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

Blue Grass Army Depot, Kentucky

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Preliminary Assessment and Site Inspection of Per- and Polyfluoroalkyl Substances

Blue Grass Army Depot, Kentucky

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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 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 Blue Grass Army Depot (BGAD) 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.

BGAD covers approximately 14,500 acres in Madison County, Kentucky, with approximately 1,000 personnel working onsite. The nearest municipality is Richmond, Kentucky (approximately 6 miles northwest). The current mission of BGAD is to provide munitions, chemical defense equipment and special operations support to the DoD.

The BGAD PA identified nine AOPIs for investigation during the SI phase. SI sampling results from the nine 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/or groundwater at eight AOPIs; six of the nine AOPIs had PFOS, PFOA, and/or PFBS present at concentrations greater than the risk-based screening levels. The BGAD 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.

Three springs were sampled at BGAD to supplement a general evaluation of AOPIs in the north cantonment area, and those results were compared to the OSD risk screening levels because spring water is an expression of groundwater (that is, springs are points where the groundwater table intersects the land surface). The concentration of PFOS detected in the sample collected from one of the springs (SP-62) exceeded the OSD risk screening level (PFOA and PFBS were also detected in the SP-62 spring water, but at concentrations less than the OSD risk screening levels). The region drained by (i.e., contributing groundwater to) the spring is not defined but may include as many as four AOPIs. As such, PFOS, PFOA, and PFBS contained in the spring water could be derived from one or more of these AOPIs. Further investigation is required to define the source(s) of PFOS, PFOA, and PFBS at this spring.

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

AOPI Name	PFOS, PFOA, and/or PFBS detected greater than OSD Risk Screening Levels? (Yes/No/ND/NS)			Recommendation
	GW	SO	SP[1,2]	
Temporary Fire Station (Building S11)	NS[3]	No	NS	No action at this time
Former PEO-SOFSA Hangar 1 (Building 232)	Yes	No	Yes	Further study in a remedial investigation
Former PEO-SOFSA Hangar 2 (Building 229)	Yes	NS	Yes	Further study in a remedial investigation
Federal Emergency Management Agency Trailer Fire Training Area	NS[3]	No	Yes	Further study in a remedial investigation
Former Fire Station (Building 58370)	Yes	No	Yes	Further study in a remedial investigation
Old Furnace Training Area	No	No	No	No action at this time
Former Fire Training Area (SWMU 17)	Yes	No	NS	Further study in a remedial investigation
Wastewater Treatment Plant (Building 230) and Sludge Drying Beds	Yes	No	NS	Further study in a remedial investigation
Bulldozer Fire Area	ND	NS	NS	No action at this time

Notes and Acronyms:
Light gray shading – detection greater than the OSD risk screening level

1. Results from spring samples that were used to make recommendations for the AOPIs were collected at springs that may drain groundwater from beneath multiple AOPIs within that spring's basin. The source(s) of PFOS, PFOA, and PFBS in groundwater and/or surface water associated with the AOPI should be discerned during a future investigation.
2. Surface water that is an expression of groundwater (i.e., seeps/springs that are discharge points for groundwater) are compared to the OSD risk screening levels. Otherwise, the surface water and stormwater samples were collected only to re-evaluate the CSMs and are not compared to the tap water OSD risk screening level and are not included in this table.
3. BGAD is underlain by karst geology with complex groundwater flow patterns. At some AOPIs, groundwater was not encountered in the overburden or within the first 20 feet of bedrock and a sample was not collected.

GW – groundwater
ND – not detected
NS – not sampled
SO – soil
SP – spring water (i.e., expressions of groundwater, therefore the data collected at springs are compared to the OSD risk screening levels for tap water)

1 INTRODUCTION

The United States (U.S.) Army (Army) is performing preliminary assessments (PAs) and site inspections (SIs) on the current or potential historical use of per- and polyfluoroalkyl substances (PFAS) with a focus on perfluorooctane sulfonate (PFOS), perfluorooctanoic acid (PFOA), and perfluorobutanesulfonic acid (PFBS), at Army installations (installations) nationwide. The Army is the lead agency under the Comprehensive Environmental Response, Compensation, and Liability Act of 1980 (CERCLA) and Executive Order 12580 and is conducting the PA/SI consistent with its authority under CERCLA, 42 United States Code §§ 9600, et seq. (as amended), and the Defense Environmental Restoration Program, 10 United States Code §§ 2701, et seq. The PFAS PA/SI included two distinct efforts. The PA identified locations that are areas of potential interest (AOPIs) at Blue Grass Army Depot (BGAD) in Richmond, Kentucky, 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 BGAD 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 or soil, calculated using the USEPA's Regional Screening Level (RSL) calculator for residential and industrial/commercial worker receptor scenarios. Following the issuance of the 2019 OSD memo, on 08 April 2021, USEPA published an updated toxicity assessment for PFBS (USEPA 2021). Based on the updated toxicity assessment for PFBS, the OSD issued a memorandum on 15 September 2021 to include updated PFBS risk screening levels (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 BGAD, PA/SI development followed a similar process as described in the subsections below. **Section 3** provides a summary of the PA activities completed, and **Section 6** provides a summary of the SI activities completed for BGAD. 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), BGAD, and Arcadis U.S., Inc. (Arcadis). The kickoff call occurred on 05 April 2019, approximately 8 weeks before the site visit, to discuss the goals and scope of the PA, project scheduling, BGAD access, timeline for the site visit, access to BGAD 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 BGAD 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 BGAD.

A read-ahead package was prepared and submitted to the appropriate POCs 2 weeks before the site visit. The read-ahead package contained the following information:

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

1.3.2 Preliminary Assessment Site Visit

The site visit was conducted on 04 to 06 June 2019. An in-brief meeting was held to provide installation staff with the objectives of the site visit and team introductions. **Section 3** includes information regarding personnel interviewed.

Personnel interviews were conducted with individuals having significant historical knowledge at BGAD. The interviews focused on confirming information discussed in historical documents, collecting information that may have not been in historical documents, and 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, 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, was 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 06 June 2019 with the installation.

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. Map document files and associated geographic information system (GIS) data are provided as **Appendix D** (provided in the final electronic deliverable only). GIS data layers created for the project are included in a Spatial Data Standards for Facilities, Infrastructure, and Environment-compliant geodatabase.

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 BGAD.

The objectives of the SI kickoff teleconference were to:

- discuss the AOPIs selected for sampling
- gauge regulatory involvement requirements or preferences
- 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:

- discuss the proposed sampling plan for each AOPI
- identify overlapping unexploded ordnance or cultural resource areas
- confirm the plan for investigation-derived waste (IDW) handling and disposal
- identify specific installation access requirements and potential schedule conflicts
- provide 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 program (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 (Arcadis 2020) 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 (Arcadis 2020) to identify specific health and safety hazards that may be

encountered at the installation during sampling. The SSHP was designed to supplement the Accident Prevention Plan (Arcadis 2018), which was developed for Army installations nationwide. The QAPP Addendum (Arcadis 2020) and SSHP were submitted to the installation and finalized before commencement of field work.

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

After finalization of the QAPP Addendum (Arcadis 2020) 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 (Arcadis 2020).

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) 5.3 (DoD and Department of Energy 2019). Laboratory analytical results were then validated and verified by a project chemist to assess the usability of the data collected. Validated analytical results were summarized in the context of OSD risk screening levels (defined in **Section 6.5**).

2 INSTALLATION OVERVIEW

The following subsections provide general information about BGAD, 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. The information in the subsections below is excerpted from the 2016 Installation Action Plan (BGAD 2016), the Integrated Natural Resources Management Plan for 2016 to 2020 (BGAD 2017), the Environmental Baseline Survey for the Program Executive Office-Special Operations Forces Support Activity (PEO-SOFSA) Facility (Environmental Assessments, LLC 2018), Phase II Sitewide Groundwater Assessment Monitoring Systems Evaluation (URS 2001), RCRA Facility Assessment of the Fire Training Area (Law Environmental, Inc. 1989), and Conceptual Sitewide Groundwater Flow Model (URS 2000).

2.1 Site Location

BGAD covers approximately 14,500 acres in Madison County, Kentucky, with approximately 1,000 personnel working onsite. BGAD can house up to 330 military personnel in barracks (BGAD 2017). The nearest municipality is Richmond, Kentucky (approximately 6 miles northwest) with a population of approximately 33,000. Other key municipalities in the region include Berea (approximately 8 miles south) with a population of approximately 8,200, and Lexington (about 35 miles north) with a population of 350,000 (BGAD 2016). **Figure 2-1** shows the location of the installation. Most of the installation land is covered by ammunition storage points in open fields and wooded areas with a small cantonment area to the southwest (**Figure 2-2**).

2.2 Mission and Brief Site History

BGAD was originally established in April 1942 for the receipt, issuance, storage, maintenance, and disposal of ammunition. Construction of BGAD was a product of the War Department's expansion of ordnance supply depots during World War II. The installation was operated by the federal government until October 1943, at which time the operation was assumed by a corporation under the name of Blue Grass Ordnance Depot, Inc., a subsidiary of the Firestone Tire and Rubber Company. The corporation operated the installation until October 1945 when the federal government again assumed control (BGAD 2016). In 1964, BGAD merged with the Lexington Signal Depot in Avon, Kentucky, to become the Lexington-BGAD. The Lexington facility was selected for closure under the Base Realignment and Closure program in 1988 and closed in 1995, at which time the remaining portion of the installation near Richmond was designated as BGAD (BGAD 2016).

BGAD is an active federal government-owned, government-operated facility. The current mission of BGAD is to provide munitions, chemical defense equipment and special operations support to the DoD.

Specifically, the mission of BGAD is to:

- Support the Joint Warfighter by safely providing a full range of high-quality defense products and services at the right price, place, and time

- Maximize Warfighter capability through ammunition standard depot operations (store, issue, receipt, inspect, maintain, and demilitarize) of conventional munitions, missiles, non-standard ammunition, and chemical defense equipment
- Produce weapon system, combat vehicle and ammunition components to fill critical Warfighter requirements today and in the future (BGAD 2016)

In 1982, BGAD began voluntary surface water and groundwater investigations and cleanup. In April 1992, a Resource Conservation and Recovery Act facility assessment was completed, and several groundwater monitoring wells and surface water monitoring locations were established to develop a CSM. Several solid waste management units (SWMUs) were identified during this process. PFAS constituents are not regulated as a hazardous waste and were therefore not investigated or subject to corrective action during historical environmental work at BGAD. The last 5-year review for environmental sites was completed in 2017 (BGAD 2016).

2.3 Current and Projected Land Use

Land use within the facility is comprised of areas dedicated to the demolition of ordnance and munitions, storage of ordnance and munitions (nearly two thirds of the installation acreage), grazing land for cattle, agricultural land for hay production, and depot facilities. Storage of ordnance and munitions is primarily accomplished through subsurface igloos and aboveground warehouses. Disposal of ordnance and munitions is accomplished through an open burning of propellant and detonation. Approximately 30 percent (%) of the open land not used by BGAD operations is leased by the government to cattle ranchers for livestock grazing (BGAD 2016). Two housing units (one currently not in use) also exist in the southwest corner of the installation. BGAD manages approximately 4,000 acres for timber production in scattered tracts or long narrow bands of woodlands along major creeks and drainages (BGAD 2017).

There are several tenant activities at BGAD. The largest tenants are Lockheed Martin (overhauls helicopters), Blue Grass Chemical Activity (oversees the storage of chemical agents), and the Blue Grass Chemical Agent-Destruction Pilot Plant (BGCAPP). Previous tenants included Lockheed Martin at the PEO-SOFSA facility, which covered an area of approximately 30 acres and occupied four buildings (two of which were hangars used for aircraft maintenance, and two administrative and materials storage buildings), an aircraft wash pad, and a helipad, all built on imported fill. The buildings were constructed in the early 1990s, initially occupied by ServAir in the early 1990s, and then occupied by PEO-SOFSA from the mid-1990s until December 2018 (Environmental Assessments, LLC 2018). The buildings are now occupied by the Consolidated Army Prepositioned Stock (CAPS) Center.

BGAD is surrounded by private property, primarily consisting of agricultural and pastureland, commercial and industrial operations, low-density suburban housing, and recreational land including the Lake Reba Recreational Complex northwest of the installation. Land use in the vicinity of BGAD likely will remain fairly constant in the foreseeable future. The main trend emerging in the area near BGAD is the conversion of small blocks of farmland to residential or light industrial use. Depending on economic conditions and the success of local industrial parks near BGAD, this trend, coupled with increasing residential development and use, will probably continue in coming years (BGAD 2017).

2.4 Climate

The continental climate of the Blue Grass region is characterized by wide extremes of temperature and rainfall. The region experiences very warm summers, moderately cold winters, and uniform precipitation throughout the year. Annual rainfall is approximately 43.65 inches with the wettest month being June (BGAD 2017). Temperatures range from a January low average of 22.5 degrees Fahrenheit to a July high average of 86.3 degrees Fahrenheit (BGAD 2017).

2.5 Topography

BGAD is located in the Outer Bluegrass region of the Lexington Plain Section of the Interior Low Plateau province. The topography of BGAD is generally typical of that of the Outer Bluegrass subdivision, which is characterized by moderately undulating to gently rolling hills that steepen near major streams (URS 2001). Most slopes associated with drainage channels or man-made terraces exceed 15% on post. **Figure 2-3** shows the topography of the installation. The region is a mature-to-old plain developed on weak rock which is entrenched by creeks and rivers, and the area is moderately-well drained. Elevations range from about 850 feet above mean sea level along Muddy Creek to 1,040 feet above mean sea level at several places in the southwestern portion of the installation (i.e., in the cantonment area) (BGAD 2017; Law Environmental, Inc. 1989).

2.6 Geology

The surficial geology of BGAD consists of a blanket of residual, unconsolidated, reddish brown to light tan, silty clay developed on extremely shallow limestone. In the study areas investigated during this PA (i.e., areas where PFAS-containing materials were potentially used, stored, or disposed), bedrock was generally encountered 3 to 19 feet below ground surface (bgs). Across the installation, rock outcropping occurs occasionally on steep slopes and bluffs. Alluvial clays of varying shades of gray are present along major drainageways (BGAD 2017).

Most of the installation is underlain by the upper Ordovician-age Drakes and Ashlock Formations. The bedrock is primarily limestone with dolomite and shale present. A small portion of the installation near the southeast perimeter is underlain by the Silurian age Brassfield Dolomite and Crab Orchard Formation overlying the Drakes (URS 2001).

The Drakes Formation is approximately 130 feet thick in the region and primarily consists of dolomite, shale, and limestone. In the area studied during this PA/SI, the maximum thickness of the Drakes Formation is estimated to be approximately 60 feet, based on historical geologic mapping (URS 2000). This portion of the formation is described as interbedded argillaceous limestone and shale. The dark to light gray fine-grained limestone occurs in 1- to 4-inch-thick beds with sparse fossils (URS 2001). Where exposed at the ground surface, the Drakes is heavily fractured along multiple axes with no strongly preferred fracture direction (URS 2000).

Underlying the Drakes Formation is the Ashlock Formation, which is approximately 85 feet thick and consists primarily of micro-grained to medium-grained silty and dolomitic limestone with minor interbedded shale. The upper part of the Ashlock Formation (Reba and Terrill members) consists of micro-grained to fine-grained silty, dolomitic limestone with shaly partings, which weathers to blocks with

curved surfaces. Upper members of the Ashlock Formation do not appear to be very susceptible to karst feature development. The upper members are underlain by micro-grained silty dolomite, which weathers to slabs and chips with planar surfaces. Underlying the dolomite is fine-grained to medium-grained silty and argillaceous limestone. The limestone weathers to irregular pieces, and the silty beds weather to small fragments. The lower part of the Ashlock Formation (Stingy Creek, Gilbert, and Tate members) consists of micro-grained to fine-grained relatively resistant limestone. The Stingy Creek member acts somewhat as a confining unit because of its higher content of argillaceous shaly material; this results in a seep horizon between the upper and lower units of the Ashlock Formation. The Gilbert and Tate members are less argillaceous and more susceptible to karst processes (URS 2001). The upper and lower parts of the Ashlock Formation crop out in the stream valleys that are partially occupied by Lake Buck and Lake Gem.

2.7 Hydrogeology

In the study areas investigated during this PA (i.e., areas where PFAS-containing materials were potentially used, stored, or disposed), the water table at some of the study areas was encountered at relatively shallow depths (3 to 19 feet bgs) near the bedrock surface in the overburden. In other study areas, water was not observed in the overburden but was encountered in shallow (i.e., the first 20 feet) of bedrock.

Where thick limestone beds are present (typically in specific units of the Ashlock Formation), the rock is susceptible to chemical dissolution by infiltrating water, resulting in solutional enlargement of fractures and bedding plane openings. The enlarged openings create a preferred pathway for groundwater flow, which is not likely to be precisely evidenced at the surface until it emerges at a spring. Several seeps/springs and sinkholes are present on the installation. Solutionally-enhanced limestone beds may yield water to large springs, and wells installed in such beds are typically more productive (URS 2001). However, most wells in the region do not produce more than 100 gallons per minute and are not reliable for anything other than domestic use; some wells (and springs) are likely to go dry in the late summer and fall (BGAD 2017).

Seeps that emerge in areas where the heavily-fractured Drakes Formation is the uppermost bedrock are likely to run dry and emanate from the soil/bedrock contact. A generally uniform clay-rich residuum results in moderate-to-low diffuse recharge to groundwater in these areas. In areas where the lower Ashlock members are at or near the ground surface, rainfall infiltrates the soil structure and flows along more direct routes to groundwater via sinkholes and minor sinking streams. In the wet season, typically from late fall to early summer, groundwater levels are high enough that small seeps and springs in the Drakes and Ashlock Formations periodically discharge groundwater after rainfall events (URS 2000).

Given the thin saturated thickness of the overburden (where saturation is encountered), most groundwater moves through the bedrock. Flow in both the Drakes and Ashlock Formations occurs principally through secondary (fracture) porosity, and, where present, tertiary (conduit) porosity and as such is expected to be more discrete rather than diffuse. Conduit porosity is more likely to be present in the Gilbert and Tate members as evidenced by the presence of several small sinkholes and one moderate-sized spring (URS 2000). Most groundwater moving through fracture and conduit networks is expected to discharge to seeps and springs along perennial streams. Flow rates in such systems can be rapid and flow directions can be difficult to reliably predict at the local scale using potentiometric maps.

Near BGAD, water supply wells installed to depths of less than 100 feet in valley areas may produce water; however, little water is yielded in wells on hillsides or ridgetops (and some small springs may be present on hillsides). Therefore, monitoring of downgradient seeps and springs is considered necessary and potentially more important for groundwater evaluations (i.e., in addition to monitoring wells; URS 2000). Groundwater is relatively hard in the valleys and may contain elevated salt or hydrogen sulfide concentrations at depths greater than 100 feet bgs (URS 2000).

In the cantonment area in the southwest portion of the installation, nine springs have been identified (emanating from both the Drakes and Ashlock Formations) with discharge varying from 1.5 to 80 gallons per minute. These springs are located along or near two tributaries to Hays Fork; one tributary feeds and drains Lake Buck, and the other feeds and drains Lake Gem. No sinkholes were identified within the cantonment drainage area (URS 2000). Just east of the cantonment area, 12 springs/seeps have been identified with discharges of less than 5 gallons per minute. This area ultimately drains to Muddy Creek.

2.8 Surface Water Hydrology

BGAD encompasses numerous small-scale watersheds, with most of them discharging to Lake Vega and then to Muddy Creek which flows to the Kentucky River, approximately 9 miles north of the installation. Muddy Creek receives approximately 90% of BGAD drainage (Law Environmental, Inc. 1989). The southwest corner of the installation (i.e., most of the cantonment area) drains to man-made Lake Gem and Lake Buck, which flow into Hays Fork, a tributary of Silver Creek which flows to the west and northwest before reaching the Kentucky River. The northwest corner of the installation drains off post into Lake Reba, which discharges into north-flowing Otter Creek, also a tributary of the Kentucky River (URS 2001). Muddy, Silver, and Otter Creeks are generally shallow (less than 3 feet deep), have a maximum width of 15 to 30 feet, and are characterized by short, shallow riffles and long pools. Most on-post tributaries to these creeks flow intermittently and are dry during late summer and early fall (BGAD 2017).

The three major lakes on post (Lake Vega, Lake Gem, and Lake Buck) are inspected annually by the Commonwealth of Kentucky. Lake Vega covers approximately 135 acres and is located in the central portion of the installation. Lake Vega is impounded by an earth-filled, 890-foot-long dam and is the installation's drinking water supply. Lake Gem and Lake Buck cover approximately 35 acres and 15 acres, respectively, in the southwest portion of the installation. These lakes serve as flood control reservoirs. There are four smaller (less than 2 acres in size) named lakes on BGAD (A Area Lake, Lake Henron, Rock Quarry Lake, and Beaver Pond). In addition to the seven named lakes, there are unnamed lakes and ponds that retain water for livestock and wildlife (BGAD 2017).

The U.S. Fish and Wildlife Service identified approximately 235 acres of palustrine wetland habitat and 145 acres of lacustrine, unconsolidated bottom, deep-water habitat. BGAD has created additional wetlands through dam improvements and around Lake Vega and Lake Gem (BGAD 2017).

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 BGAD.

2.9.1 Stormwater Management System Description

The stormwater management system consists mainly of unlined ditches which follow natural topographic surface drainage. The cantonment area largely drains to Hays Fork Creek, and most of the remainder of the installation drains to Muddy Creek. **Figure 2-2** shows the approximate surface water and stormwater drainage divide. Stormwater is not captured for treatment except for in a limited area around the burn pans in the open burn/open detonation (OB/OD) area located east of the cantonment area. Though the stormwater management and sewer systems are not connected, some stormwater occasionally infiltrates and inflows into compromised sewer system piping during high-precipitation events, as indicated by the installation water engineers.

2.9.2 Sewer System Description

Sanitary sewer lines primarily run through the cantonment area in the southwest portion of the installation and are routed to the wastewater treatment plant [WWTP; (Building 230)] on post. The WWTP reportedly has not received industrial waste; however, as indicated by the installation water engineers, the WWTP has the potential to have received stormwater runoff from areas where PFAS-containing materials (i.e., aqueous film-forming foam [AFFF]) were potentially used, stored, or disposed. AFFF was released to the soil during fire department equipment testing and tank flushing, fire training activities, or fire responses and runoff may have entered the WWTP infrastructure via infiltration and inflow from high-precipitation events even though the stormwater management and sewer systems are not connected. The WWTP discharges treated water to Outfall 001 (south of the WWTP and downstream of Lake Gem), which flows to Hays Fork Creek.

2.10 Potable Water Supply and Drinking Water Receptors

BGAD is supplied with drinking water from Lake Vega, which covers 135 acres of the installation; the intake is located at the east end of the lake before the lake discharges to Muddy Creek. Pumps transmit raw lake water to the BGAD water treatment plant where it is pretreated for taste and odor, and a coagulant is added to enhance removal of suspended impurities by sedimentation. Next the water is filtered through a multi-media filter, disinfected, and sent to a clear well for distribution by pumping. The BGCAPP also uses water from this system, with consumption ranging from 30,000 gallons per day to 240,000 gallons per day when the plant is in peak operations (Program Executive Office, Assembled Chemical Weapons Alternative 2015). In addition, the BGCAPP badging office at the Highway 52 entrance is connected to a Madison County Utilities District water supply in case of emergency. Finally, the “Lex BG Army Commander” well on post (**Figure 2-2**) is part of a water system which regularly supplies water to at least 25 of the same people at least 6 months per year (and as such, is defined as a non-transient, non-community water system by the USEPA).

In the vicinity of BGAD, water supply wells installed to depths of less than 100 feet in valley areas may yield 100 to 500 gallons per day; however, groundwater is relatively hard in the valleys and may contain elevated salt or hydrogen sulfide concentrations at depths greater than 100 feet bgs (URS 2000). Therefore, surface water is used as a drinking water source for other communities surrounding BGAD, including from the Kentucky River and Silver Creek. While other surface water withdrawal locations along surface water features are indicated within 5 miles of the installation, watershed maps and water resource

data indicate that public water supply intakes along the Kentucky River and Silver Creek are greater than 5 miles from the installation boundary (University of Kentucky 2019).

There are a few off-post water supply wells in the surrounding area of BGAD which have various uses and owners. An Environmental Data Resources, Inc. (EDR) Survey Report was generated for BGAD. An EDR report includes search results from a variety of environmental, state, city, and other publicly available databases for a referenced property. The EDR report 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 for well search results at BGAD is provided as **Appendix E**; however, designations of the wells' use as drinking water supply or other may not be documented. Other wells may be installed in the area with use designations unspecified or other than water supply (i.e., monitoring, piezometer, agricultural/irrigation, observation, geothermal, or exploratory wells). Data limitations for information about the off-post water supply wells are discussed in **Section 9**.

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.

Habitat types at BGAD include aquatic habitat (surface water, floodplains, wetlands, and riparian zones), relic stands of warm season grass, pasture, and fragmentary forests. Forests and woodlands are predominated by black walnut, Ohio buckeye, honey locust, hackberry, white ash, and various oak and hickory canopy species. Herbaceous, shrub, and subcanopy layers of all forests on the installation were severely disturbed by cattle grazing and populations have shifted to more grazing-resistant species; sugar maple, coralberry, and scorpion grass are now the most common members of the subcanopy, shrub layers, and herbaceous layers, respectively (BGAD 2017).

The only big game species present at BGAD is the white-tailed deer, which are allowed to be harvested with intensively enforced regulations at the installation. Other game species present at BGAD include turkey, rabbit, squirrel, groundhog, coyote, quail, ducks, and geese; these species are not intensively managed as the populations are generally healthy, but the hunting of all these species except for turkey was discontinued at the installation in 2007 due to security issues. American black bears are observed as a transient species at the installation. Trapping of furbearers and other nuisance species (beaver, muskrat, groundhog, skunks, and coyotes) is permitted during the trapping season with an issued permit. Fishing is permitted in accordance with restrictions imposed by the installation at stocked Lakes Vega, Gem, Buck, Henron, and Rock Quarry (BGAD 2017).

Three species managed under the Endangered Species Act have been documented on BGAD: running buffalo clover (a plant that is federally listed as endangered and state listed as threatened), the northern long-eared bat (federally listed as threatened, state listed as endangered), and the Indiana bat (federally and state listed as endangered). Other special species that might occur on BGAD are the gray bat (which has a record of occurrence in Madison County but not specifically at BGAD) and American bald eagle (which have been observed at BGAD but have not been documented nesting on the property; BGAD 2017).

2.12 Previous PFAS Investigations

Previous (i.e., pre-PA) PFAS investigations relative to BGAD, including both those conducted and not conducted by the Army, are summarized to provide full context of available PFOS, PFOA, and PFBS data for BGAD. However, only data collected by the Army will be used to make recommendations for further investigation. The historical data described below were not validated as part of this SI and are reported as provided in the laboratory reports or historical documents provided during the PA.

In November 2016, samples were collected from the drinking water supplies at the BGAD water treatment plant (public water system identification KY3763637, located at Building 228) both pre-treatment and at the post-treatment tap, and at the BGCAPP badging office building tap, which is connected to the Madison County Utilities District water supply (public water system identification KY0760224). These samples were collected as part of the Army's response to the Third Unregulated Contaminant Monitoring Rule , and samples were analyzed for PFOS and PFOA only. Concentrations were below the reporting limits (40 ng/L and 20 ng/L, respectively) in each sample (Tetrahedron, Inc. 2018; USEPA 2017). The Madison County Utilities District was also sampled quarterly in 2013 in response to the UCMR3; samples were analyzed for six PFAS including PFOS, PFOA, and PFBS. PFOS, PFOA, and PFBS were not detected, with reporting limits of 40 ng/L PFOS, 20 ng/L PFOA, and 90 ng/L PFBS. The historical analytical results are summarized in **Table 2-1**. The laboratory which analyzed samples under UCMR3 met the USEPA's UCMR3 Laboratory Approval Program application and Proficiency Testing criteria for USEPA Method 537 Version 1.1.

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 BGAD, data was collected from three principal sources of information, which are described in the subsections below:

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

Preliminary locations of potential use, storage, and/or disposal of PFAS-containing materials were then evaluated in the PA (during records review, personnel interviews, and/or site reconnaissance) and were categorized as AOPIs or as areas not retained for further investigation at this time based on a combination of information collected (e.g., records reviewed, personnel interviews, internet searches). A summary of the observations made, and data collected through records reviews (**Appendix F**), installation personnel interviews (**Appendix G**), and site reconnaissance logs (**Appendix I**) during the PA process for BGAD 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, BGAD fire department documents, BGAD Directorate of Public Works documents, and GIS files. Internet searches were also conducted to identify publicly available and other relevant information. A list of the specific documents reviewed for BGAD is provided in **Appendix F**.

3.2 Personnel Interviews

Interviews were conducted with personnel knowledgeable about the installation's history during the site visit and during follow-up telephone conversations. If a previously identified interviewee was not available during the site visit, attempts were made to complete the interview via telephone before or following the site visit or by contacting an alternate interviewee identified by the installation POC.

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

- IRP manager/pesticide manager
- Government aviation safety officer (PEO-SOFSA)
- Safety officer
- Fire chief, fire captain, and lead fire inspector (BGAD fire department)
- Acting Directorate of Public Works environmental chief

- Directorate of Public Works director
- Superintendent for BGAD water treatment plant and WWTP operations (contractor K. Hayes Limited©)
- Water engineer
- Range supervisor
- Environmental protection specialist
- Fire chief, fire captain, fire lieutenant, and firefighter (Madison County Fire Department)

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

3.3 Site Reconnaissance

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

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

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

BGAD 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 AFFF is the most prevalent potential source of PFAS chemicals at DoD facilities. As such, this section is organized to summarize the AFFF-related uses first, and all remaining potential PFAS-containing materials in the subsequent section.

4.1 AFFF Use, Storage, and Disposal Areas

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

AFFF has been stored at two historical fire stations [i.e., the Former Fire Station [(Building 58370, formerly Building 212) and the Temporary Fire Station (Building S11)], Former PEO-SOFSA Hangar 1 (Building 232), and Former PEO-SOFSA Hangar 2 (Building 229). No releases (i.e., accidental spills/leaks from storage containers or activations of fire suppression systems) were reported at the hangar storage areas. However, during the PA site visit, the PA team observed a white staining and crust on the concrete floors near the 700-gallon tanks filled with AFFF which remain in place in each of the two Former PEO-SOFSA hangars [minor staining at Hangar 2 (Building 229)], and more pronounced staining/crust at Hangar 1 [(Building 232) in an approximate 40-foot radius from the tank]. This staining may be indicative of slow leaks in the AFFF fire suppression system. To the south of Hangar 1, historical system testing with “Blizzard” foams took place which involved shooting a foam mixture approximately 65 feet from the awning pad on the south end of the building. Blizzard foams reportedly are potentially PFAS containing material and AFFF could also have been used in this testing, as described further in **Section 5.2**.

AFFF has reportedly been used at the two historical fire stations during equipment testing (i.e., nozzle testing) and tank flushing of AFFF-capable firefighting vehicles [i.e., at the Former Fire Station (Building 58370) and the Temporary Fire Station (Building S11)], at three firefighter training areas during training exercises [Old Furnace Training Area, Former Fire Training Area (SWMU 17), and Federal Emergency Management Agency (FEMA) Trailer Fire Training Area], and at one fire response area at BGAD (Bulldozer Fire Area). The approximate dates/frequency of relevant releases, areal extent, and the estimated volume of AFFF used at each of these areas is further described in **Section 5.2**. Fire Station #1 (Building 52770) was also investigated during the PA but was it was determined that there was no

evidence of use, storage, or disposal of potentially PFAS-containing material. Fire Station #1 is classified as an area not retained for further investigation as discussed in **Section 5.1**.

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

Following document research, personnel interviews, and site reconnaissance at BGAD, metal plating operations, landfill, and the BGAD WWTP 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**.

Some historical documents indicated that plating shop wastes were reportedly disposed of at the old BGAD landfill; however, personnel interviews indicated that these wastes were from the Lexington Signal Depot facility. Interviews also indicated that the only plating operations at BGAD consisted of dip plating without the use of mist suppressants; therefore, landfilled dip plating materials are not anticipated to contain PFAS constituents.

Paint booths have been reported at BGAD; however, personnel indicated that mist suppressants were not utilized during operational activities.

Sludge from the WWTP (which potentially received PFAS-containing stormwater runoff) was placed in unlined drying beds adjacent to the WWTP (Building 230) prior to the off-site disposal of the sludge. Further discussion regarding the WWTP (Building 230) and Sludge Drying Beds AOPI is presented in **Section 5.2**. Unrelated to the WWTP, the BGAD Water Treatment Plant (Building 228), had influent and effluent samples collected and analyzed for PFOS and PFOA in 2016, with results below detection limits.

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 BGAD) 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.

Blue Grass Plating Company, LLC is a metal plating service facility located just off post to the west of the installation. The facility has been in operation for 47 years and was originally established as an electroplating metal finishing supplier in 1969. The facility has certificates of registration for the following activities: electro coating and high-volume zinc electroplating; phosphate, black oxide, passivate, cleaning and pickling, chromates - hexavalent and trivalent - clear, yellow, black, olive drab and other protective coating (barrel and rack plating) (Blue Grass Plating Company, LLC 2019). The waste disposal practices of the Blue Grass Plating Company are not known; this facility may be a source of PFAS constituents within 5 miles of the installation.

Other sources of PFAS within 5 miles of the installation may include AFFF use by the Madison County and Richmond Fire Departments if AFFF was used during fire responses. Locations of potential AFFF use off post by these entities are not known. Additionally, the Central Kentucky Regional Airport is located near Silver Creek approximately 5 miles southwest of the installation, north of the town of Berea,

Kentucky. Airport operations may have historically involved the use, storage, or disposal of PFAS-containing material (i.e., AFFF). The BGAD cantonment area also drains to Silver Creek via Hays Fork.

Several automotive shops exist within 5 miles of BGAD, including to the northwest (City of Richmond), southwest, and east. It is possible PFAS-containing products (i.e., Simoniz®) could have been used at these facilities. Waste disposal practices of the various automotive shops near BGAD are not known; therefore, they may represent sources of PFAS off post.

While potential PFAS sources exist within a 5-mile radius of BGAD, complex groundwater flow patterns are prevalent in the region, making it difficult to reliably infer whether groundwater beneath these potential PFAS sources may flow on post.

5 SUMMARY AND DISCUSSION OF PA RESULTS

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

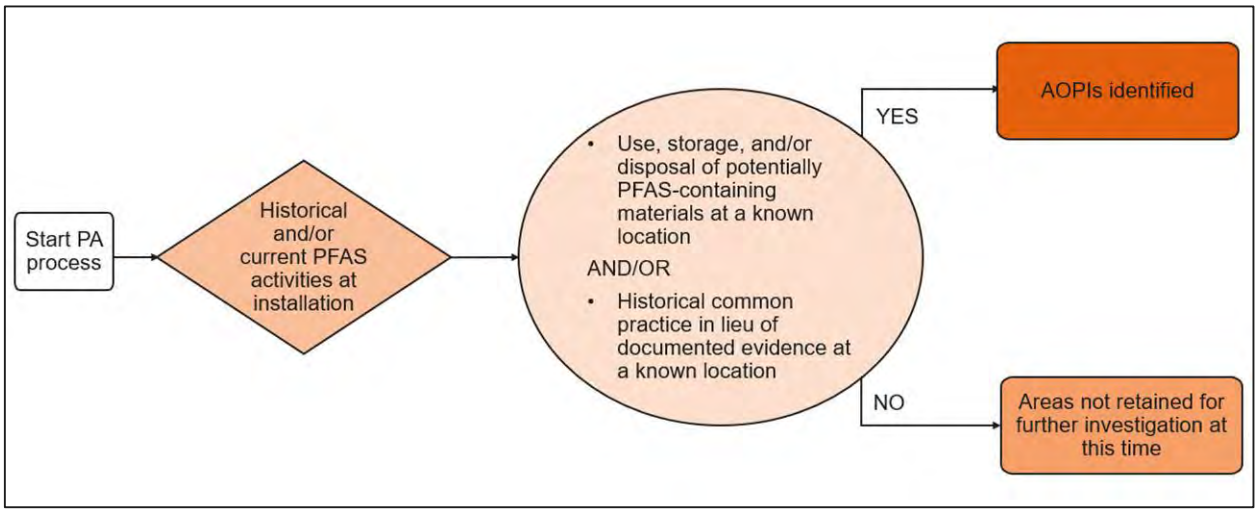

Figure 5-1: AOPI Decision Flowchart

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 BGAD are presented in **Section 9**.

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
Water Treatment Plant (Building 228)	Unknown to current	Two samples were collected here in November 2016, one from the influent and one from the effluent (i.e., pre-treatment and from the tap post-treatment water). Samples were analyzed for PFOS and PFOA; results were non-detect for both samples.	No evidence of PFOS, PFOA, or PFBS containing materials used, stored, and/or disposed of at this location; no PFAS constituents detected in collected samples.
Old Landfill and Plating Operations	Unknown	Documents note that plating shop wastes were reported to have been disposed of at the Old Landfill. The plating waste was confirmed to be from the Lexington facility. These plating operations reportedly consisted of dip plating without the use of mist suppressants.	No evidence of PFOS, PFOA, or PFBS containing materials used, stored, and/or disposed of at this location.
Fire Station #1 (Building 52770)	2007 to current	AFFF has never been stored or used at this fire station according to fire department personnel who had been on post since approximately the construction of the new fire station in 2007, and one who had been on post since approximately 1997 (**Appendix G**). The same personnel who have been on post since 2007 indicated that no AFFF had been used at BGAD during their time there. F-500 foams have been used in vehicles for various fire responses instead; F-500 is an encapsulator agent, does not contain fluorine ingredients, and is 100% biodegradable (Hazard Control Technologies 2020). No on-post firefighting vehicles currently house AFFF.	No evidence of use, storage, or disposal of potentially PFAS-containing material (i.e., AFFF).
Paint Booths (various)	Unknown	Personnel indicated mist suppressants were not utilized during paint booth operations at BGAD.	No evidence of use, storage, or disposal of PFAS-containing material.

The Madison County Fire Department has an automatic aid agreement with BGAD for fire response. During personnel interviews conducted as part of the PA site visit, the Madison County Fire Department noted that BGAD fire department responded to an off-post fire with them at a concrete silo (located at 1587 Crooksville Road) in September 2015, and each department used their own foam (about 2 to 3 gallons of concentrate each). The BGAD fire department indicated that the foam they used was F-500, which does not contain PFAS constituents.

5.2 AOPIs

Overviews for each AOPI identified during the PA process are presented in this section. Two of the AOPIs overlap with BGAD 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 the PA, none of the BGAD IRP sites have historically been investigated or are currently being investigated for the possible presence of PFOS, PFOA, PFBS. 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 **5-6** and include active monitoring wells near each AOPI.

5.2.1 Temporary Fire Station (Building S11); 21045.1043

The Temporary Fire Station (Building S11) is identified as an AOPI following personnel interviews and site reconnaissance due to the reported release of AFFF to the environment during nozzle testing of AFFF-equipped firefighting vehicles housed at the station. This site was listed under HQAES site number 21045.1043 but is now listed as no further action. This temporary station was utilized by the BGAD fire department from 2004 to 2006 or 2007. AFFF was reportedly sprayed from fire trucks out of the building's bay doors to the west towards Madison Avenue (**Figure 5-3**). It is estimated that less than 2 gallons of AFFF concentrate was released during each occurrence; however, truck tanks were also reportedly flushed at this location. The building is surrounded by concrete pads and Madison Avenue to the west (i.e., the direction AFFF was sprayed). Across Madison Avenue is a grassy area bordering a wooded area that slopes steeply to the west toward a stormwater drainage feature which flows to Lake Buck.

5.2.2 Former PEO-SOFSA Hangar 1 (Building 232)

The Former PEO-SOFSA Hangar 1 (Building 232) is identified as an AOPI following personnel interviews and site reconnaissance due to the presence of an AFFF-fire suppression system in the building. The hangar was constructed in the 1990s for rotary-wing aircraft and was occupied by PEO-SOFSA from that time until December 2018. The building is now occupied by CAPS Center operations. However, a 700-gallon tank of AFFF (the brand, type, and age of the AFFF could not be provided) remains in place at the southeast corner of the building. The fire suppression system has not been intentionally or accidentally activated according to personnel interviews; however, during the PA site visit, the PA team observed a white staining/crust on the hangar's cement floor in a quarter circle with a radius of about 40 feet out from the AFFF tank. A filled bucket of water was also observed under the piping of the fire suppression system, which may indicate leaks in the system. Service tags indicated that the system was last serviced in October 2017, but the fire inspector did not have any additional information about what the servicing involved. The fire department only reported system testing in approximately 2014; it was not clarified what this system testing entailed. An Environmental Baseline Survey (EBS) for the site concluded that aircraft washwater originating on the adjacent aircraft wash pad (outside the hangar) and aircraft maintenance spills (inside the hangar) are designed to flow to underground concrete vaults (i.e., the vault north of Building 232) via small floor drains and strip drains. A strip drain in the south end of Building 232 reportedly flows to another wastewater vault south of Building 232 (between Buildings 232 and 229). However, the small floor drains inside the hangars were reportedly grouted closed several years before the EBS was conducted (Environmental Assessments, LLC 2018). Groundwater reportedly infiltrated the

vault during other environmental sampling in 2017 (i.e., as part of the EBS; Environmental Assessments, LLC 2018). However, during the SI field work, observations made in the field suggest that the water in the vaults is not groundwater but is stormwater runoff from around the hangars and potentially wastewater from the floor drains inside the building (see additional details in **Section 7.2**).

On the south side of the building, up to three 30-gallon portable extinguisher systems (Trimax30s) were reportedly tested semiannually. The systems typically housed "Blizzard" foams (which, according to safety data sheets provided by the installation, contain proprietary fluorosurfactants and therefore potentially PFAS constituents); however, the systems were also filled with AFFF in October 2018. The systems were not discharged with AFFF and were transported to PEO-SOFSA's Lexington, Kentucky, facility after servicing with the AFFF. The historical system testing with Blizzard foams involved shooting a foam mixture approximately 65 feet from the awning pad on the south end of the building out to the grassy area at the south end of the building, towards a small creek. Wastewater collecting on this pad area reportedly drains to an underground storage tank between Former PEO-SOFSA Hangars 1 and 2.

The area was built up by bringing in fill and installing a concrete slab for the construction of the facilities (Environmental Assessments, LLC 2018). The building is surrounded by concrete pads, other industrial operations buildings, and a grassy area which slopes down to a creek to the south (**Figure 5-4**).

5.2.3 Former PEO-SOFSA Hangar 2 (Building 229)

The Former PEO-SOFSA Hangar 2 (Building 229) is identified as an AOPI following personnel interviews and site reconnaissance due to the presence of an AFFF-fire suppression system in the building. The hangar was constructed in the 1990s for rotary-wing aircraft and was occupied by PEO-SOFSA from that time until December 2018. The building is now occupied by a CAPS Center operations. However, a 700-gallon tank of AFFF (the brand, type, and age of the AFFF could not be provided) remains in place at the northeast corner of the building. The fire suppression system has not been intentionally or accidentally activated according to personnel interviews; however, during the PA site visit, the PA team observed minor staining on the hangar's cement floor just under the AFFF tank. Service tags indicated that the system was last serviced in October 2017, but the fire inspector did not have any additional information about what the servicing involved. The BGAD fire department only reported system testing in approximately 2014; it was not clear what this system testing entailed.

Similarly, as described in **Section 5.2.2**, washwater from the aircraft pad and wastewater from the floors of this hangar drain to an underground cement storage vault east of the building. The conditions at this vault are not detailed in the EBS for the area (Environmental Assessments, LLC 2018); however, the infrastructure design is believed to be similar to that for Former PEO-SOFSA Hangar 1 (Building 232). The vault appears to collect stormwater runoff from the area around the hangar and potentially wastewater from inside the hangar (see additional details in **Section 7.2**).

The building is surrounded by concrete pads, other industrial operations buildings, and grassy areas to the east and south which slope to a creek to the south (**Figure 5-4**).

5.2.4 FEMA Trailer Fire Training Area

The FEMA Trailer Fire Training Area is identified as an AOPI following post-site visit interviews with personnel previously working at the installation due to the reported possible firefighter training activities

conducted in the area behind the Former Fire Station [(Building 58370), **Section 5.2.5**]. The dates of operation of this area as a firefighter training area are unknown, and it is unknown if AFFF was used during the activities. **Figure 5-4** shows the inferred area where AFFF may have potentially been used during the training activities. However, given the AOPI's proximity to the Former Fire Station and the reported releases of AFFF there, it is likely that AFFF would have been used for firefighter training activities taking place here. The AOPI is situated between four other AOPIs: the Former Fire Station, the PEO-SOFSA Hangars 1 and 2, and the Old Furnace Training Area.

Based on historical aerial photographs, the FEMA trailer lot consisted of a graded gravel or dirt lot surrounded by other industrial buildings to the north and small stormwater drainage features surrounding the area (**Figure 5-4**). The drainage features are characterized by shrub and tree vegetation.

5.2.5 Former Fire Station (Building 58370)

The Former Fire Station [(Building 58370) formerly Building 212] is identified as an AOPI following personnel interviews and site reconnaissance due to the reported release of AFFF to the environment during nozzle testing of AFFF-equipped firefighting vehicles housed at the station. The fire station was utilized by the BGAD fire department prior to 2007. AFFF was reportedly sprayed from fire trucks in 120-foot fans along and across Garrard Street and toward Fayette Street. Before 1999, an aircraft rescue and fire-fighting vehicle was also housed at this station and used AFFF in its tank. An estimated frequency of nozzle testing activities or volume of AFFF released at this location was not provided.

The building is now a learning center. The area is surrounded by streets to the north and west, a grassy area and field to the south, and a grassy area and another building and paved lot to the east (**Figure 5-4**). Drainage from the area flows south through a stormwater ditch which runs parallel to Garrard Street and ultimately flows to Lake Gem.

5.2.6 Old Furnace Training Area

The Old Furnace Training Area is identified as an AOPI following personnel interviews and site reconnaissance due to the reported firefighter training activities conducted in the area south of Buildings 221 and 222. The area was utilized for training activities approximately three to four times per year from 1997 to 2005 or 2006. AFFF was reportedly released along the entire stretch of pavement south of Buildings 221 and 222. An estimated volume of AFFF used during the training exercises was not provided.

The area is surrounded by buildings to the north and a road and grassy area spanning east-west just south of the training area. The grassy area south of the road slopes to a wooded area and a small creek which flows to Lake Gem (**Figure 5-4**).

5.2.7 Former Fire Training Area (SWMU 17; 21045.1044)

The Former Fire Training Area (SWMU 17) is identified as an AOPI following document research, personnel interviews, and site reconnaissance due to the reported firefighter training activities conducted in the area. The site has also been identified as Blue Grass (BLGR)-050 and Site 31 in historical documents. The area was reportedly in use from 1954 to the early 1980s as a fire training area and was thereafter in use as a wood burning/kindling yard until the early 2000s. However, BGAD fire department

personnel interviewed recalled fire training with AFFF in the 1990s and early 2000s. An estimated frequency of training events or volume of AFFF used during each exercise at this AOPI was not provided.

In April 2003, part of the area was excavated to address two arsenic, mercury, and benzo(a)pyrene “hot spots” at the site as part of the IRP (Environmental Chemical Corporation 2003). The excavated plots were then backfilled with approved clean, borrowed clay material and covered with at least three inches of topsoil, fertilized, seeded, and covered with straw. The disturbed areas were graded to provide drainage away from buildings and towards existing drainage ditches. Excavations were each approximately 15 feet long, 15 feet wide, and 2 feet deep (Environmental Chemical Corporation 2003). Monitoring wells historically installed in the area have been plugged and abandoned.

The area is a vacant vegetated plot with some accumulated dead wood (**Figure 5-5**). Wooded areas and an access road surround the AOPI. The area drains to Hays Fork Creek, downstream of Lake Gem.

5.2.8 Wastewater Treatment Plant (Building 230) and Sludge Drying Beds

The WWTP (Building 230) and Sludge Drying Beds is identified as an AOPI following personnel interviews due to the reported potential receipt of PFAS-containing stormwater runoff from AOPIs where AFFF was used. Personnel indicate that while the WWTP does not intentionally receive stormwater runoff for treatment (except for runoff diverted to the plant from the burn pads at the OB/OD); it is known that the installation’s wastewater pipes are compromised in some locations and stormwater occasionally enters the pipes by inflow and infiltration during high-precipitation runoff events. Treated wastewater outfalls downgradient of Lake Gem and discharges to Hays Fork Creek. Sludge generated from the WWTP is dried in unlined beds just southwest of the WWTP before being transported offsite for disposal. The offsite disposal location of this sludge was not provided.

The WWTP (Building 230) and Sludge Drying Beds infrastructure is surrounded by grassy areas with a forested area and Hays Fork Creek to the south, downgradient of Lake Gem (**Figure 5-5**).

5.2.9 Bulldozer Fire Area

The Bulldozer Fire Area is identified as an AOPI following personnel interviews and site reconnaissance due to the reported fire response in the area involving AFFF. Bulldozers are typically staged in the OB/OD area during periods of operation to extinguish fires by means of suffocation/burial with soil. In either 2005, 2006, or 2007, one bulldozer itself caught fire, and the BGAD fire department responded with approximately 2 to 3 gallons of AFFF concentrate (BGAD fire department personnel interviewed recalled conflicting dates of the event). The AOPI is located at the northwestern, upgradient corner of the OB/OD area.

The area consists of bare soil in the bulldozer staging area (**Figure 5-6**), with a wooded area downslope to the southeast and access roads to the north and west. The area drains to the southwest (towards groundwater wells installed for OB/OD monitoring activities) to a tributary of Muddy Creek, and then downstream of Lake Vega. One upgradient background well also exists approximately 50 to 100 feet west of the reported fire.

6 SUMMARY OF SI ACTIVITIES

Based on the results of the PA at BGAD, an SI for PFOS, PFOA, and PFBS was conducted in accordance with CERCLA. SI sampling was completed at BGAD at all nine AOPIs to evaluate presence or absence of 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 programmatic information provided in the PQAPP (Arcadis 2019) and to detail the site-specific proposed scopes of work for the SI. A preliminary CSM was prepared for each of the installation's AOPIs in accordance with the USACE Engineer Manual 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, groundwater, surface water (and stormwater), and/or sediment pathways as potentially complete which guided the SI sampling. The QAPP Addendum (Arcadis 2020) details the sampling design and rationale based on each AOPI's preliminary CSM. The SI scope of work was completed in July 2020 and in April 2021 through the collection of field data and analytical samples during two separate mobilizations, referred to hereafter as Phases I and II.

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 BGAD. Changes to the prescribed procedures and sampling plan from the PQAPP (Arcadis 2019) and QAPP Addendum (Arcadis 2020) are described in **Section 6.3.3**. Analytical results obtained through SI field activities are summarized in **Section 7**.

6.1 Data Quality Objectives

As identified during the DQO process and outlined in the site-specific QAPP Addendum (Arcadis 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 determine if further investigation is warranted. This SI evaluated groundwater, soil, surface water, and stormwater to evaluate PFOS, PFOA, and PFBS presence or absence at each of the sampled AOPIs.

6.2 Sampling Design and Rationale

The rationale used to determine whether or not sampling should be conducted at each AOPI during this SI is illustrated on **Figure 6-1** below.

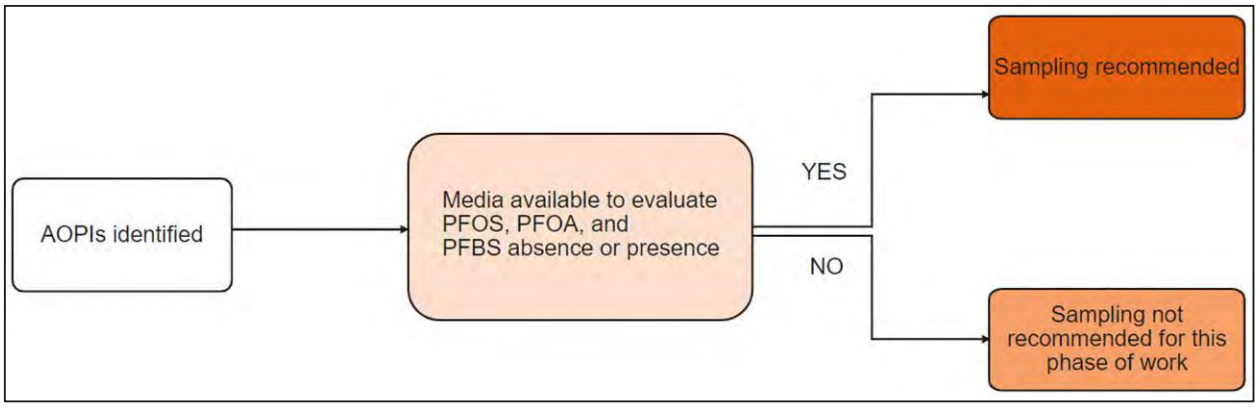

Figure 6-1: AOPI Sampling Decision Tree

6.2.1 Phase I (July 2020)

The sampling design for SI sampling activities at BGAD is detailed in Worksheet #17 of the QAPP Addendum (Arcadis 2020). Briefly, groundwater, surface water, and stormwater were sampled to identify PFOS, PFOA, and PFBS concentrations; field parameters (temperature, pH, dissolved oxygen, oxidation-reduction potential, and specific conductivity) were also measured for water samples. Groundwater was sampled at three existing monitoring wells downgradient of the Bulldozer Fire Area. 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.

Additionally, three underground wastewater vaults at the PEO-SOFSA hangars were sampled; the water was originally suspected to be groundwater infiltrating into the vaults (see further detail in **Section 6.2.2**). Surface water and stormwater were sampled at streams or drainage features downgradient of the AOPIs (if water was present at the time of the SI field event). No alternative samples were collected if the proposed surface water or stormwater sampling locations were dry during the SI sampling event. Additionally, the influent to the WWTP was sampled due to historical evidence of infiltration of stormwater into the wastewater piping infrastructure during heavy rain events.

Shallow soil was sampled from 0 to 2 feet bgs to identify PFOS, PFOA, and PFBS presence and concentrations and to evaluate the potential for those areas to be sources to surface water/stormwater and groundwater as an influence to drinking water. Additionally, samples were collected for total organic carbon (TOC), pH, and grain size analysis at one soil sampling location per AOPI planned for soil sampling. TOC, pH, and grain size data were collected as they may be useful in future fate and transport studies. The soil samples were located within the estimated potential release area at each AOPI. If large-grained fill (i.e., gravel) was encountered at the soil sampling locations (e.g., at the FEMA Fire Training Area), the gravel was cleared from the surface before advancing the auger.

6.2.2 Phase II (April 2021)

Based on the results of the initial phase of sampling, a second phase of work was completed to collect groundwater, surface water, and/or stormwater samples at AOPIs at which only soil and/or surface water samples were collected during the Phase I event. Grab groundwater samples were collected at six

temporary wells installed by sonic drilling methods; nine locations were attempted, but three of the boreholes were dry for the duration of the event and were abandoned, as discussed in **Section 6.3.3**. The temporary borehole locations were completed at locations inferred to be downgradient of the AOPIs.

In addition, five grab surface water and stormwater samples were collected during Phase II. Three of these samples were from springs, one was collected from an intermittent stream, and one was collected from a stormwater ditch. The latter two locations were previously planned for sampling but were dry during the Phase I event. The water discharged by springs is an expression of groundwater (that is, springs are points where the groundwater table intersects the land surface). Each spring has a "groundwater basin", analogous to a surface water drainage basin, from which its water is derived. The limits of these basins are typically defined through dye tracing. A sample collected from a spring, therefore, represents a composite sample of the groundwater contained within the spring's basin and provides insight into the quality of the groundwater throughout the basin. For some AOPIs, samples collected at springs were used to assess PFOS, PFOA, and PFBS in groundwater.

Additional reconnaissance was conducted at the underground vaults at the PEO-SOFSA hangars as well. Based on the observations made during the Phase II sampling event, it was determined that the vault water was stormwater from drainage around the hangars and helipad. The Phase I vault water samples are therefore discussed in the context of stormwater and are presented with the surface water results. Additional detail regarding these findings is provided in **Section 7.2** and **7.3**.

6.3 Sampling Methods and Procedures

Environmental samples were collected and analyzed in accordance with the PQAPP (Arcadis 2019), the SOPs and TGIs included as Appendix A to the PQAPP (Arcadis 2019), the QA/QC requirements identified in Worksheet #20 of the PQAPP (Arcadis 2019), 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 during 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 notes and field forms (i.e., soil boring logs, groundwater purging logs, equipment calibration forms, tailgate health and safety forms, and sample collection logs) documenting the SI sampling activities are included in **Appendices J** and **K**, respectively.

6.3.1 Field Methods

Groundwater samples were collected using a peristaltic pump for low-flow purging methods at approximately the center of the saturated screened interval at existing monitoring wells sampled during Phase I and at the temporary monitoring wells installed and sampled during Phase II. The construction

details for the existing monitoring wells sampled during the SI are included in **Table 6-1**. Groundwater samples were collected through either high-density polyethylene (HDPE) tubing using low-flow methods via a peristaltic or decontaminated bladder pump, or by using a disposable HDPE bailer. The temporary wells installed during the Phase II SI were completed via sonic drilling. The temporary wells consisted of pre-packed screens (to reduce turbidity) and riser casing. Groundwater samples were collected at first encountered groundwater at each of the temporary borehole sampling locations. At some borehole locations, first groundwater was encountered in the overburden just above the bedrock interface; at others, the boreholes were advanced 20 feet into bedrock and allowed to sit to allow groundwater accumulation in the temporary screen.

The underground wastewater vaults (at which infiltration of groundwater has been reported, but it was later determined that the water was stormwater runoff) were sampled using a disposable HDPE bailer; the depth of water in the vaults is noted on field forms in **Appendix K**.

Soil samples were collected from approximately 0 to 2 feet bgs using a decontaminated stainless-steel hand auger after clearing the top few inches of vegetation and/or non-native fill. The samples were composited (homogenized) from the 0 to 2 feet interval before bottling.

Surface water and stormwater samples were collected using direct-fill methods just below the water surface.

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 (Arcadis 2019) and QAPP Addendum (Arcadis 2020) provide QA/QC requirements for field duplicates, matrix spike/matrix spike duplicates, equipment blanks (EBs), 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 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 a hand auger, water-level meter, and the drill bit/tooling used for sonic drilling, as applicable to the sampled media. EBs were also collected on new disposable HDPE tubing and a new disposable HDPE bailer to assess if the materials influenced sampling results; disposable materials were not reused between sampling locations. Additionally, a source blank (SB) was collected from the drillers' water tote. The water was filled from a hydrant adjacent to the Temporary Fire Station Building S11 and was used for decontamination by pressure washing/steaming the tooling between boreholes. Analytical results for the EB, field blank, and SB samples are discussed in **Section 7.13**.

6.3.3 Field Change Reports

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

from the agreed upon scope of work (Arcadis 2020) were encountered during the Phase I SI field work. However, as described below, a significant follow-on scope was agreed upon based on the results from the Phase I data.

In some cases, clarifications to the established scope of work were needed but did not necessarily constitute a non-conformance from the sampling plans described in the QAPP Addendum (Arcadis 2020) (or follow-on sampling plan reported in the Field Change Reports [FCRs]). Modifications from and clarifications for the procedures and scope of work detailed in the QAPP Addendum (Arcadis 2020) and PQAPP (Arcadis 2019) and that did not affect DQOs are documented in FCRs included as **Appendix L** and are summarized below:

- FCR-BGAD-01: A stormwater sample (BGAD-FFS-1-SW) and a surface water sample (BGAD-PEO2-1-SW) could not be collected during the initial SI sampling event (July 2020) as the locations were dry at the time of sampling. However, the locations were able to be sampled during the follow-on Phase II event in April 2021.
- FCR-BGAD-02: The composite aqueous IDW sample (BGAD-IDW-1) was not analyzed for 2,4-diamino-6-nitrotoluene due to laboratory capabilities. The installation later indicated that the analyte did not need to be included for the IDW characterization.
- FCR-BGAD-03: One unplanned water sample, BGAD-PEO-1-2-(GW), was collected from a third underground vault at the PEO-SOFSA hangars. The sample was collected at the request of the installation due to the proximity of the vault to two AOPIs.
- FCR-BGAD-04: One soil field duplicate collected was not sent to the laboratory for analysis due to a misunderstanding during sample shipping.
- FCR-BGAD-05: A SB was not collected in July 2020 during the Phase I sampling event as prescribed in the QAPP Addendum (Arcadis 2020) as it was not applicable (i.e., no drilling was conducted at BGAD during the Phase I event). Similarly, an EB was not collected on a stainless-steel putty knife as this tool was not used during the SI.
- FCR-BGAD-06: The soil sample BGAD-FFTA-4-SO at the Former Fire Training Area was moved approximately 50 feet north due to obstructions (thick mulch and debris) that prohibited sampling at the originally proposed location.
- FCR-BGAD-07: One surface water sampling location (BGAD-TFS-1-SW) was moved approximately 700 feet to the southeast due to access constraints; the sample was collected at the surface water runoff collection basin feature (which is visible on **Figure 5-3** just south of the building) instead of along the intermittent stream. The WWTP inlet sampling location (BGAD-WWTP-IN-1) was also revised (to approximately 50 feet northeast of where the sample was originally mapped) based on incorrect GIS data regarding where the inlet to the WWTP was located.

Based on the results of the July 2020 sampling events, the Army provided direction to collect groundwater samples at AOPIs at which only soil or surface water samples were collected during the Phase I sampling events. In April 2021, temporary boreholes were completed via sonic drilling to collect grab groundwater samples at first encountered groundwater (i.e., whether in overburden or in bedrock). In addition, five surface water and stormwater samples were collected, as discussed in **Section 6.2**. The follow-on sampling scope was as agreed upon and detailed in **Appendix L**, FCR-08, except as noted below:

- FCR-BGAD-08: Groundwater was sampled at six of the nine planned temporary borehole locations. At the other three locations, water was not encountered in overburden or within the uppermost 20 feet of bedrock even after allowing the boreholes to remain open for one to four days. The field conditions were communicated with USAEC, and at the direction of USAEC, the boreholes were not advanced further and were abandoned at the end of the event since no groundwater had filled the boreholes.
- FCR-09: IDW was not analyzed for some anions prescribed for the analysis in the FCR-08. A follow-on event was completed on 11 August 2021 to collect a sample for the missing analyses to determine the final IDW disposal action.

6.3.4 Decontamination

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

6.3.5 Investigation-Derived Waste

Liquid IDW, including purged groundwater and decontamination fluids, was containerized, and stored at Building 51750 at the direction of the installation pending waste characterization. Excess soil cuttings from hand augering during Phase I were used to backfill the sampled shallow boreholes at the point of collection. Cuttings from the Phase II sonic drilling boreholes were spread to the ground at their respective AOPIs; in some cases, the cuttings were used to fill ruts created near fire hydrants from routine hydrant testing. Equipment IDW, including personal protective equipment and other disposable materials (e.g., gloves, plastic sheeting, bailers, and HDPE and silicon tubing) was bagged and disposed in on-post waste receptacles. IDW analytical results from both SI events are discussed in **Section 7.4**.

6.4 Data Analysis

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

6.4.1 Laboratory Analytical Methods

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

Additionally, the following general chemistry and physical characteristic analyses were completed for select soil and sediment samples in accordance with Worksheet #18 of the QAPP Addendum (Arcadis 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 were 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 M**).

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 5.3 (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 M**. The Level IV analytical reports are included within **Appendix M** 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 BGAD. Documentation generated during the data usability assessments, which were compiled into a DUSR (**Appendix M**), 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 upon the Stage 3 and Stage 4 data validation, the analytical results from environmental samples collected at BGAD are considered valid and usable for this SI evaluation with the qualifications documented in the DUSR and its associated data validation reports (**Appendix M**), and as indicated in the full analytical tables (**Appendix N**) provided for the SI results, except for two results qualified as "R" (originally qualified with an "X," described further below). Otherwise, these data are of sufficient quality to meet the objectives and requirements of the PQAPP (Arcadis 2019) and BGAD QAPP Addendum

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

The results that are qualified as estimated are usable with caution. One stormwater result (for BGAD-FFS-1-SW-041521) and one groundwater result (for BGAD-FD-1-GW-041421) from the April 2021 event were qualified with an "X" in the DUSR due to extracted internal standards recoveries less than 20%. Since the X-flagged results were non-detect, these results are recommended to be rejected and are considered unusable to determine presence or absence of the analytes due to serious deficiencies in the ability to analyze the sample and to meet published method and project quality control criteria. The "X" data qualifiers have been updated to an "R" qualifier in the full analytical tables (**Appendix N**) to indicate the rejection of these data. Neither of the two rejected results were for PFOS, PFOA, or PFBS analytes.

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 Screening Levels Calculated Using USEPA RSL Calculator
	Tap Water (ng/L or ppt) [1,2]	Soil (mg/kg or ppm) [1,2,3]	Soil (mg/kg or ppm) [1,2,3]
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 groundwater data are screened against the Residential Scenario tap water risk screening level. Surface water that is an expression of groundwater (i.e., seeps/springs that are discharge points for groundwater) are also compared to the Residential Scenario tap water risk screening level. Otherwise, the surface water and stormwater samples are collected only to re-evaluate the CSMs and are not compared to the tap water OSD risk screening level.
3. All soil data will be screened against both the Residential Scenario and Industrial/Commercial risk screening levels (as they were collected from less than 2 feet bgs), regardless of the current and projected land use of the AOPI.
mg/kg = milligram per kilogram
ng/L = nanograms per liter
ppm = parts per million
ppt = parts per trillion

The OSD residential tap water risk screening levels will be used to compare groundwater and select surface water data (i.e., for samples collected at springs, as noted above, since springs are expressions of groundwater) for this Army PFAS PA/SI. While the current and most likely future land uses of the

AOPIs at BGAD 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 9**.

7 SUMMARY AND DISCUSSION OF SI RESULTS

This section summarizes the analytical results obtained from samples collected during the SI at BGAD (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 through **7-3** summarize the groundwater, surface water, and soil analytical results for PFOS, PFOA, and PFBS. Sediment samples were not collected during the BGAD sampling because at the time of the Phase I sampling, the site approach was tailored to be similar to other installations in the PA/SI program. To remain consistent, sediment samples were also not collected during the Phase II sampling. **Table 7-4** below summarizes the AOPIs and whether their SI results exceed the OSD risk screening levels. **Appendix N** includes the full suite of analytical results for these media, as well as for the QA/QC samples. An overview of AOPIs at BGAD with OSD risk screening level exceedances is depicted on **Figure 7-1**. **Figures 7-2** through **7-5** show the PFOS, PFOA, and PFBS analytical results for groundwater, surface water, and soil 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** and **Appendix M**) are presented on the analytical tables. Groundwater and surface water data collected during the SI are reported in ng/L, or parts per trillion, and soil data are reported in mg/kg, or parts per million.

Field parameters measured for groundwater during low-flow purging and sample collection and for surface water during sample collection are provided on the field forms in **Appendix K**. Soil 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.

Table 7-4 AOPIs and OSD Risk Screening Level Exceedances

AOPI Name	OSD Exceedances (Yes/No)
Temporary Fire Station (Building S11)	No
Former PEO SOFSA Hangar 1 (Building 232)	Yes
Former PEO SOFSA Hangar 2 (Building 229)	Yes
FEMA Trailer Fire Training Area	Yes
Former Fire Station (Building 58370)	Yes
Old Furnace Training Area	No
Former Fire Training Area (SWMU-17)	Yes
WWTP (Building 230) and Sludge Drying Beds	Yes
Bulldozer Fire Area	No

Additionally, three springs were sampled at BGAD to supplement a general evaluation of the north cantonment area, and those results were compared to the OSD risk screening levels since the spring water is an expression of groundwater. Exceedances of the OSD risk screening levels were observed at one of the springs. Groundwater discharged at springs could be coming from multiple AOPIs (discussed further in **Section 7.2**).

7.1 Temporary Fire Station (Building S11)

Two shallow soil samples were collected at the Temporary Fire Station (Building S11). The surface water location planned to be sampled at this AOPI was dry during the July 2020 field event. However, an alternative surface water location was sampled to the south (and downstream) of the planned location downgradient of a drainage basin. During the April 2021 remobilization, an attempt was made to collect a groundwater grab sample near BGAD-TFS-2 using sonic drilling (**Figure 7-2**). The resulting borehole, which was drilled in an upland area, did not intercept any saturated intervals in the overburden or fractures yielding groundwater (drilled 20 feet into bedrock); therefore, a sample could not be collected (**Section 6.3.3**). As noted in **Section 2.7**, almost no groundwater is yielded on hillsides and hilltops at BGAD (URS 2000). No springs have been identified in the area near the Temporary Fire Station (Building S11) AOPI (**Figure 2-2**) to use as a proxy to evaluate groundwater from the AOPI. The subsections below describe the soil and surface water sampling results for this AOPI.

7.1.1 Soil

PFOS was detected less than the OSD risk screening levels in both shallow soil samples at concentrations of 0.0024 J- mg/kg and 0.0028 mg/kg. A “J” qualifier indicates the analyte was positively identified; however the associated numerical value is an estimated concentration only. A “J-“ qualifier indicates the result is an estimated quantity; the result may be biased low. PFOA was also detected less than the OSD risk screening levels in both shallow soil samples at concentrations of 0.00086 J- mg/kg and 0.0011 J mg/kg. PFBS was not detected in either soil sample (**Figure 7-2**; **Table 7-3**).

7.1.2 Surface Water

PFOS was detected in the surface water sample (BGAD-TFS-1-SW-070820) at a concentration of 3.7 J ng/L. PFOA and PFBS were not detected in the sample (**Figure 7-2**; **Table 7-2**). This surface water sample does not meet the criteria described in **Section 6.5** and was not compared to OSD risk screening levels.

7.2 North Cantonment Area AOPIs

The north cantonment area contains five AOPIs (**Figure 5-4**). During the April 2021 remobilization, three spring samples were collected to provide additional information regarding the quality of groundwater in the north cantonment area. The results of this general evaluation via spring sampling are discussed in the subsection below.

7.2.1 General North Cantonment Area Evaluation via Spring Sampling

As noted in **Section 6.2.2**, a sample collected from a spring represents a composite sample of the groundwater contained within the spring's groundwater basin. Because spring water is an expression of groundwater, sample results from springs are compared to the OSD risk screening levels.

Samples BGAD-SP-10-SW and BGAD-SP-11-SW were collected from springs located approximately 750 feet south-southwest and 150 feet south of the Old Furnace Training Area AOPI, respectively. BGAD-SP-62-SW was collected from a spring located approximately 1,300 feet southeast of the Former Fire Station (Building 58370). Results for these spring samples are included in **Table 7-2** and depicted on **Figure 7-3.** PFOS, PFOA, and PFBS were not detected in the sample collected from spring SP-10 (BGAD-SP-10-SW). In the sample collected from spring SP-11 (BGAD-SP-11-SW), PFOA was detected (10 ng/L) at a concentration less than the OSD risk screening level, while PFOS and PFBS were not detected at SP-11. The groundwater basin contributing groundwater to spring SP-11 is not defined. It is conceivable that the spring may drain groundwater from beneath all five of the AOPIs in the north cantonment area, because the elevation of the water table beneath these AOPIs is estimated to be higher than the elevation of the spring itself. PFOA contained in the sample from SP-11 is likely derived from the Old Furnace Training Area AOPI given their proximity and similarity in chemistry. Specifically, the detected concentration of PFOA at SP-11 (i.e., 10 ng/L) was similar to that detected in groundwater sampled at the Old Furnace Training Area (7.1 ng/L, BGAD-OFTA-1-GW). PFOS and PFBS were not detected at the BGAD-SP-11-SW spring water or BGAD-OFTA-1-GW groundwater sampling locations.

PFOS, PFOA, and PFBS were detected at BGAD-SP-62-SW. The concentration of PFOS (280 ng/L) in the sample exceeded the OSD risk screening level. The concentrations of PFOA and PFBS detected (15 ng/L and 8.1 ng/L, respectively) in the sample were less than OSD risk screening levels. The groundwater basin contributing groundwater to this spring is not defined but is not anticipated to be very large, given the relatively low flow rate documented at the spring (2 gallons per minute; URS 2000). Nevertheless, it is conceivable that the spring may drain groundwater from beneath as many as four of the AOPIs in the north cantonment area, specifically the Former PEO-SOFSA Hangars 1 (Building 232) and 2 (Building 229), the FEMA Trailer Fire Training Area, and the Former Fire Station (Building 58370). Further investigation work would be required to define the source(s) of PFOS, PFOA, and PFBS detected at this spring.

The groundwater, soil, and other surface water and stormwater sample results from the individual AOPIs in the north cantonment area are discussed in the subsections below.

7.2.2 Former PEO-SOFSA Hangar 1 (Building 232)

One shallow soil sample and two water samples (collected from underground vaults) were collected at the Former PEO-SOFSA Hangar 1 (Building 232). During the April 2021 remobilization, an additional groundwater grab sample was collected from a sonic drilling location adjacent to the southern underground vault. The subsections below summarize the PFOS, PFOA, and PFBS analytical results associated with the AOPI.

Additional reconnaissance was conducted at the underground vaults at the former PEO-SOFSA hangars during the follow-on SI event. Boreholes were drilled adjacent to the two vaults associated with the hangar (**Figure 7-3**), and bedrock was encountered very shallow (i.e., 3.5 to 10 feet bgs) with no

saturated layer encountered in the overburden. Additionally, the vaults were over half-full of water, and there was evidence of storm drains around the hangar and on the helipad. The levels of water observed in the vaults were less than 10 feet bgs and more indicative of stormwater runoff, not groundwater infiltration. Based on observations during the follow-on (i.e., Phase II) field work, the vault drainpipes did not appear to be grouted and valves did not appear shut off, in contrast to what was reported in a previous EBS for the site (Environmental Assessments, LLC 2018). Based on the observations made during the Phase II sampling event (**Appendix J**), it was determined that the vault water was stormwater from drainage around the hangars and helipad. The Phase I vault water samples are therefore discussed in the context of stormwater runoff.

7.2.2.1 Groundwater

The groundwater sample collected from sonic drilling location BGAD-PEO1-3-GW (collected from the temporary screen set 20 feet into bedrock) had detections of PFOS, PFOA, and PFBS. PFOS and PFOA were detected greater than the OSD risk screening level with concentrations of 300 J+ ng/L and 150 ng/L, respectively (i.e., in the field duplicate). PFBS was detected less than the OSD risk screening level with a concentration of 95 ng/L in the field duplicate. The concentrations observed in the field duplicate sample were slightly greater than those observed in the normal sample (**Figure 7-3**; **Table 7-1**).

7.2.2.2 Soil

PFOS was detected in the soil sample (BGAD-PEO1-1-SO) collected south of the hangar with a concentration of 0.0017 mg/kg (less than the OSD risk screening level). PFOA and PFBS were not detected in the sample (**Figure 7-3**; **Table 7-3**).

7.2.2.3 Stormwater

PFOS, PFOA, and PFBS were detected in both water samples collected from the underground vaults at the Former PEO-SOFSA Hangar 1 (Building 232): BGAD-PEO1-1-(GW) and BGAD-PEO1-2-(GW). PFOS and PFOA were detected at concentrations of 1,600 J ng/L and 82 ng/L, respectively, at the vault north of the hangar. PFBS was detected with a concentration of 93 ng/L. PFOS and PFOA were detected with concentrations of 5,800 J ng/L and 1,200 J ng/L, respectively, at the vault southeast of the hangar; PFBS was detected with a concentration of 39 ng/L. These stormwater (and potentially wastewater) samples do not meet the criteria described in **Section 6.5** and were not compared to OSD risk screening levels (**Table 7-2**; **Figure 7-3**). PFOS, PFOA, and PFBS detected in the vault may be due to industrial waste from inside the hangar (including AFFF if an incidental release from the fire suppression system occurred), and from stormwater runoff if AFFF or other PFAS-containing materials were used on the helipad area.

7.2.3 Former PEO-SOFSA Hangar 2 (Building 229)

One water sample (collected at the underground vault where groundwater infiltration was suspected) was collected at the Former PEO-SOFSA Hangar 2 (Building 229). The surface water (creek) location planned to be sampled at this AOPI was dry during the initial field event, but water was present during the April 2021 remobilization and a sample was collected. Also, during the April 2021 remobilization, one

groundwater grab sample was collected from a boring drilled with a sonic rig southeast of the underground vault.

Additional reconnaissance was conducted at the underground vault at the former PEO-SOFSA hangars during the follow-on SI event, as described in **Section 7.2.1**. At the borehole drilled adjacent to the vault at this AOPI (**Figure 7-3**), bedrock was encountered very shallow (7 feet bgs) with no saturated layer encountered in the overburden. Additionally, the vault was completely full of water, and there was evidence of storm drains around the hangar and on the helipad. No evidence of the drainpipes having been grouted or valves shut off was observed, in contrast to what was reported in the EBS for the site (Environmental Assessments, LLC 2018). Based on the observations made during the Phase II sampling event (**Appendix J**), it was determined that the vault water was stormwater from drainage around the hangars and helipad. The Phase I vault water sample from this AOPI is therefore discussed in the context of stormwater.

The subsections below summarize the PFOS, PFOA, and PFBS analytical results associated with the AOPI.

7.2.3.1 Groundwater

At the sonic drilling location BGAD-PEO2-2-GW (collected from the temporary screen set 20 feet into bedrock), PFOS was detected less than the OSD risk screening level with a concentration of 13 ng/L. PFOA was detected greater than the OSD risk screening level with a concentration of 120 ng/L. PFBS was detected less than the OSD risk screening level with a concentration of 8.7 ng/L (**Table 7-1**; **Figure 7-3**).

7.2.3.2 Stormwater and Surface Water

Similar to the underground vaults discussed in **Section 7.2.1**, the water sampled here is believed to be stormwater (and potentially wastewater), not groundwater. At the underground vault where stormwater sample BGAD-PEO2-1-(GW) was collected, PFOS was detected at a concentration of 23 ng/L. PFOA was detected with a concentration of 240 ng/L. PFBS was not detected in the sample. PFOS, PFOA, and PFBS observed in the vault may be due to industrial waste from inside the hangar (including AFFF if an incidental release from the fire suppression system occurred), and from stormwater runoff if AFFF or other PFAS-containing materials were used on the helipad area.

The surface water sample collected at BGAD-PEO2-1-SW (i.e., from the creek) had detections of PFOS, PFOA, and PFBS. PFOS was detected with a concentration of 460 ng/L (in the duplicate sample). PFOA and PFBS were detected in the duplicate sample with concentrations of 31 ng/L and 32 ng/L, respectively. The concentrations observed in the field duplicate sample were slightly greater than those observed in the normal sample (**Table 7-2**; **Figure 7-3**).

These water samples do not meet the criteria described in **Section 6.5** and were not compared to OSD risk screening levels.

7.2.4 FEMA Trailer Fire Training Area

Six shallow soil samples were collected at the FEMA Trailer Fire Training Area. During the April 2021 remobilization, an attempt was made to collect a groundwater grab sample near the BGAD-FEMA-1-SO soil sampling location (i.e., where the maximum PFOS and PFOA soil concentrations were observed at this AOPI) using sonic drilling (**Figure 7-3**). The resulting borehole, which was drilled in an upland area, did not intercept any saturated intervals in the overburden or fractures yielding groundwater (drilled 20 feet into bedrock); therefore, a sample could not be collected (**Section 6.3.3)**. As noted in **Section 2.7**, almost no groundwater is yielded on hillsides and hilltops at BGAD (URS 2000).

However, as discussed in **Section 7.2.1**, springs have been identified in the area and may be used as a proxy to evaluate groundwater from the AOPI. It is conceivable that springs SP-10, SP-11, and SP-62 could drain groundwater from beneath this AOPI. It is also conceivable that the surface water feature sampled at BGAD-PEO2-1-SW (**Figure 7-3**) may receive stormwater runoff from the FEMA Trailer Fire Training Area AOPI.

The subsection below describes the soil sampling results for this AOPI.

7.2.4.1 Soil

Six shallow soil samples were collected at the FEMA Trailer Fire Training Area. PFOS and PFOA were detected less than the OSD risk screening levels at location BGAD-FEMA-1-SO (north of the indicated fire training area where surface water runoff would have flowed); concentrations were 0.0016 mg/kg PFOS and 0.0012 mg/kg PFOA. PFBS was not detected in this sample. PFOS and PFOA were detected less than the OSD risk screening levels at location BGAD-FEMA-6-SO (located furthest to the southeast and off the gravel pad); concentrations were 0.001 J mg/kg PFOS and 0.00055 J mg/kg PFOA. PFBS was not detected in this sample. BGAD-FEMA-4-SO also had PFOS detection of 0.00075 J mg/kg, less than OSD risk screening levels. PFOA and PFBS were not detected in this sample. PFOS, PFOA, and PFBS were not detected in the other three shallow soil samples collected at this AOPI (BGAD-FEMA-2-SO, BGAD-FEMA-3-SO, and BGAD-FEMA-5-SO) (**Table 7-3**; **Figure 7-3**).

7.2.5 Former Fire Station (Building 58370)

Two shallow soil samples were collected at the Former Fire Station (Building 58370). The stormwater location planned to be sampled at this AOPI was dry during the initial field event, but water was present during the April 2021 remobilization and a sample was collected. Also, during the April 2021 remobilization, one groundwater grab sample was collected from a sonic drilling location. The subsections below summarize the PFOS, PFOA, and PFBS analytical results associated with the Former Fire Station (Building 58370) AOPI.

7.2.5.1 Groundwater

During the April 2021 remobilization a groundwater grab sample was collected from BGAD-FFS-1-GW via a temporary screen set in the saturated overburden. PFOS, PFOA, and PFBS were detected in the sample. PFOS and PFOA were detected greater than the OSD risk screening levels with concentrations of 2,600 J ng/L and 1,300 J ng/L, respectively. PFBS was detected with a concentration of 410 J ng/L, less than the OSD risk screening level (**Table 7-1**; **Figure 7-3**).

7.2.5.2 Soil

PFOS and PFOA were detected less than the OSD risk screening levels at location BGAD-FFS-1-SO (across the road from the bay doors, where interviewed personnel indicated nozzle testing sprays would be directed); concentrations were 0.072 mg/kg and 0.0058 mg/kg respectively. PFBS was not detected in this sample (**Table 7-3**; **Figure 7-3**). PFOS was detected less than the OSD risk screening level at location BGAD-FFS-2-SO (along the stormwater ditch adjacent to the building) with a concentration of 0.019 mg/kg; PFOA and PFBS were not detected in this sample.

7.2.5.3 Stormwater

During the April 2021 remobilization a stormwater sample was collected from the unlined drainage ditch west of the building at BGAD-FFS-1-SW. PFOS, PFOA, and PFBS were detected in the sample. PFOS was detected at a concentration of 170 J+ ng/L. PFOA and PFBS were detected with concentrations of 36 ng/L and 23 ng/L, respectively. This stormwater sample does not meet the criteria described in **Section 6.5** and the data were therefore not compared to OSD risk screening levels (**Table 7-2**; **Figure 7-3**).

7.2.6 Old Furnace Training Area

Three shallow soil samples and one surface water sample were collected at the Old Furnace Training Area during the Phase I field event. One groundwater grab sample was collected from a sonic drilling location during the April 2021 remobilization. The subsections below summarize the PFOS, PFOA, and PFBS analytical results associated with the AOPI.

7.2.6.1 Groundwater

During the April 2021 remobilization, one groundwater grab sample was collected from sonic drilling location, BGAD-OFTA-1-GW, via temporary screen set at the overburden/bedrock interface. PFOS and PFBS were not detected in this sample. PFOA was detected less than OSD risk screening levels at a concentration of 7.1 ng/L (**Table 7-1**; **Figure 7-3**).

7.2.6.2 Soil

PFOA was detected less than the OSD risk screening level in the soil sample collected to the northeast of the old furnace (BGAD-OFTA-3-SO) with a concentration of 0.0016 mg/kg; PFOS and PFBS were not detected in the sample. PFOA was detected less than the OSD risk screening level in the soil sample collected to the southwest of the old furnace (BGAD-OFTA-1-SO) with a concentration of 0.00071 J mg/kg; PFOS and PFBS were not detected in the sample. PFOS, PFOA, and PFBS were not detected in the remaining soil sample collected at BGAD-OFTA-2-SO (**Table 7-3**; **Figure 7-3**).

7.2.6.3 Surface Water

PFOS, PFOA, and PFBS were detected in the surface water sample (BGAD-OFTA-1-SW) collected at the intermittent drainage south of the AOPI (upstream of where the stream flows into Lake Gem). PFOS was detected at a concentration of 130 ng/L. PFOA and PFBS were detected at concentrations of 15 ng/L and 6.4 ng/L, respectively (**Table 7-2**; **Figure 7-3**). This surface water sample does not meet the criteria

described in **Section 6.5** and the data were therefore not compared to OSD risk screening levels (**Table 7-2**; **Figure 7-3**).

7.3 South Cantonment Area AOPIs

The subsections below describe the sample results from the two south cantonment area AOPIs.

7.3.1 Former Fire Training Area (SWMU 17; 21045.1044)

Six shallow soil samples were collected at the Former Fire Training Area during the initial field event. One groundwater grab sample was collected from a sonic drilling location during the April 2021 remobilization. The subsections below summarize the PFOS, PFOA, and PFBS analytical results associated with the AOPI.

7.3.1.1 Groundwater

During the April 2021 remobilization, one groundwater grab sample was collected from sonic drilling location, BGAD-FFTA-1-GW, via temporary screen set at the overburden/bedrock interface. PFOS, PFOA and PFBS were all detected in this sample. PFOS was detected above the OSD risk screening value with a concentration of 45 ng/L. PFOA and PFBS were detected below OSD risk screening values with concentrations of 15 ng/L and 7.5 ng/L, respectively (**Table 7-1**; **Figure 7-4**).

7.3.1.2 Soil

PFOS was detected less than the OSD risk screening level at four of the six soil sampling locations (BGAD-FFTA-2-SO through BGAD-FFTA-5-SO); detected PFOS concentrations ranged from 0.0017 mg/kg to 0.0067 mg/kg. PFOA was detected less than the OSD risk screening level in two samples (BGAD-FFTA-3-SO and BGAD-FFTA-5-SO) at concentration of 0.00068 J mg/kg and 0.00092 J mg/kg, respectively. PFBS was not detected in any of the six soil samples collected at this AOPI (**Table 7-3**; **Figure 7-4**).

7.3.2 Wastewater Treatment Plant (Building 230) and Sludge Drying Beds

Three water samples were collected in association with the WWTP (Building 230) and Sludge Drying Beds: one surface water sample was collected from the stream downstream of the WWTP outfall, one sample of the WWTP influent was collected because of reported infiltration of stormwater (and therefore, potential AFFF-impacted runoff) into the wastewater system piping, and one groundwater grab sample was collected from a sonic drilling location south of the Sludge Drying Beds during the April 2021 remobilization. One soil sample was collected from the center of the Sludge Drying Beds (BGAD-SDB-1-SO) during the Phase I event. The subsections below summarize the PFOS, PFOA, and PFBS analytical results associated with the WWTP (Building 230) and Sludge Drying Beds AOPI.

7.3.2.1 Groundwater

During the April 2021 remobilization, one groundwater grab sample was collected from sonic drilling location, BGAD-SDB-1-GW (collected in the saturated overburden). PFOS, PFOA and PFBS were all

detected in this sample. PFOS and PFOA were detected above OSD risk screening values with concentrations of 47 ng/L and 51 ng/L, respectively. PFBS was detected below the OSD risk screening value with a concentration of 26 ng/L (**Table 7-1**; **Figure 7-4**).

7.3.2.2 Soil

One soil sample was collected from the center of the Sludge Drying Beds (BGAD-SDB-1-SO). PFOS, PFOA, and PFBS were detected less than the OSD risk screening level with concentrations of 0.024 mg/kg, 0.0052 mg/kg, and 0.0029 mg/kg, respectively (**Table 7-3**; **Figure 7-4**).

7.3.2.3 Surface Water and Stormwater

At BGAD-WWTP-1-SW, which was collected from the tributary to Hays Fork that drains Lake Gem downstream of the WWTP outfall, PFOS, PFOA, and PFBS were detected with respective concentrations of 33 ng/L, 5.3 ng/L, and 3.6 ng/L.

At the influent to the WWTP [BGAD-WWTP-IN-1-(SW)], PFOS was detected with a concentration of 8.4 ng/L. PFOA and PFBS were not detected in this sample (**Table 7-2**; **Figure 7-4**). The sample collected at this influent water may represent some stormwater, if infiltration of the stormwater into the sewer system piping occurred (as discussed in **Section 2.9**).

These water samples do not meet the criteria described in **Section 6.5** and the data were therefore not compared to OSD risk screening levels (**Table 7-2**; **Figure 7-4**).

7.3.3 Bulldozer Fire Area

At the Bulldozer Fire Area, only downgradient groundwater samples were collected. Soil samples were not collected due to no-dig restrictions and unexploded ordnance concerns in the area prohibiting soil sampling. The subsection below describes the results from the groundwater sampling at this AOPI.

7.3.3.1 Groundwater

Three groundwater samples were collected from the center of the saturated screened interval at existing monitoring wells MW4004C02, MW4004C03, and MW4004C10. PFOS, PFOA, and PFBS were not detected in any of the three monitoring wells (**Table 7-1**; **Figure 7-5**).

7.4 Investigation Derived Waste

Liquid IDW, including purged groundwater and decontamination fluids, was containerized and stored at Building 51750 at the direction of the installation. A composite sample of the purge and decontamination wastewater was collected from the liquid IDW generated during each event. The concentrations of the analytes listed in **Appendix N** were acceptable for the installation to dispose of the Phase I IDW at the WWTP. The liquid IDW from the Phase I sampling event (approximately 30 gallons) was processed through the BGAD WWTP on 13 August 2020. As discussed in **Section 6.3.3**, additional analytical data from the Phase II liquid IDW was obtained to ensure compliance with the BGAD WWTP guidelines. That analytical data is listed in **Appendix N**, and BGAD is coordinating disposal through the Defense Logistics Agency.

7.5 TOC, pH, and Grain Size

In addition to sampling soil for PFOS, PFOA, and PFBS, one soil sample per AOPI was analyzed for TOC, pH, moisture content, and grain size data as they may be useful in future fate and transport studies. The TOC in the soil samples ranged from 1,920 to 17,200 mg/kg. The TOC at this installation was on the lower end of what is typically observed in topsoil (5,000 to 30,000 mg/kg). The combined percentage of fines (i.e., silt and clay) in soils at BGAD ranged from 35 to 71.6% with an average of 61.8%. In general, PFAS constituents tend to be more mobile in soils with less than 20% fines (silt and clay) and lower TOC. The percent moisture of the soil was 22%, which is higher than what is typical for sandy soil (0 to 10%), loam (0 to 12%), or clay (0 to 20%). The pH of the soil was slightly alkaline (7 to 9 standard units). While PFAS constituents are relatively less mobile in soils with high percentages of fines, depleted TOC may allow for enhanced mobility of the constituents in soil.

7.6 Blank Samples

The full analytical results for blank samples collected during the SI are included in **Appendix N**. PFOS, PFOA, and PFBS were not detected in any of the blank samples collected during the SI work.

7.7 Conceptual Site Models

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 7-6** through **7-9** and in this section therefore represent the current understanding of the potential for human exposure. For some AOPIs, the CSM is the same and thus shown on the same figure.

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

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

chemicals in waterways at an installation). Off-installation receptor types could include drinking water receptors (i.e., commercial/industrial workers or residents) and recreational users.

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

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

- There are no permanent residents at BGAD. Therefore, all exposure pathways for on-installation residents are incomplete.
- The AOPIs are not recreational sites and are wholly located within the installation boundaries. Therefore, the soil exposure pathways for on-installation recreational users and off-installation receptors are incomplete.
- PFOS, PFOA, and/or PFBS were detected in groundwater samples collected from temporary monitoring wells completed in inferred downgradient locations associated with six of the nine AOPIs. Groundwater samples could not be collected at the Temporary Fire Station and FEMA Trailer Fire Training Area AOPIs (i.e., groundwater was not encountered in overburden or within the first 20 feet of bedrock). PFOS, PFOA, and PFBS were not detected in groundwater samples collected from monitoring wells inferred to be downgradient of the Bulldozer Fire Area AOPI (discussed further below). At all AOPIs except the Bulldozer Fire Area, the groundwater exposure pathway (via drinking water ingestion and dermal contact) for on-installation site workers is potentially complete to account for potential future use of the downgradient on-post groundwater.
- Recreational users are not likely to contact groundwater during outdoor recreational activities. Therefore, the groundwater exposure pathway for on-installation recreational users is incomplete[1].
- Groundwater originating at the AOPIs could potentially migrate off post, and off-post groundwater could be used as a drinking water source. Therefore, at all AOPIs except the Bulldozer Fire Area, the groundwater exposure pathway (via drinking water ingestion and dermal contact) for off-installation receptors is potentially complete.
- PFOS, PFOA, and PFBS were detected in the surface water and stormwater samples collected in association with the AOPIs (i.e., at downgradient ditches and surface water bodies, springs that may

[1] While springs are points where groundwater (and any sediment transported with it) discharges at the surface, spring water and associated sediment are considered to be surface water for the purposes of assessing potential human exposure risks.

discharge groundwater originating from beneath multiple AOPIs, or in stormwater collection vaults). Additionally, groundwater could discharge at seeps or springs on- or off post and migrate to off-post surface water bodies. Further study is needed to establish groundwater flow pathways (and PFAS constituent transport pathways) at BGAD. Though the AOPIs are either in a different watershed than Lake Vega (which supplies BGAD with drinking water) or drain to surface water downstream of the lake, the groundwater flow direction on post is highly variable and groundwater originating at AOPIs has the potential to discharge to surface water including Lake Vega. Surface water from the Kentucky River and Silver Creek is used as a drinking water source for communities surrounding BGAD; the withdrawal locations of surface water have been indicated along these surface water features further than 5 miles from the installation (University of Kentucky 2019). However, there is a potential for surface water within 5 miles of the installation to realistically be used in the future as a drinking water source. Therefore, the surface water exposure pathways for on-installation site workers (via drinking water ingestion or incidental ingestion and dermal contact during site maintenance) and for off-installation receptors (via drinking water ingestion and dermal contact) are potentially complete.

- Sediment was not sampled congruently at the surface water or stormwater sampling locations. Site workers could contact constituents (if present) in sediment (e.g., while cleaning outfall locations or during stream maintenance and brush clearing around surface water or stormwater drainage features). Therefore, the sediment exposure pathway for on-installation site workers is potentially complete.
- Recreational users could contact constituents in on- or off-post waterbodies; therefore, the surface water and sediment exposure pathways (via incidental ingestion and dermal contact) for on- and off-installation recreational users are potentially complete.

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

Figure 7-6 presents the CSM for six AOPIs including the Temporary Fire Station (Building S11), Former PEO-SOFSA Hangar 1 (Building 232), FEMA Trailer Fire Training Area, Former Fire Station, Old Furnace Training Area, and Former Fire Training Area (SWMU 17). Activities at these AOPIs resulted in releases of AFFF to soil or paved surfaces.

- PFOS, PFOA, and/or PFBS were detected in soil at these AOPIs, and site workers (i.e., installation personnel) could contact constituents in soil via incidental ingestion, dermal contact, and inhalation of dust. Therefore, the soil exposure pathway for on-installation site workers is complete.

Figure 7-7 presents the CSM for the Former PEO-SOFSA Hangar 2 (Building 229). Activities at this AOPI resulted in potential releases of AFFF to soil or an underground sewer system.

- Soil was not sampled at the Former PEO-SOFSA Hangar 2 (Building 229). Site workers (i.e., installation personnel) could contact constituents (if present) in soil via incidental ingestion, dermal contact, and inhalation of dust. Therefore, the soil exposure pathway for on-installation site workers is potentially complete.

Figure 7-8 presents the CSM for the Bulldozer Fire Area. Activities at this AOPI resulted in potential releases of AFFF to soil or an underground sewer system.

- Soil was not sampled at the Bulldozer Fire Area. Site workers (i.e., installation personnel) could contact constituents (if present) in soil via incidental ingestion, dermal contact, and inhalation of dust. Therefore, the soil exposure pathway for on-installation site workers is potentially complete.
- PFOS, PFOA, and PFBS were not detected in the groundwater samples collected from monitoring wells inferred to be downgradient of the Bulldozer Fire Area AOPI. Based on the SI sample results, the groundwater exposure pathways (via drinking water ingestion and dermal contact) for on-installation site workers and for off-installation receptors are incomplete.
- There is a potential for surface runoff from soil to nearby waterbodies at this AOPI. Surface water and sediment were not sampled downgradient of the AOPI. As discussed previously, site workers and recreational users could contact constituents (if present) in surface water and sediment via incidental ingestion and dermal contact. Therefore, the surface water and sediment exposure pathways for on-installation site workers and for on- and off-installation recreational users are potentially complete.

Figure 7-9 presents the CSM for the WWTP (Building 230) and Sludge Drying Beds. It was indicated that stormwater potentially containing PFOS, PFOA, and/or PFBS (i.e., from runoff in areas where AFFF was used) may enter the WWTP and that sludge generated from the WWTP is dried in unlined beds just southwest of the WWTP.

- PFOS, PFOA, and/or PFBS were detected in sludge/soil at this AOPI. Site workers (i.e., installation personnel) could contact constituents in sludge/soil via incidental ingestion, dermal contact, and inhalation of dust. Therefore, the sludge/soil exposure pathway for on-installation site workers is complete.

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

8 OFF-POST PRIVATE POTABLE WELL INVESTIGATION

Based on SI sampling results, off-post private potable wells were researched for potential sampling as part of the PA/SI investigation at BGAD to determine whether there are off-post impacts to drinking water due to Army operations. No off-post private potable wells or surface water intakes were identified within the search area specified by the Army, at inferred downgradient locations from the AOPIs where PFOS and/or PFOA concentrations were detected at concentrations greater than the USEPA lifetime health advisory. The off-post well survey was completed using readily available information online (i.e., the Kentucky Geological Survey). Other available regional groundwater studies (i.e., United States Geological Survey reports or other) may be reviewed for the area, though groundwater models are not as reliable for interpretation of karst aquifers at a local and AOPI scale.

If such wells are identified for future sampling, community outreach and notification will be coordinated between the Army PA/SI team, BGAD, Headquarters of the Department of the Army, and USAEC Divisions to sample wells located within the specified area downgradient of the installation boundary. If off-post private potable water supply sampling occurs, a letter report presenting a summary of the investigation results and the associated laboratory reports will be included as an addendum to this report, when available.

9 CONCLUSIONS AND RECOMMENDATIONS

The PFAS PA/SI included two distinct efforts. The PA identified AOPIs at BGAD 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.

The 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 BGAD. Following the evaluation, nine AOPIs were identified.

BGAD is supplied with drinking water from Lake Vega, which covers 135 acres of the installation; the intake is located at the east end of the lake before the lake discharges to Muddy Creek. Pumps transmit raw lake water to the BGAD water treatment plant, where it is pretreated for taste and odor, and a coagulant is added to enhance removal of suspended impurities by sedimentation. Next the water is filtered through a multi-media filter, disinfected, and sent to a clear well for distribution by pumping. The BGCAPP also uses water from this system, with consumption ranging from 30,000 gallons per day to 240,000 gallons per day when the plant is in peak operation (Program Executive Office, Assembled Chemical Weapons Alternative 2015). In addition, the BGCAPP badging office at the Highway 52 entrance is connected to a Madison County water supply in case of emergency. Finally, the Lex BG Army Commander well on post (**Figure 2-2**) is part of a water system which regularly supplies water to at least 25 of the same people at least 6 months per year.

Surface water is used as a drinking water source for other communities surrounding BGAD, including from the Kentucky River and Silver Creek. While other non-drinking water surface water withdrawal locations along these surface water features are indicated within 5 miles of the installation, watershed maps and water resource data indicate that public water supply intakes along the Kentucky River and Silver Creek are greater than 5 miles from the installation boundary (University of Kentucky 2019).

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

Eight of nine AOPIs had detections of PFOS, PFOA, and PFBS in groundwater, surface water, stormwater runoff, and/or soil and six AOPIs exceeded OSD risk screening levels. Three springs were sampled at BGAD to supplement a general evaluation of the north cantonment area, and those results were compared to the OSD risk screening levels because spring water is an expression of groundwater. In their conceptual model for groundwater flow at the installation, URS (2000) noted that monitoring the quality of water from nearby, downgradient springs was a necessary, and potentially more important component of a groundwater monitoring program than monitoring the quality of groundwater at wells. Of the three springs sampled, the OSD risk screening level was exceeded for PFOS concentrations at one of the springs (SP-62). The region drained by (i.e., contributing groundwater to) the spring is not defined; but may include as many as four AOPIs. As such, PFOS contained in the spring water could be derived from

one or more of these AOPIs. Further investigation work would be required to define the source(s) of PFOS at this spring.

The greatest concentrations of PFOS, PFOA, and PFBS in groundwater were found at the Former Fire Station at 2,600 J ng/L, 1,300 J ng/L, and 410 J ng/L, respectively. The highest concentrations of PFOS, PFOA, and PFBS in surface water (i.e., streams or springs) were detected in the stream downgradient of the Former PEO-SOFSA Hangars at concentrations of 460 ng/L, 31 ng/L, and 32 ng/L, respectively. The highest concentrations of PFOS, PFOA, and PFBS in stormwater were detected at Former PEO-SOFSA Hangar 1 [(Building 232), in the stormwater runoff collection vault] at concentrations of 5,800 J ng/L, 1,200 J ng/L, and 93 ng/L, respectively. The highest PFOS detection in soil was 0.072 mg/kg at the Former Fire Station (Building 58370); the highest PFOA detection in soil was 0.0058 mg/kg at the Former Fire Station (Building 58370); the highest (and only) PFBS detection in soil was 0.0029 mg/kg at the WWTP (Building 230) and Sludge Drying Beds.

Following the SI sampling, eight of the nine AOPIs have confirmed PFOS, PFOA, and/or PFBS presence. All nine AOPIs were considered to have complete or potentially complete exposure pathways. The AOPI where PFOS, PFOA, and/or PFBS were not detected was the Bulldozer Fire Area. At this AOPI, only downgradient groundwater was sampled and PFOS, PFOA, and PFBS were not detected. The soil exposure pathway for on-installation site workers was either complete or potentially complete at all nine AOPIs. The groundwater exposure pathway for on-installation site workers was potentially complete at eight of the nine AOPIs. Due to a lack of land use controls off installation, the groundwater exposure pathway for off-installation drinking water receptors was also potentially complete at eight of the nine AOPIs. The surface water and sediment exposure pathways for on-installation site workers and for on- and off-installation recreational users was considered potentially complete for all nine AOPIs.

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 9-1** below summarizes the AOPIs identified at BGAD, PFOS, PFOA, and PFBS sampling and recommendations for each AOPI; further investigation is warranted at BGAD. In accordance with CERCLA, site-specific risk will be assessed during a future phase to evaluate whether remedial actions are required.

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

AOPI Name	PFOS, PFOA, and/or PFBS detected greater than OSD Risk Screening Levels? (Yes/No/ND/NS)			Recommendation
	GW	SO	SP[1,2]	
Temporary Fire Station (Building S11)	NS[3]	No	NA	No action at this time
Former PEO-SOFSA Hangar 1 (Building 232)	Yes	No	Yes	Further study in a remedial investigation
Former PEO-SOFSA Hangar 2 (Building 229)	Yes	NS	Yes	Further study in a remedial investigation

AOPI Name	PFOS, PFOA, and/or PFBS detected greater than OSD Risk Screening Levels? (Yes/No/ND/NS)			Recommendation
	GW	SO	SP[1,2]	
FEMA Trailer Fire Training Area	NS[3]	No	Yes	Further study in a remedial investigation
Former Fire Station (Building 58370)	Yes	No	Yes	Further study in a remedial investigation
Old Furnace Training Area	No	No	No	No action at this time
Former Fire Training Area (SWMU 17)	Yes	No	NS	Further study in a remedial investigation
WWTP (Building 230) and Sludge Drying Beds	Yes	No	NS	Further study in a remedial investigation
Bulldozer Fire Area	ND	NS	NS	No action at this time

Notes:
Light gray shading – detection greater than the OSD risk screening level

1. Results from spring samples that were used to make recommendations for the AOPIs were collected at springs that may drain groundwater from beneath multiple AOPIs within that spring's basin. The source(s) of PFOS, PFOA, and PFBS in groundwater and/or surface water associated with the AOPI should be discerned during a future investigation.
2. Surface water that is an expression of groundwater (i.e., seeps/springs that are discharge points for groundwater) are compared to the OSD risk screening levels. Otherwise, the surface water and stormwater samples were collected only to re-evaluate the CSMs and are not compared to the tap water OSD risk screening level and are not included in this table.
3. BGAD is underlain by karst geology with complex groundwater flow patterns. At some AOPIs, groundwater was not encountered in the overburden or within the first 20 feet of bedrock and a sample was not collected.

GW – groundwater
ND – not detected
NS – not sampled
SP – spring water (i.e., expressions of groundwater, therefore the data collected at springs are compared to the OSD risk screening levels for tap water)
SO – soil

Data collected during the PA (**Sections 3** through **5**) and SI (**Sections 6** through **8**) 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 BGAD are discussed below.

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

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

A comprehensive off-post 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 are limited to what were collected during this SI. Certain samples were unable to be collected due to the reasons described in **Section 6.3.3**. Available data, including PFOS, PFOA, and PFBS, are listed in **Appendix N**, which were analyzed per the selected analytical method.

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

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ACRONYMS

%	percent
AFFF	aqueous film-forming foam
AOPI	area of potential interest
Arcadis	Arcadis U.S., Inc.
Army	United States Army
BGAD	Blue Grass Army Depot (Richmond, Kentucky)
BGCAPP	Blue Grass Chemical Agent-Destruction Pilot Plant
bgs	below ground surface
CAPS	Consolidated Army Prepositioned Stock
CERCLA	Comprehensive Environmental Response, Compensation, and Liability Act of 1980
CSM	conceptual site model
DoD	Department of Defense
DQO	data quality objective
DUSR	Data Usability Summary Report
EB	equipment blank
EBS	Environmental Baseline Survey
EDR	Environmental Data Resources, Inc.
ELAP	Environmental Laboratory Accreditation Program
FCR	field change report
FEMA	Federal Emergency Management Agency
GIS	geographic information system
GW	groundwater
HDPE	high-density polyethylene
HQAES	Headquarters Army Environmental System
IDW	investigation-derived waste
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
ND	not detected
ng/L	nanograms per liter (parts per trillion)
NS	not sampled
OB/OD	open burn/open detonation
OSD	Office of the Secretary of Defense
PA	preliminary assessment
PEO-SOFSA	Program Executive Office-Special Operations Forces Support Activity
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
SB	source blank
SI	site inspection
SO	soil
SOP	standard operating procedure
SP	spring water
SSHP	Site Safety and Health Plan
SW	surface water or stormwater
SWMU	solid waste management unit
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
WWTP	wastewater treatment plant

TABLES

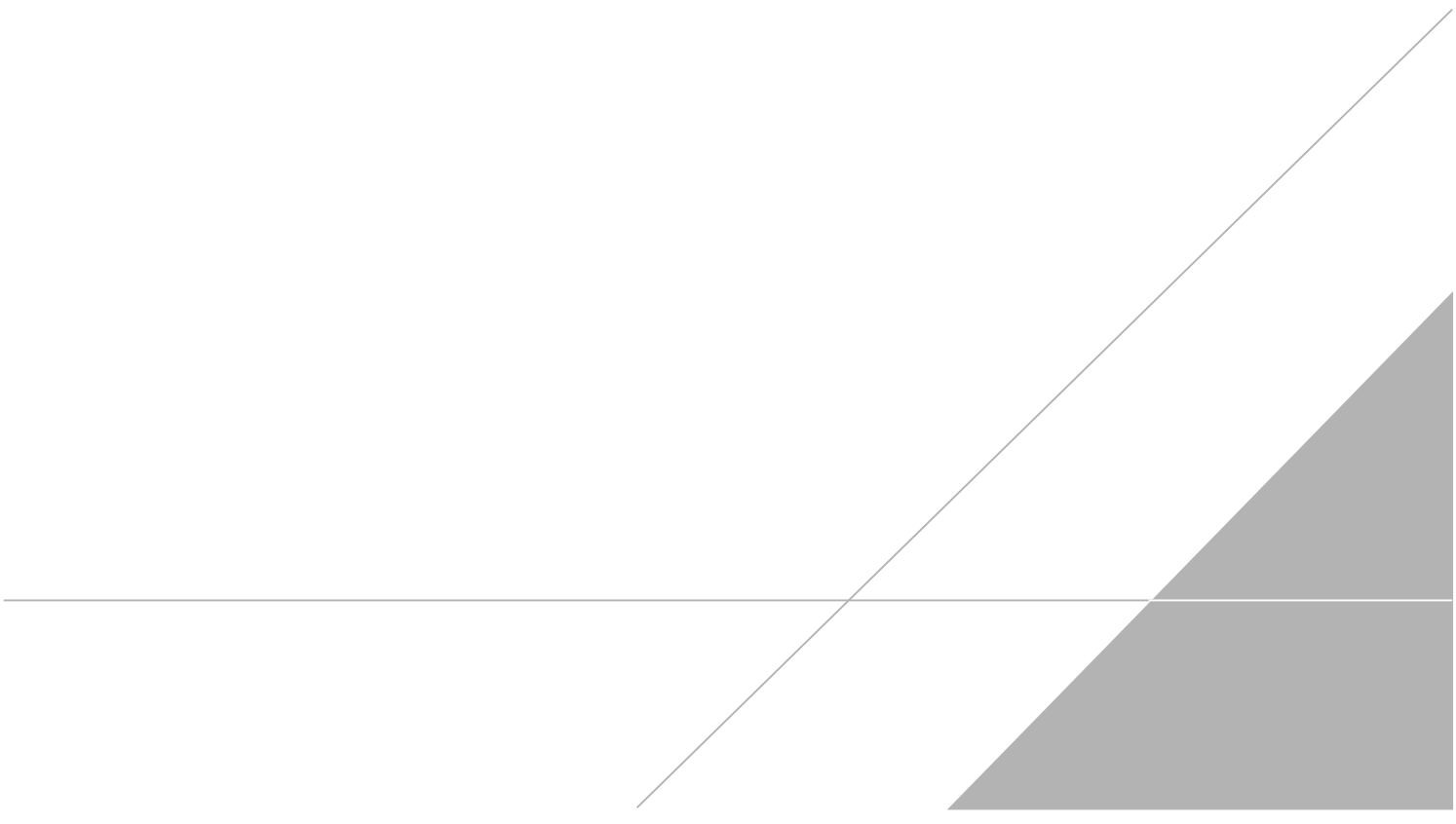

Table 2-1 - Historical PFOS, PFOA, and PFBS Analytical Data
USAEC PFAS Preliminary Assessment/Site Inspection
Blue Grass Army Depot, Kentucky

Well ID	Zip Code	Sample Date	PFOS	PFOA	PFBS	PFHpA	PFHxS	PFNA
			µg/L	µg/L	µg/L	µg/L	µg/L	µg/L
BGAD (pre-treatment) (KY0763637)	40475	November 2016	< 0.04	< 0.02	NS	NS	NS	NS
BGAD (post-treatment, Building 228) (KY0763637)	40475		< 0.04	< 0.02	NS	NS	NS	NS
Madison County Utilities District (KY0760224)	40475	January 2013	< 0.04	< 0.02	< 0.09	< 0.01	< 0.03	< 0.02
		April 2013	< 0.04	< 0.02	< 0.09	< 0.01	< 0.03	< 0.02
		September 2013	< 0.04	< 0.02	< 0.09	< 0.01	< 0.03	< 0.02
		October 2013	< 0.04	< 0.02	< 0.09	< 0.01	< 0.03	< 0.02
		November 2016	< 0.04	< 0.02	NS	NS	NS	NS

Acronyms:

< = Concentration not detected greater than the laboratory reporting limit. Non-detect concentrations are shown as less than (<) the reporting limit provided.
µg/L = micrograms per liter (parts per billion)
BGAD = Blue Grass Army Depot
NS = not sampled
PFAS = per- and polyfluoroalkyl substances
PFBS = perfluorobutanesulfonic acid
PFHpA = perfluoroheptanoic acid
PFHxS = perfluorohexanesulfonic acid
PFNA = perfluorononanoic acid
PFOA = perfluorooctanoic acid
PFOS = perfluorooctane sulfonate
USAEC = United States Army Environmental Command

Sources:

1. USEPA. 2017. Occurrence Data for the Unregulated Contaminant Monitoring Rule: UCMR3 (2013-2015) Occurrence Data. January. Available online at: https://www.epa.gov/dwucmr/occurrence-data-unregulated-contaminant-monitoring-rule, downloaded July 2019. While the zip code in which the utilities' water supply intake is indicated for the Madison County Utilities District, the exact location of the intake is not known and may be located greater than 5 miles from the installation boundary.

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Table 6-1 - Monitoring Well Construction Details
USAEC PFAS Preliminary Assessment/Site Inspection
Blue Grass Army Depot, Kentucky

Area of Potential Interest	Sampling Location ID	Total Well Depth (ft bgs)	Measuring Point	July 2020 Depth to Groundwater from MP (ft)	Screened Interval (ft bgs)	Casing Diameter (inches)	Dedicated Equipment (Y/N)
Bulldozer Fire Area*	MW4004C02	10	TOC	6.5	5.0 - 10.0	2	N
	MW4004C03	22	TOC	6.2	17.0 - 22.0	2	N
	MW4004C10	11.5	TOC	6.0	6.5 - 11.5	4	N

Acronyms/Abbreviations:
* Monitoring wells to be sampled as part of the inspection for the area of potential interest are associated with the monitoring network for the open burn/open detonation area.
bgs - below ground surface
ft - feet
ID - identification
MP - measuring point
PFAS - per- and polyfluoroalkyl substances
N - no
TOC - top of casing
USAEC - United States Army Environmental Command
Y - yes

Sources:
Approximate depths to water for the Former Fire Training Area wells are as provided by the installation from a March 2002 report (USACE. 2002. BGAD Phase III Sitewide Groundwater Monitoring Report.). Depths to water for the Bulldozer Fire Area wells (associated with the open burn/open detonation area) are as provided by the installation from a May 2019 sampling event (Jacobs Engineering Group, Inc. 2019. Groundwater and Seep Sampling Results and Data Validation Summary, Open Detonation Area, Blue Grass Army Depot, Richmond, Kentucky. July.). Lithologic and well construction data are as provided by the installation on boring logs and well construction logs.

Table 7-1 - Groundwater PFOS, PFOA, and PFBS Analytical Results
USAEC PFAS Preliminary Assessment/Site Inspection
Blue Grass Army Depot, Kentucky

ARCADIS

AOPI	Sample/Parent ID	Sample Date	Analyte	PFOS (ng/L)		PFOA (ng/L)		PFBS (ng/L)	
			OSD Tapwater Risk Screening Level	40		40		600	
			Sample Type	Result	Qual	Result	Qual	Result	Qual
Bulldozer Fire Area	BGAD-MW4004C02-070620	07/06/2020	N	4.1	U	4.1	U	4.1	U
	BGAD-MW4004C03-070620	07/06/2020	N	4.0	U	4.0	U	4.0	U
	BGAD-MW4004C10-070620	07/06/2020	N	3.9	U	3.9	U	3.9	U
	BGAD-FD-1-GW-070620 / BGAD-MW4004C10-070620	07/06/2020	FD	3.9	U	3.9	U	3.9	U
PEO-SOFSA Hangar 1 (Building 232)	BGAD-PEO1-3-GW-041421	04/14/2021	N	**150**	J	**130**	J	**94**	J
	BGAD-FD-1-GW-041421 / BGAD-PEO1-3-GW-041421	04/14/2021	FD	**300**	J+	**150**		**95**	
PEO-SOFSA Hangar 2 (Building 229)	BGAD-PEO2-2-GW-041421	04/14/2021	N	**13**		**120**		**8.7**	
Former Fire Station	BGAD-FFS-1-GW-041521	04/15/2021	N	**2,600**	J	**1,300**	J	**410**	J
Former Fire Training Area	BGAD-FFTA-1-GW-041621	04/16/2021	N	**45**		**15**		**7.5**	
Old Furnace Training Area	BGAD-OFTA-1-GW-041521	04/15/2021	N	4.3	U	**7.1**		4.3	U
Wastewater Treatment Plant and Sludge Drying Beds	BGAD-SDB-1-GW-041621	04/16/2021	N	**47**		**51**		**26**	

Notes:
1. **Bolded** values indicate the result was detected greater than the limit of detection.
2. Gray shaded value indicates the detected concentration is greater than or equal to the Office of the Secretary of Defense (OSD) risk screening level for the residential tapwater exposure scenario (OSD. 2021. Memorandum: Investigating Per- and Polyfluoroalkyl Substances within the Department of Defense Cleanup Program. September 15.).

Acronyms/Abbreviations:
AOPI = area of potential interest
BGAD = Blue Grass Army Depot, Kentucky
FD = field duplicate sample
FFS = Former Fire Station
FFTA = Former Fire Training Area
GW = groundwater
ID = identification
N = primary sample
ng/L = nanograms per liter (parts per trillion)
OFTA = Old Furnace Fire Training Area
OSD = Office of the Secretary of Defense
PEO-SOFSA = Program Executive Office - Special Operations Support Activity
PFAS = per- and polyfluoroalkyl substances
PFBS = perfluorobutane sulfonic acid
PFOA = perfluorooctanoic acid
PFOS = perfluorooctane sulfonic acid
Qual = qualifier
SDB = Sludge Drying Beds
USAEC = United States Army Environmental Command

Qualifier Description:
J+ = The result is an estimated quantity; the result may be biased high.
U = The analyte was analyzed for but the result was not detected above the limit of quantitation.

Table 7-2 - Surface Water and Stormwater PFOS, PFOA, and PFBS Analytical Results
USAEC PFAS Preliminary Assessment/Site Inspection
Blue Grass Army Depot, Kentucky

AOPI	Sample/ Parent ID	Sample Date	Analyte	PFOS (ng/L)		PFOA (ng/L)		PFBS (ng/L)	
			OSD Tapwater Risk Screening Level*	40		40		600	
			Sample Type	Result	Qual	Result	Qual	Result	Qual
Old Furnace Training Area	BGAD-OFTA-1-SW-070720	7/7/2020	N	**130**		**15**		**6.4**	
	BGAD-FD-1-SW-070720	7/7/2020	FD	**130**		**14**		**6.0**	
Temporary Fire Station (Building S11)	BGAD-TFS-1-SW-070820	7/8/2020	N	**3.7**	J	3.8	U	3.8	U
Wastewater Treatment Plant (Building 230) / Sludge Drying Beds	BGAD-WWTP-1-SW-070820	7/8/2020	N	**33**		**5.3**		**3.6**	
	BGAD-WWTP-IN-1-(SW)-070820	7/8/2020	N	**8.4**		3.7	U	3.7	U
North Cantonment Area AOPIs	BGAD-SP-10-SW-041221*	04/12/2021	N	3.6	U	3.6	U	3.6	U
	BGAD-SP-11-SW-041221*	04/12/2021	N	3.5	U	**10**		3.5	U
	BGAD-SP-62-SW-041221*	04/12/2021	N	**280**		**15**		**8.1**	
Former Fire Station	BGAD-FFS-1-SW-041521	04/15/2021	N	**170**	J+	**36**		**23**	
PEO-SOFSA Hangar 1 (Building 232)	BGAD-PEO1-1-(GW)-070720	07/07/2020	N	**1,600**	J	**82**		**93**	
	BGAD-PEO1-2-(GW)-070720	07/07/2020	N	**5,800**	J	**1,200**	J	**39**	
PEO-SOFSA Hangar 2 (Building 229)	BGAD-PEO2-1-(GW)-070720	07/07/2020	N	**23**		**240**		3.6	U
	BGAD-FD-1-SW-041221	04/12/2021	FD	**460**		**31**		**32**	
	BGAD-PEO2-1-SW-041221	04/12/2021	N	**420**		**29**		**30**	

Notes:
1. **Bolded** values indicate the result was detected greater than the limit of detection.
2. *Only results from select surface water sampling locations (marked with an asterisk) were compared to the Office of the Secretary of Defense (OSD) risk screening levels for tap water (OSD. 2021. Memorandum: Investigating Per- and Polyfluoroalkyl Substances within the Department of Defense Cleanup Program. September 15.) as appropriate, i.e., for surface water which is an expression of groundwater at springs. Samples which are not denoted by an asterisk are not compared to the OSD risk screening levels.
3. Gray shaded values indicate the result was detected greater than the OSD risk screening levels.

Acronyms/Abbreviations:
AOPI = area of potential interest
BGAD = Blue Grass Army Depot, Kentucky
FD = field duplicate sample
(GW) = Sample collected from underground vault. Based on observations made during the April 2021 remobilization this should not be considered a true groundwater sample, but instead may be classified as stormwater
ID = identification
IN = influent
N = primary sample
ng/L = nanograms per liter (parts per trillion)
OFTA = Old Furnace Fire Training Area
OSD = Office of the Secretary of Defense
PEO SOFSA = Program Executive Office-Special Operations Forces Support Activity
PFAS = per- and polyfluoroalkyl substances
PFBS = perfluorobutane sulfonic acid
PFOA = perfluorooctanoic acid
PFOS = perfluorooctane sulfonic acid
Qual = qualifier
SP = spring
SW = Surface Water
TFS = Temporary Fire Station (Building S11)
USAEC = United States Army Environmental Command
WWTP = wastewater treatment plan

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

Table 7-3 - Soil PFOS, PFOA, and PFBS Analytical Results
USAEC PFAS Preliminary Assessment/Site Inspection
Blue Grass Army Depot, Kentucky

AOPI	Sample/Parent ID	Sample Date	Analyte	PFOS (mg/kg)		PFOA (mg/kg)		PFBS (mg/kg)	
			OSD Risk Screening Levels	0.13 (R) 1.6 (I/C)		0.13 (R) 1.6 (I/C)		1.9 (R) 25 (I/C)	
			Sample Type	Result	Qual	Result	Qual	Result	Qual
FEMA Trailer Fire Training Area	BGAD-FEMA-1-SO-070620	07/06/2020	N	**0.0016**		**0.0012**		0.0011	U
	BGAD-FEMA-2-SO-070720	07/07/2020	N	0.00099	U	0.00099	U	0.00099	U
	BGAD-FEMA-3-SO-070620	07/06/2020	N	0.0012	U	0.0012	U	0.0012	U
	BGAD-FEMA-4-SO-070620	07/06/2020	N	**0.00075**	J	0.0012	U	0.0012	U
	BGAD-FEMA-5-SO-070720	07/07/2020	N	0.0011	U	0.0011	U	0.0011	U
	BGAD-FEMA-6-SO-070620	07/06/2020	N	**0.0010**	J	**0.00055**	J	0.0011	U
Former Fire Station (Building 58370)	BGAD-FFS-1-SO-070620	07/06/2020	N	**0.072**		**0.0058**		0.0012	U
	BGAD-FFS-2-SO-070620	07/06/2020	N	**0.019**		0.0013	U	0.0013	U
Former Fire Training Area (SWMU-17)	BGAD-FFTA-1-SO-070820	07/08/2020	N	0.0012	U	0.0012	U	0.0012	U
	BGAD-FFTA-2-SO-070820	07/08/2020	N	**0.0045**		0.0015	U	0.0015	U
	BGAD-FFTA-3-SO-070820	07/08/2020	N	**0.0067**		**0.00068**	J	0.0010	U
	BGAD-FFTA-4-SO-070820	07/08/2020	N	**0.0022**		0.0012	U	0.0012	U
	BGAD-FFTA-5-SO-070820	07/08/2020	N	**0.0017**		**0.00092**	J	0.0015	U
	BGAD-FFTA-6-SO-070820	07/08/2020	N	0.0026	U	0.0026	U	0.0026	U
Old Furnace Training Area	BGAD-OFTA-1-SO-070720	07/07/2020	N	0.0011	U	**0.00071**	J	0.0011	U
	BGAD-OFTA-2-SO-070720	07/07/2020	N	0.0010	U	0.0010	U	0.0010	U
	BGAD-OFTA-3-SO-070720	07/07/2020	N	0.0012	U	**0.0016**		0.0012	U
PEO-SOFSA Hangar 1 (Building 232)	BGAD-PEO1-1-SO-070720	07/07/2020	N	**0.0017**		0.0011	U	0.0011	U
	BGAD-FD-1-SO-070720 / BGAD-PEO1-1-SO-070720	07/07/2020	FD	**0.0012**		0.00099	U	0.00099	U
Sludge Drying Beds	BGAD-SDB-1-SO-070820	07/08/2020	N	**0.024**		**0.0052**		**0.0029**	
Temporary Fire Station (Building S11)	BGAD-TFS-1-SO-070720	07/07/2020	N	**0.0024**	J-	**0.00086**	J-	0.0011	U
	BGAD-TFS-2-SO-070720	07/07/2020	N	**0.0028**		**0.0011**	J	0.0012	U

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

2. Data are compared to the Office of the Secretary of Defense (OSD) risk screening levels for both the residential as well as the industrial/commercial scenarios (OSD. 2021. Memorandum: Investigating Per- and Polyfluoroalkyl Substances within the Department of Defense Cleanup Program. September 15.). No exceedances were obsereved for the residential or industrial/commercial receptor scenarios.

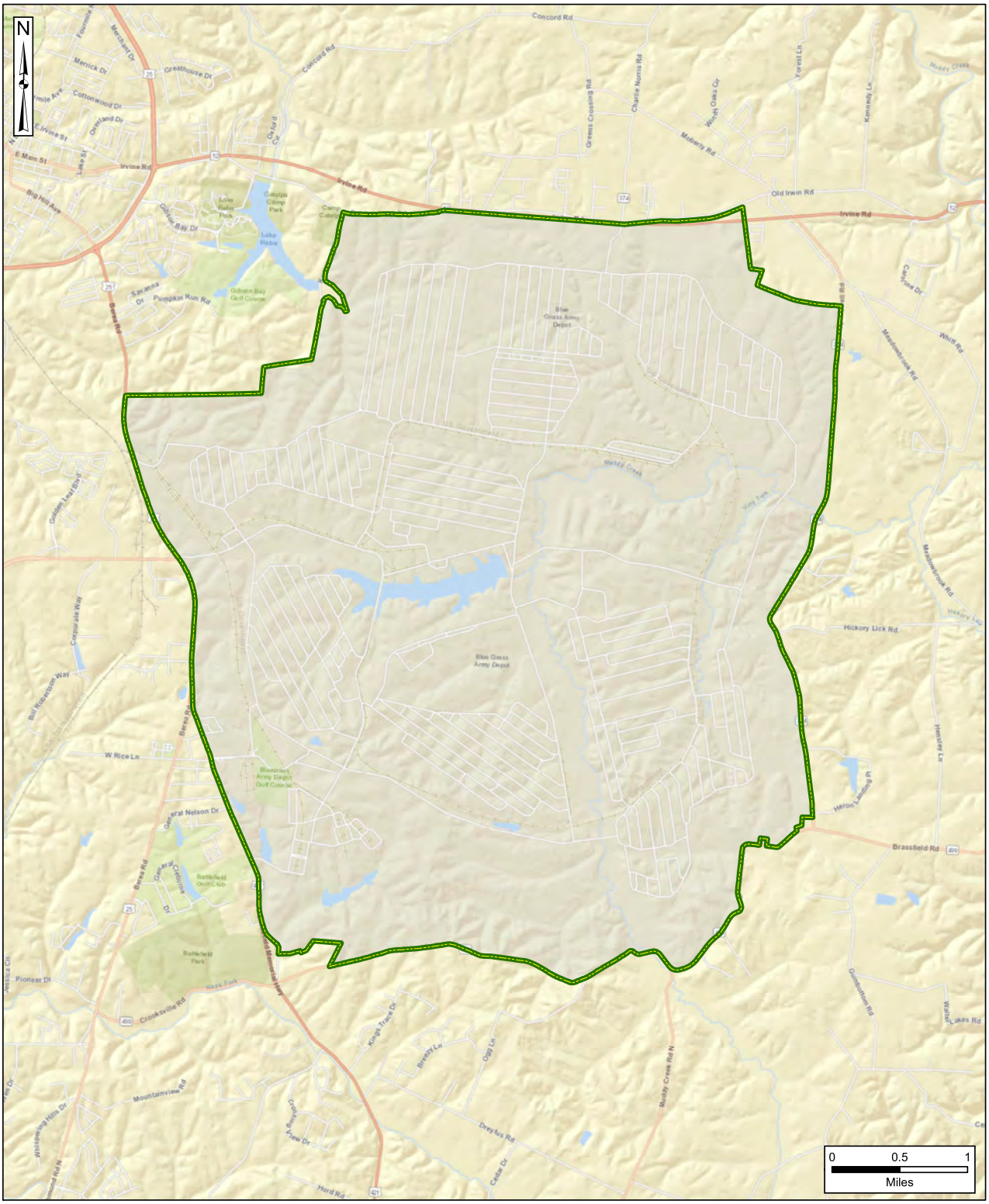
Acronyms/Abbreviations:
(R) = residential receptor scenario
(IC) = industrial/commercial receptor scenario
AOPI = area of potential interest
BGAD = Blue Grass Army Depot, Kentucky
FEMA = Federal Emergency Management Agency
FD = field duplicate sample
ID = identification
mg/kg = milligrams per kilogram (parts per million)
N = primary sample
OFTA = Old Furnace Fire Training Area
PEO-SOFSA = Program Executive Office-Special Operations Forces Support Activity
PFAS = per- and polyfluoroalkyl substances
PFBS = perfluorobutane sulfonic acid
PFOA = perfluorooctanoic acid
PFOS = perfluorooctane sulfonic acid
Qual = qualifier
SDB = Sludge Drying Beds
SWMU = solid waste management unit
TFS = Temporary Fire Station (Building S11)
USAEC = United States Army Environmental Command

Qualifier Desccription:
J- = The analyte was positively identified; however the associated numerical value is an estimated concentration only and may be biased low.
J = The analyte was positively identified; however the associated numerical value is an estimated concentration only.
U = The analyte was analyzed for but the result was not detected above the limit of quantitation.

FIGURES

USAEC PFAS Preliminary Assessment/Site Inspection
Blue Grass Army Depot, Kentucky

Figure 2-1
Site Location



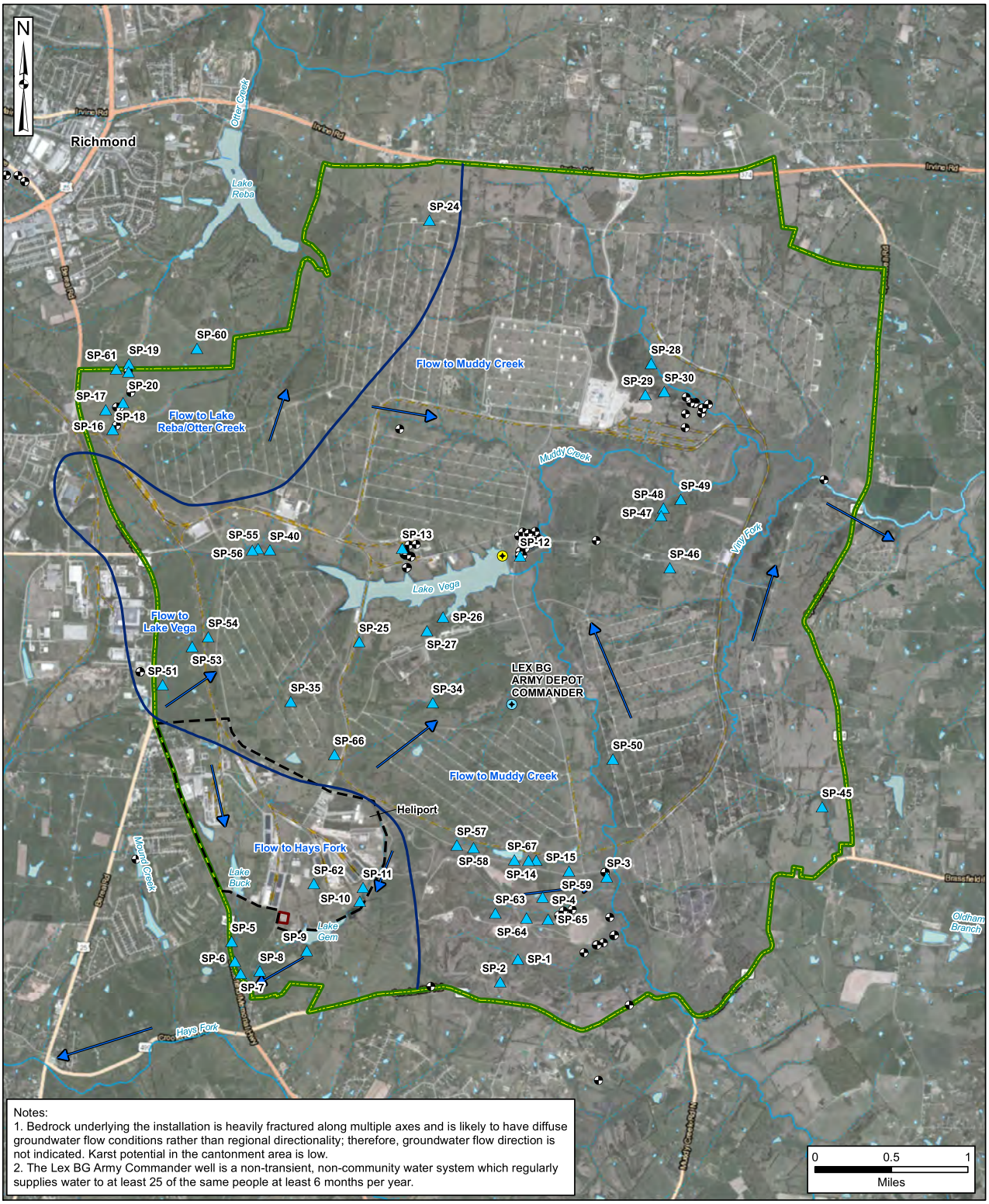
Installation Boundary

Data Sources:
BGAD, GIS Data, 2018
ESRI ArcGIS Online, StreetMap Data

Coordinate System:
WGS 1984, UTM Zone 17 North

USAEC PFAS Preliminary Assessment/Site Inspection
Blue Grass Army Depot, Kentucky

Figure 2-2
Site Layout



Notes:
1. Bedrock underlying the installation is heavily fractured along multiple axes and is likely to have diffuse groundwater flow conditions rather than regional directionality; therefore, groundwater flow direction is not indicated. Karst potential in the cantonment area is low.
2. The Lex BG Army Commander well is a non-transient, non-community water system which regularly supplies water to at least 25 of the same people at least 6 months per year.

- Installation Boundary
- Water Body
- River/Stream (Perennial)
- Stream (Intermittent)
- Approximate Surface Water Divide
- Surface Water Flow Direction
- Spring
- Potable Water Supply Intake
- Water Supply Well
- Monitoring Well
- Railroad
- IRP Site Boundary
- Cantonment Area

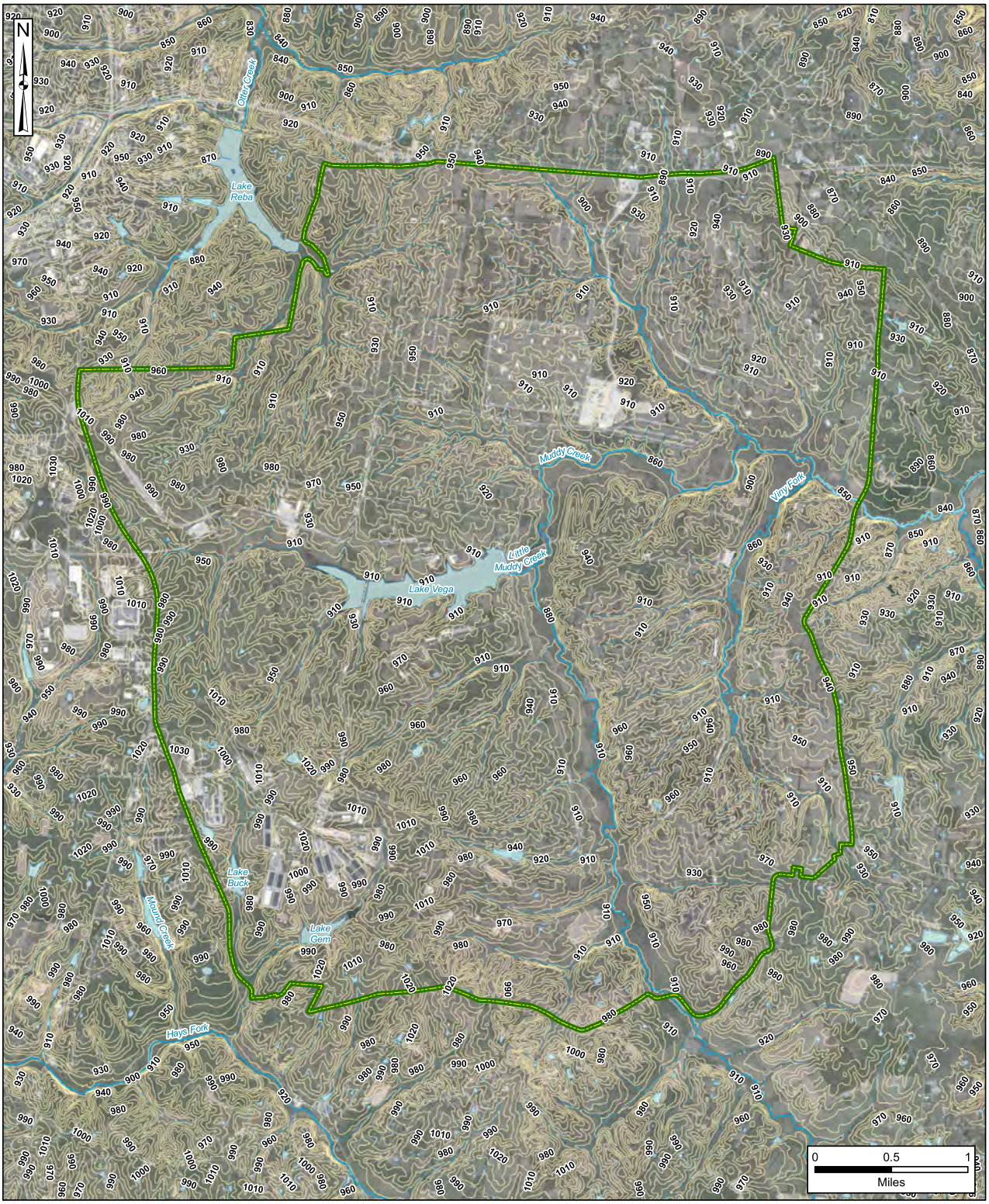
IRP = Installation Restoration Program

Data Sources:
BGAD, GIS Data, 2018
URS / Dames & Moore, Springs
ESRI ArcGIS Online, Aerial Imagery

Coordinate System:
WGS 1984, UTM Zone 17 North

USAEC PFAS Preliminary Assessment/Site Inspection
Blue Grass Army Depot, Kentucky

Figure 2-3
Topographic Map



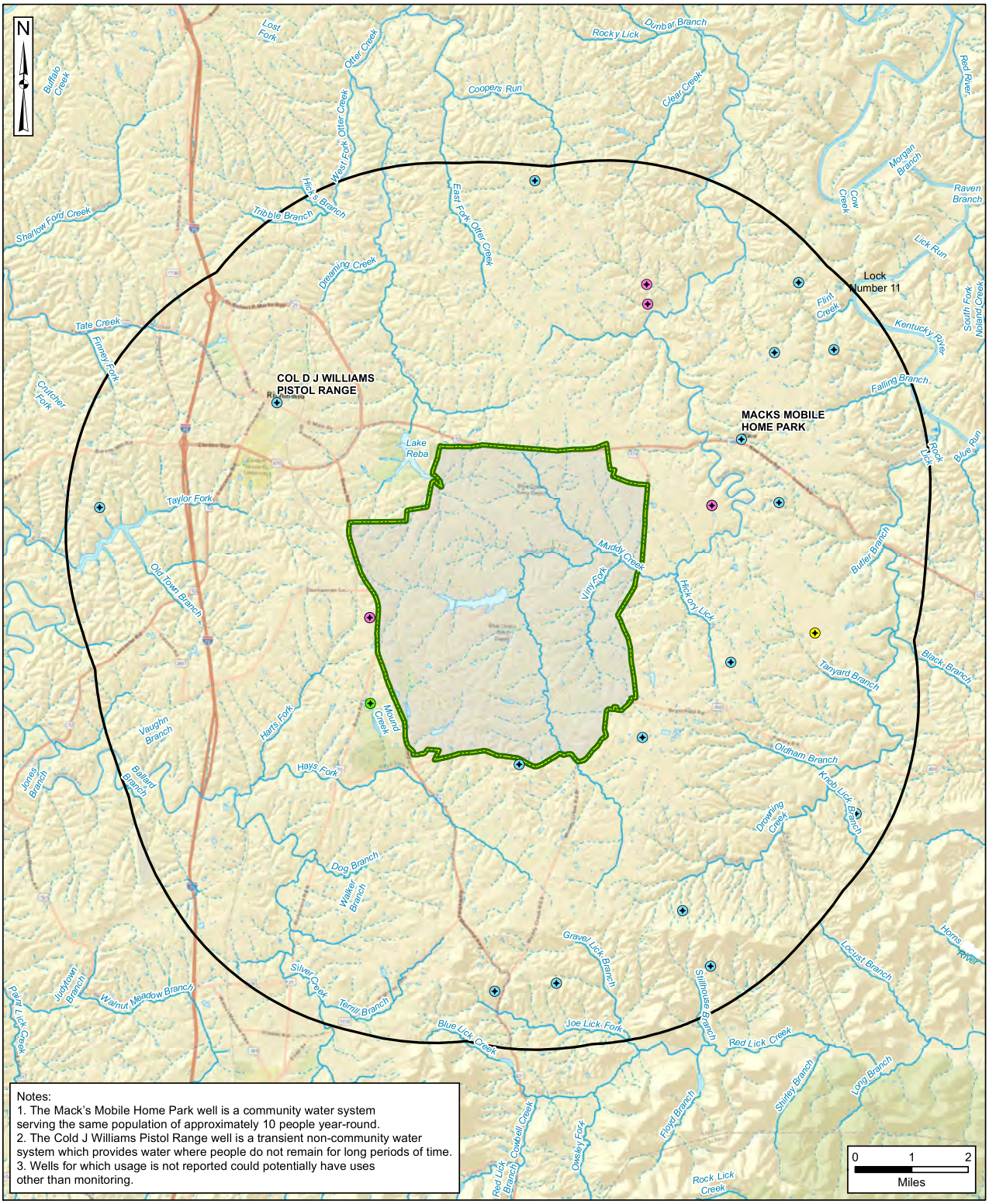
Installation Boundary
Water Body
River/Stream (Perennial)
Stream (Intermittent)
Elevation Contour (10 feet)

Data Sources:
ESRI ArcGIS Online, Aerial Imagery

Coordinate System:
WGS 1984, UTM Zone 17 North

USAEC PFAS Preliminary Assessment/Site Inspection
Blue Grass Army Depot, Kentucky

Figure 2-4
Off-Post Potable Wells



Notes:
1. The Mack's Mobile Home Park well is a community water system serving the same population of approximately 10 people year-round.
2. The Cold J Williams Pistol Range well is a transient non-community water system which provides water where people do not remain for long periods of time.
3. Wells for which usage is not reported could potentially have uses other than monitoring.

Installation Boundary
5-Mile Radius
Water Body
River/Stream (Perennial)
Stream (Intermittent)

Water Supply Wells (EDR Well Search)
- Agricultural - Irrigation
- Agricultural - Livestock Watering
- Domestic Single Household Use
- Usage Not Reported

EDR = Environmental Data Resources, Inc. Survey Report

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

Coordinate System:
WGS 1984, UTM Zone 17 North

USAEC PFAS Preliminary Assessment/Site Inspection
Blue Grass Army Depot, Kentucky

Figure 5-2
AOPI Locations

Notes:
1. Bedrock underlying the installation is heavily fractured along multiple axes and is likely to have diffuse groundwater flow conditions rather than regional directionality; therefore, groundwater flow direction is not indicated. Karst potential in the cantonment area is low.
2. The Lex BG Army Commander well is a non-transient, non-community water system which regularly supplies water to at least 25 of the same people at least 6 months per year.

- Installation Boundary
- Water Body
- River/Stream (Perennial)
- Stream (Intermittent)
- Approximate Surface Water Divide
- Surface Water Flow Direction
- Potable Water Supply Intake
- Water Supply Well
- Monitoring Well
- IRP Site Boundary
- AOPI

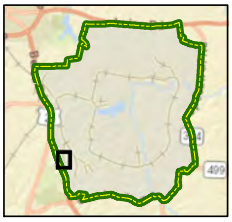
AOPI = area of potential interest
FEMA = Federal Emergency Management Agency
IRP = Installation Restoration Program
PEO-SOFSA = Program Executive Office-Special Operations Forces Support Activity
SWMU = Solid Waste Management Unit

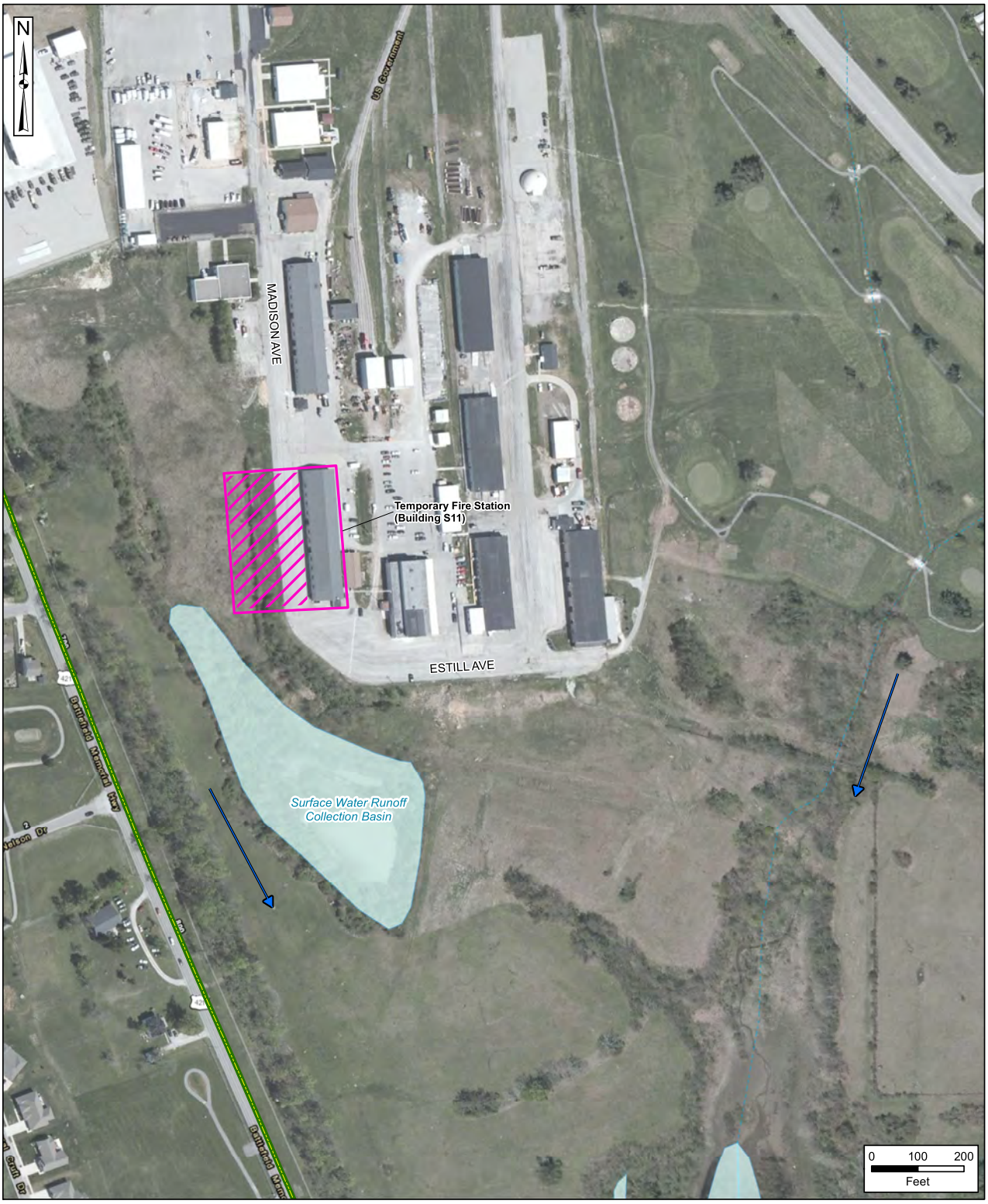
Data Sources:
BGAD, GIS Data, 2018
ESRI ArcGIS Online, Aerial Imagery

Coordinate System:
WGS 1984, UTM Zone 17 North

USAEC PFAS Preliminary Assessment/Site Inspection
Blue Grass Army Depot, Kentucky

Figure 5-3
Temporary Fire Station (Building S11) AOPI and AFFF Use Area





Installation Boundary
Water Body
River/Stream (Perennial)
Stream (Intermittent)
Surface Water Flow Direction
AOPI
Suspected AFFF Use Area

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

Data Sources:
BGAD, GIS Data, 2018
ESRI ArcGIS Online, Aerial Imagery

Coordinate System:
WGS 1984, UTM Zone 17 North

USAEC PFAS Preliminary Assessment/Site Inspection
Blue Grass Army Depot, Kentucky

Figure 5-4
North Cantonment AOPIs and AFFF Use Area

Notes:
1. The AFFF fire suppression systems in the PEO-SOFSA hangars have reportedly not been activated; however, staining/crusting has been observed on the hangar floors beneath the AFFF tanks and piping systems.
2. AFFF use area for the FEMA Trailer Fire Training Area is unknown.

- Installation Boundary
- Water Body
- River/Stream (Perennial)
- Stream (Intermittent)
- Surface Water Flow Direction
- AOPI
- Suspected AFFF Use Area
- 700-Gallon AFFF Tank
- Underground Wastewater and Surface Water Runoff Storage Vault

AFFF = aqueous film-forming Foam
AOPI = area of potential interest
FEMA = Federal Emergency Management Agency
PEO-SOFSA = Program Executive Office-Special Operations Forces Support Activity

Data Sources:
BGAD, GIS Data, 2018
ESRI ArcGIS Online, Aerial Imagery

Coordinate System:
WGS 1984, UTM Zone 17 North

USAEC PFAS Preliminary Assessment/Site Inspection
Blue Grass Army Depot, Kentucky

Figure 5-5
South Cantonment AOPIs and AFFF Use Area

Installation Boundary
Water Body
River/Stream (Perennial)
Stream (Intermittent)
IRP Site Boundary
Surface Water Flow Direction
AOPI
Suspected AFFF Use Area

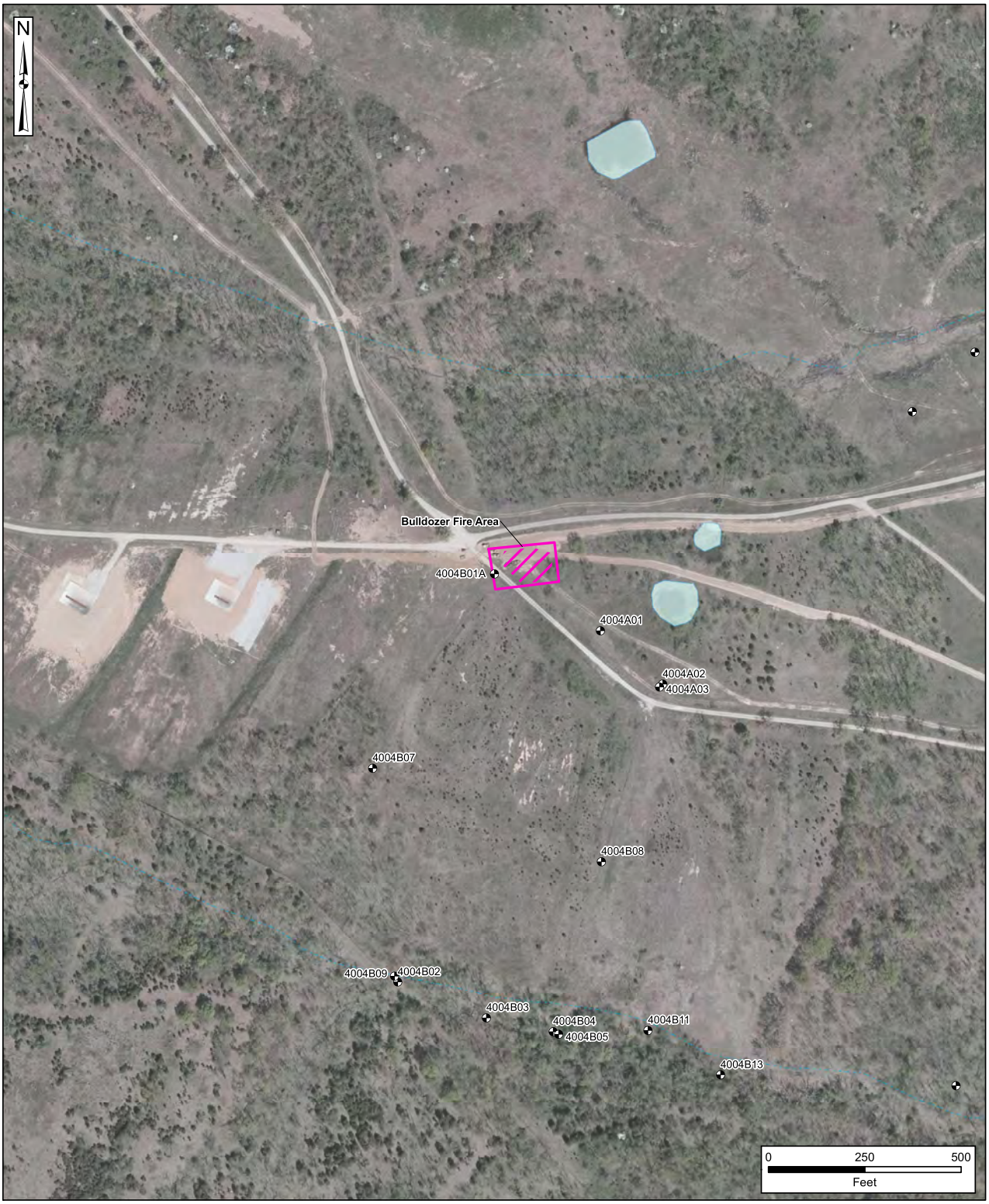
AFFF = aqueous film-forming foam
AOPI = area of potential interest
IRP = Installation Restoration Program
SWMU = Solid Waste Management Unit

Data Sources:
BGAD, GIS Data, 2018
ESRI ArcGIS Online, Aerial Imagery

Coordinate System:
WGS 1984, UTM Zone 17 North

USAEC PFAS Preliminary Assessment/Site Inspection
Blue Grass Army Depot, Kentucky

Figure 5-6
Bulldozer Fire Area AOPI and
AFFF Use Area



Installation Boundary
Water Body
River/Stream (Perennial)
Stream (Intermittent)
Monitoring Well
AOPI
Suspected AFFF Use Area

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

Data Sources:
BGAD, GIS Data, 2018
ESRI ArcGIS Online, Aerial Imagery

Coordinate System:
WGS 1984, UTM Zone 17 North

USAEC PFAS Preliminary Assessment/Site Inspection
Blue Grass Army Depot, Kentucky

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

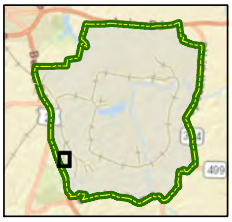
AOPI = area of potential interest
FEMA = Federal Emergency Management Agency
IRP = Installation Restoration Program
OSD = Office of the Secretary of Defense
PEO-SOFSA = Program Executive Office-Special Operations Forces Support Activity
SWMU = solid waste management unit

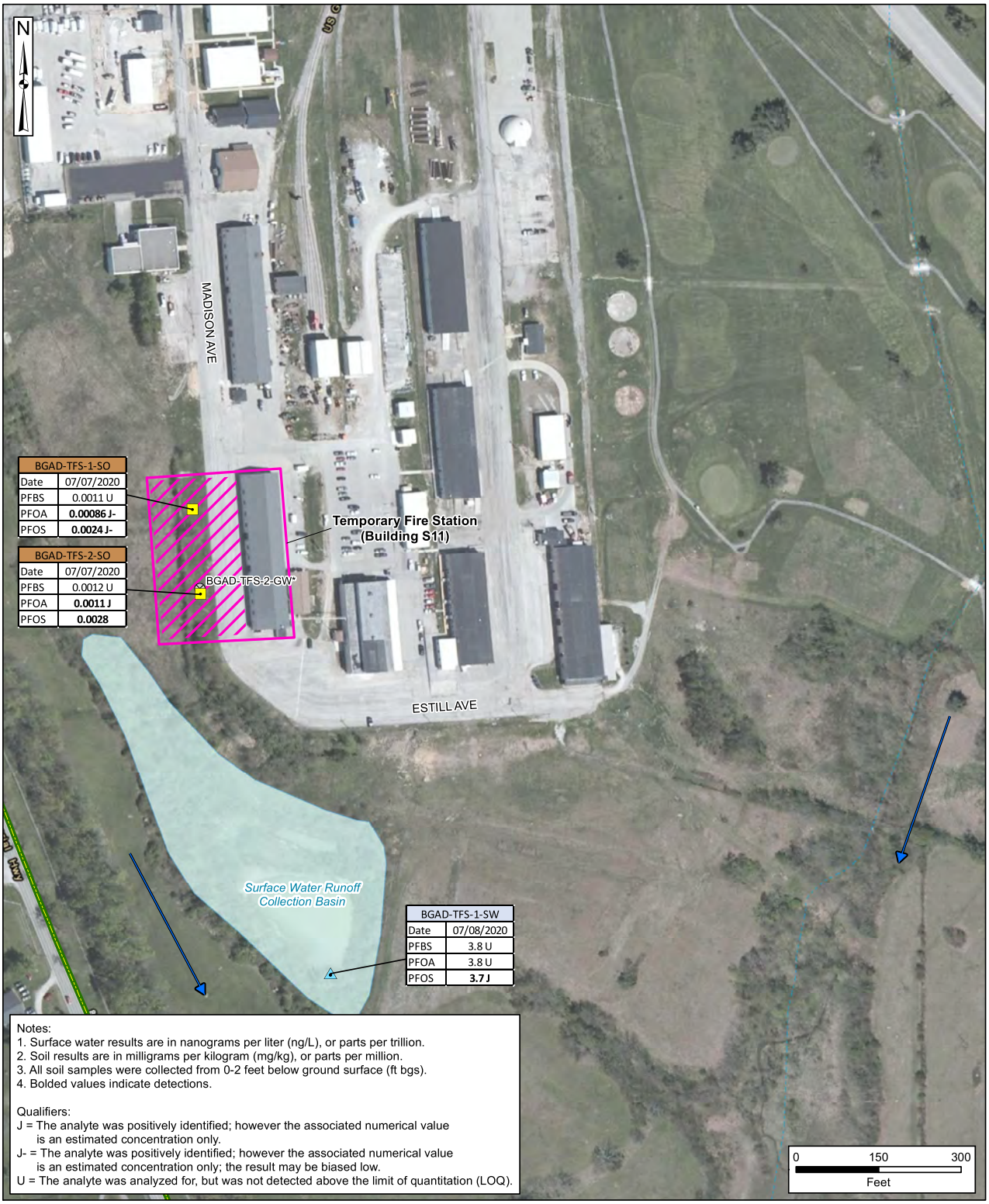
Data Sources:
BGAD, GIS Data, 2018
ESRI ArcGIS Online, Aerial Imagery

Coordinate System:
WGS 1984, UTM Zone 17 North

USAEC PFAS Preliminary Assessment/Site Inspection
Blue Grass Army Depot, Kentucky

Figure 7-2
Temporary Fire Station (Building S11) AOPI
PFOS, PFOA, and PFBS Analytical Results





BGAD-TFS-1-SO	
Date	07/07/2020
PFBS	0.0011 U
PFOA	**0.00086 J-**
PFOS	**0.0024 J-**

BGAD-TFS-2-SO	
Date	07/07/2020
PFBS	0.0012 U
PFOA	**0.0011 J**
PFOS	**0.0028**

BGAD-TFS-1-SW	
Date	07/08/2020
PFBS	3.8 U
PFOA	3.8 U
PFOS	**3.7 J**

Notes:
1. Surface water results are in nanograms per liter (ng/L), or parts per trillion.
2. Soil results are in milligrams per kilogram (mg/kg), or parts per million.
3. All soil samples were collected from 0-2 feet below ground surface (ft bgs).
4. Bolded values indicate detections.

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

- Installation Boundary
- AOPI
- Suspected AFFF Use Area
- Water Body
- Stream (Intermittent)
- Surface Water Flow Direction
- Soil Sampling Location (Hand Auger)
- Surface Water Sampling Location
- Groundwater Sampling Location (Sonic Drilling)*

*Groundwater sample could not be collected at temporary borehole (groundwater was not encountered in overburden or 20 feet into bedrock).

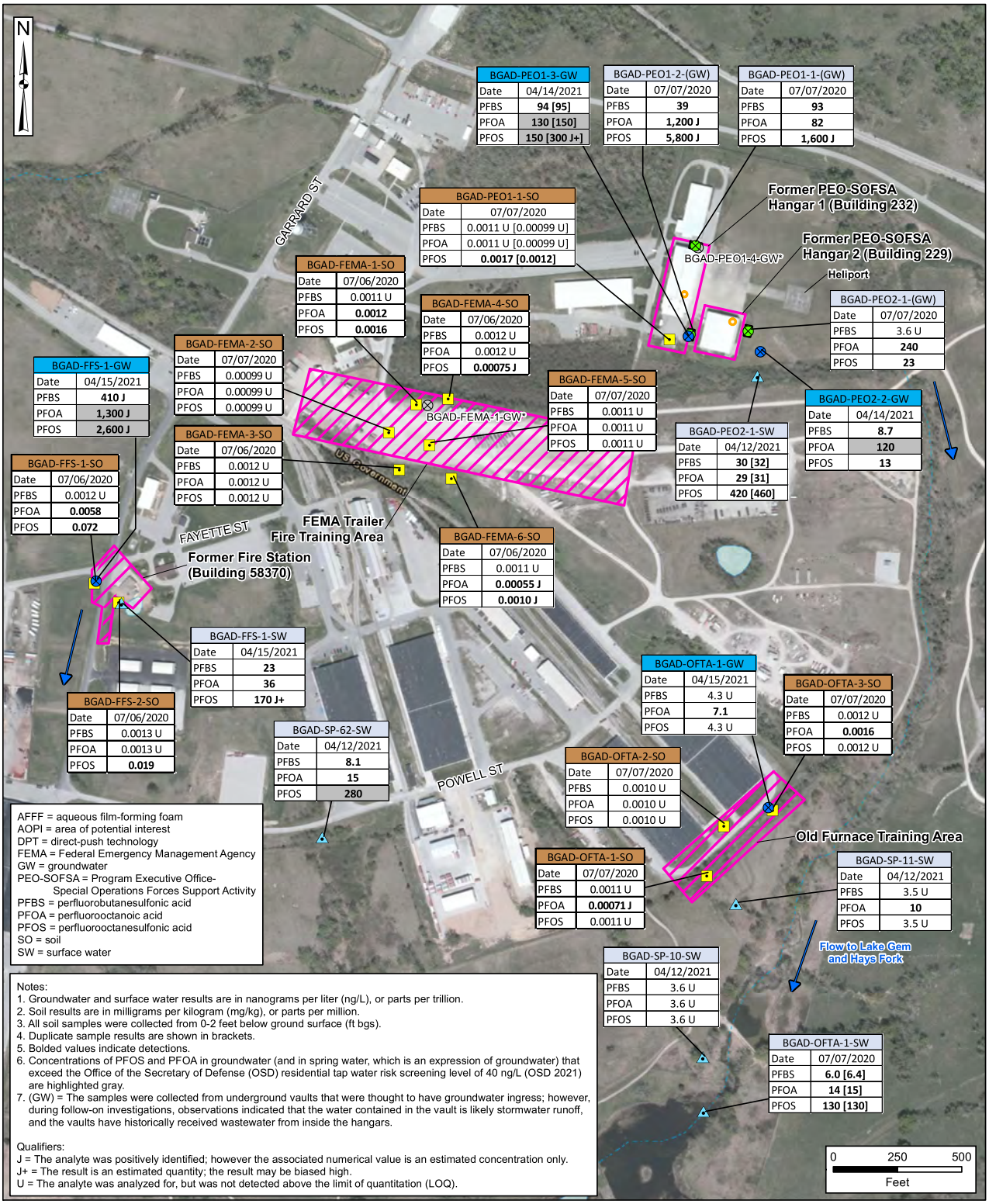
AFFF = aqueous film-forming foam
AOPI = area of potential interest
PFBS = perfluorobutanesulfonic acid
PFOA = perfluorooctanoic acid
PFOS = perfluorooctanesulfonic acid
SO = soil
SW = surface water

Data Sources:
BGAD, GIS Data, 2018
ESRI ArcGIS Online, Aerial Imagery

Coordinate System:
WGS 1984, UTM Zone 17 North

USAEC PFAS Preliminary Assessment/Site Inspection
Blue Grass Army Depot, Kentucky

Figure 7-3
North Cantonment AOPIs
PFOS, PFOA, and PFBS Analytical Results



AFFF = aqueous film-forming foam
AOPI = area of potential interest
DPT = direct-push technology
FEMA = Federal Emergency Management Agency
GW = groundwater
PEO-SOFSA = Program Executive Office-Special Operations Forces Support Activity
PFBS = perfluorobutanesulfonic acid
PFOA = perfluorooctanoic acid
PFOS = perfluorooctanesulfonic acid
SO = soil
SW = surface water

Notes:
1. Groundwater and surface water results are in nanograms per liter (ng/L), or parts per trillion.
2. Soil results are in milligrams per kilogram (mg/kg), or parts per million.
3. All soil samples were collected from 0-2 feet below ground surface (ft bgs).
4. Duplicate sample results are shown in brackets.
5. Bolded values indicate detections.
6. Concentrations of PFOS and PFOA in groundwater (and in spring water, which is an expression of groundwater) that exceed the Office of the Secretary of Defense (OSD) residential tap water risk screening level of 40 ng/L (OSD 2021) are highlighted gray.
7. (GW) = The samples were collected from underground vaults that were thought to have groundwater ingress; however, during follow-on investigations, observations indicated that the water contained in the vault is likely stormwater runoff, and the vaults have historically received wastewater from inside the hangars.

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

Installation Boundary
AOPI
Suspected AFFF Use Area
700-Gallon AFFF Tank
Underground Storage Vault
Stream (Intermittent)
Water Body
Surface Water Flow Direction
Wastewater and Surface Water Runoff Sampling Location (Underground Vault)
Groundwater Sampling Location (Sonic Drilling)
Soil Sampling Location (Hand Auger)
Surface Water/Stormwater Sampling Location
Groundwater Sampling Location (Sonic Drilling)*

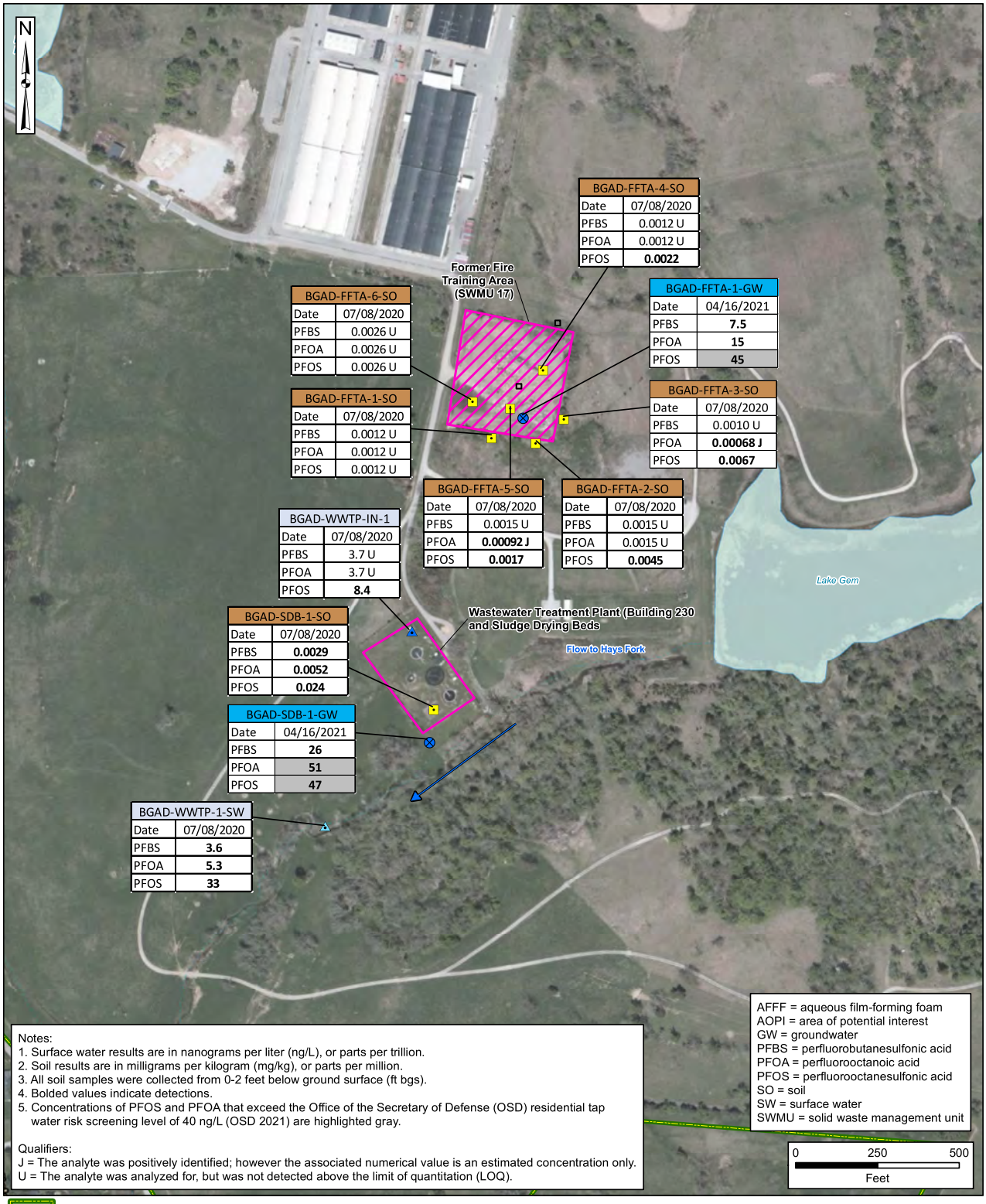
*Groundwater sample could not be collected at temporary borehole (groundwater was not encountered in overburden or 20 feet into bedrock).

Data Sources:
BGAD, GIS Data, 2018
ESRI ArcGIS Online, Aerial Imagery

Coordinate System:
WGS 1984, UTM Zone 17 North

USAEC PFAS Preliminary Assessment/Site Inspection
Blue Grass Army Depot, Kentucky

Figure 7-4
South Cantonment AOPIs
PFOS, PFOA, and PFBS Analytical Results



Notes:
1. Surface water results are in nanograms per liter (ng/L), or parts per trillion.
2. Soil results are in milligrams per kilogram (mg/kg), or parts per million.
3. All soil samples were collected from 0-2 feet below ground surface (ft bgs).
4. Bolded values indicate detections.
5. Concentrations of PFOS and PFOA that exceed the Office of the Secretary of Defense (OSD) residential tap water risk screening level of 40 ng/L (OSD 2021) are highlighted gray.

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

AFFF = aqueous film-forming foam
AOPI = area of potential interest
GW = groundwater
PFBS = perfluorobutanesulfonic acid
PFOA = perfluorooctanoic acid
PFOS = perfluorooctanesulfonic acid
SO = soil
SW = surface water
SWMU = solid waste management unit

0 250 500
Feet

Installation Boundary
AOPI
Suspected AFFF Use Area*
Approximate 2003 Excavation Area (15x15x2 feet)
Water Body
Stream (Intermittent)
Surface Water Flow Direction
Groundwater Sampling Location (Sonic Drilling)
Soil Sampling Location (Hand Auger)
Surface Water Sampling Location
Water Sample at Treatment Plant Influent

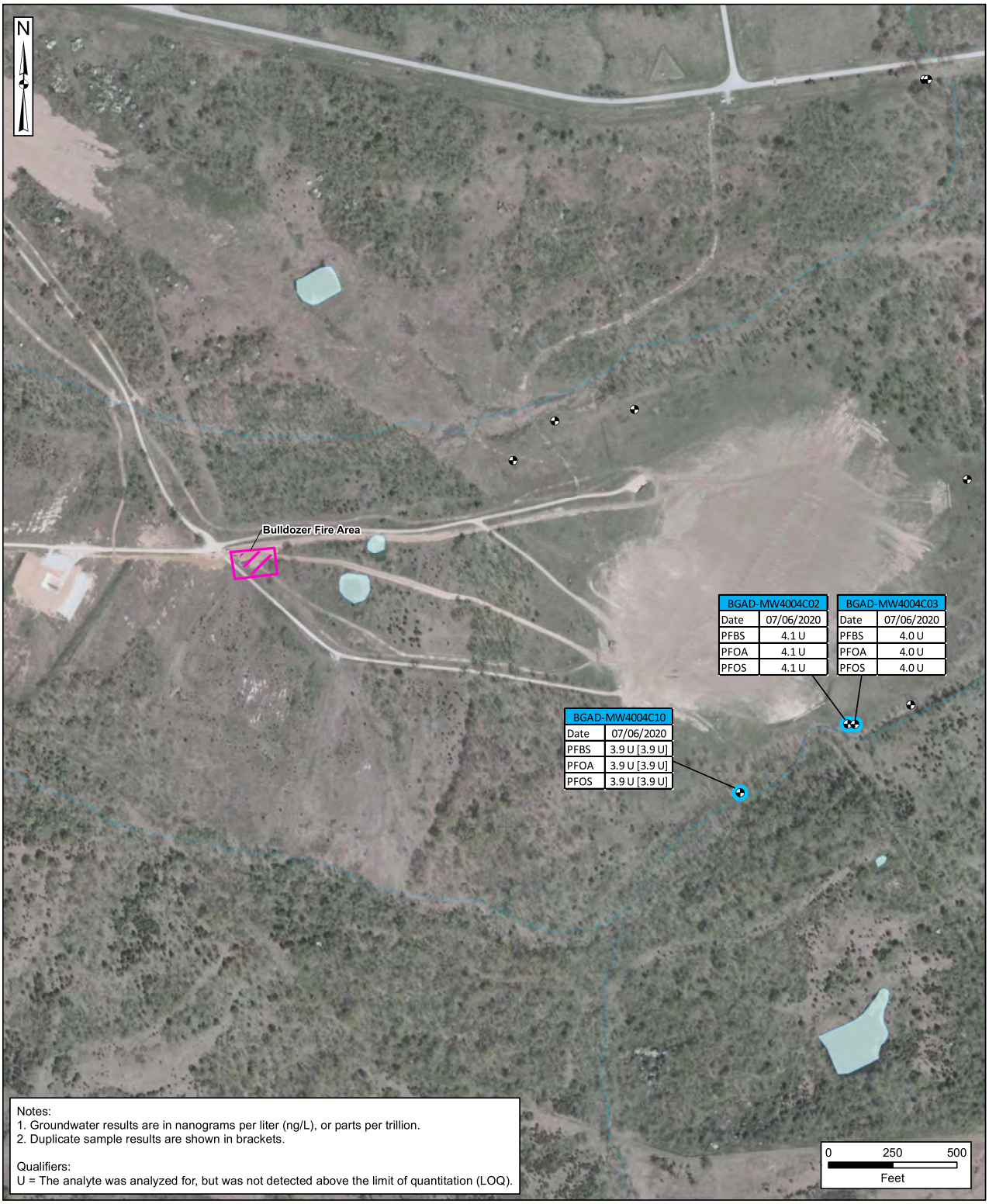
*The suspected AFFF use area at the Former Fire Training Area (SWMU-17) coincides with the Installation Restoration Program boundary for the site.

Data Sources:
BGAD, GIS Data, 2018
ESRI ArcGIS Online, Aerial Imagery

Coordinate System:
WGS 1984, UTM Zone 17 North

USAEC PFAS Preliminary Assessment/Site Inspection
Blue Grass Army Depot, Kentucky

Figure 7-5
Bulldozer Fire Area AOPI
PFOS, PFOA, and PFBS Analytical Results



Notes:
1. Groundwater results are in nanograms per liter (ng/L), or parts per trillion.
2. Duplicate sample results are shown in brackets.

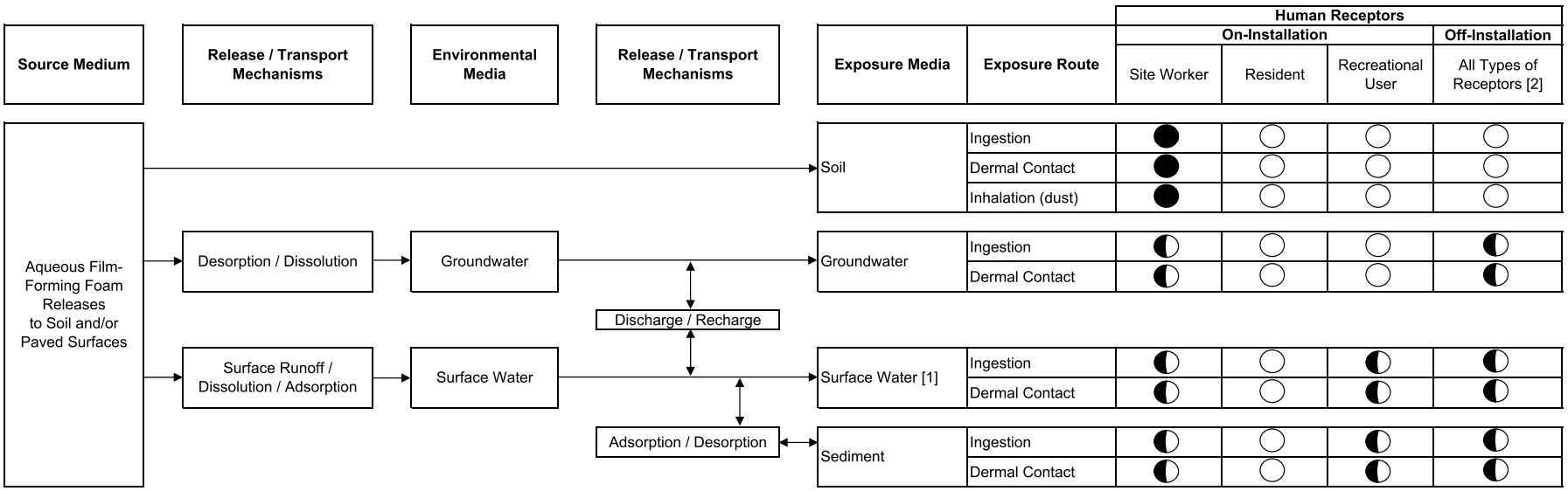
Qualifiers:
U = The analyte was analyzed for, but was not detected above the limit of quantitation (LOQ).

Installation Boundary
AOPI
Suspected AFFF Use Area
Water Body
Stream (Intermittent)
Monitoring Well
Groundwater Sampling Location - Existing Well

AFFF = aqueous film-forming foam
AOPI = area of potential interest
PFBS = perfluorobutanesulfonic acid
PFOA = perfluorooctanoic acid
PFOS = perfluorooctanesulfonic acid

Data Sources:
BGAD, GIS Data, 2018
ESRI ArcGIS Online, Aerial Imagery

Coordinate System:
WGS 1984, UTM Zone 17 North



Legend:

- ● = Complete Exposure Pathway
- ◐ = Potentially Complete Exposure Pathway
- ○ = Incomplete Exposure Pathway

Notes: [1] Surface water exposure pathway for Site Workers describes a potential drinking water scenario (i.e., Lake Vega) and describes potential incidental ingestion and dermal contact during outdoor work activities (e.g., while cleaning outfall locations or during stream maintenance and brush clearing around surface water features). Surface water exposure pathway for Recreational Users describes incidental ingestion and dermal contact during outdoor recreational activities. [2] All types of off-installation human receptors include drinking water receptors and recreational users.

Acronyms: FEMA = Federal Emergency Management Agency; PEO-SOFSA = Program Executive Office-Special Operations Forces Support Activity; SWMU = solid waste management unit

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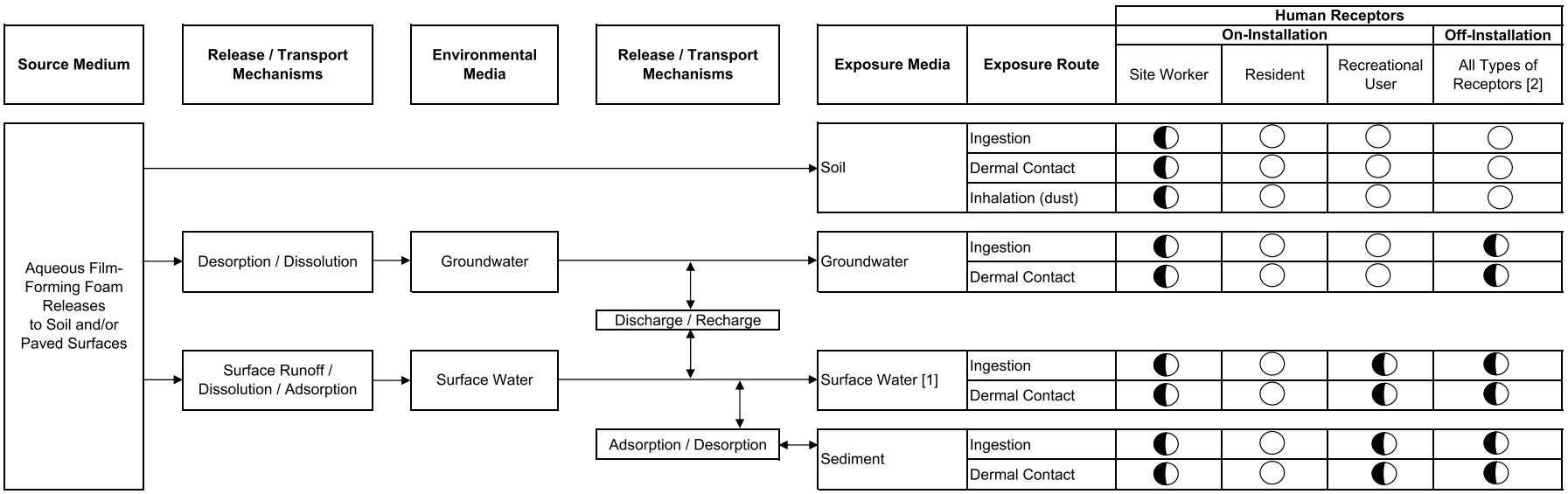
Conceptual Site Model for Temporary Fire Station (Building S11), Former PEO-SOFSA Hangar 1 (Building 232), FEMA Trailer Fire Training Area, Former Fire Station, Old Furnace Training Area, and Former Fire Training Area (SWMU 17)
USAEC PFAS Preliminary Assessment / Site Inspection
Blue Grass Army Depot, KY

Figure 7-6



Legend:

- ● = Complete Exposure Pathway
- ◐ = Potentially Complete Exposure Pathway
- ○ = Incomplete Exposure Pathway

Notes: [1] Surface water exposure pathway for Site Workers describes a potential drinking water scenario (i.e., Lake Vega) and describes potential incidental ingestion and dermal contact during outdoor work activities (e.g., while cleaning outfall locations or during stream maintenance and brush clearing around surface water features). Surface water exposure pathway for Recreational Users describes incidental ingestion and dermal contact during outdoor recreational activities. [2] All types of off-installation human receptors include drinking water receptors and recreational users.

Acronym: PEO-SOFSA = Program Executive Office-Special Operations Forces Support Activity

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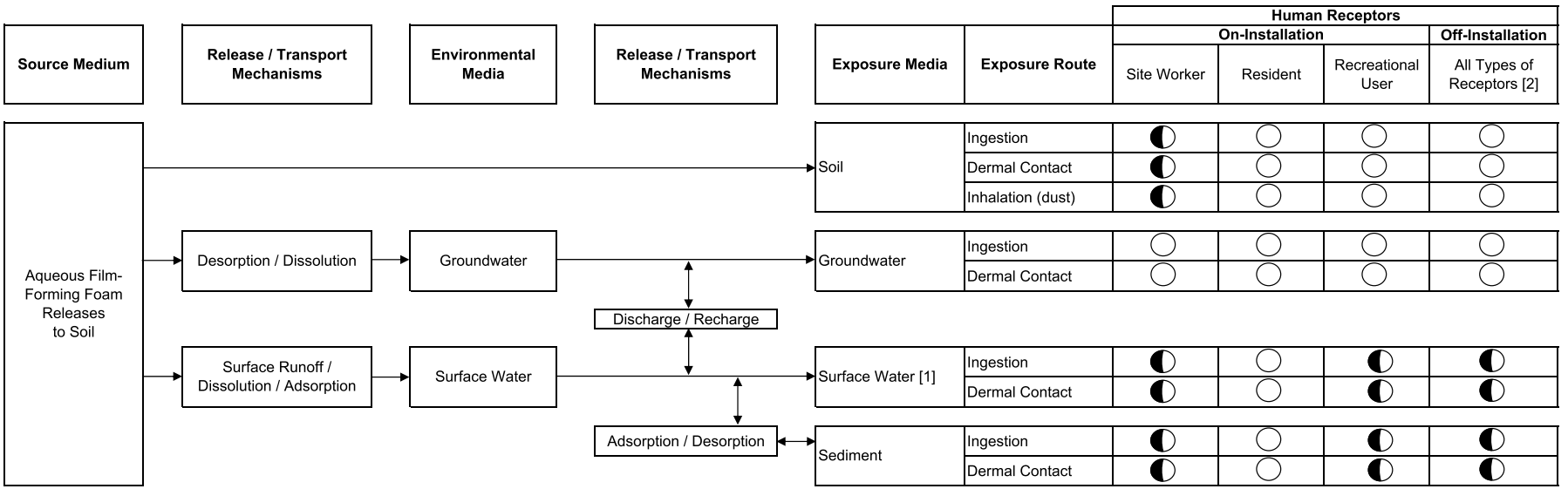
Conceptual Site Model for Former PEO-SOFSA Hangar 2 (Building 229)
USAEC PFAS Preliminary Assessment / Site Inspection
Blue Grass Army Depot, KY

Figure 7-7



Legend:

- ● = Complete Exposure Pathway
- ◐ = Potentially Complete Exposure Pathway
- ○ = Incomplete Exposure Pathway

Notes:
[1] Surface water exposure pathway for Site Workers describes a potential drinking water scenario (i.e., Lake Vega) and describes potential incidental ingestion and dermal contact during outdoor work activities (e.g., while cleaning outfall locations or during stream maintenance and brush clearing around surface water features). Surface water exposure pathway for Recreational Users describes incidental ingestion and dermal contact during outdoor recreational activities.
[2] All types of off-installation human receptors include drinking water receptors and recreational users.

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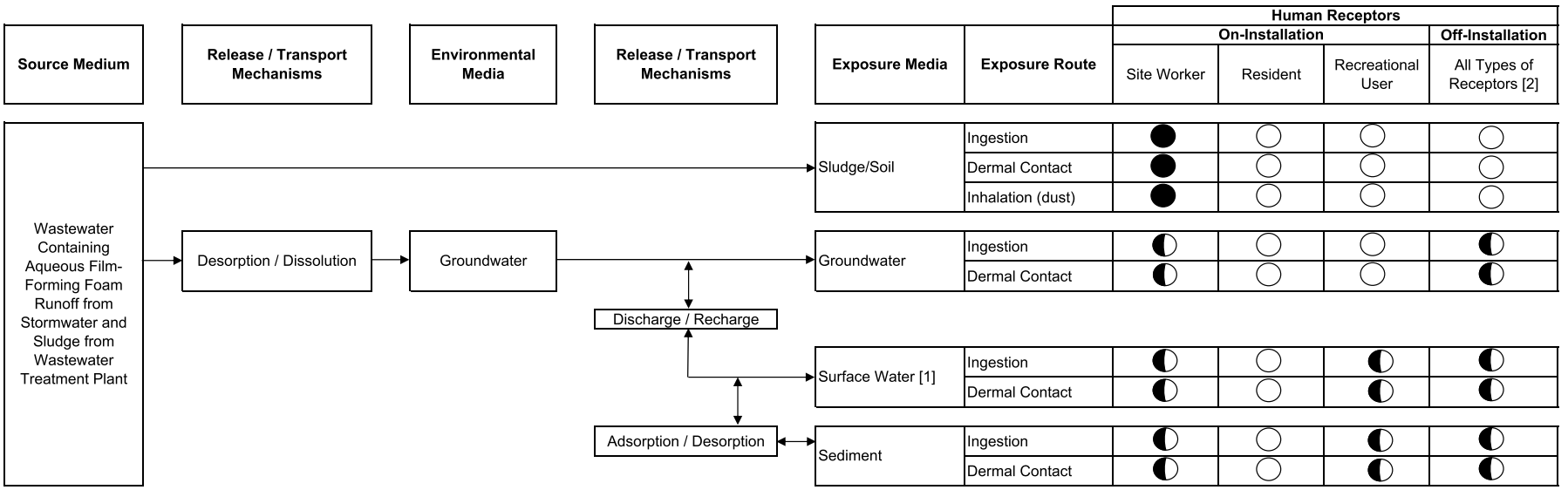
Conceptual Site Model for Bulldozer Fire Area
USAEC PFAS Preliminary Assessment / Site Inspection
Blue Grass Army Depot, KY

Figure 7-8



Exposure Media	Exposure Route	Human Receptors: On-Installation: Site Worker	On-Installation: Resident	On-Installation: Recreational User	Off-Installation: All Types of Receptors [2]
Sludge/Soil	Ingestion	●	○	○	○
	Dermal Contact	●	○	○	○
	Inhalation (dust)	●	○	○	○
Groundwater	Ingestion	◐	○	○	◐
	Dermal Contact	◐	○	○	◐
Surface Water [1]	Ingestion	◐	○	◐	◐
	Dermal Contact	◐	○	◐	◐
Sediment	Ingestion	◐	○	◐	◐
	Dermal Contact	◐	○	◐	◐

Legend:

● = Complete Exposure Pathway

◐ = Potentially Complete Exposure Pathway

○ = Incomplete Exposure Pathway

Notes:
[1] Surface water exposure pathway for Site Workers describes a potential drinking water scenario (i.e., Lake Vega) and describes potential incidental ingestion and dermal contact during outdoor work activities (e.g., while cleaning outfall locations or during stream maintenance and brush clearing around surface water features). Surface water exposure pathway for Recreational Users describes incidental ingestion and dermal contact during outdoor recreational activities.
[2] All types of off-installation human receptors include drinking water receptors and recreational users.

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Conceptual Site Model for the Wastewater Treatment Plant (Building 230) and Sludge Drying Beds
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Figure 7-9