paved area surrounded by grass and dirt areas.

6 SUMMARY OF SI ACTIVITIES

Based on the results of the PA at WSMR, an SI for PFOS, PFOA, and PFBS was conducted in accordance with CERCLA. SI sampling was completed at WSMR at all 19 AOPIs to evaluate presence or absence PFOS, PFOA, and PFBS in comparison with the OSD risk screening levels. As such, an installation-specific QAPP Addendum (Arcadis 2020) was developed to supplement the general information provided in the PQAPP (Arcadis 2019) and to detail the site-specific proposed scopes of work for the SI. A preliminary CSM was prepared for each of the installation's AOPIs in accordance with the USACE Engineer Manual on Conceptual Site Models, EM 200-1-12 (USACE 2012). The preliminary CSMs identified potential human receptors and chemical exposure pathways based on current and/or reasonably anticipated future land uses. The preliminary CSMs identified soil and groundwater 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 with multiple mobilizations in July and November 2020 and May and July 2022 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 2020) and PQAPP (Arcadis 2019). The subsections below summarize the DQOs, sampling design and rationale, sampling activities and methods, and data analyses procedures for the SI phase at WSMR. 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 2020), 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 and soil for PFOS, PFOA and PFBS presence or absence at each of the sampled AOPIs.

6.2 Sampling Design and Rationale

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

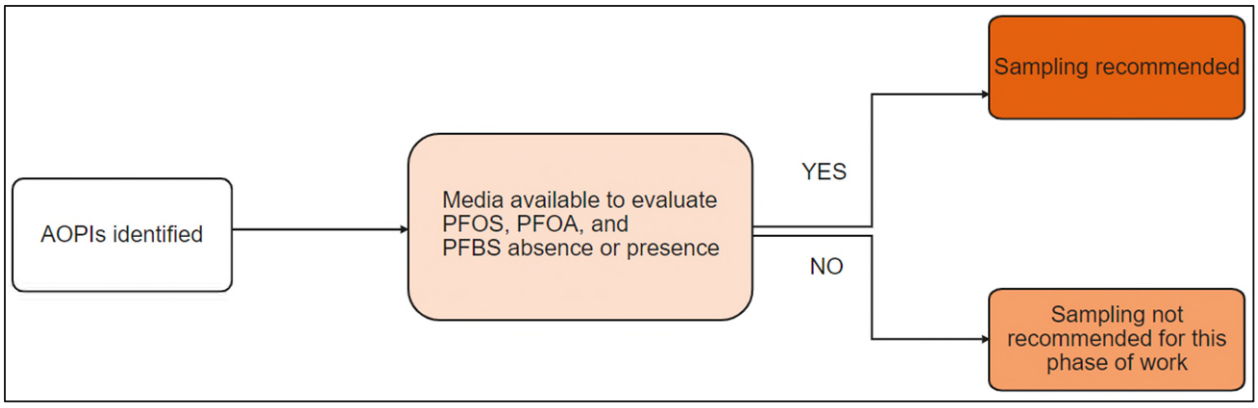

Figure 6-1: AOPI Sampling Decision Tree

The sampling design for SI sampling activities at WSMR is detailed in Worksheet #17 of the QAPP Addendum (Arcadis 2020). Briefly, groundwater samples were collected from monitoring wells and raw water supply wells via pre-treatment sample ports to inform the interpretation of PFAS presence and to update the individual AOPI CSMs. Raw water supply wells located on Main Post are located downgradient from multiple AOPIs and therefore inform potential PFAS presence for all AOPIs located upgradient. Groundwater samples were collected from between one and three downgradient raw water or monitoring well locations associated with each AOPI, when present. The raw water supply wells were sampled in relation to the nearest AOPI. The sampling depths at existing monitoring wells were at approximately the center of the saturated screened interval. **Table 6-1** includes the monitoring well construction details for the wells sampled during the SI (if available).

Soil samples were collected to evaluate PFAS presence or absence at potential release areas, to evaluate the potential for release areas to be sources of PFAS to surface water and groundwater, and to update the individual AOPI CSMs. Soil samples were analyzed for select PFAS constituents; additionally, total organic carbon (TOC), pH and grain size were analyzed in one soil sample per AOPI. At 17 of the 19 AOPIs, composite surface and/or shallow soil samples were collected from two to seven locations from within and surrounding the suspected release area. Soil was not sampled at the SRC and WSMR Landfills because these AOPIs are covered by a landfill cap, and it is not known where PFAS-impacted soils may have been deposited within the AOPIs. As a result, only groundwater samples were collected from these two AOPIs from wells around the perimeter, downgradient of the landfill.

6.3 Sampling Methods and Procedures

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

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

The sampling methods employed during the SI are detailed in the PQAPP (Arcadis 2019) and QAPP Addendum (Arcadis 2020). The subsections below provide a summary of the field methods and procedures utilized to complete the SI scope of work. 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 **Appendix K**. Photologs 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. Field parameters (temperature, pH, conductivity, dissolved oxygen, turbidity, and oxidation-reduction potential) were measured during purging and allowed to stabilize in accordance with the TGI for PFAS Sampling Procedures and Low-Flow Groundwater Purging for Monitoring Wells (P-11 in Appendix A to the PQAPP; Arcadis 2019) before groundwater sampling to ensure a representative sample was collected. Arcadis field staff used portable bladder pumps with PFAS-free high-density polyethylene tubing and a nitrogen tank configuration to collect groundwater samples.

Shallow soil samples (0 to 10 feet bgs) were collected via direct-push technology (DPT) or hand auger methods. DPT boring and composite soil sampling was completed using dual-tube top-down methods and PFAS-free acetate liners in accordance with the TGI P-12 in Appendix A to the PQAPP (Arcadis 2019). The boreholes were backfilled with the augured cuttings upon completion of sampling, after extracting sample volumes. Hand-augured boreholes were advanced to a maximum of 2 feet bgs and decontaminated stainless-steel trowels and bowls were used to collect and separately composite the top 2 feet of native soil.

Grab groundwater samples were collected from four raw water supply wells via their pre-treatment sampling ports. The sampling ports were absent of Teflon containing materials. Field parameters (temperature, pH, conductivity, dissolved oxygen, turbidity, and oxidation-reduction potential) were measured during purging and allowed to stabilize before sampling to ensure representative sample collection.

Decontamination procedures for non-dedicated equipment used during sampling are described in **Section 6.3.4**.

6.3.2 Quality Assurance/Quality Control

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

QA/QC samples were collected at the frequencies specified in the QAPP Addendum (Arcadis 2020), typically at a rate of 1 per 20 parent samples. Field duplicates and matrix spike/matrix spike duplicate samples were collected for media sampled for PFOS, PFOA, and PFBS, and total organic carbon (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 2020). The decontaminated reusable equipment from which EBs were collected include drill casing and cutting shoes, hand augers, stainless-steel bowls, stainless-steel trowels, acetate liners, and water-level meters 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 7.21**.

6.3.3 Dedicated Equipment Background

Dedicated equipment background samples were not collected at WSMR AOPIs. The sampled groundwater monitoring wells did not house dedicated down-hole equipment.

6.3.4 Field Change Reports

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

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

- FCR-WSMR-01 (PPL): Based on field conditions and locations of underground utilities, WSMR-PPL-2-SO was moved approximately 15 feet north and 5 feet east to ensure appropriate distance from underground utilities.
- FCR-WSMR-02 (VMS): Based on field conditions, WSMR-VMS-1-SO was moved approximately 15 feet to the west of the original scoped location. WSMR-VMS-2-SO was moved approximately 45 feet to the east into an arroyo bottom where soil was present. Both original locations were located within a rip rap rock area used for erosion control.
- FCR-WSMR-03 (FS3): Based on discussions with fire department staff at Fire Station 3, the WSMR-FS3-1-SO location was changed. Fire Department staff stated that in the past they would perform training across the street approximately 50 feet from the street. The original location was just north of the road surface.
- FCR-WSMR-04 (FS3STG): The storage facility at FS3 was added as an AOPI after the QAPP was completed due to historical storage of AFFF. The ground surface around FS3STG is mainly asphalted, therefore samples were collected near the north end of the facility where transportation and unloading of AFFF would likely have occurred. Two samples were collected at the north end of the facility, one at the northeast corner (WSMR-FS3STG-1-SO) and one on the northwest corner (WSMR-FS3STG-2-SO) of the facility.
- FCR-WSMR-05 (FS1): During original SI field work in July 2020, field staff observed the fire department firing the fire engine turret into a grassy area behind the fire station. In speaking with fire

department personnel, they stated they would shoot foam into this area behind the FS1. Sample WSMR-FS1-4-SO was added in the grassy area behind the fire station.

- FCR-WSMR-06 (CFDSTG): The current fire department storage building, Building 1812, was added an AOPI after the QAPP was completed due to historical storage of AFFF. A total of two samples were added, one off the southeastern corner (WSMR-FS4STG-1-SO) and one just east of the intersection of Aberdeen Avenue and Hughes Avenue in an arroyo (WSMR-FS4STG-2-SO).
- FCR-WSMR-07 (FFDSTG): The storage facility at former fire department storage was added as an AOPI after the QAPP was completed due to historical storage of AFFF. A total of four samples were added just off the concrete pad of Building 1713. Samples WSMR-FFDSTG-1-SO, WSMR-FFDSTG-2-SO, WSMR-FFDSTG-3-SO and WSMR-FFDSTG-4-SO were collected.
- FCR-WSMR-08 (FS4STG): The storage facility at FS4 was added as an AOPI after the QAPP was completed due to historical storage of AFFF. A total of three samples were added just off the concrete pad at the entrance of the storage facility. Samples WSMR-FS4STG-1-SO through WSMR-FFDSTG-3-SO were collected.
- FCR-WSMR-09 (CFTA): Fire department personnel stated in interviews they would train with foam just to the north of the training area. A total of two samples were added just to the north of the entry road to the training area. Samples WSMR-CFTA-5-SO and WSMR-CFTA-6-SO were collected.
- FRC-WSMR-10 (CTFTA): Five shallow soil samples were added to the AOPI. The samples were collected from the vehicle staging areas and foam application areas (WSMR-CT-1-SO through WSMR-CT-5-SO).
- FRC-WSMR-11 (HWSB): Four shallow soil samples were added to the AOPI. samples were collected surrounding the waste staging area (WSMR-HWSB-1-SO through WSMR-HWSB-4-SO).
- FRC-WSMR-12 (EAF): Seven shallow soil samples were added to the AOPI. The samples were collected surrounding the former building footprint (WSMR-EAF-1-SO through WSMR-EAF-7-SO).
- FRC-WSMR-13 (North of Main Post): Two proposed raw water sampling locations were added following the receipt of groundwater data from WSMR which describes the extent of the cone of depression which exists on the Main Post. Rather than groundwater flowing to the southeast, groundwater is expected to flow towards supply wells W-17 through W-20 due to well pumping influences. These wells are located to the north of the Main Post. Samples include WSMR-W10A-1-GW and WSMR-W17-1-GW.

6.3.5 Decontamination

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

6.3.6 Investigation-Derived Waste (IDW)

IDW, including purged groundwater and decontamination fluids were placed in Department of Transportation-approved 55-gallon drum, labeled as non-hazardous, and segregated by medium. All remaining soils were returned to the borehole once samples were collected. Disposal of the one IDW drum is pending approvals through WSMR Hazardous Waste Department at the time of this report.

Equipment IDW included 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. These materials were collected in bags and disposed in municipal waste receptacles.

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 Eurofins Lancaster Laboratories Environmental, an ELAP-accredited laboratory for PFAS analysis, including PFOS, PFOA, and PFBS, by liquid chromatography with tandem mass spectrometry. Laboratory analyses associated with the SI were completed in accordance with Worksheets #12.1 through #12.5 in the PQAPP (Arcadis 2019). Eighteen PFAS-related compounds, including PFOS, PFOA, and PFBS, were analyzed for in groundwater and soil samples using an analytical method that is ELAP-accredited and compliant with QSM 5.1.1 (DoD 2018) / 5.3 (DoD and Department of Energy 2019). Method QSM 5.1.1 (DoD 2018) was used in July 2020 and November 2020 sampling events, while method QSM 5.3 DoD and Department of Energy 2019) was used in May 2022 and July 2022 sampling events. Table B-15. Potable water samples were analyzed for 14 PFAS compounds, including PFOS, PFOA, and PFBS, according to USEPA Method 537 Version 1.1, in accordance with Worksheet #15 of the WSMR QAPP Addendum (Arcadis 2020).

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 2020) by the analytical method noted:

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

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

The laboratory 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 on laboratory

analytical reports. Instrument-specific detection limits (e.g., the smallest analyte concentration that can be demonstrated to be different from zero or a blank concentration with 99 percent confidence; DoD 2017), as provided for each analyte by the laboratory, are reported along with the LODs and LOQs in the laboratory analytical reports included in the Data Usability Summary Report (DUSR) (**Appendix N**)

6.4.2 Data Validation

All analytical data generated during the SI, except grain size and data generated from IDW profiling, 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 5.1.1 (DoD 2018) / 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 WSMR. Documentation generated during the data usability assessments, which were compiled into a DUSR (**Appendix N**), was prepared in accordance with the USACE Engineer Manual 200-1-10 (USACE 2005), the Final DoD General Data Validation Guidelines (DoD 2019) and the Final DoD Data Validation Guidelines Module 3: Data Validation Procedure for Per-and Polyfluoroalkyl Substances Analysis by QSM Table B-15 (DoD 2020), that reviewed precision, accuracy, completeness, representativeness, comparability, and sensitivity. A statement of overall data usability is included in the DUSR.

Based on the final data usability assessment, the environmental data collected at WSMR 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 WSMR QAPP Addendum (Arcadis 2020). Data qualifiers applied to laboratory analytical results for samples collected during the SI at WSMR are provided in the data tables, data validation reports, and the Data Usability Summary Table located at the end of the DUSR. Qualifiers for data shown on figures are defined in the notes of figures.

6.5 Office of the Secretary of Defense Risk Screening Levels

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

Table 6-2 OSD Risk Screening Levels Calculated for PFOS, PFOA, 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 data will be screened against both the Residential Scenario and Industrial/Commercial risk screening levels (if collected from less than 2 feet bgs), regardless of the current and projected land use of the AOPI.
mg/kg = milligram per kilogram
ng/L = nanogram per liter
ppm = parts per million
ppt = parts per trillion

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

7 SUMMARY AND DISCUSSION OF SI RESULTS

This section summarizes the analytical results obtained from samples collected during the SI at WSMR (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 2020). The sample results discussion below focuses on the PFOS, PFOA, and PFBS analytical results because they have OSD risk screening levels. The Army will make subsequent investigation decisions based on these constituents' concentrations relative to the OSD risk screening levels.

Tables 7-1, **7-2, and 7-3** provide a summary of the soil and groundwater analytical results for PFOS, PFOA, and PFBS. **Table 7-2** presents groundwater analytical results from monitoring wells and **Table 7-3** provides groundwater analytical results from raw water supply wells. **Table 7-4** summarizes AOPIs and whether their SI results exceed the OSD risk screening levels. **Appendix O** includes the full suite of analytical results for these media, as well as for the QA/QC samples. An overview of AOPIs at WSMR with OSD risk screening level exceedances is depicted on **Figure 7-1**. **Figures 7-2** through **7-19** show the PFOS, PFOA, and PFBS analytical results in soil, raw water, and/or groundwater 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 on the analytical tables. Groundwater data collected during the SI are reported in ng/L, or parts per trillion, and soil data are reported in mg/kg, or parts per million.

Field parameters measured for groundwater during low-flow purging and sample collection are provided on the field forms in **Appendix K**. Soil descriptions are provided on the field forms in **Appendix K**. The results of the SI are grouped by AOPI and discussed for each medium as applicable. Groundwater was generally first encountered at depths of approximately 170 to 200 feet bgs at the Main Post area, 30 to 40 feet bgs at HELSTF, and 160 to 190 feet bgs at SRC.

Table 7-4 AOPIs and OSD Risk Screening Level Exceedances

AOPI Name	OSD Exceedances (Yes/No)
Fire Station 1 (FS1)	No
FFTA Pit Soil (SWMU-21)	Yes
FFTA Waste Pile (SWMU-22)	Yes
FFTA at Martin Luther King Avenue and Hughes Avenue (FFTAMLK)	Yes
Vehicle Maintenance Shop (VMS)	No
PPL (SWMUs 1-7)	No
Fire Department Storage (FDSTG) Building	No
Former Fire Department Storage (FFDSTG) Building	Yes
Sewage Treatment Plant Percolation Ditches and Impoundment Area (STPPD)	No

AOPI Name	OSD Exceedances (Yes/No)
WSMR Landfill	No
Current Firefighting Training Area (CFTA)	No
Fire Station 2 LC (FS2)	Yes
Fire Station 4 HELSTF (FS4)	Yes
Fire Station 3 SRC (FS3)	No
Stallion Range Center FFTA (SRCFFTA) (SWMU-162)	Yes
SRC Landfill	No
Camp Tumbleweed	No
Hazardous Waste Storage Building 22895	No
Electromagnetic Facility	No

7.1 Fire Station 1 (FS1) (Building 155)

7.1.1 FS1 Soil

Soil samples were collected from four hand auger borings at the FS1 AOPI (**Figure 7-2**), from a depth of 0 to 2 ft bgs. Two of these samples (WSMR-FS1-1 and WSMR-FS1-2) were located around the wash pad, where washout or nozzle tests may have occurred. The third sampling point (WSMR-FS1-3) was positioned at the downgradient stormwater discharge location from the AOPI, where the culvert discharges into to a ditch across Aberdeen Avenue. The fourth sampling location (WSMR-FS1-4) was positioned in a grassy area to the northeast of the wash pad.

- PFOS was detected in all four samples at concentrations below the residential OSD risk screening level of 0.13 mg/kg.
- PFOA was detected in all samples except WSMR-FS1-3 at concentrations below the residential OSD risk screening level. PFOA was not detected in WSMR-FS1-3.
- PFBS was not detected in any of the samples.

The soil analytical results are presented on **Figure 7-2** and in **Table 7-1**. Groundwater was not sampled at this AOPI.

7.1.2 FS1 Groundwater

Groundwater samples were collected from nearby raw water supply wells 10-A and 17. Results are discussed in **Sections 7.19.1 and 7.19.3**. The raw water supply wells analytical results are presented in **Table 7-3.**

7.2 Former Firefighting Training Area Pit (SWMU-21) and Waste Pile (SWMU-22)

The subsections below summarize the soil PFOS, PFOA, and PFBS analytical results associated with FFTA Pit (SWMU-21) and Waste Pile (SWMU-22).

7.2.1 Former Firefighting Testing Area Pit Soil

Soil samples were collected from three locations at the FFTA Pit AOPI (**Figure 7-3**). The first location (WSMR-FFTAP-1) was a hand auger sample collected from a depth of 0 to 2 ft bgs, positioned downgradient of the former pit excavation area, where stormwater enters an arroyo. The next two locations (WSMR-FFTAP-2 and WSMR-FFTAP-3) were DPT soil borings positioned within the AOPI. The pit was reportedly excavated to a depth of 8 feet to remove soil impacted by firefighting training activities, and the majority of this soil was returned to the excavation as backfill material. Therefore, WSMR-FFTAP-2 and WSMR-FFTAP-3 were positioned in the former pit excavation area where PFAS-impacted soil may remain. Soil samples were collected from the borings at 0 to 2 bgs and 8 to 10 ft bgs. The soil analytical results were as follows:

- For the 0 to 2-foot sampling interval the results were:
  - PFOA was detected in all the samples except WSMR-FFTAP-1-SO (0-2 ft). There were no PFOA exceedances of the residential OSD risk screening level.
  - PFOS concentration from WSMR-FFTAP-2 (0.3 mg/kg) exceeds the residential OSD risk screening level of 0.13 mg/kg. The remaining soil samples contained PFOS at concentrations below the residential OSD risk screening level.
  - PFBS was not detected in any of the samples.
- For the 8 to 10-foot sampling interval the results were:
  - PFOS and PFOA were detected below the industrial/commercial OSD risk screening level.
  - PFBS was detected only at WSMR-FFTAP-2-SO (8-10 ft). The PFBS concentration was below the industrial/commercial OSD risk screening level.

The soil analytical results are presented on **Figure 7-3** and in **Table 7-1**. Groundwater was not sampled at this AOPI.

7.2.2 Former Firefighting Testing Area Waste Pile Soil

Soil samples were collected from three hand auger borings at the FFTA Waste Pile AOPI (**Figure 7-3**), from a depth of 0 to 2 ft bgs. A 50-foot by 50-foot area associated with the waste pile was reportedly scraped to a 1-foot depth. Therefore, two locations (WSMR-FFTAWP-1 and WSMR-FFTAWP-2) were positioned within the AOPI limits in the former waste pile area (the suspected release area). The third location (WSMR-FFTAWP-3) was positioned downgradient of the of the former waste pile excavation area, where stormwater runoff enters an arroyo. The soil analytical results were as follows:

- The PFOS concentration in WSMR-FFTAWP-2 (0.21 mg/kg) exceeds the residential OSD risk screening level of 0.13 mg/kg. The remaining soil samples contained PFOS at concentrations below the residential OSD risk screening level.
- PFOA was detected at concentrations below the residential OSD risk screening level in WSMR-FFTAWP-1 and WSMR-FFTAP-WP-2. PFOA was not detected in WSMR-FFTAWP-3.
- PFBS was not detected above the LOD in any of the samples.

The soil analytical results are presented on **Figure 7-3** and in **Table 7-1**. Groundwater was not sampled at this AOPI.

7.3 Former Firefighting Training Area at Martin Luther King Avenue and Hughes Avenue (FFTAMLK)

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

7.3.1 FFTAMLK Soil

Soil samples were collected from five hand auger borings at the FFTAMLK AOPI (**Figure 7-4**) from a depth of 0 to 2 feet bgs. Four locations (WSMR-FFTAMLK-1 through WSMR-FFTAMLK-4) were located within the AOPI limits adjacent to site features that may represent potential release areas (two concrete pads, a former building location, and a riprap lined area). The fifth location (WSMR-FFTAMLK-5) was positioned downgradient of the AOPI in a ponding area just north of the FFTA fence line. The soil analytical results were as follows:

- The PFOS concentration in WSMR-FFTAMLK-1 (2.1 mg/kg) exceeds both the residential and industrial/commercial OSD risk screening levels (0.13 and 1.6 mg/kg, respectively). The remaining soil samples contained PFOS at concentrations below the residential OSD risk screening level.
- PFOA was present at concentrations below the residential OSD risk screening level at WSMR-FFTAMLK-1 and WSMR-FFTAMLK-2. PFOA was not detected in the remaining samples.
- PFBS was not detected in any of the samples.

The soil analytical results are presented on **Figure 7-4** and in **Table 7-1**.

7.3.2 FFTAMLK Groundwater

Groundwater samples were collected from nearby raw water supply wells 10-A, 13A, 21, and 17. Results are discussed in **Sections 7.19.1** through **7.19.4**.

7.4 Vehicle Maintenance Shop (Building 21095)

Soil samples were collected from two hand auger borings (WSMR-VMS-1 and WSMR-VMS-2) at the VMS AOPI (**Figure 7-5**), from a depth of 0 to 2 feet bgs. The entire AOPI footprint contains concrete

pavement or building structures. Therefore, both hand auger borings were located downgradient of the AOPI, in an unlined drainage ditch. The soil analytical results were as follows:

- PFOS and PFOA were present at concentrations below the residential OSD risk screening level at WSMR-VMS-1. PFBS was not detected in these samples.
- PFOS, PFOA, and PFBS were not detected in SWMR-VMS-2.

The soil analytical results are presented on **Figure 7-5** and in **Table 7-1**. Groundwater was not sampled at this AOPI.

7.5 Photo Processing Lab (SWMUs 1-7) (Building 1621)

7.5.1 Photo Processing Lab Soil

Soil samples were collected from two DPT borings (WSMR-PPL-1 and WSMR-PPL-2) at the PPL AOPI (**Figure 7-6**), from a depth of 6 to 8 feet bgs. Floor drains in the building conveyed spills to a sanitary sewer (via terra cotta piping) with potential releases from piping to underlying soil. Therefore, the sampling locations were positioned at the building connection to the sewer line and at the 90 degrees turn near Benet Street.

PFOS, PFOA, and PFBS were not detected in either of the samples. The soil analytical results are presented on **Figure 7-6** and in **Table 7-1**.

7.6 Fire Department Storage Building 1812

Soil samples were collected from two hand auger borings at the FDSTG AOPI (**Figure 7-7**) from a depth of 0 to 2 feet bgs. One location (WSMR-FDSTG-1) was positioned just to the south of the AOPI, in an unpaved area. The second location (WSMR-FDSTG-2) was positioned downgradient of the AOPI in an unlined drainage area across Hughes Avenue. The soil analytical results were as follows:

- PFOS was detected in the sample collected at WSMR-FDSTG-1 at a concentration below the residential OSD risk screening level. PFOS was not detected at WSMR-FDSTG-2.
- PFOA and PFBS were not detected in either of the samples.

The soil analytical results are presented on **Figure 7-7** and in **Table 7-1**. Groundwater was not sampled at this AOPI.

7.7 Former Fire Department Storage (FFDSTG) Building (Building 1713)

Soil samples were collected from four hand auger borings (FFDSTG-1 though FFDSTG-4) at the FFDSTG AOPI (**Figure 7-8**), from a depth of 0 to 2 feet bgs. The four borings were located off the concrete pavement adjacent to the building. The soil analytical results were as follows:

- The PFOS concentrations at WSMR-FFDSTG-1 [0.6 (reported value from dilution) mg/kg] and WSMR-FFDSTG-4 (1.6 mg/kg) exceed the residential OSD risk screening level (0.13 mg/kg). The

remaining soil samples contained PFOS at concentrations below the residential OSD risk screening level.

- PFOA was present in all samples at concentrations below the residential OSD risk screening level.
- PFBS was only detected in the sample from WSMR-FFDSTG-4. The PFBS concentration did not exceed the residential OSD risk screening level.

The soil analytical results are presented on **Figure 7-8** and in **Table 7-1**. Groundwater was not sampled at this AOPI.

7.8 Sewage Treatment Plant Percolation Ditches and Impoundment Area

Soil samples were collected from three hand auger borings (WSMR-STPPD-1 through WSMR-STPPD-3) at the STPPD AOPI (**Figure 7-9**), from a depth of 0 to 2 feet bgs. Potentially impacted wastewater from the PPL may have been discharged to the STPPD, after treatment in the Sewage Treatment Plant. Therefore, the three hand auger borings were located as follows: WSMR-STPPD-1 and WSMR-STPPD-2 were located in the excavated earthen drainage ditches immediately east of the Sewage Treatment Plant, which historically transferred effluent from the treatment plant to an impoundment area to the east. The third hand auger boring (WSMR-STPPD-3) was positioned in the center of this impoundment area. The soil analytical results were as follows:

- PFOS was detected in all three samples at concentrations below the residential OSD risk screening level.
- PFOA was detected in the samples from WSMR-STPPD-1 and WSMR-STPPD-3 at concentrations below the residential OSD risk screening level. PFOA was not detected in the sample from WSMR-STPPD-2.
- PFBS was not detected in any of the samples.

The soil analytical results are presented on **Figure 7-9** and in **Table 7-1.** Groundwater was not sampled at this AOPI.

7.9 WSMR Landfill (SWMUs 86-87)

Groundwater samples were collected from three existing monitoring wells (MPL-04, MPL-05 and MPL-18) near the WSMR Landfill AOPI (**Figure 7-10**). MPL-5 is located to the north of the landfill, MPL-18 is located to the northeast of the landfill and MPL-04 is located to the east landfill, all in the presumed downgradient direction of groundwater movement. The groundwater analytical results were as follows:

- PFOS, PFOA, and PFBS were detected only in the groundwater sample from MPL-04.
- The PFOS, PFOA, and PFBS concentrations in MPL04 were below the residential OSD risk screening levels.

The groundwater analytical results are presented on **Figure 7-10** and in **Table 7-2**. Soil samples were not collected. The landfill was capped, therefore, there was no surface to sample soil.

7.10 Current Firefighting Training Area (CFTA) (Building 21612)

Soil samples were collected from six hand auger borings (WSMR-CFTA-1 through WSMR-CFTA-6) at the CFTA AOPI (**Figure 7-11**), from a depth of 0 to 2 feet bgs. Four locations (WSMR-CFTA-1 through WSMR-CFTA-4) were positioned around the perimeter of the AOPI concrete pad, where foam runoff from firefighting training and nozzle testing may have flowed. WSMR-CFTA-5 and WSMR-CFTA-6 were positioned on the far side of the drive leading into the AOPI. The soil analytical results were as follows:

- PFOS was detected at WSMR-CFTA-3, WSMR-CFTA-4 and WSMR-CFTA-5 (in the duplicate sample only, not the parent sample) at concentrations below the residential OSD risk screening level. PFOS was not detected in the remaining samples.
- PFOA was detected in four soil samples (WSMR-CFTA-3 through WSMER-CFTA-6) at concentrations below the residential OSD risk screening level. PFOA was not detected in the remaining samples.
- PFBS was not detected in any of the samples.

The soil analytical results are presented on **Figure 7-11** and in **Table 7-1**. Groundwater was not sampled at this AOPI.

7.11 Fire Station 2 Launch Complex (FS2) (Building 23480)

Soil samples were collected from four hand auger borings (WSMR-FS2-1 through WSMR-FS2-4) at the FS2 AOPI (**Figure 7-12**), from a depth of 0 to 2 feet bgs. The borings were positioned in areas most likely to have nozzle testing or surface water runoff from pavement. The soil analytical results were as follows:

- The PFOS concentrations at WSMR-FS2-1 (0.15 mg/kg) and WSMR-FS2-2 (0.2 mg/kg) exceed the residential OSD risk screening level (0.13 mg/kg). The remaining soil samples contained PFOS at concentrations below the residential OSD risk screening level.
- PFOA was present in all samples at concentrations below the OSD residential OSD risk screening level.
- PFBS was not detected in any of the samples.

The soil analytical results are presented on **Figure 7-12** and in **Table 7-1**. Groundwater was not sampled at this AOPI.

7.12 Fire Station 4 High Energy Laser System Test Facility (FS4) (Building 26020)

The subsections below summarize the soil and groundwater PFOS, PFOA, and PFBS analytical results associated with FS4.

7.12.1 FS4 Soil

Soil samples were collected from three DPT borings (WSMR-FS4-1 through WSMR-FS4-3) and three hand auger borings (WSMR-FS4STG-1 through WSMR-FS4STG-3) at the FS4 Storage AOPI (**Figure 7-**

13), from a depth of 0 to 2 feet bgs. The hand auger borings were located outside of the storage building, adjacent to the doorway. One of the DPT borings was positioned within the AOPI limits, behind the fire station building. The other two DPT borings were positioned down gradient of AOPI, at the closest location of pavement where runoff is likely to occur. The soil analytical results were as follows:

- Four of the six soil samples (WSMR-FS4-1, WSMR-FS4-3, WSMR-FS4STG-1, and WSMR-FS4STG-3) and contained PFOS at concentrations below the residential OSD risk screening level. PFOS was not detected in the remaining samples.
- WSMR-FS4-3 and WSMR-FS4STG-1 contained PFOA at concentrations below the residential OSD risk screening level. PFOA was not detected in the remaining samples.
- PFBS was not detected in any of the samples.

The soil analytical results are presented on **Figure 7-13** and in **Table 7-1**.

7.12.2 FS4 Groundwater

Groundwater samples were collected from two existing monitoring wells: HMW-69 (located within the AOPI limits) and HMW-70 (located immediately adjacent to the AOPI limits) (**Figure 7-13**). The groundwater analytical results were as follows:

- PFOS was detected at the groundwater sample collected from HMW-69 at a concentration below the residential OSD risk screening level. PFOS was not detected in the groundwater sample collected from HMW-70.
- PFOA was detected at the groundwater samples collected from both wells at concentrations below the residential OSD risk screening level.
- PFBS was detected at concentration above the residential OSD risk screening level in the sample HMW-70. The PFBS concentration in the groundwater sample from HMW-69 was below the residential OSD risk screening level.

The groundwater analytical results are presented on **Figure 7-13** and in **Table 7-2**.

7.13 Fire Station 3 Stallion Range Center (FS3) (Building 34228)

Soil samples were collected from seven hand auger borings at the FS3 AOPI (**Figure 7-14**), from a depth of 0 to 2 feet bgs. The borings were located as follows: WSMR-FS3-1 was positioned across the street to the north where P19 vehicles were stored and where training occurred in the past, WSMR-FS3-2 through WSMR-FS-5 were positioned at potential nozzle testing areas, and WSMR-FS3STG-1 and WSMR-FS3STG-2 were positioned adjacent to storage building doorways. The soil analytical results were as follows:

- PFOS was detected in all seven samples at concentrations below the residential OSD risk screening level.
- PFOA was detected in six of the samples at concentrations but below the residential OSD risk screening level. PFOA was not detected in WSMR-FS3STG-1.

- PFBS was not detected in any of the samples.

The soil analytical results are presented on **Figure 7-14** and in **Table 7-1**. Groundwater was not sampled at this AOPI.

7.14 Stallion Range Center Former Firefighting Training Area (SRCFFTA) (SWMU-162)

Soil samples were collected from three hand auger borings (WSMR-SRCFFTA-1 through WSMR-SRCFFTA-3) at the SRCFFTA AOPI (**Figure 7-15**), from a depth of 0 to 2 feet bgs. An excavation was previously conducted in the central portion of the AOPI to remove petroleum impacted soils. The hand auger locations were therefore positioned outside of the excavation area as follows: WSMR-SRCFFTA-2 was located near the excavation area to the northeast, and WSMR-SRCFFTA-1 and WSMR-SRCFFTA-3 were located near the AOPI boundaries, to the northeast and southwest of the excavation area, respectively. The soil analytical results were as follows:

- The PFOS concentrations at WSMR-SRCFFTA-2 (2.1 mg/kg) and WSMR-SRCFFTA-3 (0.17 mg/kg) exceed the residential OSD risk screening level (0.13 mg/kg). The remaining soil sample contained PFOS at a concentration below the residential OSD risk screening level.
- The PFOA concentration at WSMR-SRCFFTA-2 (0.28 mg/kg) exceeds the residential OSD risk screening level (0.13 mg/kg). The remaining soil samples contained PFOS at concentrations below the residential OSD risk screening level.
- PFBS was detected at WSMR-SRCFFTA-2 and WSMR-SRCFFTA-3 at a concentration below the residential OSD risk screening level. PFBS was not detected at WSMR-SRCFFTA-1.

The soil analytical results are presented on **Figure 7-15** and in **Table 7-1**. Groundwater was not sampled at this AOPI.

7.15 Stallion Range Center Landfill

Groundwater samples were collected from two existing monitoring wells near the SRC Landfill AOPI: SRW-3 (located to the east) and SRW-4 (located to the southeast) (**Figure 7-16**).

PFOS, PFOA, and PFBS were not detected in either of the groundwater samples. The groundwater analytical results are presented on **Figure 7-16** and in **Table 7-2**. Soil samples were not collected. The landfill was capped, therefore, there was no surface to sample soil.

7.16 Camp Tumbleweed Fire Training Area (FTA)

Soil samples were collected from five hand auger borings (WSMR-CT-1-SO though WSMR-CT-5-SO) at the Camp Tumbleweed FTA AOPI (**Figure 7-17**), from a depth of 0 to 2 feet bgs. The five borings were located at the vehicle staging areas and foam application areas.

PFOS, PFOA, and PFBS were not detected in any of the soil samples. The soil analytical results are presented on **Figure 7-17** and in **Table 7-1**. Groundwater was not sampled at this AOPI.

7.17 Hazardous Waste Storage Building (Building 22895)

Soil samples were collected from four hand auger borings (WSMR-HWSB-1-SO though WSMR-HWSB-4-SO) at the building 22895 – Hazardous Waste Storage Building 22895 AOPI (**Figure 7-18**), from a depth of 0 to 2 feet bgs. The four borings were located surrounding the waste staging area.

PFOS, PFOA, and PFBS were not detected in any of the soil samples. The soil analytical results are presented on **Figure 7-18** and in **Table 7-1**. Groundwater was not sampled at this AOPI.

7.18 Electromagnetic Analysis Facility (Building 23638)

Soil samples were collected from seven hand auger borings (WSMR-EAF-1-SO though WSMR-EAF-7-SO) at the building 23638 – Electromagnetic Analysis Facility. AOPI (**Figure 7-19**), from a depth of 0 to 2 feet bgs. The seven borings were located surrounding the former building footprint. The soil analytical results were as follows:

- PFOS was detected in six out of seven samples (WSMR-EAF-1-SO, WSMR-EAF-2-SO, WSMR-EAF-3-SO, WSMR-EAF-4-SO, WSMR-EAF-6-SO and WSMR-EAF-7-SO) at concentrations below the residential OSD risk screening level. PFOS was not detected in the remaining sample.
- PFOA was detected in five out of seven samples (WSMR-EAF-1-SO, WSMR-EAF-2-SO, WSMR-EAF-4-SO, WSMR-EAF-6-SO and WSMR-EAF-7-SO) at concentrations below the residential OSD risk screening level. PFOA was not detected in the remaining samples.
- PFBS was not detected in any of the samples.

The soil analytical results are presented on **Figure 7-19** and in **Table 7-1**. Groundwater was not sampled at this AOPI.

7.19 Main Post Raw Water Supply Wells

Four Raw Water Supply wells within the Main Post were sampled and analyzed for PFAS. The raw water supply wells located on Main Post are located downgradient from multiple AOPIs and therefore inform potential PFAS presence for all AOPIs located upgradient. As such, the detections in groundwater discussed below cannot be directly attributed to any singular AOPI. However, the nearest AOPIs to each raw water supply well are noted in the text. The Raw Water Supply Wells analytical results are presented in Table 7-3. The results are discussed below.

7.19.1 Well-10A

One groundwater sample was collected from raw water supply well W-10A. Well W-10A is downgradient from the Fire Station 1 AOPI, (located 0.5 miles to the south). The groundwater analytical results were as follows:

- PFOS and PFOA were not detected.
- PFBS was detected at a concentration below the residential OSD risk screening level.

The groundwater analytical results are presented in **Table 7-3.**

7.19.2 Well-13A

One groundwater sample was collected from raw water supply well W-13A, at the time of the sampling, the sample was mislabeled to W-13 which is an inactive well. Well W-13A is downgradient from the Vehicle Maintenance Shop AOPI (located 0.5 miles to the southeast). W-13A is cross gradient from the Former Firefighting Training Area at MLK and Hughes AOPI (located 0.2 miles to the west). The groundwater analytical results were as follows:

- PFOA and PFOS were not detected.
- PFBS were detected at a concentration below the residential OSD risk screening level.

The groundwater analytical results are presented in **Table 7-3.**

7.19.3 Well-17

One groundwater sample was collected from raw water supply well W-17. Well W-17 is downgradient from the Fire Station 1 AOPI (located 0.7 miles to the south).

PFOS, PFOA, and PFBS were not detected in the groundwater sample. The groundwater analytical results are presented in **Table 7-3.**

7.19.4 Well-21

One groundwater sample was collected from raw water supply well W-21. Well W-21 is downgradient to the Former Firefighting Training Area at MLK and Hughes AOPI (located 0.4 miles to the southeast) and Former Fire Department Storage Building (located 0.5 miles southwest). The groundwater analytical results were as follows:

- PFOS was not detected.
- PFOA and PFBS were detected at concentrations below the residential OSD risk screening level.

The groundwater analytical results are presented in **Table 7-3.**

7.20 TOC, pH, and Grain Size

In addition to sampling soil for PFAS, one soil sample per AOPI was analyzed for TOC, pH, moisture content, and grain size data as they may be useful in future fate and transport studies. The TOC in the soil samples ranged from 166 J+ (estimated high) to 20,700 J+ mg/kg. The TOC at this installation was within range of what is typically observed in in topsoil (5,000 to 30,000 mg/kg). The combined percentage of fines (i.e., silt and clay) in soils at WSMR ranged from 6 to 48.9% with an average of 26.4%. PFAS tend to be more mobile in soils with less than 20% fines (silt and clay) and lower TOC. The percent moisture of the soil 9.1 was typical for loam (0 to 12%). The pH of the soil was slightly alkaline (7 to 9). Based on these geochemical and physical soil characteristics, while PFAS are relatively more mobile in soils with low percentages of fines, elevated TOC may retard transport of the constituents from soil to groundwater.

7.21 Blank Samples

Detections of PFOS and PFOA constituents are summarized below for blank samples. Most detected concentrations were low-level. Other than those noted below, concentrations of PFOS, PFOA, PFBS in all other blank samples were not detected. PFBS were not detected in any of the blank samples collected during the SI work.

- PFOA was detected in sample WSRM-SB-1-071020 (1.1J ng/L) which is a source blank sample collected on July 10, 2020.
- PFOS was detected in sample WSMR-EB-4-070920 (1.9 ng/L) which is an equipment blank sample collected on July 9, 2020.
- PFOS and PFOA were detected in sample WSMR-EB-6-070720 (6.3 ng/L and 5.0 ng/L, respectively) which is an equipment blank sample collected on July 7, 2020.

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

7.22 Conceptual Site Models (CSM)

The preliminary CSMs presented in the QAPP Addendum (Arcadis 2020) were re-evaluated and updated, if necessary, based on the SI sampling results. The CSMs presented on **Figures 7-21** through **7-28** and in this section therefore represent the current understanding of the potential for human exposure. For some AOPIs, the CSM is the same and thus shown on the same figure.

Many of the PFAS constituents found in AFFF and metal plating operations are surfactants (which do not volatilize) and are found in a charged or ionic state at environmentally-relevant pH (i.e., pH 5 to 9 standard units). PFOS, PFOA, and PFBS are each negatively charged at environmentally-relevant pH. The media potentially affected by PFOS, PFOA, 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 historical use, storage, and/or disposal of PFAS-containing materials at the AOPIs, affected media are likely to consist of soil and groundwater. The most likely release and transport mechanism at WSMR is desorption from soil and dissolution in groundwater. 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 warranted 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 accessed on a regular basis 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 listed below by figure.

Figure 7-20 shows the CSM for one AOPI (STPPD [SWMU-82]) located east of the Main Post and seven of the Main Post AOPIs: FS1, FFTA Pit (SWMU-21), FFTAWP (SWMU-22), FFTAMLK, FDSTG, FFDSTG, and VMS. The STPPD (SWMU-82) received wastewater potentially impacted by PFAS from the PPL. AFFF may have been released to soil and/or paved surfaces at the Main Post AOPIs during training and fire station activities. At the VMS, an accidental AFFF release occurred during a routine maintenance operation.

- PFOS, PFOA, and/or PFBS 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.
- Groundwater was not sampled at these AOPIs. Groundwater at Main Post is locally influenced by well production causing a cone of depression in the area. As a result, the Main Post AOPIs are located potentially upgradient of drinking water wells used to supply potable water at Main Post. PFAS were detected in groundwater from raw water supply wells W-10A, W-13, and W-21. Therefore, the groundwater exposure pathways (via drinking water ingestion and dermal contact) for on-installation site workers and residents are potentially complete.
- Groundwater at Main Post is heavily influenced by water withdrawal, but generally flows to the east and southeast. Groundwater may flow off-post through the installation’s southern boundary. Due to the absence of land use controls preventing potable use of groundwater in this area, the groundwater exposure pathway for off-installation drinking water receptors is potentially complete.

Figure 7-21 shows the CSM for the PPL AOPI and Camp Tumbleweed Fire Fighting Training Area, also located at Main Post. There is a potential for PFAS presence at the PPL AOPI due to electroplating activities in relation to photo processing and at Camp Tumbleweed due to the release of AFFF during fire training activities.

- PFOS, PFOA, and/or PFBS were not detected in soil at these AOPIs; therefore, the soil exposure pathway for on-installation site workers is incomplete.
- Although PFAS were detected in groundwater from raw water supply wells located at Main Post, PFAS were not detected in soil at these two AOPIs. Therefore, the raw water supply well detections cannot conclusively be determined to be a result of operations occurring at these two AOPIs and the groundwater exposure pathways for on-installation site workers and residents are considered to be incomplete.

Figure 7-22 shows the CSM for three AOPIs located to the east of the Main Post and considered to be outside the cone of depression created by the drinking water wells used to supply potable water at Main Post: CFTA, FS2 LC, and EAF. These AOPIs have a potential for PFAS presence due to release of AFFF during fire training, fire station activities, and a historical fire response using foam.

- PFOS, PFOA, and/or PFBS 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.
- Groundwater was not sampled at these AOPIs. The AOPIs receive potable water delivered from Main Post. The groundwater flow direction at these AOPIs is variable due to the lack of topography. However, given a regional direction of groundwater flow to the northeast, the AOPIs are downgradient of existing drinking water wells used to supply potable water at WSMR. Groundwater in this area is of limited water quality and availability and is unlikely to be used as a source of drinking water in the future. Therefore, the groundwater exposure pathways (via drinking water ingestion and dermal contact) for on-installation site workers and residents are incomplete.
- Groundwater in the area generally flows to the east and southeast. As a result, groundwater at these AOPIs may flow off-post through the installation's southern boundary. Due to the absence of land use controls preventing potable use of groundwater in the off-post area, the groundwater exposure pathway for off-installation drinking water receptors is potentially complete.

Figure 7-23 shows the CSM for the Hazardous Waste Storage Building 22895, also located to the east of the Main Post.

- PFOS, PFOA, and/or PFBS were not detected in soil at this AOPI. Therefore, the soil exposure pathway for on-installation site workers is incomplete.
- Groundwater was not sampled at this AOPI. However, due to the non-detect results for soil, and the fact that groundwater in this area is unlikely to be used as a source of drinking water in the future, the groundwater exposure pathways (via drinking water ingestion and dermal contact) for on-installation site workers and residents and for off-installation drinking water receptors are incomplete.

Figure 7-24 shows the CSM for the WSMR Landfill AOPI. This AOPI has a potential for PFAS presence due to the receipt of potentially PFAS-containing wastes.

- Soil samples were not collected at this AOPI due to limited knowledge regarding where the PFAS-containing wastes were potentially deposited and the landfill having an engineered soil cap. Based on the presence of the soil cap, the soil exposure pathway for on-installation site workers is incomplete.

- PFOS, PFOA, and/or PFBS were detected in one of three groundwater samples collected at WSMR Landfill. The AOPI is in an area of limited water quality and availability, where groundwater is unlikely to be used as a source of drinking water in the future. However, the AOPI may be within the cone of depression of existing drinking water wells used to supply potable water at WSMR. Therefore, the groundwater exposure pathways (via drinking water ingestion and dermal contact) for on-installation site workers and residents are potentially complete.
- Groundwater in the area generally flows to the east and southeast. As a result, groundwater at these AOPIs may flow off-post through the installation's southern boundary. Due to the absence of land use controls preventing potable use of groundwater in the off-post area, the groundwater exposure pathway for off-installation drinking water receptors is potentially complete.

Figure 7-25 shows the CSM for FS4. This AOPI has a potential for PFAS presence due to release of AFFF during fire station activities.

- PFOS, PFOA, and/or PFBS were detected in soil at this AOPI, 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/or PFBS were detected in groundwater from monitoring wells at this AOPI. HELSTF receives potable water from five mountain-front wells to the west, which receive water from freshwater aquifers located along the southern piedmonts of the San Andres Mountains. In 2008, only four of these wells were in operation. The current number of wells in operation has not been confirmed. The groundwater flow direction at this AOPI is variable due to the lack of topography. However, the AOPI is downgradient of existing drinking water wells used to supply potable water at WSMR and the AOPI is in an area of limited water quality and availability, where groundwater is unlikely to be used as a source of drinking water in the future. Therefore, the groundwater exposure pathways (via drinking water ingestion and dermal contact) for on-installation site workers and residents are incomplete.
- Groundwater originating at this AOPI does not flow off-post. Therefore, the groundwater exposure pathway for off-installation drinking water receptors is incomplete.

Figure 7-26 shows the CSM for FS3 and SRC FFTA (SWMU-162). These AOPIs have a potential for PFAS presence due to AFFF releases from training and fire station activities.

- PFOS, PFOA, and/or PFBS 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.
- Groundwater was not sampled at these AOPIs. The SRC is in the northwestern portion of the installation. Two wells supply water to an electrodialysis plant, which desalinates the water and produces about 50,000 gallons of potable water per day. Water from this location is hauled to supply drinking water to remote sites and for construction purposes, as well as to provide water at the SRC (Coastal and Hydraulics Laboratory 2016). The groundwater flow direction at these AOPIs is generally southeast or east but pumping of drinking water supply wells in the area may influence the flow of groundwater. It is conservatively assumed that both AOPIs could impact the drinking water supply wells located in the SRC. Therefore, the groundwater exposure pathway (via drinking water

ingestion and dermal contact) for on-installation site workers is potentially complete. There are no residents in this portion of the installation, therefore the groundwater exposure pathway for on-installation residents is incomplete.

- Groundwater originating at these AOPIs flows generally to the southeast or east, away from the installation's northern boundary. Therefore, the groundwater exposure pathway for off-installation receptors is incomplete.

Figure 7-27 shows the CSM for the SRC Landfill. This AOPI has a potential for PFAS presence due to the receipt of potentially PFAS-containing wastes.

- Soil samples were not collected at this AOPI due to limited knowledge regarding where the PFAS-containing wastes were potentially deposited and the landfill having an engineered soil cap. Based on the presence of the soil cap, the soil exposure pathway for on-installation site workers is incomplete.
- PFOS, PFOA, and/or PFBS were not detected in groundwater samples from monitoring wells in proximity to SRC Landfill. Groundwater originating at this AOPI flows generally to the southeast or east, away from the installation's northern boundary. Therefore, the groundwater exposure pathways for on-installation and off-installation drinking water receptors are incomplete.

Following the SI sampling, 15 out of the 19 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 CONCLUSIONS AND RECOMMENDATIONS

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

OSD provided residential risk screening levels based on the USEPA oral reference dose for PFOS, PFOA, and PFBS in soil and groundwater (tap water) and industrial/commercial risk screening levels for PFOS, PFOA, and PFBS in soil (**Appendix A**). A combination of document review, internet searches, interviews with installation personnel, and an installation site visit were used to identify specific areas of suspected PFOS, PFOA, and PFBS use, storage, and/or disposal at WSMR. Following the evaluation, 19 AOPIs were identified.

The source of potable water for WSMR is from groundwater in alluvial aprons. Each area of the installation has its own distribution system. There are 15 raw water supply wells throughout the installation which provide drinking water (Section 2.10). In October 2016, under the IMCOM Operations Order 16-088**,** 12 samples were collected from components of three water systems at WSMR, including several wells and points of entry **(Appendix F).** They were analyzed for PFOS, PFOA and PFBS. Analytical results indicated that PFOS, PFOA and PFBS were not detected in the samples; the limits of detection were 40 ng/L, 40 ng/L and 600 ng/L, respectively. The analytical results from these PFAS samples are included in **Table 2-1**.

In 2019/2020, one point of entry sample and eight drinking water samples were collected from WSMR. They were analyzed for PFOS, PFOA and PFBS. Analytical results indicated that PFOA was detected in two samples and PFBS was detected in three samples; the limits of detection were 40 ng/L and 600 ng/L, respectively.

All AOPIs were sampled during the SI at WSMR to identify the presence or absence of PFOS, PFOA, and PFBS at each AOPI. The SI scope of work was completed in accordance with the Final PQAPP (Arcadis 2019) and the WSMR QAPP Addendum (Arcadis 2020).

Fifteen AOPIs had detections of PFOS, PFOA, and/or PFBS in soil and/or groundwater and seven AOPIs exceeded OSD risk screening levels.

PFOS, PFOA, and/or PFBS were detected in 54 of the 72 parent and five field duplicate soil samples collected. Six soil samples had an exceedance of a residential OSD risk screening level, of which three samples also had an exceedance of an industrial/commercial OSD screening level.

- The maximum concentration of PFOS in soil (2.1 mg/kg, which exceeds the residential and industrial/commercial OSD levels of 0.13 and 1.6 mg/kg, respectively) was observed at the FFTAMLK AOPI (J flagged result) and the SRCFFTA AOPI.
- The maximum concentration of PFOA in soil (0.28 mg/kg PFOA, which exceeds the residential level of 0.13) was observed at the SRCFFTA AOPI.
- The maximum concentration of PFBS in soil was observed at the FFTA Pit AOPI but did not exceed the OSD risk screening levels.

PFOS, PFOA, and/or PFBS were detected in seven of the eleven parent and two field duplicate groundwater samples collected.

- Only PFBS was detected at a concentration above the OSD risk screening level. The maximum concentration of PFBS in groundwater (650 ng/L, which exceeds the OSD level of 600 ng/l) was observed the FS 4 HELSTF AOPI.
- The maximum concentrations of PFOS and PFOA in groundwater were observed at the WSMR Landfill AOPI and the FS 4 HELSTF AOPI, respectively.

Following the SI sampling, 15 out of the 19 AOPIs were considered to have complete or potentially complete exposure pathways. Soil exposure pathways for on-installation site workers are complete at 14 AOPIs. Groundwater exposure pathways for on-installation site workers and residents are potentially complete at nine AOPIs which may be within the cone of depression created by the drinking water wells used to supply potable water at Main Post. Groundwater exposure pathways for on-installation site workers only are potentially complete at the two AOPIs at the SRC (residents are not present at the SRC). The SRC AOPIs are upgradient of or could affect drinking water supply wells located in the SRC. Due to a lack of land use controls off-installation and downgradient of WSMR, the groundwater exposure pathways for off-installation drinking water receptors are potentially complete for 12 AOPIs.

AOPIs Former Firefighting Training Area and MLK Hughes and AOPI Former Fire Department Storage Building could be contributing to Raw Water Supply Well Sample WSMR-W21 which concentrations were detected but below the OSD Residential Risk Screening level.

Although the CSMs indicate complete or potentially complete exposure pathways may exist, the recommendation for future study in a remedial investigation or no action at this time is based on the comparison of the SI analytical results for PFOS, PFOA, and PFBS to the OSD risk screening levels (**Table 6-2**). **Table 8-1** below summarizes the AOPIs identified at WSMR, PFOS, PFOA, and PFBS sampling and recommendations for each AOPI; further investigation is warranted at WSMR. In accordance with CERCLA, site-specific risk will be assessed during a future phase to evaluate whether remedial actions are required.

Table 8-1 Summary of AOPIs Identified during the PA, PFOS, PFOA, and PFBS Sampling at WSMR, and Recommendations

AOPI Name	PFOS, PFOA, and/or PFBS detected greater than OSD Risk Screening Levels? (Yes/No/ND/NS)		Recommendation
	GW	SO	
Fire Station 1 (FS1) (Building 155)	NS	No	No action at this time
Former Firefighting Training Area Pit (SWMU-21)	NS	Yes	Further study in remedial investigation

AOPI Name	PFOS, PFOA, and/or PFBS detected greater than OSD Risk Screening Levels? (Yes/No/ND/NS)		Recommendation
	GW	SO	
Former Firefighting Training Area Waste Pile (SWMU-22)	NS	Yes	Further study in remedial investigation
Former Firefighting Training Area at Martin Luther King Ave and Hughes St (FFTAMLK)	No	Yes	Further study in remedial investigation
Vehicle Maintenance Shop (VMS) (Building 21095)	NS	No	No action at this time
Photo Processing Lab (PPL) (SWMUs 1-7) (Building 1621)	No	No	No action at this time
Fire Department Storage Building (Building 1812)	NS	No	No action at this time
Former Fire Department Storage Building (Building 1713)	NS	Yes	Further study in remedial investigation
Sewage Treatment Plant Percolation Ditches and Impoundment Area	NS	No	No action at this time
WSMR Landfill (SWMUs 86-87)	No	NS	No action at this time
Current Firefighting Training Area (CFTA) (Building 21612)	NS	No	No action at this time
Fire Station 2 Launch Complex (FS2) (Building 23480)	NS	Yes	Further study in remedial investigation
Fire Station 4 High Energy Laser System Test Facility (FS4) (Building 26020)	Yes	No	Further study in remedial investigation
Fire Station 3 Stallion Range Center (FS3) (Building 34228)	NS	No	No action at this time
Stallion Range Center Firefighting Training Area (SWMU-162)	NS	Yes	Further study in remedial investigation
Stallion Range Center Landfill	ND	NS	No action at this time

AOPI Name	PFOS, PFOA, and/or PFBS detected greater than OSD Risk Screening Levels? (Yes/No/ND/NS)		Recommendation
	GW	SO	
Camp Tumbleweed Fire Training Area (FTA)	NS	ND	No action at this time
Hazardous Storage Waste Building (Building 22895)	NS	ND	No action at this time
Electromagnetic Analysis Facility (Building 23638)	NS	No	No action at this time

Notes:
Light gray shading – detection greater than the OSD risk screening level
GW – groundwater
ND – non-detect
NS – not sampled
SO – soil

Data collected during the PA (**Sections 3** through **5**) and SI (**Sections 6 and 7**) were sufficient to draw conclusions and recommendations summarized above. The data limitations relevant to the development of this PA/SI for PFOS, PFOA, and PFBS at WSMR are discussed below.

There is uncertainty about specific foams used on site for the complete history of the installation use. Additionally, the types and quantities of foams stored in each fire department storage building is unknown. Volumes of foam released during firefighting training and frequency of this firefighting training is unknown. Additionally, according to site personnel, the Hazardous Waste Storage (B22985) was reportedly sprayed down with an unidentified foam in 2008 in response to a collapsed drum in order to reduce static. The type of foam used could not be identified.

The CSMs considered potential exposures of on-installation receptors to PFAS in groundwater based on the proximity of AOPIs to existing, operational wells used to supply drinking water at WSMR. The potential for new potable well installations is improbable considering the Army implements controls which prevent intrusive work without DPW approval per the installation's master plan and the dig permitting process. However, these Army controls do not prevent future development of drinking water supplies if land is no longer controlled by the Army. Additionally, the CSMs do not include ecological receptors and exposure pathways. The potential for ecological exposures to PFAS may be evaluated at a future date if those pathways warrant further consideration.

Records gathered for the use, storage and/or disposal of PFAS-containing materials were reviewed during the PA process. Documentation specific to AFFF may have been limited (e.g., each AFFF use; procurement records, documentation of AFFF used during crash responses or fire training activities) due to lack of recordkeeping requirements for the full timeline of common AFFF practices. Anecdotal accounts of AFFF use (and therefore likely PFOS, PFOA, and PFBS use) were limited to available installation personnel, whose knowledge of AFFF use may have been restricted by their time spent at the installation

or previous roles held that limited their relevant knowledge of potential AFFF (or other PFAS-containing material) use.

A comprehensive well survey was not completed as part of this 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 documents research, installation personnel interviews, and site reconnaissance.

Finally, the available PFOS, PFOA, and PFBS analytical data is limited to raw water supply wells, monitoring wells, and soil samples collected on-post. The limited sampling scope of the SI focused on identifying presence or absence of PFAS at the AOPIs. PFAS were detected in groundwater samples collected from raw water supply wells, which provide the installation with drinking water following treatment. However, the PFAS detections in the raw water samples cannot be conclusively or directly attributed to a release from a specific AOPI at the point of this PA/SI. SI sampling at locations at or in close proximity of the AOPIs and raw water wells did not delineate the extent of PFAS impacts or identify the primary migration pathways for the chemicals. Available data, including PFOS, PFOA, and PFBS, are listed in **Appendix O**, which were analyzed per the selected analytical method.

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

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ACRONYMS

°F	degrees Fahrenheit
%	percent
AFFF	aqueous film-forming foam
AMC	Army Materiel Command
AOPI	area of potential interest
Arcadis	Arcadis U.S., Inc.
Army	United States Army
ARNG	Army National Guard
bgs	below ground surface
CERCLA	Comprehensive Environmental Response, Compensation, and Liability Act of 1980
CSM	conceptual site model
DoD	Department of Defense
DPT	direct-push technology
DQO	data quality objective
DUSR	Data Usability Summary Report
EB	equipment blank
EDR	Environmental Data Resources, Inc.
ELAP	Environmental Laboratory Accreditation Program
FTA	fire training area
GIS	geographic information system
HDPE	high-density polyethylene
HQAES	Headquarters Army Environmental System
IDW	investigation-derived waste
IMCOM	Installation Management Command
installation	United States Army or Reserve installation
IRP	Installation Restoration Program
LOD	limit of detection
LOQ	limit of quantitation
mg/kg	milligrams per kilogram (parts per million)

NA	not available
NCR	non-conformance reportng/L nanograms per liter (parts per trillion)
OSD	Office of the Secretary of Defense
PA	preliminary assessment
PFAS	per- and polyfluoroalkyl substances
PFBS	perfluorobutanesulfonic acid
PFOA	perfluorooctanoic acid
PFOS	perfluorooctane sulfonate
POC	point of contact
ppm	parts per million
ppt	parts per trillion
PQAPP	Programmatic Uniform Federal Policy-Quality Assurance Project Plan
QA	quality assurance
QAPP	Quality Assurance Project Plan
QC	quality control
QSM	Quality Systems Manual
RSL	Regional Screening Level
SI	site inspection
SOP	standard operating procedure
SSHP	Site Safety and Health Plan
TGI	technical guidance instruction
TOC	total organic carbon
U.S.	United States
USACE	United States Army Corps of Engineers
USAEC	United States Army Environmental Command
USEPA	United States Environmental Protection Agency
VAP	vertical aquifer profiling
WWTP	wastewater treatment plant

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TABLES

Table 2-1
Historical PFAS Analytical Results
USAEC PFAS Preliminary Assessment/Site Inspection
White Sands Missile Range, New Mexico

Historic Sampling Event	Location	Sample ID	Sample Date	Chemical name	Perfluorooctanoic acid (PFOA)	Perfluorobutanesulfonic acid (PFBS)	Perfluorooctane sulfonate (PFOS)
				OSD risk screening level* in ng/L	40	600	40
UCMR3	Alamogordo Domestic Water System - Facility 5441	35113604001AM	10/24/2013	ng/L	< 20	< 90	< 40
		35119822001AM	12/16/2013	ng/L	< 20	< 90	< 40
		35123107001AM	12/16/2013	ng/L	< 20	< 90	< 40
		35123117001AM	1/16/2014	ng/L	< 20	< 90	< 40
		35148037001AM	7/28/2014	ng/L	< 20	< 90	< 40
		35147383001AM	7/23/2014	ng/L	< 20	< 90	< 40
		35123115001AM	1/16/2014	ng/L	< 20	< 90	< 40
		35134695001AM	4/17/2014	ng/L	< 20	< 90	< 40
		35134706001AM	4/17/2014	ng/L	< 20	< 90	< 40
		35134697001AM	4/17/2014	ng/L	< 20	< 90	< 40
		35147384001AM	7/23/2014	ng/L	< 20	< 90	< 40
	Alamogordo Domestic Water System - Facility 99001	35113603001AM	10/24/2013	ng/L	< 20	< 90	< 40
		35113603005AM	10/24/2013	ng/L	< 20	< 90	< 40
		35134705001AM	4/17/2014	ng/L	< 20	< 90	< 40
		35134703001AM	4/17/2014	ng/L	< 20	< 90	< 40
IMCOM Operations Order 16-088	SW-17	WSMR-MP-Well 17 Dup	10/12/2016	ng/L	< 28	< 130	< 54
	SW-19	WSMR-MP-Well 19	10/12/2016	ng/L	< 27	< 130	< 57
	SW-21	WSMR-MP-Well 21	10/12/2016	ng/L	< 28	< 130	< 56
	HELSTF POE	WSMR-MR/MAR-POE	10/18/2016	ng/L	< 26	< 120	< 52
	Small Missile Range POE	WSMR-SMR-POE	10/19/2016	ng/L	< 26	< 120	< 52
	SMR-1A	WSMR-SMR-Well 1A	10/19/2016	ng/L	< 26	< 120	< 51
	Bldg 34253 POE	WSMR-SRC-POE	10/19/2016	ng/L	< 28	< 130	< 56
	SRC-2	WSMR-SRC-WELL SRC-2	10/19/2016	ng/L	< 26	< 120	< 51
	SRC-2	WSMR-SRC-WELL SRC-2 (DUP)	10/19/2016	ng/L	< 26	< 120	< 52
	SRC-3	WSMR-SRC-WELL SRC-3	10/19/2016	ng/L	< 27	< 12	< 53
	MAR-3	WSMR-Well MAR-3	10/18/2016	ng/L	< 26	< 120	< 53
	MAR-3	WSMR-Well MAR-3 (Dup)	10/18/2016	ng/L	< 26	< 120	< 52
2020 DW Data from WSMR	POE	68007-POE-1019	10/28/2019	ng/L	< 0.31	< 0.26	< 0.52
	DW10	68007-10A-0620	6/11/2020	ng/L	< 0.37	**1.7 J**	< 0.37
	DW11	68007-11A-0620	6/11/2020	ng/L	< 0.35	< 0.35	< 0.35
	DW13	68007-13A-0620	6/11/2020	ng/L	**0.91 J**	**2.3**	< 0.36
	DW15	68007-15A-0620	6/11/2020	ng/L	< 0.35	< 0.35	< 0.35
	DW19	68007-19-0620	6/11/2020	ng/L	< 0.36	< 0.36	< 0.36
	DW20	68007-20-0620	6/11/2020	ng/L	< 0.36	< 0.36	< 0.36
	DW21	68007-21-0620	6/11/2020	ng/L	**9.4**	**7.4**	< 0.35
	DW22	68007-22-0620	6/11/2020	ng/L	< 0.36	< 0.36	< 0.36

Table 2-1
Historical PFAS Analytical Results
USAEC PFAS Preliminary Assessment/Site Inspection
White Sands Missile Range, New Mexico

Notes and Acronyms:
ND = Non-detect (Note: Limit of Detection = 0.02 µg/L for PFOA and 0.04 µg/L for PFOS).
N/A = Not applicable
PFAS = per- and polyfluoroalkyl substances
OSD - Office of the Secretary of Defense
POE = Point of Entry
µg/L = micrograms per liter (parts per billion)
IMCOM - Installation Management Command
UCMR3 - third Unregulated Contaminant Monitoring Rule

All data and qualifier definitions are as provided to Arcadis by U.S. Army Corps of Engineers (unless otherwise noted [†]), for primary samples only. For qualifiers which laboratory-specific definitions were not provided, a standard definition is provided below (‡). Data were reviewed and conditionally formatted in accordance with the bolding and shading notes below.

* 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.

Table 6-1
Monitoring Well Construction Details
USAEC PFAS Preliminary Assessment/Site Inspection
White Sands Missile Range, New Mexico

Area of Potential Interest	Sampling Location ID[1]	Total Well Depth (ft bgs)	Measuring Point Elevation (ft amsl)	Measuring Point	July 2020 Depth to Groundwater from MP (ft)	July 2020 Groundwater Elevation (ft amsl)	Screened Interval (ft bgs)	Casing Diameter (inches)	Dedicated Bladder Pump (Y/N)
Main Post	WSMR-W13-070920	NA	NA	NA	NA	NA	NA	NA	N
FFTA at Martin Luther King Avenue and Hughes Street	WSMR-W21-070920	NA	NA	NA	NA	NA	NA	NA	N
WSMR Landfill (WSMRL)	WSMR-MPL04-070820	NA	3993.5	TOC	189.73	3803.77	NA	NA	N
	WSMR-MPL05-070820	NA	3991.9	TOC	187.08	3804.82	NA	NA	N
	WSMR-MPL18-070820	NA	3976.61	TOC	172.8	3803.81	NA	NA	N
Fire Station 4 HELSTF (FS4)	WSMR-HMW70-070820	45	3961.39	TOC	33.71	3927.68	25-45	2	N
	WSMR-HMW69-070820	45.25	3960.56	TOC	35.5	3925.06	25-45	2	N
SRC Landfill (SRCL)	WSMR-SRW3-071320	280	4076.13	TOC	174.2	3901.93	250-280	5	N
	WSMR-SRW4-071320	281.3	4071.25	TOC	176.55	3894.7	247-277	5	N

Notes:
1. Raw water samples were collected from W13 and M21 from their sampling spigot.

Acronyms/Abreviations:
amsl - above mean sea level
bgs - below ground surface
ft - feet
GS - ground surface
ID - identification
MP - measuring point
NA - not available
TOC - top of casing
WSMR - White Sands Missile Range

Sources:
Environmental Science & Engineering Inc. 1996. Groundwater Quality Investigation for the Monitoring Well Program at White Sands Missile Range. October.
Shaw Environmental, Inc. 2014. Revised RCRA Facility Investigation Report, SWMUs 86 and 87, Main Post Sanitary and Construction Landfills.
WSMR 2019. Interim Measures Report, SWMU 187, HELSTF TSA Gasoline Site.

Table 7-1
Soil PFAS Analytical Results
USAEC PFAS Preliminary Assessment/Site Inspection
White Sands Missile Range, New Mexico

			Analyte		PFOS (mg/kg)		PFOA (mg/kg)		PFBS (mg/kg)	
			OSD Industrial/Commercial Risk Screening Level		1.6		1.6		25	
			OSD Residential RiskScreening Levels		0.13		0.13		1.9	
Associated AOPI	Location Type	Location	Sample ID / Parent Sample ID	Sample Date	Sample Type	Result	Qual	Result	Qual	Result	Qual
Camp Tumbleweed	Soil	WSMR-CT-1	WSMR-CT-1-SO-052622	05/26/2022	N	0.00058	U	0.00058	U	0.0019	U
Camp Tumbleweed	Soil	WSMR-CT-2	WSMR-CT-2-SO-052622	05/26/2022	N	0.00059	U	0.00059	U	0.002	U
Camp Tumbleweed	Soil	WSMR-CT-3	WSMR-CT-3-SO-052622	05/26/2022	N	0.00058	U	0.00058	U	0.0019	U
Camp Tumbleweed	Soil	WSMR-CT-4	WSMR-CT-4-SO-052622	05/26/2022	N	0.00056	U	0.00056	U	0.0019	U
Camp Tumbleweed	Soil	WSMR-CT-5	WSMR-CT-5-SO-052622	05/26/2022	N	0.0006	U	0.0006	U	0.002	U
Electromagnetic Facility	Soil	WSMR-EAF-1-SO	WSMR-EAF-1-SO-072022	07/20/2022	N	**0.015**		**0.00091**		0.002	U
Electromagnetic Facility	Soil	WSMR-EAF-2-SO	WSMR-EAF-2-SO-072022	07/20/2022	N	**0.0023**		**0.0008**		0.002	U
Electromagnetic Facility	Soil	WSMR-EAF-3-SO	WSMR-EAF-3-SO-072022	07/20/2022	N	**0.031**		0.00061	U	0.002	U
Electromagnetic Facility	Soil	WSMR-EAF-4-SO	WSMR-EAF-4-SO-072022	07/20/2022	N	**0.0041**		**0.0012**		0.0025	
Electromagnetic Facility	Soil	WSMR-EAF-5-SO	WSMR-EAF-5-SO-072022	07/20/2022	N	0.00059	U	0.00059	U	0.002	U
Electromagnetic Facility	Soil	WSMR-EAF-6-SO	WSMR-EAF-6-SO-072022	07/20/2022	N	**0.0093**		**0.0013**		0.0024	U
Electromagnetic Facility	Soil	WSMR-EAF-7-SO	WSMR-EAF-7-SO-072022	07/20/2022	N	**0.0037**		**0.00067**	J	0.0024	U
Hazardous Waste Storage Building	Soil	WSMR-HWSB-1	WSMR-HWSB-1-SO-052622	05/26/2022	N	0.00061	U	0.00061	U	0.002	U
Hazardous Waste Storage Building	Soil	WSMR-HWSB-2	WSMR-HWSB-2-SO-052622	05/26/2022	N	0.0006	U	0.0006	U	0.002	U
Hazardous Waste Storage Building	Soil	WSMR-HWSB-3	WSMR-HWSB-3-SO-052622	05/26/2022	N	0.00059	U	0.00059	U	0.002	U
Hazardous Waste Storage Building	Soil	WSMR-HWSB-4	WSMR-HWSB-4-SO-052622	05/26/2022	N	0.00061	U	0.00061	U	0.002	U
			WSMR-FD-4-SO-052622 / WSMR-HWSB-4-SO-052622	05/26/2022	FD	0.00059	U	0.00059	U	0.002	U
Current Firefighting Training Area	Soil	WSMR-CFTA-1	WSMR-CFTA-1-SO(0-2)-071020	07/10/2020	N	0.00058	U	0.00058	U	0.0019	U
Current Firefighting Training Area	Soil	WSMR-CFTA-2	WSMR-CFTA-2-SO(0-2)-071020	07/10/2020	N	0.00056	U	0.00056	U	0.0019	U
Current Firefighting Training Area	Soil	WSMR-CFTA-3	WSMR-CFTA-3-SO(0-2)-071020	07/10/2020	N	**0.00059**	J	**0.0045**		0.0022	U
Current Firefighting Training Area	Soil	WSMR-CFTA-4	WSMR-CFTA-4-SO(0-2)-071020	07/10/2020	N	**0.00083**		**0.0012**		0.0023	U
Current Firefighting Training Area	Soil	WSMR-CFTA-5	WSMR-CFTA-5-SO	11/10/2020	N	0.00058	U	**0.00057**	J	0.0019	U
			WSMR-FD-4-SO-111020 / WSMR-CFTA-5-SO	11/10/2020	FD	**0.00066**		0.00064	U	0.0021	U

Table 7-1
Soil PFAS Analytical Results
USAEC PFAS Preliminary Assessment/Site Inspection
White Sands Missile Range, New Mexico

			Analyte			PFOS (mg/kg)		PFOA (mg/kg)		PFBS (mg/kg)	
			OSD Industrial/Commercial Risk Screening Level			1.6		1.6		25	
			OSD Residential RiskScreening Levels			0.13		0.13		1.9	
Associated AOPI	Location Type	Location	Sample ID / Parent Sample ID	Sample Date	Sample Type	Result	Qual	Result	Qual	Result	Qual
Current Firefighting Training Area	Soil	WSMR-CFTA-6	WSMR-CFTA-6-SO	11/10/2020	N	0.00065	U	**0.0018**		0.0022	U
Fire Department Storage Building	Soil	WSMR-FDSTG-1	WSMR-FDSTG-1-SO	11/10/2020	N	**0.0017**		0.0006	U	0.002	U
Fire Department Storage Building	Soil	WSMR-FDSTG-2	WSMR-FDSTG-2-SO	11/10/2020	N	0.00064	U	0.00064	U	0.0021	U
Former Fire Department Storage Building	Soil	WSMR-FFDSTG-1	WSMR-FFDSTG-1-SO	11/10/2020	N	**0.6**		**0.0056**		0.0021	U
Former Fire Department Storage Building	Soil	WSMR-FFDSTG-2	WSMR-FFDSTG-2-SO	11/10/2020	N	**0.0023**		**0.00055**	J	0.0021	U
Former Fire Department Storage Building	Soil	WSMR-FFDSTG-3	WSMR-FFDSTG-3-SO	11/10/2020	N	**0.049**		**0.00096**		0.0019	U
Former Fire Department Storage Building	Soil	WSMR-FFDSTG-4	WSMR-FFDSTG-4-SO	11/10/2020	N	**1.6**		**0.0029**		**0.0016**	J
FFTA at Martin Luther King Avenue and Hughes Street	Soil	WSMR-FFTAMLK-1	WSMR-FFTAMLK-1-SO(0-2)-070920	07/09/2020	N	**2.1**	J	**0.0066**		0.002	U
FFTA at Martin Luther King Avenue and Hughes Street	Soil	WSMR-FFTAMLK-2	WSMR-FFTAMLK-2-SO(0-2)-070920	07/09/2020	N	**0.015**		**0.00058**	J	0.002	U
FFTA at Martin Luther King Avenue and Hughes Street	Soil	WSMR-FFTAMLK-3	WSMR-FFTAMLK-3-SO(0-2)-070920	07/09/2020	N	**0.0052**		0.00062	U	0.0021	U
FFTA at Martin Luther King Avenue and Hughes Street	Soil	WSMR-FFTAMLK-4	WSMR-FFTAMLK-4-SO(0-2)-070920	07/09/2020	N	**0.00047**	J	0.0006	U	0.002	U
FFTA at Martin Luther King Avenue and Hughes Street	Soil	WSMR-FFTAMLK-5	WSMR-FFTAMLK-5-SO(0-2)-070920	07/09/2020	N	**0.0045**		0.00062	U	0.0021	U
			WSMR-FD-3-SO-070920 / WSMR-FFTAMLK-5-SO(0-2)-070920	07/09/2020	FD	**0.0052**		0.00063	U	0.0021	U
Former Firefighting Training Area (FFTA) Pit	Soil	WSMR-FFTAP-1	WSMR-FFTAP-1-SO(0-2)-070820	07/08/2020	N	**0.00081**		0.00059	U	0.002	U

Table 7-1
Soil PFAS Analytical Results
USAEC PFAS Preliminary Assessment/Site Inspection
White Sands Missile Range, New Mexico

			Analyte			PFOS (mg/kg)		PFOA (mg/kg)		PFBS (mg/kg)	
			OSD Industrial/Commercial Risk Screening Level			1.6		1.6		25	
			OSD Residential RiskScreening Levels			0.13		0.13		1.9	
Associated AOPI	**Location Type**	**Location**	**Sample ID / Parent Sample ID**	**Sample Date**	**Sample Type**	**Result**	**Qual**	**Result**	**Qual**	**Result**	**Qual**
Former Firefighting Training Area (FFTA) Pit	Soil	WSMR-FFTAP-2	WSMR-FFTAP-2-SO(0-2)-070720	07/07/2020	N	**0.3**		**0.0086**		0.0019	U
			WSMR-FFTAP-2-SO(8-10)-070720	07/07/2020	N	**0.0042**		**0.13**		**0.012**	
Former Firefighting Training Area (FFTA) Pit	Soil	WSMR-FFTAP-3	WSMR-FFTAP-3-SO(0-2)-070720	07/07/2020	N	**0.019**		**0.00046**	J	0.0019	U
			WSMR-FFTAP-3-SO(8-10)-070720	07/07/2020	N	**0.00046**	J	**0.007**	J	0.002	U
			WSMR-FD-1-SO-070720 / WSMR-FFTAP-3-SO(0-2)-070720	07/07/2020	FD	**0.0019**		**0.015**		0.0019	U
FFTA Waste Pile (SWMU-22)	Soil	WSMR-FFTAWP-1	WSMR-FFTAWP-1-SO(0-2)-070820	07/08/2020	N	**0.055**		**0.0023**		0.002	U
FFTA Waste Pile (SWMU-22)	Soil	WSMR-FFTAWP-2	WSMR-FFTAWP-2-SO(0-2)-070820	07/08/2020	N	**0.21**		**0.0032**		0.0019	U
FFTA Waste Pile (SWMU-22)	Soil	WSMR-FFTAWP-3	WSMR-FFTAWP-3-SO(0-2)-070820	07/08/2020	N	**0.0026**		0.00056	U	0.0019	U
			WSMR-FD-2-SO-070820 / WSMR-FFTAWP-3-SO(0-2)-070820	07/08/2020	FD	**0.0027**		0.00064	U	0.0021	U
Fire Station 1 (FS1)	Soil	WSMR-FS1-1	WSMR-FS1-1-SO(0-2)-070920	07/09/2020	N	**0.04**		**0.00086**		0.002	U
			WSMR-FS1-4-SO	11/10/2020	N	**0.04**		**0.0044**		0.0023	U
Fire Station 1 (FS1)	Soil	WSMR-FS1-2	WSMR-FS1-2-SO(0-2)-070920	07/09/2020	N	**0.011**		**0.0029**		0.002	U
Fire Station 1 (FS1)	Soil	WSMR-FS1-3	WSMR-FS1-3-SO(0-2)-070920	07/09/2020	N	**0.0028**		0.00061	U	0.002	U
Fire Station 2 Launch Complex (LC)	Soil	WSMR-FS2-1	WSMR-FS2-1-SO(0-2)-071020	07/10/2020	N	**0.15**		**0.0057**		0.002	U
Fire Station 2 Launch Complex (LC)	Soil	WSMR-FS2-2	WSMR-FS2-2-SO(0-2)-071020	07/10/2020	N	**0.2**		**0.0034**		0.0019	U
Fire Station 2 Launch Complex (LC)	Soil	WSMR-FS2-3	WSMR-FS2-3-SO(0-2)-071020	07/10/2020	N	**0.043**		**0.00062**		0.0019	U
Fire Station 2 Launch Complex (LC)	Soil	WSMR-FS2-4	WSMR-FS2-4-SO(0-2)-070720	07/07/2020	N	**0.036**		**0.00083**		0.0019	U
Fire Station 3 SRC	Soil	WSMR-FS3-1	WSMR-FS3-1-SO(0-2)-071320	07/13/2020	N	**0.07**		**0.0053**		0.002	U
Fire Station 3 SRC	Soil	WSMR-FS3-2	WSMR-FS3-2-SO(0-2)-071320	07/13/2020	N	**0.12**		**0.0011**		0.0019	U
Fire Station 3 SRC	Soil	WSMR-FS3-3	WSMR-FS3-3-SO(0-2)-071320	07/13/2020	N	**0.029**		**0.0014**		0.0021	U
Fire Station 3 SRC	Soil	WSMR-FS3-4	WSMR-FS3-4-SO(0-2)-071320	07/13/2020	N	**0.005**		**0.0005**	J	0.0019	U
Fire Station 3 SRC	Soil	WSMR-FS3-5	WSMR-FS3-5-SO(0-2)-071320	07/13/2020	N	**0.0016**		**0.00068**		0.0021	U
Fire Station 3 SRC	Soil	WSMR-FS3STG-1	WSMR-FS3STG-1-SO(0-2)-071320	07/13/2020	N	**0.01**		0.00063	U	0.0021	U
Fire Station 3 SRC	Soil	WSMR-FS3STG-2	WSMR-FS3STG-2-SO(0-2)-071320	07/13/2020	N	**0.0041**		**0.00081**		0.0023	U

Table 7-1
Soil PFAS Analytical Results
USAEC PFAS Preliminary Assessment/Site Inspection
White Sands Missile Range, New Mexico

					Analyte	PFOS (mg/kg)		PFOA (mg/kg)		PFBS (mg/kg)	
					OSD Industrial/Commercial Risk Screening Level	1.6		1.6		25	
					OSD Residential RiskScreening Levels	0.13		0.13		1.9	
Associated AOPI	Location Type	Location	Sample ID / Parent Sample ID	Sample Date	Sample Type	Result	Qual	Result	Qual	Result	Qual
Fire Station 4 HELSTF (FS4)	Soil	WSMR-FS4-1	WSMR-FS4-1-SO(0-2)-070820	07/08/2020	N	**0.00078**	J	0.0008	U	0.0027	U
Fire Station 4 HELSTF (FS4)	Soil	WSMR-FS4-2	WSMR-FS4-2-SO(0-2)-070820	07/08/2020	N	0.00064	U	0.00064	U	0.0021	U
Fire Station 4 HELSTF (FS4)	Soil	WSMR-FS4-3	WSMR-FS4-3-SO(0-2)-070820	07/08/2020	N	**0.011**		**0.004**		0.002	U
Fire Station 4 Storage	Soil	WSMR-FS4STG-1	WSMR-FS4STG-1-SO	11/10/2020	N	**0.12**		**0.0062**		0.0023	U
Fire Station 4 Storage	Soil	WSMR-FS4STG-2	WSMR-FS4STG-2-SO	11/10/2020	N	0.00067	U	0.00067	U	0.0022	U
Fire Station 4 Storage	Soil	WSMR-FS4STG-3	WSMR-FS4STG-3-SO	11/10/2020	N	**0.0027**		0.00068	U	0.0023	U
Photo Processing Lab	Soil	WSMR-PPL-1	WSMR-PPL-1-SO(6-8)-070720	07/07/2020	N	0.00061	U	0.00061	U	0.002	U
Photo Processing Lab	Soil	WSMR-PPL-2	WSMR-PPL-2-SO(6-8)-070720	07/07/2020	N	0.00061	U	0.00061	U	0.002	U
Stallion Range Center FFTA	Soil	WSMR-SRCFFTA-1	WSMR-SRCFFTA-1-SO(0-2)-071320	07/13/2020	N	**0.053**		**0.0065**		0.0026	U
Stallion Range Center FFTA	Soil	WSMR-SRCFFTA-2	WSMR-SRCFFTA-2-SO(0-2)-071320	07/13/2020	N	**2.1**		**0.28**		**0.011**	
Stallion Range Center FFTA	Soil	WSMR-SRCFFTA-3	WSMR-SRCFFTA-3-SO(0-2)-071320	07/13/2020	N	**0.17**		**0.078**		**0.011**	
Sewage Treatment Plant Percolation Ditch_Impound Area	Soil	WSMR-STPPD-1	WSMR-STPPD-1-SO(0-2)-070820	07/08/2020	N	**0.012**		**0.00046**	J	0.0021	U
Sewage Treatment Plant Percolation Ditch_Impound Area	Soil	WSMR-STPPD-2	WSMR-STPPD-2-SO(0-2)-070820	07/08/2020	N	**0.012**		0.00062	U	0.0021	U
Sewage Treatment Plant Percolation Ditch_Impound Area	Soil	WSMR-STPPD-3	WSMR-STPPD-3-SO(0-2)-070820	07/08/2020	N	**0.0093**		**0.0033**		0.002	U

Table 7-1
Soil PFAS Analytical Results
USAEC PFAS Preliminary Assessment/Site Inspection
White Sands Missile Range, New Mexico

					Analyte	PFOS (mg/kg)		PFOA (mg/kg)		PFBS (mg/kg)	
					OSD Industrial/Commercial Risk Screening Level	1.6		1.6		25	
					OSD Residential RiskScreening Levels	0.13		0.13		1.9	
Associated AOPI	Location Type	Location	Sample ID / Parent Sample ID	Sample Date	Sample Type	Result	Qual	Result	Qual	Result	Qual
Vehicle Maintenance Shop	Soil	WSMR-VMS-1	WSMR-VMS-1-SO(0-2)-070920	07/09/2020	N	**0.0024**		**0.00072**		0.0022	U
Vehicle Maintenance Shop	Soil	WSMR-VMS-2	WSMR-VMS-2-SO(0-2)-070920	07/09/2020	N	0.00063	U	0.00063	U	0.0021	U

Notes:
1. **Bolded** values indicate the result was detected greater than the limit of detection
2. Data are compared to the 2021 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.).
3. Grey shaded values indicate the result was detected greater than or equal to the OSD risk screening level for the residential scenario. Italicized values indicate the result was detected greater than the OSD risk screening level for the industrial/commercial and residential scenario.

Acronyms/Abbreviations:
AOPI = Area of Potential Interest
DPT = Direct-Push Technology
FD = field duplicate sample
ID = identification
mg/kg = milligrams per kilogram (parts per million)
N = primary sample
PFAS = per- and polyfluoroalkyl substances
PFBS = perfluorobutanesulfonic acid
PFOA = perfluorooctanoic acid
PFOS = perfluorooctane sulfonate
Qual = qualifier

Qualifier	Description
U	The analyte was analyzed for but the result was not detected above thelimit of quantitation (LOQ).
J	The analyte was positively identified; however the associated numerical value is an estimated concentration only

Table 7-2
Monitoring Wells PFOS, PFOA, and PFBS Analytical Results
USACE PFAS Preliminary Assessment/Site Inspection
White Sands Missile Range, New Mexico

			Analyte			PFOS (ng/L)		PFOA (ng/L)		PFBS (ng/L)	
			OSD Tapwater RiskScreening Level			40		40		600	
Associated AOPI	Location Type	Location	Sample ID / Parent Sample ID	Sample Date	Sample Type	Result	Qual	Result	Qual	Result	Qual
Fire Station 4 HELSTF (FS4)	Monitoring Well	WSMR-HMW69	WSMR-HMW69-070820	07/08/2020	N	**1.0**	J	**2.2**		**520**	
			WSMR-FD-1-GW-070820 / WSMR-HMW69-070820	07/08/2020	FD	**0.92**	J	**2.4**		**490**	
Fire Station 4 HELSTF (FS4)	Monitoring Well	WSMR-HMW70	WSMR-HMW70-070820	07/08/2020	N	17	U	**24**		**650**	
Stallion Range Center Landfill	Monitoring Well	WSMR-SRW-3	WSMR-SRW3-071320	07/13/2020	N	1.7	U	1.7	U	1.7	U
Stallion Range Center Landfill	Monitoring Well	WSMR-SRW-4	WSMR-SRW4-071320	07/13/2020	N	1.7	U	1.7	U	1.7	U
WSMR Landfill	Monitoring Well	WSMR-MPL04	WSMR-MPL04-070820	07/08/2020	N	**1.3**	J	**15**		**2.0**	
WSMR Landfill	Monitoring Well	WSMR-MPL05	WSMR-MPL05-070820	07/08/2020	N	1.8	U	1.8	U	1.8	U
WSMR Landfill	Monitoring Well	WSMR-MPL18	WSMR-MPL18-070820	07/08/2020	N	1.7	U	1.7	U	1.7	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 2021 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:
-- = not applicable
AOPI = Area of Potential Interest
FD = field duplicate sample
ID = identification
N = primary sample
ng/L = nanograms per liter (parts per trillion)
PFAS = per- and polyfluoroalkyl substances
PFBS = perfluorobutanesulfonic acid
PFOA = perfluorooctanoic acid
PFOS = perfluorooctane sulfonate
Qual = qualifier

Qualifier	Description
U	The analyte was analyzed for but the result was not detected above thelimit of quantitation (LOQ).
J	The analyte was positively identified; however the associated numerical value is an estimated concentration only

Table 7-3
Raw Water Wells PFOS, PFOA, and PFBS Analytical Results
USACE PFAS Preliminary Assessment/Site Inspection
White Sands Missile Range, New Mexico

			Analyte			PFOS (ng/L)		PFOA (ng/L)		PFBS (ng/L)	
			OSD Tapwater RiskScreening Level			40		40		600	
Associated AOPI	Location Type	Location	Sample ID / Parent Sample ID	Sample Date	Sample Type	Result	Qual	Result	Qual	Result	Qual
Northern Main Post Water Supply Wells	Raw Water Supply Well	WSMR-W10A-1	WSMR-W10A-1-GW-052622	05/26/2022	N	1.6	U	1.6	U	**1.8**	
Northern Main Post Water Supply Wells	Raw Water Supply Well	WSMR-W17-1	WSMR-W17-1-GW-052622	05/26/2022	N	1.6	U	1.6	U	1.6	U
			WSMR-FD-2-GW-052622 / WSMR-W17-1-GW-052622	05/26/2022	FD	1.6	U	1.6	U	1.6	U
FFTA at Martin Luther King Avenue and Hughes Street	Raw Water Supply Well	WSMR-W13	WSMR-W13-070920	07/09/2020	N	1.6	U	1.6	U	**1.4**	J
	Raw Water Supply Well	WSMR-W21	WSMR-W21-070920	07/09/2020	N	1.6	U	**6.7**		**5.6**	

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 2021 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:
-- = not applicable
AOPI = Area of Potential Interest
FD = field duplicate sample
ID = identification
N = primary sample
ng/L = nanograms per liter (parts per trillion)
PFAS = per- and polyfluoroalkyl substances
PFBS = perfluorobutanesulfonic acid
PFOA = perfluorooctanoic acid
PFOS = perfluorooctane sulfonate
Qual = qualifier

Qualifier	Description
U	The analyte was analyzed for but the result was not detected above thelimit of quantitation (LOQ).
J	The analyte was positively identified; however the associated numerical value is an estimated concentration only

FIGURES

USAEC PFAS Preliminary Assessment / Site Inspection
White Sands Missile Range, NM

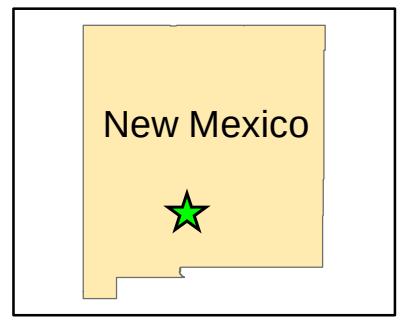
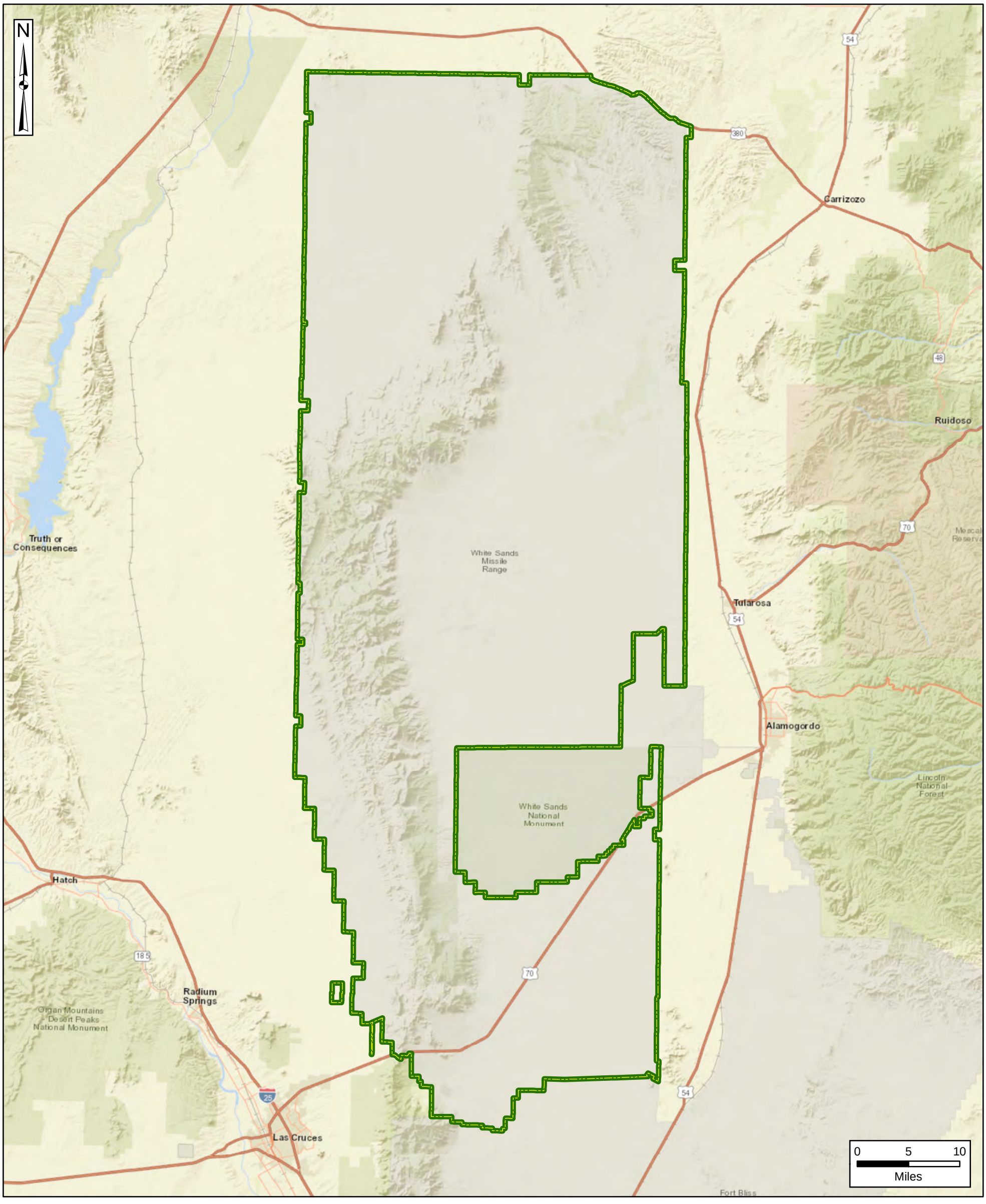


Figure 2-1
Site Location



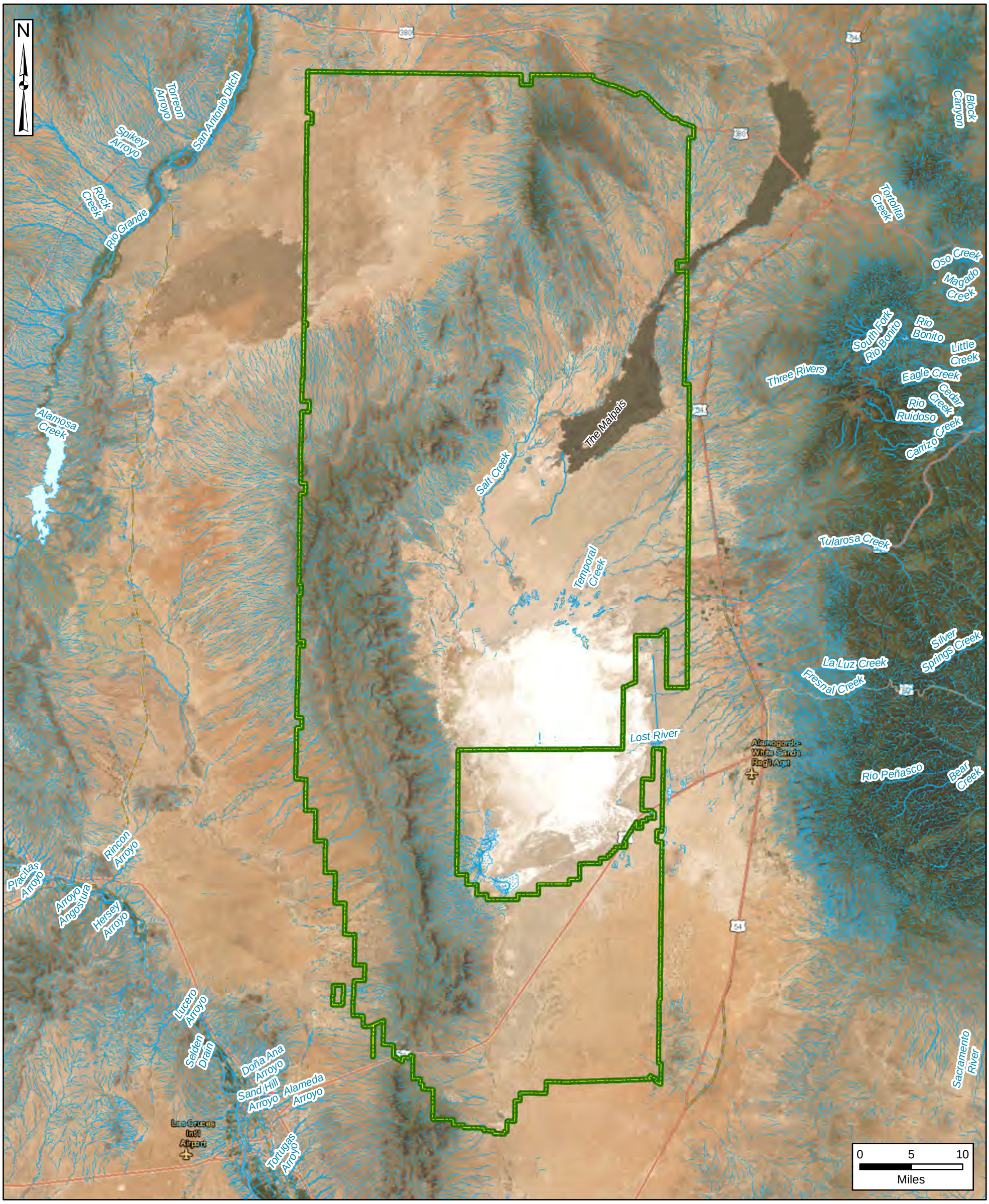
Installation Boundary

Data Sources:
ESRI ArcGIS Online, StreetMap Data

Coordinate System:
WGS 1984, UTM Zone 13 North

USAEC PFAS Preliminary Assessment / Site Inspection
White Sands Missile Range, NM

Figure 2-2
Site Layout

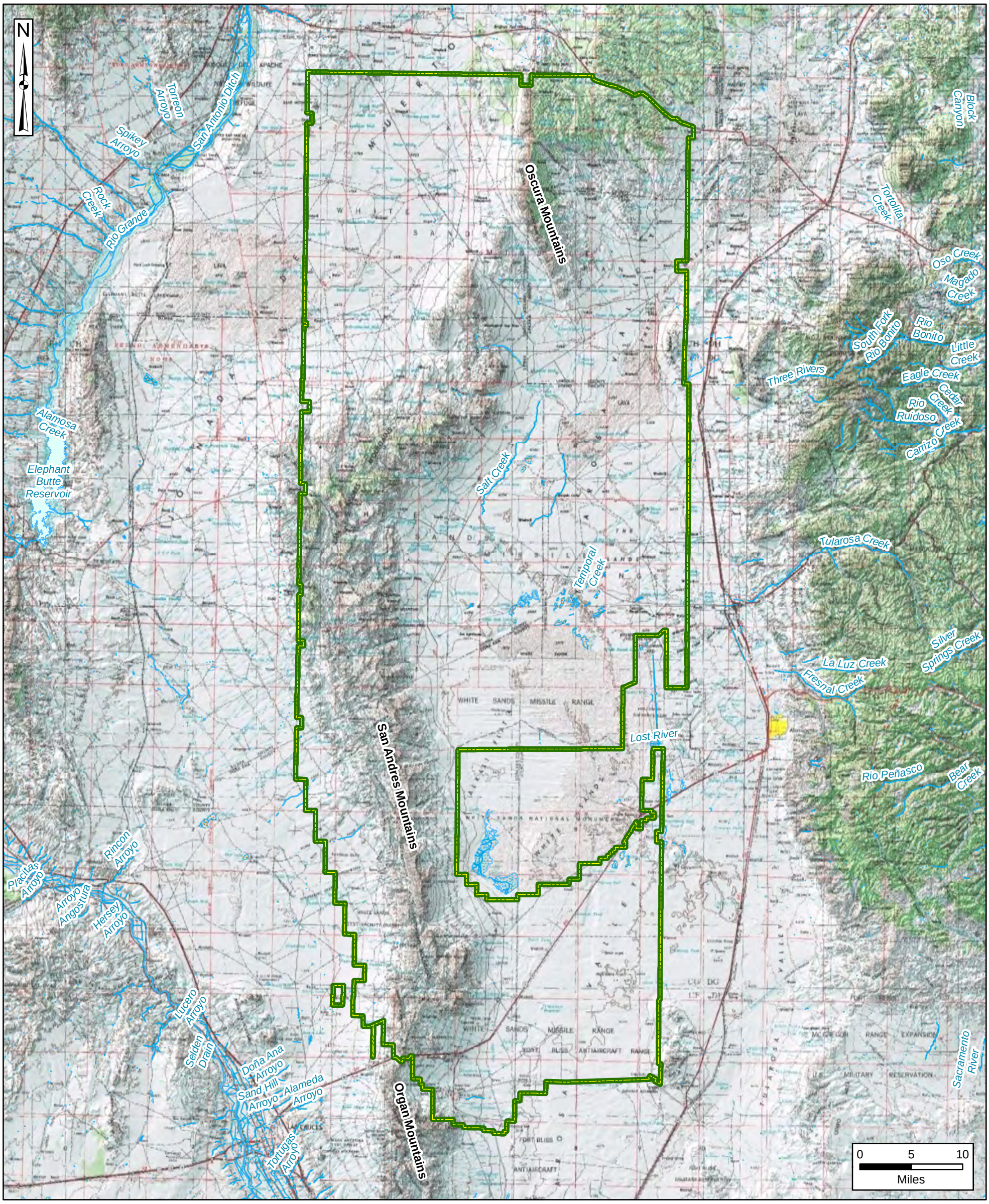


Data Sources:
NHD, Water Bodies, 2019
ESRI ArcGIS Online, Aerial Imagery

Coordinate System:
WGS 1984, UTM Zone 13 North

USAEC PFAS Preliminary Assessment / Site Inspection
White Sands Missile Range, NM

Figure 2-3
Site Topography



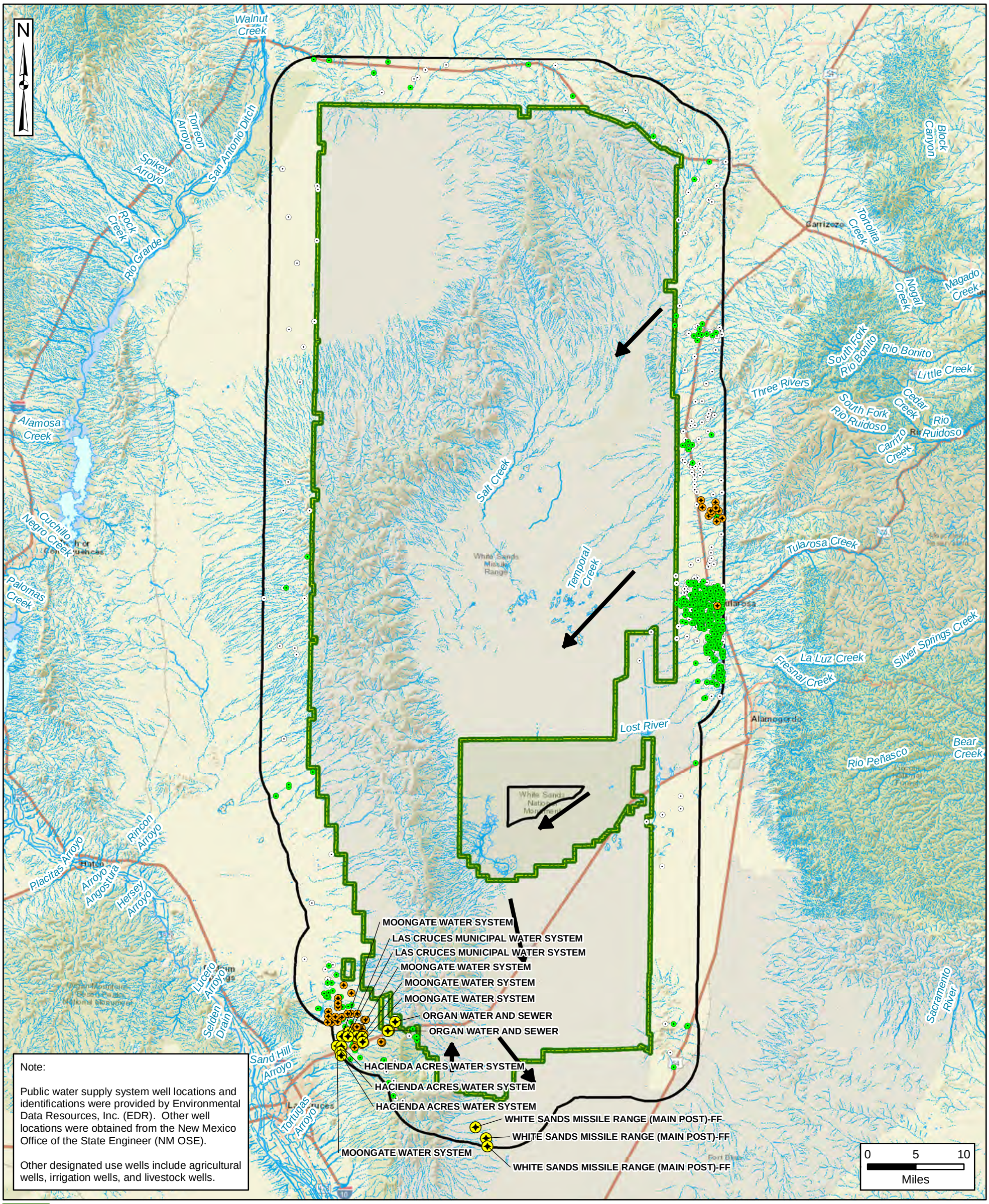
Installation Boundary
River/Stream (Perennial)
Canal/Ditch
Water Body (Perennial)
Water Body (Intermittent)
Playa

Data Sources:
NHD, Water Bodies, 2019
ESRI ArcGIS Online, USA Topo Maps

Coordinate System:
WGS 1984, UTM Zone 13 North

USAEC PFAS Preliminary Assessment / Site Inspection
White Sands Missile Range, NM

Figure 2-4
Off-Post Potable Wells



Note:

Public water supply system well locations and identifications were provided by Environmental Data Resources, Inc. (EDR). Other well locations were obtained from the New Mexico Office of the State Engineer (NM OSE).

Other designated use wells include agricultural wells, irrigation wells, and livestock wells.

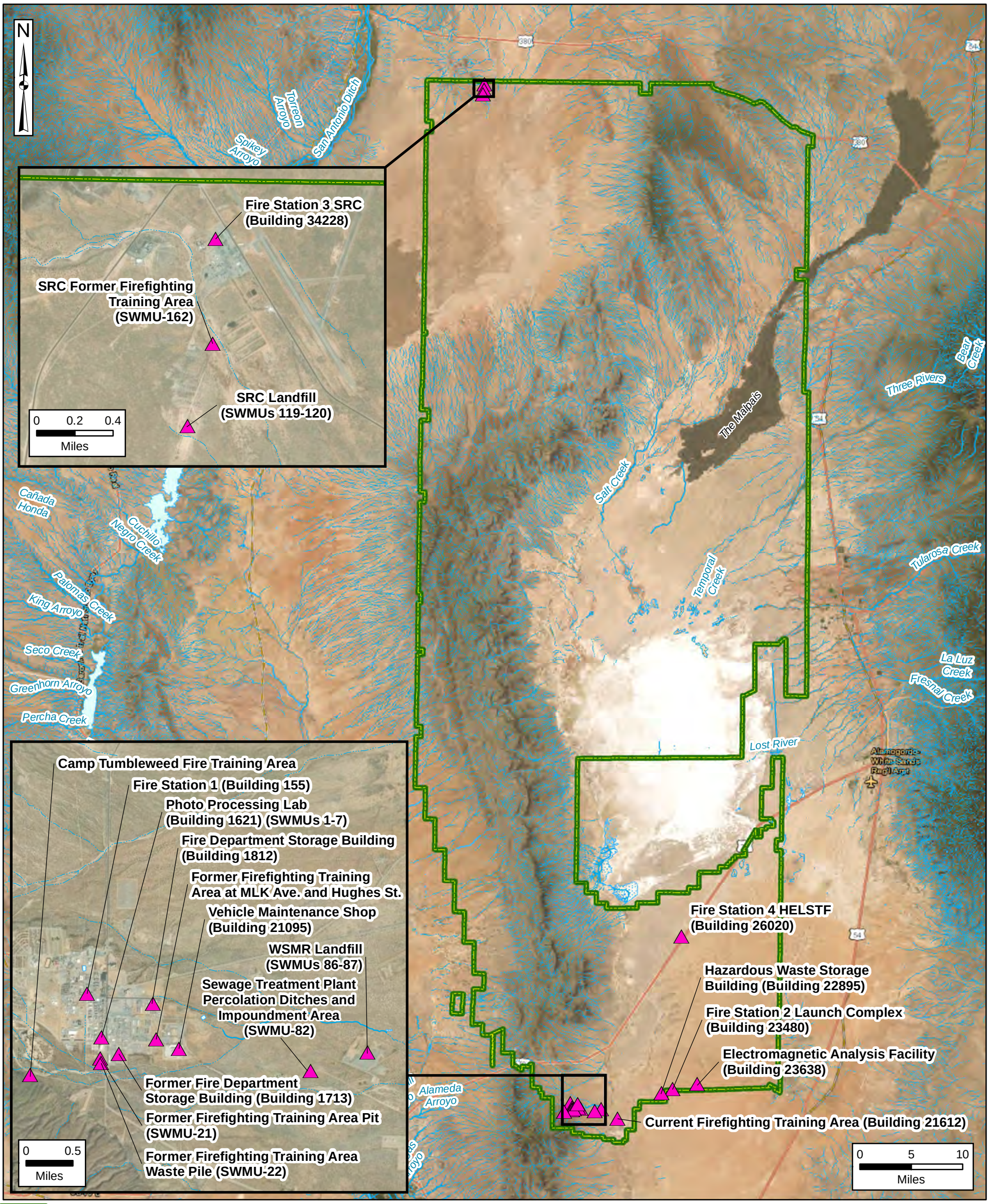
- Installation Boundary
- 5-Mile Radius
- River/Stream (Perennial)
- Stream (Intermittent)
- Canal/Ditch
- Water Body (Perennial)
- Water Body (Intermittent)
- Playa
- Public Water Supply System Well
- Other Public Supply / Community Well
- Domestic Well
- Other Designated Use Water Well
- Groundwater Flow Direction

Data Sources:
NHD, Water Bodies, 2019
WSMR, GIS Data, 2018
EDR, Well Data, 2018
NM OSE, Well Data, 2019
ESRI ArcGIS Online, StreetMap Data

Coordinate System:
WGS 1984, UTM Zone 13 North

USAEC PFAS Preliminary Assessment / Site Inspection
White Sands Missile Range, NM

Figure 5-2
AOPI Locations



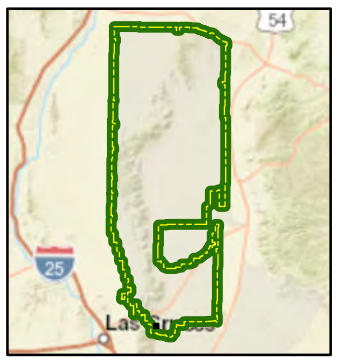
AOPI = area of potential interest
HELSTF = High Energy Laser System Test Facility
MLK Ave. = Martin Luther King Jr. Avenue
SRC = Stallion Range Center
St. = Street
SWMU = solid waste management unit

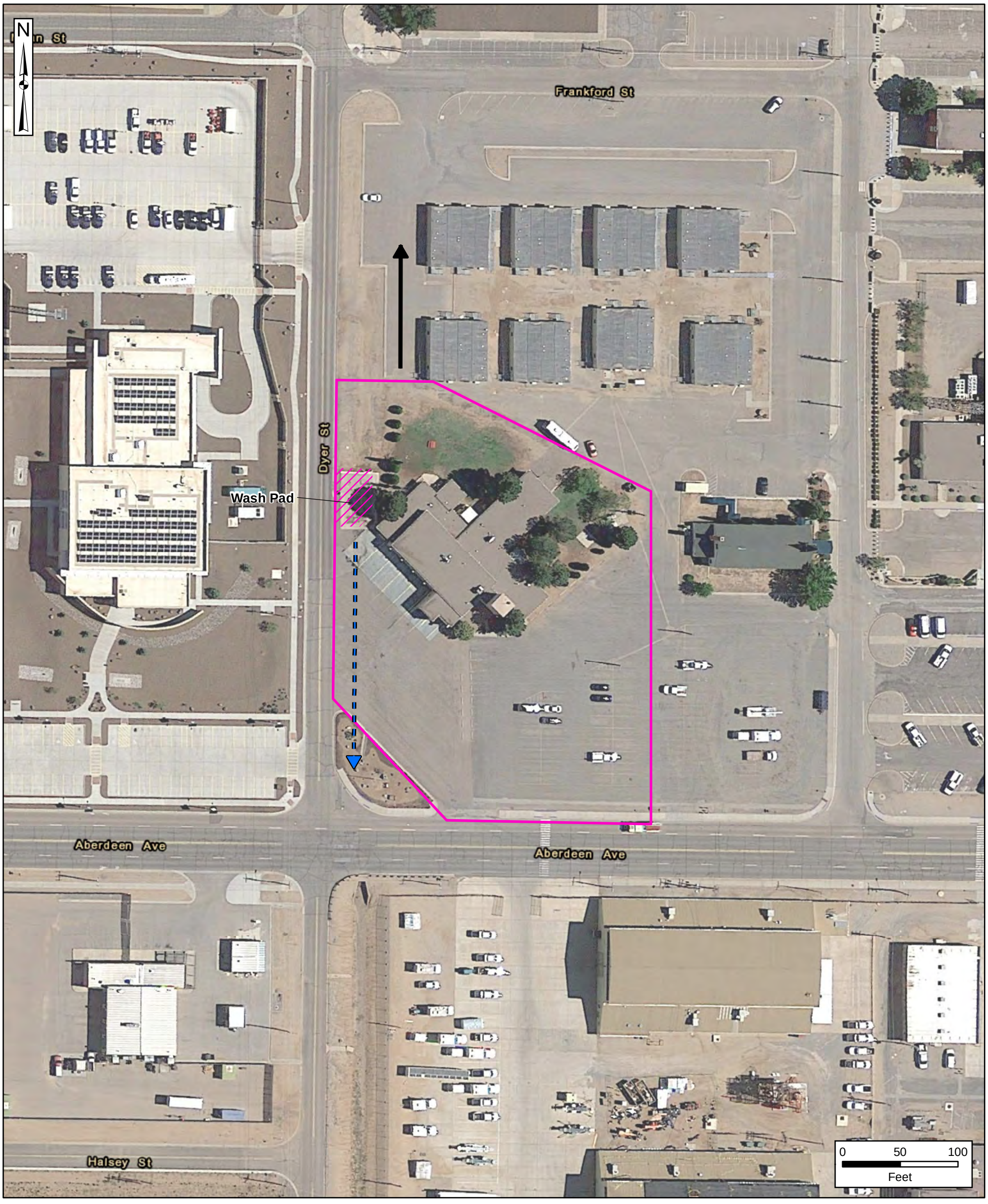
Data Sources:
NHD, Water Bodies, 2019
ESRI ArcGIS Online, Aerial Imagery

Coordinate System:
WGS 1984, UTM Zone 13 North

USAEC PFAS Preliminary Assessment / Site Inspection
White Sands Missile Range, NM

Figure 5-3
Aerial Photo of
Fire Station 1 (Building 155)





Installation Boundary
AOPI
AFFF Release Area
Surface Runoff Flow Direction
Groundwater Flow Direction

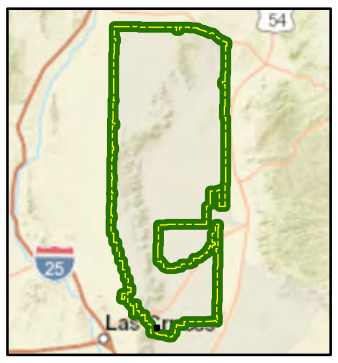
AFFF = aqueous film-forming foam
AOPI = area of potential interest

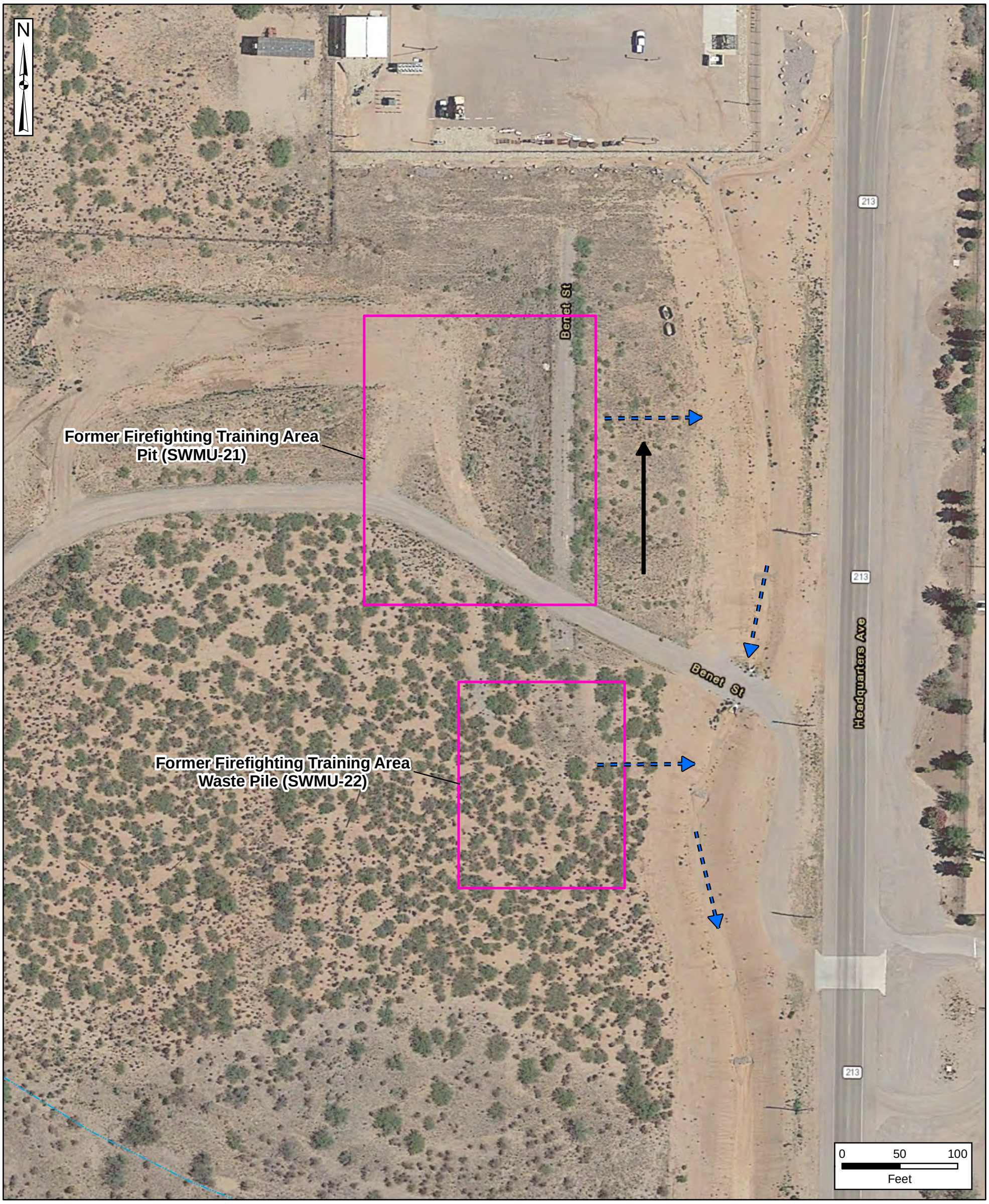
Data Sources:
Google Earth, Aerial Imagery

Coordinate System:
WGS 1984, UTM Zone 13 North

USAEC PFAS Preliminary Assessment / Site Inspection
White Sands Missile Range, NM

Figure 5-4
Aerial Photo of
Former Firefighting Training Area Pit (SWMU-21) and
Former Firefighting Training Area Waste Pile (SWMU-22)





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

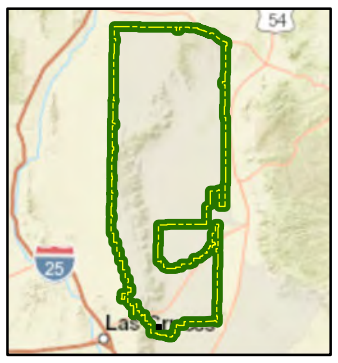
AOPI = area of potential interest
SWMU = Solid Waste Management Unit

Data Sources:
NHD, Water Bodies, 2019
Google Earth, Aerial Imagery

Coordinate System:
WGS 1984, UTM Zone 13 North

USAEC PFAS Preliminary Assessment / Site Inspection
White Sands Missile Range, NM

Figure 5-5
Aerial Photo of
Former Firefighting Training Area at
Martin Luther King Avenue and Hughes Street



Installation Boundary

AOPI

Historical Building Footprint

Surface Runoff Flow Direction

Groundwater Flow Direction

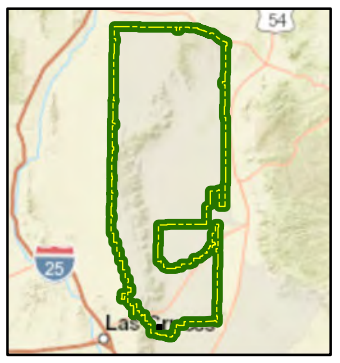
AOPI = area of potential interest

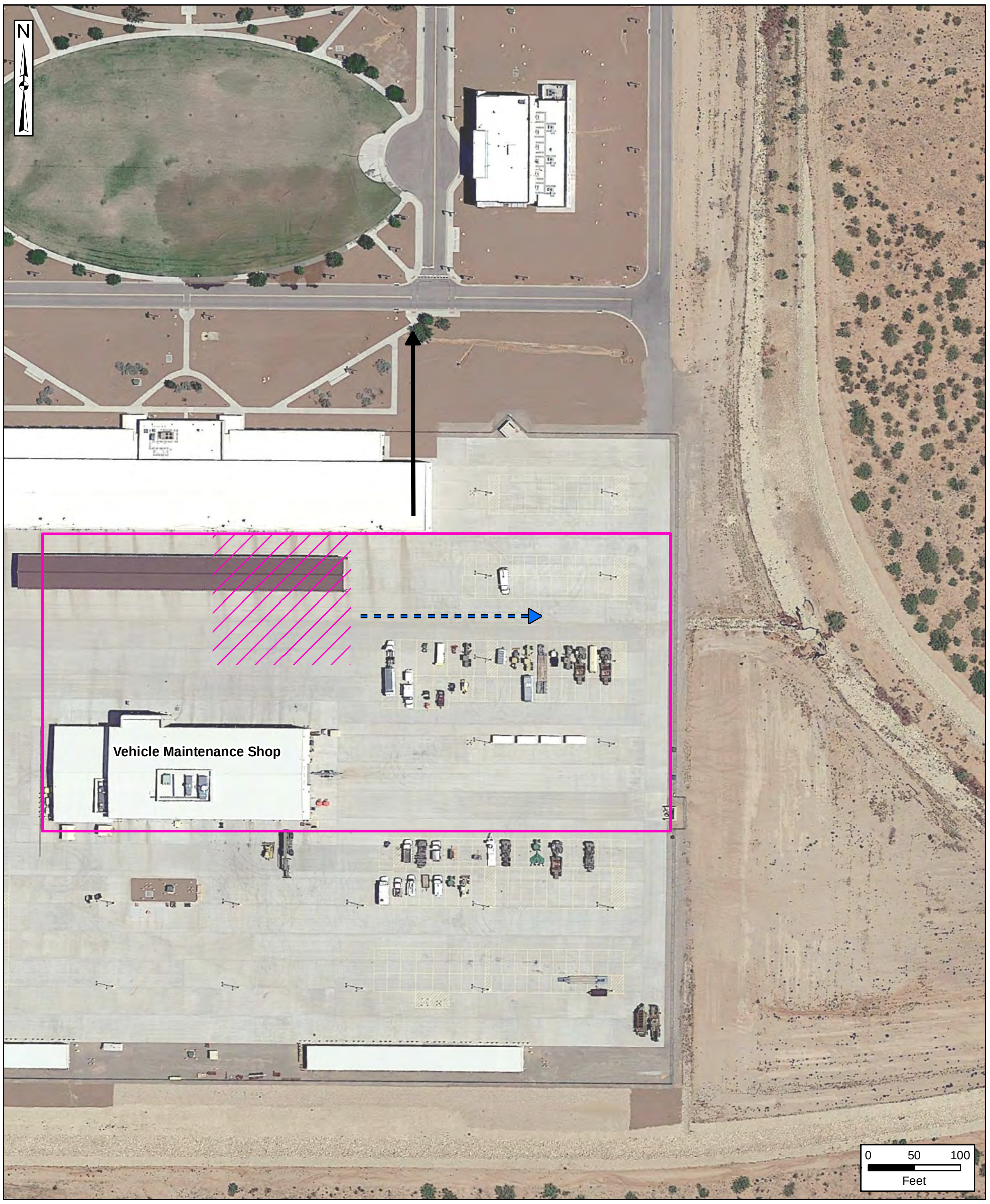
Data Sources:
Google Earth, Aerial Imagery

Coordinate System:
WGS 1984, UTM Zone 13 North

USAEC PFAS Preliminary Assessment / Site Inspection
White Sands Missile Range, NM

Figure 5-6
Aerial Photo of
Vehicle Maintenance Shop (Building 21095)





Installation Boundary

AOPI

AFFF Release Area

Surface Runoff Flow Direction

Groundwater Flow Direction

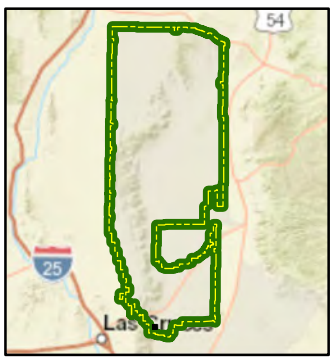
AOPI = area of potential interest
AFFF = aqueous film-forming foam

Data Sources:
Google Earth, Aerial Imagery

Coordinate System:
WGS 1984, UTM Zone 13 North

USAEC PFAS Preliminary Assessment / Site Inspection
White Sands Missile Range, NM

Figure 5-7
Aerial Photo of Photo Processing Lab
(Building 1621) (SWMUs 1-7)



Installation Boundary

AOPI

Surface Runoff Flow Direction

Groundwater Flow Direction

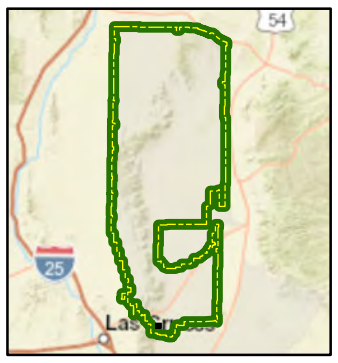
AOPI = area of potential interest
SWMU = Solid Waste Management Unit

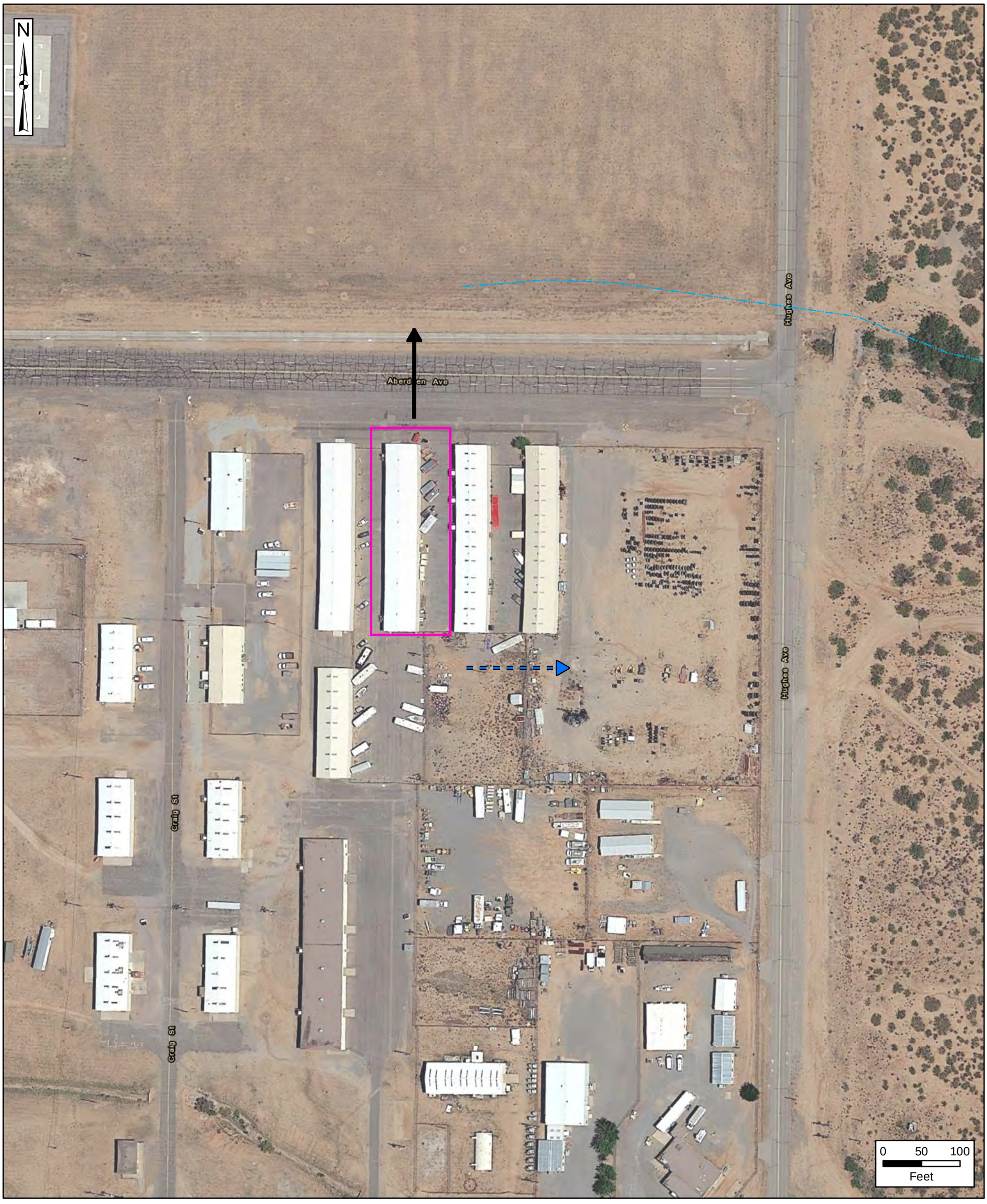
Data Sources:
Google Earth, Aerial Imagery

Coordinate System:
WGS 1984, UTM Zone 13 North

USAEC PFAS Preliminary Assessment / Site Inspection
White Sands Missile Range, NM

Figure 5-8
Aerial Photo of
Fire Department Storage Building (Building 1812)





Installation Boundary

AOPI

Stream (Intermittent)

Surface Runoff Flow Direction

Groundwater Flow Direction

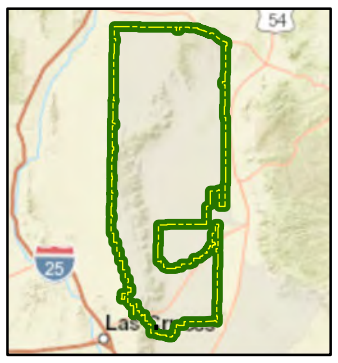
AOPI = area of potential interest

Data Sources:
Google Earth, Aerial Imagery

Coordinate System:
WGS 1984, UTM Zone 13 North

USAEC PFAS Preliminary Assessment / Site Inspection
White Sands Missile Range, NM

Figure 5-9
Aerial Photo of
Former Fire Department Storage Building (Building 1713)



Installation Boundary

AOPI

Surface Runoff Flow Direction

Groundwater Flow Direction

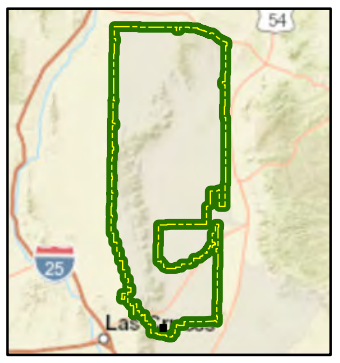
AOPI = area of potential interest

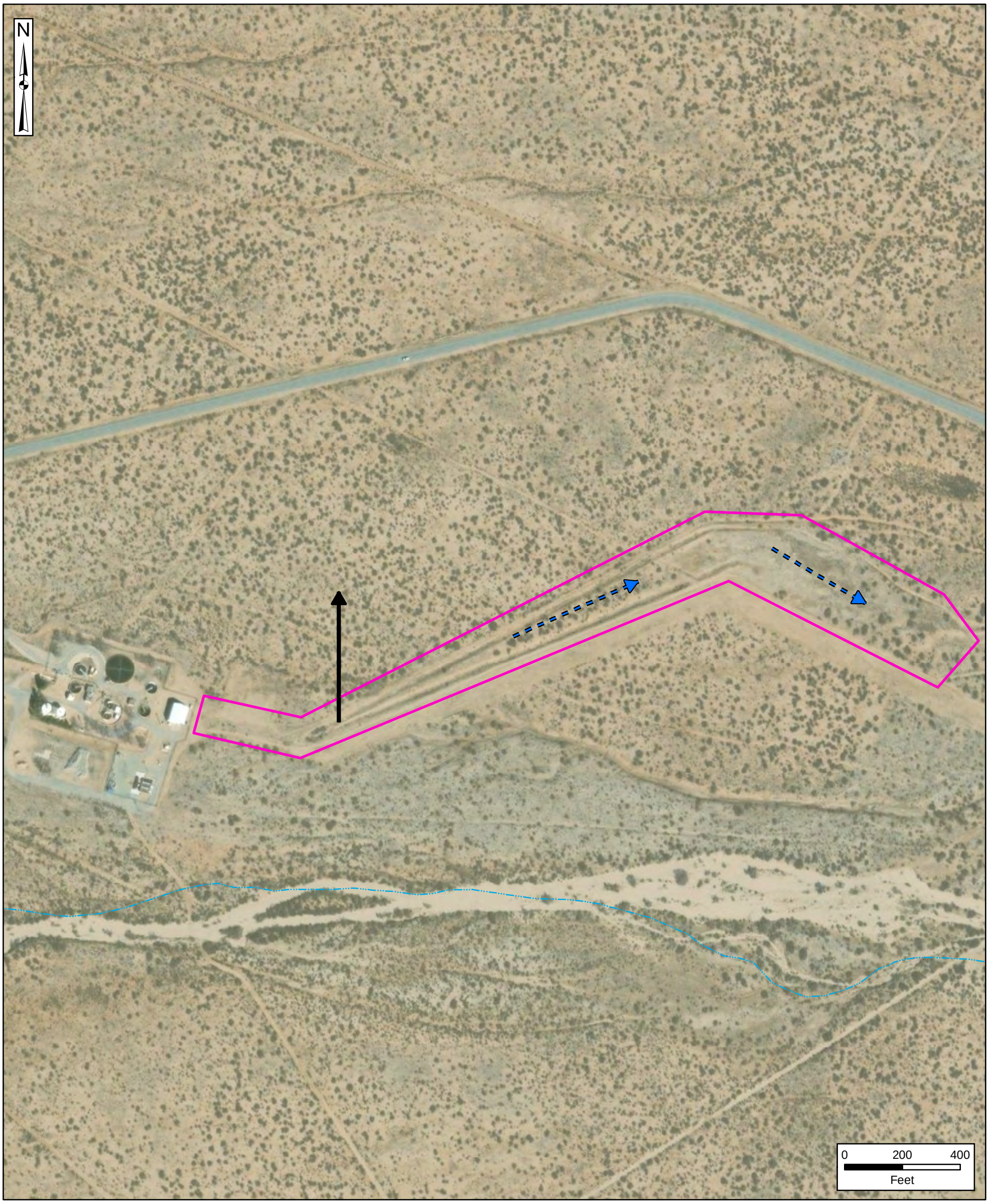
Data Sources:
Google Earth, Aerial Imagery

Coordinate System:
WGS 1984, UTM Zone 13 North

USAEC PFAS Preliminary Assessment / Site Inspection
White Sands Missile Range, NM

Figure 5-10
Aerial Photo of
Sewage Treatment Plant Percolation Ditches and
Impoundment Area (SWMU-82)





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

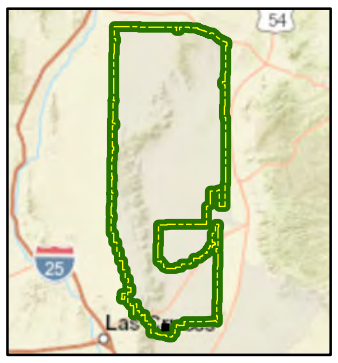
AOPI = area of potential interest
SWMU = Solid Waste Management Unit

Data Sources:
NHD, Water Bodies, 2019
ESRI ArcGIS Online, Aerial Imagery

Coordinate System:
WGS 1984, UTM Zone 13 North

USAEC PFAS Preliminary Assessment / Site Inspection
White Sands Missile Range, NM

Figure 5-11
Aerial Photo of
WSMR Landfill (SWMUs 86-87)



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

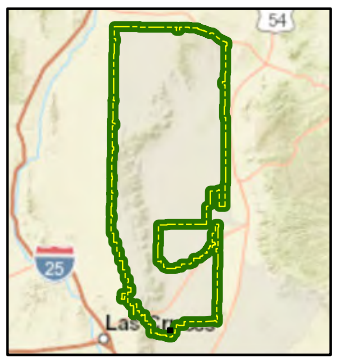
AOPI = area of potential interest
SWMU = Solid Waste Management Unit
WSMR = White Sands Missile Range

Data Sources:
NHD, Water Bodies, 2019
ESRI ArcGIS Online, Aerial Imagery

Coordinate System:
WGS 1984, UTM Zone 13 North

USAEC PFAS Preliminary Assessment / Site Inspection
White Sands Missile Range, NM

Figure 5-12
Aerial Photo of
Current Firefighting Training Area (Building 21612)



Installation Boundary

AOPI

Surface Runoff Flow Direction

Groundwater Flow Direction

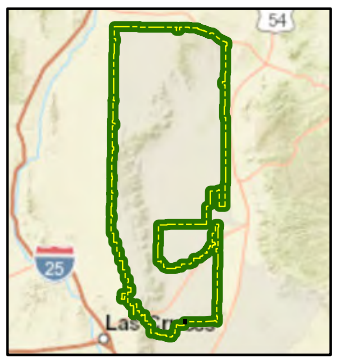
AOPI = area of potential interest
ft = feet

Data Sources:
Google Earth, Aerial Imagery

Coordinate System:
WGS 1984, UTM Zone 13 North

USAEC PFAS Preliminary Assessment / Site Inspection
White Sands Missile Range, NM

Figure 5-13
Aerial Photo of
Fire Station 2 Launch Complex (Building 23480)



Installation Boundary

AOPI

Surface Runoff Flow Direction

Groundwater Flow Direction

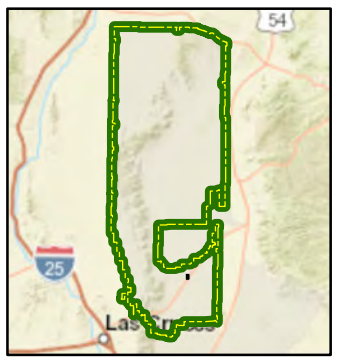
AOPI = area of potential interest

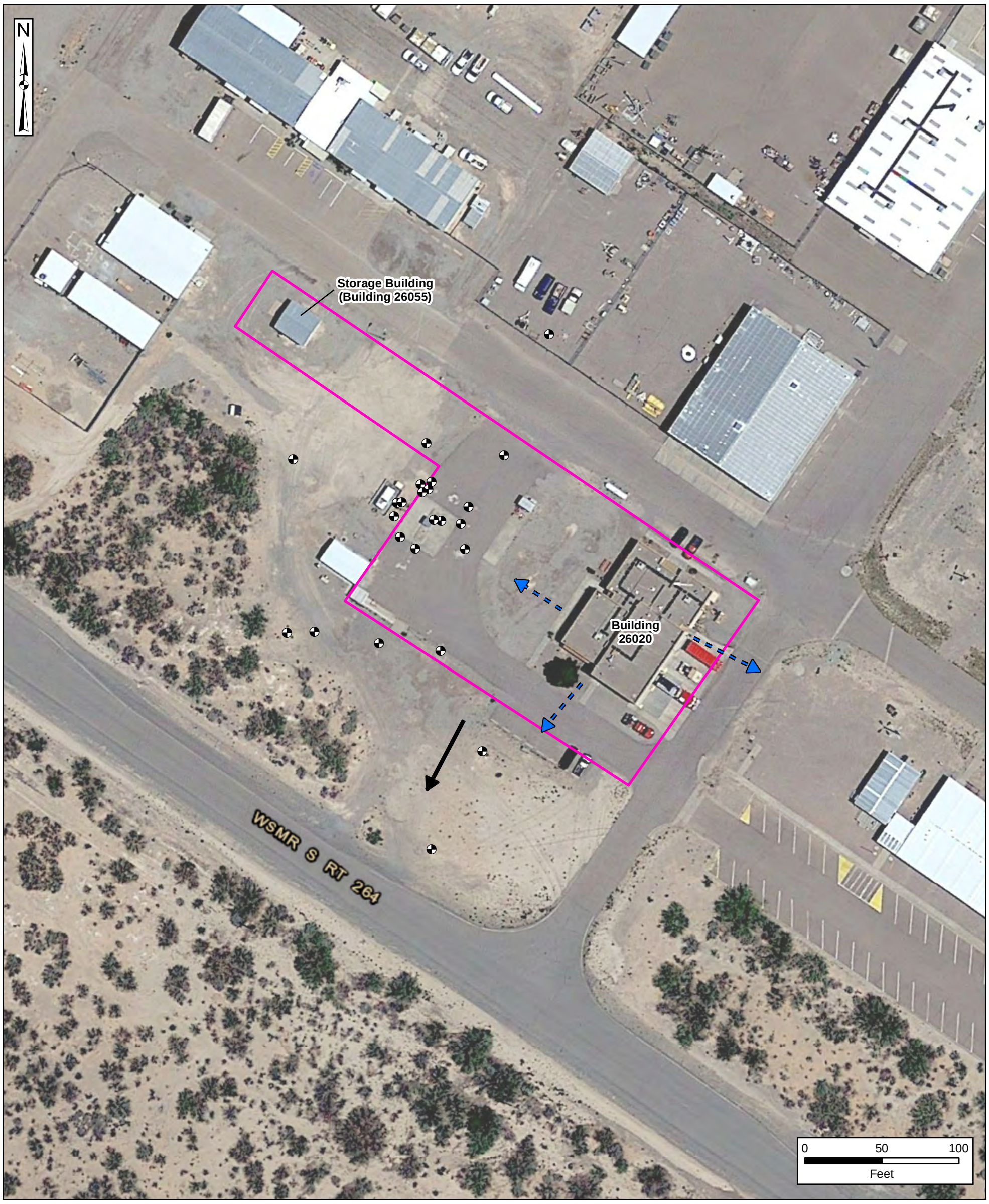
Data Sources:
Google Earth, Aerial Imagery

Coordinate System:
WGS 1984, UTM Zone 13 North

USAEC PFAS Preliminary Assessment / Site Inspection
White Sands Missile Range, NM

Figure 5-14
Aerial Photo of
Fire Station 4 High Energy Laser System Test Facility
(Building 26020)





Installation Boundary

AOPI

Surface Runoff Flow Direction

Groundwater Flow Direction

Monitoring Well

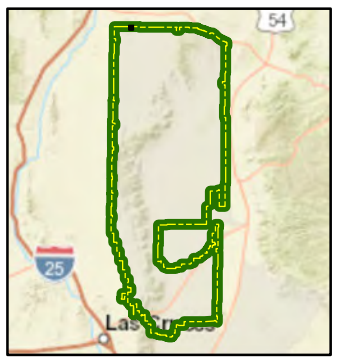
AOPI = area of potential interest

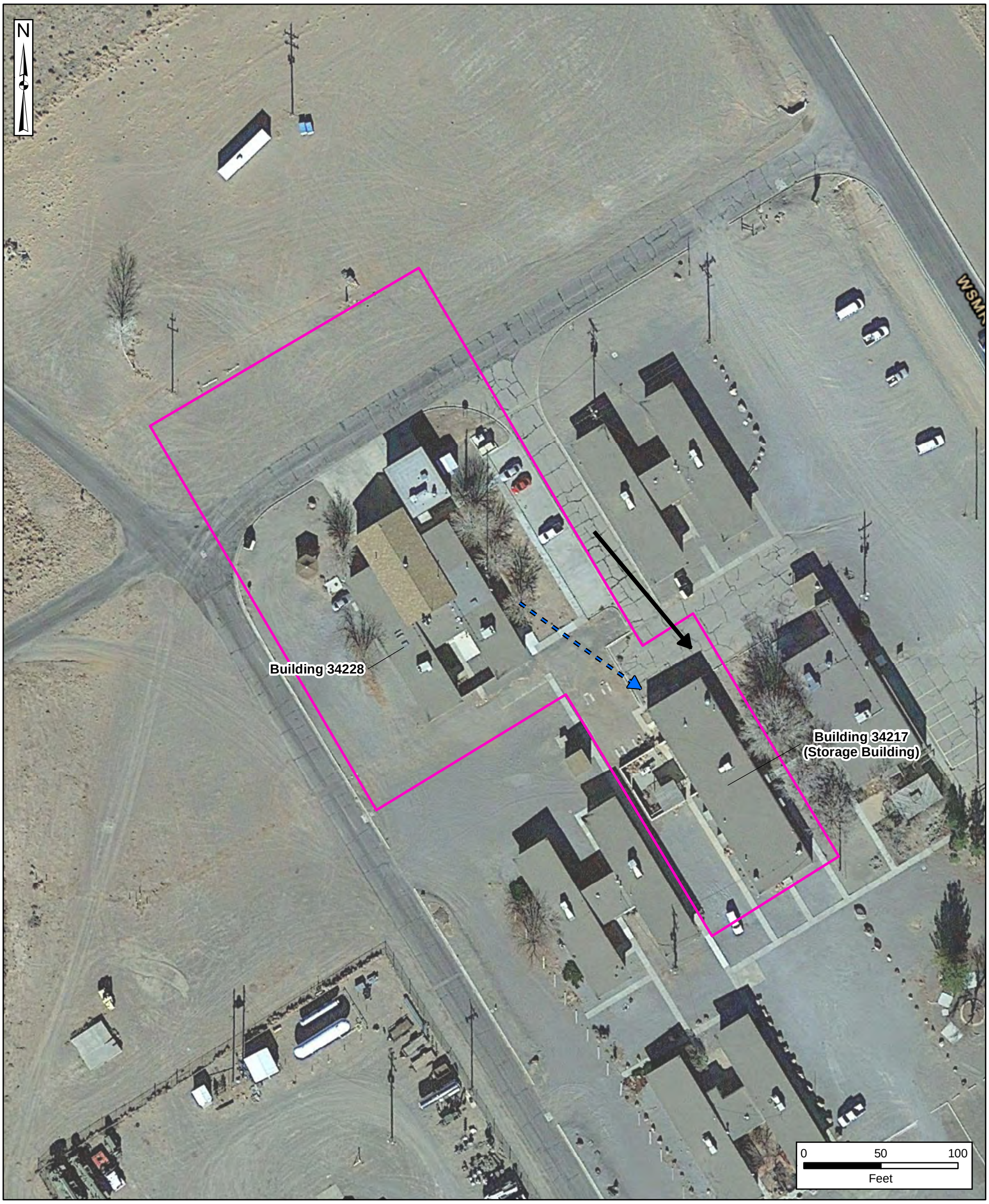
Data Sources:
Google Earth, Aerial Imagery

Coordinate System:
WGS 1984, UTM Zone 13 North

USAEC PFAS Preliminary Assessment / Site Inspection
White Sands Missile Range, NM

Figure 5-15
Aerial Photo of Fire Station 3
Stallion Range Center (Building 34228)





Installation Boundary

AOPI

Surface Runoff Flow Direction

Groundwater Flow Direction

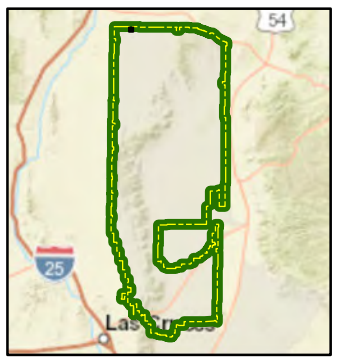
AOPI = area of potential interest

Data Sources:
Google Earth, Aerial Imagery

Coordinate System:
WGS 1984, UTM Zone 13 North

USAEC PFAS Preliminary Assessment / Site Inspection
White Sands Missile Range, NM

Figure 5-16
Aerial Photo of Stallion Range Center
Former Firefighting Training Area (SWMU-162)



Installation Boundary
AOPI
Soil Excavation Area (2011)
Stream (Intermittent)
Surface Runoff Flow Direction
Groundwater Flow Direction

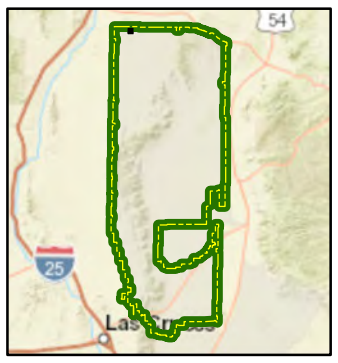
AOPI = area of potential interest
SWMU = solid waste management unit

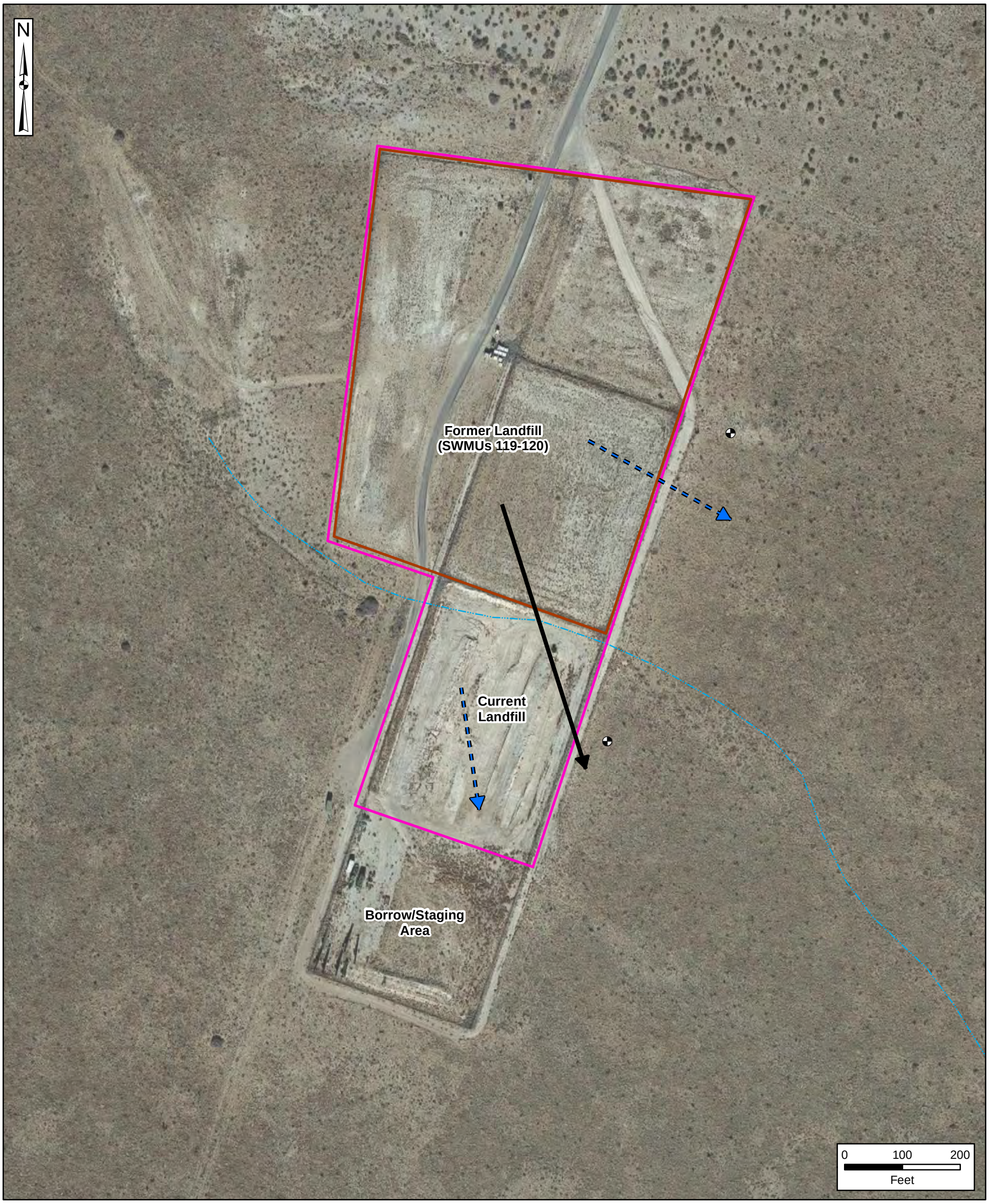
Data Sources:
NHD, Water Bodies, 2019
Google Earth, Aerial Imagery

Coordinate System:
WGS 1984, UTM Zone 13 North

USAEC PFAS Preliminary Assessment / Site Inspection
White Sands Missile Range, NM

Figure 5-17
Aerial Photo of
Stallion Range Center Landfill (SWMUs 119-120)





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

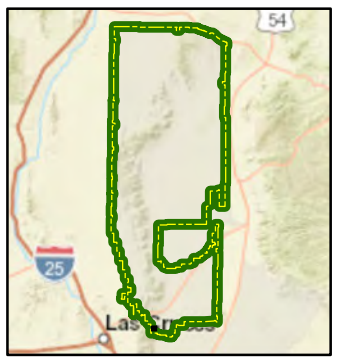
AOPI = area of potential interest
SWMU = solid waste management unit

Data Sources:
NHD, Water Bodies, 2019
Google Earth, Aerial Imagery

Coordinate System:
WGS 1984, UTM Zone 13 North

USAEC PFAS Preliminary Assessment / Site Inspection
White Sands Missile Range, NM

Figure 5-18
Aerial Photo of
Camp Tumbleweed Fire Training Area



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

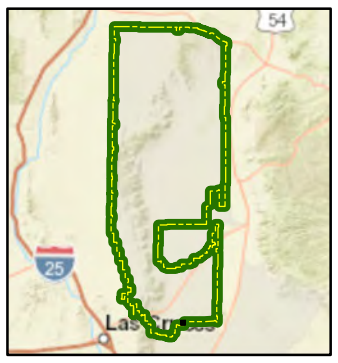
AFFF = aqueous film-forming foam
AOPI = area of potential interest

Data Sources:
Google Earth, Aerial Imagery

Coordinate System:
WGS 1984, UTM Zone 13 North

USAEC PFAS Preliminary Assessment / Site Inspection
White Sands Missile Range, NM

Figure 5-19
Aerial Photo of Hazardous Waste Storage Building (Building 22895)



N

Building 22895

0 50 100
Feet

Installation Boundary
AOPI
Inferred AFFF Release Area
Surface Runoff Flow Direction
Groundwater Flow Direction
Monitoring Well

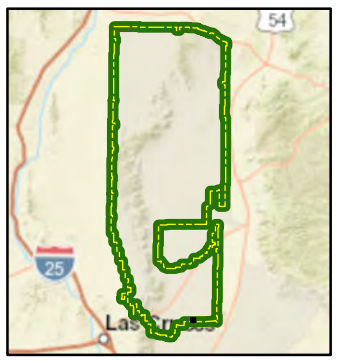
AFFF = aqueous film-forming foam
AOPI = area of potential interest

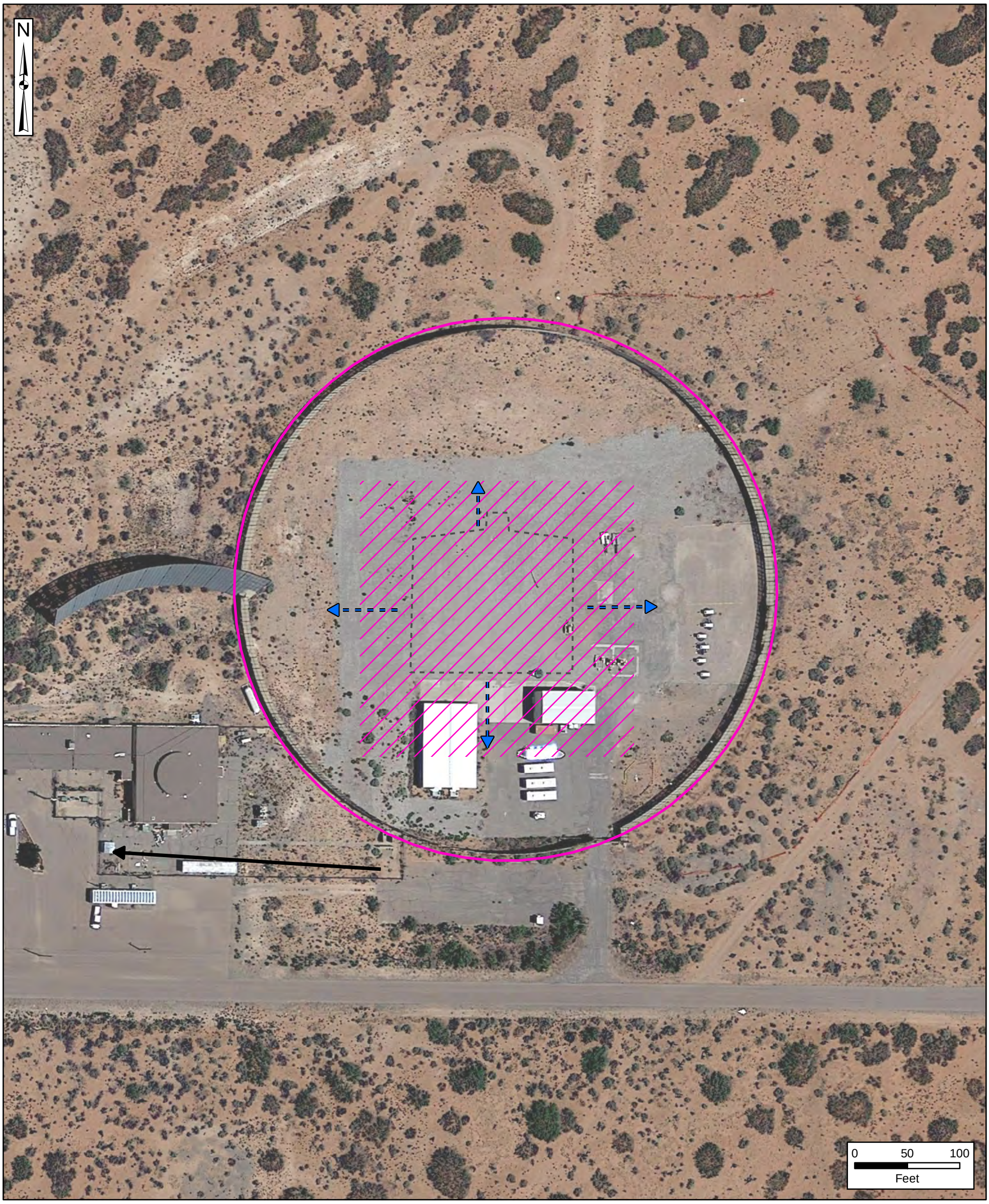
Data Sources:
Google Earth, Aerial Imagery

Coordinate System:
WGS 1984, UTM Zone 13 North

USAEC PFAS Preliminary Assessment / Site Inspection
White Sands Missile Range, NM

Figure 5-20
Aerial Photo of Electromagnetic Analysis Facility
(Building 23638)





Installation Boundary
AOPI
AFFF Release Area
Former Building Footprint
Surface Runoff Flow Direction
Groundwater Flow Direction

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

Data Sources:
Google Earth, Aerial Imagery

Coordinate System:
WGS 1984, UTM Zone 13 North

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