# FINAL PRELIMINARY ASSESSMENT OF PER- AND POLYFLUOROALKYL SUBSTANCES

## Volunteer Army Ammunition Plant, Tennessee

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# CONTENTS

Executive Summary ..... 1
1 Introduction ..... 1
1.1 Project Background ..... 1
1.2 PA Objectives ..... 2
1.3 PA Process Description ..... 2
1.3.1 Pre-Site Visit ..... 2
1.3.2 Preliminary Assessment Site Visit ..... 2
1.3.3 Post Research ..... 3
2 Installation Overview ..... 4
2.1 Site Location ..... 4
2.2 Mission and Brief Site History ..... 4
2.3 Current and Projected Land Use ..... 5
2.4 Climate ..... 5
2.5 Topography ..... 5
2.6 Geology ..... 5
2.7 Hydrogeology ..... 6
2.8 Surface Water Hydrology ..... 8
2.9 Relevant Utility Infrastructure ..... 8
2.9.1 Stormwater Management System Description ..... 8
2.9.2 Sewer System Description ..... 8
2.10 Potable Water Supply and Drinking Water Receptors ..... 9
2.11 Ecological Receptors ..... 10
2.12 Previous PFAS Investigations ..... 10
3 Summary of PA Activities ..... 11
3.1 Records Review ..... 11
3.2 Personnel Interviews ..... 11
3.3 Site Reconnaissance ..... 11
4 Potential PFAS Use, Storage, and/or Disposal Areas ..... 12
4.1 AFFF Use, Storage, and Disposal Areas ..... 12

4.2 Other PFAS Use, Storage, and/or Disposal Areas ..... 12
4.3 Readily Identifiable Off-Post PFAS Sources ..... 12
5 Summary and Discussion of PA Results ..... 14
5.1 Areas Not Retained for Further Investigation ..... 14
6 Conclusions and Recommendations ..... 16
7 References ..... 17
Acronyms ..... 18

# TABLES

Table 2-1 Historical PFOS, PFOA, and PFBS Analytical Results
Table 5-1 Installation Areas Not Retained for Further Investigation (in text)

# FIGURES

Figure 2-1 Site Location
Figure 2-2 Site Layout
Figure 2-3 Topographic Map
Figure 2-4 Off-Post Potable Supply Wells
Figure 5-1 AOPI Decision Flowchart (in text)

# APPENDICES

Appendix A Office of the Secretary of Defense. 2021. Memorandum: Investigating Per- and Polyfluoroalkyl Substances within the Department of Defense Cleanup Program. September 15.
Appendix B Preliminary Assessment Quality Control Checklist
Appendix C Antiterrorism/Operations Security Review Cover Sheet
Appendix D Not Used
Appendix E Installation EDR Survey Reports
Appendix F Research Log
Appendix G Compiled Interview Logs

# EXECUTIVE SUMMARY

The United States Army (Army) is performing preliminary assessments (PAs) 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. This Volunteer Army Ammunition Plant (VOAAP) PA was completed in accordance with the Comprehensive Environmental Response, Compensation, and Liability Act of 1980, the National Oil and Hazardous Substance Pollution Contingency Plan, and Army/Department of Defense policy and guidance.

VOAAP is located approximately 9 miles northeast of downtown Chattanooga, Tennessee, southeast of the Tennessee River in eastern Hamilton County, and occupies a total of approximately 6,350 acres (± transferred acreage). VOAAP was a government-owned and contractor-operated facility formerly used for the production and storage of trinitrotoluene (TNT). This PA focuses on the entire installation.

Based on the results of the PA for the entire installation, no AOPIs were identified. Therefore, further investigation for PFAS at VOAAP is not warranted at this time.

# 1 INTRODUCTION

The United States (U.S.) Army (Army) is performing preliminary assessments (PAs) 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 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 purpose of this PA is to identify locations that are areas of potential interest (AOPIs) at the Volunteer Army Ammunition Plant (VOAAP) 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). This report provides the PA for VOAAP and was completed in accordance CERCLA, the National Oil and Hazardous Substances Pollution Contingency Plan, and Army/Department of Defense (DoD) policy and guidance.

## 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 and 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 groundwater (tap water) or soil, calculated using the USEPA's Regional Screening Level (RSL) calculator for residential and industrial/commercial worker receptor scenarios. Following the issuance of the 2019 OSD memo, on 08 April 2021, USEPA published an updated toxicity assessment for PFBS (USEPA 2021). Based on the updated toxicity assessment for PFBS, the OSD issued a memorandum on 15 September 2021 to include updated PFBS risk screening levels. The 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). The September 2021 Memorandum: Investigating Per- and Polyfluoroalkyl Substances within the Department of Defense Cleanup Program is provided for reference as **Appendix A**.

## 1.2 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.

## 1.3 PA Process Description

For VOAAP, the PA development process is described in **Sections 1.3.1** through **1.3.3** below. **Section 3** provides a summary of the PA activities completed at VOAAP. The PA processes are documented in the PA Quality Control Checklist included as **Appendix B**. The Army PA operations security requirements package, which includes the antiterrorism/operations security review cover sheet, is included as **Appendix C**.

### 1.3.1 Pre-Site Visit

First, an installation kickoff teleconference was held among applicable points of contact (POCs) from United States Army Environmental Command (USAEC), United States Army Corps of Engineers (USACE), VOAAP, and Arcadis U.S., Inc. (Arcadis). The kickoff call occurred on 08 February 2021 to discuss the goals and scope of the PA, project scheduling, installation access, timeline for a potential site visit, and access to installation-specific databases, and to request available records.

A records review was conducted to obtain electronically available documents from the installation and external sources for review. The purpose of the records research was to identify any area on the installation that may have been a location where PFAS-containing materials were used, stored, and/or disposed, as well as to gather information on the physical setting and site history at VOAAP.

A research summary report (RSR) was prepared to document and summarize all information regarding the current and historical use, storage, and/or disposal of PFAS-containing materials obtained during the research activities conducted from February through June 2021. This report included the following:

- A list of interviewed personnel, affiliation, roles, and contact information
- Interview logs detailing all interviews that took place during the PA
- A list of the data sources collected and reviewed
- A table of sites identified during research with description and relevance
- An operations timeline
- A site figure with potential AOPIs

### 1.3.2 Preliminary Assessment Site Visit

The installation is not active and has been largely commercialized. Therefore, a site visit was not conducted.

### 1.3.3 Post Research

After the RSR was submitted, a teleconference was scheduled to discuss the preliminary findings and finalize the list of any potential AOPIs. The post-RSR teleconference took place on 04 August 2021 and determined that site inspection phase sampling was not warranted. An Army directive announced on 08 September 2021 to stop work on several non-Base Realignment and Closure excess installation investigations delayed the drafting of the VOAAP PA Report to 06 January 2022.

# 2 INSTALLATION OVERVIEW

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

## 2.1 Site Location

VOAAP is located approximately 9 miles northeast of downtown Chattanooga, Tennessee, southeast of the Tennessee River in eastern Hamilton County (**Figures 2-1** and **2-2**). The installation occupies a total of approximately 6,350 acres (± transferred acreage) (VOAAP 2002; Shaw Environmental, Inc. 2011). The area immediately surrounding VOAAP consists of semi-urban properties characterized by residential development, light commercial development, undeveloped timberland, and agriculture. The Chickamauga Reservoir (including Waconda and West Waconda Bays), one of the main recreational areas in southeastern Tennessee, lies just beyond the northern boundary of VOAAP. There is no permanent resident population at the installation (USACE 2012).

## 2.2 Mission and Brief Site History

VOAAP was a government-owned and contractor-operated facility formerly used for the production and storage of trinitrotoluene (TNT). USACE built the TNT production facility between 1941 and 1943. The initial operations at VOAAP began in July 1942 with Hercules Powder Company of Wilmington, Delaware, as the operating contractor. The plant produced more than 800,000,000 pounds of TNT before it was placed on standby status in January 1946, after the end of World War II (VOAAP 2002; Shaw Environmental, Inc. 2011).

The plant remained non-operational until the spring of 1952, when it was reactivated in support of the Korean War. The operating contractor during this time was Atlas Powder Company of Wilmington, Delaware, which had produced 283,000,000 pounds of TNT from 1952-1957. In 1957, the plant was shut down again and placed on standby status until it was reactivated for the Vietnam War in 1965. As production requirements began to decrease, processing lines were gradually reduced before all production was ultimately ceased in 1977. During this time, 1.8 billion pounds of TNT were produced (VOAAP 2002).

Between 1971 and 1975, modernization of the TNT production facilities was conducted. Six new continuous process lines were built in an area where four of the old batch process lines were previously razed. Only one of the new continuous process lines was ever used before the last TNT production occurred in 1977 (VOAAP 2002).

In 1962, the CF Industries, Inc. (CFI) lease area was established when the Army leased 824 acres of land to CFI. CFI used the land for the commercial production of ammonium nitrate fertilizer, urea, and related products until 1982 when all operations were ceased for economic reasons. All CFI production areas were dismantled for salvage and CFI no longer leases the property (VOAAP 2002).

## 2.3 Current and Projected Land Use

VOAAP has been on standby status since 1977, when TNT production ceased. At present, no TNT production or storage takes place at the facility. In 1997, VOAAP was determined to be excess property and legislation was passed in Congress to allow transfer of approximately 1,033 acres of land to Hamilton County/City of Chattanooga. The General Services Administration, the disposal agency for the Army, acts as the executing agency for all property transfer actions. Hamilton County and the City of Chattanooga purchased 940 acres in 2000 via a negotiated sale under early transfer authority (VOAAP 2002). The majority of the VOAAP property has been transferred to the City of Chattanooga/Hamilton County; however, the Army continues to conduct environmental investigations and cleanups at contaminated sites within VOAAP (Shaw Environmental, Inc. 2011).

## 2.4 Climate

The climate of Hamilton County, Tennessee, tends to be moderate, characterized by cool winters and warm summers. High temperatures in the summer typically range from the high 80s to the low 90s (in degrees Fahrenheit) with high relative humidity. Afternoon temperatures are frequently modified by thunderstorms and may drop by 10 to 15 degrees Fahrenheit in a matter of minutes. Temperatures in the winter can fall as low as the freezing point on about half of the days. Heavy snowfalls have occurred, but any appreciable accumulation of snow seldom remains on the ground for more than a few days. The average annual rainfall in Hamilton County is approximately 53 inches. The greatest amounts of rainfall typically occur in the winter, with a second peak period occurring in July (Shaw Environmental, Inc. 2011).

## 2.5 Topography

The eastern half of the original VOAAP installation contains hills and steep to moderate slopes (**Figure 2-3**); the central portion of this area contains a series of hills known as the Summit Knobs (Shaw Environmental, Inc. 2011). The western half of VOAAP is a wide valley with gently rolling topography. This valley rises abruptly to a ridge along the western boundary.

## 2.6 Geology

VOAAP is located within the Appalachian Valley and Ridge Physiographic Province, which is a long, narrow belt of dominantly calcareous sedimentary rocks deposited during the Paleozoic era. The province is approximately 1,200 miles long, beginning in the St. Lawrence Valley in the north and extending down to the Gulf Coastal Plain in the south. In Tennessee, the average width is approximately 40 miles. The Valley and Ridge Province is characterized by a succession of northeast-trending ridges. These ridges consist of more weather-resistant sandstone, sandy shale, cherty limestone, and dolomite, compared to the valleys that are made up of more soluble limestone and dolomites. Folding and thrusting have caused nearly all beds to dip to the southeast. The province is bordered on the east side by the Blue Ridge Province and to the west by the Appalachian Plateau (USACE 2012).

Mantling the bedrock across the site is a layer of residuum consisting predominantly of plastic silts and clays, containing chert fragments in discontinuous layers disseminated throughout. Across the

installation, the residuum can range from 5.5 feet to 215 feet thick. This wide range is due to variations in surface relief and the irregular bedrock surface area (USACE 2012).

The residuum underlying the Copper Ridge Dolomite displays relict structure of the parent rock. In some areas, chert beds appear competent while others have been weathered into clays. Macropores in the form of fractures have developed perpendicular to the relict joints and surface. Other macropores found in the upper few feet of the soil horizon were primarily formed by tree roots that have since rotted away, leaving void spaces. These pore spaces act as preferential flow pathways that allow water into the underlying residuum and aquifer (USACE 2012).

The bedrock stratigraphy at VOAAP consists of the Cambrian Conasauga Group and the Upper Cambrian/Lower Ordovician Knox Group. The Conasauga is approximately 1,800 feet thick and consists of the Conasauga Undivided Shale and the Maynardville Limestone. The Conasauga Undivided Shale is characterized by a light green to light brown shale interbedded with zones of gray dolomitic limestone and reddish-brown shale and siltstone. The Maynardville Limestone is characterized by medium to dark gray argillaceous limestone with thin irregular silty and dolomitic layers. The Conasauga Group is overlain by the Knox Group. Up to 2,800 feet thick, the Knox Group consists of four formations. Two of these formations can be found at VOAAP: the Copper Ridge Dolomite and the Chepultepec Dolomite. The Copper Ridge Dolomite is characterized by dark gray, fine to coarse crystalline, siliceous dolomite with dark chert layers and tin nodules abundant throughout. The Chepultepec Dolomite is characterized by light gray to medium dark gray, thin to very thick bedded, fine to coarse crystalline dolomite. The bedrock elevation at VOAAP ranges from 589 to 933 feet above mean sea level (USACE 2012).

## 2.7 Hydrogeology

Regionally, the most productive aquifers are located in carbonate formations. Groundwater occurrence in the Appalachian Valley and Ridge Physiographic Province of Hamilton County, Tennessee, is primarily in soluble limestone, dolomite, and calcareous shale. The ability of carbonate rocks to store and transmit groundwater is greatly enhanced by solution enlargement of fractures, joints, and bedding planes by mildly acidic groundwater. Formations of the Knox Group, including the Copper Ridge Dolomite, comprise the most productive aquifer system in Hamilton County. This is due to the presence of highly soluble beds or karstic features formed during an earlier period of erosion. Several springs in the Knox Group of Hamilton County produce water in excess of 5,000 gallons per minute (gpm), and water wells in the Knox Group can produce up to 3,000 gpm. Numerous springs also occur in the Maynardville Limestone of the Conasauga Group. Water wells installed near major streams may yield large quantities of groundwater, and there is evidence that extensive solution of carbonate bedrock has occurred, allowing transmission of river or lake water to the wells. Water wells in non-carbonate bedrock produce moderate yields from fractures. Moderate well yields can be expected in almost all areas underlain by non-carbonate rocks. Water wells in the vicinity of Carson Springs have been an important drinking water resource for the Eastside Utility District and Savannah Valley Utility District. Although groundwater may occur in a variety of unconsolidated deposits in Hamilton County, only the residuum has sufficient thickness, lateral extent, and permeability to be of importance. However, it should be noted that yields from wells installed in the residuum at VOAAP tend to be extremely low (USACE 2012).

Groundwater in the immediate vicinity of VOAAP occurs in a complex aquifer system consisting of folded and faulted carbonate rocks of the Knox and Conasauga Groups and the overlying residuum.

Groundwater flow is significantly affected by lithology, geologic structure, topography, precipitation, and water levels in the Chickamauga Reservoir. Groundwater flow occurs in conditions ranging from unconfined to semi-confined, with bedrock groundwater flow occurring in fractures or in dissolution zones within the carbonate beds. The groundwater potentiometric surface generally conforms with the facility's major topographic features. Based on analysis of groundwater elevation data, the property spans four groundwater basins, including the North TNT Groundwater Basin, South TNT Groundwater Basin, Northeastern Groundwater Basin, and New Landfill/Burning Ground Groundwater Basin (USACE 2012).

The North TNT Groundwater Basin is located in the TNT Manufacturing Valley (MfV) and underlies the Old TNT Manufacturing Area and Redwater Treatment Plant. Groundwater flows east and west from the higher elevations toward the central trough of the valley, and then flows north offsite toward Waconda Bay. The central domain consists of a northeasterly plunging syncline bounded on the east and west by splays of the Kingston Fault. The northeasterly plunge of the syncline and the presence of a low-permeability boundary at its base may complement prevailing northerly topographic gradients in the northern half of the domain, creating a strong tendency for northerly groundwater flow. Groundwater flow in the residuum follows the same trends as in the bedrock. A groundwater divide for the residuum groundwater is present in the central portion of the TNT MfV (USACE 2012).

Immediately south of the North TNT Groundwater Basin is the South TNT Groundwater Basin. This basin underlies a portion of the Old TNT Area, the New TNT Area, the Administrative Area on the south side of the site, the Old Magazine Area, and a small portion of the New Magazine Area. As with the North TNT Groundwater Basin, bedrock groundwater flows east and west from the higher elevations toward the central trough of the valley, and then flows in the opposite direction toward the south offsite due to a groundwater divide. Groundwater flow in the residuum follows the same trends as the bedrock. The groundwater divide for the residuum groundwater is present in the central portion of the TNT MfV (USACE 2012).

The Northeastern Groundwater Basin is present in the north-central portion of VOAAP near the Construction Debris Disposal Area. Groundwater in the bedrock of this area flows from the groundwater divides near the East Acid Area, the New Acid Area, and the New Landfill/Burning Ground Area to the north. Groundwater that flows to the north offsite is interpreted as discharging into East Waconda Bay and/or Harrison Bay. Groundwater flow in the residuum follows the same trends as in the bedrock (USACE 2012).

The New Landfill/Burning Ground Groundwater Basin is located in the eastern section of VOAAP, which includes the New Landfill/Burning Ground Area, the Eastern Magazine Area (EMA), and surrounding property. Bedrock and residuum groundwater flow in this basin follow similar trends. Groundwater generally flows in a semi-radial pattern from the EMA. The area is defined by a groundwater divide that runs from the New Landfill/Burning Ground Area south along the western margin of the EMA. In the northern portion of the area, groundwater flows north-northeast toward Chickamauga Lake. Groundwater is depicted as flowing east offsite through most of the area, with a more southerly component of flow near the southern perimeter of VOAAP. In the eastern portion of the basin, groundwater flows to the east and northeast away from VOAAP (USACE 2012).

## 2.8 Surface Water Hydrology

No major streams or rivers are located within the boundaries of VOAAP. Surface water flows across the facility and discharges from the site at several locations along the northern (east and west TNT ditches, Tyner Creek, and Harrison Branch) and southern (Poe Branch) perimeters via perennial and intermittent streams. The largest body of surface water in the vicinity of VOAAP is Waconda Bay, the southern tip of which is less than 0.5 miles from the northern end of the TNT MfV. Waconda Bay is part of the Chickamauga Reservoir, an impounded section of the Tennessee River. The Chickamauga Reservoir has a pronounced effect on the level of the water table in wells located on the northern perimeter of the TNT MfV. All of the surface water drainage from the site discharges to various tributaries of the Tennessee River including South Chickamauga Creek, Poe Branch, Friar Branch, Tyner Creek, Harrison Branch, and Wolftever Creek (USACE 2012).

## 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 at VOAAP.

### 2.9.1 Stormwater Management System Description

Most of the industrial wastewater was discharged into a network of open ditches that flowed into Pond 4, an equalization basin. The effluent exited Pond 4 through a flume and flowed into the Corps of Engineers Pond, which served as a flocculation basin (United States Army Toxic and Hazardous Materials Agency 1978).

Stormwater retention basins were present at the northern and southern ends of the New Landfill. The basins were designed for a 100-year storm event and each basin contained an overflow drain that discharged to the intermittent stream, Harrison Branch. All of the stormwater that flowed off the northwest-facing toe of the landfill flowed into the northern retention basin, where ponded stormwater infiltrated the residuum (IT Corporation 1995).

The West TNT Ditch, similar to the East TNT Ditch, was constructed as a drainage for surface water runoff from the batch process TNT lines. However, the West TNT Ditch, an unlined earthen channel, also received stormwater runoff and originally received acid waste from the TNT production buildings via acid sewer lines (IT Corporation 1995).

### 2.9.2 Sewer System Description

The Old TNT Area included three groups of batch lines (1–6, 7–12, 13–16) used to produce TNT. Each of the production buildings was connected to the acid sewer system, which carried dilute waste acid produced from accidental spills/leaks or routine water washing away from the process buildings. The sewer lines were constructed of clay or concrete pipe. Acid sewer lines discharged to unlined outfalls, including the East and West TNT Ditches. The mono, binitration, and trinitration houses of each batch line were connected in series to sewer lines that began at the trinitration houses and drained to the West TNT

Ditch. These sewer lines did not interconnect the batch lines. Each wash house drained to the East TNT Ditch (IT Corporation 1995).

The New TNT Area consisted of six continuous process lines but only one produced TNT (Line 1). All redwater and yellow water waste generated during the TNT manufacturing process was sent to the Redwater Treatment Plant via an enclosed pipeline constructed above the East TNT Ditch (IT Corporation 1995).

The CFI lease area contained VOAAP's raw water plant and the main sewage treatment plant. Raw water used by VOAAP and CFI was pumped from the Chickamauga Reservoir at a point downstream of Waconda Bay to a 24-million-gallon-per-day water treatment plant and a second 15-million-gallon-per-day plant. Each plant had two concrete settling basins. The water was chemically treated and filtered before distribution. The filter backwash sludge passed through Pond 1 to the West TNT Ditch and through the main plant outfall, and finally into Waconda Bay. Water from the plant was supplied to VOAAP, as well as offsite residential and commercial users. The main sewage treatment plant for VOAAP received sanitary wastewater and laboratory acids. Originally, the effluent outfall was to the south, which connected to a retention pond (Pond 5) before being discharged offsite into Friar Branch. Effluent was then discharged to the north into the West TNT Ditch and incorporated into the surface drainage that flows to the plant outfall in the Surface Water Discharge Area (IT Corporation 1995).

The Redwater Treatment Plant Area consisted of several buildings, tanks, tank cradles, retention ponds, and a redwater flume. Treatment of the redwater waste occurred in two aboveground settling tanks, and the persisting redwater was transported to the raw redwater storage tanks via the flume. Redwater from the raw redwater storage tanks was pumped to the evaporator building (IT Corporation 1995).

## 2.10 Potable Water Supply and Drinking Water Receptors

Groundwater at VOAAP was not used as a water source. In the past, VOAAP pumped surface water from the Tennessee River, which is approximately 1 mile from the installation (side-gradient of VOAAP), to two filtration water treatment facilities onsite. Although there was no permanent onsite residential population, water was needed for employee and facility operations. In 1984, both of the installation filtration facilities were deactivated, and VOAAP began using public water via Tennessee American Water Company (TAW). Currently, one of the treatment facilities (Filter Plant No. 1) is being leased by the Eastside Utility District, which supplied water to VOAAP property and other areas within Hamilton County. Currently, TAW, the Eastside Utility District, and the Savannah Valley Utility District supply water to the communities and industries surrounding VOAAP. TAW draws water from the Tennessee River west and south of VOAAP; the Eastside Utility District draws water from the Tennessee River; and the Savannah Valley Utility District obtains water from a series of well fields, including Carson Spring, which is northeast of VOAAP and leased by the Eastside Utility District. There is a possibility that Carson Spring draws water from an area at least partially recharged by surface and groundwater from the northeastern portion of VOAAP (Agency for Toxic Substances and Disease Registry [ASTDR] 2004).

Residential areas surround VOAAP, and some residents use groundwater from private wells as their drinking water source. There are five homes within 3 miles of the installation (north of the installation between the site boundary and the Tennessee River) that use private wells for drinking water. One of the locations filters the water through a granular activated carbon system. Other private wells are being used

as a non-potable water source (gardening, irrigation, heat pumps, swimming pools, etc.) (Agency for Toxic Substances and Disease Registry 2004).

An Environmental Data Resources, Inc. (EDR) report includes search results from a variety of environmental, state, city, and other publicly available databases for a referenced property. An EDR report was generated for VOAAP, and along with state and county geographic information system (GIS) data provided by the installation, identifies several off-post public and private wells within 5 miles of the installation boundary (**Figure 2-4**). The EDR report providing well search results is included as **Appendix E**.

## 2.11 Ecological Receptors

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

One listed species, *Scutellaria montana* (large-flowered skullcap), was found at one location and is Federal Status Listed Endangered, State Status Endangered. The population was small (four to six individuals) but healthy and in flower. The large-flowered skullcap is a perennial herb from the mint family that has suffered population declines through destroyed habitat. As of March 1994, there were 17 extant populations known, 12 in Tennessee and five in Georgia (The Nature Conservancy 1994).

## 2.12 Previous PFAS Investigations

The TAW Filter Plant was sampled in 2014 and 2015 under the Army's PFAS sampling program in response to the Third Unregulated Contaminant Monitoring Rule (UCMR3). PFOS, PFOA, and PFBS were part of the PFAS constituents analyzed in both sampling events. No constituents, including PFOS, PFOA, and PFBS, were detected at concentrations exceeding the reporting limit. The exact sampling location is not known; however, the plant supplies water to the zip code in which VOAAP was located. These data are provided in **Table 2-1** with each analyte's respective reported limit of quantitation. No additional PFAS sampling had been completed at VOAAP at the time of the PA.

# 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 VOAAP, data were collected from three principal sources of information:

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

These sources of data, along with their relative application to this PA, are discussed below. The specific findings of the records review, personnel interviews, and site reconnaissance relevant to PFAS-containing materials at VOAAP are described in **Section 4**.

## 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, VOAAP fire department documents, VOAAP 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 VOAAP is provided in **Appendix F**.

## 3.2 Personnel Interviews

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

- VOAAP, Former Arson Investigator/Chattanooga Fire Station 7, Captain
- VOAAP, Former Environment Employee of the Department of Public Works
- Highway 58 Volunteer Fire Department, Fire Chief

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

## 3.3 Site Reconnaissance

Site reconnaissance and visual surveys were not conducted at the preliminary locations identified at VOAAP during the records review process, due to the site being largely commercialized at this time. Areas were classified as not retained for further investigation or as an AOPI based on a combination of information collected (e.g., records reviewed, personnel interviews, internet searches) as described in **Section 5**.

Observations made and data collected through records reviews (**Appendix F**) and installation personnel interviews (**Appendix G**) during the PA process for VOAAP are summarized in **Section 4**.

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

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

## 4.1 AFFF Use, Storage, and Disposal Areas

AFFF was developed in the mid-1960s in response to a need for firefighting foams better suited to extinguish Class B, fuel-based fires. AFFF formulations consist of water, an organic solvent, up to 5 percent (%) hydrocarbon surfactants, and 1 to 3% PFAS (Interstate Technology and 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.

Information gathered from the PA research indicates that AFFF was not used, stored, or disposed at VOAAP. According to the document reviews and personnel interviews, any fires were extinguished and any fire training exercises were performed using water suppression only.

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

Following document research, personnel interviews, and site reconnaissance at VOAAP, other potential PFAS source types either were not identified at the installation or did not prompt further research or constitute categorization as AOPIs. VOAAP had a pesticide storage area but installation records indicate no evidence of PFAS-containing materials.

Further discussion regarding areas not retained for further investigation is presented in **Section 5.1**.

## 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 VOAAP) is not part of the PA. However, potential off-post PFAS sources within a 5-mile radius of the installation that were identified during the records search are described below.

Nearby community fire departments could potentially be off-post PFAS sources if they use AFFF. A U.S. Fire Service Station, Chattanooga Fire Station 6, Chattanooga Fire Station 8, Tri-Community Fire

Department Station 5, and Tri-Community Fire Department Station 4 are located approximately 1.9 miles, 2.1 miles, 2.3 miles, 3.8 miles, and 4.6 miles from the installation boundary, respectively.

# 5 SUMMARY AND DISCUSSION OF PA RESULTS

The preliminary locations evaluated for potential use, storage, and/or disposal of PFAS-containing materials at VOAAP 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, no areas at VOAAP have been identified as AOPIs. The process used for refining these areas is presented on **Figure 5-1**, below.

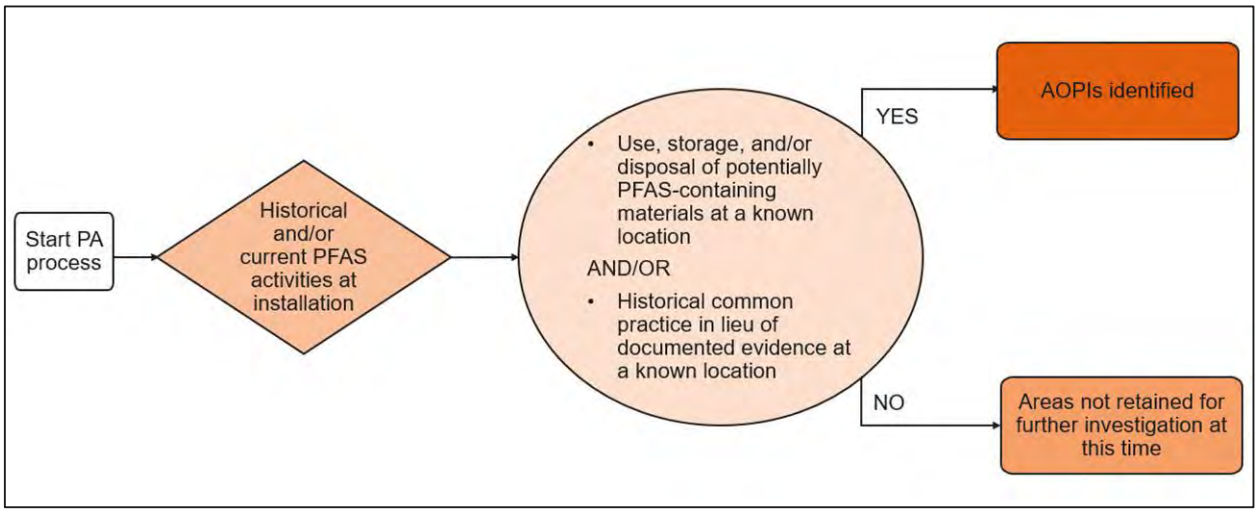


**Figure 5-1. AOPI Decision Flowchart**

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

Data limitations for this PA at VOAAP are presented in **Section 6**.

## 5.1 Areas Not Retained for Further Investigation

Through the evaluation of information obtained during the records review and personnel interviews, the areas described in **Table 5-1**, below, were categorized as areas not retained for further investigation at this time. A brief site history and rationale for categorization as an area not retained for further investigation are presented in the table.

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

| Area Description | Dates of Operation | Relevant Site History | Rationale |
|---|---|---|---|
| **Highway 58 Volunteer Fire Department** | 1970s to present | The fire department had a suppression agreement with VOAAP and went to the installation twice a year to identify fire hazards. Interviews indicate there were fires at VOAAP, one of which accounted for the loss of three buildings and at least 6 acres. However, these fires were put out using water suppression only. | No record of use, storage, and/or disposal of AFFF. Fire department used water suppression only. |
| **Old Fire Hall** | Unknown to late 1990s | Former personnel of the Old Fire Hall mentioned personnel at this facility were often “triple duty” (i.e. fire, security, and emergency medical technician [EMT]). Fire hall personnel would participate in “standbys,” where VOAAP would perform torch work. Only water suppression was used to ensure the grass did not catch on fire. | No record of use, storage, and/or disposal of AFFF. Fire department used water suppression only. |

# 6 CONCLUSIONS AND RECOMMENDATIONS

The PFAS PA at VOAAP evaluated preliminary locations for 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). A combination of document reviews, internet searches, and interviews with installation personnel were used to identify preliminary locations of suspected use, storage, and/or disposal of PFAS-containing materials at VOAAP. Following the evaluation, no AOPIs were identified. Therefore, further investigation for PFAS at VOAAP is not warranted at this time.

Data collected during the PA (**Sections 3** through **5**) were sufficient to draw the conclusions and recommendations summarized above. The data limitations relevant to the development of this PA for VOAAP are discussed below.

Data limitations were encountered during the PA process. Limited personnel were available to interview and the personnel that were interviewed indicated that there was no AFFF use at VOAAP, only water suppression. Additionally, the installation is not active and has been largely commercialized; therefore, a site visit was not conducted. Site records were also limited, especially with regard to fire hall activities.

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

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

The searches for ecological receptors and off-post PFAS sources were not exhaustive and were limited to easily identifiable and readily available information evaluated during the relevant records review and installation personnel interviews.

Finally, the available PFOS, PFOA, and PFBS analytical data are limited to the 2014 and 2015 sampling events at the TAW Filter Plant in response to the UCMR3. Additionally, the available data, including PFOS, PFOA, and PFBS data, were analyzed per the selected analytical method (EPA 537).

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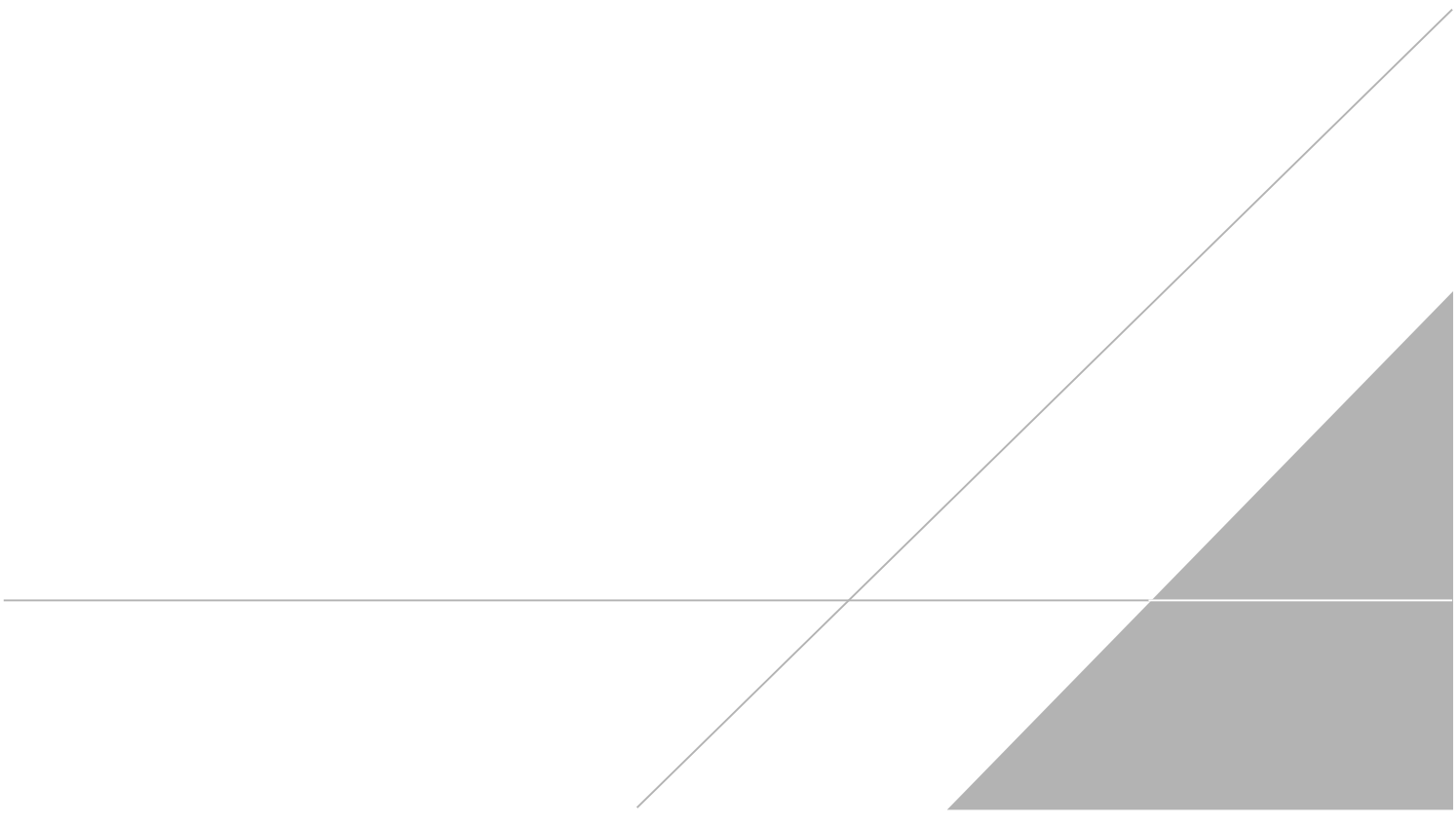
# ACRONYMS

| | |
|---|---|
| % | percent |
| AFFF | aqueous film-forming foam |
| AOPI | area of potential interest |
| Arcadis | Arcadis U.S., Inc. |
| Army | U.S. Army |
| CERCLA | Comprehensive Environmental Response, Compensation, and Liability Act of 1980 |
| CFI | CF Industries, Inc. |
| DoD | Department of Defense |
| EDR | Environmental Data Resources, Inc. |
| EMA | Eastern Magazine Area |
| GIS | geographic information system |
| gpm | gallons per minute |
| installation | U.S. Army or Reserve installation |
| IRP | Installation Restoration Program |
| MfV | Manufacturing Valley |
| ng/L | nanograms per liter (parts per trillion) |
| OSD | Office of the Secretary of Defense |
| PA | preliminary assessment |
| PFAS | per- and polyfluoroalkyl substances |
| PFBS | perfluorobutanesulfonic acid |
| PFOA | perfluorooctanoic acid |
| PFOS | perfluorooctane sulfonate |
| POC | point of contact |
| RSR | research summary report |
| TAW | Tennessee American Water Company |
| TNT | trinitrotoluene |
| U.S. | United States |
| UCMR3 | Third Unregulated Contaminant Monitoring Rule |
| USACE | United States Army Corps of Engineers |

| | |
|---|---|
| USAEC | United States Army Environmental Command |
| USEPA | United States Environmental Protection Agency |
| VOAAP | Volunteer Army Ammunition Plant |

# TABLES



# FIGURES

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