FINAL
Site Inspection Report
Rapid City Army Aviation Support Facility
Rapid City, South Dakota

Site Inspection for Perfluorooctanoic Acid (PFOA), Perfluorooctanesulfonic Acid (PFOS), Perfluorohexanesulfonic Acid (PFHxS), Perfluorononanoic Acid (PFNA), Hexafluoropropylene Oxide Dimer Acid (HFPO-DA), and Perfluorobutanesulfonic Acid (PFBS)
ARNG Installations, Nationwide

October 2023

Prepared for:

Army National Guard Headquarters
111 S. George Mason Drive
Arlington, VA 22204

UNCLASSIFIED

This page intentionally left blank

TABLE OF CONTENTS

LIST OF APPENDICES

LIST OF FIGURES

LIST OF TABLES

LIST OF ACRONYMS AND ABBREVIATIONS

°C	Degrees Celsius
%	Percent
µg/kg	Microgram(s) per kilogram
µg/L	Microgram(s) per liter
AASF	Army Aviation Support Facility
AECOM	AECOM Technical Services, Inc.
AFFF	Aqueous Film Forming Foam
AFB	Air Force Base
ANG	Air National Guard
AOI	Area of Interest
ARNG	Army National Guard
bgs	Below ground surface
btoc	Below top of casing
CERCLA	Comprehensive Environmental Response, Compensation, and Liability Act
COC	Chain-of-custody
CSM	Conceptual site model
DA	Department of the Army
DLA	Defense Logistics Agency
DoD	Department of Defense
DPT	Direct-push technology
DQI	Data quality indicator
DQO	Data quality objective
DUA	Data Usability Assessment
EA	EA Engineering, Science, and Technology, Inc., PBC
EDR	Environmental Data Resources, Inc.
EIS	Extraction internal standards
ELAP	Environmental Laboratory Accreditation Program
EM	Engineer Manual
EB	Equipment Blank
FB	Field blank
FedEx	Federal Express
ft	Foot (feet)
GIS	geographic information systems
GPR	ground penetrating radar
HDPE	High-density polyethylene
HFPO-DA	Hexafluoropropylene oxide dimer acid

HQ	Hazard Quotient
IDW	Investigation-derived waste
ITRC	Interstate Technology Regulatory Council
LC/MS/MS	Liquid chromatography tandem mass spectrometry
LCS	Laboratory control sample
LCSD	Laboratory control sample duplicate
LOQ	Limit of quantification
MIL-SPEC	military specification
MS	Matrix spike
MSD	Matrix spike duplicate
NELAP	National Environmental Laboratory Accreditation Program
ng/L	Nanogram(s) per liter
No.	Number
OSD	Office of the Secretary of Defense
PA	preliminary assessment
PFAS	per- and polyfluoroalkyl substances
PFBS	perfluorobutanesulfonic acid
PFHxS	perfluorohexanesulfonic acid
PFNA	perfluorononanoic acid
PFOA	perfluorooctanoic acid
PFOS	perfluorooctanesulfonic acid
PID	photoionization detector
PVC	polyvinyl chloride
QA	Quality assurance
QAPP	Quality Assurance Project Plan
QC	Quality control
QSM	Quality Systems Manual
RI	Remedial investigation
RPD	Relative percent difference
SDARNG	South Dakota Army National Guard
SD DANR	South Dakota Department of Agriculture & Natural Resources
SI	Site Inspection
SL	Screening level
TCRA	Time Critical Removal Action
TOC	Total organic carbon
TPP	Technical Project Planning

UFP	Uniform Federal Policy
USACE	U.S. Army Corps of Engineers
USEPA	U.S. Environmental Protection Agency
UST	Underground storage tank
Wood	Wood Environment & Infrastructure Solutions, Inc.
WSP	WSP USA Environment & Infrastructure, Inc.

EXECUTIVE SUMMARY

The Army National Guard (ARNG) G-9 is performing Preliminary Assessments (PAs) and Site Inspections (SIs) at ARNG facilities nationwide based on the current or potential historical use of per- and polyfluoroalkyl substances (PFAS) with a focus on the six compounds presented in the memorandum regarding Investigating Per- and Polyfluoroalkyl Substances within the Department of Defense Cleanup Program (Assistant Secretary of Defense, 2022) from the Office of the Secretary of Defense (OSD) dated 6 July 2022. The six compounds listed in the OSD memorandum include perfluorooctanesulfonic acid (PFOS), perfluorooctanoic acid (PFOA), perfluorobutanesulfonic acid (PFBS), perfluorononanoic acid (PFNA), perfluorohexanesulfonic acid (PFHxS), and hexafluoropropylene oxide dimer acid (HFPO-DA)[1]. These compounds are collectively referred to as "relevant compounds" throughout the document, and the applicable screening levels (SLs) are provided below in **Table ES-1**.

The PA identified one Area of Interest (AOI) where PFAS-containing materials may have been used, stored, disposed, or released historically (see **Table ES-2** for AOI location). The objective of the SI is to identify whether there has been a release to the environment from the AOI identified in the PA and determine whether further investigation is warranted, a removal action is required to address immediate threats, or no further action is required based on SLs for the relevant compounds. This SI was completed at the Rapid City Army Aviation Support Facility (AASF) in Rapid City, South Dakota and determined additional investigation is warranted for AOI 1: Overflow Area. The Rapid City AASF will also be referred to as the "Facility" throughout this document.

The Facility, operated by the South Dakota ARNG (SDARNG), is constructed on approximately 38 acres of land that is owned by the City of Rapid City and has been leased to the State of South Dakota Department of Military and Veterans Affairs since 1957 for a term of 99 years. The AASF includes several hangars, storage buildings, and administrative offices (AECOM Technical Services, Inc. [AECOM], 2020).

The PA identified one AOI for investigation during the SI phase. SI sampling results from the AOI were compared to OSD SLs. **Table ES-2** summarizes the SI results for the AOI. Based on the results of this SI, further evaluation under CERCLA is warranted in a Remedial Investigation (RI) for AOI 1: Overflow Area.

[1] Of the six PFAS compounds presented in the 6 July 2022 OSD memorandum, HFPO-DA (commonly referred to as GenX) was not included as an analyte at the time of this SI. Based on the conceptual site model (CSM) developed during the PA and revised based on SI findings, the presence of HFPO-DA is not anticipated at the facility because HFPO-DA is generally not a component of military specification (MIL-SPEC) aqueous film forming foam (AFFF) and based on its history including distribution limitations that restricted use of GenX, it is generally not a component of other products the military used. In addition, it is unlikely that GenX would be an individual chemical of concern in the absence of other PFAS.

Table ES-1. Screening Levels (Soil and Groundwater)

Analyte[2]	Residential (Soil) (µg/kg)[1] (0-2 feet bgs)	Industrial / Commercial Composite Worker (Soil) (µg/kg)[1] (2-15 feet bgs)	Tap Water (Groundwater) (ng/L)[1]
PFOA	19	250	6
PFOS	13	160	4
PFBS	1,900	25,000	601
PFHxS	130	1,600	39
PFNA	19	250	6

Notes:
1. Assistant Secretary of Defense. July 2022. Risk Based Screening Levels in Groundwater and Soil using United States Environmental Protection Agency's (USEPA's) Regional Screening Level Calculator. Hazard Quotient (HQ)=0.1. May 2022.
2. Of the six PFAS compounds presented in the 6 July 2022 OSD memorandum, HFPO-DA (commonly referred to as GenX) was not included as an analyte at the time of this SI. Based on the CSM developed during the PA and revised based on SI findings, the presence of HFPO-DA is not anticipated at the facility because HFPO-DA is generally not a component of MIL-SPEC AFFF and based on its history including distribution limitations that restricted use of GenX, it is generally not a component of other products the military used. In addition, it is unlikely that GenX would be an individual chemical of concern in the absence of other PFAS.

Abbreviations:
µg/kg = microgram(s) per kilogram
bgs = below ground surface
ng/L = nanogram(s) per liter

Table ES-2. Summary of Site Inspection Findings and Recommendations

AOI	Potential Release Area	Soil – Source Area	Groundwater – Source Area	Groundwater – Facility Boundary	Future Action
1	Overflow Area	◐	●	●	Proceed to RI

Legend:
● = Detected; exceedance of screening levels
◐ = Detected; no exceedance of screening levels
○ = Not detected

1. INTRODUCTION

1.1 PROJECT AUTHORIZATION

The Army National Guard (ARNG) G-9 is the lead agency in performing Preliminary Assessments (PAs) and Site Inspections (SIs) at ARNG facilities nationwide based on the current or potential historical use of per- and polyfluoroalkyl substances (PFAS) with a focus on the six compounds presented in the memorandum regarding Investigating Per- and Polyfluoroalkyl Substances within the Department of Defense Cleanup Program (Assistant Secretary of Defense, 2022) from the Office of the Secretary of Defense (OSD) dated 6 July 2022. The six compounds listed in the OSD memorandum are referred to as "relevant compounds" throughout this document and include perfluorooctanesulfonic acid (PFOS), perfluorooctanoic acid (PFOA), perfluorobutanesulfonic acid (PFBS), perfluorononanoic acid (PFNA), perfluorohexanesulfonic acid (PFHxS), and hexafluoropropylene oxide dimer acid (HFPO-DA)[1]. The ARNG performed this SI at the Rapid City Army Aviation Support Facility (AASF) in Rapid City, South Dakota. The Rapid City AASF is also referred to as the "Facility" throughout this report.

The SI project elements were performed in accordance with the Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA) (U.S. Environmental Protection Agency [EPA], 1980), as amended, the National Oil and Hazardous Substances Pollution Contingency Plan (40 Code of Federal Regulations Part 300; EPA, 1994), and in compliance with U.S. Department of Army (DA) requirements and guidance for field investigations.

1.2 SITE INSPECTION PURPOSE

A PA was performed at the Rapid City AASF (AECOM Technical Services, Inc. [AECOM], 2020) that identified one Area of Interest (AOI) where PFAS-containing materials may have been used, stored, disposed, or released historically. The objective of the SI is to identify whether there has been a release to the environment from the AOI identified in the PA and determine whether further investigation is warranted, a removal action is required to address immediate threats, or no further action is required based on screening levels (SLs) for the relevant compounds.

[1] Of the six PFAS compounds presented in the 6 July 2022 OSD memorandum, HFPO-DA (commonly referred to as GenX) was not included as an analyte at the time of this SI. Based on the conceptual site model (CSM) developed during the PA and revised based on SI findings, the presence of HFPO-DA is not anticipated at the facility because HFPO-DA is generally not a component of military specification (MIL-SPEC) aqueous film forming foam (AFFF) and based on its history including distribution limitations that restricted use of GenX, it is generally not a component of other products the military used. In addition, it is unlikely that GenX would be an individual chemical of concern in the absence of other PFAS.

This page intentionally left blank

2. FACILITY BACKGROUND

2.1 FACILITY LOCATION AND DESCRIPTION

The Rapid City AASF is in Pennington County, approximately 10 miles southeast of Rapid City, South Dakota and approximately 8 miles south of Ellsworth Air Force Base (AFB). The AASF is adjacent to Rapid City Regional Airport (**Figure 2-1**). The Facility is accessible from FAA Road from the north and Guard Road from the south (AECOM, 2020).

The Facility is constructed on approximately 38 acres of land that is owned by the City of Rapid City and has been leased to the State of South Dakota Department of Military and Veterans Affairs since 1957 for a term of 99 years. The AASF includes several hangars, storage buildings, and administrative offices (AECOM, 2020).

2.2 FACILITY ENVIRONMENTAL SETTING

The Rapid City AASF lies within the Black Hills regions, which is characterized as an isolated eroded mountain region; ancient rock removal by stream erosion produces this mountain setting. From a distance, the rounded hilltops, well-forested slopes, and deep valleys present a dark appearance, giving them their name. Rapid Creek is the main stream channel near the Facility (AECOM, 2020). The topography at the Site is shown on **Figure 2-2.**

2.2.1 Geology

The Facility is located within the eastern side of the Black Hills on an elliptically shaped dome created by the Laramide Orogeny. As a result of the Laramide Orogeny, crystalline basement rock and overlying Mesozoic and Paleozoic rocks were uplifted and exposed. Beneath the Facility lays Precambrian-age crystalline basement rocks that are overlain by Cambrian through Cretaceous deposits of dolomite, limestone, and sandstone. Within the Upper Cretaceous lies deposits of aged marine shales intertwined with beds of limestone and sandstone. This aged marine shale, also known as the Pierre Shale, has a range from 40 feet (ft) below ground surface (bgs) of the Facility down to 1,000 ft bgs. The Pierre Shale forms the bedrock of the Facility (AECOM, 2020).

The Pierre Shale located on the Facility can be found as a light gray to dark gray, fragmented, organic-rich shale. The material is also noncalcic and can be easily changed by weathering that results in a change in color to an orange or brown shale. Within the Pierre Shale, bentonite beds are interlayered. Additionally, roughly one-foot-thick layers of ironstone are interbedded within the Pierre Shale. On the weathered parts of the Pierre Shale, selenite crystals and ironstone nodules can be found. The Pierre Shale can be found up to depths of 40 ft bgs, but at places of weathering, the depths can be shallower (Aerostar, 2019; AECOM, 2020).

During the SI, ten borings were advanced to groundwater saturation, with termination depths between 20 to 33 ft bgs. The soil was generally classified as sandy clay, sand, or clay. Non-native fill material, namely well-graded sand, was identified in sample location AOI01-03 from surface to 5 ft bgs. Permeable lenses of gravel, sand, and silt of varying thickness were observed in most borings at depths ranging from 12 to 19 ft bgs.

2.2.2 Hydrogeology

The Black Hills area is an important recharge area for aquifers within the northern Great Plains. The Facility is located within the Williston Basin, where water flows into the Madison and Minnelusa aquifers. These aquifers are a part of the Paleozoic group, which occurs in areas that have high altitude and in uplift areas. The Madison aquifer has a siltstone, sandstone, limestone, and dolomite base. The water found in this location is typically in outcrop areas and flows to the recharge areas to the northeast. The discharge location occurs as a result of upward leakage to the lower Cretaceous aquifer located in central South Dakota. The Minnelusa aquifer has a limestone and sandstone base. The Minnelusa aquifer moves from areas of recharge to the northeast much like the Madison aquifer. A portion of the water will discharge upward by leakage into the lower Cretaceous aquifer. The lower Cretaceous aquifer is composed of sandstone and is confined by shale in areas where uplift can be found. Over one-half of the water found in these areas is moderately saline and can be briny in many parts. The salination of this water occurs from upward leakage of mineralized water from the Paleozoic aquifers (United States Geological Survey [USGS], 2002; AECOM, 2020).

During the SI, groundwater saturation was generally observed within permeable deposits at depths ranging from 12 and 19 ft bgs. Static depths to water were observed from 12 to 19 ft bgs. Well recharge rates varied by sample location. Temporary wells located at AOI01-04, AOI01-05, and RCAASF-02 had significant drawdown during purging while the other wells recharged with minimal drawdown during sampling.

Based on synoptic water level measurements taken from temporary wells during the SI fieldwork (see **Section 5.4**), groundwater flows toward the southeast (shown in **Figure 2-5)**. No potable water wells are located within the boundary of the Facility. An Environmental Data Resources, Inc. (EDR™) report conducted a well search for a 1-mile radius surrounding the Facility. Using additional online resources, such as state and local geographic information system (GIS) databases, wells were researched to a 4-mile radius of the Facility (AECOM, 2020). From a review of the South Dakota Department of Agriculture and Natural Resources (SD DANR) Water Well Completion Reports online database, there are monitoring wells, and numerous domestic and irrigation wells located downgradient of the Facility within 1 to 2 miles (SD DANR, 2022) (**Figure 2-3**).

Drinking water for the Facility is supplied by the Rapid City Water Division, which uses the Jackson Springs Gallery and the Girl Scouts Gallery as infiltration galleries along the Rapid Creek alluvium. Water is also drawn from the Minnelusa and Madison aquifers through eight wells. Surface water collects in the Rapid Creek, which collects water from the Deerfield and Pactola Reservoirs. This surface water supplies water for treatment to the Mountain View and Jackson Springs treatment plants which is then supplied for municipal use (AECOM, 2020).

2.2.3 Hydrology

The Black Hills strongly influence the hydrology of western South Dakota. Many streams in western South Dakota originate in the Black Hills, where groundwater and surface water interact extensively. The base flow of most streams in the area comes from the higher altitudes and many of the surrounding streams have headwater springs that originate from the Paleozoic carbonate

rocks. These steams generally flow eastward (USGS, 2002; AECOM, 2020). The Facility is located in the Rapid Creek Basin and surface water at the Facility flows south to southeast to unnamed tributaries of Rapid Creek as presented on **Figure 2-4**.

2.2.4 Climate

The climate at the Facility consists of four clearly separated seasons, with warm and clear summers and dry, freezing, cloudy, windy winters. Temperatures vary from average highs of 59.1 degrees Fahrenheit (°F) to average lows of 33.5 °F. The average annual temperature is 46.3 °F. Average precipitation is 18.32 inches of rain (AECOM, 2020).

2.2.5 Current and Future Land Use

The Facility is adjacent to Rapid City Municipal Airport. The Facility consists of an administration building, office areas, storage buildings, and several hangars. Exterior features are vehicle parking areas and roads. Infrastructure improvements, land acquisitions, land use controls, and reasonably anticipated future land use is not anticipated to change (AECOM, 2020). The Facility is fenced and has restricted access areas.

2.2.6 Sensitive Habitat and Threatened/Endangered Species

A wildlife survey has not occurred at the Facility, and the Facility does not have any significant areas of habitat. The following species have not been identified at the Facility but may be present in the surrounding area.

The following species are listed as federally endangered, threatened, proposed, and/or candidate species in Pennington County, South Dakota (U.S. Fish and Wildlife Service [USFWS], 2021):

Birds: Whooping Crane, *Grus americana* (Endangered); and Red Knot, *Calidris canutus rufa* (Threatened).

Flowering Plants: Leedy's Roseroot, *Rhodiola integrifolia ssp. Leedyi* (Threatened)

Insects: Monarch Butterfly, *Danaus plexippus* (Candidate)

Mammals: Northern Long-eared Bat, *Myotis septentrionalis* (Threatened).

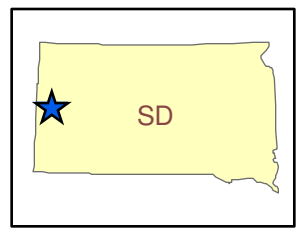
2.3 HISTORY OF PFAS USE

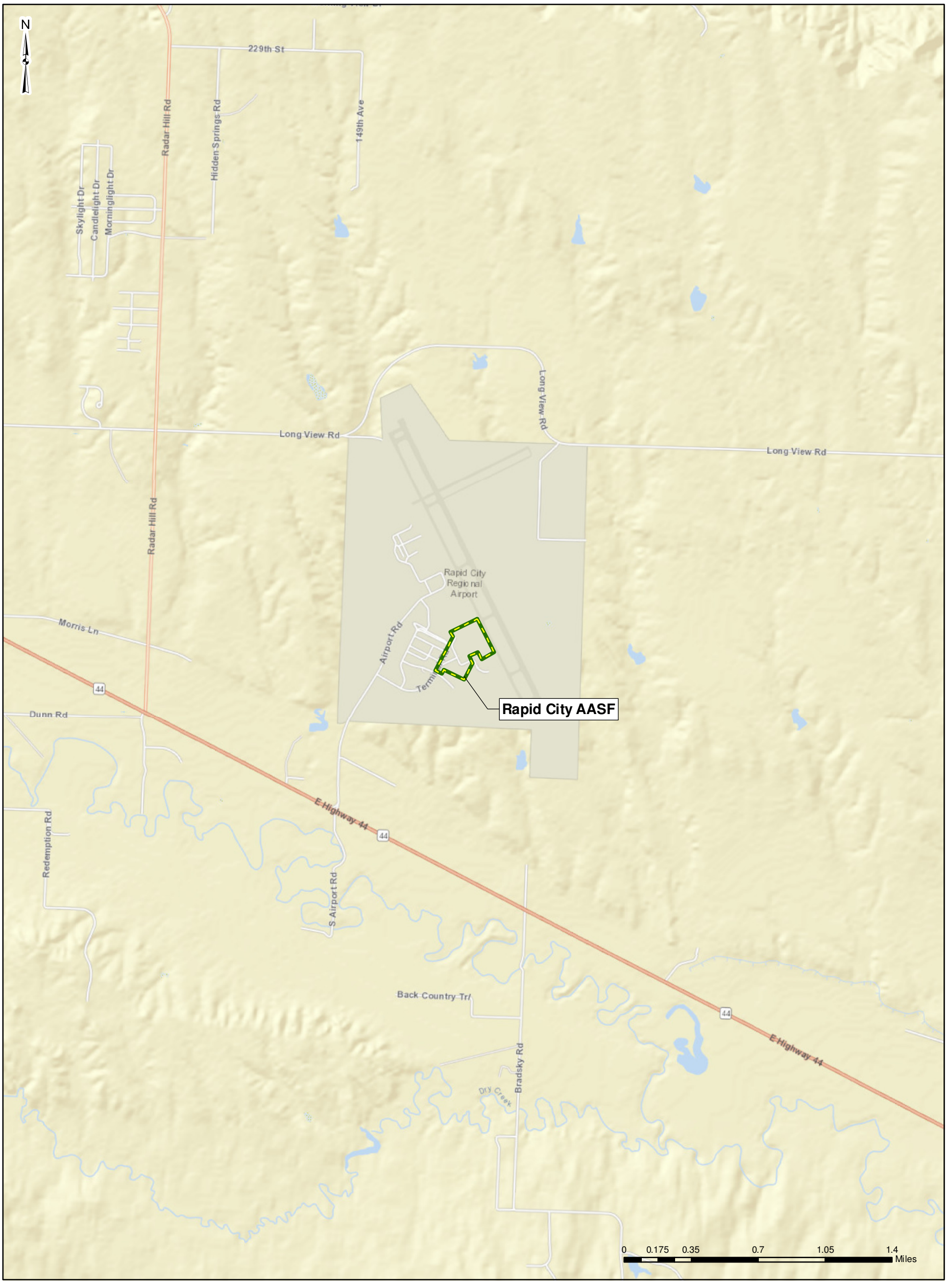
One AOI was identified in the PA where aqueous film forming foam (AFFF) may have been used, stored, disposed, or released historically at the Rapid City AASF (AECOM, 2020). Interviews and records obtained during the PA indicate that AFFF may have been used, stored, disposed, or released historically at the Facility's Main Hangar, which was constructed in 1999 by the South Dakota Army National Guard (SDARNG) and was equipped with an AFFF fire suppression system (AECOM, 2020). Since 2002, the fire suppression system has been tested annually, to ensure the fire suppression system is functional. The potential PFAS release areas

were grouped into one AOI based on preliminary data and presumed groundwater flow directions. A description of the AOI is presented in **Section 3**.

Army National Guard Site Inspections
Site Inspection Report
Rapid City AASF, South Dakota

Figure 2-1
Facility Location





Facility Data

Facility Boundary

Data Sources:
ESRI 2020

Date:.....OCTOBER 2022
Prepared By:.....WSP
Prepared For:.....USACE
Projection:.....NAD 1983 StatePlane

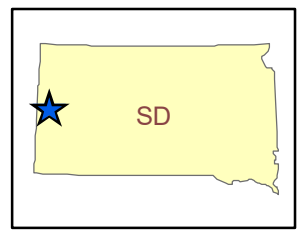
G:\ANG\a_MXD\RapidCity, SD\Facility Location.mxd - megan.cameron - 2/17/2022 - 11:40:24 AM

This page intentionally left blank

Army National Guard Site Inspections
Site Inspection Report
Rapid City, South Dakota

wood.

Figure 2-2
Facility Topography



Facility Data
- Facility Boundary
- Building
- Potential PFAS Release
- Area of Interest

Topography
- Elevation Contour (5 ft. interval)

Data Sources:
ESRI 2020
AECOM 2020

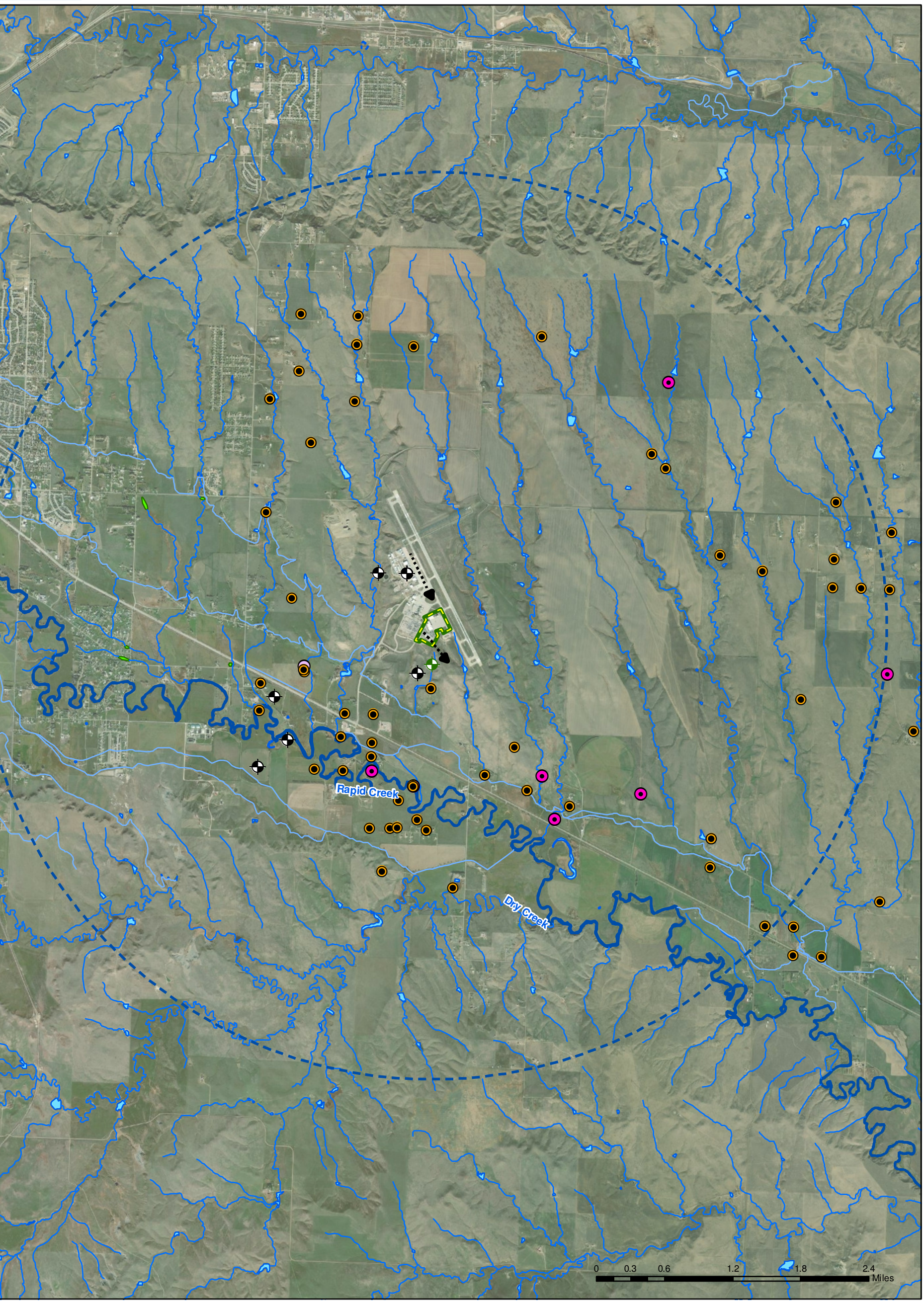
Date:.....FEBRUARY 2022
Prepared By:.....WOOD
Prepared For:.....USACE
Projection:.....NAD 1983 StatePlane

G:\ANG\a_MXD\RapidCity, SD\Figure Facility Topo.mxd - USDJ716516 - 8/31/2023 - 11:41:18 AM

This page intentionally left blank

Army National Guard Site Inspections
Site Inspection Report
Rapid City AASF, South Dakota

Figure 2-3
Groundwater Features



Facility Data
- Facility Boundary
- Facility Boundary 4 Mile Buffer

Wells
- Geothermal Well
- Irrigation Well
- Domestic Well
- Stock Well
- Monitoring Well

Hydrology
- Canal Ditch
- Stream/ River
- Major River Area
- Lake Pond
- Swamp Marsh

Hydrogeology
- Groundwater Flow Direction (November 2021)

Data Sources:
ESRI 2020
AECOM 2020

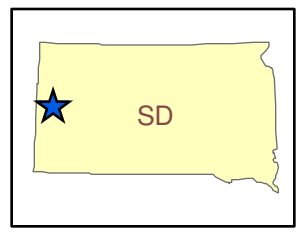
Date:.....OCTOBER 2022
Prepared By:.....WSP
Prepared For:.....USACE
Projection:.....NAD 1983 StatePlane

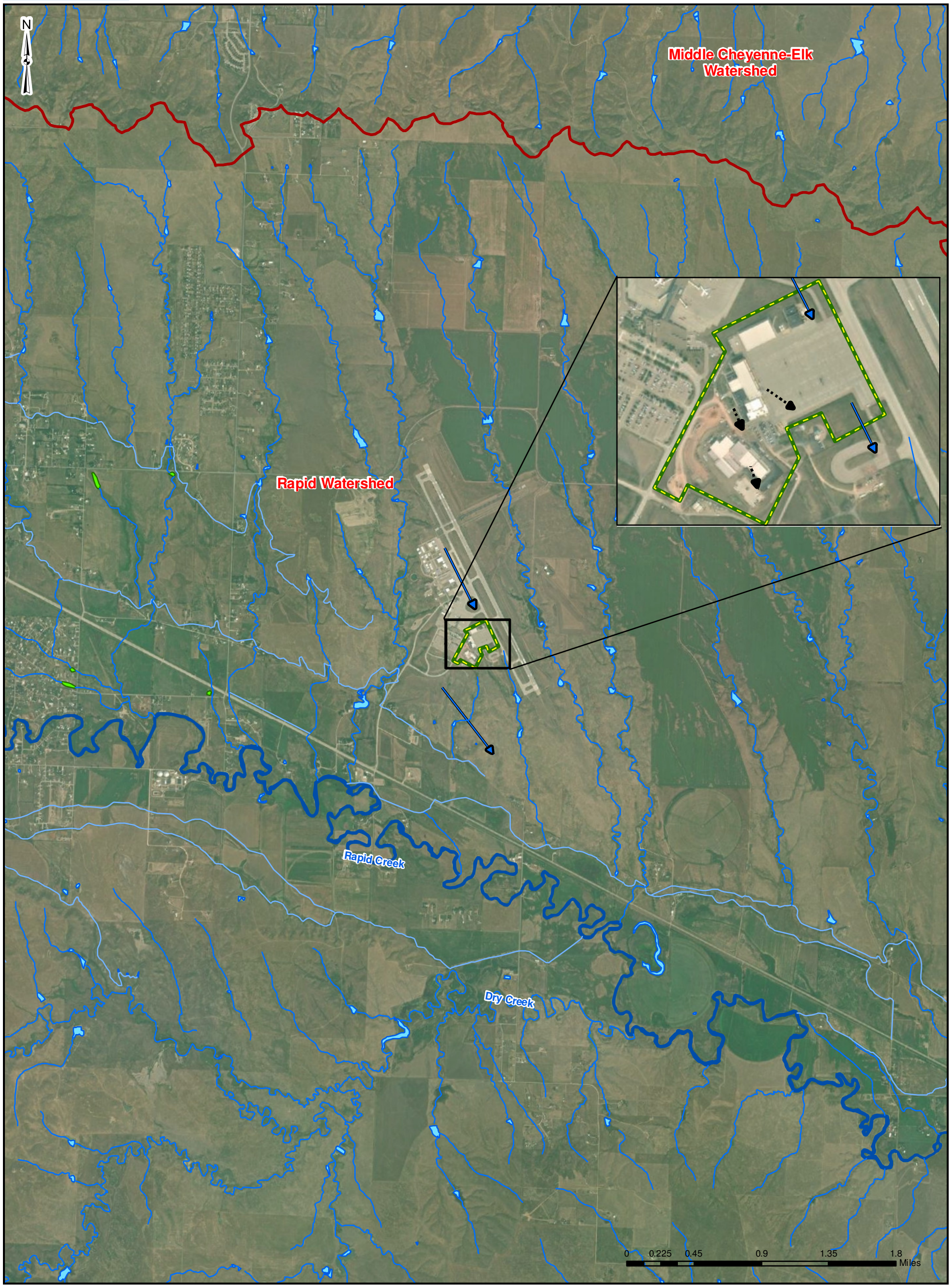
G:\ANG\a_MXD\RapidCity, SD\GroundwaterFeatures11x17.mxd - megan.cameron - 11/1/2022 - 1:26:23 PM

This page intentionally left blank

Army National Guard Site Inspections
Site Inspection Report
Rapid City AASF, South Dakota

Figure 2-4
Surface Water Features





Facility Data
- Facility Boundary

Hydrology
- Canal Ditch
- Stream/ River
- Surface Water Flow Direction
- Groundwater Flow Direction
- Water Bodies
- Swamp/Marsh/Wetland Area
- Major River Area
- Watershed Boundary

Data Sources:
ESRI 2020
AECOM 2020

Date:.....OCTOBER 2022
Prepared By:.....WSP
Prepared For:.....USACE
Projection:.....NAD 1983 StatePlane

G:\ANG\a_MXD\RapidCity, SD\SurfaceWaterFeatures11x17.mxd - megan.cameron - 2/17/2022 - 2:29:53 PM

This page intentionally left blank

Army National Guard Site Inspections
Site-Specific Quality Assurance Project Plan
Rapid City AASF, South Dakota

Figure 2-5
Groundwater Elevations, November 2021

Facility Data
- Facility Boundary
- Building
- Potential PFAS Release
- Area of Interest

Sample Location
- Temporary Groundwater Well Location

Hydrology
- Groundwater Flow Direction
- Surface Water Flow Direction
- Groundwater Elevation Contour Interval (2 Foot)

Data Sources:
ESRI 2020
AECOM

Date:.....OCTOBER 2022
Prepared By:.....WSP
Prepared For:.....USACE
Projection:.....NAD 1983 StatePlane

G:\ANG\a_MXD\RapidCity, SD\Figure 2-5 GWE November 2021_11x17.mxd - megan.cameron - 9/26/2022 - 3:57:08 PM

This page intentionally left blank

3. SUMMARY OF AREAS OF INTEREST

The PA evaluated areas where PFAS-containing materials may have been used, stored, disposed, or released historically. One potential release area was identified at the Rapid City AASF and identified as: AOI 1 Overflow Area. The AOI is shown on **Figure 3-1**.

3.1 AOI 1 – OVERFLOW AREA

The Main Hangar was constructed in 1999 by the SDARNG and was equipped with an AFFF fire suppression system. The hangar fire suppression system consists of two 1,100-gallon tanks filled with 3% AFFF concentrate. The AFFF tanks that supply the fire suppression system are housed in a separate room, adjacent to the hangar. When the fire suppression system is engaged, an automatic switch is activated that routes AFFF/water mixture from the trench drains to a 3,000-gallon concrete bypass UST, shown on **Figure 3-1**. When the fire suppression system is not engaged, liquid in the trench drains is routed to an oil/water separator, which discharged to the former wastewater lagoon that was located on the west side of the airport. As of 17 July 2023, the airport and facility sanitary sewer discharge to the Rapid City wastewater treatment plant. The airport wastewater lagoon will be reportedly decommissioned. The bypass UST is located on the southwest side of the hangar (AECOM, 2020). The former wastewater lagoon and the bypass UST are shown on **Figure 2-2**.

The fire suppression system was installed and initially tested in December of 1999 by a contractor. A firehose was connected to the test header port just inside the hangar, and a foam/water mixture was analyzed. During this test, the large plastic container over-flowed and the foam/water mixture spilled onto the concrete. The contractor addressed the spill immediately; however, a small amount of the mixture flowed into the grassy area south of the Main Hangar, **Figure 3-1**. The plastic container held approximately 500-gallons of the foam/water mixture, which was taken off-site for disposal by the contractor (AECOM, 2020).

Since 2002, the fire suppression system has been tested annually, to ensure the fire suppression system is functional. In general, the contractor will use a hose to bypass the hangar and empty approximately 500-gallons of the AFFF/water mixture directly into the bypass UST during testing. During a single testing event that occurred in 2005, the bypass was not used and the AFFF mixture was discharged to the UST via the hangar trench drain. As a result, trace PFAS in the trench drain piping may be present. When the bypass UST becomes half full, a contractor removes the AFFF/water mixture. Historically the AFFF/water mixture was sent to the Rapid City Landfill and applied to the Municipal Solid Waste Compost to prevent fires. Based on records, a total of approximately 7,500-gallons of the AFFF/water mixture was disposed of at the Rapid City Landfill, with the first disposal occurring on January 6, 2006. In 2019, the AFFF/water mixture was disposed through a DLA contract. The AFFF/water mixture is no longer taken to the Rapid City Landfill. There were no reported leaks or releases from the bypass UST since installation; however, the bypass UST does not have a leak detection system (AECOM, 2020).

There are six mobile Halon fire extinguishers that have been located on the aircraft ramp since 1987. Prior to 2005, non-AFFF fire extinguishers were used on the flight line and ramp areas.

In Spring of 2016, a portion of the concrete and grassy area southwest of the Main Hangar was excavated to make the drainage ditch deeper to allow for better storm water drainage (AECOM, 2020). According to personnel, some of the soil that was removed from the area was temporarily stored south of the Readiness Center location (see **Figure 3-1**), until the construction of the Readiness Center in 2019. Reportedly, the soil was used as fill material during construction of the Readiness Center, however, there are no records indicating where the fill was placed. The use of this soil as fill made the Readiness Center a secondary AOI 1 source.

3.2 ADJACENT SOURCES

Three potential off-Facility sources of PFAS are adjacent to the Facility and are not under the control of the SDARNG. A description of each off-Facility source is presented below and shown on **Figure 3-1**.

3.2.1 Rapid City Fire Department

The Rapid City Fire Department provides emergency response for the AASF. This department is an active fire station containing emergency response vehicles and equipment. Shown on **Figure 3-1**, the Rapid City Fire Department is located north and upgradient of the Facility, and the history of AFFF used during emergency response actions and training was not included in the PA (AECOM, 2020). According to Rapid City Fire Department personnel, historical testing was conducted in the Rapid City Fire Department Station 8 parking lot and at the Ellsworth AFB and current training is conducted on the apron in front of Station 8 using a “no foam” testing system that has been in use since 2020.

3.2.2 Ellsworth Air Force Base

Ellsworth AFB is approximately 8 miles north and upgradient of the Rapid City AASF. In 2018, a Site Inspection was completed at Ellsworth AFB and 12 areas of concern were identified for potential PFAS contamination. The media impacted by PFAS at Ellsworth AFB include surface soil, groundwater, surface water, and sediment. The results of the SI indicated PFOA and PFOS concentrations above 70 parts per trillion (individually or combined) in groundwater for nine of 12 areas investigated. Additionally, PFOA and PFOS were also detected in surface water and surface soil at four of twelve areas investigated (AECOM, 2020). Due to the distance to Ellsworth Air Force Base, it is not shown on the **Figure 3-1**.

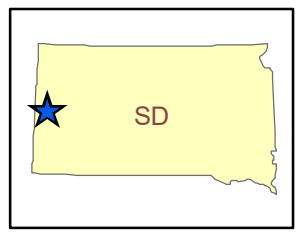
3.2.3 Landfills

Interviewees indicated that the AFFF/water mixture from the bypass UST generated during fire suppression system testing was solely applied to Municipal Solid Waste Compost at the Rapid City Landfill by a contractor. The application of AFFF/water mixture was intended to prevent compost fires. Based on records, approximately a total 7,500-gallons of the AFFF/water mixture was disposed of at the Rapid City Landfill, with the first disposal occurring on January 6, 2006. In 2019, the AFFF/water mixture was disposed through a DLA contract and incinerated. The Rapid City Landfill is approximately 7 miles west of the AASF, hydraulically cross gradient of the Facility (AECOM, 2020). Due to the distance to the Rapid City Landfill, it is not shown on the **Figure 3-1**.

Army National Guard Site Inspections
Site Inspection Report
Rapid City AASF, South Dakota

wood.

Figure 3-1
Area of Interest



Facility Data

- Facility Boundary
- Building
- Potential PFAS Release
- Area of Interest

Hydrology

Data Sources:
ESRI 2020
AECOM 2020

Date:.....FEBRUARY 2022
Prepared By:.....WOOD
Prepared For:.....USACE
Projection:.....NAD 1983 StatePlane

G:\ANG\a_MXD\RapidCity, SD\Figure AOI 11x17.mxd - USDJ716516 - 8/31/2023 - 11:46:39 AM

This page intentionally left blank

4. PROJECT DATA QUALITY OBJECTIVES

As identified during the Data Quality Objective (DQO) process and outlined in the SI Uniform Federal Policy (UFP)-Quality Assurance Project Plan (QAPP) Addendum (EA/Wood, 2021a), the objective of the SI is to identify whether there has been a release to the environment at the AOI identified in the PA. For each AOI, ARNG determines if further investigation is warranted, a removal action is required to address immediate threats, or whether no further action is warranted. This SI evaluated groundwater and soil for the presence or absence of relevant compounds at the sampled AOI.

4.1 PROBLEM STATEMENT

ARNG will recommend an AOI for remedial investigation (RI) if related soil and groundwater samples have concentrations of the relevant compounds above the OSD risk-based SLs. The SLs are presented in **Section 6.1** of this Report.

4.2 INFORMATION INPUTS

Primary information inputs for the SI include the following:

- The PA Report for Rapid City AASF (AECOM, 2020);
- Analytical data from groundwater and soil samples collected as part of this SI in accordance with the site-specific UFP-QAPP Addendum (EA/Wood, 2021a); and
- Field data collected during the SI, including groundwater elevation and water quality parameters measured at the time of sampling.

4.3 STUDY BOUNDARIES

The scope of the SI was bounded horizontally by the property limits of the Facility (**Figures 2-1** and **2-2**). Off-site sampling was not included in the scope of this SI. If future off-site sampling is required, the proper stakeholders will be notified, and necessary rights of entry will be obtained by ARNG with property owner(s). The scope of the SI was vertically bounded as follows: groundwater (approximately 17 ft bgs) and soil from direct-push technology (DPT) borings (33 ft bgs). Temporal boundaries were limited to the earliest available time field resources were available to complete the study.

4.4 ANALYTICAL APPROACH

Samples for PFAS, pH, and grain size analyses were analyzed by Eurofins, accredited under the DoD Environmental Laboratory Accreditation Program (ELAP; Accreditation Number 1.01) and the National Environmental Laboratory Accreditation Program (NELAP; Certificate Number 021). Samples for total organic carbon (TOC) analyses were analyzed by CT Laboratories; accredited under the DoD ELAP Program (Certificate Number 3806.01). Data were compared to applicable SLs within this document and decision rules as defined in the UFP-QAPP Addendum (EA/Wood, 2021a).

4.5 DATA USABILITY ASSESSMENT

The Data Usability Assessment (DUA), which is provided in **Appendix A**, is an evaluation at the conclusion of data collection activities that uses the results of both data verification and validation in the context of the overall project decisions or objectives. Using both quantitative and qualitative methods, the assessment determines whether project execution and the resulting data have met installation specific DQOs. Both sampling and analytical activities are considered to assess whether the collected data are of the right type, quality, and quantity to support the decision-making (DoD, 2019a; DoD, 2019b; EPA, 2017).

Based on the DUA, the environmental data collected during the SI were found to be acceptable and usable for this SI evaluation with the qualifications documented in the DUA and its associated data validation reports. These data are of sufficient quality to meet the objectives and requirements of the UFP-QAPP (EA 2020a).

5. SITE INSPECTION ACTIVITIES

This section describes the environmental investigation and sampling activities that occurred as part of the SI. The SI sampling approach was based on the findings of the PA and was implemented in accordance with the following approved documents.

- *Final Preliminary Assessment Report, Rapid City Army Aviation Support Facility, South Dakota,* dated August 2020 (AECOM, 2020)

- *Final Programmatic Uniform Federal Policy-Quality Assurance Project Plan, Site Inspections for Per- and Polyfluoroalkyl Substances Impacted Sites, ARNG Installations, Nationwide,* dated December 2020 (EA, 2020a)

- *Final Site Inspection Uniform Federal Policy-Quality Assurance Project Plan Addendum, Rapid City Army Aviation Support Facility, South Dakota* dated November 2021 (EA/Wood, 2021a)

- *Final Programmatic Accident Prevention Plan, Revision 1,* dated November 2020 (EA, 2020b)

- *Final Site Safety and Health Plan, Rapid City Army Aviation Support Facility, South Dakota,* dated Month 2021 (EA/Wood, 2021b).

The SI field activities were conducted from 15 to 18 November 2021 and consisted of utility clearance, DPT boring and soil sample collection, temporary monitoring well installation, grab groundwater sample collection, and land surveying. Field activities were conducted in accordance with the UFP-QAPP Addendum (EA/Wood, 2021a), except as noted in **Section 5.8**.

The following samples were collected during the SI and analyzed for 24 compounds via liquid chromatography/tandem mass spectrometry (LC/MS/MS) compliant with QSM Version 5.3 Table B-15 to fulfill the project DQOs:

- Eighteen (18) soil samples from six locations;
- Nine (9) grab groundwater samples from nine temporary well locations;
- Eleven (11) quality assurance (QA)/QC samples.

Figure 5-1 provides the sample locations for all media across the Facility. **Table 5-1** presents the list of samples collected for each medium. Field documentation is provided in **Appendix B**. A log of Daily Notice of Field Activity was completed throughout the SI field activities, which is provided in **Appendix B1**. Sampling forms are provided in **Appendix B2**, land survey data are provided in **Appendix B3**, a Field Change Request form is provided in **Appendix B4**. Additionally, a photographic log of field activities is provided in **Appendix C**.

5.1 PRE-INVESTIGATION ACTIVITIES

In preparation for the SI field activities, project team members participated in Technical Project Planning (TPP) meetings, performed utility clearance, and sampled decontamination source water. Details of these activities are presented below.

5.1.1 Technical Project Planning

The USACE TPP Process, Engineers Manual (EM) 200-1-2 (Department of the Army [DA], 2016a) defines four phases to project planning: (1) defining the project phase; (2) determining data needs; (3) developing data collection strategies; and (4) finalizing the data collection plan. The process encourages stakeholder involvement in the SI, beginning with defining overall project objectives, including DQOs, and formulating a sampling approach to address the AOI identified in the PA.

A combined TPP Meeting 1 and 2 was held on 30 September 2021, prior to SI field activities. The combined TPP Meeting 1 and 2 was conducted in general accordance with EM 200-1-2. The stakeholders for this SI included ARNG, SDARNG, SD DANR, USACE, and representatives familiar with the Facility, the regulations, and the community. Stakeholders were provided the opportunity to make comments on the technical sampling approach and methods at the combined TPP Meeting 1 and 2. The outcome of the combined TPP Meeting 1 and 2 was memorialized in the UFP-QAPP Addendum (EA/Wood, 2021a).

A TPP Meeting 3 was held after the field event to discuss the results of the SI. Meeting minutes for TPP 3 are included in **Appendix D** of this report. Future TPP meetings will provide an opportunity to discuss results and findings, and future actions, where warranted.

5.1.2 Utility Clearance

WSP USA Environment & Infrastructure, Inc. (WSP), previously doing business as Wood Environment & Infrastructure Solutions, Inc. (Wood), contacted the South Dakota 811 Portal to notify them of intrusive work at the Facility. WSP contracted Blood Hound, LLC, a private utility location service, to perform utility clearance at the Facility. Utility clearance was performed at each of the proposed boring locations on 15 November 2021 with input from the WSP field team. General locating services and ground-penetrating radar (GPR) were used to complete the clearance. Additionally, the first 5 feet of each boring were pre-cleared by WSP's drilling subcontractor, Dakota Drilling, Inc, using a hand auger to verify utility clearance in shallow subsurface where utilities would typically be encountered.

5.1.3 Source Water and PFAS Sampling Equipment Acceptability

The potable water source used for decontamination of drilling equipment was confirmed to meet acceptability criteria, as defined in the UFP-QAPP Addendum, prior to the start of field activities. A sample from a potable water source at Rapid City AASF, was collected on 06 October 2021, prior to mobilization, and analyzed for PFAS by LC/MS/MS compliant with QSM 5.3 Table B-15 (DoD, 2020). The results of the sample of the potable water source used for

decontamination of drilling equipment during the SI are provided in **Appendix F**. A discussion of the results is presented in the DUA (**Appendix A**).

Materials that were used within the sampling zone were confirmed as acceptable for use in the PFAS sampling environment. The checklist of acceptable materials for use in the PFAS sampling environment was provided in the Standard Operating Procedures appendix to the Programmatic UFP-QAPP (PQAPP) (EA, 2020a).

5.2 SOIL BORINGS AND SOIL SAMPLING

Soil samples were collected via DPT drilling methods in accordance with Standard Operating Procedure 047 *Direct-Push Technology Sampling* (EA/Wood, 2021a). A Geoprobe® 7822DT dual-tube sampling system was used to collect continuous soil cores to the target depth. A hand auger was used to collect soil from the top 5 ft of the boring in compliance with utility clearance procedures. The soil boring locations are shown on **Figure 5-1**, and boring sample depths are provided in **Table 5-1**. Several boring locations were adjusted within a 50-feet offset for reasons including drill rig access, utility avoidance and bias toward sampling within observed drainage features.

Three discrete soil samples were collected for chemical analysis from each soil boring: one sample at the surface (0 to 1 ft bgs) and two subsurface soil samples. One subsurface soil sample was collected approximately 1 ft above the groundwater table, and one was collected at the mid-point between the surface and the groundwater table (not to exceed 15 ft bgs). Groundwater was encountered at depths ranging from 12.4 to 16.85 ft bgs during drilling. Total boring completion depths, to accommodate temporary well installation, ranged from 20 to 33 ft bgs.

During the drilling, the soil cores were continuously logged for lithological descriptions by a field geologist using the Unified Soil Classification System. A photoionization detector (PID) was used to screen the breathing zone during boring activities as a part of personal safety requirements. Observations and measurements were recorded on electronic sampling forms (**Appendix B2**) and in a non-treated field logbook. Depth interval, recovery thickness, PID concentrations, moisture, relative density, Munsell color, and Unified Soil Classification System texture were recorded. The boring logs are provided in **Appendix E**.

Each sample was collected into a laboratory-supplied PFAS-free high-density polyethylene (HDPE) bottle and labeled using a PFAS-free marker or pen. Samples were packaged on ice and transported via Federal Express (FedEx) under standard chain-of-custody (COC) procedures to the laboratory and analyzed for PFAS (liquid chromatography tandem mass spectrometry [LC/MS/MS] compliant with QSM Version 5.3 Table B-15), TOC (EPA Method 9060A), pH (EPA Method 9045D), and grain size (ASTM Method D-422) in accordance with the UFP-QAPP Addendum (EA/Wood, 2021a).

Field duplicate samples were collected at a rate of 10% and analyzed for the same parameters as the accompanying samples. Matrix spike/matrix spike duplicate (MS/MSD) were collected at a rate of 5% and analyzed for the same parameters as the accompanying samples. In instances when non-dedicated sampling equipment was used, such as a hand auger for the shallow soil samples, one equipment blank (EB) was collected per day and analyzed for the same parameters

as the soil samples. A temperature blank was placed in each cooler for use in confirming that samples were preserved at or below 6 degrees Celsius (°C) during shipment.

DPT borings were converted to temporary wells, which were subsequently abandoned after sampling and surveying in accordance with the UFP-QAPP Addendum (EA/Wood, 2021a). After removal of the casings, boreholes were abandoned using bentonite chips. Borings were installed in grass areas to avoid disturbing concrete or asphalt surfaces.

5.3 TEMPORARY WELL INSTALLATION AND GROUNDWATER GRAB SAMPLING

Temporary wells were installed using a GeoProbe® 7822DT dual-tube sampling system. Once the borehole was advanced to the desired depth, a temporary well was constructed of either 5-ft or 10-ft section of 1-inch Schedule 40 poly-vinyl chloride (PVC) screen with sufficient casing to reach the ground surface. New PVC pipe and screen were used at each location to avoid cross contamination between locations. The screen intervals for the temporary wells are provided in **Table 5-2**.

Groundwater samples were collected after a period of time following well installation to allow groundwater to infiltrate and recharge the temporary well screen intervals. After the recharge period, groundwater samples were collected using a peristaltic pump with PFAS-free HDPE tubing. The temporary wells were purged at a rate determined in the field to reduce turbidity and draw down prior to sampling. Water quality parameters (e.g., temperature, specific conductance, pH, dissolved oxygen, and oxidation-reduction potential) were measured using a water quality meter and recorded on the field sampling form (**Appendix B2**) before each grab sample was collected in a separate container. Additionally, a subsample of each groundwater sample was collected in a separate container, and a shaker test was completed to identify if there were any foaming. No foaming was noted in any of the groundwater samples.

Each sample was collected in laboratory-supplied PFAS-free HDPE bottles and labeled using a PFAS-free marker or pen. Samples were packaged on ice and transported via FedEx under standard COC procedures to the laboratory and analyzed for PFAS by LC/MS/MS compliant with QSM Version 5.3 Table B-15 in accordance with the UFP-QAPP Addendum (EA/Wood, 2021a).

Field duplicate samples were collected at a rate of 10% and analyzed for the same parameters as the accompanying samples. MS/MSDs were collected at a rate of 5% and analyzed for the same parameters as the accompanying samples. Three field blank (FB) samples were collected in accordance with the UFP-QAPP Addendum (EA/Wood, 2021a). A temperature blank was placed in each cooler for use in confirming that samples were preserved at or below 6°C during shipment.

Following well surveying (described below in **Section 5.7**), temporary wells were abandoned in accordance with the SI UFP-QAPP Addendum (EA/Wood, 2021a) by removing the PVC and backfilling the hole with bentonite chips.

5.4 SYNOPTIC WATER LEVEL MEASUREMENTS

A synoptic groundwater gauging event was performed on 18 November 2021. Groundwater elevation measurements were collected from the nine new temporary monitoring wells. Water level measurements were taken from the survey mark on the northern side of the well casing. Groundwater elevation data is provided in **Table 5-3**. A groundwater flow contour map is provided as **Figure 2-4**.

5.5 SURVEYING

The northern side of each new temporary well casing was surveyed using a Trimble R10 real-time kinematic differential global positioning system. Positions were collected in the applicable South Dakota State Plane North American Datum of 1983 (horizontal) and North American Vertical Datum 1988 (vertical). Surveying data were collected on 18 November 2021 and are provided in **Appendix B3**.

5.6 INVESTIGATION-DERIVED WASTE

As of the date of this report, the disposal of PFAS investigation-derived waste (IDW) is not regulated federally. IDW generated during the SI is considered non-hazardous waste and was managed in accordance with the UFP-QAPP Addendum (EA/Wood, 2021a).

Soil IDW (i.e., soil cuttings) and liquid IDW (i.e., purge water and decontamination fluids) generated during the SI activities were drummed separately in 55-gallon steel drums. The IDW drums were subsequently stored within secondary containment in a dedicated indoor area within the Rapid City AASF Facility. The soil IDW was not sampled and assumes the characteristics of the associated soil samples collected from that source location. The liquid IDW was not sampled and assumes the characteristics of the associated groundwater samples collected from that source location.

The IDW disposal is being managed separately under a contract with EA Engineering, Science, and Technology, Inc. Specifics on the disposal of solid and liquid IDW will be addressed in an IDW Technical Memorandum.

Other solids such as spent personal protective equipment, plastic sheeting, tubing, rope, unused monitoring well construction materials, and other environmental media generated during the field activities were disposed of at a licensed solid waste landfill.

5.7 LABORATORY ANALYTICAL METHODS

Samples were analyzed by LC/MS/MS, compliant with QSM Version 5.3 Table B-15, at Eurofins in Lancaster, Pennsylvania, a DoD ELAP and NELAP-certified laboratory.

Soil samples were also analyzed for TOC using EPA Method 9060A, pH by EPA Method 9045D, and grain size using ASTM Method D-422.

5.8 Deviations from SI UFP-QAPP Addendum

Deviations from the UFP-QAPP Addendum occurred based on conditions encountered during field activities. These deviations were discussed between WSP, EA, ARNG, and USACE. Three deviations from the UFP-QAPP Addendum are noted below.

The location of AOI01-03 was chosen to assess an area of storm water runoff. When field verified, it was determined that the proposed location was not positioned in the target area, additionally a generator and a parking lot were in conflict with the originally proposed location. The sample location was shifted approximately 30 feet southeast to avoid the generator and parking lot and to assess the stormwater runoff area. A field change request was submitted on 16 November 2021. The approved field change request form is included in **Appendix B4.**

While installing the boring at AOI01-05, the groundwater depth was not evident, and the boring was installed too deep to use the peristaltic pump. Another boring was installed approximately 5 feet west of the original boring (identified as AOI01-05B). The soil samples were taken from the initial boring (AOI01-05), while the groundwater sample were taken from the step-out location (AOI01-05B).

The location of the water table was not immediately evident in several of the borings (AOI01-02, AOI01-03, AOI01-06, and AOI01-07). As such, a 10 ft screen, rather than a 5 ft screen, was used to increase the likelihood that the temporary monitoring well was screened across the water table.

Table 5-1. Site Inspection Samples by Medium
Rapid City AASF, Rapid City, South Dakota
Site Inspection Report

Sample Identification	Sample Collection Date	Sample Depth (ft bgs)	PFAS (LC/MS/MS compliant with QSM 5.3 Table B-15)	TOC (EPA Method 9060A)	pH (EPA Method 9045D)	Grain Size (ASTM D422)	Comments
Soil Samples							
AOI01-01-SB-0-1	11/17/2021	0-1	X				
AO101-01-TOC/pH/Moisture	11/17/2021	0-2		X	X		Parent Sample of AO101-01-TOC/pH/Moisture-DUP
AO101-01-TOC/pH/Moisture-DUP	11/17/2021	0-2		X	X		Field Duplicate
AO101-01-Grain Size		0-2				X	
AOI01-01-SB-6-8	11/17/2021	6-8	X				
AOI01-01-SB-10-11	11/17/2021	10-11	X				
AOI01-02-SB-0-1	11/17/2021	0-1	X				Parent Sample of AOI01-DUP02-0-1
AOI01-DUP02-0-1	11/17/2021	0-1	X				Field Duplicate
AOI01-02-SB-5-6	11/17/2021	5-6	X				
AOI01-02-SB-13-14	11/17/2021	13-14	X				
AOI01-03-SB-5-6	11/17/2021	5-6	X				
AOI01-03-SB-6-7	11/17/2021	6-7	X				
AOI01-03-SB-9.5-11	11/17/2021	9.5-11	X				
AOI01-04-SB-0-1	11/16/2021	0-1	X				
AOI01-04-SB-6-7	11/16/2021	6-7	X				
AOI01-04-SB-13-14	11/16/2021	13-14	X				
AOI01-05-SB-0-1*	11/16/2021	0-1	X				Parent Sample of AOI01-DUP01-0-1
AOI01-DUP01-0-1*	11/16/2021	0-1	X				Field Duplicate
AOI01-05-SB-6-7*	11/16/2021	6-7	X				
AOI01-05-SB-14-15*	11/16/2021	14-15	X				
AOI01-07-SB-0-1	11/16/2021	0-1	X				
AOI01-07-SB-7-8	11/16/2021	7-8	X				
AOI01-07-SB-14-15	11/16/2021	14-15	X				
Groundwater Samples							
AOI01-01-GW	11/18/2021		X				
AOI01-02-GW	11/18/2021		X				
AOI01-03-GW	11/18/2021		X				
AOI01-04-GW	11/18/2021		X				
AOI01-05-GW*	11/18/2021		X				
AOI01-06-GW	11/18/2021		X				
AOI01-07-GW	11/18/2021		X				

Sample Identification	Sample Collection Date	Sample Depth (ft bgs)	PFAS (LC/MS/MS compliant with QSM 5.3 Table B-15)	TOC (EPA Method 9060A)	pH (EPA Method 9045D)	Grain Size (ASTM D422)	Comments
RCAASF-01-GW	11/18/2021		X				
RCAASF-02-GW	11/18/2021		X				Parent Sample of DUP-01-GW
DUP-01-GW	11/18/2021		X				Field Duplicate
Blank Samples							
AOI01-Field Blank-01	11/16/2021		X				Field Blank
AOI01-Equipment Blank-01	11/16/2021		X				Equipment Blank Collected from Hand Auger
AOI01-Field Blank-02	11/17/2021		X				Field Blank
AOI01-Equipment Blank-02	11/17/2021		X				Equipment Blank Collected from Hand Auger
AOI01-Equipment Blank-03	11/17/2021		X				Equipment Blank Collected from Clean Tubing
AOI01-Field Blank-03	11/18/2021		X				Field Blank
AOI01-Equipment Blank-04	11/18/2021		X				Equipment Blank Collected from Clean Tubing
RCAASF-PW-01	10/6/2021		X				Potable Water Sample

Notes:
*Soil samples collected from initial boring location (AOI101-05). Groundwater sample collected from off-set location (AOI01-05B) and labeled as AOI01-05-GW.
AASF = Army Aviation Support Facility
ASTM = American Society for Testing and Materials
bgs = below ground surface
LC/MS/MS = Liquid Chromatography Mass Spectrometry
QSM = Quality Systems Manual
TOC = total organic carbon
USEPA = United States Environmental Protection Agency

Table 5-2. Soil Boring Depths and Temporary Well Screen Intervals
Rapid City AASF, Rapid City, South Dakota
Site Inspection Report

Area of Interest	Boring Location	Soil Boring Depth (ft bgs)	Temporary Well Screen Interval (ft bgs)
1	AOI01-01	20.0	15.0 – 20.0
	AOI01-02	25.0	13.0 – 23.0
	AOI01-03	25.0	15.0 – 25.0
	AOI01-04	25.5	20.0 – 25.0
	AOI01-05*	33.0	28.0 – 33.0
	AOI01-05B*	20.0	15.0 – 20.0
	AOI01-06	24.3	15.0 – 25.0
	AOI01-07	25.0	15.0 – 25.0
	RCAASF-01	25.0	20.0 – 25.0
	RCAASF-02	23.0	18.0 – 23.0

Notes:
*Soil samples collected from initial boring location (AOI101-05). Groundwater sample collected from second location (AOI01-05B).
bgs = below ground surface
ft = feet

Table 5-3. Groundwater Elevation
Rapid City AASF, Rapid City, South Dakota
Site Inspection Report

Monitoring Well ID	**Top of Casing Elevation (ft NAVD88)**	Depth to Water (ft btoc)	Depth to Water (ft bgs)	**Groundwater Elevation (ft NAVD 88)**
AOI01-01	3158.48	12.40	11.78	3146.08
AOI01-02	3159.58	13.35	12.72	3146.23
AOI01-03	3158.97	14.89	13.60	3144.08
AOI01-04	3153.90	15.88	15.34	3138.02
AOI01-05B*	3152.95	15.03	14.24	3137.92
AOI01-06	3154.38	16.85	16.01	3137.53
AOI01-07	3153.86	15.34	14.20	3138.52
RCAASF-01	3161.32	16.16	14.94	3145.16
RCAASF-02	3159.52	16.56	14.43	3142.96

Notes:
*Soil samples collected from initial boring location (AOI101-05). Groundwater sample collected from second location (AOI01-05B). Groundwater measurements not taken at AOI01-05
Bgs = below ground surface
btoc = below top of casing
NAVD88 = North American Vertical Datum 1988

Army National Guard Site Inspections
Site Inspection Report
Rapid City AASF, South Dakota

Figure 5-1
Site Inspection Sample Locations

Facility Data
- Facility Boundary
- Building
- Potential PFAS Release
- AOI

Sample Location
- Soil Boring and Temporary Groundwater Well Location
- Temporary Groundwater Well Location
- Soil Boring Location

Hydrology
- Groundwater Flow Direction
- Surface Water Flow Direction

Data Sources:
ESRI 2020
AECOM 2020

Date:.....OCTOBER 2022
Prepared By:.....WSP
Prepared For:.....USACE
Projection:.....NAD 1983 StatePlane

G:\ANG\a_MXD\RapidCity, SD\Figure 5-1 SampleLocation11x17.mxd - dylan.jones - 2/24/2022 - 1:15:21 PM

This page intentionally left blank

6. SITE INSPECTION RESULTS

This section presents the analytical results of the SI. The SLs used in this evaluation are presented in **Section 6.1** and **Table 6-1**. A discussion of the results for the AOI is provided in **Section 6.3**. **Tables 6-2** through **6-5** present results in soil or groundwater for the relevant compounds. Tables that contain all results are provided in **Appendix F**, and the laboratory reports are provided in **Appendix G**.

6.1 SCREENING LEVELS

The DoD has adopted a policy to retain facilities in the CERCLA process based on risk-based SLs for soil and groundwater, as described in a memorandum from the OSD (Assistant Secretary of Defense, 2022). The ARNG program under which this SI was performed follows this DoD policy. Should the maximum concentration for sampled media exceed the SLs established in the OSD memorandum, the AOI will proceed to the next phase under CERCLA. The SLs established in the OSD memorandum apply to the five compounds presented on **Table 6-1**.

Table 6-1. Screening Levels (Soil and Groundwater)

Analyt[2]	Residential (Soil) (µg/kg)[1] 0-2 ft bgs	Industrial / Commercial Composite Worker (Soil) (µg/kg)[1] 2-15 ft bgs	Tap Water (Groundwater) (ng/L)[1]
PFOA	19	250	6
PFOS	13	160	4
PFBS	1,900	25,000	601
PFHxS	130	1,600	39
PFNA	19	250	6

Notes:
1. Assistant Secretary of Defense. July 2022. Risk Based Screening Levels in Groundwater and Soil using U.S. Environmental Protection Agency's (EPA's) Regional Screening Level Calculator. Hazard Quotient (HQ)=0.1. May 2022.
2. Of the six PFAS compounds presented in the 6 July 2022 OSD memorandum, HFPO-DA (commonly referred to as GenX) was not included as an analyte at the time of this SI. Based on the CSM developed during the PA and revised based on SI findings, the presence of HFPO-DA is not anticipated at the facility because HFPO-DA is generally not a component of MIL-SPEC AFFF and based on its history including distribution limitations that restricted use of GenX, it is generally not a component of other products the military used. In addition, it is unlikely that GenX would be an individual chemical of concern in the absence of other PFAS.

Abbreviations:
µg/kg = microgram(s) per kilogram
bgs = below ground surface
ft = feet
ng/L = nanogram(s) per liter

The data in the subsequent sections are compared against the SLs presented in **Table 6-1**. The SLs for groundwater are based on direct ingestion. The SLs for soil are based on incidental ingestion and are applied to the depth intervals reasonably anticipated to be encountered by the receptors identified at the Facility: the residential scenario is applied to surface soil results (0 to 2 feet bgs) and the industrial/commercial worker scenario is applied to shallow subsurface soil

results (2 to 15 feet bgs). The SLs are not applied to deep subsurface soil results (>15 feet bgs) because 15 feet is the anticipated limit of construction activities.

6.2 SOIL PHYSICOCHEMICAL ANALYSES

To provide basic soil parameter information, soil samples were analyzed for TOC, pH, and grain size, which are important for evaluating transport through the soil medium. **Appendix E** contains the results of the TOC, pH, and grain size sampling.

The data collected in this investigation will be used in subsequent investigations, where appropriate, to assess fate and transport. According to the Interstate Technology Regulatory Council (ITRC), several important PFAS partitioning mechanisms include hydrophobic and lipophobic effects, electrostatic interactions, and interfacial behaviors. At relevant environmental pH values, certain PFAS are present as organic anions, and are therefore relatively mobile in groundwater (Xiao et al., 2015), but tend to associate with the organic carbon fraction that may be present in soil or sediment (Higgins and Luthy, 2006; Guelfo and Higgins, 2013). When sufficient organic carbon is present, organic carbon normalized distribution coefficients (K_{oc} values) can help in evaluating transport potential, though other geochemical factors (for example, pH and presence of polyvalent cations) may also affect PFAS sorption to solid phases (ITRC, 2018).

6.3 AOI 1

This section presents the analytical results for soil and groundwater in comparison to SLs for AOI 1: Overflow Area. The soil and groundwater results are summarized in **Table 6-2** through **Table 6-5**. Soil and groundwater results are presented on **Figures 6-1** through **Figure 6-7**.

6.3.1 AOI 1 Soil Analytical Results

Soil samples were collected from six boring locations associated with AOI 1 during the SI. **Tables 6-2** and **Table 6-4** summarize the soil results. **Figure 6-1** through **Figure 6-5** present the ranges of detections in soil.

Surface soil (0 to 1 ft bgs) was sampled from boring locations AOI01-01, AOI01-02, AOI01-04, AOI01-05 and AOI01-07, with duplicate surface soil samples being collected at AOI01-01 and AOI01-05. Due to the 2019 construction at the Rapid City AASF, in lieu of a surface soil sample at AOI01-03, soil was collected at the first sign of native soil (5 to 6 ft bgs). Soil was also sampled from shallow subsurface soil (5 to 8 ft bgs) and deep subsurface soil intervals (9.5 to 15 ft bgs) from boring locations AOI01-01, AOI01-02, AOI01-03, AOI01-04, AOI01-05 and AOI01-07.

PFNA, PFOA and PFOS were detected in surface soil at concentrations below their respective SLs. PFNA was detected in surface soil at two of the five sample locations (AOI01-01 and AOI01-02 [and its duplicate]) and ranged in concentration from 1.9 µg/kg to 5.8 µg/kg. PFOA was detected in surface soil at two of the five sample locations (AOI01-01 and AOI01-02 [and its duplicate]) and ranged in concentration from 1.1 µg/kg to 13.0 µg/kg. PFOS was detected in

surface soil at all five sample locations (AOI01-01, AOI01-02 [and its duplicate], AOI01-04, AOI01-05 [and its duplicate] and AOI01-07) and ranged in concentration from 1.1 J+ µg/kg to 2.6 µg/kg. PFBS and PFHxS were not detected in the surface soil samples.

PFHxS, PFNA, PFOA and PFOS were detected in shallow subsurface soil at concentrations below their respective SLs. PFHxS was detected in shallow subsurface soil at one of six shallow subsurface sampling locations (AOI01-03) at a maximum concentration of 0.36 J µg/kg. PFNA was detected in shallow subsurface soil at one of six locations at a concentration of 0.54 J µg/kg (AOI01-01). PFOA was detected in shallow subsurface soil at one of six locations at a concentration of 1.7 µg/kg (AOI01-01). PFOS was detected in shallow subsurface soil at one of six locations at a concentration of 0.75 µg/kg (AOI01-03). PFBS was not detected in shallow subsurface soil samples.

PFNA, PFOA and PFOS were detected in deep subsurface soil at concentrations below their respective SLs. PFNA was detected in deep subsurface soil at one of six locations at a concentration of 1.9 µg/kg (AOI01-01). PFOA was detected in deep subsurface soil at one of six location at a concentration of 1.7 µg/kg (AOI01-01). PFOS was detected in deep subsurface soil in two of six locations and ranged in concentration from 0.88 µg/kg to 2.0 µg/kg (AOI01-01 and AOI01-02). PFBS and PFHxS were not detected in the deep subsurface soil samples.

6.3.2 AOI 1 Groundwater Analytical Results

Groundwater samples were collected from seven temporary wells associated with AOI 1 during the SI. **Figure 6-6** and **Figure 6-7** presents the ranges of detections in groundwater. **Table 6-5** summarizes the groundwater results.

Groundwater was sampled from temporary monitoring well locations AOI01-01 through AOI01-07. PFHxS, PFNA, PFOA and PFOS were detected at concentrations exceeding their respective SLs. PFHxS was detected in all groundwater samples with concentrations ranging from 5.1 to 280 ng/L, and it exceeded the SL at three locations (AOI01-01, AOI01-03, and AOI01-07). PFNA was detected in all groundwater samples with concentrations ranging from 0.41 J to 140 ng/L, and it exceeded the SL at two locations (AOI01-01 and AOI01-02). PFOA was detected in all groundwater samples with concentrations ranging from 4.5 J- ng/L to 1,300 J- ng/L, and it exceeded the SL at six locations (AOI01-01, AOI01-02, AOI01-03, AOI01-04, AOI01-06, and AOI01-07). PFOS was detected in all groundwater samples with concentrations ranging from 1.4 J ng/L to 880 ng/L, and it exceeded the SL at five locations (AOI01-01, AOI01-02, AOI01-03, AOI01-06, and AOI01-07). PFBS was detected at concentrations below the respective SL. PFBS was detected in all locations and ranged in concentration from 2.8 J- ng/L to 21 J- ng/L.

6.3.3 Conclusions

Based on the results of the SI, PFHxS, PFNA, PFOA, and/or PFOS were detected in groundwater at concentrations above their respective SLs at all locations except AOI01-05B. Based on the exceedances of the SLs in groundwater, further evaluation at AOI 1 is warranted. While no soil samples exceeded the SLs, PFHxS, PFNA, PFOS and PFOA were detected in

surface soil samples and shallow subsurface soil samples. PFNA, PFOA and PFOS were detected in deep subsurface soil at concentrations below their respective SLs.

6.4 BOUNDARY SAMPLE LOCATIONS

This section presents the analytical results for soil and groundwater in comparison to SLs for samples collected at the Facility boundary. The detected compounds are summarized in **Tables 6-2 through 6-5**. Soil and groundwater results are presented on **Figures 6-1 through 6-7**.

6.4.1 Boundary Sample Locations – Soil Analytical Results

No soil samples were collected from boundary locations.

6.4.2 Boundary Sample Locations – Groundwater Analytical Results

Groundwater was sampled from RCAASF-01 and RCAASF-02. PFHxS was detected at concentrations exceeding its respective SL. PFHxS was detected at both locations at concentrations ranging from 19 ng/L to 430 ng/L [430 ng/L in the sample duplicate]; PFHxS exceeds the SL at one location (RCAASF-02). PFOA was detected at both locations with concentrations ranging from 8.9 J- ng/L to 87 J- ng/L [89 J- ng/L in the sample duplicate]; PFOA exceeded the screening level at both locations (RCAASF-01 and RCAASF-02). PFOS was detected at both locations with concentrations ranging from 11 ng/L to 310 ng/L [310 ng/L in the sample duplicate]; PFOS exceeded the SL at both locations (RCAASF-01 and RCAASF-02).

PFBS and PFNA were detected in at both boundary locations at concentrations below their respective SLs. PFNA was detected at a concentration ranging from 1.5 J ng/L to 2.1 ng/L (2.3 ng/L in the sample duplicate). PFBS was detected in both locations at concentrations ranging from 3.4 J- ng/L to 25 J- ng/L (24 J- ng/L in the sample duplicate).

6.4.3 Conclusions

Based on the results of the SI, PFHxS, PFOA and PFOS were detected in upgradient boundary groundwater samples at concentrations above their respective SLs. These results may indicate a potential off-Facility source upgradient of AOI 1.

Table 6-2
PFOA, PFOS, PFBS, PFNA, and PFHxS Results in Surface Soil
Site Inspection Report
Rapid City AASF

Area of Interest		AOI01-01													
Location ID		AOI01-01		AOI01-02		AOI01-02		AOI01-04		AOI01-05		AOI01-05		AOI01-07	
Sample ID		AO101-01-SB-0-1		AO101-02-SB-0-1		AO101-DUP02-0-1		AO101-04-SB-0-1		AO101-05-SB-0-1		AO101-DUP01-0-1		AO101-07-SB-0-1	
Sample Date		11/17/2021		11/17/2021		11/17/2021		11/16/2021		11/16/2021		11/16/2021		11/16/2021	
Depth		0 - 1 ft		0 - 1 ft		0 - 1 ft		0 - 1 ft		0 - 1 ft		0 - 1 ft		0 - 1 ft	
Analyte	**OSD Screening Level [1]**	**Result**	**Qual**	**Result**	**Qual**	**Result**	**Qual**	**Result**	**Qual**	**Result**	**Qual**	**Result**	**Qual**	**Result**	**Qual**
Soil, PFAS by LCMSMS compliant with QSM 5.3 Table B-15 (µg/kg)															
PFBS	1900	ND	U	ND	U	ND	U	ND	U	ND	U	ND	U	ND	U
PFHxS	130	ND	U	ND	U	ND	U	ND	U	ND	U	ND	U	ND	U
PFNA	19	5.8		2.0		1.9		ND	U	ND	U	ND	U	ND	U
PFOA	19	13		1.1		1.7		ND	U	ND	U	ND	U	ND	U
PFOS	13	2.6		1.2		2.0		1.1	J+	1.1	J+	1.1	J+	1.1	J+

Notes

Gray Fill	Detected concentration exceeded OSD Screening Levels

References

1. Assistant Secretary of Defense, July 2022. *Risk Based Screening Levels Calculated for PFOA, PFOS, PFBS, PFHxS, and PFNA in Groundwater or Soil using USEPA's Regional Screening Level Calculator. HQ=0.1. May 2022.* The screening levels for soil are based on residential scenario for incidental ingestion of contaminated soil.

Chemical Abbreviations

PFBS	perfluorobutanesulfonic acid
PFHxS	perfluorohexanesulfonic acid
PFNA	perfluorononanoic acid
PFOA	perfluorooctanoic acid
PFOS	perfluorooctanesulfonic acid

Interpreted Qualifiers

J+ = The result is an estimated quantity, but the result may be biased high.
U = The analyte was not detected at a level greater than or equal to the adjusted DL.

Acronyms and Abbreviations

µg/kg	microgram(s) per kilogram
AASF	Army Aviation Support Facility
AOI	Area of Interest
DUP	duplicate
HQ	Hazard Quotient
ID	identification
LCMSMS	liquid chromatography with tandem mass spectrometry
LOD	limit of detection
LOQ	limit of quantitation
ND	analyte not detected above the LOD (LOD values are presented in Appendix F)
OSD	Office of the Secretary of the Defense
QSM	Quality Systems Manual
PFAS	per- and polyfluoroalkyl substances
SB	soil boring
USEPA	United States Environmental Protection Agency
Qual	interpreted qualifier

This page intentionally left blank

Table 6-3
PFOA, PFOS, PFBS, PFNA, and PFHxS Results in Shallow Subsurface Soil
Site Inspection Report
Rapid City AASF

	Area of Interest	AOI01													
	Location ID	AOI01-01		AOI01-02		AOI01-03		AOI01-03		AOI01-04		AOI01-05		AOI01-07	
	Sample ID	AO101-01-SB-6-8		AO101-02-SB-5-6		AO101-03-SB-5-6		AO101-03-SB-6-7		AO101-04-SB-6-7		AO101-05-SB-6-7		AO101-07-SB-7-8	
	Sample Date	11/17/2021		11/17/2021		11/17/2021		11/17/2021		11/16/2021		11/16/2021		11/16/2021	
	Depth	6 - 8 ft		5 - 6 ft		5 - 6 ft		6 - 7 ft		6 - 7 ft		6 - 7 ft		7 - 8 ft	
Analyte	**OSD Screening Level [1]**	**Result**	**Qual**	**Result**	**Qual**	**Result**	**Qual**	**Result**	**Qual**	**Result**	**Qual**	**Result**	**Qual**	**Result**	**Qual**
Soil, PFAS by LCMSMS compliant with QSM 5.3 Table B-15 (µg/kg)															
PFBS	25000	ND	U	ND	U	ND	U	ND	U	ND	U	ND	U	ND	U
PFHxS	1600	ND	U	ND	U	0.36	J	0.33	J	ND	U	ND	U	ND	U
PFNA	250	0.54	J	ND	U	ND	U	ND	U	ND	U	ND	U	ND	U
PFOA	250	1.7		ND	U	ND	U	ND	U	ND	U	ND	U	ND	U
PFOS	160	ND	U	ND	U	ND	U	0.75		ND	U	ND	U	ND	U

Notes

Gray Fill — Detected concentration exceeded OSD Screening Levels

References

1. Assistant Secretary of Defense, July 2022. *Risk Based Screening Levels Calculated for PFOA, PFOS, PFBS, PFHxS, and PFNA in Groundwater or Soil using USEPA's Regional Screening Level Calculator. HQ=0.1. May 2022.* The screening levels for soil are based on Industrial/Commercial Composite Worker scenario for incidental ingestion of contaminated soil.

Chemical Abbreviations

PFBS	perfluorobutanesulfonic acid
PFHxS	perfluorohexanesulfonic acid
PFNA	perfluorononanoic acid
PFOA	perfluorooctanoic acid
PFOS	perfluorooctanesulfonic acid

Interpreted Qualifiers

J = The result is an estimated quantity.

U = The analyte was not detected at a level greater than or equal to the adjusted DL.

Acronyms and Abbreviations

µg/kg	microgram(s) per kilogram
AASF	Army Aviation Support Facility
AOI	Area of Interest
DUP	duplicate
HQ	Hazard Quotient
ID	identification
LCMSMS	liquid chromatography with tandem mass spectrometry
LOD	limit of detection
LOQ	limit of quantitation
ND	analyte not detected above the LOD (LOD values are presented in Appendix F)
OSD	Office of the Secretary of the Defense
QSM	Quality Systems Manual
PFAS	per- and polyfluoroalkyl substances
SB	soil boring
USEPA	United States Environmental Protection Agency
Qual	interpreted qualifier

This page intentionally left blank

Table 6-4
PFOA, PFOS, PFBS, PFNA, and PFHxS Results in Deep Subsurface Soil
Site Inspection Report
Rapid City AASF

	Area of Interest	AOI01-01											
	Location ID	AOI01-01		AOI01-02		AOI01-03		AOI01-04		AOI01-05		AOI01-07	
	Sample ID	AO101-01-SB-10-11		AO101-02-SB-13-14		AO101-03-SB-9.5-11		AO101-04-SB-13-14		AO101-05-SB-14-15		AO101-07-SB-14-15	
	Sample Date	11/17/2021		11/17/2021		11/17/2021		11/16/2021		11/16/2021		11/16/2021	
	Depth	10 - 11 ft		13 - 14 ft		9.5 - 11 ft		13 - 14 ft		14 - 15 ft		14 - 15 ft	
Analyte	**OSD Screening Level [1]**	**Result**	**Qual**	**Result**	**Qual**	**Result**	**Qual**	**Result**	**Qual**	**Result**	**Qual**	**Result**	**Qual**
Soil, PFAS by LCMSMS compliant with QSM 5.3 Table B-15 (µg/kg)													
PFBS	25000	ND	U	ND	U	ND	U	ND	U	ND	U	ND	U
PFHxS	1600	ND	U	ND	U	ND	U	ND	U	ND	U	ND	U
PFNA	250	1.9		ND	U	ND	U	ND	U	ND	U	ND	U
PFOA	250	1.7		ND	U	ND	U	ND	U	ND	U	ND	U
PFOS	160	2.0		0.88		ND	U	ND	U	ND	U	ND	U

Notes

Gray Fill — Detected concentration exceeded OSD Screening Levels

References

1. Assistant Secretary of Defense, July 2022. *Risk Based Screening Levels Calculated for PFOA, PFOS, PFBS, PFHxS, and PFNA in Groundwater or Soil using USEPA's Regional Screening Level Calculator. HQ=0.1. May 2022.* The screening levels for soil are based on Industrial/Commercial Composite Worker scenario for incidental ingestion of contaminated soil.

Chemical Abbreviations

PFBS	perfluorobutanesulfonic acid
PFHxS	perfluorohexanesulfonic acid
PFNA	perfluorononanoic acid
PFOA	perfluorooctanoic acid
PFOS	perfluorooctanesulfonic acid

Interpreted Qualifiers

U = The analyte was not detected at a level greater than or equal to the adjusted DL.

Acronyms and Abbreviations

µg/kg	microgram(s) per kilogram
AASF	Army Aviation Support Facility
AOI	Area of Interest
DUP	duplicate
HQ	Hazard Quotient
ID	identification
LCMSMS	liquid chromatography with tandem mass spectrometry
LOD	limit of detection
LOQ	limit of quantitation
ND	analyte not detected above the LOD (LOD values are presented in Appendix F)
OSD	Office of the Secretary of the Defense
QSM	Quality Systems Manual
PFAS	per- and polyfluoroalkyl substances
SB	soil boring
USEPA	United States Environmental Protection Agency
Qual	interpreted qualifier

This page intentionally left blank

Table 6-5
PFOA, PFOS, PFBS, PFNA, and PFHxS Results in Groundwater
Site Inspection Report
Rapid City AASF

Area of Interest		AOI01-01														BOUNDARY					
Location ID		AOI01-01		AOI01-02		AOI01-03		AOI01-04		AOI01-05B		AOI01-06		AOI01-07		RCAASF-01		RCAASF-02		RCAASF-02, Duplicate	
Sample ID		AO101-01-GW		AO101-02-GW		AO101-03-GW		AO101-04-GW		AO101-05-GW		AO101-06-GW		AO101-07-GW		RCAASF-01-GW		RCAASF-02-GW		DUP-01-GW	
Sample Date		11/18/2021		11/18/2021		11/18/2021		11/18/2021		11/18/2021		11/17/2021		11/18/2021		11/18/2021		11/18/2021		11/18/2021	
Analyte	**OSD Screening Level [1]**	**Result**	**Qual**	**Result**	**Qual**	**Result**	**Qual**	**Result**	**Qual**	**Result**	**Qual**	**Result**	**Qual**	**Result**	**Qual**	**Result**	**Qual**	**Result**	**Qual**	**Result**	**Qual**
Water, PFAS by LCMSMS compliant with QSM 5.3 Table B-15 (ng/l)																					
PFBS	601	8.3	J-	4.1	J-	21	J-	3.1	J-	2.8	J-	5.0		14	J-	3.4	J-	25	J-	24	J-
PFHxS	39	66		31		280		5.1		5.8		22		160		19		430		430	
PFNA	6	140		26		5.1		0.41	J	0.9	J	0.63	J+	1.0	J	1.5	J	2.1		2.3	
PFOA	6	1300	J-	470	J-	81	J-	7.0	J-	4.5	J-	6.4		26	J-	8.9	J-	87	J-	89	J-
PFOS	4	120		83		880		1.6	J	1.4	J	19	J+	63		11		310		310	

Notes

Gray Fill — Detected concentration exceeded OSD Screening Levels

References

1. Assistant Secretary of Defense, July 2022. *Risk Based Screening Levels Calculated for PFOA, PFOS, PFBS, PFHxS, and PFNA in Groundwater or Soil using USEPA's Regional Screening Level Calculator. HQ=0.1* . May 2022. Groundwater screening levels based on residential scenario for direct ingestion of groundwater.

Chemical Abbreviations

PFBS	perfluorobutanesulfonic acid
PFHxS	perfluorohexanesulfonic acid
PFNA	perfluorononanoic acid
PFOA	perfluorooctanoic acid
PFOS	perfluorooctanesulfonic acid

Interpreted Qualifiers

J = Estimated concentration.
J+ = The result is an estimated quantity, but the result may be biased high.
J- = The result is an estimated quantity, but the result may be biased low.
U = The analyte was not detected at a level greater than or equal to the adjusted DL.
UJ = The analyte was not detected at a level greater than or equal to the adjusted DL.
However, the reported adjusted DL is approximate and may be inaccurate or imprecise.

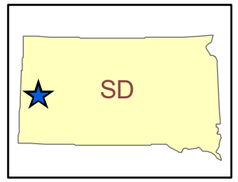
Acronyms and Abbreviations

AASF	Army Aviation Support Facility
AOI	Area of Interest
DUP	duplicate
HQ	Hazard Quotient
ID	identification
LCMSMS	liquid chromatography with tandem mass spectrometry
LOD	limit of detection
LOQ	limit of quantitation
ND	analyte not detected above the LOD (LOD values are presented in Appendix F)
ng/L	nanogram(s) per liter
OSD	Office of the Secretary of the Defense
QSM	Quality Systems Manual
PFAS	per- and polyfluoroalkyl substances
SB	soil boring
USEPA	United States Environmental Protection Agency
Qual	interpreted qualifier

This page intentionally left blank

Army National Guard Site Inspections
Site Inspection Report
Rapid City AASF, South Dakota

Figure 6-1
PFOA Detections in Soil



Facility Data
- Area of Interest
- Buildings
- Potential PFAS Release
- Facility Boundary

Hydrology
- Groundwater Flow Direction
- Surface Water Flow Direction

PFNA Results (ng/L)
- ND
- >ND - 19
- >19 - 250
- >250 - 2,500
- >2,500

NOTES:
PFOA = perfluorooctanoic acid
ND = Non-Detect
(µg/Kg) = Microgram(s) per Kilogram
*At AOI01-03, surface samples were taken at 5-6 feet bgs to account for known historic earthwork
Exceedances of the OSD SL are depicted with a yellow halo.

Data Sources:
ESRI 2020
AECOM 2020

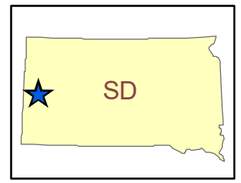
Date:.....SEPTEMBER 2022
Prepared By:.....WOOD
Prepared For:.....USACE
Projection:.....NAD 83 State Plane

G:\ANG\a_MXD\RapidCity, SD\Analytical results figures\PFOA Detections in Soil.mxd - USDJ716516 - 8/31/2023 - 12:08:22 PM

This page intentionally left blank

Army National Guard Site Inspections
Site Inspection Report
Rapid City AASF, South Dakota

Figure 6-2
PFOS Detections in Soil



Facility Data
- Area of Interest
- Buildings
- Potential PFAS Release
- Facility Boundary

Hydrology
- Groundwater Flow Direction
- Surface Water Flow Direction

PFOS Results (ng/L)
- ND
- >ND - 13
- >13 - 160
- >160 - 1,600
- >1,600

NOTES:
PFOS = perfluorooctanesulfonic acid
ND = Non-Detect
(µg/Kg) = Microgram(s) per Kilogram
*At AOI01-03, surface samples were taken at 5-6 feet bgs to account for known historic earthwork
Exceedances of the OSD SL are depicted with a yellow halo.

Data Sources:
ESRI 2020
AECOM 2020

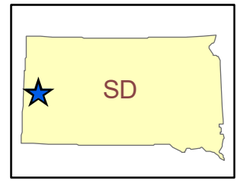
Date:.....SEPTEMBER 2022
Prepared By:.....WOOD
Prepared For:.....USACE
Projection:.....NAD 83 State Plane

G:\ANG\a_MXD\RapidCity, SD\Analytical results figures\PFOS Detections in Soil.mxd - USDJ716516 - 8/31/2023 - 12:17:43 PM

This page intentionally left blank

Army National Guard Site Inspections
Site Inspection Report
Rapid City AASF, South Dakota

Figure 6-3
PFBS Detections in Soil



Facility Data
- Area of Interest
- Buildings
- Potential PFAS Release
- Facility Boundary

Hydrology
- Groundwater Flow Direction
- Surface Water Flow Direction

PFBS Results (ng/L)
- ND
- >ND - 10
- >10 - 1,900
- >1,900 - 25,000
- >25,000

NOTES:
PFBS = perfluorobutanesulfonic acid
ND = Non-Detect
(µg/Kg) = Microgram(s) per Kilogram
*At AOI01-03, surface samples were taken at 5-6 feet bgs to account for known historic earthwork
Exceedances of the OSD SL are depicted with a yellow halo.

Data Sources:
ESRI 2020
AECOM 2020

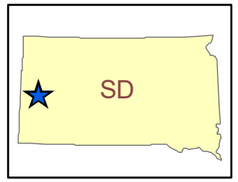
Date:.....SEPTEMBER 2022
Prepared By:.....WOOD
Prepared For:.....USACE
Projection:.....NAD 83 State Plane

G:\ANG\a_MXD\RapidCity, SD\Analytical results figures\PFBS Detections in Soil.mxd - USDJ716516 - 8/31/2023 - 12:23:00 PM

This page intentionally left blank

Army National Guard Site Inspections
Site Inspection Report
Rapid City AASF, South Dakota

Figure 6-4
PFHxS Detections in Soil



Facility Data
- Area of Interest
- Buildings
- Potential PFAS Release
- Facility Boundary

Hydrology
- Groundwater Flow Direction
- Surface Water Flow Direction

PFHxS Results (ng/L)
- ND
- >ND - 10
- >10 - 130
- >130 - 1,600
- >1,600

NOTES:
PFHxS = perfluorohexanesulfonic acid
ND = Non-Detect
(µg/Kg) = Microgram(s) per Kilogram
*At AOI01-03, surface samples were taken at 5-6 feet bgs to account for known historic earthwork
Exceedances of the OSD SL are depicted with a yellow halo.

Data Sources:
ESRI 2020
AECOM 2020

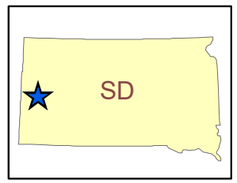
Date:.....SEPTEMBER 2022
Prepared By:.....WOOD
Prepared For:.....USACE
Projection:.....NAD 83 State Plane

G:\ANG\a_MXD\RapidCity, SD\Analytical results figures\PFHxS Detections in Soil.mxd - USDJ716516 - 8/31/2023 - 12:27:52 PM

This page intentionally left blank

Army National Guard Site Inspections
Site Inspection Report
Rapid City AASF, South Dakota

Figure 6-5
PFNA Detections in Soil



Facility Data
- Area of Interest
- Buildings
- Potential PFAS Release
- Facility Boundary

Hydrology
- Groundwater Flow Direction
- Surface Water Flow Direction

PFNA Results (ng/L)
- ND
- >ND - 19
- >19 - 250
- >250 - 2,500
- >2,500

NOTES:
PFNA = perfluorononanoic acid
ND = Non-Detect
(µg/Kg) = Microgram(s) per Kilogram
*At AOI01-03, surface samples were taken at 5-6 feet bgs to account for known historic earthwork
Exceedances of the OSD SL are depicted with a yellow halo.

Data Sources:
ESRI 2020
AECOM 2020

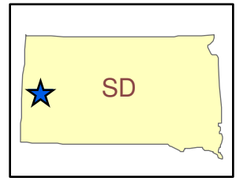
Date:.....SEPTEMBER 2022
Prepared By:.....WOOD
Prepared For:.....USACE
Projection:.....NAD 83 State Plane

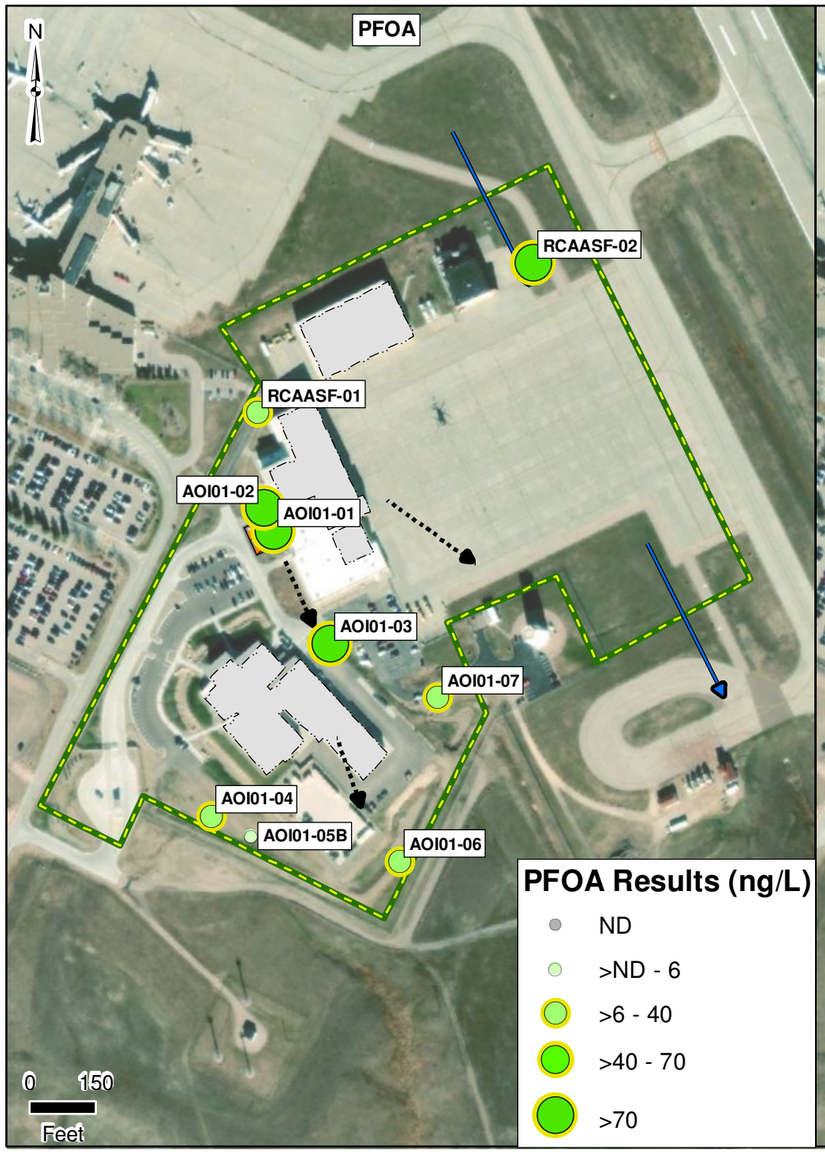
G:\ANG\a_MXD\RapidCity, SD\Analytical results figures\PFNA Detections in Soil.mxd - USDJ716516 - 10/31/2023 - 1:58:56 PM

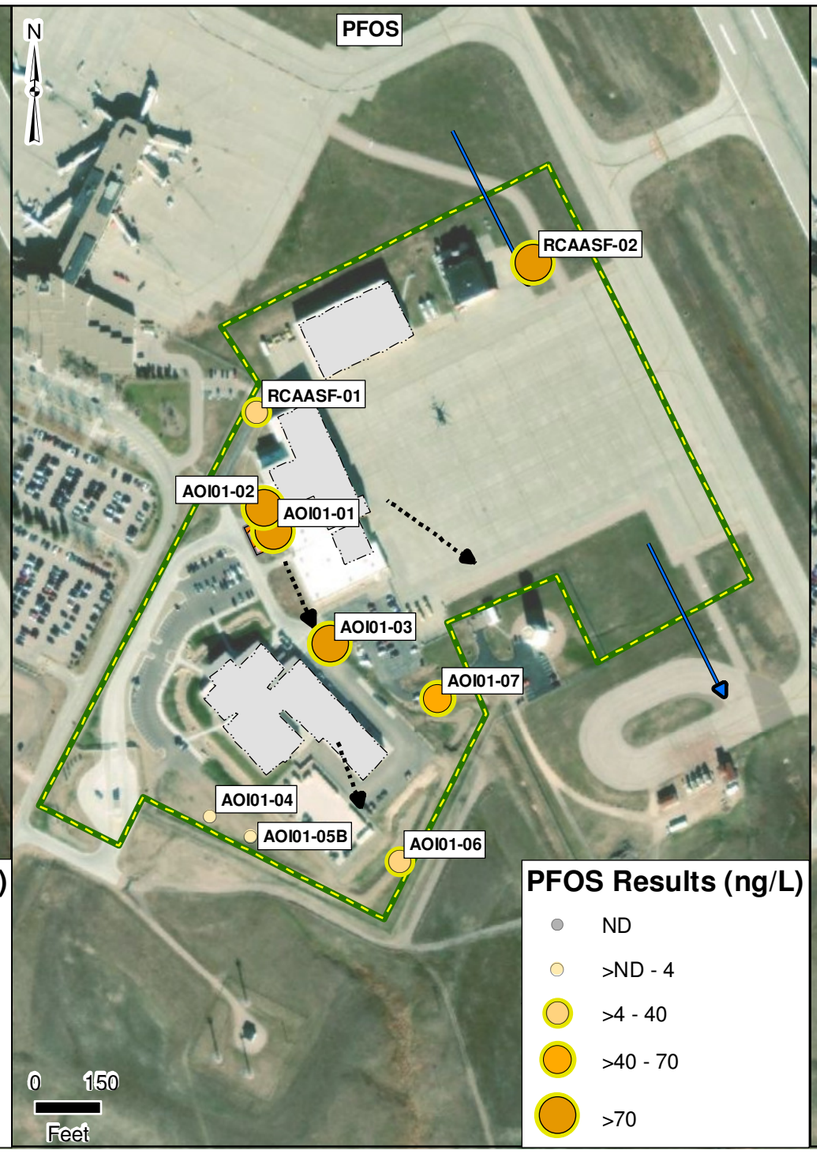
This page intentionally left blank

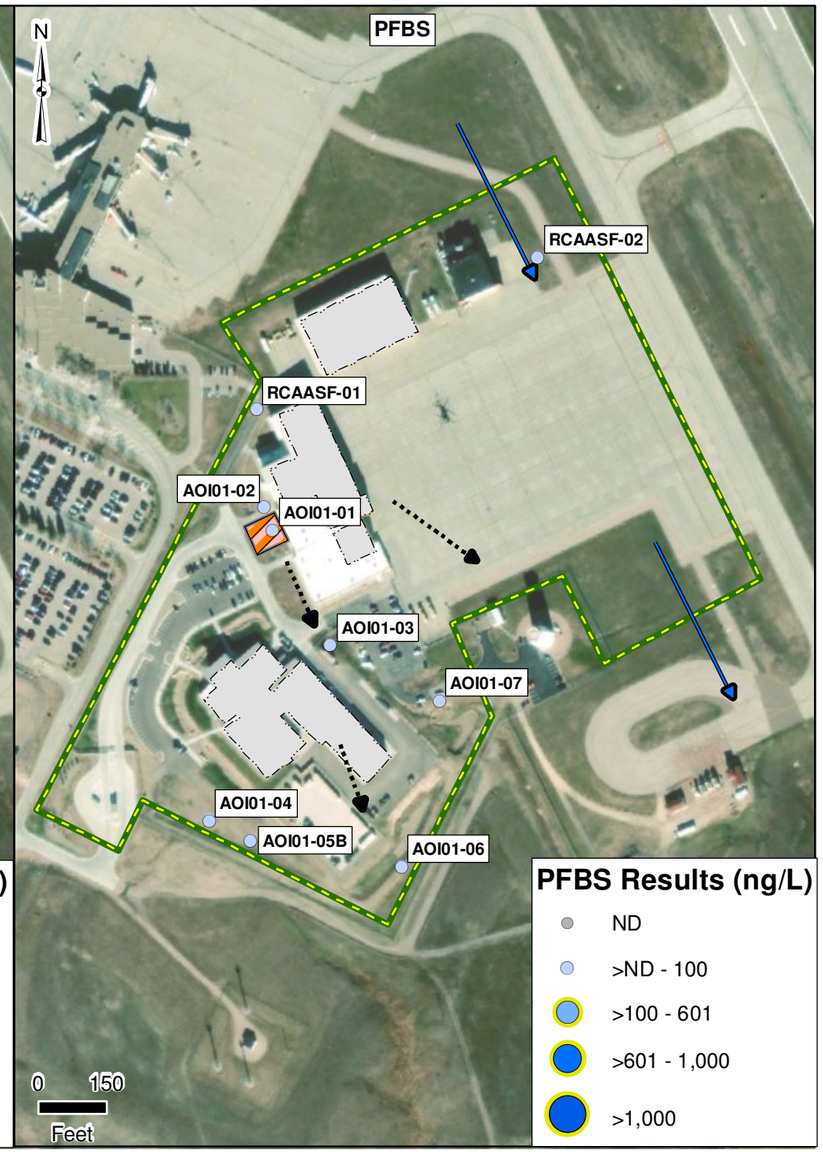
Army National Guard Site Inspections
Site Inspection Report
Rapid City AASF, South Dakota

Figure 6-6
PFOA, PFOS, and PFBS Detections in Groundwater









Facility Data
- Area of Interest
- Buildings
- Potential PFAS Release
- Facility Boundary

Hydrology
- Groundwater Flow Direction
- Surface Water Flow Direction

NOTES:
PFOS = perfluorooctanesulfonic acid
PFOA = perfluorooctanoic acid
PFBS = perfluorobutanesulfonic acid
ND = Non-Detect
ng/L = nanogram(s) per liter
Exceedances of the OSD SL are depicted with a yellow halo.

Data Sources:
ESRI 2020
AECOM 2020

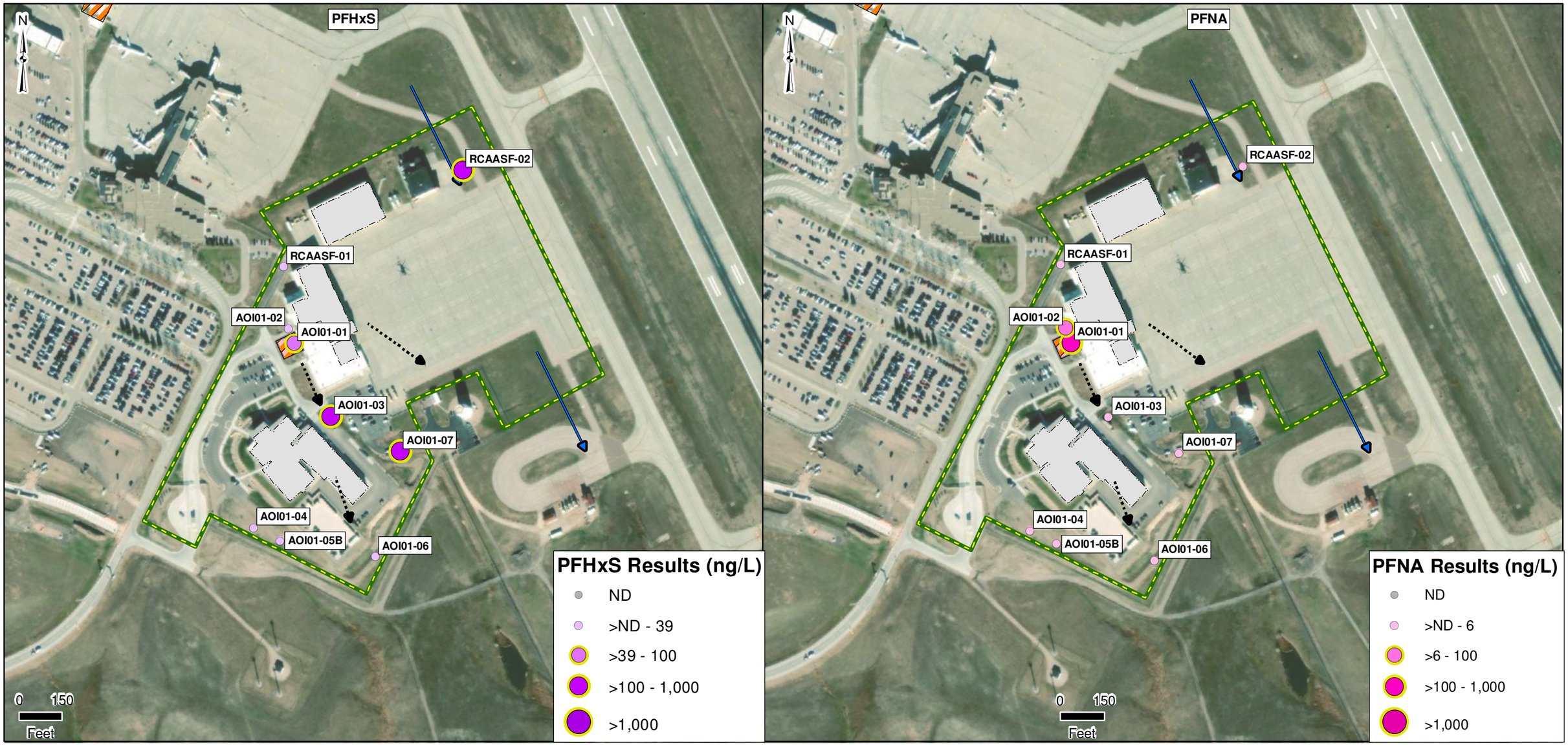
Date:.....SEPTEMBER 2022
Prepared By:.....WSP
Prepared For:.....USACE
Projection:.....NAD 83 State Plane

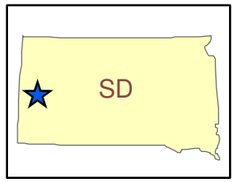
G:\ANG\a_MXD\RapidCity, SD\Analytical results figures\PFOA_PFOS_PFBS Detections in GW.mxd - megan.cameron - 9/26/2022 - 3:33:43 PM

This page intentionally left blank

Army National Guard Site Inspections
Site Inspection Report
Rapid City AASF, South Dakota

Figure 6-7
PFHxS, and PFNA Detections in Groundwater





Facility Data
- Area of Interest
- Buildings
- Potential PFAS Release
- Facility Boundary

Hydrology
- Groundwater Flow Direction
- Surface Water Flow Direction

NOTES:
PFHxS = Perfluorohexanesulfonic acid
PFNA = Perfluorooctanoic acid
ND = Non-Detect
ng/L = nanogram(s) per liter
Exceedances of the OSD SL are depicted with a yellow halo.

Data Sources:
ESRI 2020
AECOM 2020

Date:.....SEPTEMBER 2022
Prepared By:.....WSP
Prepared For:.....USACE
Projection:.....NAD 83 State Plane

G:\ANG\a_MXD\RapidCity, SD\Analytical results figures\PFHxS_PFNA_ Detections in GW.mxd - megan.cameron - 9/26/2022 - 3:37:20 PM

This page intentionally left blank

7. EXPOSURE PATHWAYS

The Conceptual Site Model (CSM) for the AOI, revised based on the SI findings, is presented on **Figure 7-1**. Please note that while the CSM discussion assists in determining if a receptor may be impacted, the decision to move from SI to RI or interim action is determined based upon exceedances of the SLs for the relevant compounds and whether the release is more than likely attributable to the DoD. A CSM presents the current understanding of the Facility conditions with respect to known and suspected sources, potential transport mechanisms and migration pathways, and potentially exposed human receptors. A human exposure pathway is considered potentially complete when the following conditions are present:

1. Contaminant source;
2. Environmental fate and transport;
3. Exposure point;
4. Exposure route; and
5. Potentially exposed populations.

If any of these elements are missing, the pathway is incomplete. The CSM figures use an empty circle symbol to represent an incomplete exposure pathway. Areas with no identified complete pathway generally warrant no further action. However, the pathway is considered potentially complete if the relevant compounds are detected, in which case the CSM figure uses a half-filled circle symbol to represent a potentially complete exposure pathway. Additionally, a completely filled circle symbol is used to indicate when a potentially complete exposure pathway has detections of the relevant compounds above the SLs. Areas with an identified potentially complete pathway and a complete pathway may warrant further investigation. Although the CSMs indicate whether potentially complete exposure pathways may exist, the recommendation for future study in a RI or no action at this time is based on the comparison of the SI analytical results for the relevant compounds to the SLs.

In general, the potential routes of exposure to the relevant compounds are ingestion and inhalation. Human exposure via the dermal contact pathway may occur, and current risk practice suggests it is an insignificant pathway compared to ingestion; however, exposure data for dermal pathways are sparse and continue to be the subject of toxicological study. The receptors evaluated are consistent with those listed in EPA guidance for risk screening (EPA, 2001). Receptors at the Facility include site workers (e.g., facility staff and visiting soldiers), construction workers, potential trespasser, offsite resident, and recreational users outside the Facility boundary.

7.1 SOIL EXPOSURE PATHWAY

The SI results in soil were used to determine whether a potentially complete pathway exists between the source and potential receptors at the AOI based on the aforementioned criteria.

7.1.1 AOI 1

AOI 1 is the Main Hangar, area south of the Main Hangar and immediate surrounding area. The Main Hangar, constructed in 1999, was equipped with an AFFF fire suppression system, consisting of two 1,100-gallon tanks filled with 3 percent AFFF concentrate. While the fire suppression system is engaged, an automatic switch activates to route the AFFF/water mixture to a 3,000-gallon concrete bypass underground storage tank. The system was initially tested in December of 1999 and during this test, the large plastic container over-flowed and released a foam/water mixture spill onto the concrete. The contractor addressed the spill, but a small amount flowed onto the grassy area south of the Main Hangar. In Spring of 2016, a portion of the concrete and grassy area southwest of the Main Hangar was excavated to make the drainage ditch deeper to allow for better storm water drainage (AECOM, 2020). According to personnel, some of the soil that was removed from the area was used as fill material, during the construction of the Readiness Center in 2019, making the Readiness Center a potential secondary AOI 1 source.

PFNA, PFOA and PFOS were detected in surface soil at concentrations below their respective SLs in the two borings located at the original release area (AOI01-01 and AOI01-02). Additionally, PFOS was detected in surface soil at concentrations below the SLs in the anticipated flow path (AOI01-07). PFOS was also detected in surface soil at concentrations below the SLs in two soil borings in the estimated location of the fill material south of the Readiness Center (AOI01-04 and AOI01-05). Site workers and construction workers could contact constituents in surface soil via incidental ingestion and inhalation of dust. Therefore, the surface soil exposure pathway for facility workers and construction workers are potentially complete. PFHxS, PFNA, PFOA and PFOS were detected in shallow subsurface soil at concentrations below their respective SLs. Construction workers could contact constituents in shallow subsurface soil via incidental ingestion and inhalation of dust; therefore, the subsurface soil exposure pathway for construction workers is potentially complete. The CSM is presented in **Figure 7-1**.

7.2 GROUNDWATER EXPOSURE PATHWAY

The SI results in groundwater were used to determine whether a potentially complete pathway exists between the source and potential receptors at the AOI based on the aforementioned criteria.

7.2.1 AOI 1

AOI 1 is the Main Hangar, the area south of the Main Hangar and the immediate surrounding area. The aforementioned release of PFAS to the ground surface occurred in December of 1999 south of the Main Hangar. Relevant compounds were detected in the groundwater at all sampling locations. The concentration of PFHxS in groundwater exceeded the SL at four of the nine temporary well locations. The concentration of PFNA in groundwater exceeded the SL at two of the nine temporary well locations. The concentration of PFOA in groundwater exceeded the SL at eight of the nine temporary well locations. The concentration of PFOS in groundwater exceeded the SL at seven of the nine temporary well locations. Based on the results of the SI at AOI 1, ground disturbing activities that extend to the water table (approximately 12-15 ft bgs)

could result in construction worker exposure to constituents in groundwater via incidental ingestion. Potential residential receptors downgradient of the AOI could also be exposed by ingestion of groundwater. The concentration at the potential point of exposure for off-site residents is not known, therefore, the exposure pathway for ingestion is potentially complete for off-site residential receptors. Drinking water for the Facility is supplied by the City of Rapid City; therefore, the pathway for ingestion of shallow groundwater by a site worker or trespasser is incomplete.

The CSM is presented in **Figure 7-1**.

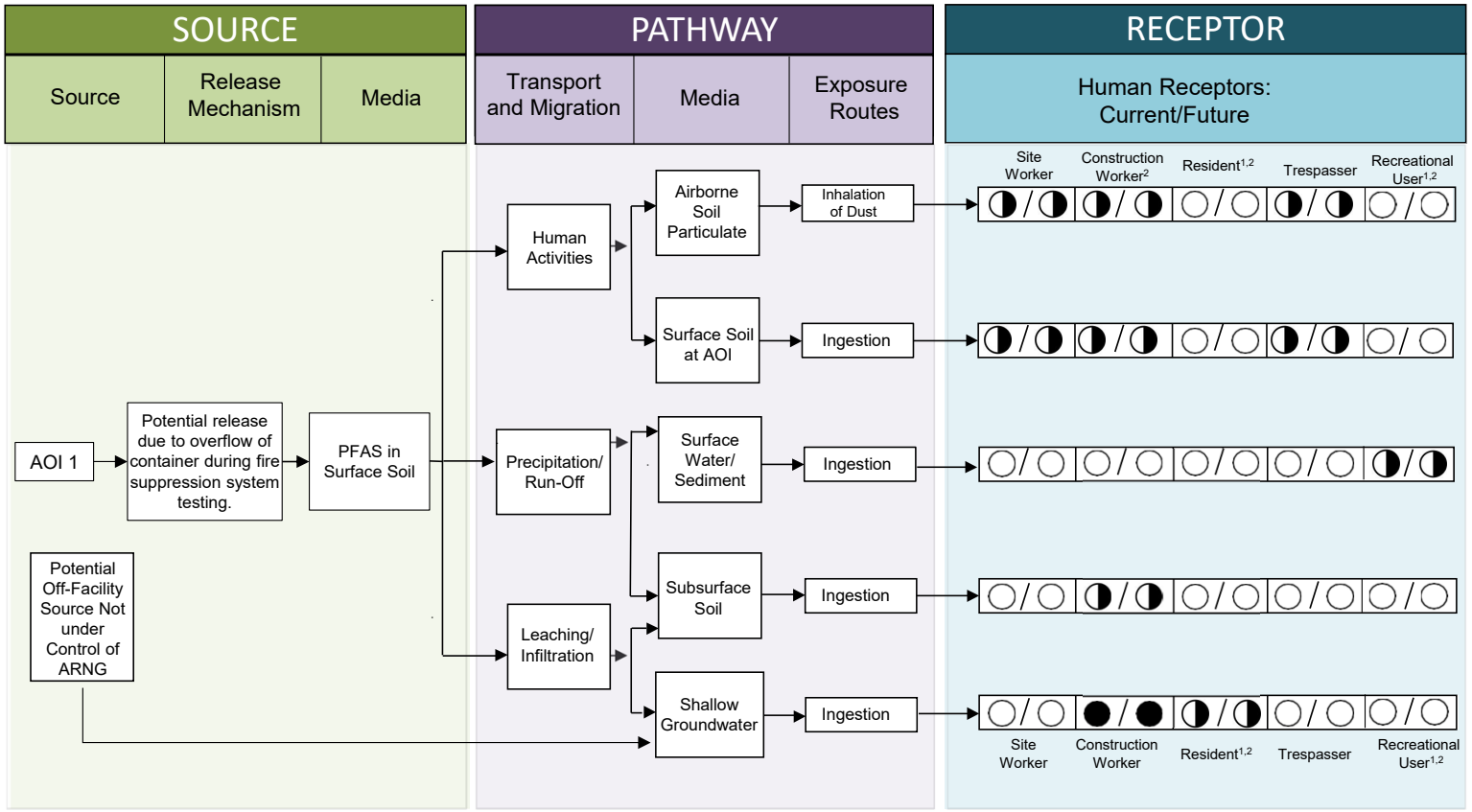
7.3 SURFACE WATER AND SEDIMENT EXPOSURE PATHWAY

There is no surface water located at the AASF, however, stormwater at the Facility is managed by a series of grassed trenches and small retention basins before being ultimately discharged to Rapid Creek. Stormwater has the potential to transport AFFF or PFAS-impacted soils to water bodies. No surface water or sediment samples were collected as part of the SI.

7.3.1 AOI 1

AOI 1 is the Main Hangar, the area south of the Main Hangar and the immediate surrounding area. The aforementioned release of PFAS to the ground surface occurred in December of 1999 south of the Main Hangar. Relevant compounds were detected in the surface soil at concentrations below SLs at sample locations associated with the original release area and anticipated flow path (see **Section 7.1**). Due to the presence of relevant compounds in soil, there is the potential for stormwater to transport PFAS-impacted soil to Rapid Creek and expose the potential recreational user by ingestion of surface water. The CSM is presented in **Figure 7-1**.

This page intentionally left blank



LEGEND

- Flow Chart Continues
- Incomplete Pathway
- Potentially Complete Pathway
- Potentially Complete Pathway with Exceedance of SL

Notes:

1. The resident and recreational user refers to off-site receptors.
2. Inhalation of dust for off-site receptors is highly unlikely.

Figure 7-1
Conceptual Site Model, AOI 1
Rapid City AASF, South Dakota

This page intentionally left blank

8. SUMMARY AND OUTCOME

This section summarizes SI activities and findings. The most significant findings are summarized in this section and are reproduced directly or abstracted from information contained in this report. The outcome provides general and comparative interpretations of the findings relative to the SLs.

8.1 SI ACTIVITIES

The SI field activities at the Facility were conducted from 15 to 18 November 2021. The SI field activities included soil and groundwater sampling. Field activities were conducted in accordance with the UFP-QAPP Addendum (EA/Wood, 2021a), except as previously noted in **Section 5.8**.

To fulfill the project DQOs set forth in the approved SI UFP-QAPP Addendum (EA/Wood, 2021a), samples were collected and analyzed for a subset of 24 PFAS compounds by LC/MS/MS compliant with QSM 5.3 Table B-15 as follows.

- Eighteen (18) soil samples from six locations;
- Nine (9) grab groundwater samples from nine temporary well locations;
- Eleven (11) quality assurance (QA)/QC samples.

An SI is conducted when the PA determines an AOI exists based on probable use, storage, and/or disposal of PFAS-containing materials. The SI includes multi-media sampling at the AOI 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. Additionally, the CSM was refined to assess whether a potentially complete pathway exists between the source and potential receptors for potential exposure at the AOI, which is described in **Section 7**.

8.2 OUTCOME

Based on the results of this SI, further evaluation in the form of a RI is warranted for AOI 1. Based on the CSM developed and revised based on the SI findings, there is potential for exposure to receptors from AOI 1 from sources on the Facility resulting from historical DoD activities.

Sample chemical analytical concentrations collected during the SI were compared against the project SLs in soil and groundwater, as described in **Table 6-1**. The following bullets summarize the SI results relative to the SLs:

At AOI 1:

- Relevant compounds were detected in groundwater in the AOI 1 source area. The concentration of PFHxS in groundwater exceeded the SL at three of the seven temporary well locations, with a maximum concentration of 280 ng/L. The concentration of PFNA in groundwater exceeded the SL at two of the seven temporary well locations with a maximum concentration of 140 ng/L. The concentration of PFOA in groundwater

exceeded the SL at six of the seven temporary well locations with a maximum concentration of 1,300 J- ng/L. The concentration of PFOS in groundwater exceeded the SL at five of the seven temporary well locations with a maximum concentration of 880 ng/L. PFBS did not exceed the SLs. Based on the results of the SI, further evaluation of AOI 1 is warranted in the RI.

- Relevant compounds were detected in soil at AOI 1 at concentrations below their respective SLs.

Upgradient of AOI 1:

- PFHxS, PFOA, and PFOS were detected in groundwater upgradient of the Facility in sample RCAASF-01 and RCAASF-02 above their respective SLs. The concentration of PFHxS in groundwater exceeded the SL at both temporary well locations, with a maximum concentration of 430 ng/L. The concentration of PFOA in groundwater exceeded the SL at both temporary well locations with a maximum concentration of 89 J- ng/L. The concentration of PFOS in groundwater exceeded the SL both temporary well locations with a maximum concentration of 310 ng/L. PFBS and PFNA were detected in groundwater samples from both temporary well locations but did not exceed the SLs. Based on the results of the SI, there may be potential off-facility sources upgradient of the Rapid City AASF not related to DoD activities that have affected the groundwater.
- Soil was not sampled at the two upgradient locations.

Of the six PFAS compounds presented in the 6 July 2022 OSD memorandum, HFPO-DA (commonly referred to as GenX) was not included as an analyte at the time of this SI. Based on the CSM developed during the PA and revised based on SI findings, the presence of HFPO-DA is not anticipated at the facility because HFPO-DA is generally not a component of MIL-SPEC AFFF and based on its history including distribution limitations that restricted use of GenX, it is generally not a component of other products the military used. In addition, it is unlikely that GenX would be an individual chemical of concern in the absence of other PFAS.

Table 8-1. Summary of Site Inspection Findings and Recommendations

AOI	Potential Release Area	Soil – Source Area	Groundwater – Source Area	Groundwater – Facility Boundary	Future Action
1	Overflow Area	◐	●	●	Proceed to RI

Legend:
● = Detected; exceedance of screening levels
◐ = Detected; no exceedance of screening levels
○ = Not detected

9. REFERENCES

AECOM. 2020. *Final Preliminary Assessment Report, Rapid City Army Aviation Support Facility, South Dakota*. August.

Aerostar, 2019. Final Site Inspections Report of Aqueous Film Forming Form Areas at Ellsworth Air Force Base, Meade and Pennington Counties, South Dakota. November

Assistant Secretary of Defense. 2022. Investigating Per- and Polyfluoroalkyl Substances within the Department of Defense Cleanup Program. United States Department of Defense. 6 July.

Department of the Army (DA). 2016a. *EM-200-1-2, Environmental Quality, Technical Project Planning Process*. 29 February.

———. 2016b. *Army Guidance to Address Perfluorooctane Sulfonate (PFOS) and Perfluorooctanoic Acid (PFOA) Contamination*. August.

———. 2018. *Army Guidance for Addressing Releases of Per-and Polyfluoroalkyl Substances*. September.

DoD. 2019a. *Department of Defense (DoD), Department of Energy (DOE) Consolidated Quality Systems Manual (QSM) for Environmental Laboratories, Version 5.3*. May.

———. 2019b. *General Data Validation Guidelines*. November.

———. 2020. *Data Validation Guidelines Module 3: Data Validation Procedure for Per- and Polyfluoroalkyl Substances Analysis by QSM Table B-15*. May.

EA, Engineering, Science, and Technology, PBC (EA). 2020. *Final Programmatic Uniform Federal Policy Quality Assurance Project Plan, Site Inspections for Per- and Polyfluoroalkyl Substances Impacted Sites, ARNG Installations, Nationwide*. December.

EA Engineering, Science, and Technology, PBC and Wood Environment & Infrastructure Solutions, Inc. (EA/Wood). 2021a. *Final Site Inspection Uniform Federal Policy Quality Assurance Project Plan (UFP-QAPP) Addendum, Rapid City Army Aviation Support Facility, Rapid City, South Dakota, Per- and Polyfluoroalkyl Substances Impacted Sites, ARNG Installations, Nationwide*. November.

———. 2021b. *Accident Prevention Plan/Site Safety and Health Plan Addendum, Site Inspections for Per- and Polyfluoroalkyl Substances Impacted Sites, ARNG Installations, Nationwide, Rapid City Army Aviation Support Facility Rapid City, South Dakota*. November.

Guelfo, J.L. and C.P. Higgins. 2013. *Subsurface transport potential of perfluoroalkyl acids and aqueous film-forming foam (AFFF)-impacted sites*. Environmental Science and Technology 47(9):4164-71.

Higgins, C.P., and R.G. Luthy. 2006. *Sorption of perfluorinated surfactants on sediments*. Environmental Science and Technology 40 (23): 7251-7256.

ITRC. 2018. *Environmental Fate and Transport for Per- and Polyfluoroalkyl Substances*. March.

South Dakota Department of Agriculture and Natural Resources. (SD DANR).2022 https://apps.sd.gov/nr68welllogs/. Accessed 6 December.

U.S. Environmental Protection Agency (EPA). 1980. *Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA)*. 11 December.

———. 1994. *National Oil and Hazardous Substances Pollution Contingency Plan (Final Rule).* 40 Code of Federal Regulations Part 300; 59 Federal Register 47384. September.

———. 2001. *Risk Assessment Guidance for Superfund, Volume I: Human Health Evaluation* Manual (Part D, Standardized Planning, Reporting, and Review of Superfund Risk Assessments). December.

———. 2005. *Federal Facilities Remedial Site Inspection Summary Guide.* 21 July.

———. 2006. *Guidance on Systematic Planning Using the Data Quality Objectives Process* USEPA/240/B-06/001. February.

———. 2017. *National Functional Guidelines for Organic Superfund Data Review*. OLEM 9355.0-136, EPA-540-R-2017-002. Office of Superfund Remediation and Technology Innovation. January.

U.S. Fish and Wildlife Service (USFWS). 2021. *Endangered Species.* http://ecos.fws.gov/ipac/. Accessed 6 December.

United States Geological Survey (USGS), 2002. *Hydrology of the Black Hills Area, South Dakota*. November

Xiao, F., M. F. Simcik, T.R. Halbach, and J.S Gulliver. 2015, *Perfluorooctane sulfonate (PFOS) and perfluorooctanoate (PFOA) in soils and groundwater of a U.S. metropolitan area: Migration and implications for human exposure*. Water Research 72:64-74.