Memo

To **Mr. Keith Freihofer**
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AMEC # **2-9133-0006**

From **Kerry Tull**

cc

Date **May 8, 2019**

Subject **Final Report - FY16 Phase I Regional Site Inspections for PFCs at Virginia Air National Guard, Former 192nd Fighter Wing, Richmond IAP Byrd Field, Sandston, Virginia**

Mr. Freihofer:

Attached is one electronic copy and one hard copy of the Final Report – FY 16 Phase I Regional Site Inspections for PFCs at Virginia Air National Guard, Former 192nd Fighter Wing, Richmond IAP Byrd Field**,** Sandston, Virginia. This report has been completed as part of Contract No. W9133L-14-D-0002, Task Order 0006.

Please contact me at (207) 828-3514 if you have any questions.

Sincerely,

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FINAL REPORT
FY16 PHASE I REGIONAL SITE INSPECTIONS FOR PERFLUORINATED COMPOUNDS
Volume I of VII

VIRGINIA AIR NATIONAL GUARD
FORMER 192ND FIGHTER WING
RICHMOND IAP BYRD FIELD
SANDSTON, VIRGINIA

Contract #: W9133L-14-D-0002
Delivery Order 0006

Amec Foster Wheeler Project #: 2-9133-0006.07
7 May 2019

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FY16 Phase I Regional Site Inspections
For Perfluorinated Compounds

Virginia Air National Guard – Former 192nd Fighter Wing
Richmond IAP Byrd Field
Sandston, Virginia

Prepared for:
National Guard Bureau
Operations Division, Restoration Branch
Joint Base Andrews, MD 20762-5157

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ACRONYMS & ABBREVIATIONS

192nd FW	192nd Fighter Wing
A4OR	Operations Restoration Branch
Accumark	Accumark, LLC
AFFF	Aqueous Film Forming Foam
Amec Foster Wheeler	Amec Foster Wheeler Environment & Infrastructure, Inc.
AMSL	Above Mean Sea Level
ANG	Air National Guard
BB&E	BB&E, Inc.
bgs	below ground surface
BRAC	Base Realignment and Closure
CRAC	Capital Regional Airport Commission
°C	Degrees Celsius
°F	Degrees Fahrenheit
DoD	Department of Defense
DPT	Direct Push Technology
DQO	Data Quality Objective
EBS	Environmental Baseline Survey
EDR	Environmental Data Resources
ELAP	Environmental Laboratory Accreditation Program
FAA	Federal Aviation Administration
FBI	Federal Bureau of Investigation
ft	Feet/foot
FSP	Field Sampling Plan
FSS	Fire Suppression System
FTA	Fire Training Area
HA	Health Advisory
HDPE	High-Density Polyethylene
HSA	Hollow Stem Auger
IAP	
IDW	Investigation Derived Waste
IRP	Installation Restoration Program
µg/kg	micrograms per kilogram
µg/L	micrograms per liter
NFA	No Further Action
NGB	National Guard Bureau
NRCS	National Resources Conservation Service

OWS	Oil Water Separator
ORP	Oxidation Reduction Potential
PA	Preliminary Assessment
%	percent
PFBS	Perfluorobutanesulfonic Acid
PFC	Perfluorinated Compound
PFOA	Perfluorooctanoic Acid
PFOS	Perfluorooctanesulfonic Acid
POC	Point of Contact
POTW	Publicly Owned Treatment Works
PRL	Potential Release Location
PVC	Polyvinyl Chloride
QA	Quality Assurance
QAPP	Quality Assurance Project Plan
QC	Quality Control
RIBF	Richmond IAP Byrd Field
RSL	Regional Screening Level
SAIC	Science Applications International Corporation
SB	Soil Boring (sample designation)
SD	Sediment (sample designation)
SW	Surface Water (sample designation)
SHSP	Site Health and Safety Plan
SI	Site Inspection
TestAmerica	Test America Laboratories, Inc.
TCLP	Toxicity Characteristic Leaching Procedure
TOC	Top of Casing
TW	Temporary Well (sample designation)
UCMR3	Third Unregulated Contaminant Monitoring Rule
USAF	United States Air Force
USEPA	United States Environmental Protection Agency
VA811	Virginia 811 One Call Utility Notification Center
VANG	Virginia Air National Guard
Vista	Vista Analytical Laboratories, Inc.

EXECUTIVE SUMMARY

Amec Foster Wheeler Environment & Infrastructure, Inc. (Amec Foster Wheeler) was contracted by the National Guard Bureau (NGB) Operations Restoration Branch (A4OR) under Contract # W9133L-14-D-0002, Delivery Order 0006 to conduct Phase I Regional Site Inspections (SIs) for Perfluorinated Compounds (PFCs) at multiple Air National Guard (ANG) Installations. This report has been prepared for SIs conducted at on-Base Potential Release Locations (PRLs) identified on the Former 192nd Fighter Wing (192nd FW), Virginia Air National Guard, Richmond IAP Byrd Field (RIBF), in the city of Sandston, Virginia. This Report presents the results and recommendations from the 2017 SI field activities conducted in November 2017 at RIBF. The objectives of the SI were to determine the presence or absence of PFCs at each PRL and the Base boundary, and based on the findings:

1) Determine if PRL is eligible for a decision of No Further Action (NFA);
2) Assess if PFCs are migrating off-Base; and
3) Provide data which can be used for developing Data Quality Objectives (DQOs) if further investigations are recommended.

To meet the objectives, Amec Foster Wheeler performed SIs at the following five PRLs:

- PRL 1: Building 3649 – Former Main Hangar;
- PRL 2: Building 3645 – Former Fire Station;
- PRL 3: Building 2851 – Former Fuel System Maintenance Dock;
- PRL 4: Building 96 – Former Hush House; and
- PRL 5: Concrete Apron/Ramp.

Based on recommendations from the Preliminary Assessment (PA) conducted by BB&E, Inc. (BB&E) in August 2015, soil, groundwater, surface water, and sediment samples were collected. Samples were analyzed for PFCs listed on the United States Environmental Protection Agency's (USEPA) Third Unregulated Contaminant Monitoring Rule (UCMR3) list (USEPA, 2012); The detected PFC concentrations were compared against screening criteria for perfluorooctanoic acid (PFOA), perfluorooctanesulfonic acid (PFOS), and perfluorobutane sulfonate (PFBS) including: the USEPA lifetime drinking water Health Advisory (HA) for PFOS (USEPA, 2016a) and HA for PFOA (USEPA, 2016b); the USEPA Regional Screening Level (RSL) table for PFBS in residential

soil (USEPA, 2018); the USEPA RSL for PFBS in tap water; and calculated screening levels using the USEPA screening level calculator for PFOA and PFBS in soil and sediment. These screening criteria are presented below:

Table ES-1: USEPA and USAF SI Screening Criteria

Parameter	Chemical Abstract Number	USEPA Regional Screening Level Table (November 2017)[a]		USAF Guidance for Soils and Sediments[b] (µg/kg)	USEPA Health Advisory Drinking Water (Surface Water or Groundwater) (µg/L)[c]
		Residential Soil (µg/kg)	Tap Water (µg/L)		
Perfluorobutanesulfonic acid (PFBS)	375-73-5	1,300,000[d]	400[f]	NL	NL
Perfluorooctanoic acid (PFOA)	335-67-1	NL	NL	1,260	0.07[e]
Perfluorooctane sulfonate (PFOS)	1763-23-1	NL	NL	1,260	

Notes and Abbreviations:
NL – Not listed
USAF – U.S. Air Force
USEPA – U.S. Environmental Protection Agency
µg/L - micrograms per liter
µg/kg - micrograms per kilogram

[a] USEPA Regional Screening Levels (USEPA, 2017).

[b] Screening levels calculated using the USEPA Regional Screening Level calculator [https://epa-prgs.ornl.gov/cgi-bin/chemicals/csl_search]. The toxicity value input for the calculator is the Tier 3 value reference dose of 0.00002 mg/kg/day derived by USEPA in their Drinking Water Health Advisories for both PFOS (USEPA, 2016a) and PFOA (USEPA, 2016b).

[c] USEPA, 2016b. *Drinking Water Health Advisory for Perfluorooctanoic Acid (PFOA)* and USEPA, 2016a. *Drinking Water Health Advisory for Perfluorooctane Sulfonate (PFOS).*

[d] PFBS RSL for Residential Soil concentration presented in Work Plan was 1,600,000 µg/kg based on the May 2016 RSL values. This table has been updated to include the more recent RSL values published in November 2017.

[e] Note: When PFOA and PFOS are both present, the combined detected concentrations of the compounds are compared with the 0.07 µg/L health advisory value for groundwater and surface water.

[f] PFBS RSL for Tap Water presented in the SI Work Plan (Amec, 2017) was 380 µg/L based on the May 2016 RSL values. This table has been updated to include the more recent RSL values published in November 2017.

Based on comparison of analytical data to the screening criteria in the table above, Amec Foster Wheeler recommends further investigation at each of the five PRLs investigated and at the base boundary. Amec Foster Wheeler also recommends that further investigations include analysis of additional compounds, including precursor compounds, to supplement the UCMR3 list. Precursor compounds have potential to result in increased concentrations downgradient and can serve as a lingering source. An overview of conclusions from SI activities and recommended DQOs for future investigations, includes the following:

Table ES-2: Screening Criteria Exceedances and Recommendations

PRL	Screening Criteria Exceedance				Recommendations
	Soil	GW	SW	SD	
1		X			GW investigation to determine the nature and extent of the confirmed PFC release. Soil investigation, including soils in the saturated zone, to determine if the soil may be a contributing source to GW.
2		X	X		GW investigation to determine the nature and extent of the confirmed PFC release. Soil investigation, including soils in the saturated zone, to determine if the soil may be a contributing source to GW. SW investigation to evaluate migration pathway of PFCs.
3		X	X		GW investigation to determine the nature and extent of the confirmed PFC release. Soil investigation, including soils in the saturated zone, to determine if the soil may be a contributing source to GW. SW investigation to evaluate migration pathway of PFCs.
4					GW investigation to determine the nature and extent of the confirmed release. Soil investigation, including soils in the saturated zone, to determine if the soil may be a contributing source to GW.
5		X	X		GW investigation to determine the nature and extent of the confirmed PFC release. Soil investigation, including soils in the saturated zone, to determine if the soil may be a contributing source to GW. SW investigation to evaluate migration pathway of PFCs.
Base Boundary Wells		X			GW investigation both up and downgradient of the base boundary to evaluate potential off base sources and to evaluate the nature and extent of the confirmed release.

Notes:
GW – Groundwater
NFA – No Further Action
PFC – Perfluorinated Compound
PRL – Potential Release Area
SD – Sediment
SW – Surface water
X – Screening criteria exceedance

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1.0 INTRODUCTION

Amec Foster Wheeler Environment & Infrastructure, Inc. (Amec Foster Wheeler) was contracted by the National Guard Bureau (NGB) under Contract # W9133L-14-D-0002, Delivery Order 0006 to conduct Phase I Regional Site Inspections (SIs) for perfluorooctanoic acid (PFOA), perfluorooctanesulfonic acid (PFOS), and perfluorobutane sulfonate (PFBS) at multiple Air National Guard (ANG) Installations. The scope of the Contract includes performance of an SI at on-Base Potential Release Locations (PRLs) identified at the 192nd Fighter Wing (192nd FW), Virginia Air National Guard (VANG), former Richmond IAP Byrd Field (RIBF), in the Town of Sandston, Virginia. This SI Report describes the objectives, procedures, and activities which were completed, and presents Amec Foster Wheeler's findings and recommendations. The Base location is shown in **Figure 1**, and the Base and area features are shown on **Figure 2**.

1.1 Background

The VANG, operating most recently as the 192nd FW, serviced a variety of military aircraft and occupied approximately 143 acres between 1947 and 2008. In 2005, the 192nd FW facility was placed in the United States Air Force (USAF) Base Realignment and Closure (BRAC) Program. As a result, the Base was closed in 2007/2008 and the property was developed by the Capital Regional Airport Commission (CRAC) for industrial use (BB&E, Inc. [BB&E], 2016). Additionally, a portion of the former Base is currently leased by the Federal Bureau of Investigation (FBI). Prior to the Preliminary Assessment (PA) (BB&E, 2016), potential releases of perfluorinated compounds (PFCs) from use and storage of aqueous film forming foam (AFFF) had not been evaluated at RIBF.

In 2015, BB&E conducted a PA site visit for VANG at the former RIBF to identify potential locations of historical environmental releases of PFOA, PFOS, and PFBS, specifically from AFFF usage and storage. The PA site visit process included a review of any documented Fire Training Areas (FTAs) in operation since 1970, other uses or releases of AFFF, and the completion of a site reconnaissance. The goal of the PA site visit was to determine if any PRLs posed a potential threat to human health and the environment, and required additional inspection (BB&E, 2015).

According to the PA, there is no evidence that a FTA was located within the footprint of the former RIBF. The USAF/ANG online administrative record was reviewed for references to potential FTAs located on the former RIBF. The administrative record did not contain any references to an on-Base FTA for the former RIBF. Fire training activities historically were conducted at a FTA

operated by CRAC and located off-Base, on airport property. An *Environmental Baseline Survey* (EBS) conducted in 2001 shows the location of two adjacent facilities used for fire training (Science Applications International Corporation [SAIC], 2001). One is the former fire training pit, located off-Base to the southwest of the airport. This FTA was reportedly used by the VANG and was operated by the CRAC. The EBS stated that it can be assumed that "…aircraft was used for training purposes and thousands of gallons of jet propellant-4 were dumped on the field". Former Fire Chief Troy Springer indicated that the area was remediated and has not been used for the past six years, as of 2001 (SAIC, 2001). The other FTA is the City of Richmond Fire Training Academy, which is located adjacent to the east of the Base. The Fire Training Academy was operated by the City of Richmond and was used to train municipal fire fighters.

Although no FTAs were historically located at the former RIBF, five PRLs were identified where AFFF types Ansulite Mil-spec [3 percent (%)] and Ansul Class A (1%) were potentially stored, used, or released. These PRLs consisted of hangars, fire stations, and fuel spill areas (BB&E, 2016). The five PRLs were recommended for further inspection (**Table 1**).

1.2 Purpose and Scope

The objective of the SI is to determine the presence or absence of PFOA, PFOS, and PFBS in the potentially affected media (i.e., soil, sediment, surface water, and/or groundwater) at each of the PRLs and at the former Base boundary. This data has been used to develop recommendations for appropriate paths forward to either provide an NFA conclusion or recommendations for further investigations. SI investigative tasks included:

- Advancing up to 20 soil borings using direct push technology (DPT) to a maximum depth of 10 feet (F) below ground surface (bgs), or first encountered groundwater, at the PRLs, and collect up to two soil samples from each boring;
- Installing up to six temporary monitoring wells at locations downgradient of the PRLs and along the base boundary, and collect groundwater samples at each location;
- Collecting two groundwater samples from existing permanent wells to characterize groundwater downgradient of PRLs and at the base boundary;
- Collecting one surface water sample from each PRL as appropriate; and,
- Collecting two sediment samples, one each from PRL 1 (Former Main Hangar; Building 3649) and PRL 2 (Former Fire Station; Building 3645).

Based on locations where AFFF was potentially used or stored, five PRLs were identified at the Base in the *PFC PA Site Visit Report* (BB&E, 2016). The PRLs are illustrated on **Figure 3**, and the SI summary is presented as **Table 2**.

All field activities were conducted in accordance with the *Final SI Work Plan*, which included a Quality Assurance Project Plan (QAPP), Field Sampling Plan (FSP), and Site Health and Safety Plan (SHSP) (Amec Foster Wheeler, 2017). The scope of the SI is outlined in the following sections.

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2.0 INSTALLATION DESCRIPTION

Section 2.1 describes the location and environs of RIBF. A brief history of RIBF is provided in **Section 2.2**.

2.1 Location

The former RIBF is located approximately four miles east-southeast of Richmond, Virginia, adjacent to the Richmond International Airport in Henrico County, Virginia (**Figures 1** and **2**). The RIBF is bounded to the north by single-family residential properties; to the east by the Richmond Fire Academy, a residence, and vacant wooded land; and to the south and west by the Richmond International Airport. Each of the five PRLs is located in separate areas across the RIBF. The locations of each PRL are shown on **Figure 3**.

2.2 Organization and History

The VANG, operating most recently as the 192nd FW, serviced a variety of military aircraft and occupied approximately 143 acres between 1947 and 2008. In 2005, the 192nd FW facility was placed in the USAF BRAC Program. As a result, the Base was closed in 2007/2008 and the property was developed by the CRAC for industrial use (BB&E, 2016). Additionally, a portion of the former base is currently leased by the FBI.

Activities at the Base have been typical of those at most airports and military air bases, including fueling and maintenance operations. These activities include the usage, handling, storage, and disposal of various products, including potentially hazardous materials.

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3.0 ENVIRONMENTAL SETTING

The following sections provide information on the environmental setting at the former RIBF. This information is summarized from reports prepared during previous environmental evaluations at the former RIBF, as referenced in the following subsections.

3.1 Climate

The average summertime high in Sandston is 86 degrees Fahrenheit (°F). The average low in the winter is 30 °F. The hottest month is July with an average high temperature of 87.5 °F. The coldest month is January with an average low temperature of 27.6 °F. Precipitation averages 43.91 inches per year. July is the wettest month with an average of 4.67 inches of precipitation. February is the driest month with an average of 2.98 inches of precipitation (rssWeather, 2011).

3.2 Topography

Henrico County, Virginia overlaps the Coastal Plain Physiographic Province and the Piedmont Physiographic Province. The boundary of the two provinces, known as the Fall Zone, runs north-south through the county. The Coastal Plain is found to the east of the Fall Zone, and the Piedmont to the west. The former RIBF facility is located seven miles east of the Fall Zone in the Coastal Plain Physiographic Province. The elevation of the Coastal Plain Physiographic Province ranges from sea level to a maximum topographic elevation of 300 ft above mean sea level (amsl). The topography of the general region of the former RIBF facility is relative flat to gently rolling, with surface elevations range from approximately 145 to 160 ft amsl (AECOM, 2013).

3.3 Geology

Site geologic conditions observed during historical investigations at the former RIBF indicate that clay and silty-clay soils are present from the ground surface to depths of approximately 14 to 17 ft bgs. Below this depth, the formation transitions to a silty-sand/clayey-sand aquifer to a depth of approximately 30 ft bgs and then transitions to clayey-sand and gravel aquifer. Overall, the soil at the site is tan brown to dark gray, dry to moist, very plastic clay that overlies white to tan and red fine-grained sand that is less than five percent clay and silt content. Red and tan gravel was encountered at a depth of approximately 30 ft bgs and continued to the base of the lower surficial aquifer. A silty-clay layer at the base of the lower aquifer of undetermined thickness was encountered at a depth of 48 ft bgs (CH2M Hill, 2001).

3.4 Soils

According to the National Resources Conservation Service Web Soil Survey (National Resources Conservation Service [NRCS], 2017), soils in the vicinity of Former Main Hangar (PRL 1) and the Concrete Apron/Ramp (PRL 5) are mapped as Lynchburg fine sandy loam on the western portion of the PRLs, and Atlee very fine sandy loam on the east. Soils in the vicinity of the Former Fire Station (PRL 2), the Former Fuel System Maintenance Dock (PRL 3), and the Former Hush House (PRL 4) are mapped as Lynchburg fine sandy loam (NRCS, 2017). Lynchburg fine sandy loams and Atlee very fine sandy loams are derived from loamy marine deposits originating from marine terraces parent material.

Soils observed during the SI activities generally consisted of fine silt and clays over layers of poorly graded and well-graded sand strata. Within the sand strata, occasional layers of finer material (silty sand) and coarser material (gravelly sand) were encountered. Native material appeared to be of marine origin, which coincides with regionally mapped NRCS soil classifications.

3.5 Surface Water Hydrology

The site is located within the watershed of the Lower James River. Storm water at the former RIBF is directed to man-made collection and conveyance structures, which drain to the White Oak Swamp Creek and its on-site, unnamed tributary. The White Oak Swamp Creek enters the RIBF property from a 7.5-ft diameter culvert, which provides drainage from the adjacent Richmond International Airport. White Oak Swamp Creek drains to the Chickahominy River, which flows in to the James Rivers, 21 miles east of the former base. The Base does not lie within the 100- or 500-year floodplains (ITSI, 2009).

3.6 Regional Groundwater Hydrogeology

The main aquifers of the Coastal Plain province are the Chickahominy, the Patuxent, the Aquia, and the Yorktown. The Yorktown aquifer is unconfined or semi-confined. The other three aquifers are confined. Characteristics of each aquifer are provided below.

The Patuxent aquifer, the principal aquifer of Henrico County, is associated with deltaic stream channels that are highly porous and permeable. The screened interval for wells that produce potable water from the Patuxent aquifer is between 166 and 595 ft bgs.

Overlying the Patuxent Aquifer is the Aquia aquifer, which lies within the Tertiary Age Aquia Formation. The thickness of the aquifer ranges from 50 to 60 ft and the screened interval for potable water wells in this aquifer is between 120 and 130 ft bgs. It is confined by the underlying clays of the Cretaceous Age Potomac Group and the overlying Tertiary Age Marlboro.

Lying above the Aquia aquifer within the Tertiary Age Piney Point Formation is the Chickahominy aquifer. It is confined by the underlying Marlboro clay and the overlying Choptank clay. Potable water wells in this aquifer have an average depth of 75 ft bgs and the aquifer's average thickness is between 10 and 15 ft.

Above the Chickahominy aquifer in the Tertiary Age Yorktown-Eastover Formation is the water-table aquifer, also known as the Yorktown aquifer. Potable water wells in this aquifer are screened from 35 to 45 ft bgs; however, this aquifer has not been significantly developed because it may be vulnerable to contamination from leaking tanks and septic systems and can be susceptible to fluctuations in yield during times of drought.

With the exception of the Yorktown aquifer, each aquifer is recharged to the west of the former RIBF in the unconfined portions near the Fall Zone. The surficial Yorktown aquifer is recharged by vertical infiltration of rainfall and surface water. The Yorktown aquifer is the most susceptible to contamination by surface pollutants because it is unconfined to semi-confined. The deeper aquifers are shielded from vertical infiltration of contaminated groundwater by the overlying Choptank clay aquiclude (CH2M Hill, 2001).

Referencing the *Final Remedial Investigation/Feasibility Study Report for Site 1 and Site 3* (CH2M Hill, 2001), the site aquifer (Yorktown Aquifer) is a semi-confined aquifer consisting of relatively clean sand beginning at about 20 ft bgs. The upper portion of the aquifer, starting at approximately 18 to 20 ft bgs consists of a less permeable upper/transitional zone extending to approximately 35 ft bgs. The upper zone is underlain by a more permeable lower zone (approximately 35 to 47 ft bgs). The depth to water across the site is 9 to 14 ft bgs. The groundwater velocity in the upper less permeable zone is approximately 32 to 43 ft per year, while the groundwater in the lower more permeable zone is 70 to 122 ft per year. The groundwater flow direction in both the upper and lower portions of the aquifer is generally to the southeast toward White Oak Swamp Creek.

3.7 Local Groundwater Hydrology

Shallow groundwater at the former RIBF is located within the semi-confined Yorktown aquifer. The potentiometric groundwater surface is generally located between 9 and 14.3 ft bgs, with seasonal fluctuations of up to 5 ft.

According to AECOM's 2013 *Focused Feasibility Study* (AECOM, 2013), horizontal groundwater flow directions in the upper and lower portions of the Yorktown aquifer are towards White Oak Swamp Creek, with average hydraulic gradients of 0.0037 ft/ft (upper) and 0.003 ft/ft (lower); vertical groundwater flow direction is downward from the upper to lower portion of the surficial aquifer with an estimated hydraulic gradient of 0.047 ft/ft. As groundwater migrates toward the White Oak Swamp Creek, an upward vertical gradient is present where groundwater discharges to the creek bed.

Groundwater flow in both the upper and lower portions of the Yorktown aquifer are toward White Oak Swamp Creek. Historical reports indicate that the direction of groundwater flow to the south of White Oak Swamp Creek was northwestward toward the creek, and that groundwater flow to the north of White Oak Swamp Creek was to the southeast. The mean hydraulic conductivity of the upper aquifer is approximately 2.41 ft/day; the mean hydraulic conductivity of the lower aquifer is approximately 9.65 ft/day; and the average groundwater velocity is estimated at 21.7 ft/year and 42 ft/year in the upper and lower aquifers, respectively (AECOM, 2013).

3.8 Critical Habitat and Threatened/Endangered Species

According to the Virginia Department of Game and Inland Fisheries Fish & Wildlife Information Service (VDGIF, 2017), there are seven endangered species found in Henrico County: the Small Whorled Pogonia, Sensitive Joint-vetch, Swamp Pink, Atlantic sturgeon, Dwarf wedgemussel, James Spinymussel, and the northern long-eared bat. The Dwarf wedgemussel and James Spinymussel are species of bivalve mollusk that are endangered. Small Whorled Pogonia, Sensitive Join-vetch, and Swamp Pink are species of flowering plants that are endangered. The Atlantic sturgeon is an endangered fish species and the northern long-eared bat is an endangered mammal species. However, since the general area of the Base is developed, these species are not likely to be found at the PRLs.

3.9 Drinking Water Supply

The former Base is supplied with municipal water purchased from the Henrico County Department of Public Utilities. Henrico County municipal water is derived from the James River approximately eight miles south of the Base (HCPU, 2017). Historically, commercial water wells owned by Henrico County also provided water for the municipal drinking water system. The majority of Henrico County commercial water wells produced from the confined Patuxent aquifer (SAIC, 2001).

A review of the Environmental Data Resources (EDR) Radius Map™ Report with Geocheck® dated 27 July 2015, shows two water wells within a one-mile radius of the former RIBF (EDR, 2015). These wells are listed on the United States Geological Survey database which typically lists monitoring or test wells. Both wells identified in the EDR Report are depicted on **Figure 2**.

According to the 2001 EBS (SAIC, 2001), no water wells were drilled within the Base boundary (other than groundwater monitoring wells) between 1947 and 2001. However, SAIC identified four nearby water supply wells within one mile of the RIBF. The closest well identified was a Municipal Water Well #36, located approximately 700-800 ft northeast of the RIBF. Two domestic water supply wells were identified between ½ and one mile to the east-southeast of the RIBF. And one fire protection well was identified between ½ and one mile to the west of the RIBF. Seven additional wells were identified in the surrounding area greater than one mile from the base. Wells identified by SAIC are depicted on **Figure 2.**

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4.0 PRELIMINARY ASSESSMENT

BB&E conducted a PA site visit for ANG at the former RIBF in August 2015, to identify potential locations of historical environmental releases of PFOA, PFOS, and PFBS, specifically from AFFF usage and storage. Briefly, the PA site visit process included a review of documented FTAs in operation since 1970, and any other use or release of AFFF, and the completion of a site reconnaissance. The goal of the PA site visit was to determine if a PRL poses a potential threat to human health and the environment and requires additional inspection (BB&E, 2015).

The findings of AFFF use and storage at each of the five PRLs recommended for inclusion in the SI, as documented in the *PA Site Visit Report*, are summarized below. A summary of recommendations is presented in **Table 1**.

4.1 PRL 1: Building 3649 – Former Main Hangar

Building 3649 was the former Main Hangar. It is unknown if AFFF was utilized or stored at this location; however, based on the dates of operation and the use of the building, AFFF may have been present at this location. The former Main Hangar (64,605 square ft) was constructed in 1958 with concrete block walls and a concrete floor and was equipped with an Oil Water Separator (OWS). No record of historical AFFF use or spills was noted. Photographs taken during the 2001 EBS site visit show the inside of the Main Hangar. The presence of overhead piping may indicate that a Fire Suppression System was a part of this structure. No other information regarding the type of piping was identified during the PA investigation. Photographs taken during the EBS show a trench drain that was reportedly discharged to the OWS (SAIC, 2001). The OWS would have likely discharged to the sanitary sewer system, similar to other OWSs on-Base, with subsequent discharge to the local publicly owned treatment works (POTW). AFFF may have impacted environmental media by bypassing the onsite containment floor drain and oil water separator system.

4.2 PRL 2: Building 3645 – Former Fire Station

Building 3645 was the former Fire Station. It is unknown if AFFF was utilized at this location; however, based on the dates of operation and the use of the building, AFFF may have been used. According to the 2009 *Final Modified Comprehensive Site Evaluation Phase I Report* (ITSI, 2009), the former Fire Station (6,191 square ft) was built in 1958 with concrete block walls and a sealed concrete floor. No record of historical AFFF use or spills was noted. A photograph from the 2001

EBS site visit shows five overhead doors on the north side of the Fire Station (SAIC, 2001). Four Aircraft Rescue Fire Fighting vehicles are noted to be parked inside the Fire Station. The discharge location from the floor drains within the Fire Station, if present, is not known. It should be noted that the EBS discusses the presence of 10 OWSs at the Base. No OWSs are listed in association with the Fire Station. The sanitary sewer at the Base was connected to the local POTW. No records of known releases of AFFF were identified as part of the PA investigation (BB&E, 2016). AFFF may have impacted environmental media by bypassing the onsite containment floor drain system.

4.3 PRL 3: Building 2851 – Former Fuel System Maintenance Dock

Building 2851, the Former Fuel System Maintenance Dock, was built in 1977 with concrete walls and a concrete pad for the floor. The building is 17,052 square ft. The 2001 EBS indicates that the building is equipped with floor drains that are connected to a 2,000-gallon OWS system, which was noted as "active" during the EBS site visit. This OWS system was noted to have been installed in 1996, replacing the previous 400-gallon OWS that was installed when the building was constructed (1977). Both OWS systems were constructed of steel and drained to the sanitary sewer. According to the EBS, no major spills were noted to have occurred at the Fuel System Maintenance Dock, only minor spills that were cleaned up with absorbent materials (SAIC, 2001). While conducting surveillance and oversight on injections at the nearby Installation Restoration Program (IRP) Site 3 on 29 September 2015, BB&E toured this building. Mr. Jim Colmer of BB&E, noted that the building had an AFFF system with four turrets and a 150-gallon ANSUL (manufacturer's name) AFFF tank. The storage tank was noted to be sweating, indicating that some liquid likely remained inside the tank. Floor drains were also observed within the Former Fuel System Maintenance Dock during the site visit (BB&E, 2015). No records of known releases of AFFF were identified at the Former Fuel System Maintenance Dock as part of the PA investigation. AFFF may have impacted environmental media by bypassing the onsite containment floor drain and OWS system.

4.4 PRL 4: Building 96 – Former Hush House (Jet Engine Test Cell)

Building 96 was the former Hush House or Jet Engine Test Cell. According to the 2001 EBS, this Hush House was built in 1992 as a requirement of the conversion of the Base to the F-16 airframe. The Hush House is a 5,440 square ft building equipped with metal walls and a concrete pad floor. Floor drains are present within the Hush House. One of the floor drains is connected to a 2,000-

gallon steel OWS that was installed in 1992. The OWS discharges to the sanitary sewer. The remainder of the floor drains within the Hush House discharge directly to the sanitary sewer. An uncovered, concrete-bermed fuel storage area was noted adjacent to the west of the Former Hush House (SAIC, 2001). No records of known releases of AFFF were identified as part of the PA investigation (BB&E, 2016). AFFF may have impacted environmental media by bypassing the onsite containment floor drain and oil water separator system.

4.5 PRL 5: Concrete Apron/Ramp

Although there are no records or Base personnel accounts of AFFF usage, the Concrete Ramp/Apron area located in the southwestern portion of the RIBF property may have been impacted by AFFF due to the historical presence and operation of aircraft. A wash rack with a drain was noted to be present during the 2001 EBS site visit on the southern portion of the apron (SAIC, 2001). Storm water from the remainder of the Concrete Ramp/Apron area appears to flow to the north toward an unnamed ditch. No records of known releases of AFFF were identified as part of the PA investigation (BB&E, 2016).

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5.0 FIELD PROGRAM METHODS

The following subsections summarize utility clearance and permitting activities; soil boring installation, sampling, and abandonment; temporary groundwater monitoring well construction, development, sampling, and abandonment; surface water sampling; and sediment sampling. SI activities were conducted in accordance with the *Final Work Plan* (Amec Foster Wheeler, 2017) and the *ANG Investigation Guidance* (ANG, 2009). The SI field activities were conducted during 6 through 10 November 2017. Photographs of field activities are included in **Appendix A**.

5.1 Utility Location and Clearance

On 13 February 2017, a site reconnaissance was completed at the former RIBF to evaluate each of the PRLs and identify areas where AFFF may have been potentially discharged or infiltrated into vadose zone soil. Amec Foster Wheeler was accompanied during the site reconnaissance by personnel from CRAC and the FBI to evaluate and verify the placement of each drilling location.

Prior to commencement of SI activities, drilling locations were pre-marked, and details of the proposed borehole locations were provided to the Virginia 811 One Call utility notification center (VA811). VA811 assigned ticket No. B729900469-00B to drilling activities on the site on 26 October 2017. Prior to subsurface activities, public utilities were cleared, and no locations were required to be moved. Due to the former RIBF being an inactive base, a USAF-103 ticket was not required.

On 31 October 2017, Amec Foster Wheeler met with a private utility company, Accumark, LLC (Accumark) and cleared Base utilities at each of the 20 proposed soil boring and six proposed temporary well locations using geophysical techniques. Equipment employed by Accumark included ground-penetrating radar and electro-magnetic induction locating equipment. Utility clearance activities were performed at the direction and oversight of Amec Foster Wheeler, with the RIBF Point of Contact (POC) accompanying as an escort.

5.2 Permits

As described in **Section 5.1**, Amec Foster Wheeler obtained utility clearance permits for the SI activities, including VA811 with One Call. It was determined by the RIBF POC that Federal Aviation Administration (FAA) permits were required for performance of SI activities. An FAA permit was completed to obtain work clearance approval for each of the borings and temporary well locations. Amec Foster Wheeler obtained a Final Determination Letter dated 14 August 2017

from Mr. Kyle Allison of the FAA providing work clearance approval. No other permits were required.

5.3 Soil Boring Installation

Between 6 November and 10 November 2017, 20 soil borings were advanced and six temporary monitoring wells installed to investigate potential PFC impacts in soil and groundwater at RIBF. The borings were advanced by Cascade Drilling LP with TWS Environmental, LLC and Amec Foster Wheeler oversight using DPT and hollow stem auger (HSA) drilling techniques. Soil borings advanced solely for soil sample collection were completed at 10 ft bgs. Soil borings advanced for installation of temporary monitoring wells were completed below the water table, at depths up to 20 ft bgs. Individual borehole depths are provided in the soil boring logs included in **Appendix B**.

Soil boring locations were selected based on PRL use and physical characteristics to target the most probable AFFF release areas. Twenty-five soil borings were advanced in and around the five PRLs using DPT and HSA drilling methods (19 borings for soil sampling only, five borings for temporary monitoring well installation, and one boring for combined temporary monitoring well installation and soil sampling). Soil cores were collected continuously for field screening at 5-ft intervals in new, dedicated acetate liners. Drilling rods/tools were decontaminated between borings in accordance with protocol described in the *Final Work Plan* (Amec Foster Wheeler, 2017).

5.4 Soil Sampling

As described in the *Final Work Plan* (Amec Foster Wheeler, 2017), shallow soil samples were to be collected from the upper two ft of soil, directly beneath asphalt or pavement, if present; and deep soil samples were to be collected from the 2-ft interval above the soil/water table interface or 10 ft bgs, whichever was encountered first.

Soil samples were collected directly from single-use, acetate liners. After retrieval from the core barrel, the core liner was opened lengthwise and the soil was examined. Soil characteristics were logged in accordance with the Unified Soil Classification System. Soil was also visually inspected for potential impacts. Shallow soil samples were collected from the upper two ft of soil, directly beneath asphalt or pavement, if present. Deep soil samples were collected from 8 to 10 ft bgs at every location, as the water table was not encountered in the upper 10 ft of each soil boring. Soil samples were collected in six ounce high-density polyethylene (HDPE) containers and

immediately cooled with ice to less than 4 Degrees Celsius (°C).

5.5 Soil Boring Abandonment

Following the completion of drilling activities, each boring was backfilled with hydrated bentonite chips just below grade in order to seal the boring. Surface completions were patched with like materials (topsoil/seed) in accordance with RIBF specifications.

5.6 Temporary Monitoring Well Installation and Development

Six temporary monitoring wells were installed to investigate potential groundwater impacts at the five RIBF PRLs and at the Base boundaries. The primary purpose of installing the temporary monitoring wells was to assess groundwater quality downgradient of the PRLs and at the Base boundary. Although well elevation surveys were not part of this project scope, temporary well locations were determined based on historical groundwater data and topographic contours, historical indications of possible impact, and Base features such as buildings and the Base boundary. In general, temporary monitoring wells were installed at locations with the greatest potential to intercept PFCs dissolved in groundwater based on available data and might not represent the highest concentrations at each PRL.

Soil cuttings were monitored continuously to verify soil lithology, then inspected, logged, and field screened in accordance with the FSP. Temporary monitoring wells were installed in accordance with Amec Foster Wheeler's PFC-specific Standard Operating Procedure for installation of monitoring wells (AFW-04).

The temporary monitoring well borings were advanced with HSA tools. Temporary monitoring wells were constructed within borings using a two-inch diameter, schedule 40 polyvinyl chloride (PVC) riser with a 10-ft, 0.010-inch slot screened interval with the water table bisecting the well screen. New dedicated well materials were used at each temporary monitoring well location. The annulus surrounding each well screen and riser was backfilled with No.1 filter sand, which was placed from the bottom of the borehole to the ground surface. No annular seals were installed.

The temporary monitoring wells, as well as two existing permanent monitoring wells (TMW-37 and MW-01-36), were developed prior to sampling using a submersible pump to purge the screened interval and remove fine particles that had accumulated. Water quality parameters were monitored and recorded at periodic intervals. Monitoring wells were considered adequately developed when water quality parameters had stabilized and turbidity was low (i.e., <50

Nephelometric Turbidity Units where feasible).

Well development water was containerized in steel 55-gallon drums and managed in accordance with **Section 5.13**. Equipment and pumps inserted into the well were decontaminated following each use in accordance with **Section 5.12**. Well development logs are included in **Appendix C**.

5.7 Water Level Measurements

Prior to well purging, static water level measurements were collected with an electronic water level meter. Water levels were measured as a distance below the top of the PVC riser and recorded on field data sheets.

5.8 Groundwater Sampling

Eight groundwater samples were collected, six from temporary monitoring wells and two from existing permanent monitoring wells (TMW-37 and MW-01-36). Wells were purged with a peristaltic pump, and United States Environmental Protection Agency (USEPA) Low Stress sampling methodology was followed to collect groundwater samples. The initial water level was recorded using an electronic water level meter prior to purging and sampling activities. Low-density polyethylene tubing was inserted into the monitoring well to the depth recorded in the sampling logs above the bottom of the well to prevent disturbances and re-suspension of sediment present in the bottom of the well. In general, the pump intake was placed in the middle of the saturated interval. The tubing was connected to a multi-parameter water quality probe flow-through cell and then to the peristaltic pump. The pump rate during purging was maintained at a steady flow rate between 100 and 300 milliliters per minute, such that drawdown of the water level within the well did not exceed a maximum allowable drawdown of 0.3 ft. The following parameters were monitored and recorded during purging: temperature, pH, oxidation-reduction potential (ORP), dissolved oxygen, turbidity, temperature, specific conductivity, and water level on approximately five-minute intervals.

The well was considered stabilized after three consecutive readings as follows:

- +/-0.1 for pH,
- +/-3% for specific conductance (conductivity),
- +/-10 millivolts for ORP,
- +/-10% for dissolved oxygen, and

- +/-10% for turbidity.

Upon stabilization, groundwater samples were collected in 125 milliliter HDPE containers and immediately cooled with ice to less than 4°C. Groundwater sampling logs and water quality instrument calibration logs are included in **Appendix D** and **Appendix E**, respectively.

5.9 Temporary Monitoring Well Abandonment

Following the completion of sampling activities, each temporary well was pulled from the ground allowing the formation to collapse into the borehole. Subsequent boring abandonment was completed in accordance with **Section 5.5**. Surface completions were patched with like materials (topsoil/seed) in accordance with RIBF specifications.

5.10 Surface Water Sampling

A total of three surface water samples were collected, one each from PRL 2, PRL 3, and PRL 5. Prior to sample collection, the following parameters were monitored as per the *Final Work Plan*: temperature, pH, ORP, dissolved oxygen, turbidity, and specific conductivity (Amec Foster Wheeler, 2017). Surface water samples were collected from mid-depth in the center of the water column. Surface water samples were collected using a decontaminated bottle sampler attached to a pole (e.g., stainless steel pole and dipper) or directly into the sample container itself. After retrieval from the sampling device, the surface water samples were inspected for visual evidence of impact. Surface water samples were immediately cooled with ice to less than 4°C. Re-usable sampling equipment was decontaminated in accordance with the *Final Work Plan* (Amec Foster Wheeler, 2017). Surface water sampling logs are included in **Appendix F**.

5.11 Sediment Sampling

In accordance with the SI work plan two sediment samples were collected, one each from PRL 1 and PRL 2. Samples were collected from the upper 0.5 foot of sediment utilizing a clean hand auger. The hand auger was used to collect a 6-inch plug of sediment. After retrieval, sediment was transferred to a clean stainless-steel bowl, homogenized, and then placed in 6-ounce HDPE laboratory-supplied containers. Samples were immediately cooled with ice to less than 4°C. Re-usable sampling equipment was decontaminated in accordance with the *Final Work Plan* (Amec Foster Wheeler, 2017). Sediment sampling logs are included in **Appendix F**.

5.12 Decontamination

Field sampling equipment (e.g., water level indicators, pumps, bowls, trowels, shovels, and other downhole equipment) was decontaminated prior to initial use, and between collection of samples. Liquinox® soap diluted with PFC-free water was used to wash sampling equipment with a clean HDPE brush used to remove debris and particulates. PFC-free water was used to rinse soapy water from the sampling equipment. The PFC-free water was obtained from an onsite water source. Prior to use, a sample of the water was submitted to Vista Analytical Laboratories, Inc. (Vista) for analysis of the six PFC compounds on the UCMR3 list. Concentrations were reviewed to ensure Amec Foster Wheeler's internal PFC-free criteria were met. The associated laboratory data report is included in **Appendix G**. Decontamination fluids were containerized in steel 55-gallon drums and managed in accordance with **Section 5.13**.

5.13 Investigation Derived Waste Management

Investigation Derived Waste (IDW) (including soil cuttings, purge water, development water, and decontamination fluids) was collected and contained in labeled, secured, steel 55-gallon drums. Soil drums were filled to no more than 2/3 of maximum capacity of the drum to ensure compliance with Department of Transportation weight restrictions. Drums were staged on-site in an area designated by the RIBF POC. After the completion of field activities, representative composite samples were collected for both solid and liquid IDW. Samples were placed in laboratory-supplied containers using clean disposable gloves and immediately cooled with ice to less than 4°C. New, disposable nitrile gloves were donned prior to sample collection and were worn throughout the sample collection process. The soil and liquid IDW were characterized as non-hazardous. The disposal of drums was completed in a timely manner and in accordance with RIBF policy for IDW. A total of 13 IDW solids and three IDW liquids drums were generated as part of the SI activities. A&D Environmental Services, Inc. transported and disposed of the IDW drums at their facility in Greenville, South Carolina on 10 January 2018. IDW profiles, waste manifest forms, and laboratory data reports are included in **Appendix G**.

5.14 Laboratory

Soil, groundwater, sediment, and surface water samples were submitted to Vista, in El Dorado Hills, California for analysis of PFC compounds on the UCMR3 list by Modified USEPA Method 537.1. Vista is accredited under the Department of Defense (DoD) Environmental Laboratory Accreditation Program (ELAP) and maintains a National ELAP certification via reciprocity in

Virginia.

Waste characterization samples were sent to TestAmerica Laboratories, Inc. (TestAmerica) in Arvada, Colorado for analysis of Toxicity Characteristic Leaching Procedure (TCLP) Resource Conservation and Recovery Act metals including mercury (Methods 6010C and 7471A), TCLP volatile organic compounds (Method 8260B), TCLP semi volatile organic compounds (Method 8270D), and total polychlorinated biphenyls (Method 8082A). TestAmerica is accredited under the DoD ELAP.

5.15 Field Quality Assurance/Quality Control Sample Results

Quality Assurance (QA) and Quality Control (QC) samples, including field duplicates, matrix spike/matrix spike duplicates, equipment rinsate samples, and field blanks were analyzed for the same PFC parameters as the associated project samples. The analytical results for the field duplicates are presented in **Table 3** through **Table 6**.

5.16 Data Validation and Usability

Amec Foster Wheeler performed a data quality review of samples collected during field activities and submitted to Vista for analysis of PFCs, consisting of: 44 soil samples, which included four field duplicates; three sediment samples, which included one field duplicate; and 16 aqueous samples, which included eight primary groundwater samples, three primary surface water samples, two field duplicates, two equipment rinsate blanks, and one decontamination source water sample).

The laboratory analytical data generated during the SI were reviewed by a qualified analytical chemist for conformance with the project DQOs specified in the QAPP found in the *Final Work Plan* (Amec Foster Wheeler, 2017). Amec Foster Wheeler performed USEPA Stage 4 validation on 10% of the field samples and USEPA Stage 2B validation on the remaining field samples associated with this sampling event. The Stage 4 validation includes review of the QC results in the laboratory's analytical report and reported on QC summary forms as well as recalculation checks and review of the instrument raw data outputs. The Stage 2B validation included review of the QC results in the laboratory's analytical report and reported on QC summary forms with no review of the associated raw data. Data from equipment and field blanks did not undergo validation because results from these samples are only used to assess data usability for field samples. The validation was performed in general accordance with: Amec Foster Wheeler Final QAPP found within the *Final Work Plan* (Amec Foster Wheeler, 2017); DoD Quality Systems

Manual for Environmental Laboratories (DOD, 2017); and USEPA Determination of Selected Perfluorinated Alkyl Acids in Drinking Water by Solid Phase Extraction and Liquid Chromatography/Tandem Mass Spectrometry (USEPA, 2009).

Amec Foster Wheeler evaluated 360 data records from field samples during the validation. Amec Foster Wheeler J qualified[1] 48 records (13%) as estimated values because of field duplicate imprecision, and/or analyte concentrations outside the instrument's calibration range; B qualified[2] 16 records (4.4%) because of detections in the associated field and/or laboratory blanks; and Q qualified[3] 1 result (0.3%) because of detections in the associated laboratory and field blanks and field duplicate imprecision. The Data Validation Report, including qualified data, is included as **Appendix H**. Laboratory analytical reports and chains of custody forms are provided in **Appendix I.**

[1] The analyte was positively identified; the associated numerical value is the approximate concentration of the analyte in the sample.

[2] The analyte was detected in the sample and an associated blank and the concentration detected in the sample was less than 10 times the concentration detected in the blank.

[3] The analyte was B qualified because of a detection in an associated blank and J qualified because of an additional QC issue.

6.0 SITE INVESTIGATIONS

This SI field program was designed to collect data needed to evaluate the presence/absence of PFC compounds at each of the five PRLs. The scope of the SI was designed using recommendations presented in the PA prepared by BB&E (BB&E, 2016). The following sections describe the investigation approach that was used to fulfill the objectives of the SI. The work was conducted in accordance with the QAPP, SHSP, and FSP presented in the approved *Final Work Plan* (Amec Foster Wheeler, 2017).

6.1 Field Activities Summary

The following SI field activities were completed:

PRL Name	Location Type	Analyzed Parameters[1]	Soil Borings	Soil Samples	Groundwater Samples (Existing Wells)	Groundwater Samples (Temporary Wells)	Surface Water Samples	Sediment Samples
1. Bldg. 3649 (Former Main Hangar)	Hangar with AFFF FSS	PFCs	4	8	0	1	0	1
2. Bldg. 3645 (Former Fire Station)	Fire Station	PFCs	4	8	0	1	1	1
3. Bldg. 2851 (Former Fuel System Maint. Dock)	Hangar with AFFF FSS	PFCs	4	8	0	1	1	0
4. Bldg. 96 Former Hush House (Jet Engine Test Cell)	Hangar with AFFF FSS	PFCs	4	8	0	1	0	0
5. Concrete Apron/Ramp	Ramp Fuel Emergency	PFCs	4	8	1	0	1	0
Base Boundary Wells	Base Boundary	PFCs	0	0	1	2	0	0
TOTAL			20	40	2	6	3	2

Notes:
FSS = Fire Suppression System

[1]Soil, groundwater, surface water, and sediment samples were collected and analyzed for the PFCs listed on the USEPA's Third Unregulated Contaminant Monitoring Rule (UCMR3) list.

Individual sampling locations are shown on **Figures 4** through **Figure 9.** Field activity photographs, soil boring and monitoring well construction, well development, groundwater

sampling, and surface water and sediment sampling logs are included in **Appendices A**, **B, C**, **D,** and **F,** respectively.

6.2 General Work Plan Deviations

Deviations from the general work plan included the following conditions:

- The November 2017 USEPA residential soil Regional Screening Level (RSL) value for PFBS (1,300,000 micrograms per kilogram [µg/kg]) was used as the screening value in place of the May 2016 USEPA residential soil RSL value for PFBS (1,600,000 µg/kg). The updated RSL value was not published at the time the Work Plan was finalized.
- The November 2017 USEPA Tap Water RSL value for PFBS [400 micrograms per liter (µg/L)] was used as the screening value in place of the May 2016 USEPA Tap Water RSL value for PFBS (380 µg/L). The updated RSL value was not published at the time the Work Plan was finalized.

Work Plan deviations specific to an individual PRL are discussed in the following sub sections.

6.3 PRL 1: Building 3649 – Former Main Hangar

6.3.1 Site Deviations

One deviation from the Work Plan occurred at this PRL. No surface water sample (01SW01) was collected due to the lack of surface water at the time of sampling. No other deviations, apart from the general Work Plan deviations (see **Section 6.2**), occurred at this PRL.

6.3.2 Soil Sampling

Four soil borings (SB) (01SB01, 01SB02, 01SB03, and 01SB04) were advanced at PRL 1 on 7 November 2017, and shallow soil samples (0-2 ft bgs) were collected from each boring. Due to the location of utilities, two borings (01SB03 and 01SB04) were pre-cleared using a hand auger. The borings were completed using DPT drilling techniques, and deep samples (8-10 ft bgs) were collected from the bottom two ft of each boring. A total of eight soil samples were collected at this PRL.

Soil boring locations are illustrated on **Figure 4.**

6.3.3 Groundwater Sampling

Temporary monitoring well TW-01 was drilled to a depth of 20 ft bgs on 6 November 2017, and a

well screen was installed from 10 -20 ft bgs. Groundwater was measured at a depth of 16.04 ft below top of casing (TOC) in TW-01 prior to purging and sampling. One groundwater sample was collected on 7 November 2017.

Temporary monitoring well locations are illustrated on **Figure 4.**

6.3.4 Sediment Sampling

One sediment sample (SD) (01SD01) was collected at PRL 1 on 8 November 2017. The sediment sample was collected using hand tools from the upper 0.5 ft of sediment near an area of stormwater drainage.

Sediment sample locations are illustrated on **Figure 4.**

6.4 PRL 2: Building 3645 – Former Fire Station

6.4.1 Site Deviations

No deviations, other than general Work Plan deviations occurred at this PRL.

6.4.2 Soil Sampling

Four soil borings (02SB01, 02SB02, 02SB03, and 02SB04) were advanced at PRL 2 on 6 and 7 November 2017, and shallow soil samples (0-2 ft bgs) were collected from each boring. The borings were completed using DPT drilling techniques, and deep samples (8-10 ft bgs) were collected from the bottom two ft of each boring. A total of eight soil samples were collected at this PRL.

Soil boring locations are illustrated on **Figure 5.**

6.4.3 Groundwater Sampling

Temporary monitoring well TW-02 was drilled to a depth of 20 ft bgs on 7 November 2017, and a well screen was installed from 10 -20 ft bgs. Groundwater was measured at a depth of 18.25 ft below TOC in TW-02 prior to purging and sampling. One groundwater sample was collected on 7 November 2017.

Temporary monitoring well locations are illustrated on **Figure 5.**

6.4.4 Sediment Sampling

One sediment sample (02SD01) was collected at PRL 2 on 8 November 2017. The sediment sample was collected using hand tools from the upper 0.5 ft of sediment near the White Oak

Swamp Creek downgradient from PRL 2.

Sediment sample locations are illustrated on **Figure 5.**

6.4.5 Surface Water Sampling

One surface water sample (02SW01) was collected at PRL 2 on 8 November 2017. The surface water sample was collected from White Oak Swamp Creek downgradient from PRL 2.

Surface water sample locations are illustrated on **Figure 5.**

6.5 PRL 3: Building 2851 – Former Fuel System Maintenance Dock

6.5.1 Site Deviations

No deviations, other than general Work Plan deviations occurred at this PRL.

6.5.2 Soil Sampling

Four soil borings (03SB01, 03SB02, 03SB03, and 03SB04) were advanced at PRL 3 on 8 and 9 November 2017, and shallow soil samples (0-2 ft bgs) were collected from each boring. The borings were completed using DPT drilling techniques, and deep samples (8-10 ft bgs) were collected from the bottom two ft of each boring. A total of eight soil samples were collected at this PRL.

Soil boring locations are illustrated on **Figure 6.**

6.5.3 Groundwater Sampling

Temporary monitoring well TW-03 was drilled to a depth of 20 ft bgs on 8 November 2017, and a well screen was installed from 10-20 ft bgs. Groundwater was measured at a depth of 12.58 ft below TOC in TW-03 prior to purging and sampling. One groundwater sample was collected on 9 November 2017.

Temporary monitoring well locations are illustrated on **Figure 6.**

6.5.4 Surface Water Sampling

One surface water sample (03SW01) was collected at PRL 3 on 9 November 2017. The surface water sample was collected from White Oak Swamp Creek near PRL 3.

Surface water sample locations are illustrated on **Figure 6.**

6.6 PRL 4: Building 96 – Former Hush House

6.6.1 Site Deviations

One deviation from the Work Plan occurred at this PRL. No surface water sample (04SW01) was collected due to the lack of surface water at the time of SI activities. No other deviations, apart from the general Work Plan deviations, occurred at this PRL.

6.6.2 Soil Sampling

Four soil borings (04SB01, 04SB02, 04SB03, and 04SB04) were advanced at PRL 4 on 7 and 8 November 2017, and shallow soil samples (0-2 ft bgs) were collected from each boring. The borings were completed using DPT drilling techniques, and deep samples (8-10 ft bgs) were collected from the bottom two ft of each boring. A total of eight soil samples were collected at this PRL.

Soil boring locations are illustrated on **Figure 7.**

6.6.3 Groundwater Sampling

Temporary monitoring well TW-04 was drilled to a depth of 20 ft bgs on 6 November 2017, and a well screen was installed from 10- 20 ft bgs. Groundwater was measured at a depth of 15.05 ft below TOC in TW-04 prior to purging and sampling. One groundwater sample was collected on 8 November 2017.

Temporary monitoring well locations are illustrated on **Figure 7**.

6.7 PRL 5: Concrete Apron/Ramp

6.7.1 Site Deviations

No deviations, other than general Work Plan deviations occurred at this PRL.

6.7.2 Soil Sampling

Four soil borings (05SB01, 05SB02, 05SB03, and 05SB04) were advanced at PRL 5 on 8 November 2017, and shallow soil samples (0-2 ft bgs) were collected from each boring. The borings were completed using DPT drilling techniques, and deep samples (8-10 ft bgs) were collected from the bottom two ft of each boring. A total of eight soil samples were collected at this PRL

Soil boring locations are illustrated on **Figure 8.**

6.7.3 Groundwater Sampling

One groundwater sample was collected on 8 November 2017 from existing permanent groundwater monitoring well TMW-37. Groundwater was measured at a depth of 17.90 ft below TOC prior to purging and sampling. Based on historical records, TMW-37 is screened from 12-27 ft bgs; the bottom of the well screen was measured at a depth of 27 ft (measured from TOC).

Temporary monitoring well locations are illustrated on **Figure 8**.

6.7.4 Surface Water Sampling

One surface water sample (05SW01) was collected at PRL 5 on 8 November 2017. The surface water sample was collected in the White Oak Swamp Creek downgradient from PRL 5.

Surface water sample locations are illustrated on **Figure 8.**

6.8 Base Boundary Wells

6.8.1 Site Deviations

No deviations, other than general Work Plan deviations occurred at this PRL.

6.8.2 Groundwater Sampling

Temporary monitoring wells BW-01 and BW-02 were drilled to a depth of 20 ft bgs on 9 November 2017, and a well screen was installed from 10-20 ft bgs for each well. Groundwater was measured at a depth of 11.58 ft and 8.62 ft below TOC in BW-01 and BW-02, respectively, prior to purging and sampling. Two groundwater samples were collected from the base boundary temporary monitoring wells on 9 November 2017 (BW-02) and 10 November 2017 (BW-01).

In addition, one groundwater sample was collected on 10 November 2017 from existing permanent groundwater monitoring well MW-01-36. Groundwater was measured at a depth of 13.42 ft below TOC prior to purging and sampling. Based on historical records, MW-01-36 is screened from 14.15-29.15 ft bgs; the bottom of the well screen was measured at a depth of 29.15 ft (measured from TOC). A total of three groundwater samples were collected from the base boundary wells.

Base boundary monitoring well locations are illustrated on **Figure 9.**

7.0 SOIL AND GROUNDWATER STANDARDS

A soil or groundwater standard is an environmental and/or public health statute or rule used in identifying Base contamination that may pose a risk to human health or the environment. Soil and groundwater standards are federal, and state human health and environment-based regulations used to:

- Determine the appropriate levels of Base clean-up;
- Define and formulate remedial action alternatives; and,
- Govern implementation and operation of the selected remedial action.

Currently no promulgated Standards exist for these compounds.

In accordance with *Interim Air Force Guidance on Sampling and Response Actions for Perfluorinated Compounds at Active and BRAC Installations* (USAF, 2012) and USEPA lifetime drinking water Heath Advisories (HAs) for PFOS (USEPA, 2016a) and PFOA (USEPA, 2016b), a release is considered confirmed if the following concentrations are exceeded:

PFOS:

- 0.07 µg/L in groundwater/surface water that is used as or contributes to a drinking water source (combined with PFOA value).
- 1,260 µg/kg in soil (calculated in the absence of RSL values[4]).
- 1,260 µg/kg in sediment (calculated in the absence of RSL values).

PFOA:

- 0.07 µg/L in groundwater/surface water (combined with PFOS value).
- 1,260 µg/kg in soil (calculated in the absence of RSL values).
- 1,260 µg/kg in sediment (calculated in the absence of RSL values).

USEPA has also derived (RSL values for PFBS, for which there is a Tier 2 toxicity value (USEPA, 2017). The USAF will also consider a release to be confirmed if the following concentrations are

[4] Air Force Guidance screening levels calculated using the USEPA Regional Screening Level calculator [https://epa-prgs.ornl.gov/cgi-bin/chemicals/csl_search]. The toxicity value input for the calculator is the Tier 3 value reference dose of 0.00002 mg/kg/day derived by USEPA in their Drinking Water Health Advisories for both PFOS (USEPA, 2016a) and PFOA (USEPA, 2016b).

exceeded:

PFBS:

- 400 µg/L in groundwater/surface water.
- 1,300,000 µg/kg in soil/sediment.

The HA, RSLs and USAF Guidance values are collectively referred to as screening criteria in this Report. **Table 7** presents the screening criteria for comparing the analytical results for PFBS, PFOA, and PFOS.

8.0 SITE INVESTIGATION RESULTS

This section presents the soil, groundwater, surface water, and sediment data collected during the SI activities and a comparison of detections. Detections of PFBS, PFOA and PFOS are compared to the screening criteria as defined in the Work Plan and presented in **Table 7**. Locations of detected analytes are shown on **Figure 4** through **Figure 9**.

8.1 PRL 1: Building 3649 – Former Main Hangar

8.1.1 PRL 1 Soil Analytical Results

Eight soil samples were collected and analyzed as described in **Section 6.3.3**: 01SB01 from 0-2 and 8-10 ft bgs; 01SB02 from 0-2 and 8-10 ft bgs; 01SB03 from 0-2 and 8-10 ft bgs; and 01SB04 from 0-2 and 8-10 ft bgs. Analytical results from soil samples indicate that four of the six PFCs were detected above the laboratory reporting limit in at least one of the four soil samples collected; however, no compounds exceeded the screening criteria in any of the eight soil samples collected from PRL 1.

Comparisons of analytical results to applicable screening criteria are presented on **Table 3**. The soil boring locations showing detected compounds are depicted on **Figure 4**.

8.1.2 PRL 1 Groundwater Analytical Results

One groundwater sample was collected from TW-01 and analyzed as described in **Section 6.3.4**. Analytical results from the groundwater sample indicates that five PFC compounds were detected at concentrations above the laboratory detection limit, with one compound exceeding the groundwater screening criterion. PFOS was detected in TW-01 above the 0.07 µg/L USEPA Drinking Water HA (USEPA, 2016a), at a concentration of 0.181 µg/L. The combined PFOS and PFOA concentration is 0.220 µg/L at this location.

Comparisons of analytical results to applicable screening criteria are presented on **Table 4**. The temporary monitoring well location showing detected compounds is illustrated on **Figure 4.**

8.1.3 PRL 1 Sediment Analytical Results

One sediment sample was collected and analyzed as described in **Section 6.3.2**, 01SD01 from 0-0.5 ft bgs. Analytical results from the sediment sample indicate one PFC compound was detected above the laboratory reporting limit; however, no compounds exceeded the screening criteria in the sediment sample collected from PRL 1.

Comparisons of analytical results, including field duplicate results, to applicable criteria are presented on **Table 5**. The sediment sample location showing detected compounds are depicted on **Figure 4.**

8.2 PRL 2: Building 3645 – Former Fire Station

8.2.1 PRL 2 Soil Analytical Results

Eight soil samples were collected and analyzed as described in **Section 6.4.4**: 02SB01 from 0-2 and 8-10 ft bgs; 02SB02 from 0-2 and 8-10 ft bgs; 02SB03 from 0-2 and 8-10 ft bgs; and 02SB04 from 0-2 and 8-10 ft bgs. Analytical results from soil samples indicate that each of the six PFCs were detected above the laboratory reporting limit in at least one sample; however, no compounds exceeded the screening criteria in either of the eight samples collected from PRL 2.

Comparisons of analytical results to applicable screening criteria are presented on **Table 3**. The soil boring locations showing detected compounds are depicted on **Figure 5.**

8.2.2 PRL 2 Groundwater Analytical Results

One groundwater sample was collected from TW-02 and analyzed as described in **Section 6.4.5**. Analytical results from the groundwater sample indicates that six PFC compounds were detected at concentrations above the laboratory detection limit, with two compounds exceeding the groundwater screening criterion. PFOS and PFOA were detected in TW-02 above the 0.07 µg/L USEPA Drinking Water HA, at a concentration of 1.68 µg/L and 0.588 µg/L, respectively. The combined PFOS and PFOA concentration is 2.27 µg/L at this location.

Comparisons of analytical results to applicable screening criteria are presented on **Table 4**. The temporary monitoring well location showing detected compounds is illustrated on **Figure 5.**

8.2.3 PRL 2 Sediment Analytical Results

One sediment sample was collected and analyzed as described in **Section 6.4.2**, 02SD01 from 0-0.5 ft bgs. Analytical results from the sediment sample indicate five PFC compounds were detected above the laboratory reporting limit; however, no compounds exceeded the screening criteria in the sediment sample collected from PRL 2.

Comparisons of analytical results, including field duplicate results, to applicable criteria are presented on **Table 5**. The sediment sample location showing detected compounds are depicted on **Figure 5.**

8.2.4 PRL 2 Surface Water Analytical Results

One surface water sample (02SW01) was collected and analyzed as described in **Section 6.4.3**. Analytical results from the surface water sample indicate six PFCs were detected above the laboratory reporting limit; with one compound exceeding the surface water screening criterion. PFOS was detected in 02SW01 above the 0.07 µg/L USEPA Drinking Water HA, at a concentration of 0.0937 µg/L. The combined PFOS and PFOA concentration is 0.14 µg/L at this location.

Comparisons of analytical results to applicable screening criteria are presented on **Table 6**. The surface water location showing detected compounds is illustrated on **Figure 5**.

8.3 PRL 3: Building 2851 – Former Fuel System Maintenance Dock

8.3.1 PRL 3 Soil Analytical Results

Eight soil samples were collected and analyzed as described in **Section 6.5.3**: 03SB01 from 0-2 and 8-10 ft bgs; 03SB02 from 0-2 and 8-10 ft bgs; 03SB03 from 0-2 and 8-10 ft bgs; and 03SB04 from 0-2 and 8-10 ft bgs. Analytical results from soil samples indicate that three of the six PFCs were detected above the laboratory reporting limit in at least one sample; however, no compounds exceeded the screening criteria in either of the eight samples collected from PRL 3.

Comparisons of analytical results to applicable screening criteria are presented on **Table 3**. The soil boring locations showing detected compounds are depicted on **Figure 6**.

8.3.2 PRL 3 Groundwater Analytical Results

One groundwater sample was collected from TW-03 and analyzed as described in **Section 6.5.4**. Analytical results from the groundwater sample indicates that six PFCs were detected at concentrations above the laboratory detection limit, with two compounds exceeding the USEPA Drinking Water HA of 0.07 µg/L. PFOS and PFOA were detected in TW-03 at a concentration of 0.31 µg/L and 0.303 µg/L, respectively. The combined PFOS and PFOA concentration is 0.61 µg/L at this location.

Comparisons of analytical results to applicable criteria are presented on **Table 4**. The temporary monitoring well location showing detected compounds is illustrated on **Figure 6.**

8.3.3 PRL 3 Surface Water Analytical Results

One surface water sample (03SW01) was collected and analyzed as described in **Section 6.5.2**. Analytical results from the surface water sample indicate six PFCs were detected above the laboratory reporting limit; with two compounds exceeding the surface water screening criterion. PFOS and PFOA were detected in 03SW01 above the 0.07 µg/L USEPA Drinking Water HA, at a concentration of 0.453 µg/L and 0.1 µg/L, respectively. The combined PFOS and PFOA concentration is 0.553 µg/L at this location.

Comparisons of analytical results to applicable screening criteria are presented on **Table 6**. The surface water location showing detected compounds is illustrated on **Figure 6.**

8.4 PRL 4: Building 96 – Former Hush House

8.4.1 PRL 4 Soil Analytical Results

Eight soil samples were collected and analyzed as described in **Section 6.6.2:** 04SB01 from 0-2 and 8-10 ft bgs; 04SB02 from 0-2 and 8-10 ft bgs; 04SB03 from 0-2 and 8-10 ft bgs; and 04SB04 from 0-2 and 8-10 ft bgs. Analytical results from soil samples indicate four of the six PFCs were detected above the laboratory reporting limit in at least one sample; however, no compounds exceeded the screening criteria in the eight samples collected from PRL 4.

Comparisons of analytical results to applicable screening criteria are presented on **Table 3**. The soil boring locations showing detected compounds are depicted on **Figure 7.**

8.4.2 PRL 4 Groundwater Analytical Results

One groundwater sample was collected from TW-04 and analyzed as described in **Section 6.6.3**. Analytical results from the groundwater sample indicates that four PFCs were detected at concentrations above the laboratory detection limit, however, no compounds exceed the USEPA Drinking Water HA of 0.07 µg/L.

Comparisons of analytical results to applicable criteria are presented on **Table 4**. The temporary monitoring well location showing detected compounds is illustrated on **Figure 7**.

8.5 PRL 5: Concrete Apron/Ramp

8.5.1 PRL 5 Soil Analytical Results

Eight soil samples were collected and analyzed as described in **Section 6.7.3**: 05SB01 from 0-2 and 8-10 ft bgs; 05SB02 from 0-2 and 8-10 ft bgs: 05SB03 from 0-2 and 8-10 ft bgs; and 05SB04

from 0-2 and 8-10 ft bgs. Analytical results from soil samples indicate four of the six PFCs were detected above the laboratory reporting limit in at least one sample; however, no compounds exceeded the screening criteria in either of the eight samples collected from PRL 5.

Comparisons of analytical results to applicable screening criteria are presented on **Table 3**. The soil boring locations showing detected compounds are depicted on **Figure 8**.

8.5.2 PRL 5 Groundwater Analytical Results

One groundwater sample was collected from TMW-37 and analyzed as described in **Section 6.7.4**. Analytical results from the groundwater sample indicates that six PFCs were detected at concentrations above the laboratory detection limit, with two compounds exceeding the USEPA Drinking Water HA of 0.07 µg/L. PFOS and PFOA were detected in TMW-37 at a concentration of 0.33 µg/L and 0.162 µg/L, respectively. The combined PFOS and PFOA concentration is 0.49 µg/L at this location.

Comparisons of analytical results to applicable criteria are presented on **Table 4**. The temporary monitoring well location showing detected compounds is illustrated on **Figure 8.**

8.5.3 PRL 5 Surface Water Analytical Results

One surface water sample (05SW01) was collected and analyzed as described in **Section 6.7.2**. Analytical results from the surface water sample indicate six PFCs were detected above the laboratory reporting limit; with one compound exceeding the surface water screening criterion. PFOS was detected in 05SW01 above the 0.07 µg/L USEPA Drinking Water HA, at a concentration of 0.0809 µg/L. The combined PFOS and PFOA concentration is 0.120 µg/L at this location.

Comparisons of analytical results to applicable screening criteria are presented on **Table 6**. The surface water location showing detected compounds is illustrated on **Figure 8.**

8.6 Base Boundary Wells

8.6.1 Groundwater Analytical Results

One groundwater sample was collected from BW-01 and analyzed as described in **Section 6.8.2**. Analytical results from the groundwater sample indicates that six PFCs were detected at concentrations above the laboratory detection limit, with one compound exceeding the USEPA Drinking Water HA of 0.07 µg/L. PFOS was detected at a concentration of 0.21 µg/L in BW-01. The combined PFOS and PFOA concentration is 0.23 µg/L at this location.

One groundwater sample was collected from BW-02 and analyzed as described in **Section 6.8.2**. Analytical results from the groundwater sample indicates that five of the six PFCs were detected at concentrations above the laboratory detection limit, with two compounds exceeding the USEPA Drinking Water HA of 0.07 µg/L. PFOS and PFOA were detected in BW-02 at a concentration of 0.423 µg/L and 0.112 µg/L, respectively. The combined PFOS and PFOA concentration is 0.535 µg/L at this location.

Lastly, one groundwater sample was collected from MW-01-36 and analyzed as described in **Section 6.8.2**. Analytical results from the groundwater sample indicates that six PFCs were detected at concentrations above the laboratory detection limit, however, no compounds exceed the USEPA Drinking Water HA of 0.07 µg/L.

Comparisons of analytical results to applicable screening criteria are presented on **Table 4**. The temporary monitoring well location showing detected compounds is illustrated on **Figure 9.**

9.0 CONCLUSIONS/RECOMMENDATIONS

This section presents the SI conclusions and recommendations at each PRL. The recommendations are based on data collected by Amec Foster Wheeler during this SI, and an evaluation of results compared to applicable screening criteria.

A review of soil analytical data compared to soil screening criteria indicates there are no USEPA RSL exceedances for PFBS, and no USAF Guidance screening level exceedances for PFOS or PFOA at RBIF locations near the five PRLs. However, soil may be an ongoing source of contaminants to groundwater.

A review of groundwater data compared to screening criteria indicates exceedances of the USEPA Drinking Water HA existing at six of the eight temporary or existing monitoring wells sampled for PFOS and at four of the eight temporary or existing monitoring wells sampled for PFOA. A review of groundwater data compared to screening criteria indicates no exceedances of the USEPA Drinking Water HA for PFBS at any of the PRLs.

Groundwater results exceed the USEPA Drinking Water HA at temporary monitoring wells sampled at PRLs 1, 2, 3 and 5, and at the Base Boundary. Therefore, based on the local and regional groundwater flow directions at the RIBF there is a potential for PFC migration downgradient of each PRL toward the White Oak Swamp Creek and at the Base Boundary toward the southeast.

A review of surface water analytical data compared to screening criteria indicates there are no USEPA RSL exceedances for PFBS, however, there are exceedances of the USAF Guidance screening level for PFOS at PRL 2, PRL 3, and PRL 5, and for PFOA at PRL 3.

A review of sediment analytical data compared to screening criteria indicates there are no USEPA RSL exceedances for PFBS, and no USAF Guidance screening level exceedances for PFOS or PFOA at locations to evaluate the stormwater drainage basin. Although contamination was detected within the stormwater drainage basin, this is considered a migration pathway and is not likely to be an ongoing source of contamination.

Based on the SI results, additional investigation is recommended at each of the five PRLs and the Base boundary. The following DQOs are recommended:

- Additional soil investigations are recommended at each of the five PRLs to evaluate the extent of PFCs including within the saturated zone.

- Additional investigations are recommended to evaluate concentrations of PFCs in groundwater at each of the five PRLs. This should include a source evaluation and delineation to determine the nature and extent of the release.
- Additional investigations are recommended to further evaluate concentrations of PFCs in surface water at PRL 2, PRL 3, and PRL 5. This should include an evaluation to identify the source, and downstream investigation to determine the nature and extent of the release. A second round of surface water samples should be collected concurrent with this evaluation to relate concentrations within the stormwater basin to concentrations up- and down-stream.
- Additional investigations are recommended both up and downgradient of the Base boundary to evaluate if there are PFCs migrating onto the Base and the extent of contamination migrating off Base.

Amec Foster Wheeler recommends that further investigations include analysis of additional compounds, including precursor compounds, to supplement the UCMR3 list. Precursor compounds have potential to result in increased concentrations downgradient and can serve as a lingering source.

9.1 PRL Sites Summary

In summary, additional investigations are recommended for each of the five PRLs and the Base boundary.

These recommendations are summarized in **Table 8** below.

Table 8: Screening Criteria Exceedances and Recommendations

PRL	Screening Criteria Exceedance				Recommendations
	Soil	GW	SW	SD	
1		X			GW investigation to determine the nature and extent of the confirmed PFC release. Soil investigation, including soils in the saturated zone, to determine if the soil may be a contributing source to GW.
2		X	X		GW investigation to determine the nature and extent of the confirmed PFC release. Soil investigation, including soils in the saturated zone, to determine if the soil may be a contributing source to GW. SW investigation to evaluate migration pathway of PFCs.

PRL	Screening Criteria Exceedance				Recommendations
	Soil	GW	SW	SD	
3		X	X		GW investigation to determine the nature and extent of the confirmed PFC release. Soil investigation, including soils in the saturated zone, to determine if the soil may be a contributing source to GW. SW investigation to evaluate migration pathway of PFCs.
4					GW investigation to determine the nature and extent of the confirmed release. Soil investigation, including soils in the saturated zone, to determine if the soil may be a contributing source to GW.
5		X	X		GW investigation to determine the nature and extent of the confirmed PFC release. Soil investigation, including soils in the saturated zone, to determine if the soil may be a contributing source to GW. SW investigation to evaluate migration pathway of PFCs.
Base Boundary Wells		X			GW investigation both up and downgradient of the base boundary to evaluate potential off base sources and to evaluate the nature and extent of the confirmed release.

Notes:
GW – Groundwater
PFC – Perfluorinated Compound
PRL – Potential Release Area
SD – Sediment
SW – Surface water
X – Screening criteria exceedance

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TABLES

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Table 1

Preliminary Assessment Recommendations

FY16 Phase I Regional Site Inspections for Perfluorinated Compounds

Former 192nd Fighter Wing, Richmond Air National Guard

Richmond IAP Byrd Field, Sandston, Virginia

List of PRLs		
PRL	**Use**	**Recommendation**
1. Building 3649 – Former Main Hangar	Former Main Hangar with AFFF Fire Suppression System (FSS)	Soil, sediment, surface water, and groundwater inspection
2. Building 3645 – Former Fire Station	Former Fire Station	Soil, sediment, surface water, and groundwater inspection
3. Building 2851 – Former Fuel System Maintenance Dock	Former Fuel System Maintenance Dock with AFFF FSS	Soil, surface water, and groundwater inspection
4. Building 96 – Former Hush House (Jet Engine Test Cell)	Former Hush House (Jet Engine Test Cell)	Soil, surface water, and groundwater inspection
5. Concrete Ramp/Apron	Aircraft ramp/runway	Soil, surface water, and groundwater inspection

Notes:

Recommendations provided by BB&E, Inc. in the Final Perfluorinated Compounds Preliminary Assessment Site Visit Report (BB&E, 2016)

Table 2

Summary of Site Inspection Activities

FY16 Phase I Regional Site Inspections for Perfluorinated Compounds

Former 192nd Fighter Wing, Richmond Air National Guard

Richmond IAP Byrd Field, Sandston, Virginia

PRL Name	Location Type	Analyzed Parameters[1]	Soil Borings	Soil Samples	Groundwater Samples (Existing Wells)	Groundwater Samples (Temporary Wells)	Surface Water Samples	Sediment Samples
1. Bldg. 3649 (Former Main Hangar)	Hangar with AFFF FSS	PFCs	4	8	0	1	0	1
2. Bldg. 3645 (Former Fire Station)	Fire Station	PFCs	4	8	0	1	1	1
3. Bldg. 2851 (Former Fuel System Maint. Dock)	Hangar with AFFF FSS	PFCs	4	8	0	1	1	0
4. Bldg. 96 Former Hush House (Jet Engine Test Cell)	Hangar with AFFF FSS	PFCs	4	8	0	1	0	0
5. Concrete Apron/Ramp	Ramp Fuel Emergency	PFCs	4	8	1	0	1	0
Base Boundary Wells	Base Boundary	PFCs	0	0	1	2	0	0
TOTAL			20	40	2	6	3	2

Notes:

[1] Soil, groundwater, surface water, and sediment samples were collected and analyzed for the PFCs listed on the USEPA's Third Unregulated Contaminant Monitoring Rule (UCMR3) list.

FSS = Fire Suppression System

Table 3
Summary of Soil Analytical Testing Results
FY16 Phase I Regional Site Inspections for Perfluorinated Compounds
192nd Fighter Wing, Virginia Air National Guard
Richmond IAP Byrd Field, Sandston, Virginia

						Perfluorooctanesulfonic acid (PFOS)	Perfluorooctanoic acid (PFOA)	Perfluorobutanesulfonic acid (PFBS)	Perfluoroheptanoic acid (PFHpA)	Perfluorohexanesulfonic acid (PFHxS)	Perfluorononanoic acid (PFNA)
					Analyte:						
					Screening Level:	1.26[1]	1.26[1]	1300[2]	NA	NA	NA
PRL	**Location**	**Sample ID**	**Sample Date**	**Sample Depth (ft.)**	**Sample Type**	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg
1	01SB01	RICHM-01-SB01-0-2	07-Nov-17	0.0-2.0	N	0.0142	0.000414 B	0.000984 U	0.000984 U	0.000431 J	0.000984 U
		RICHM-01-SB01-8-10	07-Nov-17	8.0-10.0	N	0.000972 U	0.000972 U	0.000972 U	0.000972 U	0.000988 J	0.000972 U
	01SB02	RICHM-01-SB02-0-2	07-Nov-17	0.0-2.0	N	0.00646	0.000976 U	0.000976 U	0.000976 U	0.000976 U	0.000976 U
		RICHM-01-SB02-8-10	07-Nov-17	8.0-10.0	N	0.00101 U	0.00101 U	0.00101 U	0.00101 U	0.00111 J	0.00101 U
	01SB03	RICHM-01-SB03-0-2	07-Nov-17	0.0-2.0	N	0.00539 J	0.000746 B	0.000994 U	0.000994 U	0.000994 U	0.000526 J
		RICHM-SO-DUP01-110717	07-Nov-17	0.0-2.0	FD	0.00331 J	0.000983 U	0.000983 U	0.000983 U	0.000983 U	0.000983 U
		RICHM-01-SB03-8-10	07-Nov-17	8.0-10.0	N	0.000984 U	0.000984 U	0.000984 U	0.000984 U	0.000984 U	0.000984 U
	01SB04	RICHM-01-SB04-0-2	07-Nov-17	0.0-2.0	N	0.000394 J	0.00045 B	0.000887 U	0.000887 U	0.000636 J	0.000887 U
		RICHM-01-SB04-8-10	07-Nov-17	8.0-10.0	N	0.000978 U	0.000978 U	0.000978 U	0.000978 U	0.000978 U	0.000978 U
2	02SB01	RICHM-02-SB01-0-2	06-Nov-17	0.0-2.0	N	0.0712	0.00206 B	0.000304 J	0.000456 J	0.00734	0.000939 U
		RICHM-02-SB01-8-10	06-Nov-17	8.0-10.0	N	0.0013 J	0.000947 U	0.000947 U	0.000947 U	0.00104 J	0.000947 U
	02SB02	RICHM-02-SB02-0-2	07-Nov-17	0.0-2.0	N	0.103 J	0.00279 Q	0.00042 J	0.000621 J	0.0101	0.000522 J
		RICHM-SO-DUP02-110717	07-Nov-17	0.0-2.0	FD	0.173 J	0.00485 J	0.00035 J	0.000887 J	0.0126	0.000621 J
		RICHM-02-SB02-8-10	07-Nov-17	8.0-10.0	N	0.00362	0.000493 B	0.000941 U	0.000941 U	0.003	0.000941 U

Table 3
Summary of Soil Analytical Testing Results
FY16 Phase I Regional Site Inspections for Perfluorinated Compounds
192nd Fighter Wing, Virginia Air National Guard
Richmond IAP Byrd Field, Sandston, Virginia

						Analyte:	Perfluorooctanesulfonic acid (PFOS)	Perfluorooctanoic acid (PFOA)	Perfluorobutanesulfonic acid (PFBS)	Perfluoroheptanoic acid (PFHpA)	Perfluorohexanesulfonic acid (PFHxS)	Perfluorononanoic acid (PFNA)
						Screening Level:	1.26[1]	1.26[1]	1300[2]	NA	NA	NA
2	02SB03	RICHM-02-SB03-0-2	07-Nov-17	0.0-2.0	N		0.118	0.00669	0.000599 J	0.00109 J	0.0153	0.000401 J
		RICHM-02-SB03-8-10	07-Nov-17	8.0-10.0	N		0.000989 U	0.00695	0.004	0.00136 J	0.0341	0.000309 J
	02SB04	RICHM-02-SB04-0-2	07-Nov-17	0.0-2.0	N		0.0401	0.000552 B	0.000935 U	0.000935 U	0.00196	0.000935 U
		RICHM-02-SB04-8-10	07-Nov-17	8.0-10.0	N		0.000981 U	0.000981 U	0.000981 U	0.000981 U	0.000981 U	0.000981 U
3	03SB01	RICHM-03-SB01-0-2	08-Nov-17	0.0-2.0	N		0.0123	0.000394 B	0.000996 U	0.000996 U	0.000996 U	0.000996 U
		RICHM-03-SB01-8-10	08-Nov-17	8.0-10.0	N		0.000987 U	0.000987 U	0.000987 U	0.000987 U	0.000987 U	0.000987 U
	03SB02	RICHM-03-SB02-0-2	08-Nov-17	0.0-2.0	N		0.00095 U	0.00034 B	0.00095 U	0.000561 J	0.00095 U	0.00095 U
		RICHM-03-SB02-8-10	08-Nov-17	8.0-10.0	N		0.000948 U	0.000948 U	0.000948 U	0.000948 U	0.000948 U	0.000948 U
	03SB03	RICHM-03-SB03-0-2	09-Nov-17	0.0-2.0	N		0.00457	0.000309 B	0.000946 U	0.000946 U	0.000946 U	0.000946 U
		RICHM-03-SB03-8-10	09-Nov-17	8.0-10.0	N		0.000974 U	0.000974 U	0.000974 U	0.000974 U	0.000974 U	0.000974 U
	03SB04	RICHM-03-SB04-0-2	09-Nov-17	0.0-2.0	N		0.005	0.000611 B	0.000995 U	0.000995 U	0.00142 J	0.000995 U
		RICHM-03-SB04-8-10	09-Nov-17	8.0-10.0	N		0.000998 U	0.000998 U	0.000998 U	0.00037 J	0.000998 U	0.000998 U
4	04SB01	RICHM-04-SB01-0-2	07-Nov-17	0.0-2.0	N		0.0159	0.000866 B	0.000995 U	0.000758 J	0.00252	0.000995 U
		RICHM-04-SB01-8-10	07-Nov-17	8.0-10.0	N		0.001 U	0.001 U	0.001 U	0.001 U	0.001 U	0.001 U
	04SB02	RICHM-04-SB02-0-2	07-Nov-17	0.0-2.0	N		0.001 U	0.001 U	0.001 U	0.001 U	0.001 U	0.001 U
		RICHM-04-SB02-8-10	07-Nov-17	8.0-10.0	N		0.000965 U	0.000965 U	0.000965 U	0.000965 U	0.000965 U	0.000965 U
	04SB03	RICHM-04-SB03-0-2	08-Nov-17	0.0-2.0	N		0.00486	0.000974 U	0.000974 U	0.000974 U	0.000974 U	0.000974 U
		RICHM-04-SB03-8-10	08-Nov-17	8.0-10.0	N		0.000989 U	0.000989 U	0.000989 U	0.000989 U	0.000989 U	0.000989 U
		RICHM-SO-DUP03-110817	08-Nov-17	8.0-10.0	FD		0.000996 U	0.000996 U	0.000996 U	0.000996 U	0.000996 U	0.000996 U

Table 3
Summary of Soil Analytical Testing Results
FY16 Phase I Regional Site Inspections for Perfluorinated Compounds
192nd Fighter Wing, Virginia Air National Guard
Richmond IAP Byrd Field, Sandston, Virginia

						Analyte:	Perfluorooctanesulfonic acid (PFOS)	Perfluorooctanoic acid (PFOA)	Perfluorobutanesulfonic acid (PFBS)	Perfluoroheptanoic acid (PFHpA)	Perfluorohexanesulfonic acid (PFHxS)	Perfluorononanoic acid (PFNA)
						Screening Level:	1.26[1]	1.26[1]	1300[2]	NA	NA	NA
4	04SB04	RICHM-04-SB04-0-2	08-Nov-17	0.0-2.0	N		0.00222	0.000954 U	0.000954 U	0.000954 U	0.000381 J	0.000954 U
		RICHM-04-SB04-8-10	08-Nov-17	8.0-10.0	N		0.000946 U	0.000946 U	0.000946 U	0.000946 U	0.000946 U	0.000946 U
5	05SB01	RICHM-05-SB01-0-2	08-Nov-17	0.0-2.0	N		0.00501	0.000995 U	0.000995 U	0.000995 U	0.000995 U	0.000995 U
		RICHM-05-SB01-8-10	08-Nov-17	8.0-10.0	N		0.001 U	0.001 U	0.001 U	0.001 U	0.001 U	0.001 U
	05SB02	RICHM-05-SB02-0-2	08-Nov-17	0.0-2.0	N		0.0021	0.000984 U	0.000984 U	0.000984 U	0.000984 U	0.000984 U
		RICHM-05-SB02-8-10	08-Nov-17	8.0-10.0	N		0.00096 U	0.00096 U	0.00096 U	0.00096 U	0.00096 U	0.00096 U
	05SB03	RICHM-05-SB03-0-2	08-Nov-17	0.0-2.0	N		0.00589	0.000973 U	0.000973 U	0.000973 U	0.000973 U	0.000973 U
		RICHM-05-SB03-8-10	08-Nov-17	8.0-10.0	N		0.000954 U	0.000734 B	0.000954 U	0.000954 U	0.00137 J	0.000954 U
	05SB04	RICHM-05-SB04-0-2	08-Nov-17	0.0-2.0	N		0.0586 J	0.001 U	0.001 U	0.001 U	0.000739 J	0.000472 J
		RICHM-SO-DUP04-110817	08-Nov-17	0.0-2.0	FD		0.0411 J	0.000963 U	0.000963 U	0.000963 U	0.000461 J	0.000321 J
		RICHM-05-SB04-8-10	08-Nov-17	8.0-10.0	N		0.000298 J	0.000993 U	0.000993 U	0.000993 U	0.000993 U	0.000993 U

Notes:
FD - Field Duplicate Sample
ft - feet
ID - Identification
J - The analyte was positively identified and the associated numerical value it the approximate concentration in the sample.
mg/kg - milligrams per kilogram
N - Normal Field Sample
NA - Not applicable
PRL - Potential Release Location
U - The analyte was analyzed for, but was not detected above the reported limit of detection.
PFAS analysis by Modified USEPA Method 537 using Liquid Chromatography and Tandem Mass Spectrometry
[1] Screening levels calculated using the USEPA Regional Screening Level calculator [https://epa-prgs.ornl.gov/cgi-bin/chemicals/csl_search]
[2] USEPA Residential Screening Levels (November 2017) [https://www.epa.gov/risk/regional-screening-levels-rsls-generic-tables-november-2017]

Table 4
Summary of Groundwater Analytical Testing Results
FY16 Phase I Regional Site Inspections for Perfluorinated Compounds
192nd Fighter Wing, Virginia Air National Guard
Richmond IAP Byrd Field, Richmond, Virginia

						Perfluorooctanesulfonic acid (PFOS)	Perfluorooctanoic acid (PFOA)	PFOS+PFOA	Perfluorobutanesulfonic acid (PFBS)	Perfluoroheptanoic acid (PFHpA)	Perfluorohexanesulfonic acid (PFHxS)	Perfluorononanoic acid (PFNA)
					Analyte:							
					Health Advisory:	0.07	0.07	0.07	NA	NA	NA	NA
					EPA RSL Tapwater[1]:	NA	NA	NA	400	NA	NA	NA
PRL	**Location**	**Sample ID**	**Sample Date**	**Sample Depth (ft.)**	**Sample Type**	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L
1	TW-01	RICHM-GW-TW01-110717	07-Nov-17	18.0-18.0	N	0.181	0.0392	0.220	0.00908	0.0137	0.166	0.00548 U
		RICHM-GW-DUP01-110717	07-Nov-17	18.0-18.0	FD	0.148	0.0341	0.182	0.0087	0.012	0.155	0.00534 U
2	TW-02	RICHM-GW-TW02-110717	07-Nov-17	18.0-18.0	N	1.68	0.588	2.27	0.307	0.125	4.03	0.00409 J
3	TW-03	RICHM-GW-TW03-110917	09-Nov-17	18.0-18.0	N	0.31	0.303	0.61	0.0105	0.735	0.0634	0.05
4	TW-04	RICHM-GW-TW04-110817	08-Nov-17	18.0-18.0	N	0.00553 U	0.0113 B	NA	0.0205	0.112	0.0953	0.00553 U
5	TMW-37	RICHM-GW-TMW37-110817	08-Nov-17	23.0-23.0	N	0.33	0.162	0.49	0.0738	0.0513	0.832	0.00262 J
BBW	BW-01	RICHM-GW-BW01-111017	10-Nov-17	18.0-18.0	N	0.21	0.0201 B	0.23	0.0104	0.0168	0.154	0.0025 J
	BW-02	RICHM-GW-BW02-110917	09-Nov-17	18.0-18.0	N	0.423	0.112	0.535	0.078	0.0446	0.916	0.00521 U
	MW-01-36	RICHM-GW-MW-01-36-111017	10-Nov-17	30.0-30.0	N	0.059	0.0588	0.12	0.0107	0.193	0.0606	0.00744 J

Table 4

Summary of Groundwater Analytical Testing Results

FY16 Phase I Regional Site Inspections for Perfluorinated Compounds

192nd Fighter Wing, Virginia Air National Guard

Richmond IAP Byrd Field, Richmond, Virginia

Light Shaded Blue - Exceeds Health Advisory

FD - Field Duplicate Sample

ft - feet

ID - Identification

J - The analyte was positively identified and the associated numerical value it the approximate concentration in the sample.

N - Normal Field Sample

NA - Not applicable

PRL - Potential Release Location

U - The analyte was analyzed for, but was not detected above the reported limit of detection.

µg/L - micrograms per liter

PFOS+PFOA - Co-occurrence of PFOA and PFOS (PFOA + PFOS) in aqueous samples is reported using the following guidelines:

1. If both PFOA and PFOS are detected at of above the detection limit (DL), then the sum of PFOA + PFOS is reported.
2. If either PFOA or PFOS is detected at or above the DL and the other is below the DL, then PFOA + PFOS is reported as "NA" represent Not Applicable.
3. If neither PFOA nor PFOS is detected at or above the DL, then PFOA + PFOS is reported as "ND" representing Not Detected.

PFAS analysis by Modified USEPA Method 537 using Liquid Chromatography and Tandem Mass Spectrometry

Health Advisory from USEPA Office of Water, 2016a and 2016b, Health Advisories (Has) for drinking water.

[1] USEPA Residential Screening Levels (November 2017) [https://www.epa.gov/risk/regional-screening-levels-rsls-generic-tables-november-2017]

Table 5

Summary of Sediment Analytical Testing Results

FY16 Phase I Regional Site Inspections for Perfluorinated Compounds

192nd Fighter Wing, Virginia Air National Guard

Richmond IAP Byrd Field, Richmond, Virginia

					Analyte:	Perfluorooctanesulfonic acid (PFOS)	Perfluorooctanoic acid (PFOA)	Perfluorobutanesulfonic acid (PFBS)	Perfluoroheptanoic acid (PFHpA)	Perfluorohexanesulfonic acid (PFHxS)	Perfluorononanoic acid (PFNA)
					Screening Level:	1.26[1]	1.26[1]	NA	NA	NA	NA
PRL	**Location**	**Sample ID**	**Sample Date**	**Sample Depth (ft.)**	**Sample Type**	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg
1	01SD01	RICHM-01-SD01-0-0.5	08-Nov-17	0.0-0.5	N	0.00429	0.001 U	0.001 U	0.001 U	0.001 U	0.001 U
2	02SD01	RICHM-02-SD01-0-0.5	08-Nov-17	0.0-0.5	N	0.00633	0.00131 B	0.000994 U	0.000352 J	0.00329	0.00125 J
		RICHM-SD-DUP01-110817	08-Nov-17	0.0-0.5	FD	0.00558	0.00105 B	0.000957 U	0.000276 J	0.00225	0.000959 J

Notes:

FD - Field Duplicate Sample

ft - feet

ID - Identification

J - The analyte was positively identified and the associated numerical value it the approximate concentration in the sample.

mg/kg - milligrams per kilogram

N - Normal Field Sample

NA - Not applicable

PRL - Potential Release Location

U - The analyte was analyzed for, but was not detected above the reported limit of detection.

USEPA - U.S. Environmental Protection Agency

PFAS analysis by Modified USEPA Method 537 using Liquid Chromatography and Tandem Mass Spectrometry

Table 6
Summary of Surface Water Analytical Testing Results
FY16 Phase I Regional Site Inspections for Perfluorinated Compounds
192nd Fighter Wing, Virginia Air National Guard
Richmond IAP Byrd Field, Richmond, Virginia

						Perfluorooctanesulfonic acid (PFOS)	Perfluorooctanoic acid (PFOA)	PFOS+PFOA	Perfluorobutanesulfonic acid (PFBS)	Perfluoroheptanoic acid (PFHpA)	Perfluorohexanesulfonic acid (PFHxS)	Perfluorononanoic acid (PFNA)
					Analyte:							
					Health Advisory:	0.07	0.07	0.07	NA	NA	NA	NA
					EPA RSL Tapwater[1]:	NA	NA	NA	400	NA	NA	NA
PRL	**Location**	**Sample ID**	**Sample Date**	**Sample Depth (ft.)**	**Sample Type**	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L
2	02SW01	RICHM-02-SW01-110817	08-Nov-17	0.0-0.5	N	0.0937	0.0463	0.14	0.0101	0.0331	0.0602	0.0165
3	03SW01	RICHM-03-SW01-110917	09-Nov-17	0.5-0.5	N	0.453	0.1	0.6	0.0671	0.0956	0.444	0.264
5	05SW01	RICHM-05-SW01-110817	08-Nov-17	0.0-0.5	N	0.0809	0.0399	0.121	0.00662 J	0.0286	0.0497	0.0167
		RICHM-SW-DUP01-110817	08-Nov-17	0.0-0.5	FD	0.0722	0.0384	0.111	0.00886	0.0276	0.0501	0.0158

Notes:
Light Shaded Blue - Exceeds Health Advisory
FD - Field Duplicate Sample
ft - feet
ID - Identification
N - Normal Field Sample
NA - Not applicable
PRL - Potential Release Location
µg/L - micrograms per liter
PFAS analysis by Modified USEPA Method 537 using Liquid Chromatography and Tandem Mass Spectrometry
Health Advisory from USEPA Office of Water, 2016a and 2016b, Health Advisories (Has) for drinking water.
[1] USEPA Residential Screening Levels (November 2017) [https://www.epa.gov/risk/regional-screening-levels-rsls-generic-tables-november-2017]

Table 7

USEPA and USAF SI Screening Criteria

FY16 Phase I Regional Site Inspections for Perfluorinated Compounds

Former 192nd Fighter Wing, Richmond Air National Guard

Richmond IAP Byrd Field, Sandston, Virginia

Table ES-1: USEPA and USAF SI Screening Criteria

Parameter	Chemical Abstract Number	USEPA Regional Screening Level Table (November 2017)[a]		USAF Guidance for Soils and Sediments[b] (µg/kg)	USEPA Health Advisory Drinking Water (Surface Water or Groundwater) (µg/L)[c]
		Residential Soil (µg/kg)	Tap Water (µg/L)		
Perfluorobutanesulfonic acid (PFBS)	375-73-5	1,300,000[d]	400[f]	NL	NL
Perfluorooctanoic acid (PFOA)	335-67-1	NL	NL	1,260	0.07[e]
Perfluorooctane sulfonate (PFOS)	1763-23-1	NL	NL	1,260	

Notes and Abbreviations:

NL – Not listed

USAF – U.S. Air Force

USEPA – U.S. Environmental Protection Agency

µg/L - micrograms per liter

µg/kg - micrograms per kilogram

[a] USEPA Regional Screening Levels (USEPA, 2017).

[b] Screening levels calculated using the USEPA Regional Screening Level calculator [https://epa-prgs.ornl.gov/cgi-bin/chemicals/csl_search]. The toxicity value input for the calculator is the Tier 3 value reference dose of 0.00002 mg/kg/day derived by USEPA in their Drinking Water Health Advisories for both PFOS (USEPA, 2016a) and PFOA (USEPA, 2016b).

[c] USEPA, 2016b. *Drinking Water Health Advisory for Perfluorooctanoic Acid (PFOA)* and USEPA, 2016a. *Drinking Water Health Advisory for Perfluorooctane Sulfonate (PFOS).*

[d] PFBS RSL for Residential Soil concentration presented in Work Plan was 1,600,000 µg/kg based on the May 2016 RSL values. This table has been updated to include the more recent RSL values published in November 2017.

[e] Note: When PFOA and PFOS are both present, the combined detected concentrations of the compounds are compared with the 0.07 µg/L health advisory value for groundwater and surface water.

[f] PFBS RSL for Tap Water presented in the SI Work Plan (Amec, 2017) was 380 µg/L based on the May 2016 RSL values. This table has been updated to include the more recent RSL values published in November 2017.

Table 8

Screening Criteria Exceedances and Recommendations

FY16 Phase I Regional Site Inspections for Perfluorinated Compounds

Former 192nd Fighter Wing, Richmond Air National Guard

Richmond IAP Byrd Field, Sandston, Virginia

PRL	Screening Criteria Exceedance				Recommendations
	Soil	GW	SW	SD	
1		X			GW investigation to determine the nature and extent of the confirmed PFC release. Soil investigation to determine if the soil may be a contributing source to GW.
2		X	X		GW investigation to determine the nature and extent of the confirmed PFC release. Soil investigation to determine if the soil may be a contributing source to GW. SW investigation to evaluate migration pathway of PFCs.
3		X	X		GW investigation to determine the nature and extent of the confirmed PFC release. Soil investigation to determine if the soil may be a contributing source to GW. SW investigation to evaluate migration pathway of PFCs.
4					NFA
5		X	X		GW investigation to determine the nature and extent of the confirmed PFC release. Soil investigation to determine if the soil may be a contributing source to GW. SW investigation to evaluate migration pathway of PFCs.

Notes:

GW - Groundwater

PFC - Perfluorinated Compound

PRL - Potential Release Location

SD - Sediment

SW - Surface water

X - Screening criteria exceedance

FIGURES

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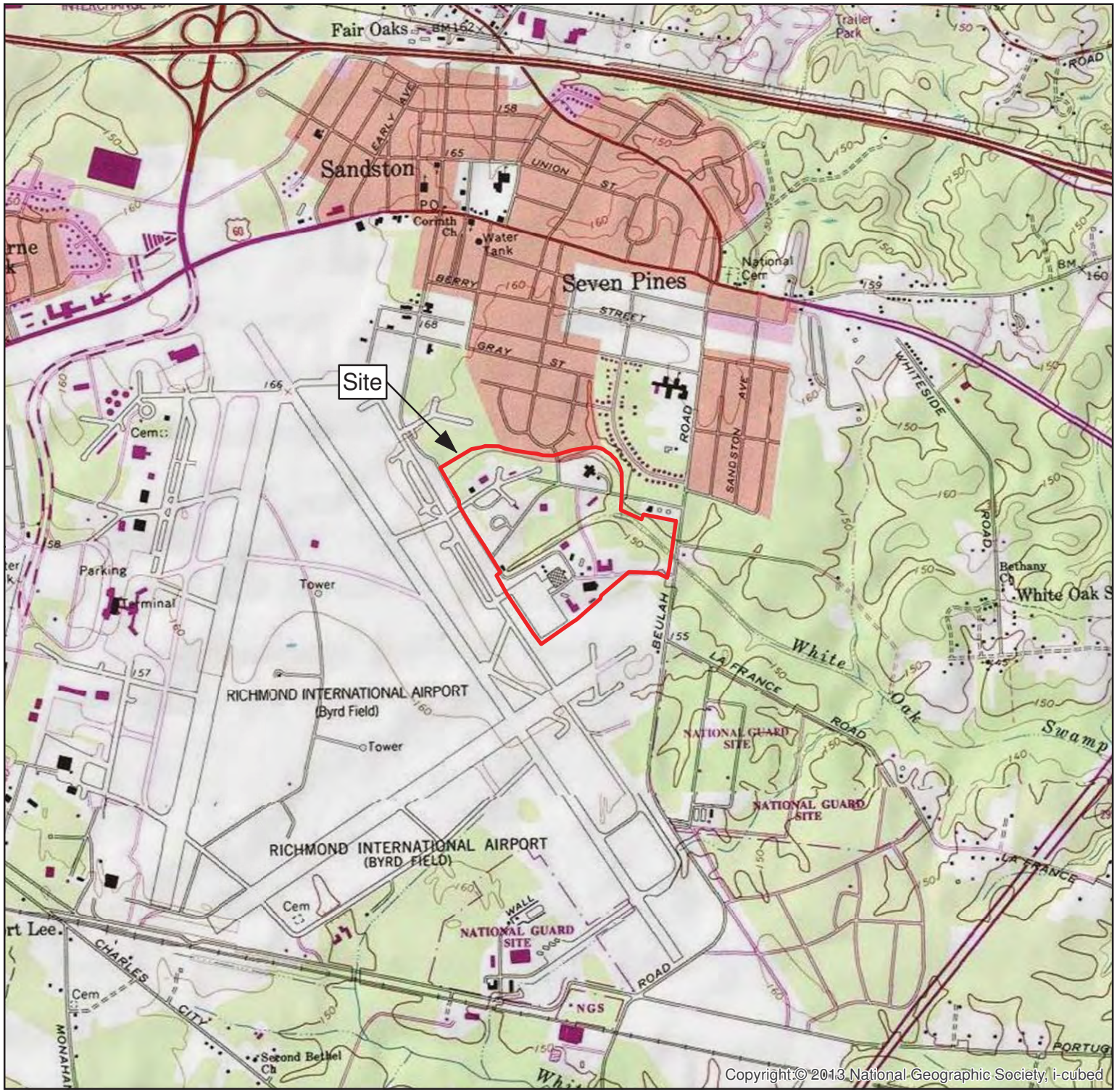

SITE LOCATION MAP

Richmond
Air National Guard Base
Sandston, Virginia

Legend

Installation Area (approximate)

Location of Site

Notes & Sources

Sources: Installation Area data layer obtained from Figure 2 (Site Features and Potential AOCs) of the Final Perfluorinated Compounds Preliminary Assessment Site Visit Report prepared by BB&E and dated January 2016.

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FIGURE 1

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SITE & AREA FEATURES

Former Richmond
Air National Guard Base
Sandston, Virginia

Legend

- Domestic Water Well (SAIC, 2001) (approximate)
- Municipal Water Well (SAIC, 2001) (approximate)
- Well (EDR, 2015) (approximate)
- Streams and Rivers
- Approximate Regional Groundwater Flow
- Installation Area (approximate)

Location of Site

Notes & Sources

Sources: Installation Area data layer obtained from Figure 2 (Site Features and Potential AOCs) of the Final Perfluorinated Compounds Preliminary Assessment Site Visit Report prepared by BB&E and dated January 2016. Groundwater flow direction based on information from the AECOM 2017 Groundwater Monitoring Report Site 1 Basewide Groundwater Operable Unit (OU1), Former Virginia Air National Guard Base, Sandston, Virginia. Lakes and ponds and rivers and stream data layer sourced from VADEQ, Virginia Environmental GIS

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FIGURE
2

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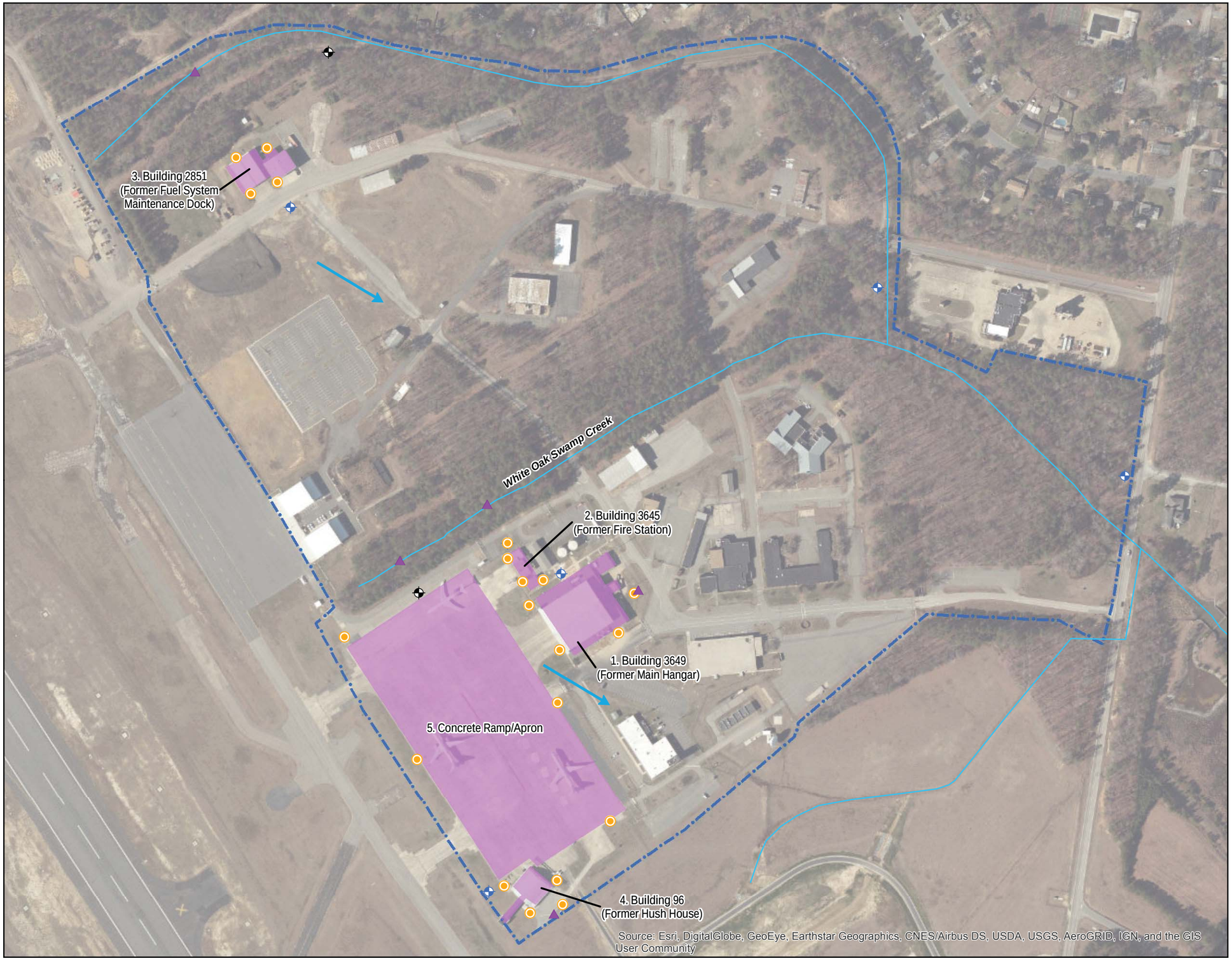

PRL LOCATIONS

Richmond
Air National Guard Base
Sandston, Virginia

Legend

- Temporary Monitoring Well
- Existing Monitoring Well
- Soil Sample
- Surface Water/Sediment Sample
- Approximate Regional Groundwater Flow
- Streams and Rivers
- Potential AFFF PFC PRL (approximate)
- Installation Area (approximate)

Notes & Sources

Notes:
AFFF - aqueous film forming foam
PRL - potential release location
PFC - perfluorinated compounds

Sources: Potential AFFF PFC PRLs and Installation Area datalayers obtained from Figure 2 of the Final Perfluorinated Compounds Preliminary Assessment Site Visit Report prepared by BB&E and dated January 2016.
Groundwater flow direction based on information from the AECOM 2017 Groundwater Monitoring Report Site 1 Basewide Groundwater Operable Unit (OU1), Former Virginia Air National Guard Base, Sandston, Virginia.

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FIGURE
3

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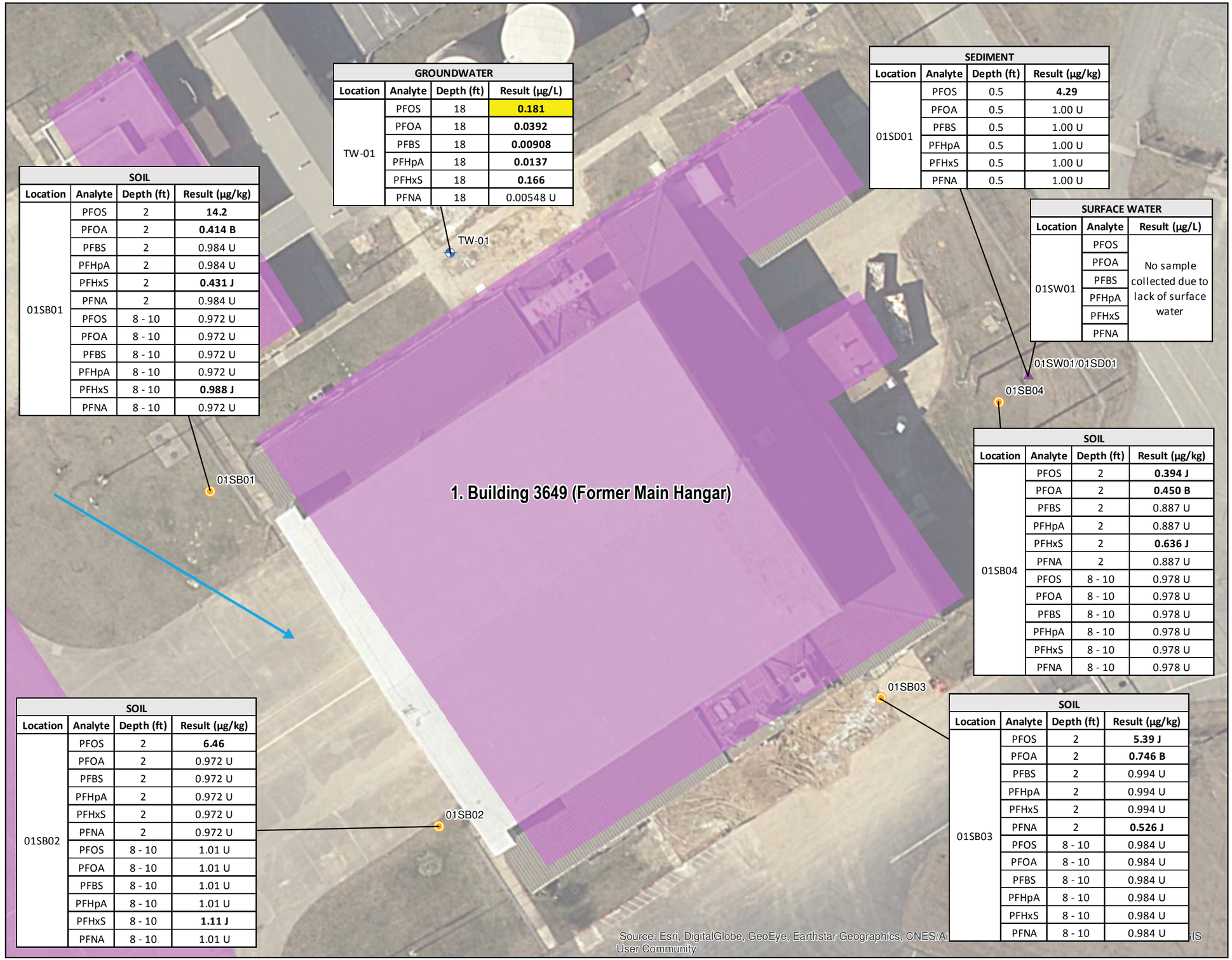
PRL 1
SAMPLE RESULTS
Richmond
Air National Guard Base
Sandston, Virginia



GROUNDWATER			
Location	Analyte	Depth (ft)	Result (µg/L)
TW-01	PFOS	18	**0.181**
	PFOA	18	**0.0392**
	PFBS	18	**0.00908**
	PFHpA	18	**0.0137**
	PFHxS	18	**0.166**
	PFNA	18	0.00548 U

SOIL			
Location	Analyte	Depth (ft)	Result (µg/kg)
01SB01	PFOS	2	**14.2**
	PFOA	2	**0.414 B**
	PFBS	2	0.984 U
	PFHpA	2	0.984 U
	PFHxS	2	**0.431 J**
	PFNA	2	0.984 U
	PFOS	8 - 10	0.972 U
	PFOA	8 - 10	0.972 U
	PFBS	8 - 10	0.972 U
	PFHpA	8 - 10	0.972 U
	PFHxS	8 - 10	**0.988 J**
	PFNA	8 - 10	0.972 U

SEDIMENT			
Location	Analyte	Depth (ft)	Result (µg/kg)
01SD01	PFOS	0.5	**4.29**
	PFOA	0.5	1.00 U
	PFBS	0.5	1.00 U
	PFHpA	0.5	1.00 U
	PFHxS	0.5	1.00 U
	PFNA	0.5	1.00 U

SURFACE WATER		
Location	Analyte	Result (µg/L)
01SW01	PFOS	No sample collected due to lack of surface water
	PFOA	
	PFBS	
	PFHpA	
	PFHxS	
	PFNA	

SOIL			
Location	Analyte	Depth (ft)	Result (µg/kg)
01SB04	PFOS	2	**0.394 J**
	PFOA	2	**0.450 B**
	PFBS	2	0.887 U
	PFHpA	2	0.887 U
	PFHxS	2	**0.636 J**
	PFNA	2	0.887 U
	PFOS	8 - 10	0.978 U
	PFOA	8 - 10	0.978 U
	PFBS	8 - 10	0.978 U
	PFHpA	8 - 10	0.978 U
	PFHxS	8 - 10	0.978 U
	PFNA	8 - 10	0.978 U

SOIL			
Location	Analyte	Depth (ft)	Result (µg/kg)
01SB02	PFOS	2	**6.46**
	PFOA	2	0.972 U
	PFBS	2	0.972 U
	PFHpA	2	0.972 U
	PFHxS	2	0.972 U
	PFNA	2	0.972 U
	PFOS	8 - 10	1.01 U
	PFOA	8 - 10	1.01 U
	PFBS	8 - 10	1.01 U
	PFHpA	8 - 10	1.01 U
	PFHxS	8 - 10	**1.11 J**
	PFNA	8 - 10	1.01 U

SOIL			
Location	Analyte	Depth (ft)	Result (µg/kg)
01SB03	PFOS	2	**5.39 J**
	PFOA	2	**0.746 B**
	PFBS	2	0.994 U
	PFHpA	2	0.994 U
	PFHxS	2	0.994 U
	PFNA	2	**0.526 J**
	PFOS	8 - 10	0.984 U
	PFOA	8 - 10	0.984 U
	PFBS	8 - 10	0.984 U
	PFHpA	8 - 10	0.984 U
	PFHxS	8 - 10	0.984 U
	PFNA	8 - 10	0.984 U

Legend

- Temporary Monitoring Well
- Soil Sample
- Surface Water/Sediment Sample
- Approximate Regional Groundwater Flow
- Potential AFFF PFC PRL (approximate)

Notes & Sources

Notes:
AFFF - aqueous film forming foam
ft - feet
µg/kg - micrograms per kilogram
µg/L - micrograms per liter
PRL - potential release location
PFC - perfluorinated compounds
PFOS - Perfluorooctanesulfonic acid
PFOA - Perfluorooctanoic acid
PFBS - Perfluorobutanesulfonic acid
PFHpA - Perfluoroheptanoic acid
PFHxS - Perfluorohexanesulfonic acid
PFNA - Perfluorononanoic acid
B - The analyte was found in an associated blank, as well as in the sample.
J - The analyte was positively identified and the associated numerical value is the approximate concentration of the analyte in the sample.
Q - The analyte is both B qualified because of blank detection and J qualified because of an additional QC issue.
U - The analyte was analyzed for, but was not detected above the reported limit of detection (LOD).
BOLD text indicates a detection.
YELLOW highlighted cells indicate 0.07 µg/L
Health Advisory Exceedance in water or 1,260 µg/kg
Air Force Calculated Screening Level Exceedance in soil.
Groundwater depths presented in the tables represent the approximate pump intake depth.

Sources: Potential AFFF PFC PRLs and Installation Area datalayers obtained from Figure 2 of the Final Perfluorinated Compounds Preliminary Assessment Site Visit Report prepared by BB&E and dated January 2016.
Groundwater flow direction based on information from the AECOM 2017 Groundwater Monitoring Report Site 1 Basewide Groundwater Operable Unit (OU1), Former Virginia Air National Guard Base, Sandston, Virginia.

0 20 40 Feet

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FIGURE
4

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PRL 2
SAMPLE RESULTS
Richmond
Air National Guard Base
Sandston, Virginia

SEDIMENT			
Location	Analyte	Depth (ft)	Result (µg/kg)
02SD01	PFOS	0.5	**6.33**
	PFOA	0.5	**1.31 B**
	PFBS	0.5	0.994 U
	PFHpA	0.5	**0.352 J**
	PFHxS	0.5	**3.29**
	PFNA	0.5	**1.25 J**

SURFACE WATER		
Location	Analyte	Result (µg/L)
02SW01	PFOS	**0.0937**
	PFOA	**0.0463**
	PFBS	**0.0101**
	PFHpA	**0.0331**
	PFHxS	**0.0602**
	PFNA	**0.0165**

GROUNDWATER			
Location	Analyte	Depth (ft)	Result (µg/L)
TW-02	PFOS	18	**1.68**
	PFOA	18	**0.588**
	PFBS	18	**0.307**
	PFHpA	18	**0.125**
	PFHxS	18	**4.03**
	PFNA	18	**0.00409 J**

SOIL			
Location	Analyte	Depth (ft)	Result (µg/kg)
02SB01	PFOS	2	**71.2**
	PFOA	2	**2.06 B**
	PFBS	2	**0.304 J**
	PFHpA	2	**0.456 J**
	PFHxS	2	**7.34 J**
	PFNA	2	0.938 U
	PFOS	8 - 10	**1.30 J**
	PFOA	8 - 10	0.947 U
	PFBS	8 - 10	0.947 U
	PFHpA	8 - 10	0.947 U
	PFHxS	8 - 10	**1.04 J**
	PFNA	8 - 10	0.947 U

SOIL			
Location	Analyte	Depth (ft)	Result (µg/kg)
02SB02	PFOS	2	**103 J**
	PFOA	2	**2.79 Q**
	PFBS	2	**0.420 J**
	PFHpA	2	**0.621 J**
	PFHxS	2	**10.1**
	PFNA	2	**0.522 J**
	PFOS	8 - 10	**3.62**
	PFOA	8 - 10	**0.493 B**
	PFBS	8 - 10	0.941 U
	PFHpA	8 - 10	0.941 U
	PFHxS	8 - 10	**3.00**
	PFNA	8 - 10	0.941 U

SOIL			
Location	Analyte	Depth (ft)	Result (µg/kg)
02SB03	PFOS	2	**118**
	PFOA	2	**6.69 B**
	PFBS	2	**0.599 J**
	PFHpA	2	**1.09 J**
	PFHxS	2	**15.3**
	PFNA	2	**0.401 J**
	PFOS	8 - 10	0.981 U
	PFOA	8 - 10	**6.95 B**
	PFBS	8 - 10	**4.00**
	PFHpA	8 - 10	**1.36 J**
	PFHxS	8 - 10	**34.1**
	PFNA	8 - 10	**0.390 J**

SOIL			
Location	Analyte	Depth (ft)	Result (µg/kg)
02SB04	PFOS	2	**40.1**
	PFOA	2	**0.552 B**
	PFBS	2	0.935 U
	PFHpA	2	0.935 U
	PFHxS	2	**1.96**
	PFNA	2	0.935 U
	PFOS	8 - 10	0.981 U
	PFOA	8 - 10	0.981 U
	PFBS	8 - 10	0.981 U
	PFHpA	8 - 10	0.981 U
	PFHxS	8 - 10	0.981 U
	PFNA	8 - 10	0.981 U

02SW01/02SD01
White Oak Swamp Creek
02SB01 TW-02
02SB02
02SB03
02SB04
2. Building 3645 (Former Fire Station)

Source: Esri, DigitalGlobe, GeoEye, Earthstar Geographics, CNES/Airbus DS, USDA, USGS, AeroGRID, IGN, and the GIS User Community

Legend

- Temporary Monitoring Well
- Soil Sample
- Surface Water/Sediment Sample
- Approximate Regional Groundwater Flow
- Streams and Rivers
- Potential AFFF PFC PRL (approximate)

Notes & Sources

Notes:
AFFF - aqueous film forming foam
ft - feet
µg/kg - micrograms per kilogram
µg/L - micrograms per liter
PRL - potential release location
PFC - perfluorinated compounds
PFOS - Perfluorooctanesulfonic acid
PFOA - Perfluorooctanoic acid
PFBS - Perfluorobutanesulfonic acid
PFHpA - Perfluoroheptanoic acid
PFHxS - Perfluorohexanesulfonic acid
PFNA - Perfluorononanoic acid
B - The analyte was found in an associated blank, as well as in the sample.
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U - The analyte was analyzed for, but was not detected above the reported limit of detection (LOD).
BOLD text indicates a detection.
YELLOW highlighted cells indicate 0.07 µg/L Health Advisory Exceedance in water or 1,260 µg/kg Air Force Calculated Screening Level Exceedance in soil.
Groundwater depths presented in the tables represent the approximate pump intake depth.

Sources: Potential AFFF PFC PRLs and Installation Area datalayers obtained from Figure 2 of the Final Perfluorinated Compounds Preliminary Assessment Site Visit Report prepared by BB&E and dated January 2016.
Groundwater flow direction based on information from the AECOM 2017 Groundwater Monitoring Report Site 1 Basewide Groundwater Operable Unit (OU1), Former Virginia Air National Guard Base, Sandston, Virginia.

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FIGURE
5

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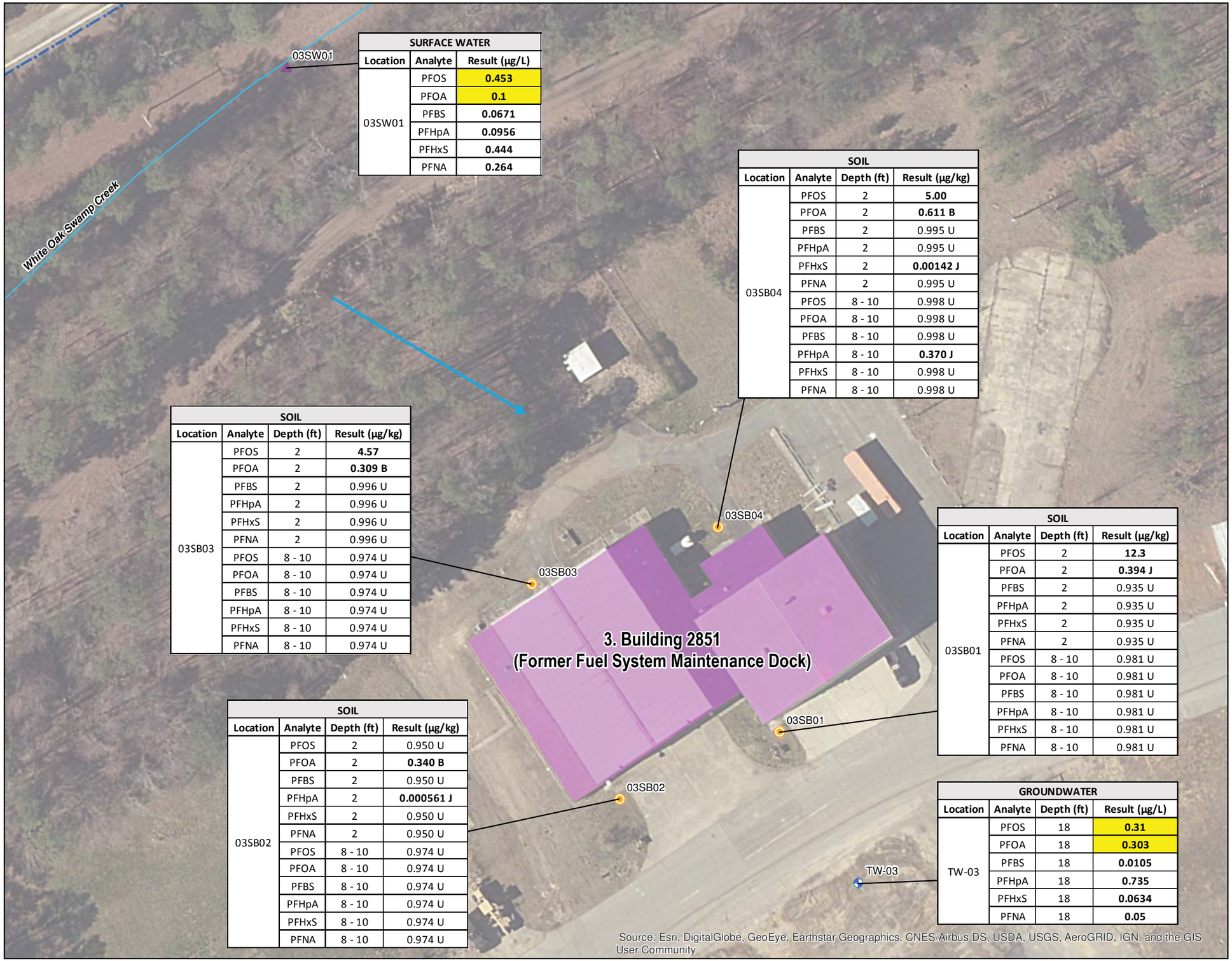

SURFACE WATER		
Location	Analyte	Result (µg/L)
03SW01	PFOS	**0.453**
	PFOA	**0.1**
	PFBS	**0.0671**
	PFHpA	**0.0956**
	PFHxS	**0.444**
	PFNA	**0.264**

SOIL			
Location	Analyte	Depth (ft)	Result (µg/kg)
03SB04	PFOS	2	**5.00**
	PFOA	2	**0.611 B**
	PFBS	2	0.995 U
	PFHpA	2	0.995 U
	PFHxS	2	**0.00142 J**
	PFNA	2	0.995 U
	PFOS	8 - 10	0.998 U
	PFOA	8 - 10	0.998 U
	PFBS	8 - 10	0.998 U
	PFHpA	8 - 10	**0.370 J**
	PFHxS	8 - 10	0.998 U
	PFNA	8 - 10	0.998 U

SOIL			
Location	Analyte	Depth (ft)	Result (µg/kg)
03SB03	PFOS	2	**4.57**
	PFOA	2	**0.309 B**
	PFBS	2	0.996 U
	PFHpA	2	0.996 U
	PFHxS	2	0.996 U
	PFNA	2	0.996 U
	PFOS	8 - 10	0.974 U
	PFOA	8 - 10	0.974 U
	PFBS	8 - 10	0.974 U
	PFHpA	8 - 10	0.974 U
	PFHxS	8 - 10	0.974 U
	PFNA	8 - 10	0.974 U

SOIL			
Location	Analyte	Depth (ft)	Result (µg/kg)
03SB01	PFOS	2	**12.3**
	PFOA	2	**0.394 J**
	PFBS	2	0.935 U
	PFHpA	2	0.935 U
	PFHxS	2	0.935 U
	PFNA	2	0.935 U
	PFOS	8 - 10	0.981 U
	PFOA	8 - 10	0.981 U
	PFBS	8 - 10	0.981 U
	PFHpA	8 - 10	0.981 U
	PFHxS	8 - 10	0.981 U
	PFNA	8 - 10	0.981 U

SOIL			
Location	Analyte	Depth (ft)	Result (µg/kg)
03SB02	PFOS	2	0.950 U
	PFOA	2	**0.340 B**
	PFBS	2	0.950 U
	PFHpA	2	**0.000561 J**
	PFHxS	2	0.950 U
	PFNA	2	0.950 U
	PFOS	8 - 10	0.974 U
	PFOA	8 - 10	0.974 U
	PFBS	8 - 10	0.974 U
	PFHpA	8 - 10	0.974 U
	PFHxS	8 - 10	0.974 U
	PFNA	8 - 10	0.974 U

GROUNDWATER			
Location	Analyte	Depth (ft)	Result (µg/L)
TW-03	PFOS	18	**0.31**
	PFOA	18	**0.303**
	PFBS	18	**0.0105**
	PFHpA	18	**0.735**
	PFHxS	18	**0.0634**
	PFNA	18	**0.05**

Source: Esri, DigitalGlobe, GeoEye, Earthstar Geographics, CNES/Airbus DS, USDA, USGS, AeroGRID, IGN, and the GIS User Community

PRL 3
SAMPLE RESULTS
Richmond
Air National Guard Base
Sandston, Virginia

Legend

- Temporary Monitoring Well
- Soil Sample
- Surface Water/Sediment Sample
- Approximate Regional Groundwater Flow
- Streams and Rivers
- Potential AFFF PFC PRL (approximate)
- Installation Area (approximate)

Notes & Sources

Notes:
AFFF - aqueous film forming foam
ft - feet
µg/kg - micrograms per kilogram
µg/L - micrograms per liter
PRL - potential release location
PFC - perfluorinated compounds
PFOS - Perfluorooctanesulfonic acid
PFOA - Perfluorooctanoic acid
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PFHpA - Perfluoroheptanoic acid
PFHxS - Perfluorohexanesulfonic acid
PFNA - Perfluorononanoic acid
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YELLOW highlighted cells indicate 0.07 µg/L Health Advisory Exceedance in water or 1,260 µg/kg Air Force Calculated Screening Level Exceedance in soil.
Groundwater depths presented in the tables represent the approximate pump intake depth.

Sources: Potential AFFF PFC PRLs and Installation Area datalayers obtained from Figure 2 of the Final Perfluorinated Compounds Preliminary Assessment Site Visit Report prepared by BB&E and dated January 2016.
Groundwater flow direction based on information from the AECOM 2017 Groundwater Monitoring Report Site 1 Basewide Groundwater Operable Unit (OU1), Former Virginia Air National Guard Base, Sandston, Virginia.

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FIGURE
6

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PRL 4
SAMPLE RESULTS
Richmond
Air National Guard Base
Sandston, Virginia

SOIL			
Location	**Analyte**	**Depth (ft)**	**Result (µg/kg)**
04SB01	PFOS	2	**15.9**
	PFOA	2	**0.866 J**
	PFBS	2	0.995 U
	PFHpA	2	**0.758 J**
	PFHxS	2	**2.52**
	PFNA	2	0.995 U
	PFOS	8 - 10	1.00 U
	PFOA	8 - 10	1.00 U
	PFBS	8 - 10	1.00 U
	PFHpA	8 - 10	1.00 U
	PFHxS	8 - 10	1.00 U
	PFNA	8 - 10	1.00 U

SOIL			
Location	**Analyte**	**Depth (ft)**	**Result (µg/kg)**
04SB04	PFOS	2	**2.22**
	PFOA	2	0.954 U
	PFBS	2	0.954 U
	PFHpA	2	0.954 U
	PFHxS	2	**0.381 J**
	PFNA	2	0.954 U
	PFOS	8 - 10	0.946 U
	PFOA	8 - 10	0.946 U
	PFBS	8 - 10	0.946 U
	PFHpA	8 - 10	0.946 U
	PFHxS	8 - 10	0.946 U
	PFNA	8 - 10	0.946 U

GROUNDWATER			
Location	**Analyte**	**Depth (ft)**	**Result (µg/L)**
TW-04	PFOS	18	0.00553 U
	PFOA	18	**0.0113**
	PFBS	18	**0.0205**
	PFHpA	18	**0.112**
	PFHxS	18	**0.0953**
	PFNA	18	0.00553 U

SOIL			
Location	**Analyte**	**Depth (ft)**	**Result (µg/kg)**
04SB02	PFOS	2	1.00 U
	PFOA	2	1.00 U
	PFBS	2	1.00 U
	PFHpA	2	1.00 U
	PFHxS	2	1.00 U
	PFNA	2	1.00 U
	PFOS	8 - 10	0.965 U
	PFOA	8 - 10	0.965 U
	PFBS	8 - 10	0.965 U
	PFHpA	8 - 10	0.965 U
	PFHxS	8 - 10	0.965 U
	PFNA	8 - 10	0.965 U

SURFACE WATER		
Location	**Analyte**	**Result (µg/L)**
04SW01	PFOS	No sample collected due to lack of surface water
	PFOA	
	PFBS	
	PFHpA	
	PFHxS	
	PFNA	

SOIL			
Location	**Analyte**	**Depth (ft)**	**Result (µg/kg)**
04SB03	PFOS	2	**4.86**
	PFOA	2	0.974 U
	PFBS	2	0.974 U
	PFHpA	2	0.974 U
	PFHxS	2	0.974 U
	PFNA	2	0.974 U
	PFOS	8 - 10	0.996 U
	PFOA	8 - 10	0.996 U
	PFBS	8 - 10	0.996 U
	PFHpA	8 - 10	0.996 U
	PFHxS	8 - 10	0.996 U
	PFNA	8 - 10	0.996 U

04SB01
TW-04
04SB04
04SB03
04SB02
04SW01

4. Building 96
(Former Hush House)

Source: Esri, DigitalGlobe, GeoEye, Earthstar Geographics, CNES/Airbus DS, USDA, USGS, AeroGRID, IGN, and the GIS User Community

Legend

- Temporary Monitoring Well
- Soil Sample
- Surface Water/Sediment Sample
- Approximate Regional Groundwater Flow
- Potential AFFF PFC PRL (approximate)
- Installation Area (approximate)

Notes & Sources

Notes:
AFFF - aqueous film forming foam
ft - feet
µg/kg - micrograms per kilogram
µg/L - micrograms per liter
PRL - potential release location
PFC - perfluorinated compounds
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Health Advisory Exceedance in water or 1,260 µg/kg
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FIGURE
7

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PRL 5
SAMPLE RESULTS
Richmond
Air National Guard Base
Sandston, Virginia

SURFACE WATER		
Location	Analyte	Result (µg/L)
05SW01	PFOS	**0.0809**
	PFOA	**0.0399**
	PFBS	**0.00662 J**
	PFHpA	**0.0286**
	PFHxS	**0.0497**
	PFNA	**0.0167**

GROUNDWATER			
Location	Analyte	Depth (ft)	Result (µg/L)
TMW-37	PFOS	23	**0.33**
	PFOA	23	**0.162**
	PFBS	23	**0.0738**
	PFHpA	23	**0.0513**
	PFHxS	23	**0.832**
	PFNA	23	**0.00262 J**

SOIL			
Location	Analyte	Depth (ft)	Result (µg/kg)
05SB04	PFOS	2	**58.6 J**
	PFOA	2	1.00 U
	PFBS	2	1.00 U
	PFHpA	2	1.00 U
	PFHxS	2	**0.739 J**
	PFNA	2	**0.472 J**
	PFOS	8 - 10	**0.298 J**
	PFOA	8 - 10	0.993 U
	PFBS	8 - 10	0.993 U
	PFHpA	8 - 10	0.993 U
	PFHxS	8 - 10	0.993 U
	PFNA	8 - 10	0.993 U

SOIL			
Location	Analyte	Depth (ft)	Result (µg/kg)
05SB01	PFOS	2	**5.01**
	PFOA	2	0.995 U
	PFBS	2	0.995 U
	PFHpA	2	0.995 U
	PFHxS	2	0.995 U
	PFNA	2	0.995 U
	PFOS	8 - 10	1.00 U
	PFOA	8 - 10	1.00 U
	PFBS	8 - 10	1.00 U
	PFHpA	8 - 10	1.00 U
	PFHxS	8 - 10	1.00 U
	PFNA	8 - 10	1.00 U

SOIL			
Location	Analyte	Depth (ft)	Result (µg/kg)
05SB02	PFOS	2	**2.10**
	PFOA	2	0.984 U
	PFBS	2	0.984 U
	PFHpA	2	0.984 U
	PFHxS	2	0.984 U
	PFNA	2	0.984 U
	PFOS	8 - 10	0.960 U
	PFOA	8 - 10	0.960 U
	PFBS	8 - 10	0.960 U
	PFHpA	8 - 10	0.960 U
	PFHxS	8 - 10	0.960 U
	PFNA	8 - 10	0.960 U

SOIL			
Location	Analyte	Depth (ft)	Result (µg/kg)
05SB03	PFOS	2	**5.89**
	PFOA	2	0.973 U
	PFBS	2	0.973 U
	PFHpA	2	0.973 U
	PFHxS	2	0.973 U
	PFNA	2	0.973 U
	PFOS	8 - 10	0.960 U
	PFOA	8 - 10	**0.734 B**
	PFBS	8 - 10	0.960 U
	PFHpA	8 - 10	0.960 U
	PFHxS	8 - 10	**1.37 J**
	PFNA	8 - 10	0.960 U

05SW01
TMW-37
05SB01
05SB04
05SB02
05SB03
1. Building 3649 (Former Main Hangar)
5. Concrete Ramp/Apron
4. Building 96 (Former Hush House)

Source: Esri, DigitalGlobe, GeoEye, Earthstar Geographics, CNES/Airbus DS, USDA, USGS, AeroGRID, IGN, and the GIS User Community

Legend

- Existing Monitoring Well
- Soil Sample
- Surface Water/Sediment Sample
- Approximate Regional Groundwater Flow
- Streams and Rivers
- Potential AFFF PFC PRL (approximate)
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PFOA - Perfluorooctanoic acid
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FIGURE 8

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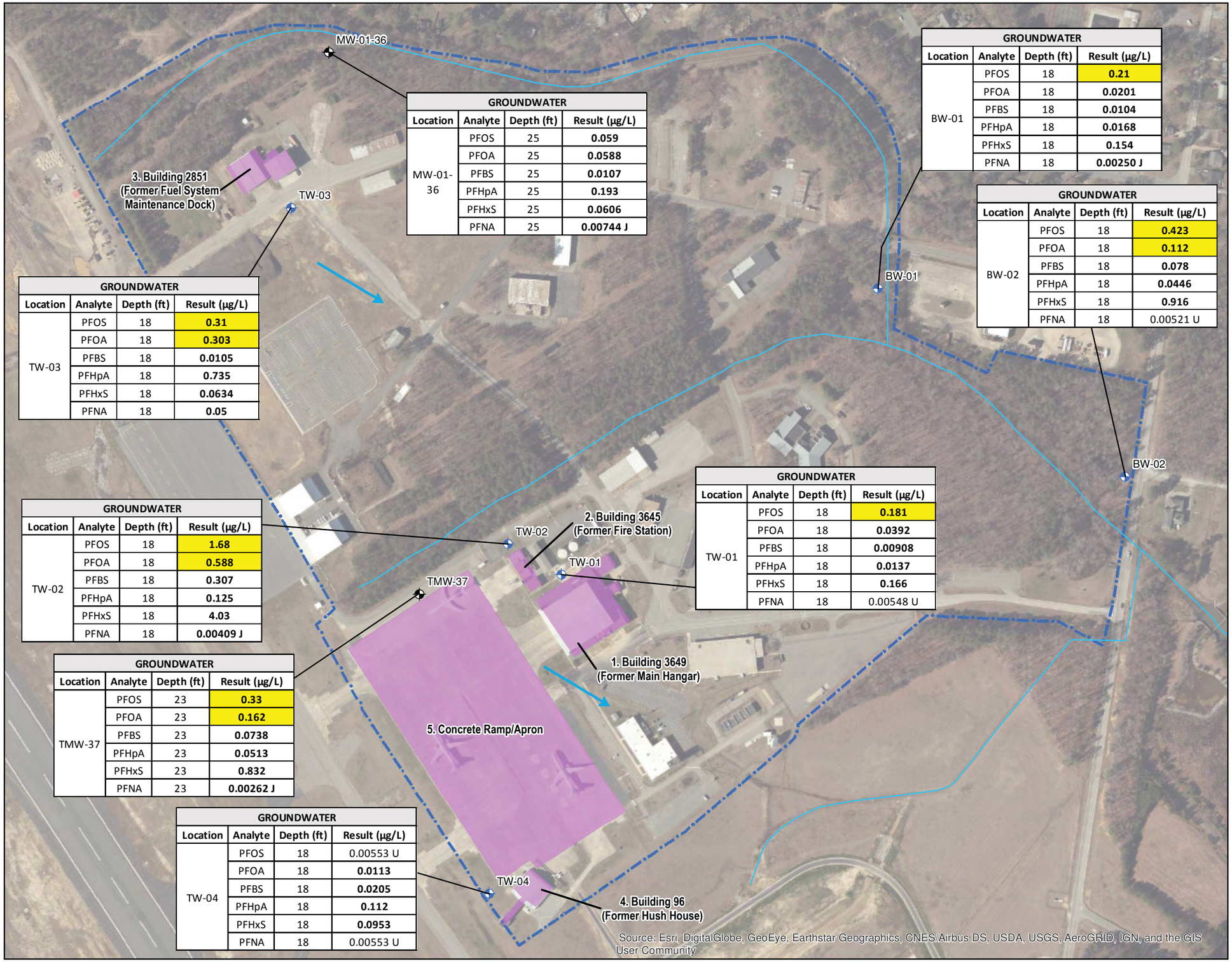

GROUNDWATER			
Location	Analyte	Depth (ft)	Result (µg/L)
MW-01-36	PFOS	25	**0.059**
	PFOA	25	**0.0588**
	PFBS	25	**0.0107**
	PFHpA	25	**0.193**
	PFHxS	25	**0.0606**
	PFNA	25	**0.00744 J**

GROUNDWATER			
Location	Analyte	Depth (ft)	Result (µg/L)
BW-01	PFOS	18	**0.21**
	PFOA	18	**0.0201**
	PFBS	18	**0.0104**
	PFHpA	18	**0.0168**
	PFHxS	18	**0.154**
	PFNA	18	**0.00250 J**

GROUNDWATER			
Location	Analyte	Depth (ft)	Result (µg/L)
BW-02	PFOS	18	**0.423**
	PFOA	18	**0.112**
	PFBS	18	**0.078**
	PFHpA	18	**0.0446**
	PFHxS	18	**0.916**
	PFNA	18	0.00521 U

GROUNDWATER			
Location	Analyte	Depth (ft)	Result (µg/L)
TW-03	PFOS	18	**0.31**
	PFOA	18	**0.303**
	PFBS	18	**0.0105**
	PFHpA	18	**0.735**
	PFHxS	18	**0.0634**
	PFNA	18	**0.05**

GROUNDWATER			
Location	Analyte	Depth (ft)	Result (µg/L)
TW-01	PFOS	18	**0.181**
	PFOA	18	**0.0392**
	PFBS	18	**0.00908**
	PFHpA	18	**0.0137**
	PFHxS	18	**0.166**
	PFNA	18	0.00548 U

GROUNDWATER			
Location	Analyte	Depth (ft)	Result (µg/L)
TW-02	PFOS	18	**1.68**
	PFOA	18	**0.588**
	PFBS	18	**0.307**
	PFHpA	18	**0.125**
	PFHxS	18	**4.03**
	PFNA	18	**0.00409 J**

GROUNDWATER			
Location	Analyte	Depth (ft)	Result (µg/L)
TMW-37	PFOS	23	**0.33**
	PFOA	23	**0.162**
	PFBS	23	**0.0738**
	PFHpA	23	**0.0513**
	PFHxS	23	**0.832**
	PFNA	23	**0.00262 J**

GROUNDWATER			
Location	Analyte	Depth (ft)	Result (µg/L)
TW-04	PFOS	18	0.00553 U
	PFOA	18	**0.0113**
	PFBS	18	**0.0205**
	PFHpA	18	**0.112**
	PFHxS	18	**0.0953**
	PFNA	18	0.00553 U

GROUNDWATER SAMPLE RESULTS

Richmond
Air National Guard Base
Sandston, Virginia

Legend

- Temporary Monitoring Well
- Existing Monitoring Well
- Approximate Regional Groundwater Flow
- Streams and Rivers
- Potential AFFF PFC PRL (approximate)
- Installation Area (approximate)

Notes & Sources

Notes:
AFFF - aqueous film forming foam
ft - feet
µg/kg - micrograms per kilogram
µg/L - micrograms per liter
PRL - potential release location
PFC - perfluorinated compounds
PFOS - Perfluorooctanesulfonic acid
PFOA - Perfluorooctanoic acid
PFBS - Perfluorobutanesulfonic acid
PFHpA - Perfluoroheptanoic acid
PFHxS - Perfluorohexanesulfonic acid
PFNA - Perfluorononanoic acid
B - The analyte was found in an associated blank, as well as in the sample.
J - The analyte was positively identified and the associated numerical value is the approximate concentration of the analyte in the sample.
Q - The analyte is both B qualified because of blank detection and J qualified because of an additional QC issue.
U - The analyte was analyzed for, but was not detected above the reported limit of detection (LOD).
BOLD text indicates a detection.
YELLOW highlighted cells indicate 0.07 µg/L Health Advisory Exceedance in water or 1,260 µg/kg Air Force Calculated Screening Level Exceedance in soil.
Groundwater depths presented in the tables represent the approximate pump intake depth.

Sources: Potential AFFF PFC PRLs and Installation Area datalayers obtained from Figure 2 of the Final Perfluorinated Compounds Preliminary Assessment Site Visit Report prepared by BB&E and dated January 2016.
Groundwater flow direction based on information from the AECOM 2017 Groundwater Monitoring Report Site 1 Basewide Groundwater Operable Unit (OU1), Former Virginia Air National Guard Base, Sandston, Virginia.

0 150 300 Feet

N

amec foster wheeler
Amec Foster Wheeler
Environment & Infrastructure, Inc.
4021 Stirrup Creek Drive, Suite 100
Durham, NC 27703

FIGURE 9

Document: P:\Projects\ANG Phase I-291330006\7.0_Sites\Richmond\7_Cadd and GIS\MXDs\Fig9_GW_SampleResults.mxd PDF: P:\Projects\ANG Phase I-291330006\7.0_Sites\Richmond\Figures\Figure 9 - GW Sample Results.pdf 10/17/2018 7:49 AM brian.peters

APPENDIX A

FIELD ACTIVITY PHOTOGRAPHIC LOG

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PHOTO 1:

Photo of TW-01 being installed at PRL 1 using hollow stem augers.

PHOTO 2:

Photo of TW-02 being installed at PRL 2 using hollow stem augers.

PHOTO 3:

Photo of TW-03 being installed at PRL 3 using hollow stem augers.

PHOTO 4:

Photo of TW-04 being installed at PRL 4 using hollow stem augers.

PHOTO 5:

Photo of BW-01 being installed at the Base boundary using hollow stem augers.

PHOTO 6:

Photo of BW-02 being installed at the Base boundary using hollow stem augers.

PHOTO 7:

An example of two-inch diameter, schedule 40 PVC riser and screen being installed for temporary well location.

PHOTO 8:

An example of a temporary well after installation.

PHOTO 9:

Photo of abandoned and backfilled temporary well location after sampling was completed.

PHOTO 10:

Photo showing hand clearing method completed at necessary locations using post-hole digger and hand auger.

PHOTO 11:

Photo of boring location 02SB04 preparing to use direct push method.

PHOTO 12:

Photo of sediment sample location 01SD01. Photo shows area of drainage, but lack of surface water.

PHOTO 13:

Photo of sediment sample location 02SD01 near White Oak Swamp Creek drainage area.

PHOTO 14:

Photo of White Oak Swamp Creek near samples 02SW01 and 05SW01.

PHOTO 15:

Photo showing decontamination of hollow stem augers between locations.

PHOTO 16:

Photo showing staging of drums containing IDW before appropriate disposal.

APPENDIX B

SOIL BORING AND MONITORING WELL CONSTRUCTION LOGS

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DEPTH (ft)	SOIL CLASSIFICATION AND REMARKS SEE KEY SYMBOL SHEET FOR EXPLANATION OF SYMBOLS AND ABBREVIATIONS USED BELOW.	LEGEND	ELEV (ft)	SAMPLES: BLOW CT PER 6 IN	SAMPLE ID	TYPE	PID (ppm)	RECOVERY (feet)	MONITORING WELL CONSTRUCTION DETAILS AND REMARKS	DEPTH
0	Reddish brown fat CLAY, silty, stiff, highly plastic, no odor, moist (CH)				RICHM-01SB01-0-2		0.0	4.5		0
5	Reddish brown fat CLAY, silty, stiff, highly plastic, no odor, moist (CH)				RICHM-01SB01-8-10		0.0	4.5		5
10									Bottom of boring at 10 feet. Not refusal.	10
15										15
20										20
25										25

START DATE: 11/7/2017
END DATE: 11/7/2017
DRILLER: TWS, Cascade
EQUIPMENT: Geoprobe 7822DT
METHOD: Direct Push
HOLE DIA.: 2 1/4" ID
SITE: RICHM
LOGGED BY: David Young

GROUND ELEVATION: ft.
VERTICAL DATUM:
NORTHING: 3711041.969 ft.
EASTING: 11827760.87 ft.
HORIZONTAL DATUM: NAD 83

THIS RECORD IS A REASONABLE INTERPRETATION OF SUBSURFACE CONDITIONS AT THE EXPLORATION LOCATION. SUBSURFACE CONDITIONS AT OTHER LOCATIONS AND AT OTHER TIMES MAY DIFFER. INTERFACES BETWEEN STRATA ARE APPROXIMATE. TRANSITIONS BETWEEN STRATA MAY BE GRADUAL.

SOIL BORING / MONITORING WELL RECORD

Project: Richmond ANG FY16 Site Inspection for PFC
Project No: 291330006.07
Checked By: BL

Boring No. 01SB01

amec foster wheeler
271 Mill Road
Chelmsford, MA 01824

RICHMOND ANG LOG RICHMOND BORING LOGS.GPJ PFC TEMPLATE.GDT 2/2/18

DEPTH (ft)	SOIL CLASSIFICATION AND REMARKS SEE KEY SYMBOL SHEET FOR EXPLANATION OF SYMBOLS AND ABBREVIATIONS USED BELOW.	LEGEND	ELEV (ft)	SAMPLES: BLOW CT PER 6 IN	SAMPLE ID	TYPE	PID (ppm)	RECOVERY (feet)	MONITORING WELL CONSTRUCTION DETAILS AND REMARKS	DEPTH
0	Reddish brown fat CLAY, silty, stiff, highly plastic, no odor, moist (CH)				RICHM-01SB02-0-2		0.0	4.5		0
5	Reddish brown fat CLAY, silty, stiff, highly plastic, no odor, moist (CH)				RICHM-01SB02-8-10		0.0	4.5		5
10									Bottom of boring at 10 feet. Not refusal.	10
15										15
20										20
25										25

START DATE: 11/7/2017
END DATE: 11/7/2017
DRILLER: TWS, Cascade
EQUIPMENT: Geoprobe 7822DT
METHOD: Direct Push
HOLE DIA.: 2 1/4 ID
SITE: RICHM
LOGGED BY: David Young

GROUND ELEVATION: ft.
VERTICAL DATUM:
NORTHING: 3710902.976 ft.
EASTING: 11827855.9 ft.
HORIZONTAL DATUM: NAD 83

THIS RECORD IS A REASONABLE INTERPRETATION OF SUBSURFACE CONDITIONS AT THE EXPLORATION LOCATION. SUBSURFACE CONDITIONS AT OTHER LOCATIONS AND AT OTHER TIMES MAY DIFFER. INTERFACES BETWEEN STRATA ARE APPROXIMATE. TRANSITIONS BETWEEN STRATA MAY BE GRADUAL.

SOIL BORING / MONITORING WELL RECORD

Project: Richmond ANG FY16 Site Inspection for PFC
Project No: 291330006.07
Checked By: BL

Boring No. 01SB02

amec foster wheeler
271 Mill Road
Chelmsford, MA 01824

RICHMOND ANG LOG RICHMOND BORING LOGS.GPJ PFC TEMPLATE.GDT 2/2/18

DEPTH (ft)	SOIL CLASSIFICATION AND REMARKS SEE KEY SYMBOL SHEET FOR EXPLANATION OF SYMBOLS AND ABBREVIATIONS USED BELOW.	LEGEND	ELEV (ft)	SAMPLES: BLOW CT PER 6 IN	SAMPLE ID	TYPE	PID (ppm)	RECOVERY (feet)	MONITORING WELL CONSTRUCTION DETAILS AND REMARKS	DEPTH
0	Reddish brown fat CLAY, silty, stiff, highly plastic, no odor, moist (CH)				RICHM-01SB03-0-2 and RICHM-SO-DUP01		0.0	4.5		0
5	Reddish brown fat CLAY, silty, stiff, highly plastic, no odor, moist (CH)				RICHM-01SB03-8-10		0.0	4.5		5
10									Bottom of boring at 10 feet. Not refusal.	10
15										15
20										20
25										25

START DATE: 11/7/2017
END DATE: 11/7/2017
DRILLER: TWS, Cascade
EQUIPMENT: Geoprobe 7822DT
METHOD: Direct Push
HOLE DIA.: 2 1/4" ID
SITE: RICHM
LOGGED BY: David Young

GROUND ELEVATION: ft.
VERTICAL DATUM:
NORTHING: 3710956.139 ft.
EASTING: 11828039.64 ft.
HORIZONTAL DATUM: NAD 83

Note: Hand auger to 5 ft bgs

THIS RECORD IS A REASONABLE INTERPRETATION OF SUBSURFACE CONDITIONS AT THE EXPLORATION LOCATION. SUBSURFACE CONDITIONS AT OTHER LOCATIONS AND AT OTHER TIMES MAY DIFFER. INTERFACES BETWEEN STRATA ARE APPROXIMATE. TRANSITIONS BETWEEN STRATA MAY BE GRADUAL.

SOIL BORING / MONITORING WELL RECORD

Project: Richmond ANG FY16 Site Inspection for PFC
Project No: 291330006.07
Checked By: BL

Boring No. 01SB03

amec foster wheeler
271 Mill Road
Chelmsford, MA 01824

RICHMOND ANG LOG RICHMOND BORING LOGS.GPJ PFC TEMPLATE.GDT 2/2/18

DEPTH (ft)	SOIL CLASSIFICATION AND REMARKS SEE KEY SYMBOL SHEET FOR EXPLANATION OF SYMBOLS AND ABBREVIATIONS USED BELOW.	LEGEND	ELEV (ft)	SAMPLES: BLOW CT PER 6 IN	SAMPLE ID	TYPE	PID (ppm)	RECOVERY (feet)	MONITORING WELL CONSTRUCTION DETAILS AND REMARKS	DEPTH
0	Reddish brown fat CLAY, silty, stiff, highly plastic, no odor, moist (CH)				RICHM-01SB04-0-2		0.0	4.5		0
5	Reddish brown fat CLAY, silty, stiff, highly plastic, no odor, moist (CH)				RICHM-01SB04-8-10		0.0	4.5		5
10									Bottom of boring at 10 feet. Not refusal.	10
15										15
20										20
25										25

START DATE: 11/7/2017
END DATE: 11/7/2017
DRILLER: TWS, Cascade
EQUIPMENT: Geoprobe 7822DT
METHOD: Direct Push
HOLE DIA.: 2 1/4" ID
SITE: RICHM
LOGGED BY: David Young

GROUND ELEVATION: ft.
VERTICAL DATUM:
NORTHING: 3711079.021 ft.
EASTING: 11828088.64 ft.
HORIZONTAL DATUM: NAD 83

Note: Hand auger to 5 ft bgs

THIS RECORD IS A REASONABLE INTERPRETATION OF SUBSURFACE CONDITIONS AT THE EXPLORATION LOCATION. SUBSURFACE CONDITIONS AT OTHER LOCATIONS AND AT OTHER TIMES MAY DIFFER. INTERFACES BETWEEN STRATA ARE APPROXIMATE. TRANSITIONS BETWEEN STRATA MAY BE GRADUAL.

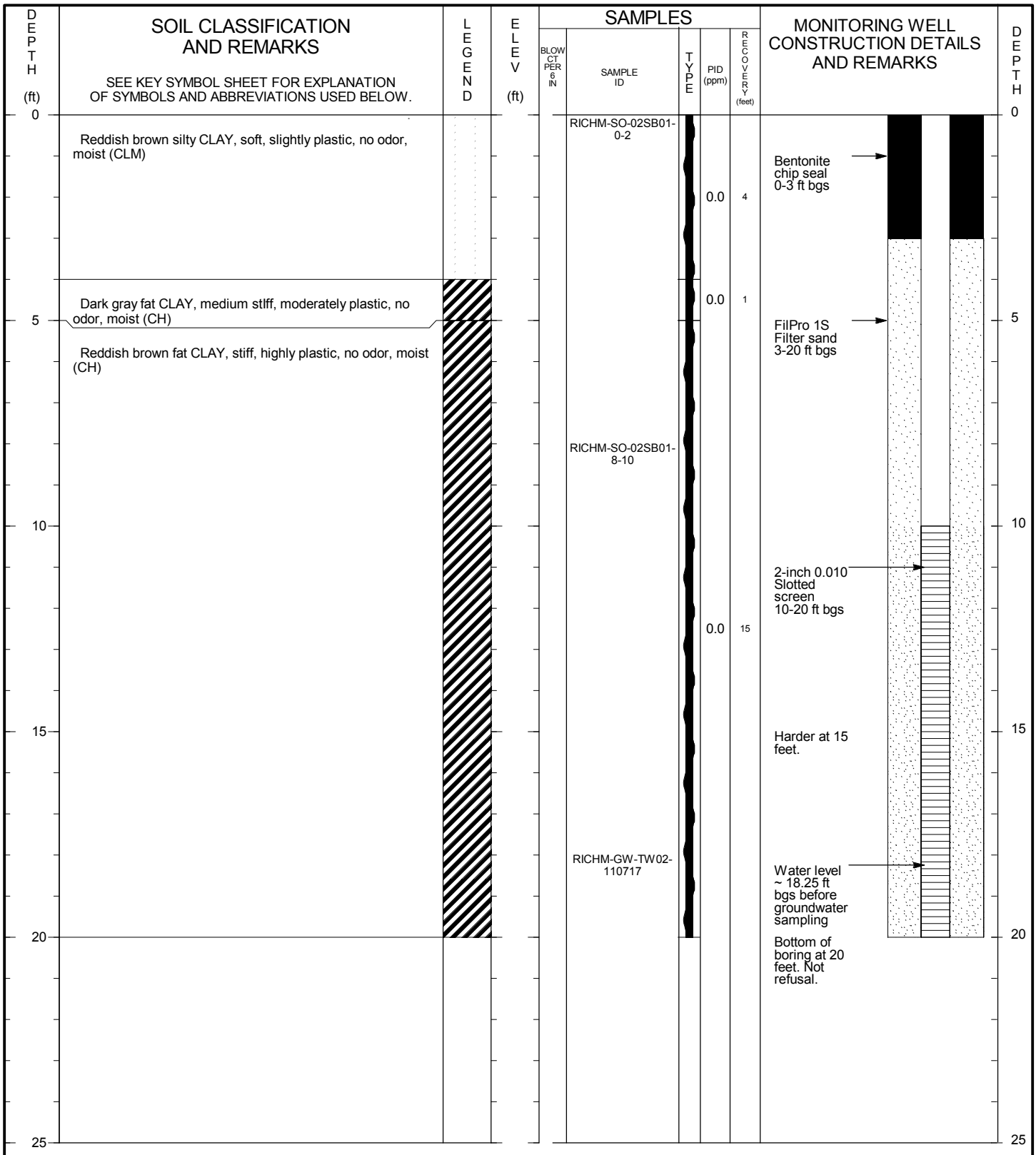
SOIL BORING / MONITORING WELL RECORD

Project: Richmond ANG FY16 Site Inspection for PFC
Project No: 291330006.07
Checked By: BL

Boring No. 01SB04

amec foster wheeler
271 Mill Road
Chelmsford, MA 01824

RICHMOND ANG LOG RICHMOND BORING LOGS.GPJ PFC TEMPLATE.GDT 2/2/18



START DATE: 11/7/2017
END DATE: 11/7/2017
DRILLER: TWS, Cascade
EQUIPMENT: Geoprobe 7822DT
METHOD: Hollow Stem Auger
HOLE DIA.: 8-inch
SITE: RICHM
LOGGED BY: David Young

GROUND ELEVATION: ft.
VERTICAL DATUM:
NORTHING: 3711236.135 ft.
EASTING: 11827693.91 ft.
HORIZONTAL DATUM: NAD 83

Note: Temporary well abandoned

THIS RECORD IS A REASONABLE INTERPRETATION OF SUBSURFACE CONDITIONS AT THE EXPLORATION LOCATION. SUBSURFACE CONDITIONS AT OTHER LOCATIONS AND AT OTHER TIMES MAY DIFFER. INTERFACES BETWEEN STRATA ARE APPROXIMATE. TRANSITIONS BETWEEN STRATA MAY BE GRADUAL.

SOIL BORING / MONITORING WELL RECORD

Project: Richmond ANG FY16 Site Inspection for PFC
Project No: 291330006.07
Checked By: BL

Well No. 02SB01/TW-02

amec foster wheeler
271 Mill Road
Chelmsford, MA 01824

RICHMOND ANG LOG RICHMOND BORING LOGS.GPJ PFC TEMPLATE.GDT 2/2/18

DEPTH (ft)	SOIL CLASSIFICATION AND REMARKS SEE KEY SYMBOL SHEET FOR EXPLANATION OF SYMBOLS AND ABBREVIATIONS USED BELOW.	LEGEND	ELEV (ft)	SAMPLES: BLOW CT PER 6 IN	SAMPLE ID	TYPE	PID (ppm)	RECOVERY (feet)	MONITORING WELL CONSTRUCTION DETAILS AND REMARKS	DEPTH
0	Reddish brown fat CLAY, silty, stiff, highly plastic, no odor, moist (CH)				RICHM-02SB02-0-2 and RICHM-SO-DUP02		0.0	4.5		0
5	Reddish brown fat CLAY, silty, stiff, highly plastic, no odor, moist (CH)				RICHM-02SB02-8-10		0.0	4.5		5
10									Bottom of boring at 10 feet. Not refusal.	10
15										15
20										20
25										25

START DATE: 11/7/2017
END DATE: 11/7/2017
DRILLER: TWS, Cascade
EQUIPMENT: Geoprobe 7822DT
METHOD: Direct Push
HOLE DIA.: 2 1/4" ID
SITE: RICHM
LOGGED BY: David Young

GROUND ELEVATION: ft.
VERTICAL DATUM:
NORTHING: 3711187.938 ft.
EASTING: 11827694.83 ft.
HORIZONTAL DATUM: NAD 83

THIS RECORD IS A REASONABLE INTERPRETATION OF SUBSURFACE CONDITIONS AT THE EXPLORATION LOCATION. SUBSURFACE CONDITIONS AT OTHER LOCATIONS AND AT OTHER TIMES MAY DIFFER. INTERFACES BETWEEN STRATA ARE APPROXIMATE. TRANSITIONS BETWEEN STRATA MAY BE GRADUAL.

SOIL BORING / MONITORING WELL RECORD

Project: Richmond ANG FY16 Site Inspection for PFC
Project No: 291330006.07
Checked By: BL

Boring No. 02SB02

amec foster wheeler
271 Mill Road
Chelmsford, MA 01824

RICHMOND ANG LOG RICHMOND BORING LOGS.GPJ PFC TEMPLATE.GDT 2/2/18

DEPTH (ft)	SOIL CLASSIFICATION AND REMARKS SEE KEY SYMBOL SHEET FOR EXPLANATION OF SYMBOLS AND ABBREVIATIONS USED BELOW.	LEGEND	ELEV (ft)	SAMPLES: BLOW CT PER 6 IN	SAMPLE ID	TYPE	PID (ppm)	RECOVERY (feet)	MONITORING WELL CONSTRUCTION DETAILS AND REMARKS	DEPTH
0	Reddish brown fat CLAY, silty, stiff, highly plastic, no odor, moist (CH)				RICHM-02SB03-0-2		0.0	4.5		0
5	Reddish brown fat CLAY, silty, stiff, highly plastic, no odor, moist (CH)				RICHM-02SB03-8-10		0.0	4.5		5
10									Bottom of boring at 10 feet. Not refusal.	10
15										15
20										20
25										25

START DATE: 11/7/2017
END DATE: 11/7/2017
DRILLER: TWS, Cascade
EQUIPMENT: Geoprobe 7822DT
METHOD: Direct Push
HOLE DIA.: 2 1/4" ID
SITE: RICHM
LOGGED BY: David Young

GROUND ELEVATION: ft.
VERTICAL DATUM:
NORTHING: 3711115.552 ft.
EASTING: 11827740.84 ft.
HORIZONTAL DATUM: NAD 83

THIS RECORD IS A REASONABLE INTERPRETATION OF SUBSURFACE CONDITIONS AT THE EXPLORATION LOCATION. SUBSURFACE CONDITIONS AT OTHER LOCATIONS AND AT OTHER TIMES MAY DIFFER. INTERFACES BETWEEN STRATA ARE APPROXIMATE. TRANSITIONS BETWEEN STRATA MAY BE GRADUAL.

SOIL BORING / MONITORING WELL RECORD

Project: Richmond ANG FY16 Site Inspection for PFC
Project No: 291330006.07
Checked By: BL

Boring No. 02SB03

amec foster wheeler
271 Mill Road
Chelmsford, MA 01824

RICHMOND ANG LOG RICHMOND BORING LOGS.GPJ PFC TEMPLATE.GDT 2/2/18

DEPTH (ft)	SOIL CLASSIFICATION AND REMARKS SEE KEY SYMBOL SHEET FOR EXPLANATION OF SYMBOLS AND ABBREVIATIONS USED BELOW.	LEGEND	ELEV (ft)	SAMPLES: BLOW CT PER 6 IN	SAMPLE ID	TYPE	PID (ppm)	RECOVERY (feet)	MONITORING WELL CONSTRUCTION DETAILS AND REMARKS	DEPTH
0	Reddish brown fat CLAY, silty, stiff, highly plastic, no odor, moist (CH)				RICHM-02SB04-0-2		0.0	4.5		0
5	Reddish brown fat CLAY, silty, stiff, highly plastic, no odor, moist (CH)				RICHM-02SB04-8-10		0.0	4.5		5
10									Bottom of boring at 10 feet. Not refusal.	10
15										15
20										20
25										25

START DATE: 11/7/2017
END DATE: 11/7/2017
DRILLER: TWS, Cascade
EQUIPMENT: Geoprobe 7822DT
METHOD: Direct Push
HOLE DIA.: 2 1/4" ID
SITE: RICHM
LOGGED BY: David Young

GROUND ELEVATION: ft.
VERTICAL DATUM:
NORTHING: 3711120.933 ft.
EASTING: 11827805.12 ft.
HORIZONTAL DATUM: NAD 83

THIS RECORD IS A REASONABLE INTERPRETATION OF SUBSURFACE CONDITIONS AT THE EXPLORATION LOCATION. SUBSURFACE CONDITIONS AT OTHER LOCATIONS AND AT OTHER TIMES MAY DIFFER. INTERFACES BETWEEN STRATA ARE APPROXIMATE. TRANSITIONS BETWEEN STRATA MAY BE GRADUAL.

SOIL BORING / MONITORING WELL RECORD

Project: Richmond ANG FY16 Site Inspection for PFC
Project No: 291330006.07
Checked By: BL

Boring No. 02SB04

amec foster wheeler
271 Mill Road
Chelmsford, MA 01824

RICHMOND ANG LOG RICHMOND BORING LOGS.GPJ PFC TEMPLATE.GDT 2/2/18

DEPTH (ft)	SOIL CLASSIFICATION AND REMARKS SEE KEY SYMBOL SHEET FOR EXPLANATION OF SYMBOLS AND ABBREVIATIONS USED BELOW.	LEGEND	ELEV (ft)	SAMPLES: BLOW CT PER 6 IN	SAMPLE ID	TYPE	PID (ppm)	RECOVERY (feet)	MONITORING WELL CONSTRUCTION DETAILS AND REMARKS	DEPTH
0	Reddish brown fat CLAY, silty, stiff, highly plastic, no odor, moist (CH)				RICHM-03SB01-0-2		0.0	4.5		0
5	Reddish brown fat CLAY, silty, stiff, highly plastic, no odor, moist (CH)				RICHM-03SB01-8-10		0.0	4.5		5
10									Bottom of boring at 10 feet. Not refusal.	10
15										15
20										20
25										25

START DATE: 11/8/2017
END DATE: 11/8/2017
DRILLER: TWS, Cascade
EQUIPMENT: Geoprobe 7822DT
METHOD: Direct Push
HOLE DIA.: 2 1/4" ID
SITE: RICHM
LOGGED BY: David Young

GROUND ELEVATION: ft.
VERTICAL DATUM:
NORTHING: 3712358.913 ft.
EASTING: 11826977.59 ft.
HORIZONTAL DATUM: NAD 83

THIS RECORD IS A REASONABLE INTERPRETATION OF SUBSURFACE CONDITIONS AT THE EXPLORATION LOCATION. SUBSURFACE CONDITIONS AT OTHER LOCATIONS AND AT OTHER TIMES MAY DIFFER. INTERFACES BETWEEN STRATA ARE APPROXIMATE. TRANSITIONS BETWEEN STRATA MAY BE GRADUAL.

SOIL BORING / MONITORING WELL RECORD

Project: Richmond ANG FY16 Site Inspection for PFC
Project No: 291330006.07
Checked By: BL

Boring No. 03SB01

amec foster wheeler
271 Mill Road
Chelmsford, MA 01824

RICHMOND ANG LOG RICHMOND BORING LOGS.GPJ PFC TEMPLATE.GDT 2/2/18

DEPTH (ft)	SOIL CLASSIFICATION AND REMARKS SEE KEY SYMBOL SHEET FOR EXPLANATION OF SYMBOLS AND ABBREVIATIONS USED BELOW.	LEGEND	ELEV (ft)	SAMPLES: BLOW CT PER 6 IN	SAMPLE ID	TYPE	PID (ppm)	RECOVERY (feet)	MONITORING WELL CONSTRUCTION DETAILS AND REMARKS	DEPTH
0	Reddish brown fat CLAY, silty, stiff, highly plastic, no odor, moist (CH)				RICHM-03SB02-0-2		0.0	4.5		0
5	Reddish brown fat CLAY, silty, stiff, highly plastic, no odor, moist (CH)				RICHM-03SB02-8-10		0.0	4.5		5
10									Bottom of boring at 10 feet. Not refusal.	10
15										15
20										20
25										25

START DATE: 11/8/2017
END DATE: 11/8/2017
DRILLER: TWS, Cascade
EQUIPMENT: Geoprobe 7822DT
METHOD: Direct Push
HOLE DIA.: 2 1/4" ID
SITE: RICHM
LOGGED BY: David Young

GROUND ELEVATION: ft.
VERTICAL DATUM:
NORTHING: 3712323.919 ft.
EASTING: 11826894.6 ft.
HORIZONTAL DATUM: NAD 83

THIS RECORD IS A REASONABLE INTERPRETATION OF SUBSURFACE CONDITIONS AT THE EXPLORATION LOCATION. SUBSURFACE CONDITIONS AT OTHER LOCATIONS AND AT OTHER TIMES MAY DIFFER. INTERFACES BETWEEN STRATA ARE APPROXIMATE. TRANSITIONS BETWEEN STRATA MAY BE GRADUAL.

SOIL BORING / MONITORING WELL RECORD

Project: Richmond ANG FY16 Site Inspection for PFC
Project No: 291330006.07
Checked By: BL

Boring No. 03SB02

amec foster wheeler
271 Mill Road
Chelmsford, MA 01824

RICHMOND ANG LOG RICHMOND BORING LOGS.GPJ PFC TEMPLATE.GDT 2/2/18

DEPTH (ft)	SOIL CLASSIFICATION AND REMARKS SEE KEY SYMBOL SHEET FOR EXPLANATION OF SYMBOLS AND ABBREVIATIONS USED BELOW.	LEGEND	ELEV (ft)	SAMPLES: BLOW CT PER 6 IN	SAMPLE ID	TYPE	PID (ppm)	RECOVERY (feet)	MONITORING WELL CONSTRUCTION DETAILS AND REMARKS	DEPTH
0	Reddish brown fat CLAY, silty, stiff, highly plastic, no odor, moist (CH)				RICHM-03SB03-0-2		0.0	4.5		0
5	Reddish brown fat CLAY, silty, stiff, highly plastic, no odor, moist (CH)				RICHM-03SB03-8-10		0.0	4.5		5
10									Bottom of boring at 10 feet. Not refusal.	10
15										15
20										20
25										25

START DATE: 11/9/2017
END DATE: 11/9/2017
DRILLER: TWS, Cascade
EQUIPMENT: Geoprobe 7822DT
METHOD: Direct Push
HOLE DIA.: 2 1/4" ID
SITE: RICHM
LOGGED BY: David Young

GROUND ELEVATION: ft.
VERTICAL DATUM:
NORTHING: 3712435.372 ft.
EASTING: 11826849.04 ft.
HORIZONTAL DATUM: NAD 83

THIS RECORD IS A REASONABLE INTERPRETATION OF SUBSURFACE CONDITIONS AT THE EXPLORATION LOCATION. SUBSURFACE CONDITIONS AT OTHER LOCATIONS AND AT OTHER TIMES MAY DIFFER. INTERFACES BETWEEN STRATA ARE APPROXIMATE. TRANSITIONS BETWEEN STRATA MAY BE GRADUAL.

SOIL BORING / MONITORING WELL RECORD

Project: Richmond ANG FY16 Site Inspection for PFC
Project No: 291330006.07
Checked By: BL

Boring No. 03SB03

amec foster wheeler
271 Mill Road
Chelmsford, MA 01824

RICHMOND ANG LOG RICHMOND BORING LOGS.GPJ PFC TEMPLATE.GDT 2/2/18

DEPTH (ft)	SOIL CLASSIFICATION AND REMARKS SEE KEY SYMBOL SHEET FOR EXPLANATION OF SYMBOLS AND ABBREVIATIONS USED BELOW.	LEGEND	ELEV (ft)	SAMPLES: BLOW CT PER 6 IN	SAMPLE ID	TYPE	PID (ppm)	RECOVERY (feet)	MONITORING WELL CONSTRUCTION DETAILS AND REMARKS	DEPTH
0	Reddish brown fat CLAY, silty, stiff, highly plastic, no odor, moist (CH)				RICHM-03SB04-0-2		0.0	4.5		0
5	Reddish brown fat CLAY, silty, stiff, highly plastic, no odor, moist (CH)				RICHM-03SB04-8-10		0.0	4.5		5
10									Bottom of boring at 10 feet. Not refusal.	10
15										15
20										20
25										25

START DATE: 11/9/2017
END DATE: 11/9/2017
DRILLER: TWS, Cascade
EQUIPMENT: Geoprobe 7822DT
METHOD: Direct Push
HOLE DIA.: 2 1/4" ID
SITE: RICHM
LOGGED BY: David Young

GROUND ELEVATION: ft.
VERTICAL DATUM:
NORTHING: 3712464.989 ft.
EASTING: 11826945.58 ft.
HORIZONTAL DATUM: NAD 83

THIS RECORD IS A REASONABLE INTERPRETATION OF SUBSURFACE CONDITIONS AT THE EXPLORATION LOCATION. SUBSURFACE CONDITIONS AT OTHER LOCATIONS AND AT OTHER TIMES MAY DIFFER. INTERFACES BETWEEN STRATA ARE APPROXIMATE. TRANSITIONS BETWEEN STRATA MAY BE GRADUAL.

SOIL BORING / MONITORING WELL RECORD

Project: Richmond ANG FY16 Site Inspection for PFC
Project No: 291330006.07
Checked By: BL

Boring No. 03SB04

amec foster wheeler
271 Mill Road
Chelmsford, MA 01824

RICHMOND ANG LOG RICHMOND BORING LOGS.GPJ PFC TEMPLATE.GDT 2/2/18

DEPTH (ft)	SOIL CLASSIFICATION AND REMARKS SEE KEY SYMBOL SHEET FOR EXPLANATION OF SYMBOLS AND ABBREVIATIONS USED BELOW.	LEGEND	ELEV (ft)	SAMPLES: BLOW CT PER 6 IN	SAMPLE ID	TYPE	PID (ppm)	RECOVERY (feet)	MONITORING WELL CONSTRUCTION DETAILS AND REMARKS	DEPTH
0	Reddish brown fat CLAY, silty, stiff, highly plastic, no odor, moist (CH)				RICHM-04SB01-0-2		0.0	4.5		0
5	Reddish brown fat CLAY, silty, stiff, highly plastic, no odor, moist (CH)				RICHM-04SB01-8-10		0.0	4.5		5
10									Bottom of boring at 10 feet. Not refusal.	10
15										15
20										20
25										25

START DATE: 11/7/2017
END DATE: 11/7/2017
DRILLER: TWS, Cascade
EQUIPMENT: Geoprobe 7822DT
METHOD: Direct Push
HOLE DIA.: 2 1/4" ID
SITE: RICHM
LOGGED BY: David Young

GROUND ELEVATION: ft.
VERTICAL DATUM:
NORTHING: 3710169.285 ft.
EASTING: 11827683.64 ft.
HORIZONTAL DATUM: NAD 83

THIS RECORD IS A REASONABLE INTERPRETATION OF SUBSURFACE CONDITIONS AT THE EXPLORATION LOCATION. SUBSURFACE CONDITIONS AT OTHER LOCATIONS AND AT OTHER TIMES MAY DIFFER. INTERFACES BETWEEN STRATA ARE APPROXIMATE. TRANSITIONS BETWEEN STRATA MAY BE GRADUAL.

SOIL BORING / MONITORING WELL RECORD

Project: Richmond ANG FY16 Site Inspection for PFC
Project No: 291330006.07
Checked By: BL

Boring No. 04SB01

amec foster wheeler
271 Mill Road
Chelmsford, MA 01824

RICHMOND ANG LOG RICHMOND BORING LOGS.GPJ PFC TEMPLATE.GDT 2/2/18

DEPTH (ft)	SOIL CLASSIFICATION AND REMARKS SEE KEY SYMBOL SHEET FOR EXPLANATION OF SYMBOLS AND ABBREVIATIONS USED BELOW.	LEGEND	ELEV (ft)	SAMPLES: BLOW CT PER 6 IN	SAMPLE ID	TYPE	PID (ppm)	RECOVERY (feet)	MONITORING WELL CONSTRUCTION DETAILS AND REMARKS	DEPTH
0	Reddish brown fat CLAY, silty, stiff, highly plastic, no odor, moist (CH)				RICHM-04SB02-0-2		0.0	4.5		0
5	Reddish brown fat CLAY, silty, stiff, highly plastic, no odor, moist (CH)				RICHM-04SB02-8-10		0.0	4.5		5
10									Bottom of boring at 10 feet. Not refusal.	10
15										15
20										20
25										25

START DATE: 11/7/2017
END DATE: 11/7/2017
DRILLER: TWS, Cascade
EQUIPMENT: Geoprobe 7822DT
METHOD: Direct Push
HOLE DIA.: 2 1/4" ID
SITE: RICHM
LOGGED BY: David Young

GROUND ELEVATION: ft.
VERTICAL DATUM:
NORTHING: 3710084.061 ft.
EASTING: 11827764.5 ft.
HORIZONTAL DATUM: NAD 83

THIS RECORD IS A REASONABLE INTERPRETATION OF SUBSURFACE CONDITIONS AT THE EXPLORATION LOCATION. SUBSURFACE CONDITIONS AT OTHER LOCATIONS AND AT OTHER TIMES MAY DIFFER. INTERFACES BETWEEN STRATA ARE APPROXIMATE. TRANSITIONS BETWEEN STRATA MAY BE GRADUAL.

SOIL BORING / MONITORING WELL RECORD

Project: Richmond ANG FY16 Site Inspection for PFC
Project No: 291330006.07
Checked By: BL

Boring No. 04SB02

amec foster wheeler
271 Mill Road
Chelmsford, MA 01824

RICHMOND ANG LOG RICHMOND BORING LOGS.GPJ PFC TEMPLATE.GDT 2/2/18

DEPTH (ft)	SOIL CLASSIFICATION AND REMARKS SEE KEY SYMBOL SHEET FOR EXPLANATION OF SYMBOLS AND ABBREVIATIONS USED BELOW.	LEGEND	ELEV (ft)	SAMPLES: BLOW CT PER 6 IN	SAMPLE ID	TYPE	PID (ppm)	RECOVERY (feet)	MONITORING WELL CONSTRUCTION DETAILS AND REMARKS	DEPTH
0	Reddish brown fat CLAY, silty, stiff, highly plastic, no odor, moist (CH)				RICHM-04SB03-0-2		0.0	4.5		0
5	Reddish brown fat CLAY, silty, stiff, highly plastic, no odor, moist (CH)				RICHM-04SB03-8-10 and RICHM-SO-DUP03		0.0	4.5		5
10									Bottom of boring at 10 feet. Not refusal.	10
15										15
20										20
25										25

START DATE: 11/8/2017
END DATE: 11/8/2017
DRILLER: TWS, Cascade
EQUIPMENT: Geoprobe 7822DT
METHOD: Direct Push
HOLE DIA.: 2 1/4" ID
SITE: RICHM
LOGGED BY: David Young

GROUND ELEVATION: ft.
VERTICAL DATUM:
NORTHING: 3710111.558 ft.
EASTING: 11827865.5 ft.
HORIZONTAL DATUM: NAD 83

Note: Hand auger to 5 ft bgs

THIS RECORD IS A REASONABLE INTERPRETATION OF SUBSURFACE CONDITIONS AT THE EXPLORATION LOCATION. SUBSURFACE CONDITIONS AT OTHER LOCATIONS AND AT OTHER TIMES MAY DIFFER. INTERFACES BETWEEN STRATA ARE APPROXIMATE. TRANSITIONS BETWEEN STRATA MAY BE GRADUAL.

SOIL BORING / MONITORING WELL RECORD

Project: Richmond ANG FY16 Site Inspection for PFC
Project No: 291330006.07
Checked By: BL

Boring No. 04SB03

amec foster wheeler
271 Mill Road
Chelmsford, MA 01824

RICHMOND ANG LOG RICHMOND BORING LOGS.GPJ PFC TEMPLATE.GDT 2/2/18

DEPTH (ft)	SOIL CLASSIFICATION AND REMARKS SEE KEY SYMBOL SHEET FOR EXPLANATION OF SYMBOLS AND ABBREVIATIONS USED BELOW.	LEGEND	ELEV (ft)	SAMPLES: BLOW CT PER 6 IN	SAMPLE ID	TYPE	PID (ppm)	RECOVERY (feet)	MONITORING WELL CONSTRUCTION DETAILS AND REMARKS	DEPTH
0	Reddish brown fat CLAY, silty, stiff, highly plastic, no odor, moist (CH)				RICHM-04SB04-0-2		0.0	4.5		0
5	Reddish brown fat CLAY, silty, stiff, highly plastic, no odor, moist (CH)				RICHM-04SB04-8-10		0.0	4.5		5
10									Bottom of boring at 10 feet. Not refusal.	10
15										15
20										20
25										25

START DATE: 11/8/2017
END DATE: 11/8/2017
DRILLER: TWS, Cascade
EQUIPMENT: Geoprobe 7822DT
METHOD: Direct Push
HOLE DIA.: 2 1/4" ID
SITE: RICHM
LOGGED BY: David Young

GROUND ELEVATION: ft.
VERTICAL DATUM:
NORTHING: 3710185.283 ft.
EASTING: 11827848.16 ft.
HORIZONTAL DATUM: NAD 83

THIS RECORD IS A REASONABLE INTERPRETATION OF SUBSURFACE CONDITIONS AT THE EXPLORATION LOCATION. SUBSURFACE CONDITIONS AT OTHER LOCATIONS AND AT OTHER TIMES MAY DIFFER. INTERFACES BETWEEN STRATA ARE APPROXIMATE. TRANSITIONS BETWEEN STRATA MAY BE GRADUAL.

SOIL BORING / MONITORING WELL RECORD

Project: Richmond ANG FY16 Site Inspection for PFC
Project No: 291330006.07
Checked By: BL

Boring No. 04SB04

amec foster wheeler
271 Mill Road
Chelmsford, MA 01824

RICHMOND ANG LOG RICHMOND BORING LOGS.GPJ PFC TEMPLATE.GDT 2/2/18

DEPTH (ft)	SOIL CLASSIFICATION AND REMARKS SEE KEY SYMBOL SHEET FOR EXPLANATION OF SYMBOLS AND ABBREVIATIONS USED BELOW.	LEGEND	ELEV (ft)	SAMPLES: BLOW CT PER 6 IN	SAMPLE ID	TYPE	PID (ppm)	RECOVERY (feet)	MONITORING WELL CONSTRUCTION DETAILS AND REMARKS	DEPTH
0	Reddish brown fat CLAY, silty, stiff, highly plastic, no odor, moist (CH)				RICHM-05SB01-0-2		0.0	4.5		0
5	Reddish brown fat CLAY, silty, stiff, highly plastic, no odor, moist (CH)				RICHM-05SB01-8-10		0.0	4.5		5
10									Bottom of boring at 10 feet. Not refusal.	10
15										15
20										20
25										25

START DATE: 11/8/2017
END DATE: 11/8/2017
DRILLER: TWS, Cascade
EQUIPMENT: Geoprobe 7822DT
METHOD: Direct Push
HOLE DIA.: 2 1/4" ID
SITE: RICHM
LOGGED BY: David Young

GROUND ELEVATION: ft.
VERTICAL DATUM:
NORTHING: 3710943.27 ft.
EASTING: 11827186.62 ft.
HORIZONTAL DATUM: NAD 83

THIS RECORD IS A REASONABLE INTERPRETATION OF SUBSURFACE CONDITIONS AT THE EXPLORATION LOCATION. SUBSURFACE CONDITIONS AT OTHER LOCATIONS AND AT OTHER TIMES MAY DIFFER. INTERFACES BETWEEN STRATA ARE APPROXIMATE. TRANSITIONS BETWEEN STRATA MAY BE GRADUAL.

SOIL BORING / MONITORING WELL RECORD

Project: Richmond ANG FY16 Site Inspection for PFC
Project No: 291330006.07
Checked By: BL

Boring No. 05SB01

amec foster wheeler
271 Mill Road
Chelmsford, MA 01824

RICHMOND ANG LOG RICHMOND BORING LOGS.GPJ PFC TEMPLATE.GDT 2/2/18

DEPTH (ft)	SOIL CLASSIFICATION AND REMARKS SEE KEY SYMBOL SHEET FOR EXPLANATION OF SYMBOLS AND ABBREVIATIONS USED BELOW.	LEGEND	ELEV (ft)	SAMPLES: BLOW CT PER 6 IN	SAMPLE ID	TYPE	PID (ppm)	RECOVERY (feet)	MONITORING WELL CONSTRUCTION DETAILS AND REMARKS	DEPTH
0	Reddish brown fat CLAY, silty, stiff, highly plastic, no odor, moist (CH)				RICHM-05SB02-0-2		0.0	4.5		0
5	Reddish brown fat CLAY, silty, stiff, highly plastic, no odor, moist (CH)				RICHM-05SB02-8-10		0.0	4.5		5
10									Bottom of boring at 10 feet. Not refusal.	10
15										15
20										20
25										25

START DATE: 11/8/2017
END DATE: 11/8/2017
DRILLER: TWS, Cascade
EQUIPMENT: Geoprobe 7822DT
METHOD: Direct Push
HOLE DIA.: 2 1/4" ID
SITE: RICHM
LOGGED BY: David Young

GROUND ELEVATION: ft.
VERTICAL DATUM:
NORTHING: 3710562.153 ft.
EASTING: 11827412.46 ft.
HORIZONTAL DATUM: NAD 83

Note: Hand auger to 5 ft bgs

THIS RECORD IS A REASONABLE INTERPRETATION OF SUBSURFACE CONDITIONS AT THE EXPLORATION LOCATION. SUBSURFACE CONDITIONS AT OTHER LOCATIONS AND AT OTHER TIMES MAY DIFFER. INTERFACES BETWEEN STRATA ARE APPROXIMATE. TRANSITIONS BETWEEN STRATA MAY BE GRADUAL.

SOIL BORING / MONITORING WELL RECORD

Project: Richmond ANG FY16 Site Inspection for PFC
Project No: 291330006.07
Checked By: BL

Boring No. 05SB02

amec foster wheeler
271 Mill Road
Chelmsford, MA 01824

RICHMOND ANG LOG RICHMOND BORING LOGS.GPJ PFC TEMPLATE.GDT 2/2/18

DEPTH (ft)	SOIL CLASSIFICATION AND REMARKS SEE KEY SYMBOL SHEET FOR EXPLANATION OF SYMBOLS AND ABBREVIATIONS USED BELOW.	LEGEND	ELEV (ft)	SAMPLES: BLOW CT PER 6 IN	SAMPLE ID	TYPE	PID (ppm)	RECOVERY (feet)	MONITORING WELL CONSTRUCTION DETAILS AND REMARKS	DEPTH
0	Reddish brown fat CLAY, silty, stiff, highly plastic, no odor, moist (CH)				RICHM-05SB03-0-2		0.0	4.5		0
5	Reddish brown fat CLAY, silty, stiff, highly plastic, no odor, moist (CH)				RICHM-05SB03-8-10		0.0	4.5		5
10									Bottom of boring at 10 feet. Not refusal.	10
15										15
20										20
25										25

START DATE: 11/8/2017
END DATE: 11/8/2017
DRILLER: TWS, Cascade
EQUIPMENT: Geoprobe 7822DT
METHOD: Direct Push
HOLE DIA.: 2 1/4" ID
SITE: RICHM
LOGGED BY: David Young

GROUND ELEVATION: ft.
VERTICAL DATUM:
NORTHING: 3710371.114 ft.
EASTING: 11828013.85 ft.
HORIZONTAL DATUM: NAD 83

THIS RECORD IS A REASONABLE INTERPRETATION OF SUBSURFACE CONDITIONS AT THE EXPLORATION LOCATION. SUBSURFACE CONDITIONS AT OTHER LOCATIONS AND AT OTHER TIMES MAY DIFFER. INTERFACES BETWEEN STRATA ARE APPROXIMATE. TRANSITIONS BETWEEN STRATA MAY BE GRADUAL.

SOIL BORING / MONITORING WELL RECORD

Project: Richmond ANG FY16 Site Inspection for PFC
Project No: 291330006.07
Checked By: BL

Boring No. 05SB03

amec foster wheeler
271 Mill Road
Chelmsford, MA 01824

RICHMOND ANG LOG RICHMOND BORING LOGS.GPJ PFC TEMPLATE.GDT 2/2/18

DEPTH (ft)	SOIL CLASSIFICATION AND REMARKS SEE KEY SYMBOL SHEET FOR EXPLANATION OF SYMBOLS AND ABBREVIATIONS USED BELOW.	LEGEND	ELEV (ft)	SAMPLES: BLOW CT PER 6 IN	SAMPLE ID	TYPE	PID (ppm)	RECOVERY (feet)	MONITORING WELL CONSTRUCTION DETAILS AND REMARKS	DEPTH
0	Reddish brown fat CLAY, silty, stiff, highly plastic, no odor, moist (CH)				RICHM-05SB04-0-2 and RICHM-SO-DUP04		0.0	4.5		0
5	Reddish brown fat CLAY, silty, stiff, highly plastic, no odor, moist (CH)				RICHM-05SB04-8-10		0.0	4.5		5
10									Bottom of boring at 10 feet. Not refusal.	10
15										15
20										20
25										25

START DATE: 11/8/2017
END DATE: 11/8/2017
DRILLER: TWS, Cascade
EQUIPMENT: Geoprobe 7822DT
METHOD: Direct Push
HOLE DIA.: 2 1/4" ID
SITE: RICHM
LOGGED BY: David Young

GROUND ELEVATION: ft.
VERTICAL DATUM:
NORTHING: 3710738.409 ft.
EASTING: 11827850.1 ft.
HORIZONTAL DATUM: NAD 83

Note: Hand auger to 5 ft bgs

THIS RECORD IS A REASONABLE INTERPRETATION OF SUBSURFACE CONDITIONS AT THE EXPLORATION LOCATION. SUBSURFACE CONDITIONS AT OTHER LOCATIONS AND AT OTHER TIMES MAY DIFFER. INTERFACES BETWEEN STRATA ARE APPROXIMATE. TRANSITIONS BETWEEN STRATA MAY BE GRADUAL.

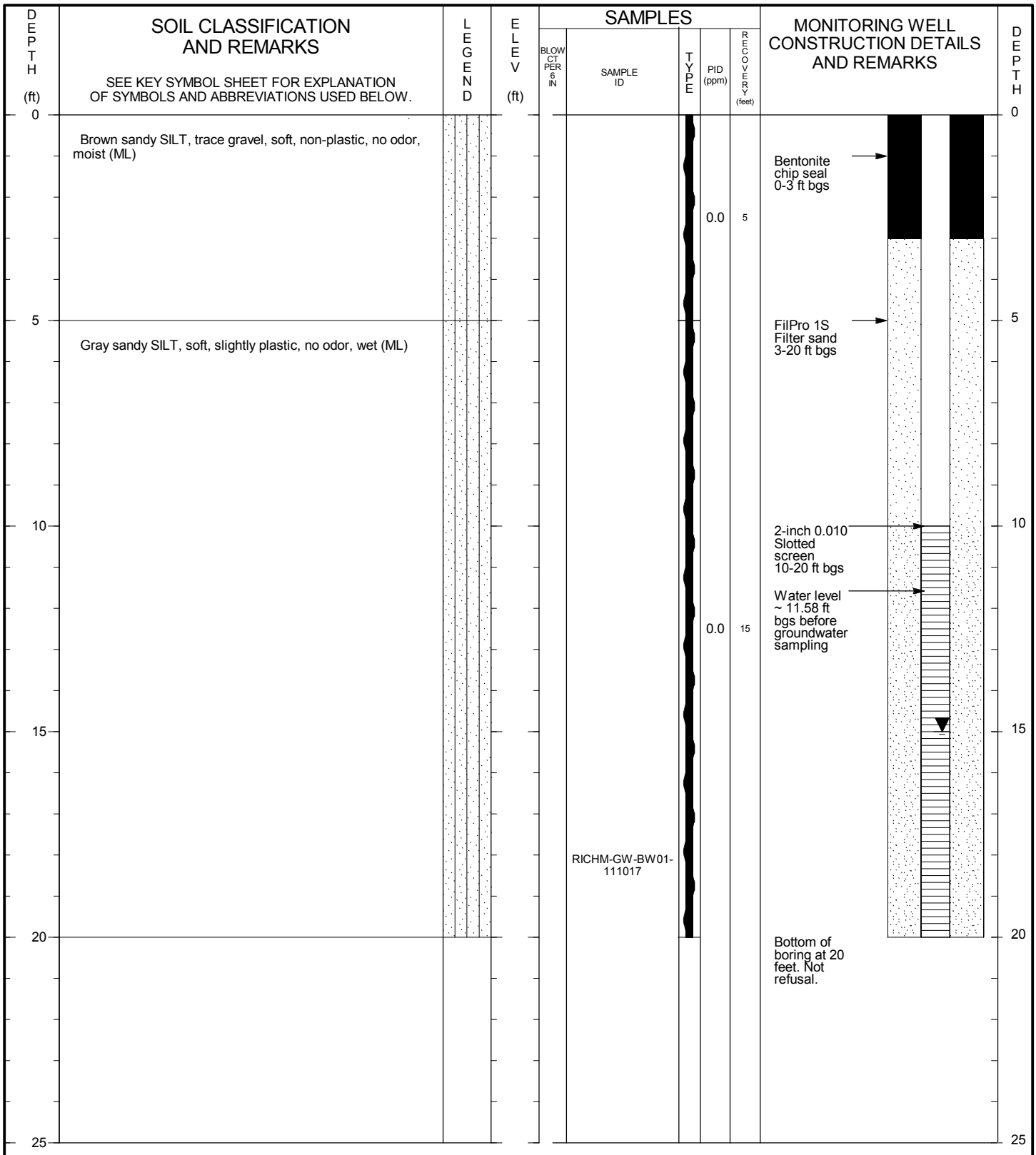
SOIL BORING / MONITORING WELL RECORD

Project: Richmond ANG FY16 Site Inspection for PFC
Project No: 291330006.07
Checked By: BL

Boring No. 05SB04

amec foster wheeler
271 Mill Road
Chelmsford, MA 01824

RICHMOND ANG LOG RICHMOND BORING LOGS.GPJ PFC TEMPLATE.GDT 2/2/18



START DATE:	11/9/2017	GROUND ELEVATION:	ft.
END DATE:	11/9/2017	VERTICAL DATUM:	
DRILLER:	TWS, Cascade	NORTHING:	3712030.353 ft.
EQUIPMENT:	Geoprobe 7822DT	EASTING:	11828845.99 ft.
METHOD:	Hollow Stem Auger	HORIZONTAL DATUM:	NAD 83
HOLE DIA.:	8-inch		
SITE:	RICHM		
LOGGED BY:	David Young		

THIS RECORD IS A REASONABLE INTERPRETATION OF SUBSURFACE CONDITIONS AT THE EXPLORATION LOCATION. SUBSURFACE CONDITIONS AT OTHER LOCATIONS AND AT OTHER TIMES MAY DIFFER. INTERFACES BETWEEN STRATA ARE APPROXIMATE. TRANSITIONS BETWEEN STRATA MAY BE GRADUAL.

SOIL BORING / MONITORING WELL RECORD

Project: Richmond ANG FY16 Site Inspection for PFC

Project No: 291330006.07

Checked By: BL

Boring No. BW-01

amec foster wheeler

271 Mill Road
Chelmsford, MA 01824

RICHMOND ANG LOG RICHMOND BORING LOGS.GPJ PFC TEMPLATE.GDT 2/2/18

DEPTH (ft)	SOIL CLASSIFICATION AND REMARKS SEE KEY SYMBOL SHEET FOR EXPLANATION OF SYMBOLS AND ABBREVIATIONS USED BELOW.	LEGEND	ELEV (ft)	SAMPLES: BLOW CT PER 6 IN	SAMPLE ID	TYPE	PID (ppm)	RECOVERY (feet)	MONITORING WELL CONSTRUCTION DETAILS AND REMARKS	DEPTH
0	Brown sandy SILT, soft, non-plastic, no odor, moist (ML)						0.0	7	Bentonite chip seal 0-3 ft bgs	0
5									FilPro 1S Filter sand 3-20 ft bgs	5
	Gray sandy SILT, soft, slightly plastic, no odor, wet (ML)								Water level ~ 8.62 ft bgs before groundwater sampling	
10									2-inch 0.010 Slotted screen 10-20 ft bgs	10
							0.0	13		
15										15
					RICHM-GW-BW02-110917					
20									Bottom of boring at 20 feet. Not refusal.	20
25										25

START DATE: 11/9/2017
END DATE: 11/9/2017
DRILLER: TWS, Cascade
EQUIPMENT: Geoprobe 7822DT
METHOD: Hollow Stem Auger
HOLE DIA.: 8-inch
SITE: RICHM
LOGGED BY: David Young

GROUND ELEVATION: ft.
VERTICAL DATUM:
NORTHING: 3711445.723 ft.
EASTING: 11829615.88 ft.
HORIZONTAL DATUM: NAD 83

THIS RECORD IS A REASONABLE INTERPRETATION OF SUBSURFACE CONDITIONS AT THE EXPLORATION LOCATION. SUBSURFACE CONDITIONS AT OTHER LOCATIONS AND AT OTHER TIMES MAY DIFFER. INTERFACES BETWEEN STRATA ARE APPROXIMATE. TRANSITIONS BETWEEN STRATA MAY BE GRADUAL.

SOIL BORING / MONITORING WELL RECORD

Project: Richmond ANG FY16 Site Inspection for PFC
Project No: 291330006.07
Checked By: BL

Boring No. BW-02

amec foster wheeler
271 Mill Road
Chelmsford, MA 01824

RICHMOND ANG LOG RICHMOND BORING LOGS.GPJ PFC TEMPLATE.GDT 2/2/18

DEPTH (ft)	SOIL CLASSIFICATION AND REMARKS SEE KEY SYMBOL SHEET FOR EXPLANATION OF SYMBOLS AND ABBREVIATIONS USED BELOW.	LEGEND	ELEV (ft)	SAMPLES: BLOW CT PER 6 IN	SAMPLE ID	TYPE	PID (ppm)	RECOVERY (feet)	MONITORING WELL CONSTRUCTION DETAILS AND REMARKS	DEPTH
0	Reddish brown fat CLAY, silty, stiff, slightly plastic, no odor, moist (CH)								Bentonite chip seal 0-3 ft bgs	0
5									FilPro 1S Filter sand 3-20 ft bgs	5
10							0.0	20	2-inch 0.010 Slotted screen 10-20 ft bgs	10
15									Water level ~ 16.04 ft bgs before groundwater sampling	15
20					RICHM-GW-TW01-110717 and RICHM-GW-DUP01				Bottom of boring at 20 feet. Not refusal.	20
25										25

START DATE: 11/6/2017
END DATE: 11/6/2017
DRILLER: TWS, Cascade
EQUIPMENT: Geoprobe 7822DT
METHOD: Hollow Stem Auger
HOLE DIA.: 8-inch
SITE: RICHM
LOGGED BY: David Young

GROUND ELEVATION: ft.
VERTICAL DATUM:
NORTHING: 3711140.988 ft.
EASTING: 11827860.59 ft.
HORIZONTAL DATUM: NAD 83

Note: Hand auger to 5 ft bgs; temporary well abandoned

THIS RECORD IS A REASONABLE INTERPRETATION OF SUBSURFACE CONDITIONS AT THE EXPLORATION LOCATION. SUBSURFACE CONDITIONS AT OTHER LOCATIONS AND AT OTHER TIMES MAY DIFFER. INTERFACES BETWEEN STRATA ARE APPROXIMATE. TRANSITIONS BETWEEN STRATA MAY BE GRADUAL.

SOIL BORING / MONITORING WELL RECORD

Project: Richmond ANG FY16 Site Inspection for PFC
Project No: 291330006.07
Checked By: BL

Well No. TW-01

amec foster wheeler
271 Mill Road
Chelmsford, MA 01824

RICHMOND ANG LOG RICHMOND BORING LOGS.GPJ PFC TEMPLATE.GDT 2/2/18

DEPTH (ft)	SOIL CLASSIFICATION AND REMARKS	LEGEND	ELEV (ft)	SAMPLES: BLOW CT PER 6 IN	SAMPLE ID	TYPE	PID (ppm)	RECOVERY (feet)	MONITORING WELL CONSTRUCTION DETAILS AND REMARKS	DEPTH
0	Reddish brown fat CLAY, silty, stiff, highly plastic, no odor, moist (CH)								Bentonite chip seal 0-3 ft bgs	0
5									FilPro 1S Filter sand 3-20 ft bgs	5
							0.0	16		
10									2-inch 0.010 Slotted screen 10-20 ft bgs	10
									Water level ~ 12.58 ft bgs before groundwater sampling	
15	Yellowish brown sandy SILT, very soft, non-plastic, no odor, wet (ML)									15
					RICHM-GW-TW03-110917		0.0	4		
20									Bottom of boring at 20 feet. Not refusal.	20
25										25

SEE KEY SYMBOL SHEET FOR EXPLANATION OF SYMBOLS AND ABBREVIATIONS USED BELOW.

START DATE:	11/8/2017	GROUND ELEVATION:	ft.
END DATE:	11/8/2017	VERTICAL DATUM:	
DRILLER:	TWS, Cascade	NORTHING:	3712280.422 ft.
EQUIPMENT:	Geoprobe 7822DT	EASTING:	11827018.34 ft.
METHOD:	Direct Push	HORIZONTAL DATUM:	NAD 83
HOLE DIA.:	8-inch		
SITE:	RICHM	Note: Temporary well abandoned	
LOGGED BY:	David Young		

THIS RECORD IS A REASONABLE INTERPRETATION OF SUBSURFACE CONDITIONS AT THE EXPLORATION LOCATION. SUBSURFACE CONDITIONS AT OTHER LOCATIONS AND AT OTHER TIMES MAY DIFFER. INTERFACES BETWEEN STRATA ARE APPROXIMATE. TRANSITIONS BETWEEN STRATA MAY BE GRADUAL.

SOIL BORING / MONITORING WELL RECORD

Project: Richmond ANG FY16 Site Inspection for PFC

Project No: 291330006.07 **Well No. TW-03**

Checked By: BL

amec foster wheeler

271 Mill Road
Chelmsford, MA 01824

RICHMOND ANG LOG RICHMOND BORING LOGS.GPJ PFC TEMPLATE.GDT 2/2/18

DEPTH (ft)	SOIL CLASSIFICATION AND REMARKS	LEGEND	ELEV (ft)	SAMPLES: BLOW CT PER 6 IN	SAMPLE ID	TYPE	PID (ppm)	RECOVERY (feet)	MONITORING WELL CONSTRUCTION DETAILS AND REMARKS	DEPTH
0	Yellowish brown fat CLAY, silty, stiff, highly plastic, no odor, moist (CH)								Bentonite chip seal 0-3 ft bgs	0
5									FilPro 1S Filter sand 3-20 ft bgs	5
10							0.0	20	2-inch 0.010 Slotted screen 10-20 ft bgs	10
15					RICHM-GW-TW04-110817				Water level ~ 15.05 ft bgs before groundwater sampling	15
20									Bottom of boring at 20 feet. Not refusal.	20
25										25

START DATE: 11/6/2017
END DATE: 11/6/2017
DRILLER: TWS, Cascade
EQUIPMENT: Geoprobe 7822DT
METHOD: Hollow Stem Auger
HOLE DIA.: 8-inch
SITE: RICHM
LOGGED BY: David Young

GROUND ELEVATION: ft.
VERTICAL DATUM:
NORTHING: 3710150.634 ft.
EASTING: 11827635.95 ft.
HORIZONTAL DATUM: NAD 83

Note: Hand auger to 4 ft bgs; temporary well abandoned

THIS RECORD IS A REASONABLE INTERPRETATION OF SUBSURFACE CONDITIONS AT THE EXPLORATION LOCATION. SUBSURFACE CONDITIONS AT OTHER LOCATIONS AND AT OTHER TIMES MAY DIFFER. INTERFACES BETWEEN STRATA ARE APPROXIMATE. TRANSITIONS BETWEEN STRATA MAY BE GRADUAL.

SOIL BORING / MONITORING WELL RECORD

Project: Richmond ANG FY16 Site Inspection for PFC
Project No: 291330006.07
Checked By: BL

Well No. TW-04

amec foster wheeler
271 Mill Road
Chelmsford, MA 01824

RICHMOND ANG LOG RICHMOND BORING LOGS.GPJ PFC TEMPLATE.GDT 2/2/18

APPENDIX C

WELL DEVELOPMENT LOGS

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WELL DEVELOPMENT LOG

Project Name:	Phase 1 Regional Site Inspections for Per-Fluorinated Compounds at Multiple Air National Guard Installations	**Project Number:**	291330006.07
Contract:	W9133L-14-D-0002	**Task Order:**	0006
Installation:	RICHM	**Date Started/Date Completed:**	11/09/17/11/09/17
Well ID:	BW-01	**Initial Depth to Water (ft):**	11.55
Measuring Point:	Top of Casing	**Total Depth of Well (ft):**	20.0
Development Method:	PUMPED	**Depth to Water After Purging (ft):**	16.95
Total Volume Purged (gal):	10	**1 Casing Volume (gal):**	1.4
Technician(s):	Sarah Levine	**3 Casing Volumes (gal):**	4.2

Date/Time	Intake Depth (feet)	Water Level (feet)	Rate (Gpm)	Temp. (°C)	pH (units)	Specific Electrical Conductance (mS/cm)	DO (mg/L)	ORP (mV)	Turbidity (NTU)	Cum. Volume (gal.)	Comments/Observations During Purging (color, sediment, etc.)
11/09/17 16:14			1.5								Pumping Started
11/09/17 16:19	19.5	16.35	1.5	18.91	5.28	0.112	2.29	38.6	Over	4	Brown, turbid
11/09/17 16:24	19.5	16.70	1.5	18.60	5.39	0.096	1.47	2.9	Over	8	Brown, turbid

Instruments (Manufacturer, Model, and Serial No.):

Equipment Calibrated (Y/N): Yes

Calibrated Within Criteria (Y/N): Yes

Turbidity Meter, Water Quality Meter, Water Level Meter
Hanna 98703 08J101227,
YSI 556 MPS H0006328

Calculations:

Saturated well casing volume: V= Π(R^2)H*7.48 gal/ft^3

V = Volume (gal/ft)
Π = 3.14
R = well radius (ft) = (well diameter (in)/12 (in/ft))/2)
H = height of water column (ft)

V= Π(R^2)H*7.48 gal/ft^3
=Π * (2.0 (in)/12 (in/ft))/2)^2 * 8.45 * 7.48 gal/ft^3
= 1.4 gal.

Signature:

Notes:

None

Name (print):

Sarah Levine

QA/QC'd by: dry

QA/QC Date: 1/2/2018

WELL DEVELOPMENT LOG

Project Name:	Phase 1 Regional Site Inspections for Per-Fluorinated Compounds at Multiple Air National Guard Installations	**Project Number:**	291330006.07
Contract:	W9133L-14-D-0002	**Task Order:**	0006
Installation:	RICHM	**Date Started/Date Completed:**	11/09/17/11/09/17
Well ID:	BW-02	**Initial Depth to Water (ft):**	7.7
Measuring Point:	Top of Casing	**Total Depth of Well (ft):**	20.0
Development Method:	PUMPED	**Depth to Water After Purging (ft):**	10.48
Total Volume Purged (gal):	9	**1 Casing Volume (gal):**	2.0
Technician(s):	Sarah Levine	**3 Casing Volumes (gal):**	6.1

Date/Time	Intake Depth (feet)	Water Level (feet)	Rate (Gpm)	Temp. (°C)	pH (units)	Specific Electrical Conductance (mS/cm)	DO (mg/L)	ORP (mV)	Turbidity (NTU)	Cum. Volume (gal.)	Comments/Observations During Purging (color, sediment, etc.)
11/09/17 12:55			1.5								Pumping Started
11/09/17 13:00	19.5	8.95	1.5	16.45	4.68	0.151	7.95	45.1	Over	4	Light brown, turbid
11/09/17 13:05	19.5	9.36	1.5	16.26	5.12	0.161	6.58	25.2	226	8	Light brown, cloudy

Instruments (Manufacturer, Model, and Serial No.):

Equipment Calibrated (Y/N): Yes Calibrated Within Criteria (Y/N): Yes

Turbidity Meter, Water Quality Meter, Water Level Meter
Hanna 98703 08J101227,
YSI 556 MPS H0006328

Calculations:

Saturated well casing volume: V= Π(R^2)H*7.48 gal/ft^3

V = Volume (gal/ft)
Π = 3.14
R = well radius (ft) = (well diameter (in)/12 (in/ft))/2)
H = height of water column (ft)

V= Π(R^2)H*7.48 gal/ft^3
=Π * (2.0 (in)/12 (in/ft))/2)^2 * 12.30 * 7.48 gal/ft^3
= 2.0 gal.

Signature:

Notes:

Purged with submersible Waterspout 1 complete.

Name (print):

Sarah Levine

QA/QC'd by: dry **QA/QC Date:** 1/2/2018

WELL DEVELOPMENT LOG

Project Name:	Phase 1 Regional Site Inspections for Per-Fluorinated Compounds at Multiple Air National Guard Installations	**Project Number:**	291330006.07
Contract:	W9133L-14-D-0002	**Task Order:**	0006
Installation:	RICHM	**Date Started/Date Completed:**	11/06/17/11/06/17
Well ID:	TW-01	**Initial Depth to Water (ft):**	16.05
Measuring Point:	Top of Casing	**Total Depth of Well (ft):**	20.0
Development Method:	PUMPED	**Depth to Water After Purging (ft):**	Dry
Total Volume Purged (gal):	4.5	**1 Casing Volume (gal):**	0.6
Technician(s):	Sarah Levine	**3 Casing Volumes (gal):**	1.9

Date/Time	Intake Depth (feet)	Water Level (feet)	Rate (Gpm)	Temp. (°C)	pH (units)	Specific Electrical Conductance (mS/cm)	DO (mg/L)	ORP (mV)	Turbidity (NTU)	Cum. Volume (gal.)	Comments/Observations During Purging (color, sediment, etc.)
11/06/17 15:53			1.5								Pumping Started
11/06/17 15:56	19.5	Na	1.5	Na	Na	Na	Na	Na	Na	1.5	Brown, very turbid
11/06/17 16:00	19.5	16.55	Na	Na	Na	Na	Na	Na	Na	1.5	Brown, turbid
11/06/17 16:01	19.5	Na	1.5	20.10	3.88	0.046	5.89	84.9	Over	3	Brown, turbid
11/06/17 16:09	19.5	16.4	Na	Na	Na	Na	Na	Na	Na	3	Light brown, turbid
11/06/17 16:11	19.5	Na	Na	Na	Na	Na	Na	Na	Na	4.5	Light brown, turbid

Instruments (Manufacturer, Model, and Serial No.):

Equipment Calibrated (Y/N): Yes

Calibrated Within Criteria (Y/N): Yes

Turbidity Meter, Water Quality Meter, Water Level Meter
Hanna 98703 H0006328,
YSI 556 MPS 08J101227

Calculations:

Saturated well casing volume: V= Π(R^2)H*7.48 gal/ft^3

V = Volume (gal/ft)
Π = 3.14
R = well radius (ft) = (well diameter (in)/12 (in/ft))/2)
H = height of water column (ft)

V= Π(R^2)H*7.48 gal/ft^3
=Π * (2.0 (in)/12 (in/ft))/2)^2 * 3.95 * 7.48 gal/ft^3
= 0.6 gal.

Signature:

Notes:

Pump well dry and allowed to recharge in 1-2 minute intervals.

Name (print):

Sarah Levine

QA/QC'd by: dry

QA/QC Date: 1/2/2018

WELL DEVELOPMENT LOG

Project Name:	Phase 1 Regional Site Inspections for Per-Fluorinated Compounds at Multiple Air National Guard Installations	**Project Number:**	291330006.07
Contract:	W9133L-14-D-0002	**Task Order:**	0006
Installation:	RICHM	**Date Started/Date Completed:**	11/07/17/11/07/17
Well ID:	TW-02	**Initial Depth to Water (ft):**	17.65
Measuring Point:	Top of Casing	**Total Depth of Well (ft):**	20.0
Development Method:	PUMPED	**Depth to Water After Purging (ft):**	19.78
Total Volume Purged (gal):	4	**1 Casing Volume (gal):**	0.4
Technician(s):	Sarah Levine	**3 Casing Volumes (gal):**	1.2

Date/Time	Intake Depth (feet)	Water Level (feet)	Rate (Gpm)	Temp. (°C)	pH (units)	Specific Electrical Conductance (mS/cm)	DO (mg/L)	ORP (mV)	Turbidity (NTU)	Cum. Volume (gal.)	Comments/Observations During Purging (color, sediment, etc.)
11/07/17 13:02			1.5								Pumping Started
11/07/17 13:02	19.5	17.65	1.5	17.67	5.16	0.084	10.07	128.0	165	1	Light brown tint
11/07/17 13:03	19.5	Na	Na	Na	Na	Na	Na	Na	Na	1	Dry
11/07/17 13:09	19.5	18.82	1.5	17.42	4.94	0.065	6.83	66.2	158	1.5	Light brown
11/07/17 13:11	19.5	Na	Na	Na	Na	Na	Na	Na	Na	1.5	Dry
11/07/17 13:19	19.5	18.64	1.5	17.48	4.96	0.064	6.20	46.2	1.8	3	Light brown tint
11/07/17 13:21	19.5	Na	Na	Na	Na	Na	Na	Na	Na	3	Dry

Instruments (Manufacturer, Model, and Serial No.):

Equipment Calibrated (Y/N): Yes Calibrated Within Criteria (Y/N): Yes

Turbidity Meter, Water Quality Meter, Water Level Meter
Hanna 98703 08J101227,
YSI 556 MPS H0006328

Calculations:

Saturated well casing volume: V= Π(R^2)H*7.48 gal/ft^3

V = Volume (gal/ft)
Π = 3.14
R = well radius (ft) = (well diameter (in)/12 (in/ft))/2)
H = height of water column (ft)

V= Π(R^2)H*7.48 gal/ft^3
=Π * (2.0 (in)/12 (in/ft))/2)^2 * 2.35 * 7.48 gal/ft^3
= 0.4 gal.

Signature:

Notes:

Pumped dry intermittantly at approx 1.5 gpm.

Name (print):

Sarah Levine

QA/QC'd by: dry **QA/QC Date:** 1/2/2018

WELL DEVELOPMENT LOG

Project Name:	Phase 1 Regional Site Inspections for Per-Fluorinated Compounds at Multiple Air National Guard Installations	**Project Number:**	291330006.07
Contract:	W9133L-14-D-0002	**Task Order:**	0006
Installation:	RICHM	**Date Started/Date Completed:**	11/09/17/11/09/17
Well ID:	TW-03	**Initial Depth to Water (ft):**	12.4
Measuring Point:	Top of Casing	**Total Depth of Well (ft):**	20.0
Development Method:	PUMPED	**Depth to Water After Purging (ft):**	19.04
Total Volume Purged (gal):	8	**1 Casing Volume (gal):**	1.2
Technician(s):	Sarah Levine	**3 Casing Volumes (gal):**	3.7

Date/Time	Intake Depth (feet)	Water Level (feet)	Rate (Gpm)	Temp. (°C)	pH (units)	Specific Electrical Conductance (mS/cm)	DO (mg/L)	ORP (mV)	Turbidity (NTU)	Cum. Volume (gal.)	Comments/Observations During Purging (color, sediment, etc.)
11/09/17 10:57			1.5								Pumping Started
11/09/17 10:59	19.5	17.55	1.5	Na	Na	Na	Na	Na	Over	3.5	Light brown, turbid
11/09/17 11:01	19.5	Na	1.5	17.83	5.64	0.047	3.22	47.1	Over	5	Dry. Stop
11/09/17 11:06	19.5	15.25	1.5	Na	Na	Na	Na	Na	Over	6	Start. Light brown, turbid
11/09/17 11:07	19.5	Na	1.5	16.90	5.52	0.048	4.42	49.3	Over	6	Dry
11/09/17 11:11	19.5	16.08	1.5	Na	Na	Na	Na	Na	Over	8	Turbid

Instruments (Manufacturer, Model, and Serial No.):

Equipment Calibrated (Y/N): Yes Calibrated Within Criteria (Y/N): Yes

Turbidity Meter, Water Quality Meter, Water Level Meter
Hanna 98703 08J101227,
YSI 556 MPS H0006328

Calculations:

Saturated well casing volume: V= Π(R^2)H*7.48 gal/ft^3

V = Volume (gal/ft)
Π = 3.14
R = well radius (ft) = (well diameter (in)/12 (in/ft))/2)
H = height of water column (ft)

V= Π(R^2)H*7.48 gal/ft^3
=Π * (2.0 (in)/12 (in/ft))/2)^2 * 7.60 * 7.48 gal/ft^3
= 1.2 gal.

Signature:

Notes:

Purged with submersible Waterspout 1 Complete.

Name (print):

Sarah Levine

QA/QC'd by: dry **QA/QC Date:** 1/2/2018

WELL DEVELOPMENT LOG

Project Name:	Phase 1 Regional Site Inspections for Per-Fluorinated Compounds at Multiple Air National Guard Installations	**Project Number:**	291330006.07
Contract:	W9133L-14-D-0002	**Task Order:**	0006
Installation:	RICHM	**Date Started/Date Completed:**	11/06/17/11/06/17
Well ID:	TW-04	**Initial Depth to Water (ft):**	15.25
Measuring Point:	Top of Casing	**Total Depth of Well (ft):**	20.0
Development Method:	PUMPED	**Depth to Water After Purging (ft):**	19.24
Total Volume Purged (gal):	3.5	**1 Casing Volume (gal):**	0.8
Technician(s):	Sarah Levine	**3 Casing Volumes (gal):**	2.3

Date/Time	Intake Depth (feet)	Water Level (feet)	Rate (Gpm)	Temp. (°C)	pH (units)	Specific Electrical Conductance (mS/cm)	DO (mg/L)	ORP (mV)	Turbidity (NTU)	Cum. Volume (gal.)	Comments/Observations During Purging (color, sediment, etc.)
11/06/17 12:29			1.5 gpm								Pumping Started
11/06/17 12:34	19.5	Na	Na	Na	Na	Na	Na	Na	Over	1.5	Pump stop. Brown, turbid
11/06/17 12:38	19.5	18.35	1.5	20.81	3.98	.074	4.76	249.6	Over	2.5	Brown, turnid
11/06/17 12:39	19.5	18.96	Na	Na	Na	Na	Na	Na	Ns	Na	Stop
11/06/17 12:48	19.5	19.31	1.5	21.19	3.52	0.043	5.10	160.0	Over	3.5	Light brown, turbid
11/06/17 12:50											Stop

Instruments (Manufacturer, Model, and Serial No.):

Equipment Calibrated (Y/N): Yes

Calibrated Within Criteria (Y/N): Yes

Turbidity Meter, Water Quality Meter, Water Level Meter
Hanna 98703 08J101227,
YSI 556 MPS H0006328

Calculations:

Saturated well casing volume: V= Π(R^2)H*7.48 gal/ft^3

V = Volume (gal/ft)
Π = 3.14
R = well radius (ft) = (well diameter (in)/12 (in/ft))/2)
H = height of water column (ft)

V= Π(R^2)H*7.48 gal/ft^3
=Π * (2.0 (in)/12 (in/ft))/2)^2 * 4.75 * 7.48 gal/ft^3
= 0.8 gal.

Signature:

Notes:

Intermittant flow during development. Well ran dry in approx 2 minutes. Waited 5 min for recharge and restarted pump. Purged dry repeatedly at approx 1.5gpm using a submersible Waterspout 1 Complete pump.

Name (print):

Sarah Levine

QA/QC'd by: dry

QA/QC Date: 1/2/2018

WELL DEVELOPMENT LOG

Project Name:	Phase 1 Regional Site Inspections for Per-Fluorinated Compounds at Multiple Air National Guard Installations	**Project Number:**	291330006.07
Contract:	W9133L-14-D-0002	**Task Order:**	0006
Installation:	RICHM	**Date Started/Date Completed:**	11/06/17/11/06/17
Well ID:	TMW-37	**Initial Depth to Water (ft):**	17.8
Measuring Point:	Top of Casing	**Total Depth of Well (ft):**	27.0
Development Method:	PUMPED	**Depth to Water After Purging (ft):**	24.35
Total Volume Purged (gal):	6	**1 Casing Volume (gal):**	1.5
Technician(s):	Sarah Levine	**3 Casing Volumes (gal):**	4.5

Date/Time	Intake Depth (feet)	Water Level (feet)	Rate (Gpm)	Temp. (°C)	pH (units)	Specific Electrical Conductance (mS/cm)	DO (mg/L)	ORP (mV)	Turbidity (NTU)	Cum. Volume (gal.)	Comments/Observations During Purging (color, sediment, etc.)
11/06/17 13:22			1.5								Pumping Started
11/06/17 13:24	26.5	17.75	Na	Na	Na	Na	Na	Na	Na	3	Brown, turbid
11/06/17 13:26	26.5	24.78	1.5	21.41	3.78	0.036	4.57	87.3	203	3	Light brown, turbid
11/06/17 13:29	26.5	18.60	Na	Na	Na	Na	Na	Na	Na	6	Brown, turbid
11/06/17 13:31	26.5	24.10	1.5	21.14	3.20	0.030	3.07	125.1	Over	6	Brown, turbid

Instruments (Manufacturer, Model, and Serial No.):

Equipment Calibrated (Y/N): Yes — Calibrated Within Criteria (Y/N): Yes

Turbidity Meter, Water Quality Meter, Water Level Meter
Hanna 98703 H0006328,
YSI 556 MPS 08J101227

Calculations:

Saturated well casing volume: V= Π(R^2)H*7.48 gal/ft^3

V = Volume (gal/ft)
Π = 3.14
R = well radius (ft) = (well diameter (in)/12 (in/ft))/2)
H = height of water column (ft)

V= Π(R^2)H*7.48 gal/ft^3
=Π * (2.0 (in)/12 (in/ft))/2)^2 * 9.20 * 7.48 gal/ft^3
= 1.5 gal.

Signature:

Notes:

Well purged using submersible Waterspout 1 Complete at approx 1.5gpm. High recharge

Name (print):

Sarah Levine

QA/QC'd by: dry **QA/QC Date:** 1/2/2018

WELL DEVELOPMENT LOG

Project Name:	Phase 1 Regional Site Inspections for Per-Fluorinated Compounds at Multiple Air National Guard Installations	**Project Number:**	291330006.07
Contract:	W9133L-14-D-0002	**Task Order:**	0006
Installation:	RICHM	**Date Started/Date Completed:**	11/09/17/11/09/17
Well ID:	MW-01-36	**Initial Depth to Water (ft):**	13.3
Measuring Point:	Top of Casing	**Total Depth of Well (ft):**	29.15
Development Method:	PUMPED	**Depth to Water After Purging (ft):**	17.18
Total Volume Purged (gal):	12.5	**1 Casing Volume (gal):**	3.6
Technician(s):	Sarah Levine	**3 Casing Volumes (gal):**	10.9

Date/Time	Intake Depth (feet)	Water Level (feet)	Rate (Gpm)	Temp. (°C)	pH (units)	Specific Electrical Conductance (mS/cm)	DO (mg/L)	ORP (mV)	Turbidity (NTU)	Cum. Volume (gal.)	Comments/Observations During Purging (color, sediment, etc.)
11/09/17 11:31			1.5								Pumping Started
11/09/17 11:33	29	16.95	1.5	15.25	4.05	0.032	2.19	113.0	Over	4	Brown, turbid
11/09/17 11:38	29	17.03	1.5	15.40	4.35	0.031	2.67	87.7	206	8	Cloudy
11/09/17 11:43	29	17.14	1.5	15.36	4.40	0.032	2.93	77.4	95.9	12	Cloudy

Instruments (Manufacturer, Model, and Serial No.):

Equipment Calibrated (Y/N): Yes Calibrated Within Criteria (Y/N): Yes

Turbidity Meter, Water Quality Meter, Water Level Meter
Hanna 98703 08J101227,
YSI 556 MPS H0006328

Calculations:

Saturated well casing volume: V= Π(R^2)H*7.48 gal/ft^3

V = Volume (gal/ft)
Π = 3.14
R = well radius (ft) = (well diameter (in)/12 (in/ft))/2)
H = height of water column (ft)

V= Π(R^2)H*7.48 gal/ft^3
=Π * (2.0 (in)/12 (in/ft))/2)^2 * 22.20 * 7.48 gal/ft^3
= 3.6 gal.

Signature:

Notes:

Purged with submersible Waterspout 1 Complete.

Name (print):

Sarah Levine

QA/QC'd by: dry **QA/QC Date:** 1/2/2018

APPENDIX D

GROUNDWATER SAMPLING LOGS

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GROUNDWATER SAMPLING RECORD

Project Name:	Phase 1 Regional Site Inspections for Per-Fluorinated Compounds at Multiple Air National Guard Installations	**Project Number:**	291330006.07
Contract:	W9133L-14-D-0002	**Task Order:**	0006
Installation:	RICHM	**Technician(s):**	Sarah Levine
Well ID:	BW-01	**Date:**	11/10/17
Initial Depth to Water (ft):	11.58	**Well Diameter (in):**	2.0
Total Depth of Well (ft):	20.0	**1 Casing Volume (gal):**	1.4
Method of Purging:	Peri-pump	**3 Casing Volumes (gal):**	4.1
Measuring Point (toc, tor, etc.):	Top of Casing	**Pump Intake Depth (feet):**	18

Time	Water Level (feet)	Flow Rate (Gpm)	Cum. Volume (gal.)	Temp. (°C)	pH (SU)	Specific Electrical Conductance (mS/cm)	DO (mg/L)	ORP (mV)	Turbidity (NTU)	Comments/Observations During Purging (color, sediment, odor, etc.)
Stabilization Criteria				±0.5°C	±0.1	±3%	±10%	±10%	±10% and <10 NTU	
08:02		0.034								Pumping/Purging Started
08:06	11.68	0.034	.136	16.89	6.23	0.124	1.54	63.7	-	Clear
08:10	11.68	0.034	.272	16.82	5.90	0.107	1.36	66.7	-	Clear
08:14	11.65	0.034	.408	16.76	5.67	0.099	1.14	69.6	-	Clear
08:18	11.65	0.034	.544	16.65	5.49	0.096	1.06	73.1	-	Clear
08:22	11.65	0.034	.680	16.92	5.36	0.093	1.00	72.4	-	Clear
08:26	11.65	0.034	.816	17.13	5.41	0.093	1.01	62.3	-	Clear
08:30	11.65	0.034	.952	17.23	5.43	0.091	0.92	52.5	-	Clear
08:34	11.65	0.034	1.088	17.22	5.38	0.091	0.86	44.4	-	Clear
08:38	11.65	0.034	1.224	17.51	5.30	0.090	0.82	31.0	-	Clear
08:42	11.65	0.034	1.36	17.52	5.26	0.089	0.80	28.7	-	Clear
08:46	11.65	0.034	1.496	17.49	5.23	0.088	0.79	25.8	4.87	Clear

Stability Reached (Y/N): Yes — If No, Provide Explanation: NA

Final Values:	**17.49**	**5.23**	**0.088**	**0.79**	**25.8**	**4.87**	

Sample ID:	RICHM-GW-BW01-111017	**Method of Sampling:**	Low flow, Peri-pump
QA/QC Samples (Yes/No):	No	**Sample Date:**	11/10/17
Duplicate ID:	NA	**Sample Collection Time:**	08:50
Sample Container Type(s):	125 ml HDPE	**Total Volume Purged (gal):**	1.5
Preservative(s):	Ice (4 °C)	**Sample Depth (ft):**	18
Analysis/Method(s):	UCMR3 List	**Depth to Water After Sampling (ft):**	11.65

Instruments (Manufacturer, Model, and Serial No.):

Equipment Calibrated (Y/N): Yes — Calibrated Within Criteria (Y/N): Yes

Turbidity Meter, Water Quality Meter, Water Level Meter, Peristaltic Pump
Hanna 98703 H0006328, YSI 556 MPS 08J101227

Calculations:

Saturated well casing volume: V= Π(R^2)H*7.48 gal/ft^3

V=Volume (gal/ft)
Π = 3.14
R = well radius (ft) = (well diameter (in)/12 (in/ft))/2)
H = height of water column (ft)

V= Π(R^2)H*7.48 gal/ft^3
= Π * (2.0 (in)/12 (in/ft))/2)^2 * 8.42 * 7.48 gal/ft^3
= 1.4 gal.

Signature:

Notes:

Initial problem with turbidimeter reading low turbidities. Fixed by sample collection. Turbidity reading at sample collection: 4.87

Name (print): Sarah Levine

QA/QC'd by: dry — **QA/QC Date:** 1/2/2018

GROUNDWATER SAMPLING RECORD

Project Name:	Phase 1 Regional Site Inspections for Per-Fluorinated Compounds at Multiple Air National Guard Installations	**Project Number:**	291330006.07
Contract:	W9133L-14-D-0002	**Task Order:**	0006
Installation:	RICHM	**Technician(s):**	Sarah Levine
Well ID:	BW-02	**Date:**	11/09/17
Initial Depth to Water (ft):	8.62	**Well Diameter (in):**	2.0
Total Depth of Well (ft):	20.0	**1 Casing Volume (gal):**	1.9
Method of Purging:	Peri-pump	**3 Casing Volumes (gal):**	5.6
Measuring Point (toc, tor, etc.):	Top of Casing	**Pump Intake Depth (feet):**	18

Time	Water Level (feet)	Flow Rate (Gpm)	Cum. Volume (gal.)	Temp. (°C)	pH (SU)	Specific Electrical Conductance (mS/cm)	DO (mg/L)	ORP (mV)	Turbidity (NTU)	Comments/Observations During Purging (color, sediment, odor, etc.)
Stabilization Criteria				±0.5°C	±0.1	±3%	±10%	±10%	±10% and <10 NTU	
13:29		0.044								Pumping/Purging Started
13:33	7.65	0.044	0.178	16.47	4.99	0.162	2.58	28.9	431	Cloudy, light brown tint
13:37	7.68	0.044	.355	16.56	4.93	0.158	2.56	21.2	169	Cloudy
13:41	7.67	0.044	.533	16.59	4.86	0.156	2.48	21.5	99.7	Cloudy
13:45	7.65	0.044	.711	16.62	4.81	0.156	2.42	25.7	58.5	Clear
13:49	7.65	0.044	.889	16.69	4.76	0.154	2.32	27.1	52.9	Clear
13:53	7.65	0.044	1.06	16.72	4.74	0.151	2.22	28.3	40.6	Clear
13:57	7.65	0.044	1.24	16.71	4.70	0.150	2.24	29.7	29.3	Clear
14:01	7.65	0.044	1.42	16.71	4.64	0.146	2.22	31.8	18.8	Clear
14:05	7.65	0.044	1.60	16.68	4.61	0.144	2.19	33.1	15.1	Clear
14:09	7.65	0.044	1.78	16.68	4.59	0.143	2.16	32.9	12.4	Clear
14:13	7.65	0.044	1.95	16.67	4.57	0.142	2.14	32.3	9.58	Clear

Stability Reached (Y/N): Yes — If No, Provide Explanation: NA

Final Values:	**16.67**	**4.57**	**0.142**	**2.14**	**32.3**	**9.58**	

Sample ID:	RICHM-GW-BW02-110917	**Method of Sampling:**	Low flow, Peri-pump
QA/QC Samples (Yes/No):	No	**Sample Date:**	11/09/17
Duplicate ID:	NA	**Sample Collection Time:**	14:15
Sample Container Type(s):	125 ml HDPE	**Total Volume Purged (gal):**	2
Preservative(s):	Ice (4 °C)	**Sample Depth (ft):**	18
Analysis/Method(s):	UCMR3 List	**Depth to Water After Sampling (ft):**	7.65

Instruments (Manufacturer, Model, and Serial No.):

Equipment Calibrated (Y/N): Yes — Calibrated Within Criteria (Y/N): Yes

Turbidity Meter, Water Quality Meter, Water Level Meter, Peristaltic Pump
Hanna 98703 H0006328, YSI 556 MPS 08J101227

Calculations:

Saturated well casing volume: V= Π(R^2)H*7.48 gal/ft^3

V=Volume (gal/ft)
Π = 3.14
R = well radius (ft) = (well diameter (in)/12 (in/ft))/2)
H = height of water column (ft)

V= Π(R^2)H*7.48 gal/ft^3
= Π * (2.0 (in)/12 (in/ft))/2)^2 * 11.38 * 7.48 gal/ft^3
= 1.9 gal.

Signature:

Notes:

None

Name (print): Sarah Levine

QA/QC'd by: dry — **QA/QC Date:** 1/2/2018

GROUNDWATER SAMPLING RECORD

amec foster wheeler

Project Name:	Phase 1 Regional Site Inspections for Per-Fluorinated Compounds at Multiple Air National Guard Installations	**Project Number:**	291330006.07
Contract:	W9133L-14-D-0002	**Task Order:**	0006
Installation:	RICHM	**Technician(s):**	Sarah Levine
Well ID:	TW-01	**Date:**	11/07/17
Initial Depth to Water (ft):	16.04	**Well Diameter (in):**	2.0
Total Depth of Well (ft):	20.0	**1 Casing Volume (gal):**	0.6
Method of Purging:	Peri-pump	**3 Casing Volumes (gal):**	1.9
Measuring Point (toc, tor, etc.):	Top of Casing	**Pump Intake Depth (feet):**	18

Time	Water Level (feet)	Flow Rate (Gpm)	Cum. Volume (gal.)	Temp. (°C)	pH (SU)	Specific Electrical Conductance (mS/cm)	DO (mg/L)	ORP (mV)	Turbidity (NTU)	Comments/Observations During Purging (color, sediment, odor, etc.)
		Stabilization Criteria		±0.5°C	±0.1	±3%	±10%	±10%	±10% and <10 NTU	
11:15		0.04								Pumping/Purging Started
11:20	16.34	0.04	.16	17.26	5.67	0.067	5.07	146.2	59.8	Fairly clear
11:24	16.36	0.04	.32	17.66	5.34	0.065	4.90	139.4	24.9	Clear
11:28	16.37	0.04	.48	17.68	5.22	0.064	4.76	101.0	18.8	Clear
11:32	16.37	0.04	.64	17.64	5.09	0.062	4.70	75.4	10.8	Clear
11:36	16.73	0.04	.80	17.68	4.98	0.060	4.65	61.2	6.78	Clear
11:40	16.37	0.04	.96	17.78	4.94	0.055	4.39	48.7	4.01	Clear
11:44	16.37	0.04	1.12	17.75	4.86	0.054	4.41	45.5	2.42	Clear
11:48	16.37	0.04	1.28	17.73	4.79	0.052	4.34	46.4	1.99	Clear
11:52	16.37	0.04	1.44	17.71	4.74	0.052	4.28	498.1	1.70	Clear
Stability Reached (Y/N):			Yes		If No, Provide Explanation					NA
			Final Values:	**17.71**	**4.74**	**0.052**	**4.28**	**498.1**	**1.70**	

Sample ID:	RICHM-GW-TW01-110717	**Method of Sampling:**	Low flow, Peri-pump
QA/QC Samples (Yes/No):	Yes DUP, MS/MSD	**Sample Date:**	11/07/17
Duplicate ID:	RICHM-GW-DUP01-110717	**Sample Collection Time:**	12:00
Sample Container Type(s):	125ml HDPE	**Total Volume Purged (gal):**	1.5
Preservative(s):	Ice (4 °C)	**Sample Depth (ft):**	18
Analysis/Method(s):	UCMR3 List	**Depth to Water After Sampling (ft):**	16.25

Instruments (Manufacturer, Model, and Serial No.):

Equipment Calibrated (Y/N): Yes   Calibrated Within Criteria (Y/N): Yes

Turbidity Meter, Water Quality Meter, Water Level Meter, Peristaltic Pump
Hanna 98703 H0006328, YSI 556 MPS 08J101227

Calculations:

Saturated well casing volume: V= Π(R^2)H*7.48 gal/ft^3

V=Volume (gal/ft)
Π = 3.14
R = well radius (ft) = (well diameter (in)/12 (in/ft))/2)
H = height of water column (ft)

V= Π(R^2)H*7.48 gal/ft^3
= Π * (2.0 (in)/12 (in/ft))/2)^2 * 3.96 * 7.48 gal/ft^3
= 0.6 gal.

Signature:

Notes:

None

Name (print):

Sarah Levine

QA/QC'd by: dry   **QA/QC Date:** 1/2/2018

GROUNDWATER SAMPLING RECORD

Project Name:	Phase 1 Regional Site Inspections for Per-Fluorinated Compounds at Multiple Air National Guard Installations	**Project Number:**	291330006.07
Contract:	W9133L-14-D-0002	**Task Order:**	0006
Installation:	RICHM	**Technician(s):**	Sarah Levine
Well ID:	TW-02	**Date:**	11/07/17
Initial Depth to Water (ft):	18.25	**Well Diameter (in):**	2.0
Total Depth of Well (ft):	20.0	**1 Casing Volume (gal):**	0.3
Method of Purging:	Peri-Pump	**3 Casing Volumes (gal):**	0.9
Measuring Point (toc, tor, etc.):	Top of Casing	**Pump Intake Depth (feet):**	18.5

Time	Water Level (feet)	Flow Rate (Gpm)	Cum. Volume (gal.)	Temp. (°C)	pH (SU)	Specific Electrical Conductance (mS/cm)	DO (mg/L)	ORP (mV)	Turbidity (NTU)	Comments/Observations During Purging (color, sediment, odor, etc.)
Stabilization Criteria				±0.5°C	±0.1	±3%	±10%	±10%	±10% and <10 NTU	
13:57		0.06								Pumping/Purging Started
14:02	18.29	0.06	.24	19.10	4.90	0.061	5.29	37.3	16.6	Clear
14:06	18.35	0.06	.48	19.36	4.87	0.062	5.15	38.2	12.9	Clear
14:10	18.39	0.06	.72	19.46	4.76	0.062	5.08	37.2	10.7	Clear
14:14	18.41	0.06	.96	19.48	4.64	0.062	5.29	39.5	9.24	Clear
14:18	18.44	0.06	1.2	19.55	4.59	0.062	5.22	40.0	7.02	Clear
14:22	18.46	0.06	1.44	19.55	4.57	0.062	5.19	38.6	5.83	Clear

Stability Reached (Y/N): Yes — If No, Provide Explanation: NA

Final Values:	**19.55**	**4.57**	**0.062**	**5.19**	**38.6**	**5.83**

Sample ID:	RICHM-GW-TW02-110717	**Method of Sampling:**	Low flow, Peri-pump
QA/QC Samples (Yes/No):	No	**Sample Date:**	11/07/17
Duplicate ID:	NA	**Sample Collection Time:**	14:30
Sample Container Type(s):	125 ml HDPE	**Total Volume Purged (gal):**	1.5
Preservative(s):	Ice (4 °C)	**Sample Depth (ft):**	18.5
Analysis/Method(s):	UCMR3 List	**Depth to Water After Sampling (ft):**	18.38

Instruments (Manufacturer, Model, and Serial No.):

Equipment Calibrated (Y/N): Yes — Calibrated Within Criteria (Y/N): Yes

Turbidity Meter, Water Quality Meter, Water Level Meter, Peristaltic Pump
Hanna 98703 H0006328, YSI 556 MPS 08J101227

Calculations:

Saturated well casing volume: V= Π(R^2)H*7.48 gal/ft^3

V=Volume (gal/ft)
Π = 3.14
R = well radius (ft) = (well diameter (in)/12 (in/ft))/2)
H = height of water column (ft)

V= Π(R^2)H*7.48 gal/ft^3
= Π * (2.0 (in)/12 (in/ft))/2)^2 * 1.75 * 7.48 gal/ft^3
= 0.3 gal.

Signature:

Notes:

None

Name (print): Sarah Levine

QA/QC'd by: dry — **QA/QC Date:** 1/2/2018

GROUNDWATER SAMPLING RECORD

Project Name:	Phase 1 Regional Site Inspections for Per-Fluorinated Compounds at Multiple Air National Guard Installations	**Project Number:**	291330006.07
Contract:	W9133L-14-D-0002	**Task Order:**	0006
Installation:	RICHM	**Technician(s):**	Sarah Levine
Well ID:	TW-03	**Date:**	11/09/17
Initial Depth to Water (ft):	12.58	**Well Diameter (in):**	2.0
Total Depth of Well (ft):	20.0	**1 Casing Volume (gal):**	1.2
Method of Purging:	Peri-pump	**3 Casing Volumes (gal):**	3.7
Measuring Point (toc, tor, etc.):	Top of Casing	**Pump Intake Depth (feet):**	18

Time	Water Level (feet)	Flow Rate (Gpm)	Cum. Volume (gal.)	Temp. (°C)	pH (SU)	Specific Electrical Conductance (mS/cm)	DO (mg/L)	ORP (mV)	Turbidity (NTU)	Comments/Observations During Purging (color, sediment, odor, etc.)
Stabilization Criteria				±0.5°C	±0.1	±3%	±10%	±10%	±10% and <10 NTU	
15:05		0.029								Pumping/Purging Started
15:07	12.55	0.029	.057	18.21	4.97	0.039	4.06	54.8	10.5	Clear
15:11	12.55	0.029	.171	18.55	5.09	0.037	2.89	24.3	61.3	Clear
15:15	12.55	0.029	.285	18.68	4.94	0.036	2.00	10.0	26.0	Clear
15:19	12.55	0.029	.399	18.59	4.81	0.037	1.89	17.8	15.0	Clear
15:23	12.55	0.029	.513	18.58	4.68	0.037	1.81	19.6	10.3	Clear
15:27	12.55	0.029	.627	18.57	4.62	0.037	1.71	17.7	5.49	Clear
15:31	12.55	0.029	.741	18.57	4.55	0.035	1.70	15.9	4.51	Clear
15:35	12.55	0.029	.855	18.61	4.52	0.035	1.68	16.3	3.28	Clear
15:39	12.55	0.029	.969	18.62	4.54	0.035	1.66	14.8	3.08	Clear

Stability Reached (Y/N): Yes — If No, Provide Explanation: NA

	Final Values:	18.62	4.54	0.035	1.66	14.8	3.08	

Sample ID:	RICHM-GW-TW03-110917	**Method of Sampling:**	Low flow, Peri-pump
QA/QC Samples (Yes/No):	No	**Sample Date:**	11/09/17
Duplicate ID:	NA	**Sample Collection Time:**	15:45
Sample Container Type(s):	125 ml HDPE	**Total Volume Purged (gal):**	1.0
Preservative(s):	Ice (4 °C)	**Sample Depth (ft):**	18
Analysis/Method(s):	UCMR3 List	**Depth to Water After Sampling (ft):**	12.55

Instruments (Manufacturer, Model, and Serial No.):

Equipment Calibrated (Y/N): Yes — Calibrated Within Criteria (Y/N): Yes

Turbidity Meter, Water Quality Meter, Water Level Meter, Peristaltic Pump
Hanna 98703 H0006328, YSI 556 MPS 08J101227

Calculations:

Saturated well casing volume: V= Π(R^2)H*7.48 gal/ft^3

V=Volume (gal/ft)
Π = 3.14
R = well radius (ft) = (well diameter (in)/12 (in/ft))/2)
H = height of water column (ft)

V= Π(R^2)H*7.48 gal/ft^3
= Π * (2.0 (in)/12 (in/ft))/2)^2 * 7.42 * 7.48 gal/ft^3
= 1.2 gal.

Signature:

Notes:

None

Name (print): Sarah Levine

QA/QC'd by: dry — **QA/QC Date:** 1/2/2018

GROUNDWATER SAMPLING RECORD

amec foster wheeler

Project Name:	Phase 1 Regional Site Inspections for Per-Fluorinated Compounds at Multiple Air National Guard Installations	**Project Number:**	291330006.07
Contract:	W9133L-14-D-0002	**Task Order:**	0006
Installation:	RICHM	**Technician(s):**	Sarah Levine
Well ID:	TW-04	**Date:**	11/08/17
Initial Depth to Water (ft):	15.05	**Well Diameter (in):**	2.0
Total Depth of Well (ft):	20.0	**1 Casing Volume (gal):**	0.8
Method of Purging:	Peri-pump	**3 Casing Volumes (gal):**	2.4
Measuring Point (toc, tor, etc.):	Top of Casing	**Pump Intake Depth (feet):**	18

Time	Water Level (feet)	Flow Rate (Gpm)	Cum. Volume (gal.)	Temp. (°C)	pH (SU)	Specific Electrical Conductance (mS/cm)	DO (mg/L)	ORP (mV)	Turbidity (NTU)	Comments/Observations During Purging (color, sediment, odor, etc.)
		Stabilization Criteria		±0.5°C	±0.1	±3%	±10%	±10%	±10% and <10 NTU	
09:21		0.05								Pumping/Purging Started
09:22	15.29	0.05	0	16.05	5.15	0.048	10.44	45.5	7.10	Clear
09:26	15.57	0.05	.2	16.99	5.16	0.047	8.11	38.4	2.64	Clear
09:30	15.69	0.05	.4	17.18	5.15	0.047	7.53	37.0	2.57	Clear
09:34	15.84	0.05	.6	17.48	5.10	0.048	6.99	37.3	2.22	Clear
09:38	15.93	0.05	.8	17.29	4.94	0.047	6.82	45.6	1.86	Clear
09:42	16.09	0.05	1.0	17.34	4.83	0.047	6.78	49.3	1.15	Clear
09:46	16.21	0.05	1.2	17.29	4.80	0.047	6.66	47.8	0.93	Clear
09:50	16.30	0.05	1.4	7.18	4.79	0.048	6.58	47.1	0.87	Clear

Stability Reached (Y/N): Yes — If No, Provide Explanation: NA

	Temp.	pH	SEC	DO	ORP	Turbidity
Final Values:	7.18	4.79	0.048	6.58	47.1	0.87

Sample ID:	RICHM-GW-TW04-110817	**Method of Sampling:**	Low flow, Peri-pump
QA/QC Samples (Yes/No):	No	**Sample Date:**	11/08/17
Duplicate ID:	NA	**Sample Collection Time:**	10:00
Sample Container Type(s):	125 ml HDPE	**Total Volume Purged (gal):**	1.5
Preservative(s):	Ice (4 °C)	**Sample Depth (ft):**	18
Analysis/Method(s):	UCMR3 List	**Depth to Water After Sampling (ft):**	15.87

Instruments (Manufacturer, Model, and Serial No.):

Equipment Calibrated (Y/N): Yes — Calibrated Within Criteria (Y/N): Yes

Turbidity Meter, Water Quality Meter, Water Level Meter, Peristaltic Pump
Hanna 98703 H0006328, YSI 556 MPS 08J101227

Calculations:

Saturated well casing volume: V= Π(R^2)H*7.48 gal/ft^3

V=Volume (gal/ft)
Π = 3.14
R = well radius (ft) = (well diameter (in)/12 (in/ft))/2)
H = height of water column (ft)

V= Π(R^2)H*7.48 gal/ft^3
= Π * (2.0 (in)/12 (in/ft))/2)^2 * 4.95 * 7.48 gal/ft^3
= 0.8 gal.

Signature:

Notes: None

Name (print): Sarah Levine

QA/QC'd by: dry — **QA/QC Date:** 1/2/2018

GROUNDWATER SAMPLING RECORD

Project Name:	Phase 1 Regional Site Inspections for Per-Fluorinated Compounds at Multiple Air National Guard Installations	**Project Number:**	291330006.07
Contract:	W9133L-14-D-0002	**Task Order:**	0006
Installation:	RICHM	**Technician(s):**	Sarah Levine
Well ID:	TMW-37	**Date:**	11/08/17
Initial Depth to Water (ft):	17.9	**Well Diameter (in):**	2.0
Total Depth of Well (ft):	27.0	**1 Casing Volume (gal):**	1.5
Method of Purging:	Peri-pump	**3 Casing Volumes (gal):**	4.5
Measuring Point (toc, tor, etc.):	Top of Casing	**Pump Intake Depth (feet):**	23

Time	Water Level (feet)	Flow Rate (Gpm)	Cum. Volume (gal.)	Temp. (°C)	pH (SU)	Specific Electrical Conductance (mS/cm)	DO (mg/L)	ORP (mV)	Turbidity (NTU)	Comments/Observations During Purging (color, sediment, odor, etc.)
Stabilization Criteria				±0.5°C	±0.1	±3%	±10%	±10%	±10% and <10 NTU	
11:14		0.625								Pumping/Purging Started
11:18	18.13	0.625	.25	18.92	4.74	0.034	1.53	46.0	65.0	Cloudy
11:22	18.11	0.625	.5	19.45	4.67	0.034	1.46	26.1	66.2	Cloudy
11:26	18.09	0.625	.75	19.57	4.58	0.034	1.38	25.3	68.4	Cloudy
11:30	18.05	0.625	1	19.65	4.52	0.035	1.38	22.9	68.9	Cloudy
11:34	18.05	0.625	1.25	19.71	4.44	0.035	1.39	24.0	66.3	Cloudy
11:38	18.06	0.625	1.5	19.80	4.36	0.035	1.39	26.4	58.1	Cloudy
11:42	18.07	0.625	1.75	19.86	4.32	0.035	1.40	26.3	48.3	Cloudy
11:46	18.08	0.625	2	19.83	4.33	0.035	1.38	24.3	36.7	Clear
11:50	18.09	0.625	2.25	19.85	4.25	0.035	1.27	27.4	29.7	Clear
11:54	18.10	0.625	2.5	19.99	4.26	0.035	1.31	23.7	23.0	Clear
11:58	18.11	0.625	2.75	19.96	4.29	0.034	1.22	18.8	17.2	Clear
12:02	18.12	0.625	3	19.96	4.25	0.035	1.21	20.4	14.6	Clear
12:06	18.13	0.625	3.25	19.98	4.23	0.035	1.19	19.1	11.8	Clear
12:10	18.14	0.625	3.5	19.97	4.22	0.035	1.17	18.3	9.47	Clear

Stability Reached (Y/N): Yes — If No, Provide Explanation: NA

Final Values:	**19.97**	**4.22**	**0.035**	**1.17**	**18.3**	**9.47**	

Sample ID:	RICHM-GW-TMW37-110817	**Method of Sampling:**	Low flow, Peri-pump
QA/QC Samples (Yes/No):	No	**Sample Date:**	11/08/17
Duplicate ID:	NA	**Sample Collection Time:**	12:15
Sample Container Type(s):	125 ml HDPE	**Total Volume Purged (gal):**	3.5
Preservative(s):	Ice (4 °C)	**Sample Depth (ft):**	23
Analysis/Method(s):	UCMR3 List	**Depth to Water After Sampling (ft):**	18.03

Instruments (Manufacturer, Model, and Serial No.):

Equipment Calibrated (Y/N): Yes — Calibrated Within Criteria (Y/N): Yes

Turbidity Meter, Water Quality Meter, Water Level Meter, Peristaltic Pump
Hanna 98703 H0006328, YSI 556 MPS 08J101227

Calculations:

Saturated well casing volume: V= Π(R^2)H*7.48 gal/ft^3

V=Volume (gal/ft)
Π = 3.14
R = well radius (ft) = (well diameter (in)/12 (in/ft))/2)
H = height of water column (ft)

V= Π(R^2)H*7.48 gal/ft^3
= Π * (2.0 (in)/12 (in/ft))/2)^2 * 9.10 * 7.48 gal/ft^3
= 1.5 gal.

Signature:

Notes:

None

Name (print): Sarah Levine

QA/QC'd by: dry — **QA/QC Date:** 1/2/2018

GROUNDWATER SAMPLING RECORD

amec foster wheeler

Project Name:	Phase 1 Regional Site Inspections for Per-Fluorinated Compounds at Multiple Air National Guard Installations	**Project Number:**	291330006.07
Contract:	W9133L-14-D-0002	**Task Order:**	0006
Installation:	RICHM	**Technician(s):**	Sarah Levine
Well ID:	MW-01-36	**Date:**	11/10/17
Initial Depth to Water (ft):	13.42	**Well Diameter (in):**	2.0
Total Depth of Well (ft):	29.15	**1 Casing Volume (gal):**	3.6
Method of Purging:	Peri-pump	**3 Casing Volumes (gal):**	10.9
Measuring Point (toc, tor, etc.):	Top of Casing	**Pump Intake Depth (feet):**	25

Time	Water Level (feet)	Flow Rate (Gpm)	Cum. Volume (gal.)	Temp. (°C)	pH (SU)	Specific Electrical Conductance (mS/cm)	DO (mg/L)	ORP (mV)	Turbidity (NTU)	Comments/Observations During Purging (color, sediment, odor, etc.)
Stabilization Criteria				±0.5°C	±0.1	±3%	±10%	±10%	±10% and <10 NTU	
09:32		0.045								Pumping/Purging Started
09:36	13.45	0.045	0.181	16.12	4.09	0.035	3.75	92.9	15.9	Clear
09:40	13.43	0.045	0.362	16.12	3.80	0.035	2.56	102.8	9.92	Clear
09:44	13.42	0.045	0.543	16.13	3.77	0.034	2.13	101.2	7.94	Clear
09:48	13.43	0.045	0.724	16.05	3.79	0.033	1.60	97.9	5.94	Clear
09:52	13.43	0.045	0.905	16.02	3.68	0.033	1.34	99.8	5.63	Clear
09:56	13.44	0.045	1.086	15.98	3.63	0.033	1.29	100.2	5.49	Clear
10:00	13.45	0.045	1.267	16.09	3.74	0.033	1.26	84.7	5.80	Clear
10:04	13.47	0.045	1.448	16.17	3.87	0.033	1.19	82.6	6.47	Clear
10:08	13.48	0.045	1.629	16.25	3.83	0.033	1.20	87.1	6.18	Clear
10:12	13.48	0.045	1.810	16.27	3.85	0.033	1.20	90.1	7.04	Clear
Stability Reached (Y/N):			Yes		If No, Provide Explanation				NA	
			Final Values:	**16.27**	**3.85**	**0.033**	**1.20**	**90.1**	**7.04**	

Sample ID:	RICHM-MW-01-36-111017	**Method of Sampling:**	Low flow, Peri-pump
QA/QC Samples (Yes/No):	No	**Sample Date:**	11/10/17
Duplicate ID:	NA	**Sample Collection Time:**	10:20
Sample Container Type(s):	125 ml HDPE	**Total Volume Purged (gal):**	2
Preservative(s):	Ice (4 °C)	**Sample Depth (ft):**	25
Analysis/Method(s):	UCMR3 List	**Depth to Water After Sampling (ft):**	13.48

Instruments (Manufacturer, Model, and Serial No.):

Equipment Calibrated (Y/N): Yes Calibrated Within Criteria (Y/N): Yes

Turbidity Meter, Water Quality Meter, Water Level Meter, Peristaltic Pump
Hanna 98703 H0006328, YSI 556 MPS 08J101227

Calculations:

Saturated well casing volume: V= Π(R^2)H*7.48 gal/ft^3

V=Volume (gal/ft)
Π = 3.14
R = well radius (ft) = (well diameter (in)/12 (in/ft))/2)
H = height of water column (ft)

V= Π(R^2)H*7.48 gal/ft^3
= Π * (2.0 (in)/12 (in/ft))/2)^2 * 22.08 * 7.48 gal/ft^3
= 3.6 gal.

Signature: [signature]

Notes:

None

Name (print): Sarah Levine

QA/QC'd by: dry **QA/QC Date:** 1/2/2018

APPENDIX E

WATER QUALITY SAMPLING INSTRUMENT CALIBRATION FORMS

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WATER QUALITY SAMPLING INSTRUMENT CALIBRATION FORM

Project Name:	Phase 1 Regional Site Inspections for Per-Fluorinated Compounds at Multiple Air National Guard Installations	**Project Number:**	291330006.07
Contract:	W9133L-14-D-0002 **Task Order:** 0006	**Date:**	11/06/17
Installation:	RICHM	**Calibration Start Time:**	09:47
Sample Technician(s):	Sarah Levine	**Calibration End Time:**	11:23

Readings Before Calibration

Date	Time (24hr)	Temperature (°C)	pH (SU)	Turbidity (NTUs)	Specific Electrical Conductance (mS/cm)	D.O. (%)	Salinity (%)	ORP/Eh (mV)	Barometric Pressure (mm Hg)	Comments
11/06/17	09:47	Na	3.70	0	1.309	86.7	Na	212.8	760	None
			7.46	15						
			9.86	100						
				750						

Readings After Calibration

Date	Time (24hr)	Temperature (°C)	pH (SU)	Turbidity (NTUs)	Specific Electrical Conductance (mS/cm)	D.O. (%)	Salinity (%)	ORP/Eh (mV)	Barometric Pressure (mm Hg)	Comments
11/06/17	09:47	Na	4.00	0	1.413	100	Na	240	760	None
			7.00	15						
			10.00	100						
				750						

Calibration Materials Record:

pH Calibration Standards

Standard	Cal. Standard Lot #	Expiration Date
pH (4)	7GF303	06/01/19
pH (7)	7GF779	06/01/19
pH (10)	7GF743	06/01/19

Specific Electrical Conductance, Salinity, Dissolved Oxygen (DO) and Oxidation Reduction Potential (ORP) Calibration Standards

Standard	Cal. Standard Lot #	Expiration Date
Spec. Conductance	7GH1079	08/01/18
Salinity	Na	11/06/17
D.O.	Na	11/06/17
ORP	1720	06/01/22

Turbidity Standards

Standard	Cal. Standard Lot #	Expiration Date
10	2444	04/01/18
20	2455	10/01/17
100	2456	10/01/17
800	2457	10/01/17

Instruments (Manufacturer, Model, and Serial No.):

	Manufacturer/Model	Serial No
Water Quality Meter:	YSI 556 MPS	08J101227
Turbidity Meter:	Hanna 98703	H0006328

Calibrated Within Acceptance Criteria (Y/N): Yes

If No, Provide Explanation: NA

Notes: None

Signature: 

Name (print): Sarah Levine

QA/QC'd by: dry **QA/QC Date:** 1/2/2018

WATER QUALITY SAMPLING INSTRUMENT CALIBRATION FORM

Project Name:	Phase 1 Regional Site Inspections for Per-Fluorinated Compounds at Multiple Air National Guard Installations	**Project Number:**	291330006.07
Contract:	W9133L-14-D-0002 **Task Order:** 0006	**Date:**	11/07/17
Installation:	RICHM	**Calibration Start Time:**	10:23
Sample Technician(s):	Sarah Levine	**Calibration End Time:**	10:51

Readings Before Calibration

Date	Time (24hr)	Temperature (°C)	pH (SU)	Turbidity (NTUs)	Specific Electrical Conductance (mS/cm)	D.O. (%)	Salinity (%)	ORP/Eh (mV)	Barometric Pressure (mm Hg)	Comments
11/07/17	10:32	Na	4.09	0	1.210	109.6	Na	261.0	760	None
			6.65	15						
			9.91	100						
				750						

Readings After Calibration

Date	Time (24hr)	Temperature (°C)	pH (SU)	Turbidity (NTUs)	Specific Electrical Conductance (mS/cm)	D.O. (%)	Salinity (%)	ORP/Eh (mV)	Barometric Pressure (mm Hg)	Comments
11/07/17	10:32	Na	4.00	<0.1	1.413	100	Na	240	760	None
			7.00	15						
			10.00	100						
				750						

Calibration Materials Record:

pH Calibration Standards

Standard	Cal. Standard Lot #	Expiration Date
pH (4)	7GF303	06/01/19
pH (7)	7GF779	06/01/19
pH (10)	7GF743	06/01/19

Specific Electrical Conductance, Salinity, Dissolved Oxygen (DO) and Oxidation Reduction Potential (ORP) Calibration Standards

Standard	Cal. Standard Lot #	Expiration Date
Spec. Conductance	7GH1079	08/01/18
Salinity	Na	11/07/17
D.O.	Na	11/07/17
ORP	1720	06/01/22

Turbidity Standards

Standard	Cal. Standard Lot #	Expiration Date
10	2444	04/01/18
20	2455	10/01/17
100	2456	10/01/17
800	2457	10/01/17

Instruments (Manufacturer, Model, and Serial No.):

	Manufacturer/Model	Serial No
Water Quality Meter:	YSI 556 MPS	08J101227
Turbidity Meter:	LaMotte 2020	H0006328

Calibrated Within Acceptance Criteria (Y/N): Yes

If No, Provide Explanation: NA

Notes: None

Signature: 

Name (print): Sarah Levine

QA/QC'd by: dry **QA/QC Date:** 1/2/2018

WATER QUALITY SAMPLING INSTRUMENT CALIBRATION FORM

Project Name:	Phase 1 Regional Site Inspections for Per-Fluorinated Compounds at Multiple Air National Guard Installations	**Project Number:**	291330006.07
Contract:	W9133L-14-D-0002 **Task Order:** 0006	**Date:**	11/08/17
Installation:	RICHM	**Calibration Start Time:**	08:06
Sample Technician(s):	Sarah Levine	**Calibration End Time:**	08:32

Readings Before Calibration

Date	Time (24hr)	Temperature (°C)	pH (SU)	Turbidity (NTUs)	Specific Electrical Conductance (mS/cm)	D.O. (%)	Salinity (%)	ORP/Eh (mV)	Barometric Pressure (mm Hg)	Comments
11/08/17	08:15	Na	3.90	0	1.318	113.5	Na	258	760	None
			6.82	15						
			10.21	100						
				750						

Readings After Calibration

Date	Time (24hr)	Temperature (°C)	pH (SU)	Turbidity (NTUs)	Specific Electrical Conductance (mS/cm)	D.O. (%)	Salinity (%)	ORP/Eh (mV)	Barometric Pressure (mm Hg)	Comments
11/08/17	08:15	Na	4.00	<0.1	1.413	100	Na	240	760	None
			7.00	15						
			10.00	100						
				750						

Calibration Materials Record:

pH Calibration Standards

Standard	Cal. Standard Lot #	Expiration Date
pH (4)	7GF303	06/01/19
pH (7)	7GF779	06/01/19
pH (10)	7GF743	06/01/19

Specific Electrical Conductance, Salinity, Dissolved Oxygen (DO) and Oxidation Reduction Potential (ORP) Calibration Standards

Standard	Cal. Standard Lot #	Expiration Date
Spec. Conductance	7GH1079	08/01/18
Salinity	Na	11/08/17
D.O.	Na	11/08/17
ORP	1720	06/01/22

Turbidity Standards

Standard	Cal. Standard Lot #	Expiration Date
10	2444	04/01/18
20	2455	10/01/17
100	2456	10/01/17
800	2457	10/01/17

Instruments (Manufacturer, Model, and Serial No.):

	Manufacturer/Model	Serial No
Water Quality Meter:	YSI 556 MPS	08J101227
Turbidity Meter:	LaMotte 2020	H0006328

Calibrated Within Acceptance Criteria (Y/N): Yes

If No, Provide Explanation: NA

Notes: None

Signature: 

Name (print): Sarah Levine

QA/QC'd by: dry **QA/QC Date:** 1/2/2018

WATER QUALITY SAMPLING INSTRUMENT CALIBRATION FORM

Project Name:	Phase 1 Regional Site Inspections for Per-Fluorinated Compounds at Multiple Air National Guard Installations	**Project Number:**	291330006.07
Contract:	W9133L-14-D-0002 **Task Order:** 0006	**Date:**	11/09/17
Installation:	RICHM	**Calibration Start Time:**	07:49
Sample Technician(s):	Sarah Levine	**Calibration End Time:**	08:13

Readings Before Calibration

Date	Time (24hr)	Temperature (°C)	pH (SU)	Turbidity (NTUs)	Specific Electrical Conductance (mS/cm)	D.O. (%)	Salinity (%)	ORP/Eh (mV)	Barometric Pressure (mm Hg)	Comments
11/09/17	07:49	Na	4.07	0	1.293	114.7	Na	259.5	760	None
			6.74	15						
			9.91	100						
				750						

Readings After Calibration

Date	Time (24hr)	Temperature (°C)	pH (SU)	Turbidity (NTUs)	Specific Electrical Conductance (mS/cm)	D.O. (%)	Salinity (%)	ORP/Eh (mV)	Barometric Pressure (mm Hg)	Comments
11/09/17	07:49	Na	4.00	<0.1	1.413	100	Na	240.0	760	None
			7.00	15						
			10.00	100						
				750						

Calibration Materials Record:

pH Calibration Standards

Standard	Cal. Standard Lot #	Expiration Date
pH (4)	7GF303	06/01/19
pH (7)	7GF779	06/01/19
pH (10)	7GF743	06/01/19

Specific Electrical Conductance, Salinity, Dissolved Oxygen (DO) and Oxidation Reduction Potential (ORP) Calibration Standards

Standard	Cal. Standard Lot #	Expiration Date
Spec. Conductance	7GH1079	08/01/18
Salinity	Na	11/09/17
D.O.	Na	11/09/17
ORP	1720	06/01/22

Turbidity Standards

Standard	Cal. Standard Lot #	Expiration Date
10	2444	04/01/18
20	2455	10/01/17
100	2456	10/01/17
800	2457	10/01/17

Instruments (Manufacturer, Model, and Serial No.):

	Manufacturer/Model	Serial No
Water Quality Meter:	YSI 556 MPS	08J101227
Turbidity Meter:	LaMotte 2020	H0006328

Calibrated Within Acceptance Criteria (Y/N): Yes

If No, Provide Explanation: NA

Notes: None

Signature: 

Name (print): Sarah Levine

QA/QC'd by: dry **QA/QC Date:** 1/2/2018

WATER QUALITY SAMPLING INSTRUMENT CALIBRATION FORM

Project Name:	Phase 1 Regional Site Inspections for Per-Fluorinated Compounds at Multiple Air National Guard Installations	**Project Number:**	291330006.07
Contract:	W9133L-14-D-0002 **Task Order:** 0006	**Date:**	11/10/17
Installation:	RICHM	**Calibration Start Time:**	07:28
Sample Technician(s):	Sarah Levine	**Calibration End Time:**	07:48

Readings Before Calibration

Date	Time (24hr)	Temperature (°C)	pH (SU)	Turbidity (NTUs)	Specific Electrical Conductance (mS/cm)	D.O. (%)	Salinity (%)	ORP/Eh (mV)	Barometric Pressure (mm Hg)	Comments
11/10/17	07:46	Na	3.90	0	1.395	115.3	Na	258.4	760	None
			6.86	20						
			9.90	100						
				750						

Readings After Calibration

Date	Time (24hr)	Temperature (°C)	pH (SU)	Turbidity (NTUs)	Specific Electrical Conductance (mS/cm)	D.O. (%)	Salinity (%)	ORP/Eh (mV)	Barometric Pressure (mm Hg)	Comments
11/10/17	07:46	Na	4.00	<0.1	1.413	100	Na	240	760	None
			7.00	20						
			10.00	100						
				750						

Calibration Materials Record:

pH Calibration Standards

Standard	Cal. Standard Lot #	Expiration Date
pH (4)	7GF303	06/01/19
pH (7)	7GF779	06/01/19
pH (10)	7GF743	06/01/19

Specific Electrical Conductance, Salinity, Dissolved Oxygen (DO) and Oxidation Reduction Potential (ORP) Calibration Standards

Standard	Cal. Standard Lot #	Expiration Date
Spec. Conductance	7GH1079	08/01/18
Salinity	Na	11/10/17
D.O.	Na	11/10/17
ORP	1720	06/01/22

Turbidity Standards

Standard	Cal. Standard Lot #	Expiration Date
10	2444	04/01/18
20	2455	10/01/17
100	2456	10/01/17
800	2457	10/01/17

Instruments (Manufacturer, Model, and Serial No.):

	Manufacturer/Model	Serial No
Water Quality Meter:	YSI 556 MPS	08J101227
Turbidity Meter:	LaMotte 2020	H0006328

Calibrated Within Acceptance Criteria (Y/N): Yes

If No, Provide Explanation: NA

Notes: None

Signature: 

Name (print): Sarah Levine

QA/QC'd by: dry **QA/QC Date:** 1/2/2018

APPENDIX F

SEDIMENT AND SURFACE WATER SAMPLING LOGS

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SAMPLE COLLECTION LOG
SEDIMENT / SURFACE SOIL / SURFACE WATER

Project Name:	Phase 1 Regional Site Inspections for Per-Fluorinated Compounds at Multiple Air National Guard Installations	**Project Number:**	291330006.07
Contract:	W9133L-14-D-0002	**Task Order:**	0006
Installation:	RICHM	**Date:**	11/08/17
Location ID:	01SD01	**Northing/Easting:**	4153856/295834
Technician(s):	Sarah Levine		

SEDIMENT SAMPLE

Description

NAME (USCS Symbol): color, moisture, % by wt, plasticity, dilatancy, toughness, dry strength,consistency

CL, silty clay with fine gravel, reddish brown, moist, no odor, low plasticity, soft, low dry strength

Sample Depth (ft):	0 - 0.5	**Sample ID:**	RICHM-01-SD01-0-0.5
MS/MSD Collected:	Yes	**Sample Date:**	11/08/17
Duplicate ID:	NA	**Sample Collection Time:**	14:15
Sample Container Type(s):	6OZ HDPE	**Sample Collection Methods:**	Hand auger
Preservative(s):	Ice (4 °C)	**Analysis/Method(s):**	UCMR3 List

SURFACE SOIL SAMPLE

Description

NAME (USCS Symbol): color, moisture, % by wt, plasticity, dilatancy, toughness, dry strength,consistency

NA

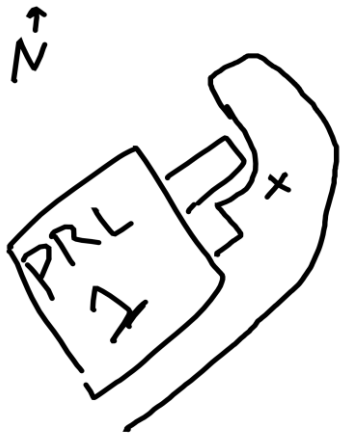
Sample Depth (ft):	NA	**Sample ID:**	NA
MS/MSD Collected:	NA	**Sample Date:**	NA
Duplicate ID:	NA	**Sample Collection Time:**	NA
Sample Container Type(s):	NA	**Sample Collection Methods:**	NA
Preservative(s):	NA	**Analysis/Method(s):**	NA

SURFACE WATER SAMPLE

Time	Intake Depth (in)	Temp. (°C)	pH (units)	Specific Electrical Conductance (mS/cm)	DO (mg/L)	ORP (mV)	Turbidity (NTU)	Comments/Observations During Purging (color, sediment, etc.)
NA	NA	NA	NA	NA	NA	NA	NA	NA

Sample Depth (ft):	NA	**Sample Date:**	NA
Sample ID:	NA	**Sample Collection Time:**	NA
MS/MSD Collected:	NA	**Sample Collection Methods:**	NA
Duplicate ID:	NA	**Surface Water Depth (ft):**	NA
Sample Container Type(s):	NA	**Water Body and Water Quality Characteristics:**	
Preservative(s):	NA	NA	
Analysis/Method(s):	NA		

Location Sketch:



Instruments (Manufacturer, Model, and Serial No.):

Equipment Calibrated (Y/N):	NA
Calibrated Within Criteria (Y/N):	NA

Manual Hand Tools

Notes:

None

Signature:

Name (print)**:** Sarah Levine

QA/QC'd by: dry **QA/QC Date:** 1/2/2018

SAMPLE COLLECTION LOG
SEDIMENT / SURFACE SOIL / SURFACE WATER

Project Name:	Phase 1 Regional Site Inspections for Per-Fluorinated Compounds at Multiple Air National Guard Installations	**Project Number:**	291330006.07
Contract:	W9133L-14-D-0002	**Task Order:**	0006
Installation:	RICHM	**Date:**	11/08/17
Location ID:	02SD01 and 02SW01	**Northing/Easting:**	4153944/295700
Technician(s):	Sarah Levine		

SEDIMENT SAMPLE

Description

NAME (USCS Symbol): color, moisture, % by wt, plasticity, dilatancy, toughness, dry strength,consistency

ML, silt with sand, brown, moist, no plasticity, low toughness, low dry strength, very soft

Sample Depth (ft):	0 - 0.5	**Sample ID:**	RICHM-02-SD01-0-0.5
MS/MSD Collected:	No	**Sample Date:**	11/08/17
Duplicate ID:	RICHM-SD-DUP01-110817	**Sample Collection Time:**	15:20
Sample Container Type(s):	6oz HDPE	**Sample Collection Methods:**	Hand auger
Preservative(s):	Ice (4 °C)	**Analysis/Method(s):**	UCMR3 List

SURFACE SOIL SAMPLE

Description

NAME (USCS Symbol): color, moisture, % by wt, plasticity, dilatancy, toughness, dry strength,consistency

NA

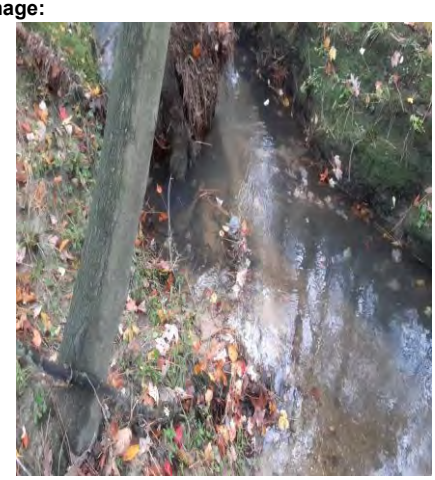
Sample Depth (ft):	NA	**Sample ID:**	NA
MS/MSD Collected:	NA	**Sample Date:**	NA
Duplicate ID:	NA	**Sample Collection Time:**	NA
Sample Container Type(s):	NA	**Sample Collection Methods:**	NA
Preservative(s):	NA	**Analysis/Method(s):**	NA

SURFACE WATER SAMPLE

Time	Intake Depth (in)	Temp. (°C)	pH (units)	Specific Electrical Conductance (mS/cm)	DO (mg/L)	ORP (mV)	Turbidity (NTU)	Comments/Observations During Purging (color, sediment, etc.)
16:01	6	11.54	6.17	0.111	9.11	93.9	13.1	Clear

Sample Depth (ft):	0.5 - 0.5	**Sample Date:**	11/08/17
Sample ID:	RICHM-02-SW01-110817	**Sample Collection Time:**	16:15
MS/MSD Collected:	Yes	**Sample Collection Methods:**	Sample container
Duplicate ID:	NA	**Surface Water Depth (ft):**	0.5
Sample Container Type(s):	125ml HDPE	**Water Body and Water Quality Characteristics:**	
Preservative(s):	Ice (4 °C)	Stream, Flowing, Clear	
Analysis/Method(s):	UCMR3 List		

Location Image:



Caption: SW-SD location

Instruments (Manufacturer, Model, and Serial No.):

Equipment Calibrated (Y/N):	Yes
Calibrated Within Criteria (Y/N):	Yes

Turbidity Meter, Water Quality Meter, Manual Hand Tools
Hanna 98703 H0006328,
YSI 556 MPS 08J101227

Notes:

None

Signature:

Name (print):

Sarah Levine

QA/QC'd by: dry **QA/QC Date:** 1/2/2018

SAMPLE COLLECTION LOG
SEDIMENT / SURFACE SOIL / SURFACE WATER

Project Name:	Phase 1 Regional Site Inspections for Per-Fluorinated Compounds at Multiple Air National Guard Installations	**Project Number:**	291330006.07
Contract:	W9133L-14-D-0002	**Task Order:**	0006
Installation:	RICHM	**Date:**	11/09/17
Location ID:	03SW01	**Northing/Easting:**	See figure/See figure
Technician(s):	Sarah Levine		

SEDIMENT SAMPLE

Description

NAME (USCS Symbol): color, moisture, % by wt, plasticity, dilatancy, toughness, dry strength,consistency

NA

Sample Depth (ft):	NA	**Sample ID:**	NA
MS/MSD Collected:	NA	**Sample Date:**	NA
Duplicate ID:	NA	**Sample Collection Time:**	NA
Sample Container Type(s):	NA	**Sample Collection Methods:**	NA
Preservative(s):	NA	**Analysis/Method(s):**	NA

SURFACE SOIL SAMPLE

Description

NAME (USCS Symbol): color, moisture, % by wt, plasticity, dilatancy, toughness, dry strength,consistency

NA

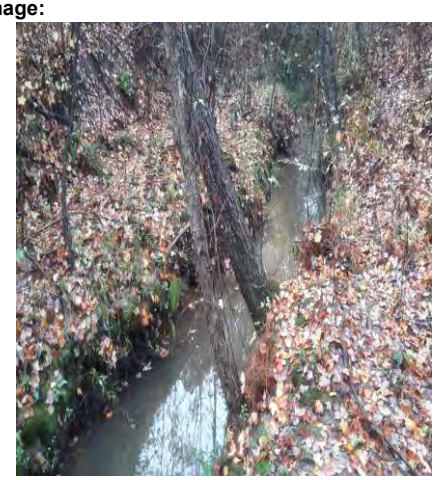
Sample Depth (ft):	NA	**Sample ID:**	NA
MS/MSD Collected:	NA	**Sample Date:**	NA
Duplicate ID:	NA	**Sample Collection Time:**	NA
Sample Container Type(s):	NA	**Sample Collection Methods:**	NA
Preservative(s):	NA	**Analysis/Method(s):**	NA

SURFACE WATER SAMPLE

Time	Intake Depth (in)	Temp. (°C)	pH (units)	Specific Electrical Conductance (mS/cm)	DO (mg/L)	ORP (mV)	Turbidity (NTU)	Comments/Observations During Purging (color, sediment, etc.)
10:09	6	13.20	6.19	0.158	8.09	229.8	14.2	None

Sample Depth (ft):	0.5 - 0.5	**Sample Date:**	11/09/17
Sample ID:	RICHM-03-SW01-110917	**Sample Collection Time:**	10:15
MS/MSD Collected:	No	**Sample Collection Methods:**	Sample containers
Duplicate ID:	NA	**Surface Water Depth (ft):**	0.5
Sample Container Type(s):	125ML HDPE	**Water Body and Water Quality Characteristics:**	
Preservative(s):	Ice (4 °C)	Stream, Flowing, Clear	
Analysis/Method(s):	UCMR3 List		

Location Image:



Caption: SW sample

Instruments (Manufacturer, Model, and Serial No.):

Equipment Calibrated (Y/N):	Yes
Calibrated Within Criteria (Y/N):	Yes

Turbidity Meter, Water Quality Meter, Other(s): Sample bottles
Hanna 98703 H0006328,
YSI 556 MPS 08J101227

Notes:

None

Signature:

Name (print): Sarah Levine

QA/QC'd by:	dry	**QA/QC Date:**	1/2/2018

SAMPLE COLLECTION LOG
SEDIMENT / SURFACE SOIL / SURFACE WATER

Project Name:	Phase 1 Regional Site Inspections for Per-Fluorinated Compounds at Multiple Air National Guard Installations	**Project Number:**	291330006.07
Contract:	W9133L-14-D-0002	**Task Order:**	0006
Installation:	RICHM	**Date:**	11/08/17
Location ID:	05SW01	**Northing/Easting:**	See figure/See figure
Technician(s):	Sarah Levine		

SEDIMENT SAMPLE

Description

NAME (USCS Symbol): color, moisture, % by wt, plasticity, dilatancy, toughness, dry strength,consistency

NA

Sample Depth (ft):	NA	**Sample ID:**	NA
MS/MSD Collected:	NA	**Sample Date:**	NA
Duplicate ID:	NA	**Sample Collection Time:**	NA
Sample Container Type(s):	NA	**Sample Collection Methods:**	NA
Preservative(s):	NA	**Analysis/Method(s):**	NA

SURFACE SOIL SAMPLE

Description

NAME (USCS Symbol): color, moisture, % by wt, plasticity, dilatancy, toughness, dry strength,consistency

NA

Sample Depth (ft):	NA	**Sample ID:**	NA
MS/MSD Collected:	NA	**Sample Date:**	NA
Duplicate ID:	NA	**Sample Collection Time:**	NA
Sample Container Type(s):	NA	**Sample Collection Methods:**	NA
Preservative(s):	NA	**Analysis/Method(s):**	NA

SURFACE WATER SAMPLE

Time	Intake Depth (in)	Temp. (°C)	pH (units)	Specific Electrical Conductance (mS/cm)	DO (mg/L)	ORP (mV)	Turbidity (NTU)	Comments/Observations During Purging (color, sediment, etc.)
16:27	2	11.23	6.46	0.108	9.67	66.9	11.8	Clear

Sample Depth (ft):	0.2 - 0.2	**Sample Date:**	11/08/17
Sample ID:	RICHM-05-SW01-110817	**Sample Collection Time:**	16:30
MS/MSD Collected:	No	**Sample Collection Methods:**	Sample container
Duplicate ID:	RICHM-SW-DUP01-110817	**Surface Water Depth (ft):**	0.2
Sample Container Type(s):	125ML HDPE	**Water Body and Water Quality Characteristics:**	
Preservative(s):	Ice (4 °C)	Stream, Flowing, Clear	
Analysis/Method(s):	UCMR3 List		

Location Image:

Caption: SW Sample location

Instruments (Manufacturer, Model, and Serial No.):

Equipment Calibrated (Y/N):	Yes
Calibrated Within Criteria (Y/N):	Yes

Turbidity Meter, Water Quality Meter, Manual Hand Tools
Hanna 98703 H0006328,
YSI 556 MPS 08J101227

Notes:

None

Signature:

Name (print): Sarah Levine

QA/QC'd by:	dry	**QA/QC Date:**	1/2/2018

APPENDIX G

INVESTIGATION DERIVED WASTE PROFILES AND WASTE MANIFEST FORMS

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APPENDIX H

DATA VALIDATION REPORTS

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APPENDIX I
LABORATORY ANALYTICAL REPORTS

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