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Air Force Civil Engineer Center

Draft Final

Work Plan for the Assessment of Perfluorinated Compounds at the Former Fire Training Area (FT-07)

Performance-Based Remediation

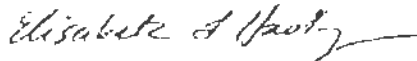
Moody Air Force Base, Valdosta, GA

Contract No FA8903-09-D-8550

Task Order 0003

January 2013

Revision 1



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**Draft Final Work Plan for the
Assessment of Perfluorinated
Compounds at the Former Fire
Training Area (FT-07)**

Performance-Based Remediation
Moody Air Force Base, Georgia

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Air Force Civil Engineer Center

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Our Ref.:
Contract FA8903-09-D-8550
Task Order 0003
ARCADIS Project GP12MAFB.1201

Date:
January 2013

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Acronyms and Abbreviations

AFCEC	Air Force Civil Engineer Center
AFCEE	Air Force Center for Engineering and Environment
AFFF	Aqueous film-forming foams
ARCADIS	ARCADIS U.S., Inc.
bgs	below ground surface
°C	Celsius
CDM	CDM Federal Programs Corporation
CERCLA	Comprehensive Environmental Reponse, Compensation, and Liability Act
ft	foot/feet
FT-07	Former Fire Training Area
FTA	fire training area
HASP	Health and Safety Plan
IDW	Investigation Derived Waste
Interim Guidance	<i>Interim Air Force Guidance on Sampling and Response Actions for Perfluorinated Compounds at Active and BRAC Installations</i> (AFCEE 2012)
MAFB	Moody Air Force Base
mL	milliliter
MS	matrix spike
MSD	matrix spike duplicate
NAPL	Non-Aqueous Phase Liquid
NTU	Nephelometric Turbidity Units
ORP	oxidation reduction potential
PFC	perfluorinated compounds
PFOA	perfluorooctanoic acid
PFOS	perfluorooctanoic sulfonate

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PHA	provisional health advisory
PID	photoionization detector
QA	quality assurance
QC	quality control
QAPP	Quality Assurance Project Plan
RCRA	Resource Conservation and Recovery Act
RFI	RCRA Facility Investigation
SOP	Standard Operating Procedure
UFP	Uniform Federal Policy
µg/L	micrograms per liter
URS	URS Group, Inc.
USAF	U.S. Air Force
VOC	volatile organic compounds
USEPA	U.S. Environmental Protection Agency
WBZ	water-bearing zone
Work Plan	<i>Work Plan for the Assessment of Perfluorinated Compounds</i> (this document)

1. Introduction

This Work Plan for the Assessment of Perfluorinated Compounds (Work Plan) has been prepared to document proposed groundwater sampling activities at the Former Fire Training Area (FT-07) at Moody Air Force Base (MAFB), Valdosta, Georgia (**Figure 1**). ARCADIS U.S., Inc. (ARCADIS) has prepared this document under the Worldwide Environmental Restoration and Construction Contract FA8903-09-D-8550, Task Order 0003. This Work Plan proposes to conduct investigation and characterization activities to determine whether perfluorinated compounds (PFCs) are present at FT-07 using sampling methodologies consistent with the *Interim Air Force Guidance on Sampling and Response Actions for Perfluorinated Compounds at Active and BRAC Installations* (Air Force Center for Engineering and the Environment [AFCEE] 2012; Interim Guidance).

1.1 Purpose of the Work Plan

PFCs include a class of synthetic compounds that are chemically stable and highly resistant to biological degradation. PFCs may be present within FT-07 due to the historical use of Aqueous Film Forming Foams (AFFF), which have been used by the U.S. Air Force (USAF) to extinguish petroleum fires. PFCs do not readily sorb to aquifer materials and, as a result, PFC groundwater plumes can extend long distances downgradient from the source areas. Per the Interim Guidance (AFCEE 2012), Air Force Civil Engineer Center (AFCEC) is planning to evaluate unlined fire training areas (FTAs) that were operable between 1970 and 2000 for PFC contamination.

PFCs are currently not regulated under the Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA) or the Resource Conservation and Recovery Act (RCRA). However, the U.S. Environmental Protection Agency (USEPA) has issued provisional health advisory (PHA) levels for perfluorooctanoic sulfonate (PFOS; 0.2 micrograms per liter [$\mu\text{g/L}$]) and perfluorooctanoic acid (PFOA; 0.4 $\mu\text{g/L}$).

Despite the lack of regulatory guidance or standards, AFCEC is moving forward to characterize the nature and extent of PFCs in accordance with Phase I of the Environmental Restoration Program USAF-wide strategy for addressing potential environmental contamination of PFCs above the USEPA PHA levels (AFCEE 2012). Phase I consists of initial sampling to confirm a possible environmental release of PFOS at concentrations greater than or equal to 0.2 $\mu\text{g/L}$ in groundwater and PFOA at concentrations greater than or equal to 0.4 $\mu\text{g/L}$ in groundwater.

As stated above, the first phase of work is to determine whether PFCs are present in groundwater in the vicinity and downgradient of the historical burn pits at FT-07. The scope of work will include collection of groundwater samples from existing monitoring wells and analysis for six PFCs listed in the Interim Guidance (AFCEE 2012). Based on Phase I results, additional investigation may be necessary to further understand the nature and extent of PFCs in soil and groundwater at FT-07.

1.2 Site Background

MAFB is an active USAF base that occupies almost 11,000 acres of land in Lowndes and Lanier counties in south-central Georgia, approximately 10 miles northeast of Valdosta. Georgia State Highway 125 (Bemiss Road) is the primary access road to MAFB, and Interstate Highway 75 passes about 10 miles to the west of MAFB. A site vicinity map is provided as **Figure 1**. FT-07 covers approximately 10 acres north of the munitions storage area in the eastern portion of MAFB, between the Flightline and Grand Bay Swamp. A map showing the current site features around FT-07 is presented as **Figure 2**. The site formerly included seven burn pits, a tree-shaped pipe structure, a building, and a mock aircraft for fire training exercises. The former tree-shaped pipe structure and mock aircraft were both located within PIT-1. In 1988, a concrete hot cargo pad was constructed over two of the former burn pits for use in mission training and support (CDM Federal Programs Corporation [CDM] 2003). The historical burn pits (PIT-1 through PIT-7) are shown on **Figure 3**.

1.2.1 Facility Overview

Weekly training activities were conducted at FT-07 in the seven burn pits until 1975, shown on **Figure 3**. During that period, waste fuel and miscellaneous wastes, including soils, solvents, and paints were used for fire-training exercises. Since that time, training exercises have been conducted approximately four times a year with non-contaminated JP-4 jet fuel. AFFFs and Purple K (a dry chemical fire-fighting agent) were the primary fire-fighting materials used (CDM 2003). In 1988, a concrete hot cargo pad was constructed near two of the former burn pits and is now used for mission training and support. In 1997, a new Fire Training Area was constructed northeast of the former location to replace the former training area (see **Figure 3**) (URS Group, Inc. [URS] 2012a). Limited information is available on the construction and historical use of the burn pits at FT-07.

1.2.2 Environmental Setting

1.2.2.1 Site Geology

MAFB is located on the northeastern edge of the Valdosta Ridge, which is considered to be a severely eroded barrier island. The ridge is approximately 36 miles long and 2.5 miles wide, and MAFB is located on the summit of the ridge, typically 240 to 260 feet (ft) above mean sea level. The topography of MAFB grades down toward the east to the Grand Bay Swamp.

The overburden in the MAFB area is a blend of clayey-sand, silty-sand to silty-clay lenses of varying thickness and depths. Throughout the MAFB investigations, a laterally continuous, basal clay unit has been encountered at depths ranging from 60 ft below ground surface (bgs) to the east by North Perimeter Road, to up to 110 ft bgs to the northwest of MAFB. This unit has been encountered in the FT-07 area at depths ranging from 59 to approximately 70 ft bgs.

Geophysical surveys completed during the Supplemental RCRA Facility Investigation (RFI) indicate a possible clay to limestone unit at approximately 85 to 95 ft bgs and extending from 20 to 80 ft in thickness. The average thickness of the basal confining clay unit ranges from 10 to 45 ft at prior sampling locations (CDM 2003).

1.2.2.2 Site Hydrogeology

Base-wide hydrogeology shows two major water-bearing zones: a shallow/intermediate water-bearing zone (WBZ) and a deep WBZ. These two WBZs are confined to semi-confined. During drilling, water rises in the monitoring wells to an elevation that is above the zone of saturation. The MAFB-wide shallow/intermediate WBZ is typically encountered between 22 to 40 ft bgs. The deep WBZ is typically encountered approximately 60 ft bgs and extends to the basal clay unit (URS 2012a). The aquifer is hydraulically connected from the surface to the basal clay with interfingering silt/clay lenses throughout the aquifer. Groundwater flow in FT-07 is consistently towards the east with a hydraulic gradient of approximately 0.01 ft/ft (URS 2012b). Hydraulic conductivity values measured during slug tests at FT-07 ranged from 1 to 10 ft per day (URS 2012b).

1.2.3 Prior Investigation and Sampling

No previous investigations have been completed at FT-07 for the purposes of assessing PFC contamination. This Work Plan represents the initial investigation to evaluate the potential for environmental releases of PFCs from FT-07.

Previously completed site investigation activities at FT-07 have included an RFI (Geraghty & Miller, Inc. 1993), Supplemental RFI (CDM 1998), Supplemental RFI Data Gaps Plan (CDM 2000), Revised Supplemental RFI Report (CDM 2003), Data Gaps Investigation (URS 2012b), and ongoing long-term monitoring.

1.2.4 Nature and Extent of Contamination

Previously completed investigations have identified two volatile organic compound (VOC) plumes extending east from the former Fire Training Area(s) towards the Grand Bay Swamp (Area 1 and Area 2). Area 1 corresponds to the location of a former underground storage tank, and Area 2 is located south of Area 1 downgradient of several former burn pits (**Figure 3**). No burial activities have been documented at FT-07 (CDM 2003). Corrective actions implemented at the site include a combination of in-situ-enhanced bioremediation and Monitored Natural Attenuation to address VOCs in groundwater.

2. Proposed Scope of Work

2.1 Overview of Proposed Activities

The primary objective of the investigation at FT-07 is to characterize the presence of PFCs associated with previous activities conducted at FT-07. Phase I of the investigation will consist of sampling 14 existing monitoring wells to determine whether an environmental release of PFCs has occurred and to evaluate the potential need for additional investigation activities. If PFCs are detected during this first phase of investigation, the results may be used to develop a scope of work for a second phase of investigation (if needed).

2.2 Sampling Equipment and Procedures

2.2.1 Pre-Field Security Clearance

Before starting work, all activities will be coordinated with the appropriate MAFB departments (i.e., underground utilities and Flightline access). Field personnel will obtain proper clearance from security and maintenance personnel at MAFB for access to FT-07. All MAFB clearance protocols will be coordinated in advance of site mobilization.

2.2.2 Investigation Phase I – Sample Existing Wells

2.2.2.1 Proposed Sample Locations

ARCADIS anticipates that any PFC-affected groundwater at the FTA would originate from one or more historical burn pit locations (**Figure 3**) and flow eastward. ARCADIS has, therefore, selected a suite of wells located downgradient of potential PFC usage areas for sampling during Phase I. The list of wells to be sampled, their screened intervals, and the selection rationale is presented in **Table 1**. Well locations are shown on **Figure 3**.

There are no existing monitoring wells present downgradient of PIT-7. Investigation in this area will be completed during Phase 2, if warranted, based on the results of the Phase I investigation.

2.2.2.2 Equipment and Sampling Procedures

All sampling activities will be completed in accordance with the *Final Base-Wide Quality Assurance Project Plan (QAPP)* (ARCADIS 2012a). To prevent contamination of the collected samples, TeflonTM materials will not be used during the collection, storage, and/or shipment of the samples. TeflonTM is manufactured using PFOA. Other specific details of the sampling activities are provided in this section, consistent with information provided in ARCADIS Standard Operating Procedures (SOPs), included in **Appendix A**.

Immediately after removing the well cap for gauging, the headspace of each well to be sampled will be field-screened for VOC vapors using a photoionization detector (PID), calibrated to 100 parts per million hexane standard. The depth to groundwater in each well will be measured, relative to a reference point marked on the casing if present, using an oil/water interface probe or water-level meter attached to a measuring tape, graduated to 0.01 ft, and adjusted for the length of the probe. The PID readings and depth-to-water information for each well will be recorded on a field gauging log.

Immediately prior to purging each well, a 0.75-inch-diameter QED Environmental Systems bladder pump will be attached to low-density polyethylene tubing and set in the well. New tubing will be used for each well sampled. The pump and tubing will be slowly lowered into the well to the target depth at a sufficiently slow rate so as to minimize any mixing of the water column between the blank and screened sections of the well. Once the pump has been set in the well and secured so that no slippage occurs, a YSI 556-01 water-quality meter encased in a flow-through cell will be attached to the discharge line and used to collect groundwater stabilization parameters (i.e., temperature, pH, dissolved oxygen, turbidity, specific electrical conductance, and oxygen-reduction potential [ORP]). Each well will be purged at a calculated flow rate between 100 and 200 milliliters per minute (mL/minute) to minimize groundwater level drawdown (a target of less than 0.33 ft of drawdown in each well) until field parameters stabilize or the well has been purged for 20 minutes, whichever occurs first.

Groundwater levels will be measured during purging using an oil/water interface probe and recorded on a field sampling form at 3-minute-intervals. In addition, the physical appearance and odor (if any) of the purge water (e.g., organic or sulfide odors or black precipitates) will also be recorded on the field sampling form. Stabilization is considered to be achieved when three consecutive readings, recorded at 3-minute-intervals, meet the following criteria:

- Temperature is within +/- 3 percent (minimum of 0.2° Celsius [C])
- pH is within +/- 0.1 Standard Unit
- Specific electrical conductance is within +/- 3 percent
- ORP is within +/- 10 millivolts
- Dissolved oxygen is within +/- 0.3 milligrams per liter, or turbidity is within +/-10 percent if turbidity is greater than 10 Nephelometric Turbidity Units (NTU); otherwise if turbidity is less than 10 NTU then turbidity stabilization should be equal to +/- 1 NTU.

Once purging has been completed, the pump tubing will be disconnected from the flow-through cell, and groundwater samples will be collected directly from the discharge end of the tubing. If drawdown of greater than 0.33 ft occurs within a well during purging, the well will be considered to be slow recovering (i.e., screened across low permeability silt/clay soils). In this case, purging will be terminated and groundwater samples will be collected using a bailer equipped with a bottom emptying device.

Groundwater purging and sampling activities will be conducted in accordance with the following ARCADIS SOPs, included in **Appendix A**:

- SOP F-01, Chain-of-Custody, Handling, Packing and Shipping
- SOP F-15, Water Level and Non-Aqueous Phase Liquid (NAPL) Thickness Measurement
- SOP F-16, Standard Groundwater Sampling for Monitoring Wells
- SOP F-17, Low-Flow Groundwater Purging and Sampling Procedures for Monitoring Wells
- SOP F-19, Photoionization Detector Air Monitoring and Field Screening
- SOP F-25, Down-Hole Groundwater Field Parameter Measurement
- SOP F-27, Field Equipment Decontamination

Also included in Appendix A is a copy of SOP F-02 for Soil Drilling and Sample Collection, which will be used as a basis for the collection of any soil samples needed during Phase 2 activities. These SOPs will be followed unless SOP instructions differ from the details described in this Work Plan specific to PFCs (e.g., sample handling

procedures). Any deviations from the SOPs will be noted in the field documentation and discussed in the final findings report.

Groundwater samples will be collected in four unfiltered 250 mL high density polyethylene bottles. PFC samples do not need to be collected headspace free. Samples will be labeled with the location, sample depth, date and time, and placed under chain-of-custody control for shipping in a cooler containing blue ice, and transported via an overnight courier to Test America in Denver, Colorado, for analysis.

2.2.2.3 Equipment Decontamination

The submersible pump and other re-usable equipment used for groundwater sampling will be broken down and decontaminated between wells using a three-step process. Groundwater sampling equipment will first be washed with a non-phosphate detergent and deionized water solution followed by a two-stage deionized water rinse. To limit the possibility of cross-contamination from the decontamination process, new wash and rinse solutions will be prepared after the sampling of every five monitoring wells.

2.2.3 Investigation Phase II – Install Temporary Wells

If results of the Phase I investigation indicate concentrations of PFCs above the USEPA PHA levels, additional investigation to further characterize the nature and extent of PFCs may be warranted as part of a Phase II investigation. Potential Phase II activities include the installation and sampling of temporary wells strategically placed to assess PFC plume geometry, and the collection of soil samples at select locations. Phase II investigation activities will be detailed in a work plan addendum, submitted to AFCEC for approval prior to the completion of field activities.

2.3 Sample Handling and Analysis

Labeled sample bottles will be wrapped in bubble wrap to prevent bottle breakage. Samples will be stored at 4°C and shipped on ice. A temperature blank will be placed in the cooler prior to shipment. Each cooler will be custody-sealed. Sample temperature will be confirmed to be at or below 4°C when the samples are received at the laboratory.

Care will be taken to avoid sample contamination issues by using Teflon-free sample containers and sampling equipment, Gore-Tex free clothing, and avoiding the consumption of packaged food during sampling.

Samples will be shipped to Test America - Denver and analyzed within the standard turnaround time (10 days) for PFOS, PFOA, and the suite of four other PFCs specified in the Interim Guidance (AFCEE 2012). Test America - Denver is accredited for PFC analysis under the U.S. Department of Defense Environmental Laboratory Program, as required by the Interim Guidance (**Appendix B**). A copy of Test America's SOP No. DV-LC-0012 for the Analysis of PFOA and other PFCs in Water and Soil using liquid chromatography / tandem mass spectrometry is included in Appendix C.

PFCs will be analyzed using a modified version of USEPA Method 537 known as SOP DV-LC-0012, based on liquid chromatography/tandem mass spectrometry. The reporting limits and method detection limits for the analytes of interest under this method are provided in **Table 2**.

2.4 Waste Management Plan

Investigation derived waste (IDW), including purge water from groundwater sampling activities and decontamination fluids from the sampling equipment will be containerized and disposed of per State of Georgia regulations. Disposable equipment includes personal protective equipment (e.g., Tyvek[®], coveralls, gloves, booties, and air purifying respirator cartridges) and disposable sampling equipment, such as disposable bailers. If the media sampled exhibits hazardous characteristics per the results of waste characterization sampling, disposable equipment will also be disposed of as a hazardous waste. These materials will be stored within the IDW storage area (adjacent to the Northeast Landfill, LF-04) in labeled 55-gallon drums pending analytical results for waste characterization (see SOP F-28 in **Appendix A**).

3. Quality Assurance/Quality Control Sample Collection and Analysis

The field quality assurance/quality control (QA/QC) program includes collection of equipment blanks, duplicates, and matrix spikes/matrix spike duplicates (MS/MSDs) in accordance with the QAPP (ARCADIS 2012a). Reference Uniform Federal Policy (UFP) Worksheets specific to PFC analysis by Method DV-LC-0012 are included as **Appendix D**.

3.1 Equipment Blanks

The purpose of an equipment blank sample is to determine the validity of sampling results for wells that do not have dedicated sampling equipment by establishing the efficiency of the decontamination procedures. Equipment rinsate blanks will be collected from groundwater sampling devices at a frequency of one per 20 field samples with a minimum of one per day of sampling activities.

Equipment blanks will be collected in the same manner as groundwater samples and analyzed for PFCs. The concentration levels of any artifact found in any equipment blank will be noted and compared to the groundwater sample results.

3.2 Duplicates

Blind duplicate samples will be collected at a frequency of one for every 20 samples with a minimum of one per day of sampling activities. Results of the analysis from the duplicates will be used to evaluate repeatability of the analytical procedures.

3.3 Matrix Spike/ Matrix Spike Duplicates

MS/MSD samples are analyzed by adding a known amount of a compound that is similar chemically to the target analyte to ascertain any matrix effects on recoveries and to determine the accuracy and precision of the method in the matrix. Samples will be collected in triplicate from locations where MS/MSD samples are required and labeled in the same manner as the primary samples. MS/MSD samples will be

collected at a rate of one per batch¹. QA/QC samples will be submitted to Test America
- Denver under chain-of-custody procedures.

¹ The QAPP defines an analytical batch as no more than 20 analytical samples.

4. Health and Safety Plan

All field activities will be conducted in accordance with the Site-Specific Health and Safety Plan (HASP, ARCADIS 2012b). The HASP will be maintained onsite by field personnel during field activities. All applicable federal and state health and safety requirements will be followed during the field activities proposed in this Work Plan.

5. Schedule

Sampling activities will begin in early 2013 after receiving AFCEC approval of this Work Plan and authorization to proceed. Results of Phase I activities will be summarized in a figure and data table and provided with a cover letter for internal use by AFCEC. Following AFCEC review of Phase I results, ARCADIS will recommend an appropriate course of action and schedule for a Phase II investigation, if necessary.

6. References

- AFCEE. 2012. *Interim Air Force Guidance on Sampling and Response Actions for Perfluorinated Compounds at Active and BRAC Installations*. August 27.
- ARCADIS. 2012a. *Final Base-Wide Quality Assurance Project Plan (QAPP)*. Performance-Based Remediation, Moody Air Force Base, Valdosta, Georgia. October.
- ARCADIS. 2012b. *Site-Specific Health and Safety Plan*. Performance-Based Remediation, Moody Air Force Base, Valdosta, Georgia. October.
- CDM. 1998. *RCRA Facility Investigation Report for Moody Air Force Base, Valdosta, Georgia*.
- CDM. 2000. *Supplemental RCRA Facility Investigation Data Gaps Work Plan*. Fire Training Area (FT-07), Moody Air Force Base, Valdosta, Georgia. August.
- CDM. 2003. *Revised Supplemental RCRA Facility Investigation Report*. Volume 1. Former Fire Training Area (FT-07), Moody Air Force Base, Valdosta, Georgia. January.
- Geraghty & Miller, Inc. 1993. *RCRA Facility Investigation Report*. Volumes I and II. Moody Air Force Base, Georgia. November.
- URS. 2012a. *Draft Final Seventh Annual Corrective Action Plan Progress Report for the Former Fire Training Area (FT-07), Moody Air Force Base*. June 27.
- URS. 2012b. *Draft Final Data Gaps Investigation Report Updated Conceptual Site Model for the Former Fire Training Area (FT-07), Moody Air Force Base*. July 25.

Tables

Table 1
Proposed Monitoring Well Sampling

Work Plan for the Assessment of Perfluorinated Compounds at FT-07
Performance-Based Remediation
Moody Air Force Base, Valdosta, Georgia

Well ID	Water Bearing Zone	Screen Interval (ft bgs)	Selection Rationale	Approximate Distance Downgradient from the Closest Pit
FT07-FT04	S	3 to 18	Downgradient of PIT-5	460 ft from PIT-5
FT07-FT07	S	5 to 20	Background well, upgradient of known sources	NA
FT07-FT09	S	3 to 18	Downgradient of PIT-1, shallow zone	200 ft from PIT-1
FT07-FT15	S	3 to 13	Downgradient of current FTA, shallow zone	165 ft from current FTA boundary
FT07-FT18	S	4 to 14	Downgradient of PIT-2	160 ft from PIT-2
FT07-FT19	I	23 to 33	Side/downgradient of PIT-4, plume width	600 ft from PIT-4
FT07-MW21	I	20 to 30	Downgradient of PIT-1, intermediate zone	230 ft from PIT-1
FT07-MW22	I	10 to 20	Downgradient of PIT-4, plume width	550 ft from PIT-4
FT07-MW32	I	40.2 to 50.2	Downgradient of current FTA, intermediate zone	165 ft from current FTA boundary
FT07-MW138	I	11.9 to 21.9	Downgradient of PIT-4	350 ft from PIT-4
FT07-MW141	I	14.8 to 24.8	Side/downgradient of PIT-4, plume width	600 ft from PIT-4
FT07-MW142	I	15.3 to 25.3	Downgradient of PIT-6	950 ft from PIT-6
FT07-MW144	I	20 to 30	Downgradient of PIT-6	500 ft from PIT-6
FT07-MW146	I	20 to 30	Downgradient of PIT-3 and PIT-4	370 ft from PIT-3

Notes:

S = Shallow Zone

I = Intermediate Zone

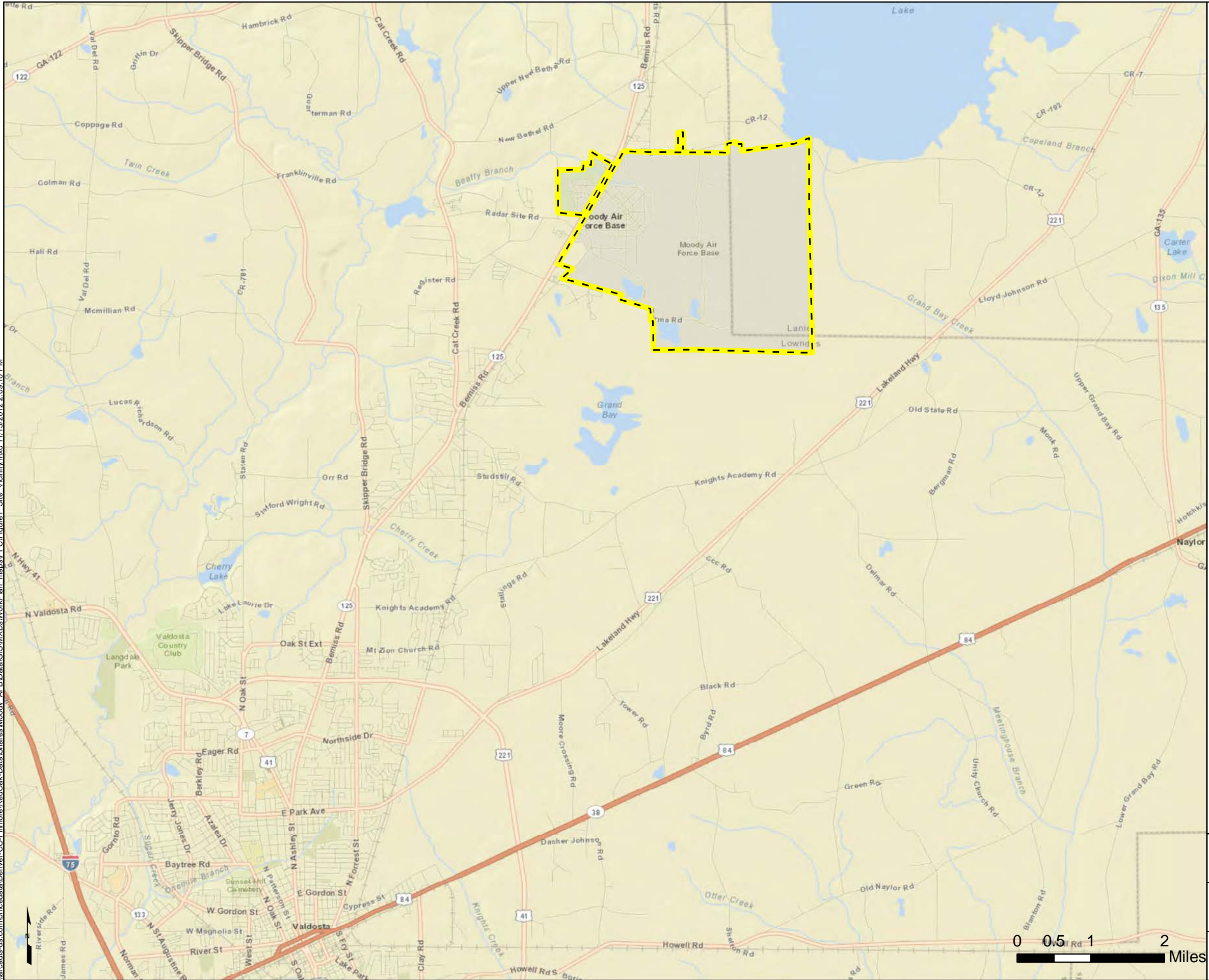
Table 2
Analytical Reporting Limits and Method Detection Limits for PFC Compounds

Work Plan for the Assessment of Perfluorinated Compounds at FT-07
Performance-Based Remediation
Moody Air Force Base, Valdosta, Georgia

Compound	Acronym	Reporting Limit (µg/L)	Method Detection Limit (µg/L)
Perfluorobutane sulfonate	PFBS	0.02	0.00824
Perfluoroheptanoic acid	PFHpA	0.03	0.0132
Perfluorohexane sulfonate	PFHxS	0.03	0.00697
Perfluorooctanoic acid	PFOA	0.02	0.00979
Perfluorooctanoic sulfonate	PFOS	0.03	0.0133
Perfluorononanoic acid	PFNA	0.04	0.0174

Figures

City: DEN Div/Group: IM Created By: B. Baldwin Last Saved By: baldwinb
Moody AFB (66WERC08 EN15 CDEN0)
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Legend

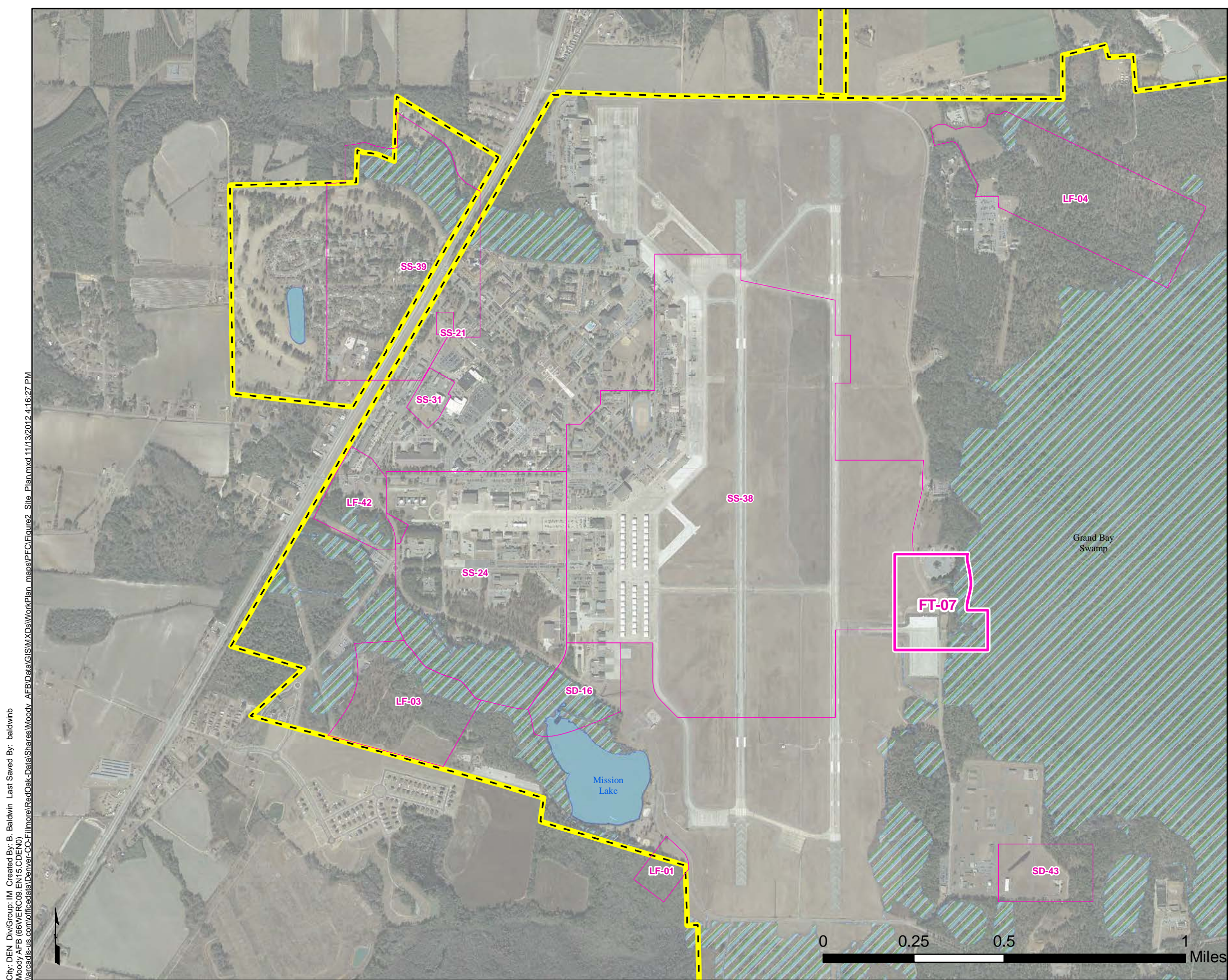
 Installation Boundary

Notes:
· Underlying map image source: World Street Map.

MOODY AIR FORCE BASE
VALDOSTA, GEORGIA
Field Work Plan for the Assessment of Perfluorinated Compounds

Site Vicinity Map





Legend

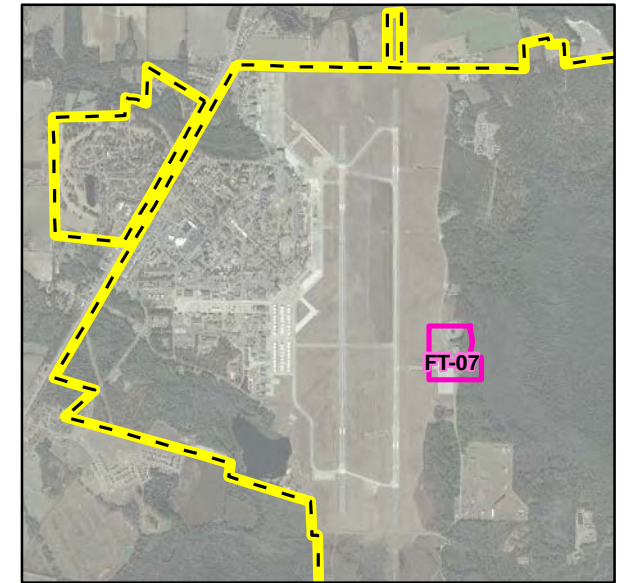
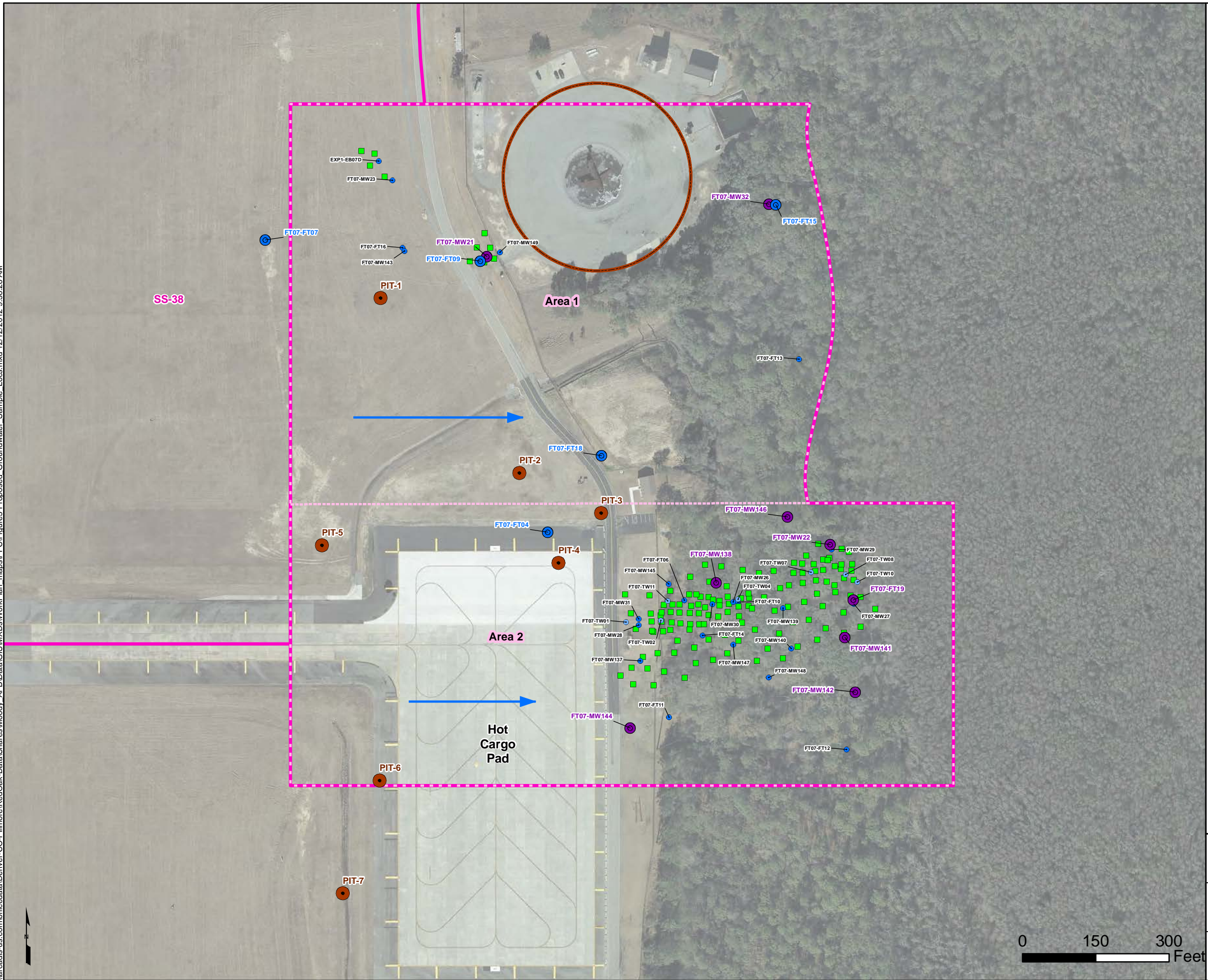
- Environmental Restoration Site Boundary for FT-07
- Environmental Restoration Site Boundary for Other Sites
- Installation Boundary
- Wetland
- Water Body

MOODY AIR FORCE BASE
VALDOSTA, GEORGIA
Field Work Plan for the Assessment of Perfluorinated Compounds

Site Plan



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Legend

- Site Boundary
- FT-07 Area Boundary
- Installation Boundary
- Current Fire Training Area
- Approximate location of historical burn pits
- Existing shallow monitoring well proposed for sampling
- Existing intermediate monitoring well proposed for sampling
- Existing groundwater monitoring well
- Existing groundwater observation well
- Existing groundwater injection well
- Groundwater Flow Direction

Notes:
Wells that have been abandoned are not depicted.

MOODY AIR FORCE BASE
VALDOSTA, GEORGIA
Field Work Plan for the Assessment of Perfluorinated Compounds

Proposed Groundwater Sample Locations



Appendix A

ARCADIS Standard Operating
Procedures (SOPs)

SOP F-01	Chain-of-Custody, Handling, Packing, and Shipping
SOP F-02	Soil Drilling and Sample Collection
SOP F-15	Water-Level and NAPL Thickness Measurement
SOP F-16	Standard Groundwater Sampling for Monitoring Wells
SOP F-17	Low-Flow Groundwater Purging and Sampling Procedures for Monitoring Wells
SOP F-19	Photoionization Detector Air Monitoring and Field Screening
SOP F-25	Down-Hole Groundwater Field Parameter Measurement
SOP F-27	Field Equipment Decontamination
SOP F-28	Investigation-Derived Waste Handling and Storage

F-01

Chain-of-Custody, Handling,
Packing, and Shipping

Chain-of-Custody, Handling, Packing and Shipping

Rev. #: 2

Rev Date: March 6, 2009

I. Scope and Application

This Standard Operating Procedure (SOP) describes the chain-of-custody, handling, packing, and shipping procedures for the management of samples to decrease the potential for cross-contamination, tampering, mis-identification, and breakage, and to insure that samples are maintained in a controlled environment from the time of collection until receipt by the analytical laboratory.

II. Personnel Qualifications

ARCADIS field sampling personnel will have current health and safety training, including 40-hour HAZWOPER training, Department of Transportation (DOT) training, site supervisor training, and site-specific training, as needed. In addition, ARCADIS field sampling personnel will be versed in the relevant SOPs and possess the skills and experience necessary to successfully complete the desired field work.

III. Equipment List

The following list provides materials that may be required for each project. Project documents and sample collection requirements should be reviewed prior to initiating field operations:

- indelible ink pens (black or blue);
- polyethylene bags (resealable-type);
- clear packing tape, strapping tape, duct tape;
- chain of custody
- DOT shipping forms, as applicable
- custody seals or tape;
- appropriate sample containers and labels,;
- insulated coolers of adequate size for samples and sufficient ice to maintain 4°C during collection and transfer of samples;
- wet ice;
- cushioning and absorbent material (i.e., bubble wrap or bags);

- temperature blank
- sample return shipping papers and addresses; and
- field notebook.

IV. Cautions

Review project requirements and select appropriate supplies prior to field mobilization.

Insure that appropriate sample containers with applicable preservatives, coolers, and packing material have been supplied by the laboratory.

Understand the offsite transfer requirements for the facility at which samples are collected.

If overnight courier service is required schedule pick-up or know where the drop-off service center is located and the hours of operation. Prior to using air transportation, confirm air shipment is acceptable under DOT and International Air Transport Association (IATA) regulation

Schedule pick-up time for laboratory courier or know location of laboratory/service center and hours of operation.

Understand DOT and IATA shipping requirements and evaluate dangerous goods shipping regulations relative to the samples being collected (i.e. complete an ARCADIS shipping determination). Review the ARCADIS SOPs for shipping, packaging and labeling of dangerous goods. Potential samples requiring compliance with this DOT regulation include:

- Methanol preservation for Volatile Organic Compounds in soil samples
- Non-aqueous phase liquids (NAPL)

V. Health and Safety Considerations

Follow health and safety procedures outlined in the project/site Health and Safety Plan (HASP).

Use caution and appropriate cut resistant gloves when tightening lids to 40 mL vials. These vials can break while tightening and can lacerate hand. Amber vials (thinner glass) are more prone to breakage.

Some sample containers contain preservatives.

- The preservatives must be retained in the sample container and should in no instance be rinsed out.
- Preservatives may be corrosive and standard care should be exercised to reduce potential contact to personnel skin or clothing. Follow project safety procedures if spillage is observed.
- If sample container caps are broken discard the bottle. Do not use for sample collection.

VI. Procedure

Chain-of-Custody Procedures

1. Prior to collecting samples, complete the chain-of-custody record header information by filling in the project number, project name, and the name(s) of the sampling technician(s) and other relevant project information. Attachment 1 provides an example chain-o- custody record
2. Chain-of-custody information **MUST** be printed legibly using indelible ink (black or blue).
3. After sample collection, enter the individual sample information on the chain-of-custody:
 - a. Sample Identification indicates the well number or soil location that the sample was collected from. Appropriate values for this field include well locations, grid points, or soil boring identification numbers (e.g., MW-3, X-20, SB-30). When the depth interval is included, the complete sample ID would be "SB-30 (0.5-1.0) where the depth interval is in feet. Please note it is very important that the use of hyphens in sample names and depth units (i.e., feet or inches) remain consistent for all samples entered on the chain-of-custody form. **DO NOT** use the apostrophe or quotes in the sample ID. Sample names may also use the abbreviations "FB," "TB," and "DUP" as prefixes or suffixes to indicate that the sample is a field blank, trip blank, or field duplicate, respectively. **NOTE:** The sample

nomenclature may be dictated by the project database and require unique identification for each sample collected for the project. Consult the project data management plan for additional information regarding sample identification.

- b. List the date of sample collection. The date format to be followed should be mm/dd/yy (e.g., 03/07/09) or mm/dd/yyyy (e.g. 03/07/2009).
- c. List the time that the sample was collected. The time value should be presented using military format. For example, 3:15 P.M. should be entered as 15:15.
- d. The composite field should be checked if the sample is a composite over a period of time or from several different locations and mixed prior to placing in sample containers.
- e. The "Grab". field should be marked with an "X" if the sample was collected as an individual grab sample. (e.g. monitoring well sample or soil interval).
- f. Any sample preservation should be noted.
- g. The analytical parameters that the samples are being analyzed for should be written legibly on the diagonal lines. As much detail as possible should be presented to allow the analytical laboratory to properly analyze the samples. For example, polychlorinated biphenyl (PCB) analyses may be represented by entering "PCBs" or "Method 8082." Multiple methods and/or analytical parameters may be combined for each column (e.g., PCBs/VOCs/SVOCs or 8082/8260/8270). These columns should also be used to present project-specific parameter lists (e.g., Appendix IX+3 target analyte list. Each sample that requires a particular parameter analysis will be identified by placing the number of containers in the appropriate analytical parameter column. For metals in particular, indicate which metals are required.
- h. Number of containers for each method requested. This information may be included under the parameter or as a total for the sample based on the chain of custody form used.
- i. Note which samples should be used for site specific matrix spikes.
- j. Indicate any special project requirements.

- k. Indicate turnaround time required.
 - l. Provide contact name and phone number in the event that problems are encountered when samples are received at the laboratory.
 - m. If available attach the Laboratory Task Order or Work Authorization forms
 - n. The remarks field should be used to communicate special analytical requirements to the laboratory. These requirements may be on a per sample basis such as “extract and hold sample until notified,” or may be used to inform the laboratory of special reporting requirements for the entire sample delivery group (SDG). Reporting requirements that should be specified in the remarks column include: 1) turnaround time; 2) contact and address where data reports should be sent; 3) name of laboratory project manager; and 4) type of sample preservation used.
 - o. The “Relinquished By” field should contain the signature of the sampling technician who relinquished custody of the samples to the shipping courier or the analytical laboratory.
 - p. The “Date” field following the signature block indicates the date the samples were relinquished. The date format should be mm/dd/yyyy (e.g., 03/07/2005).
 - q. The “Time” field following the signature block indicates the time that the samples were relinquished. The time value should be presented using military format. For example, 3:15 P.M. should be entered as 15:15.
 - r. The “Received By” section is signed by sample courier or laboratory representative who received the samples from the sampling technician or it is signed upon laboratory receipt from the overnight courier service.
- 3. Complete as many chain-of-custody forms as necessary to properly document the collection and transfer of the samples to the analytical laboratory.
 - 4. Upon completing the chain-of-custody forms, forward two copies to the analytical laboratory and retain one copy for the field records.
 - 5. If electronic chain-of-custody forms are utilized, sign the form and make 1 copy for ARCADIS internal records and forward the original with the samples to the laboratory.

Handling Procedures

1. After completing the sample collection procedures, record the following information in the field notebook with indelible ink:
 - project number and site name;
 - sample identification code and other sample identification information, if appropriate;
 - sampling method;
 - date;
 - name of sampler(s);
 - time;
 - location (project reference);
 - location of field duplicates and both sample identifications;
 - locations that field QC samples were collected including equipment blanks, field blanks and additional sample volume for matrix spikes; and
 - any comments.
2. Complete the sample label with the following information in indelible ink:
 - sample type (e.g., surface water);
 - sample identification code and other sample identification information, if applicable;
 - analysis required;
 - date;
 - time sampled; and
 - initials of sampling personnel;

- sample matrix; and
 - preservative added, if applicable.
3. Cover the label with clear packing tape to secure the label onto the container and to protect the label from liquid.
 4. Confirm that all caps on the sample containers are secure and tightly closed.
 5. In some instances it may be necessary to wrap the sample container cap with clear packing tape to prevent it from becoming loose.
 6. For some projects individual custody seals may be required. Custody seal evidence tape may be placed on the shipping container or they may be placed on each sample container such that the cooler or cap cannot be opened without breaking the custody seal. The custody seal should be initialed and dated prior to relinquishing the samples.

Packing Procedures

Following collection, samples must be placed on wet ice to initiate cooling to 4°C immediately. Retain samples on ice until ready to pack for shipment to the laboratory.

1. Secure the outside and inside of the drain plug at the bottom of the cooler being used for sample transport with “Duct” tape.
2. Place a new large heavy duty plastic garbage bag inside each cooler
3. Place each sample bottle wrapped in bubble wrap inside the garbage bag. VOC vials may be grouped by sample in individual resealable plastic bags). If a cooler temperature blank is supplied by the laboratory, it should be packaged following the same procedures as the samples. If the laboratory did not include a temperature blank, do not add one. Place 1 to 2 inches of cushioning material (i.e., vermiculite) at the bottom of the cooler.
4. Place the sealed sample containers upright in the cooler.
5. Package ice in large resealable plastic bags and place inside the large garbage bag in the cooler. Samples placed on ice will be cooled to and maintained at a temperature of approximately 4°C.

6. Fill the remaining space in the cooler with cushioning material such as bubble wrap. The cooler must be securely packed and cushioned in an upright position and be surrounded (Note: to comply with 49 CFR 173.4, filled cooler must not exceed 64 pounds).
7. Place the completed chain-of-custody record(s) in a large resealable bag and tape the bag to the inside of the cooler lid.
8. Close the lid of the cooler and fasten with packing tape.
9. Wrap strapping tape around both ends of the cooler.
10. Mark the cooler on the outside with the following information: shipping address, return address, "Fragile, Handle with Care" labels on the top and on one side, and arrows indicating "This Side Up" on two adjacent sides.
11. Place custody seal evidence tape over front right and back left of the cooler lid, initial and date, then cover with clear plastic tape.

Note: Procedure numbers 2, 3, 5, and 6 may be modified in cases where laboratories provide customized shipping coolers. These cooler types are designed so the sample bottles and ice packs fit snugly within preformed styrofoam cushioning and insulating packing material.

Shipping Procedures

1. All samples will be delivered by an express carrier within 48 hours of sample collection. Alternatively, samples may be delivered directly to the laboratory or laboratory service center or a laboratory courier may be used for sample pickup.
2. If parameters with short holding times are required (e.g., VOCs [EnCore™ Sampler], nitrate, nitrite, ortho-phosphate and BOD), sampling personnel will take precautions to ship or deliver samples to the laboratory so that the holding times will not be exceeded.
3. Samples must be maintained at 4°C±2°C until shipment and through receipt at the laboratory
4. All shipments must be in accordance with DOT regulations and ARCADIS dangerous goods shipping SOPs.

5. When the samples are received by the laboratory, laboratory personnel will complete the chain-of-custody by recording the date and time of receipt of samples, measuring and recording the internal temperature of the shipping container, and checking the sample identification numbers on the containers to ensure they correspond with the chain-of-custody forms.

Any deviations between the chain-of-custody and the sample containers, broken containers, or temperature excursions will be communicated to ARCADIS immediately by the laboratory.

VII. Waste Management

Not applicable

VIII. Data Recording and Management

Chain-of-custody records will be transmitted to the ARCADIS PM or designee at the end of each day unless otherwise directed by the ARCADIS PM. The sampling team leader retains copies of the chain-of-custody forms for filing in the project file. Record retention shall be in accordance with project requirements.

IX. Quality Assurance

Chain-of-custody forms will be legibly completed in accordance with the applicable project documents such as Sampling and Analysis Plan (SAP), Quality Assurance Project Plan (QAPP), Work Plan, or other project guidance documents. A copy of the completed chain-of-custody form will be sent to the ARCADIS Project Manager or designee for review.

X. References

Not Applicable

Attachment 1



ID#:

CHAIN OF CUSTODY & LABORATORY ANALYSIS REQUEST FORM

Page ____ of ____

Lab Work Order #

[illegible]



F-02

Soil Drilling and Sample Collection

Soil Drilling and Sample Collection

Rev. #: 2

Rev Date: March 8, 2011

I. Scope and Application

Overburden drilling is commonly performed using the hollow-stem auger drilling method. Other drilling methods suitable for overburden drilling, which are sometimes necessary due to site-specific geologic conditions, include: drive-and-wash, spun casing, Rotasonic, dual-rotary (Barber Rig), and fluid/mud rotary. Direct-push techniques (e.g., Geoprobe or cone penetrometer) may also be used. The drilling method to be used at a given site will be selected based on site-specific consideration of anticipated drilling depths, site or regional geologic knowledge, types of sampling to be conducted, required sample quality and volume, and cost.

No oils or grease will be used on equipment introduced into the boring (e.g., drill rod, casing, or sampling tools).

II. Personnel Qualifications

The Project Manager (a qualified geologist, environmental scientist, or engineer) will identify the appropriate soil boring locations, depth and soil sample intervals in a written plan.

Personnel responsible for overseeing drilling operations must have at least 16 hours of prior training overseeing drilling activities with an experienced geologist, environmental scientist, or engineer with at least 2 years of prior experience.

III. Equipment List

The following materials will be available during soil boring and sampling activities, as required:

- Site Plan with proposed soil boring/well locations;
- Work Plan or Field Sampling Plan (FSP), and site Health and Safety Plan (HASP);
- personal protective equipment (PPE), as required by the HASP;
- drilling equipment required by the American Society for Testing and Materials (ASTM) D 1586, when performing split-spoon sampling;
- disposable plastic liners, when drilling with direct-push equipment;
- appropriate soil sampling equipment (e.g., stainless steel spatulas, knife);

- equipment cleaning materials;
- appropriate sample containers and labels;
- chain-of-custody forms;
- insulated coolers with ice, when collecting samples requiring preservation by chilling;
- photoionization detector (PID) or flame ionization detector (FID); and
- field notebook and/or personal digital assistant (PDA).

IV. Cautions

Prior to beginning field work, underground utilities in the vicinity of the drilling areas will be identified by one of the following three actions (lines of evidence):

- Contact the State One Call
- Obtain a detailed site utility plan drawn to scale, preferably an “as-built” plan
- Conduct a detailed visual site inspection

In the event that one or more of the above lines of evidence cannot be conducted, or if the accuracy of utility location is questionable, a minimum of one additional line of evidence will be utilized as appropriate or suitable to the conditions. Examples of additional lines of evidence include but are not limited to:

- Private utility locating service
- Research of state, county or municipal utility records and maps including computer drawn maps or geographical information systems (GIS)
- Contact with the utility provider to obtain their utility location records
- Hand augering or digging
- Hydro-knife
- Air-knife
- Radio Frequency Detector (RFD)

- Ground Penetrating Radar (GPR)
- Any other method that may give ample evidence of the presence or location of subgrade utilities.

Overhead power lines also present risks and the following safe clearance must be maintained from them.

Power Line Voltage Phase to Phase (kV)	Minimum Safe Clearance (feet)
50 or below	10
Above 50 to 200	15
Above 200 to 350	20
Above 350 to 500	25
Above 500 to 750	35
Above 750 to 1,000	35

ANSI Standard B30.5-1994, 5-3.4.5

Avoid using drilling fluids or materials that could impact groundwater or soil quality, or could be incompatible with the subsurface conditions.

Water used for drilling and sampling of soil or bedrock, decontamination of drilling/sampling equipment, or grouting boreholes upon completion will be of a quality acceptable for project objectives. Testing of water supply should be considered.

Specifications of materials used for backfilling borehole will be obtained, reviewed and approved to meet project quality objectives.

V. Health and Safety Considerations

Field activities associated with overburden drilling and soil sampling will be performed in accordance with a site-specific HASP, a copy of which will be present on site during such activities.

VI. Procedure

Drilling Procedures

The drilling contractor will be responsible for obtaining accurate and representative samples; informing the supervising geologist of changes in drilling pressure; and

keeping a separate general log of soils encountered, including blow counts (i.e., the number of blows from a soil sampling drive weight [140 pounds] required to drive the split-barrel sampler in 6-inch increments). The term “samples” means soil materials from particular depth intervals, whether or not portions of these materials are submitted for laboratory analysis. Records will also be kept of occurrences of premature refusal due to boulders or construction materials that may have been used as fill. Where a boring cannot be advanced to the desired depth, the boring will be abandoned and an additional boring will be advanced at an adjacent location to obtain the required sample. Where it is desirable to avoid leaving vertical connections between depth intervals, the borehole will be sealed using cement and/or bentonite. Multiple refusals may lead to a decision by the supervising geologist to abandon that sampling location.

Soil Characterization Procedures

Soils encountered while drilling soil borings will be collected using one of the following methods:

- 2-inch split-barrel (split-spoon) sampler, if using the ASTM D 1586 - Standard Test Method for Penetration Test and Split-Barrel Sampling of Soils
- Plastic internal soil sample sleeves if using direct-push drilling.

Soils are typically field screened with an FID or PID at sites where volatile organic compounds are present in the subsurface. Field screening is performed using one of the following methods:

- Upon opening the sampler, the soil is split open and the PID or FID probe is placed in the opening and covered with a gloved hand. Such readings should be obtained at several locations along the length of the sample
- A portion of the collected soil is placed in a jar, which is covered with aluminum foil, sealed, and allowed to warm to room temperature. After warming, the cover is removed, the foil is pieced with the FID or PID probe, and a reading is obtained.

Samples selected for laboratory analysis will be handled, packed, and shipped in accordance with the procedures outlined in the Work Plan, FSP, or Chain-of-Custody, Handling, Packing, and Shipping SOP.

A geologist will be onsite during drilling and sampling operations to describe each soil interval on the soil boring log, including:

- percent recovery;
- structure and degree of sample disturbance;
- soil type;
- color;
- moisture condition;
- density;
- grain-size;
- consistency; and
- other observations, particularly relating to the presence of waste materials

Further details regarding geologic description of soils are presented in the Soil Description SOP.

Particular care will be taken to fully describe any sheens observed, oil saturation, staining, discoloration, evidence of chemical impacts, or unnatural materials.

VII. Waste Management

Water generated during cleaning procedures will be collected and contained onsite in appropriate containers for future analysis and appropriate disposal.

PPE (such as gloves, disposable clothing, and other disposable equipment) resulting from personnel cleaning procedures and soil sampling/handling activities will be placed in plastic bags. These bags will be transferred into appropriately labeled 55-gallon drums or a covered roll-off box for appropriate disposal.

Soil materials will be placed in sealed 55-gallon steel drums or covered roll-off boxes and stored in a secured area. Once full, the material will be analyzed to determine the appropriate disposal method.

VIII. Data Recording and Management

The supervising geologist or scientist will be responsible for documenting drilling events using a bound field notebook and/or PDA to record all relevant information in a clear and concise format. The record of drilling events will include:

- start and finish dates of drilling;
- name and location of project;
- project number, client, and site location;
- sample number and depths;
- blow counts and recovery;
- depth to water;
- type of drilling method;
- drilling equipment specifications, including the diameter of drilling tools;
- documentation of any elevated organic vapor readings;
- names of drillers, inspectors, or other people onsite; and
- weather conditions.

IX. Quality Assurance

Equipment will be cleaned prior to use onsite, between each drilling location, and prior to leaving the site. Drilling equipment and associated tools, including augers, drill rods, sampling equipment, wrenches, and other equipment or tools that may have come in contact with soils and/or waste materials will be cleaned with high-pressure steam-cleaning equipment using a potable water source. The drilling equipment will be cleaned in an area designated by the supervising engineer or geologist that is located outside of the work zone. More elaborate cleaning procedures may be required for reusable soil samplers (split-spoons) when soil samples are obtained for laboratory analysis of chemical constituents.

X. References

American Society of Testing and Materials (ASTM) D 1586 - *Standard Test Method for Penetration Test and Split-Barrel Sampling of Soils*.

F-15

Water-Level and NAPL Thickness
Measurement

Water-Level and NAPL Thickness Measurement Procedures

Rev. #: 0

Rev Date: February 27, 2009

I. Scope and Application

Monitoring well water levels and thickness of non-aqueous phase liquids (NAPLs) will be determined, as appropriate, to develop groundwater elevation contour maps and to assess the presence or absence of NAPL in wells. This SOP applies to light and/or dense NAPLs (LNAPLs and DNAPLs, respectively). In addition, because this SOP describes water-level measurement from surveyed measurement points, this SOP can be followed, to obtain surface water level measurements from surveyed measurement points.

Fluid levels will be measured using an electric water-level probe and/or NAPL-water interface probe from established reference points. Reference points are surveyed, and are established at the highest point at the top of well riser, and will be based on mean sea level, or local/onsite datum. The Operating and Maintenance (O&M) Instruction Manual for the electric water level probe and/or interface probe should be reviewed prior to commencing work for safe and accurate operation.

II. Personnel Qualifications

Individuals conducting fluid level measurements will have been trained in the proper use of the instruments, including their use for measuring fluid levels and the bottom depth of wells. In addition, ARCADIS field sampling personnel will have current health and safety training including 40-hour HAZWOPER training, site supervisor training, site-specific training, first aid, and CPR, as needed. In addition, ARCADIS field sampling personnel will be versed in the relevant SOPs and possess the required skills and experience necessary to successfully complete the desired field work. ARCADIS field personnel will also be compliant with client-specific training requirements, such as (but not limited to) LPS or other behavior-based training, and short-service employee restrictions.

III. Equipment List

The following materials, as required, shall be available during fluid level measurements.

- photoionization detector (PID)
- appropriate health and safety equipment, as specified in the site Health and Safety Plan (HASp)

- laboratory-type soap (Alconox or equivalent), methanol/hexane rinse, potable water, distilled water, and/or other equipment that may be needed for decontamination purposes
- electronic NAPL-water interface probe
- electronic water-level meter
- 6-foot engineer's rule
- portable containers
- plastic sheeting
- field logbook and/or personal digital assistant (PDA)
- indelible ink pen
- digital camera (optional, if allowed by site policy)

IV. Cautions

Electronic water-level probes and NAPL-water interface probes can sometimes produce false-positive readings. For example, if the inside surface of the well has condensation above the water level, then an electronic water-level probe may produce a signal by contacting the side of the well rather than the true water level in the well. In addition, NAPL-water interface probes can sometimes indicate false positive signals when contacting a sediment layer on the bottom of a well. In contrast, a NAPL-water interface probe may produce a false-negative (no signal) if a floating layer of non-aqueous phase liquid (NAPL) is too thin, such as a film or sheen. To produce reliable data, the electronic water level probe and/or interface probe should be raised and lowered several times at the approximate depth where the instrument produces a tone indicating a fluid interface to verify consistent, repeatable results. In addition, a bottom-loading bailer should periodically be used to check for the presence of NAPLs rather than relying solely on the NAPL-water interface probe.

The graduated tape or cable with depth markings is designed to indicate the depth of the electronic sensor that detects the fluid interface, but not the depth of the bottom of the instrument. When using these devices to measure the total well depth, the additional length of the instrument below the electronic sensor must be added to the apparent well depth reading, as observed on the tape or cable of the instrument, to obtain the true total depth of the well. If the depth markings on the tape or cable are

worn or otherwise difficult to read, extra care must be taken in obtaining the depth readings.

V. Health and Safety Considerations

The HASP will be followed, as appropriate, to ensure the safety of field personnel. Access to wells may expose field personnel to hazardous materials such as contaminated groundwater or NAPL. Other potential hazards include stinging insects that may inhabit well heads, other biologic hazards, and potentially the use of sharp cutting tools (scissors, knife). Appropriate personal protective equipment (PPE) will be worn during these activities. Field personnel will thoroughly review client-specific health and safety requirements, which may preclude the use of fixed/folding-blade knives.

VI. Procedure

Calibration Procedures

If there is any uncertainty regarding the accuracy of the tape or cable associated with the electronic water-level probe or NAPL-water interface probe, it should be checked versus a standard length prior to use to assess if the tape or cable above the meter has been correctly calibrated by the manufacturer, and to identify evidence of tape or cable stretching, etc.

1. Measure the lengths between markers on the cable with a 6-foot engineer's rule or a fiberglass engineer's tape. The tape or cable associated with the electronic water-level probe or NAPL-water interface probe should be checked for the length corresponding to the deepest total well depth to be monitored during the data collection event.
2. If the length designations on the tape or cable associated with the electronic water-level probe or NAPL-water interface probe are found to be incorrect, the probe will not be used until it is repaired by the manufacturer.
3. Record verification of this calibration process in field logbook or PDA.

Measurement Procedures

The detailed procedure for obtaining fluid level depth measurements is as follows. Field notes on logs will be treated as secured documentation and indelible ink will be used. As a general rule, the order of measuring should proceed from the least to most contaminated monitoring wells, based on available data.

1. Identify site and well number in field logbook using indelible ink, along with date, time, personnel, and weather conditions.
2. Field personnel will avoid activities that may introduce contamination into monitoring wells. Activities such as dispensing gasoline into vehicles or generators should be accomplished well in advance of obtaining field measurements.
3. Don PPE as required by the HASP..
4. Clean the NAPL/water interface probe and cable in accordance with the appropriate cleaning procedures. Down-hole instrumentation should be cleaned prior to obtaining readings at the first monitoring well and upon completion of readings at each well.
5. Clean the NAPL/water level interface probe and cable with a soapy (Alconox) water rinse followed by a solvent rinse (if appropriate based on site-specific constituents of concern) an analyte-free water rinse Contain rinse water in a portable container that will be transferred to an on-site container.
6. Put clean plastic sheeting on the ground next to the well.
7. Unlock and open the well cover while standing upwind from the well. Place the well cap on the plastic sheeting.
8. Locate a measuring reference point on the well casing. If one is not found, initiate a reference point at the highest discernable point on the inner casing (or outer if an inner casing is not present) by notching with a hacksaw, or using an indelible marker. All down-hole measurements will be taken from the reference point established at each well on the inner casing (on the outer only if an inner casing is not present).
9. Measure to the nearest hundredth of a foot and record the height of the inner and outer casings (from reference point, as appropriate) to ground level.
10. Record the inside diameter of the well casing in the field log.
11. If an electronic water level probe is used to measure the water level, lower the probe until it emits a signal (tone and or light) indicating the top of the water surface. Gently raise and lower the instrument through this interface to confirm its depth. Measure and record the depth of the water surface, and the total well depth, to the nearest hundredth of a foot from the reference point at the top of

the well. Lower the probe to the bottom of the well to obtain a total depth measurement.

12. If a NAPL/water interface probe is being used to measure the depth and thickness of NAPL, lower the instrument until it emits a signal (tone and or light) indicating whether LNAPL is present. Continue to lower the NAPL/water level interface probe until it indicates the top of water. Lower the probe to the bottom of the well to obtain a total depth measurement. Note also of the depth indicating the bottom of water and top of DNAPL layer, if any, based on the signal emitted by the interface probe. At each fluid interface, gently raise and lower the instrument through each the interface to confirm its depth. Measure to the nearest hundredth of a foot and record the depth of each fluid interface, and the total well depth, from the reference point.
13. Clean the NAPL/water interface probe and cable in accordance with the appropriate cleaning procedures.
14. If using a bailer to confirm the presence/absence of NAPL, the bailer should either have been previously dedicated to the well, or be a new previously unused bailer.
15. Compare the depth of the well to previous records, and note any discrepancy.
16. Lock the well when all activities are completed.

VII. Waste Management

Decontamination fluids, PPE, and other disposable equipment will be properly stored on site in labeled containers and disposed of properly. Be certain that waste containers are properly labeled and documented in the field log book. Review appropriate waste management SOPs, which may be state- or client-specific.

VIII. Data Recording and Management

Fluid level measurement data will be recorded legibly on “write-in-the-rain” field notebook in indelible pen and/or a PDA. Field situations such as apparent well damage or suspected tampering, or other observations of conditions that may result in compromised data collection will be photographically documented where practicable.

IX. Quality Assurance

As described in the detailed procedure, the electronic water-level meter and/or NAPL-water interface probe will be calibrated prior to use versus an engineer's rule to ensure accurate length demarcations on the tape or cable. Fluid interface measurements will be verified by gently raising and lowering the instrument through each interface to confirm repeatable results.

X. References

No literature references are required for this SOP.

F-16

Standard Groundwater Sampling
for Monitoring Wells

Standard Groundwater Sampling for Monitoring Wells

Rev. #: 1

Rev Date: July 16, 2008

I. Scope and Application

This Standard Operating Procedure (SOP) describes the procedures to be used to collect groundwater samples using traditional purging and sampling techniques. For low-flow purging techniques, please refer to the Low Flow Purging SOP. Monitoring wells must be developed after installation at least 1 week prior to groundwater sample collection. Monitoring wells will not be sampled until the well has been developed. During precipitation events, groundwater sampling will be discontinued until precipitation ceases or a cover has been erected over the sampling area and monitoring well.

Both filtered and unfiltered groundwater samples may be collected using this SOP. Filtered samples may be obtained using a 1.0-, 0.45-, or 0.1-micron disposable filter.

II. Personnel Qualifications

ARCADIS personnel directing, supervising, or leading groundwater sample collection activities should have a minimum of 2 years of previous groundwater sampling experience. Field employees with less than 6 months of experience should be accompanied by a supervisor (as described above) to ensure that proper sample collection techniques are employed.

III. Equipment List

The following materials shall be available, as required, during groundwater sampling:

- site plan of monitoring well locations and site Field Sampling Plan (FSP);
- appropriate health and safety equipment, as specified in the site Health and Safety Plan (HASP);
- photoionization detector (PID) or flame ionization detector (FID), as needed, in accordance with the HASP;
- monitoring well construction logs or tables and historical water level information, if available;
- dedicated plastic sheeting or other clean surface to prevent sample contact with the ground;
- if bailers are to be used in sampling:

- appropriate dedicated bottom-loading, bottom-emptying bailers (i.e., polyvinyl chloride [PVC], Teflon, or stainless steel);
 - polypropylene rope;
- if submersible pumps are to be used in sampling:
 - dedicated tubing and other equipment necessary for purging;
 - generator or battery for operation of pumps, if required;
 - a pump selected in accordance with the FSP or Work Plan (parameter-specific [e.g., submersible, bladder, peristaltic]);
- graduated buckets to measure purge water;
- water-level or oil/water interface probe, in accordance with the FSP or Work Plan;
- conductivity/temperature/pH meter;
- down-hole dissolved oxygen meter, oxidation reduction potential meter, and/or turbidity meter, if specified in the FSP;
- water sample containers appropriate for the analytical method(s) with preservative, as needed (parameter-specific);
- filter, as needed, in accordance with the analytical method and parameter;
- appropriate blanks (trip blank supplied by the laboratory), as specified in the FSP;
- Ziploc-type freezer bags for use as ice containers;
- appropriate transport containers (coolers) with ice and appropriate labeling, packing, and shipping materials;
- appropriate groundwater sampling log (example attached);
- chain-of-custody forms;
- site map with well locations and groundwater contour maps;

- keys to wells and contingent bolt cutters for rusted locks and replacement keyed-alike locks; and
- drums or other containers for purge water, as specified by the site investigation derived waste (IDW) management plan.

IV. Cautions

If heavy precipitation occurs and no cover over the sampling area and monitoring well can be erected, sampling must be discontinued until adequate cover is provided. Rain water could contaminate groundwater samples.

Remember that field logs and some forms are considered to be legal documents. All field logs and forms should therefore be filled out in indelible ink.

It may be necessary to field filter some parameters (e.g., metals) prior to collection, depending on preservation, analytical method, and project quality objectives.

Check monitoring well logs for use of bentonite pellets. Make note of potential use of bentonite pellets on the groundwater sampling log. Coated bentonite pellets have been found to contaminate monitoring wells with elevated levels of acetone.

Store and/or stage empty and full sample containers and coolers out of direct sunlight.

To mitigate potential cross-contamination, groundwater samples are to be collected in a pre-determined order from least impacted to more impacted based on previous analytical data. If no analytical data are available, samples are to be collected in the following order:

1. First sample the upgradient well(s).
2. Next, sample the well located furthest downgradient of the interpreted or known source.
3. The remaining wells should be progressively sampled in order from downgradient to upgradient, such that the wells closest to the interpreted or known source are sampled last.

Be careful not to over-tighten lids with Teflon liners or septa (e.g., 40 mL vials). Over-tightening can impair the integrity of the seal.

V. Health and Safety Considerations

If thunder or lighting is present, discontinue sampling until 30 minutes have passed after the last occurrence of thunder or lighting.

VI. Procedure

The procedures to sample monitoring wells will be as follows:

1. Don safety equipment, as required in the HASP. Depending on site-specific security and safety considerations, this often must be done prior to entering the work area.
2. Review equipment list (Section III above) to confirm that the appropriate equipment has been acquired.
3. Record site and monitoring well identification on the groundwater sampling log, along with date, arrival time, and weather conditions. Also identify the personnel present, equipment utilized, and other relevant data requested on the log.
4. Label all sample containers with indelible ink.
5. Place plastic sheeting adjacent to the well for use as a clean work area, if conditions allow. Otherwise, prevent sampling equipment from contacting the ground or other surface that could compromise sample integrity.
6. Remove lock from well and if rusted or broken, replace with a new brass keyed-alike lock.
7. Unlock and open the well cover while standing upwind of the well. Remove well cap and place on the plastic sheeting.
8. Set the sampling device, meters, and other sampling equipment on the plastic sheeting. If a dedicated sampling device stored in the well is to be used, this may also be set temporarily on the plastic sheeting, for convenience. However, if a dedicated sampling device is stored below the water table, removing it may compromise water-level data, so water level measurements should be taken prior to removing the device.
9. Obtain a water-level depth and bottom-of-well depth using an electric well probe and record on the groundwater sampling log using indelible ink. Clean the probe(s) after each use in accord with the FSP or the equipment

decontamination SOP.

Note: Water levels may be measured at all wells prior to initiating any sampling activities, depending on FSP requirements.

10. Calculate the number of gallons of water in the well using the length of water column (in feet). Record the well volume on the groundwater sampling log using indelible ink.
11. Remove the required purge volume of water from the well (measure purge water volume in measuring buckets). The required purge volume will be three to five well volumes (the water column in the well screen and casing) unless the well runs dry, in which case, the water that comes into the well will be sampled (USEPA, 1996). In any case, the pumping rate will be decreased during sampling to limit the potential for volatilization of organics potentially present in the groundwater.
12. Field parameter measurements will be periodically collected in accord with FSP specifications. The typical time intervals of field parameter measurement are (1) after each well volume removed, and (2) before sampling. If the field parameters are being measured above-ground (rather than with a downhole probe), then the final pre-sampling parameter measurement should be collected at the reduced flow rate to be used during sampling. The physical appearance of the purged water should be noted on the groundwater sampling log. In addition, water level measurements should be collected and recorded to verify that the well purging is in accord with the guidelines set forth in the previous step.
13. Unless otherwise specified by the applicable regulatory agencies, all purge water will be contained. Contained purge water will be managed in accordance with the FSP or Work Plan. If historical concentrations in the well are less than federal or state regulated concentrations appropriate for current land use, *and permission has been granted by the oversight regulatory agency* to dispose of clean purge water on the ground next to the well(s), then purge water will be allowed to infiltrate into the ground surface downgradient from the monitoring well after the well is sampled.
14. After the appropriate purge volume of groundwater in the well has been removed, or if the well has been bailed dry and allowed to recover, obtain the groundwater sample needed for analysis with the dedicated bailer or from the dedicated sampling tubing, pour the groundwater directly from the sampling device into the appropriate container in the order of volatilization sensitivity of

the parameters sampled, and tightly screw on the cap (snug, but not too tight). The suggested order for sample parameter collection, based on volatilization sensitivity, is presented below:

- a. volatile organic compounds (VOCs);
 - b. semi-volatile organic compounds (SVOCs);
 - c. polychlorinated biphenyls (PCBs)/pesticides;
 - d. metals; and
 - e. wet chemistry.
15. When sampling for volatiles, water samples will be collected directly from the bailer or dedicated tubing into 40 mL vials with Teflon-lined septa.
 16. For other analytical samples, sample containers for each analyte type should be filled in the order specified by the FSP. If a bailer is used, then the sample for dissolved metals and/or filtered PCBs should either be placed directly from the bailer into a pressure filter apparatus or pumped directly from the bailer with a peristaltic pump, through an in-line filter, into the pre-preserved sample bottle. If dedicated sample tubing is used, then the filter should be installed in-line just prior to filtered sample collection.
 17. If sampling for total and filtered metals and/or PCBs, a filtered and unfiltered sample will be collected. Sample filtration for the filtered sample will be performed in the field utilizing a pump prior to preservation. Attach (clamp) a new 1.0-, 0.45-, or 0.1-micron filter to the discharge tubing of the pump (note the filter flow direction). Turn the pump on and allow 100 mL (or manufacturer recommended amount) of fluid through the filter before sample collection. Dispense the filtered liquid directly into the laboratory sample bottles. If bailers are used for purging and sampling, a proper volume of purge water will be placed in a disposable or decontaminated polyethylene container and pumped through the filter and into the sample container using a peristaltic pump.
 18. Place the custody seal around the cap and the sampler container, if required. Note the time on the sample label. Secure with packing material and maintain at approximately 4°C on wet ice contained in double Ziploc-type freezer bags during storage in an insulated, durable transport container.
 19. Replace the well cap and lock well, or install a new lock if needed.

20. Record the time sampling procedures were completed on the appropriate field logs (using indelible ink).
21. Complete the procedures for chain-of-custody, handling, packing, and shipping. Chain-of-custody forms should be filled out and checked against the labels on the sample containers progressively after each sample is collected.
22. Place all disposable sampling materials (such as plastic sheeting, disposable tubing or bailers, and health and safety equipment) in appropriate containers.
23. If new locks were installed, forward copies of the keys to the client Project Manager (PM) and ARCADIS PM at the end of the sampling activities.

VII. Waste Management

Purge water will be managed as specified in the FSP or Work Plan, and according to state and/or federal requirements. Personal protective equipment (PPE) and decontaminated fluids will be contained separately and staged at the sampling location. Containers must be labeled at the time of collection. Labels will include date, location(s), site name, city, state, and description of matrix contained (e.g., soil, groundwater, PPE). General guidelines for IDW management are set forth in a separate IDW management SOP.

VIII. Data Recording and Management

Initial field logs and chain-of-custody records will be transmitted to the ARCADIS PM at the end of each day unless otherwise directed by the PM. The groundwater team leader retains copies of the groundwater sampling logs. All field data should be recorded in indelible ink.

IX. Quality Assurance

Field-derived quality assurance blanks will be collected as specified in the FSP, depending on the project quality objectives. Typically, field rinse blanks will be collected when non-dedicated equipment is used during groundwater sampling. Field rinse blanks will be used to confirm that decontamination procedures are sufficient and samples are representative of site conditions. Trip blanks for VOCs, which aid in the detection of contaminants from other media, sources, or the container itself, will be kept with the coolers and the sample containers throughout the sampling activities.

X. References

USEPA. 1986. RCRA Groundwater Monitoring Technical Enforcement Guidance Document (September 1986).

USEPA. 1991. Handbook Groundwater, Volume ii Methodology, Office of Research and Development, Washington, DC. USEPN62S, /6-90/016b (July, 1991).

U.S. Geological Survey (USGS). 1977. National Handbook of Recommended Methods for Water-Data Acquisition: USGS Office of Water Data Coordination. Reston, Virginia.

F-17

Low-Flow Groundwater Purging
and Sampling Procedures for
Monitoring Wells

**Low-Flow Groundwater
Purging and Sampling
Procedures for Monitoring
Wells**

Rev. #: 4

Rev Date: February 2, 2011

I. Scope and Application

Groundwater samples will be collected from monitoring wells to evaluate groundwater quality. The protocol presented in this standard operating procedure (SOP) describes the procedures to be used to purge monitoring wells and collect groundwater samples. This protocol has been developed in accordance with the United States Environmental Protection Agency (USEPA) Region I Low Stress (Low Flow) Purging and Sampling Procedures for the Collection of Groundwater Samples from Monitoring Wells (USEPA SOP No. GW0001; July 30, 1996). Both filtered and unfiltered groundwater samples may be collected using this low-flow sampling method. Filtered samples will be obtained using a 0.45-micron disposable filter. No wells will be sampled until well development has been performed in accordance with the procedures presented in the SOP titled Monitoring Well Development, unless that well has been sampled or developed within the prior 1-year time period. Groundwater samples will not be collected within 1 week following well development.

II. Personnel Qualifications

ARCADIS personnel directing, supervising, or leading groundwater sample collection activities should have a minimum of 2 years of previous groundwater sampling experience. ARCADIS personnel providing assistance to groundwater sample collection and associated activities should have a minimum of 6 months of related experience or an advanced degree in environmental sciences, engineering, hydrogeology, or geology.

The supervisor of the groundwater sampling team will have at least 1 year of previous supervised groundwater sampling experience.

Prior to mobilizing to the field, the groundwater sampling team should review and be thoroughly familiar with relevant site-specific documents including but not limited to the site work plan, field sampling plan, QAPP, HASP, and historical information. Additionally, the groundwater sampling team should review and be thoroughly familiar with documentation provided by equipment manufacturers for all equipment that will be used in the field prior to mobilization.

III. Equipment List

Specific to this activity, the following materials (or equivalent) will be available:

- Health and safety equipment (as required in the site Health and Safety Plan [HASP]).

- Site Plan, well construction records, prior groundwater sampling records (if available).
- Sampling pump, which may consist of one or more of the following:
 - submersible pump (e.g., Grundfos Redi-Flo 2);
 - peristaltic pump (e.g., ISCO Model 150); and/or
 - bladder pump (e.g., Marschalk System 1, QED Well Wizard, Geotech, etc.).
- Appropriate controller and power source for pump:
 - Submersible and peristaltic pumps require electric power from either a generator or a deep cell battery.
 - Submersible pumps such as Grundfos require a pump controller to run the pump
 - Bladder pumps require a pump controller and a gas source (e.g., air compressor or compressed N₂ or CO₂ gas cylinders).
- Teflon[®] tubing or Teflon[®]-lined polyethylene tubing of an appropriate size for the pump being used. For peristaltic pumps, dedicated Tygon[®] tubing (or other type as specified by the manufacturer) will also be used through the pump apparatus.
- Water-level probe (e.g., Solinst Model 101).
- Water-quality (temperature/pH/specific conductivity/ORP/turbidity/dissolved oxygen) meter and flow-through measurement cell. Several brands may be used, including:
 - YSI 6-Series Multi-Parameter Instrument;
 - Hydrolab Series 3 or Series 4a Multiprobe and Display; and/or
 - Horiba U-10 or U-22 Water Quality Monitoring System.
- Supplemental turbidity meter (e.g., Horiba U-10, Hach 2100P, LaMotte 2020). Turbidity measurements collected with multi-parameter meters have been shown to sometimes be unreliable due to fouling of the optic lens of the

turbidity meter within the flow-through cell. A supplemental turbidity meter will be used to verify turbidity data during purging if such fouling is suspected. Note that industry improvements may eliminate the need for these supplemental measurements in the future.

- Appropriate water sample containers (supplied by the laboratory).
- Appropriate blanks (trip blank supplied by the laboratory).
- 0.45-micron disposable filters (if field filtering is required).
- Large glass mixing container (if sampling with a bailer).
- Teflon[®] stirring rod (if sampling with a bailer).
- Cleaning equipment.
- Groundwater sampling log (attached) or bound field logbook.

Note that in the future, the client may acquire different makes/models of some of this equipment if the listed makes/models are no longer available, or as a result of general upgrades or additional equipment acquisitions. In the event that the client uses a different make/model of the equipment listed, the client will use an equivalent type of equipment (e.g., pumps, flow-through analytical cells) and note the specific make/model of the equipment used during a sampling event on the groundwater sampling log. In addition, should the client desire to change to a markedly different sampling methodology (e.g., discrete interval samplers, passive diffusion bags, or a yet to be developed technique), the client will submit a proposed SOP for the new methodology for USEPA approval prior to implementing such a change.

The maintenance requirements for the above equipment generally involve decontamination or periodic cleaning, battery charging, and proper storage, as specified by the manufacturer. For operational difficulties, the equipment will be serviced by a qualified technician.

IV. Cautions

If heavy precipitation occurs and no cover over the sampling area and monitoring well can be erected, sampling must be discontinued until adequate cover is provided. Rain water could contaminate groundwater samples.

Do not use permanent marker or felt-tip pens for labels on sample container or sample coolers – use indelible ink. The permanent markers could introduce volatile constituents into the samples.

It may be necessary to field filter some parameters (e.g., metals) prior to collection, depending on preservation, analytical method, and project quality objectives.

Store and/or stage empty and full sample containers and coolers out of direct sunlight.

To mitigate potential cross-contamination, groundwater samples are to be collected in a pre-determined order from least impacted to impacted based on previous analytical data. If no analytical data are available, samples are collected in order of upgradient, then furthest downgradient to source area locations.

Be careful not to over-tighten lids with Teflon liners or septa (e.g., 40 mL vials). Over-tightening can cause the glass to shatter or impair the integrity of the Teflon seal.

V. Health and Safety Considerations

Use caution and appropriate cut resistant gloves when tightening lids to 40 mL vials. These vials can break while tightening and can lacerate hand. Amber vials (thinner glass) are more prone to breakage.

If thunder or lightning is present, discontinue sampling and take cover until 30 minutes have passed after the last occurrence of thunder or lightning.

Use caution when removing well caps as well may be under pressure, cap can dislodge forcefully and cause injury.

Use caution when opening protective casing on stickup wells as wasps frequently nest inside the tops of the covers. Also watch for fire ant mounds near well pads when sampling in the south or western U.S.

VI. Procedure

Groundwater will be purged from the wells using an appropriate pump. Peristaltic pumps will initially be used to purge and sample all wells when applicable. If the depth to water is below the sampling range of a peristaltic pump (approximately 25 feet), submersible pumps or bladder pumps will be used provided the well is constructed with a casing diameter greater than or equal to 2 inches (the minimum well diameter capable of accommodating such pumps). Bladder pumps are preferred over peristaltic and submersible pumps if sampling of VOCs is required to prevent volatilization. For smaller diameter wells where the depth to water is below the sampling range of a

peristaltic pump, alternative sampling methods (i.e., bailing or small diameter bladder pumps) will be used to purge and sample the groundwater. Purge water will be collected and containerized.

1. Calibrate field instruments according to manufacturer procedures for calibration.
2. Measure initial depth to groundwater prior to placement of pumps.
3. Prepare and install pump in well: For submersible and non-dedicated bladder pumps, decontaminate pump according to site decontamination procedures. Non-dedicated bladder pumps will require a new Teflon[®] bladder and attachment of an air line, sample discharge line, and safety cable prior to placement in the well. Attach the air line tubing to the air port on the top of the bladder pump. Attach the sample discharge tubing to the water port on the top of the bladder pump. Care should be taken not to reverse the air and discharge tubing lines during bladder pump set-up as this could result in bladder failure or rupture. Attach and secure a safety cable to the eyebolt on the top of bladder pump (if present, depending on pump model used). Slowly lower pump, safety cable, tubing, and electrical lines into the well to a depth corresponding to the approximate center of the saturated screen section of the well. Take care to avoid twisting and tangling of safety cable, tubing, and electrical lines while lowering pump into well; twisted and tangled lines could result in the pump becoming stuck in the well casing. Also, make sure to keep tubing and lines from touching the ground or other surfaces while introducing them into the well as this could lead to well contamination. If a peristaltic pump is being used, slowly lower the sampling tubing into the well to a depth corresponding to the approximate center of the saturated screen section of the well. The pump intake or sampling tube must be kept at least 2 feet above the bottom of the well to prevent mobilization of any sediment present in the bottom of the well.
4. If using a bladder pump, connect the air line to the pump controller output port. The pump controller should then be connected to a supply line from an air compressor or compressed gas cylinder using an appropriate regulator and air hose. Take care to tighten the regulator connector onto the gas cylinder (if used) to prevent leaks. Teflon tape may be used on the threads of the cylinder to provide a tighter seal. Once the air compressor or gas cylinder is connected to the pump controller, turn on the compressor or open the valve on the cylinder to begin the gas flow. Turn on the pump controller if an on/off switch is present and verify that all batteries are charged and fully operating before beginning to pump.
5. Connect the pump discharge water line to the bottom inlet port on the flow-through cell connected to the water quality meter.

6. Measure the water level again with the pump in the well before starting the pump. Start pumping the well at 200 to 500 milliliters (mL) per minute (or at lower site-specific rate if specified). The pump rate should be adjusted to cause little or no water level drawdown in the well (less than 0.3 feet below the initial static depth to water measurement) and the water level should stabilize. The water level should be monitored every 3 to 5 minutes (or as appropriate, lower flow rates may require longer time between readings) during pumping if the well diameter is of sufficient size to allow such monitoring. Care should be taken not to break pump suction or cause entrainment of air in the sample. Record pumping rate adjustments and depths to water. If necessary, pumping rates should be reduced to the minimum capabilities of the pump to avoid pumping the well dry and/or to stabilize indicator parameters. A steady flow rate should be maintained to the extent practicable. Groundwater sampling records from previous sampling events (if available) should be reviewed prior to mobilization to estimate the optimum pumping rate and anticipated drawdown for the well in order to more efficiently reach a stabilized pumping condition.

If the recharge rate of the well is very low, alternative purging techniques should be used, which will vary based on the well construction and screen position. For wells screened across the water table, the well should be pumped dry and sampling should commence as soon as the volume in the well has recovered sufficiently to permit collection of samples. For wells screened entirely below the water table, the well should be pumped until a stabilized level (which may be below the maximum displacement goal of 0.3 feet) can be maintained and monitoring for stabilization of field indicator parameters can commence. If a lower stabilization level cannot be maintained, the well should be pumped until the drawdown is at a level slightly higher than the bentonite seal above the well screen. Sampling should commence after one well volume has been removed and the well has recovered sufficiently to permit collection of samples.

During purging, monitor the field indicator parameters (e.g., turbidity, temperature, specific conductance, pH, etc.) every 3 to 5 minutes (or as appropriate). Field indicator parameters will be measured using a flow-through analytical cell or a clean container such as a glass beaker. Record field indicator parameters on the groundwater sampling log. The well is considered stabilized and ready for sample collection when turbidity values remain within 10% (or within 1 NTU if the turbidity reading is less than 10 NTU), the specific conductance and temperature values remain within 3%, ORP readings remain within ± 10 mV and pH remains within 0.1 units for three consecutive readings collected at 3- to 5-minute intervals (or other appropriate interval, alternate stabilization goals may exist in different geographic regions, consult the site-specific Work Plan for stabilization criteria). If the field indicator parameters do not stabilize within 1 hour of the start of purging, but the groundwater turbidity is

below the goal of 50 NTU and the values for all other parameters are within 10%, the well can be sampled. If the parameters have stabilized but the turbidity is not in the range of the 50 NTU goal, the pump flow rate should be decreased to a minimum rate of 100 mL/min to reduce turbidity levels as low as possible. Dissolved oxygen is extremely susceptible to various external influences (including temperature or the presence of bubbles on the DO meter); care should be taken to minimize the agitation or other disturbance of water within the flow-through cell while collecting these measurements. If air bubbles are present on the DO probe or in the discharge tubing, remove them before taking a measurement. If dissolved oxygen values are not within acceptable range for the temperature of groundwater (Attachment 1), then again check for and remove air bubbles on probe before re-measuring. If the dissolved oxygen value is 0.00 or less, then the meter should be serviced and re-calibrated. If the dissolved oxygen values are above possible results, then the meter should be serviced and re-calibrated.

During extreme weather conditions, stabilization of field indicator parameters may be difficult to obtain. Modifications to the sampling procedures to alleviate these conditions (e.g., measuring the water temperature in the well adjacent to the pump intake) will be documented in the field notes. If other field conditions exist that preclude stabilization of certain parameters, an explanation of why the parameters did not stabilize will also be documented in the field logbook.

7. Complete the sample label(s) and cover the label(s) with clear packing tape to secure the label onto the container.
8. After the indicator parameters have stabilized, collect groundwater samples by diverting flow out of the unfiltered discharge tubing into the appropriate labeled sample container. If a flow-through analytical cell is being used to measure field parameters, the flow-through cell should be disconnected after stabilization of the field indicator parameters and prior to groundwater sample collection. Under no circumstances should analytical samples be collected from the discharge of the flow-through cell. When the container is full, tightly screw on the cap. Samples should be collected in the following order: VOCs, TOC, SVOCs, metals and cyanide, and others (or other order as defined in the site-specific Work Plan).
9. If sampling for total and filtered metals and/or PCBs, a filtered and unfiltered sample will be collected. Install an in-line, disposable 0.45-micron particle filter on the discharge tubing after the appropriate unfiltered groundwater sample has been collected. Continue to run the pump until an initial volume of "flush" water has been run through the filter in accordance with the manufacturer's directions (generally 100 to 300 mL). Collect filtered groundwater sample by diverting flow

out of the filter into the appropriately labeled sample container. When the container is full, tightly screw on the cap.

10. Secure with packing material and store at 4°C in an insulated transport container provided by the laboratory.
11. Record on the groundwater sampling log or bound field logbook the time sampling procedures were completed, any pertinent observations of the sample (e.g., physical appearance, and the presence or lack of odors or sheens), and the values of the stabilized field indicator parameters as measured during the final reading during purging (Attachment 2 – Example Sampling Log).
12. Turn off the pump and air compressor or close the gas cylinder valve if using a bladder pump set-up. Slowly remove the pump, tubing, lines, and safety cable from the well. Do not allow the tubing or lines to touch the ground or any other surfaces which could contaminate them. .
13. If tubing is to be dedicated to a well, it should be folded to a length that will allow the well to be capped and also facilitate retrieval of the tubing during later sampling events. A length of rope or string should be used to tie the tubing to the well cap. Alternatively, if tubing and safety line are to be saved and reused for sampling the well at a later date they may be coiled neatly and placed in a clean plastic bag that is clearly labeled with the well ID. Make sure the bag is tightly sealed before placing it in storage.
14. Secure the well and properly dispose of personal protective equipment (PPE) and disposable equipment.
15. Complete the procedures for packaging, shipping, and handling with associated chain-of-custody.
16. Complete decontamination procedures for flow-through analytical cell and submersible or bladder pump, as appropriate.
17. At the end of the day, perform calibration check of field instruments.

If it is not technically feasible to use the low-flow sampling method, purging and sampling of monitoring wells may be conducted using the bailer method as outlined below:

1. Don appropriate PPE (as required by the HASP).
2. Place plastic sheeting around the well.

3. Clean sampling equipment.
4. Open the well cover while standing upwind of the well. Remove well cap and place on the plastic sheeting. Insert PID probe approximately 4 to 6 inches into the casing or the well headspace and cover with gloved hand. Record the PID reading in the field log. If the well headspace reading is less than 5 PID units, proceed; if the headspace reading is greater than 5 PID units, screen the air within the breathing zone. If the breathing zone reading is less than 5 PID units, proceed. If the PID reading in the breathing zone is above 5 PID units, move upwind from well for 5 minutes to allow the volatiles to dissipate. Repeat the breathing zone test. If the reading is still above 5 PID units, don appropriate respiratory protection in accordance with the requirements of the HASP. Record all PID readings. For wells that are part of the regular weekly monitoring program and prior PID measurements have not resulted in a breathing zone reading above 5 PID units, PID measurements will be taken monthly.
5. Measure the depth to water and determine depth of well by examining drilling log data or by direct measurement. Calculate the volume of water in the well (in gallons) by using the length of the water column (in feet), multiplying by 0.163 for a 2-inch well or by 0.653 for a 4-inch well. For other well diameters, use the formula:

$$\text{Volume (in gallons)} = \pi \text{ TIMES well radius (in feet) squared TIMES length of water column (in feet) TIMES 7.481 (gallons per cubic foot)}$$
6. Measure a length of rope or twine at least 10 feet greater than the total depth of the well. Secure one end of the rope to the well casing and secure the other end to the bailer. Test the knots and make sure the rope will not loosen. Check bailers so that all parts are intact and will not be lost in the well.
7. Lower bailer into well and remove one well volume of water. Contain all water in appropriate containers.
8. Monitor the field indicator parameters (e.g., turbidity, temperature, specific conductance, and pH). Measure field indicator parameters using a clean container such as a glass beaker or sampling cups provided with the instrument. Record field indicator parameters on the groundwater sampling log.
9. Repeat Steps 7 and 8 until three or four well volumes have been removed. Examine the field indicator parameter data to determine if the parameters have stabilized. The well is considered stabilized and ready for sample collection when turbidity values remain within 10% (or within 1 NTU if the turbidity reading is less than 10 NTU), the specific conductance and temperature values remain

within 3%, and pH remains within 0.1 units for three consecutive readings collected once per well volume removed.

10. If the field indicator parameters have not stabilized, remove a maximum of five well volumes prior to sample collection. Alternatively, five well volumes may be removed without measuring the field indicator parameters.
11. If the recharge rate of the well is very low, wells screened across the water table may be bailed dry and sampling should commence as soon as the volume in the well has recovered sufficiently to permit collection of samples. For wells screened entirely below the water table, the well should only be bailed down to a level slightly higher than the bentonite seal above the well screen. The well should not be bailed completely dry, to maintain the integrity of the seal. Sampling should commence as soon as the well volume has recovered sufficiently to permit sample collection.
12. Following purging, allow water level in well to recharge to a sufficient level to permit sample collection.
13. Complete the sample label and cover the label with clear packing tape to secure the label onto the container.
14. Slowly lower the bailer into the screened portion of the well and carefully retrieve a filled bailer from the well causing minimal disturbance to the water and any sediment in the well.
15. The sample collection order (as appropriate) will be as follows:
 - a. VOCs;
 - b. TOC;
 - c. SVOCs;
 - d. metals and cyanide; and
 - e. others.
16. When sampling for volatiles, collect water samples directly from the bailer into 40-mL vials with Teflon[®]-lined septa.
17. For other analytical samples, remove the cap from the large glass mixing container and slowly empty the bailer into the large glass mixing container. The

sample for dissolved metals and/or filtered PCBs should either be placed directly from the bailer into a pressure filter apparatus or pumped directly from the bailer with a peristaltic pump, through an in-line filter, into the pre-preserved sample bottle.

18. Continue collecting samples until the mixing container contains a sufficient volume for all laboratory samples.
19. Mix the entire sample volume with the Teflon[®] stirring rod and transfer the appropriate volume into the laboratory jar(s). Secure the sample jar cap(s) tightly.
20. If sampling for total and filtered metals and/or PCBs, a filtered and unfiltered sample will be collected. Sample filtration for the filtered sample will be performed in the field using a peristaltic pump prior to preservation. Install new medical-grade silicone tubing in the pump head. Place new Teflon[®] tubing into the sample mixing container and attach to the intake side of pump tubing. Attach (clamp) a new 0.45-micron filter (note the filter flow direction). Turn the pump on and dispense the filtered liquid directly into the laboratory sample bottles.
21. Secure with packing material and store at 4°C in an insulated transport container provided by the laboratory.
22. After sample containers have been filled, remove one additional volume of groundwater. Measure the pH, temperature, turbidity, and conductivity. Record on the groundwater sampling log or bound field logbook the time sampling procedures were completed, any pertinent observations of the sample (e.g., physical appearance, and the presence or lack of odors or sheens), and the values of the field indicator parameters.
23. Remove bailer from well, secure well, and properly dispose of PPE and disposable equipment.
24. If a bailer is to be dedicated to a well, it should be secured inside the well above the water table, if possible. Dedicated bailers should be tied to the well cap so that inadvertent loss of the bailer will not occur when the well is opened.
25. Complete the procedures for packaging, shipping, and handling with associated chain-of-custody.

VII. Waste Management

Materials generated during groundwater sampling activities, including disposable equipment, will be placed in appropriate containers. Containerized waste will be disposed of by the client consistent with the procedures identified in the HASP.

VIII. Data Recording and Management

Initial field logs and chain-of-custody records will be transmitted to the ARCADIS PM at the end of each day unless otherwise directed by the PM. The groundwater team leader retains copies of the groundwater sampling logs.

IX. Quality Assurance

In addition to the quality control samples to be collected in accordance with this SOP, the following quality control procedures should be observed in the field:

- Collect samples from monitoring wells in order of increasing concentration, to the extent known based on review of historical site information if available.
- Equipment blanks should include the pump and tubing (if using disposable tubing) or the pump only (if using tubing dedicated to each well).
- Collect equipment blanks after wells with higher concentrations (if known) have been sampled.
- Operate all monitoring instrumentation in accordance with manufacturer's instructions and calibration procedures. Calibrate instruments at the beginning of each day and verify the calibration at the end of each day. Record all calibration activities in the field notebook.
- Clean all groundwater sampling equipment prior to use in the first well and after each subsequent well using procedures for equipment decontamination.

X. References

United States Environmental Protection Agency (USEPA). 1986. RCRA Groundwater Monitoring Technical Enforcement Guidance Document (September 1986).

USEPA Region II. 1998. *Ground Water Sampling Procedure Low Stress (Low Flow) Purging and Sampling*.

USEPA. 1991. Handbook Groundwater, Volume II Methodology, Office of Research and Development, Washington, DC. USEPN62S, /6-90/016b (July, 1991).

U.S. Geological Survey (USGS). 1977. National Handbook of Recommended Methods for Water-Data Acquisition: USGS Office of Water Data Coordination. Reston, Virginia.

Attachment 1

Groundwater Sampling Log

WATER SAMPLING LOG

Project No. _____

Date _____

Site Location: _____

Monitoring Well Number_____

Rep./Field Blank No. _____

Sample Collection Time_____

Weather_____

Sampling Method _____

Evacuation Data:

Depth to bottom of well (ft bls) _____

Casing stickup height (feet)_____

Depth to water from top of casing _____

Screened Interval (ft bls) _____

Water Column ____ (ft) Gallons in well_____

Casing Diameter: _____

Evacuation Volume (x 3) = _____

Casing Volume 1"=0.04 gal gal/ft, 2"=0.16 gal/ft

Field Parameters:

[illegible]

Analyses:

[illegible]

Remarks _____

Sampling Personnel _____

Attachment 2

Oxygen Solubility in Fresh Water

Temperature (degrees C)	Dissolved Oxygen (mg/L)
0	14.6
1	14.19
2	13.81
3	13.44
4	13.09
5	12.75
6	12.43
7	12.12
8	11.83
9	11.55
10	11.27
11	11.01
12	10.76
13	10.52
14	10.29
15	10.07
16	9.85
17	9.65
18	9.45
19	9.26
20	9.07
21	8.9
22	8.72
23	8.56
24	8.4
25	8.24
26	8.09
27	7.95
28	7.81
29	7.67
30	7.54
31	7.41
32	7.28
33	7.16
34	7.05
35	6.93

Reference: Vesilind, P.A., *Introduction to Environmental Engineering*, PWS Publishing Company, Boston, 468 pages (1996).



WATER SAMPLING LOG

Project No. _____

Date _____

Site Location: _____

Monitoring Well Number _____

Rep./Field Blank No. _____

Sample Collection Time _____

Weather _____

Sampling Method _____

Evacuation Data:

Depth to bottom of well (ft bls) _____

Casing stickup height (feet) _____

Depth to water from top of casing _____

Screened Interval (ft bls) _____

Water Column ____ (ft) Gallons in well _____

Casing Diameter: _____

Evacuation Volume (x 3) = _____

Casing Volume 1"=0.04 gal gal/ft, 2"=0.16 gal/ft

Field Parameters:

Time	Gallons Purged	Temp (°C)	pH (SU)	DO (mg/L)	Spec. Cond. (µmhos/cm)	Turb (NTU)	Redox (mV)	Depth to Water (ft)

Analyses:

Analytical Parameter	Sample Bottles	Preservative

Remarks _____

Sampling Personnel _____

F-19

Photoionization Detector Air
Monitoring and Field Screening

Photoionization Detector Air Monitoring and Field Screening

Rev. #: 1

Rev Date: November 8, 2009

I. Scope and Application

Field screening with a photoionization detector (PID), such as an HNu™, Photovac™, MicroTIP™, or MiniRAE™, is a procedure to measure relative concentrations of volatile organic compounds (VOCs) and other compounds. Characteristics of the PID are presented in Attachment 1 and the compounds a PID can detect are presented in Attachment 2. Field screening will frequently be conducted on the following:

- Work area air to assess exposure to on-site workers of air contaminants via the air pathway;
- Well headspaces as a precautionary measure each time the well cover is opened; and
- Headspace of soil samples to assess the relative concentration of volatile organics in the sample or to select particular intervals for off-site analysis for VOCs.

II. Personnel Qualifications

Personnel performing this method should be familiar with the basic principles of quantitative analytical chemistry (such as calibration) and familiar with the particular operation of the instrument to be used.

III. Equipment List

The following materials, as required, shall be available while performing PID field screening:

- personal protective equipment (PPE), as required by the site Health and Safety Plan (HASP);
- PID and operating manual;
- PID extra battery pack and battery charger;
- calibration canisters for the PID;
- sample jars;
- Q-tips;

- aluminum foil;
- field calibration log (attached); and
- field notebook.

IV. Cautions

PIDs are sensitive to moisture and may not function under high humidity. PIDs cannot be used to indicate oxygen deficiency or combustible gases.

V. Health and Safety Considerations

Since the PIDs cannot detect all of the chemicals that may be present at a sample location, a zero reading on either instrument does not necessarily signify the absence of air contaminants. PIDs cannot be used as an indicator for oxygen deficiency.

VI. Procedure (*Note these procedures were written particular to one specific instrument model, therefore please also refer to your owners manual. However the general principles – such as always measuring both a zero and span gas after an instrument adjustment/at the beginning of the analytical day, after four hours of testing and again at the end of an analytical day can be applied to all instruments.*)

PID Calibration

PID field instruments will be calibrated and operated to yield “total organic vapor” in parts per million (ppm) (v/v) relative to benzene or isobutylene (or equivalent). Operation, maintenance, and calibration shall be performed in accordance with the manufacturer’s instructions and entered on the PID calibration and maintenance log (Attachment 3).

1. Don PPE, as required by the HASP.
2. Perform a BATTERY CHECK. Turn the FUNCTION switch to the BATTERY CHECK position. Check that the indicator is within or beyond the green battery arc. If battery is low, the battery must be charged before calibration.
3. Allow the instrument to warm up, then calibrate the PID. If equipped, turn the FUNCTION switch to the STANDBY position and rotate the ZERO

POTENTIOMETER until the meter reads zero with the instrument sampling clean air. Wait 15 to 20 seconds to confirm the adjustment. If unstable, readjust. If equipped, check to see that the SPAN POTENTIOMETER is adjusted for the probe being used (e.g., 9.8 for 10.2 electron volts [eV]). Set the FUNCTION switch to the desired ppm range (0-20, 0-200, or 0-2,000). A violet glow from the ultraviolet (UV) source should be visible at the sample inlet of the probe/sensor unit.

4. Listen for the fan operation to verify fan function.
5. Connect one end of the sampling hose to the calibration canister regulator outlet and the other end to the sampling probe of the PID. Crack the regulator valve and take a reading after 5 to 10 seconds. Adjust the span potentiometer to produce the concentration listed on the span gas cylinder. Record appropriate information on a PID Calibration and Maintenance Log (Attachment 3, or equivalent).
6. If so equipped, set the alarm at desired level.
7. Recheck the zero with fresh/clean air
8. Always recheck both zero and span after making any instrument adjustment, after four hours of screening work and again after sample analysis.

Work Area Air Monitoring

1. Measure and record the background PID reading.
2. Measure and record the breathing space reading.

Well Headspace Screening

1. Measure and record the background PID reading.
2. Unlock and open the well cover while standing upwind of the well.
3. Remove the well cap.
4. Place the PID probe approximately 6 inches above the top of the casing.
5. Record all PID readings and proceed in accordance with the HASP.

Field Screening Procedures

Soil samples will be field screened upon collection with the PID for a relative measure of the total volatile organic concentration. The following steps define the PID field screening procedures.

1. Half-fill two clean glass jars with the sample (if sufficient quantities of soil are available) to be analyzed. Quickly cover each open top with one or two sheets of clean aluminum foil and subsequently apply screw caps to tightly seal the jars. Sixteen-ounce (approximately 500 mL) soil or “mason” type jars are preferred; jars less than 8 ounces (approximately 250 mL) total capacity may not be used.
2. Allow headspace development for at least 10 minutes. Vigorously shake jars for 15 seconds at both the beginning and end of the headspace development period. Where ambient temperatures are below 32°F (0°C), headspace development should be within a heated building.
3. Subsequent to headspace development, remove screw lid to expose the foil seal. Quickly puncture foil seal with instrument sampling probe, to a point about one-half of the headspace depth. Exercise care to avoid contact with water droplets or soil particulates.
4. Following probe insertion through foil seal, record the highest meter response for each sample as the jar headspace concentration. Using the foil seal/probe insertion method, maximum response should occur between 2 and 5 seconds. Erratic meter response may occur at high organic vapor concentrations or conditions of elevated headspace moisture, in which case headspace data should be recorded and erratic meter response noted.
5. The headspace screening data from both jar samples should be recorded and compared; generally, replicate values should be consistent to plus or minus 20%. It should be noted that in some cases (e.g., 6-inch increment soil borings), sufficient sample quantities may not be available to perform duplicate screenings. One screening will be considered sufficient for this case.
6. PID field instruments will be operated and calibrated to yield “total organic vapors” in ppm (v/v) as benzene. PID instruments must be operated with at least a 10.0 eV (+) lamp source. Operation, maintenance, and calibration will be performed in accordance with the manufacturer’s specifications presented in Attachment 12-1. For jar headspace analysis, instrument calibration will be checked/adjusted at least twice per day, at the beginning and end of each day

of use. Calibration will exceed twice per day if conditions and/or manufacturer's specifications dictate.

7. Instrumentation with digital (LED/LCD) displays may not be able to discern maximum headspace response unless equipped with a "maximum hold" feature or strip-chart recorder.

VII. Waste Management

Do not dispose canisters of compressed gas, if there is still compressed gas in the canister. Return the canister to the manufacturer for proper disposal.

VIII. Data Recording and Management

Measurements will be recorded in the field notebook or boring logs at the time of measurement with notation of date, time, location, depth (if applicable), and item monitored. If a data memory is available, readings will be downloaded from the unit upon access to a computer with software to retrieve the data.

IX. Quality Assurance

After each use, the readout unit should be wiped down with a clean cloth or paper towel.

For a HNu, the UV light source window and ionization chamber should be cleaned once a month in the following manner:

1. With the PID off, disconnect the sensor/probe from the unit.
2. Remove the exhaust screw, grasp the end cap in one hand and the probe shell in the other, and pull apart.
3. Loosen the screws on top of the end cap and separate the end cap and ion chamber from the lamp and lamp housing.
4. Tilt the lamp housing with one hand over the opening so that the lamp slides out into your hand.
5. Clean the lamp with lens paper and HNu cleaning compound (except 11.7 eV). For the 11.7 eV lamp, use a chlorinated organic solvent.

6. Clean the ion chamber using methanol on a Q-tip and then dry gently at 50°C to 60°C for 30 minutes.
7. Following cleaning, reassemble by first sliding the lamp back into the lamp housing. Place ion chamber on top of the housing, making sure the contacts are properly aligned.
8. Place the end cap on top of the ion chamber and replace the two screws (tighten the screws only enough to seal the o-ring).
9. Line up the pins on the base of the lamp housing with pins inside the probe shell and slide the housing assembly into the shell.

X. References

Denahan, S.A. et. al. "Relationships Between Chemical Screening Methodologies for Petroleum Contaminated Soils: Theory and Practice" *Chapter 5 In Principles and Practices for Petroleum Contaminated Soils*, E.J. Calabrese and P.T. Kostecki Eds., Lewis Publishers 1993.

Fitzgerald, J. "Onsite Analytical Screening of Gasoline Contaminated Media Using a Jar Headspace Procedure" *Chapter 4 in Principles and Practices for Petroleum Contaminated Soils*, E.J. Calabrese and P.T. Kostecki Eds., Lewis Publishers 1993.

ATTACHMENT 1

Characteristics of the Photoionization Detector (PID)

I. Introduction

PIDs are used in the field to detect a variety of compounds in air. PIDs can be used to detect leaks of volatile substances in drums and tanks, to determine the presence of volatile compounds in soil and water, and to make ambient air surveys. If personnel are thoroughly trained to operate the instrument and interpret the data, these PID instruments can be a valuable tool. Its use can help in deciding the level of protection to be worn, assist in determining the implementation of other safety procedures, and in determining subsequent monitoring or sampling locations.

Portable PIDs detect the concentration of organic gases, as well as a few inorganic gases. The basis for detection is the ionization of gaseous species. The incoming gas molecules are subjected to UV radiation, which ionizes molecules that have an ionization potential (IP) less than or equal to that rated for the UV source. Every molecule has a characteristic IP, which is the energy required to remove an electron from the molecule, thus yielding a positively charged ion and the free electron. These ions are attracted to an oppositely charged electrode, causing a current and an electric signal to the LED display. Compounds are measured on a ppm volume basis.

II. HNu PI-101 / MiniRAE or Equivalent PID

The PIDs detect the concentration of organic gases, as well as a few inorganic gases. The basis for detection is the ionization of gaseous species. The incoming gas molecules are subjected to UV radiation, which is energetic enough to ionize many gaseous compounds. Each molecule is transformed into charged ion pairs, creating a current between two electrodes. Every molecule has a characteristic IP, which is the energy required to remove an electron from the molecule, yielding a positively charged ion and the free electron.

Three probes, each containing a different UV light source, are available for use with the PID. Probe energies are typically 9.5, 10.2, and 11.7 eV, respectively. All three probes detect many aromatic and large-molecule hydrocarbons. In addition, the 10.2 eV and 11.7 eV probes detect some smaller organic molecules and some halogenated hydrocarbons. The 10.2 eV probe is the most useful for environmental response work, as it is more durable than the 11.7 eV probe and detects more compounds than the 9.5 eV probe. A listing of molecules and compounds that the HNu can detect is presented in Attachment 2.

The primary PID calibration gas is either benzene or isobutylene. The span potentiometer knob is turned to 9.8 for benzene calibration. A knob setting of zero increases the sensitivity to benzene approximately 10-fold. Its lower detection limit is in the low ppm range. Additionally, response time is rapid; the dot matrix liquid crystal displays 90% of the indicated concentration within 3 seconds.

III. Limitations

The PID instrument can monitor several vapors and gases in air. Many non-volatile liquids, toxic solids, particulates, and other toxic gases and vapors, however, cannot be detected with PIDs (such as methane). Since the PIDs cannot detect all of the chemicals that may be present at a sample location, a zero reading on either instrument does not necessarily signify the absence of air contaminants.

The PID instrument is generally not specific and their response to different compounds is relative to the calibration gases. Instrument readings may be higher or lower than the true concentration. This effect can be observed when monitoring total contaminant concentrations if several different compounds are being detected at once. In addition, the response of these instruments is not linear over the entire detection range. Therefore, care must be taken when interpreting the data. Concentrations should be reported in terms of the calibration gas and probe type.

PIDs are small, portable instruments and may not yield results as accurate as laboratory instruments. PIDs were originally designed for specific industrial applications. They are relatively easy to use and interpret when detecting total concentrations of known contaminants in air, but interpretation becomes more difficult when trying to identify the individual components of a mixture. PIDs cannot be used as an indicator for combustible gases or oxygen deficiency.

ATTACHMENT 2

Molecules and Compounds Detected by a PID

<u>Some Atoms and Simple Molecules</u>			<u>Paraffins and Cycloparaffins</u>	
	<u>IP(eV)</u>	<u>IP(eV)</u>	<u>Molecule</u>	<u>IP(eV)</u>
H	13.595 I ₂	9.28	methane	12.98
C	11.264 HF	15.77	ethane	11.65
N	14.54 HCl	12.74	propane	11.07
O	13.614 HBr	11.62	n-butane	10.63
Si	8.149 HI	10.38	i-butane	10.57
S	10.357 SO ₂	12.34	n-pentane	10.35
F	17.42 CO ₂	13.79	i-pentane	10.32
Cl	13.01 COS	11.18	2,2-dimethylpropane	10.35
Br	11.84 CS ₂	10.08	n-hexane	10.18
I	10.48 N ₂ O	12.90	2-methylpentane	10.12
H ₂	15.426 NO ₂	9.78	3-methylpentane	10.08
N ₂	15.580 O ₃	12.80	2,2-dimethylbutane	10.06
O ₂	12.075 H ₂ O	12.59	2,3-dimethylbutane	10.02
CO	14.01 H ₂ S	10.46	n-heptane	10.08
CN	15.13 H ₂ Se	9.88	2,2,4-trimethylpentane	9.86
NO	9.25 H ₂ Te	9.14	cyclopropane	10.06
CH	11.1 HCN	3.91	cyclopentane	10.53
OH	13.18 C ₂ N ₂	13.8	cyclohexane	9.88
F ₂	15.7 NH ₃	10.15	methcyclohexane	9.8
Cl ₂	11.48 CH ₃	9.840		
Br ₂	10.55 CH ₄	12.98		

Alkyl Halides

<u>IP(eV)</u>	<u>IP(eV)</u>
HCl	12.74
Cl ₂	11.48
CH ₄	12.98
methyl chloride	11.28
dichloromethane	11.35
trichloromethane	11.42
tetrachloromethane	11.47
ethyl chloride	10.98
1,2-dichloroethane	11.12
1-chloropropane	10.82
2-chloropropane	10.78
1,2-dichloropropane	10.87
1,3-dichloropropane	10.85
1-chlorobutane	10.67
2-chlorobutane	10.65
1-chloro-2-methylpropane	10.66
2-chloro-2-methylpropane	10.61
HBr	11.62
Br ₂	10.55
methyl bromide	10.53
dibromomethane	10.49
tribromomethane	10.51
CH ₂ BrCl	10.77
CHBr ₂ Cl	10.59
ethyl bromide	10.29
1,1-dibromoethane	10.19
1-bromo-2-chloroethane	10.63
1-bromopropane	10.18
2-bromopropane	10.075
1,3-dibromopropane	10.07
1-bromobutane	10.13
2-bromobutane	9.98
1-bromo-2-methylpropane	10.09
2-bromo-2-methylpropane	9.89
1-bromopentane	10.10
HI	10.38
I ₂	9.28

Alkyl Halides

<u>Molecule</u>	<u>IP(eV)</u>
methyl iodide	9.54
diiodomethane	9.34
ethyl iodide	9.33
1-iodopropane	9.26
2-iodopropane	9.17
1-iodobutane	9.21
2-iodobutane	9.09
1-iodo-2-methylpropane	9.18
2-iodo-2-methylpropane	9.02
1-iodopentane	9.19
F ₂	15.7
HF	15.77
CFCl ₃ (Freon 11)	11.77
CF ₂ Cl ₂ (Freon 12)	12.31
CF ₃ Cl (Freon 13)	12.91
CHClF ₂ (Freon 22)	12.45
CFBR ₃	10.67
CF ₂ Br ₂	11.07
CH ₃ CF ₂ Cl (Genetron 101)	11.98
CFCl ₂ CF ₂ Cl	11.99
CF ₃ CCl ₃ (Freon 113)	11.78
CFHBrCH ₂ Cl	10.75
CF ₂ BrCH ₂ Br	10.83
CF ₃ CH ₂ I	10.00
n-C ₃ F ₇ I	10.36
n-C ₃ F ₇ CH ₂ Cl	11.84
n-C ₃ F ₇ CH ₂ I	9.96

Aliphatic Alcohol, Ether, Thiol, and Sulfides

<u>Molecule</u>	<u>IP(eV)</u>
H ₂ O	12.59
methyl alcohol	10.85
ethyl alcohol	10.48
n-propyl alcohol	10.20
i-propyl alcohol	10.16
n-butyl alcohol	10.04
dimethyl ether	10.00
diethyl ether	9.53
n-propyl ether	9.27
i-propyl ether	9.20
H ₂ S	10.46
methanethiol	9.440
ethanethiol	9.285
1-propanethiol	9.195
1-butanethiol	9.14
dimethyl sulfide	8.685
ethyl methyl sulfide	8.55
diethyl sulfide	8.430
di-n-propyl sulfide	8.30

Aliphatic Aldehydes and Ketones

<u>Molecule</u>	<u>IP(eV)</u>
CO ₂	13.79
formaldehyde	10.87
acetaldehyde	10.21
propionaldehyde	9.98
n-butyraldehyde	9.86
isobutyraldehyde	9.74
n-valeraldehyde	9.82
isovaleraldehyde	9.71
acrolein	10.10
crotonaldehyde	9.73
benzaldehyde	9.53
acetone	9.69
methyl ethyl ketone	9.53
methyl n-propyl ketone	9.39
methyl i-propyl ketone	9.32
diethyl ketone	9.32
methyl n-butyl ketone	9.34
methyl i-butyl ketone	9.30
3,3-dimethyl butanone	9.17
2-heptanone	9.33
cyclopentanone	9.26
cyclohexanone	9.14
2,3-butanedione	9.23
2,4-pentanedione	8.87

Aliphatic Acids and Esters

<u>Molecule</u>	<u>IP(eV)</u>
CO ₂	13.79
formic acid	11.05
acetic acid	10.37
propionic acid	10.24
n-butyric acid	10.16
isobutyric acid	10.02
n-valeric acid	10.12
methyl formate	10.815
ethyl formate	10.61
n-propyl formate	10.54
n-butyl formate	10.50
isobutyl formate	10.46
methyl acetate	10.27
ethyl acetate	10.11
n-propyl acetate	10.04
isopropyl acetate	9.99
n-butyl acetate	10.01
isobutyl acetate	9.97
sec-butyl acetate	9.91
methyl propionate	10.15
ethyl propionate	10.00
methyl n-butyrate	10.07
methyl isobutyrate	9.98

Aliphatic Amines and Amides

<u>Molecule</u>	<u>IP(eV)</u>
NH ₃	10.15
methyl amine	8.97
ethyl amine	8.86
n-propyl amine	8.78
i-propyl amine	8.72
n-butyl amine	8.71
i-butyl amine	8.70
s-butyl amine	8.70
t-butyl amine	8.64
dimethyl amine	8.24
diethyl amine	8.01
di-n-propyl amine	7.84
di-i-propyl amine	7.73
di-n-butyl amine	7.69
trimethyl amine	7.82
triethyl amine	7.50
tri-n-propyl amine	7.23
formamide	10.25
acetamide	9.77
N-methyl acetamide	8.90
N,N-dimethyl formamide	9.12
N,N-dimethyl acetamide	8.81
N,N-diethyl formamide	8.89
N,N-diethyl acetamide	8.60

Other Aliphatic Molecules with N Atom

<u>Molecule</u>	<u>IP(eV)</u>
nitromethane	11.08
nitroethane	10.88
1-nitropropane	10.81
2-nitropropane	10.71
HCN	13.91
acetonitrile	12.22
propionitrile	11.84
n-butyronitrile	11.67
acrylonitrile	10.91
3-butene-nitrile	10.39
ethyl nitrate	11.22
n-propyl nitrate	
methyl thiocyanate	10.065
ethyl thiocyanate	9.89
methyl isothiocyanate	9.25
ethyl isothiocyanate	9.14

Olefins, Cyclo-olefins, Acetylenes

<u>Molecule</u>	<u>IP(eV)</u>
ethylene	10.515
propylene	9.73
1-butene	9.58
2-methylpropene	9.23
trans-2-butene	9.13
cis-2-butene	9.13
1-pentene	9.50
2-methyl-1-butene	9.12
3-methyl-1-butene	9.51
3-methyl-2-butene	8.67
1-hexene	9.46
1,3-butadiene	9.07
isoprene	8.845
cyclopentene	9.01
cyclohexene	8.945
4-methylcyclohexene	8.91
4-vinylcyclohexene	8.93
cyclo-octatetraene	7.99
acetylene	11.41
propyne	10.36
1-butyne	10.18

Some Derivatives of Olefins

<u>Molecule</u>	<u>IP(eV)</u>
vinyl chloride	9.995
cis-dichloroethylene	9.65
trans-dichloroethylene	9.66
trichloroethylene	9.45
tetrachloroethylene	9.32
vinyl bromide	9.80
1,2-dibromoethylene	9.45
tribromoethylene	9.27
3-chloropropene	10.04
2,3-dichloropropene	9.82
1-bromopropene	9.30
3-bromopropene	9.7
CF ₃ CCl=CClCF ₃	10.36
n-C ₅ F ₁₁ CF=CF ₂	10.48
acrolein	10.10
crotonaldehyde	9.73
mesityl oxide	9.08
vinyl methyl ether	8.93
allyl alcohol	9.67
vinyl acetate	9.19

Aromatic Compounds

<u>Molecule</u>	<u>IP(eV)</u>
benzene	9.245
toluene	8.82
ethyl benzene	8.76
n-propyl benzene	8.72
i-propyl benzene	8.69
n-butyl benzene	8.69
s-butyl benzene	8.68
t-butyl benzene	8.68
o-xylene	8.56
m-xylene	8.56
p-xylene	8.445
mesitylene	8.40
durene	8.025
styrene	8.47
alpha-methyl styrene	8.35
ethynylbenzene	8.815
naphthalene	8.12
1-methylnapthalene	7.69
2-methylnapthalene	7.955
biphenyl	8.27
phenol	8.50
anisole	8.22
phenetole	8.13
benzaldehyde	9.53
acetophenone	9.27
benzenethiol	8.33
phenyl isocyanate	8.77

Aromatic Compounds

<u>Molecule</u>	<u>IP(eV)</u>
phenyl isothiocyanate	8.520
benzonitrile	9.705
nitrobenzene	9.92
aniline	7.70
fluoro-benzene	9.195
chloro-benzene	9.07
bromo-benzene	8.98
iodo-benzene	8.73
o-dichlorobenzene	9.07
m-dichlorobenzene	9.12
p-dichlorobenzene	8.94
1-chloro-2-fluorobenzene	9.155
1-chloro-3-fluorobenzene	9.21
1-chloro-4-fluorobenzene	8.99
o-fluorotoluene	8.915
m-fluorotoluene	8.915
p-fluorotoluene	8.785
o-chlorotoluene	8.83
m-chlorotoluene	8.83
p-chlorotoluene	8.70
o-bromotoluene	8.79
m-bromotoluene	8.81
p-bromotoluene	8.67
o-iodotoluene	8.62
m-iodotoluene	8.61
p-iodotoluene	8.50
benzotrifluoride	9.68
o-fluorophenol	8.66

Heterocyclic Molecules

<u>Molecule</u>	<u>IP(eV)</u>
furan	8.89
2-methyl furan	8.39
2-furaldehyde	9.21
tetrahydrofuran	9.54
dihydropyran	8.34
tetrahydropyran	9.26
thiophene	8.860
2-chlorothiophene	8.68
2-bromothiophene	8.63
pyrrole	8.20
pyridine	9.32
2-picoline	9.02
3-picoline	9.04
4-picoline	9.04
2,3-lutidine	8.85
2,4-lutidine	8.85
2,6-lutidine	8.85

Miscellaneous Molecules

<u>Molecule</u>	<u>IP(eV)</u>
ethylene oxide	10.565
propylene oxide	10.22
p-dioxane	9.13
dimethoxymethane	10.00
diethoxymethane	9.70
1,1-dimethoxyethane	9.65
propiolactone	9.70
methyl disulfide	8.46
ethyl disulfide	8.27
diethyl sulfite	9.68
thiolacetic acid	10.00
acetyl chloride	11.02
acetyl bromide	10.55
cyclo-C ₆ H ₁₁ CF ₃	10.46
(n-C ₃ F ₇)(CH ₃)C=O	10.58
trichlorovinylsilane	10.79
(C ₂ F ₅) ₃ N	11.7
isoprene	9.08
phosgene	11.77

Notes:

Reference: HNu Systems, Inc., 1985

IP = Ionization Potential

ATTACHMENT 3

PID CALIBRATION AND MAINTENANCE LOG						
Instrument Model Number						
Instrument Serial Number						
Calibration Gas ppm						
Date/Time	Initials	Battery Check	Calibration			
			Background Value	True Gas Value	Measured Gas Value	Adjust
COMMENTS:						

F-25

Down-Hole Groundwater Field
Parameter Measurement

Down-Hole Groundwater Field Parameter Measurement

Rev. #: 0

Rev Date: March 10, 2009

I. Scope and Application

This SOP provides procedures for collecting down-hole measurements of standard groundwater quality parameters such as pH, temperature, electrical conductivity, and dissolved oxygen and other parameters in wells or piezometers. The measurements are obtained with a portable field meter that can be lowered into the well on a cable. The data are shown visually on a hand-held display, and may be periodically saved into memory (i.e., data-logging) for later retrieval.

II. Personnel Qualifications

ARCADIS personnel directing, supervising, or leading groundwater sample collection activities should have a minimum of 1 years of previous groundwater sampling experience. ARCADIS personnel providing assistance to groundwater sample collection and associated activities should have a minimum of 6 months of related experience or an advanced degree in environmental sciences, engineering, hydrogeology, or geology.

Prior to mobilizing to the field, the groundwater sampling team should review and be thoroughly familiar with relevant site-specific documents, including but not limited to the project work plan, Field Sampling Plan (FSP), Quality Assurance Project Plan (QAPP), Health and Safety Plan (HASP), and pertinent historical information. Additionally, the groundwater sampling team should review and be thoroughly familiar with documentation provided by equipment manufacturers for all equipment that will be used in the field prior to mobilization.

III. Equipment List

The following materials (or equivalent) shall be available for collecting down-hole measurements of standard groundwater quality parameters at monitoring and remediation wells:

- Health and safety equipment (as required in the site-specific HASP).
- Site plan, well construction records, prior groundwater sampling records (if available).
- Portable groundwater quality meter suitable for lowering into a well. See Table 1 for list of suitable meters and capabilities.
- Water-level probe (e.g., Solinst Model 101 or equivalent).

- Cleaning equipment for decontamination, including containers and solutions, as specified in the FSP.
- Field logbook, groundwater sampling logs, and/or personal digital assistant (PDA) (as specified in the FSP).

The maintenance requirements for the above equipment generally involve decontamination or periodic cleaning, battery charging, and proper storage, as specified by the manufacturer. For operational difficulties, the equipment will be serviced by a qualified technician.

IV. Cautions

Groundwater quality meters should not be allowed to contact non-aqueous phase liquids (NAPLs). Do not perform measurements with a down-hole meter at wells where light non-aqueous phase liquids (LNAPLs) is present, or lower the instrument into DNAPL (if present) at the bottom of the well.

V. Health and Safety Considerations

Use caution when removing well caps, as the well may be under pressure. The well cap may dislodge forcefully and cause injury.

Use caution when opening the protective casing on stickup wells, as wasps frequently nest inside the casing. Also watch for fire ant mounds near well pads when sampling in the south or western U.S.

There is a potential pinch-point at the top of a well riser and casing when instruments are being lowered into wells. Fingers could become caught between the instrument, cable, and well casing.

If thunder or lightning is present, discontinue sampling and take cover until 30 minutes have passed after the last occurrence of thunder or lightning.

VI. Procedure

1. Don appropriate PPE as required by the HASP.
2. Calibrate the field meter prior to the commencement of the day's activities or according to manufacturer's specifications. Record calibration activities in the field logbook and include at a minimum (where applicable):

- name of field meter calibrated
 - field meter serial/ID number
 - frequency of calibration
 - date of calibration
 - results of calibration
 - name of person performing calibration
 - identification and serial number of calibration fluid(s)
3. Record the site name, well identification, date and time of measurement, weather, absence/presence of odors, and other conditions in the field logbook, groundwater sampling logs, and/or PDA.
 4. Prepare the work area and open the well.
 5. Record the well diameter, total depth, screened interval, and stickup height from the well construction details. Confirm the well diameter and stickup height.
 6. Measure and record the depth to water and total well/piezometer depth. Compare current total depth measurement to previous total depth and/or the total depth from the well construction details. If total depth has decreased, note and record the thickness of apparent silt/sediment accumulation.
 7. The target depth of measurements is at the midpoint of the well screen or open interval, taking siltation into account as necessary. If additional information is sought regarding vertical stratification of water quality, then measurements can be obtained at other depths.
 8. Steadily and carefully lower the field meter to the target depth. Try to avoid creating turbulence in the water column while the field meter is being lowered.
 9. If the cable is marked in length units (e.g., feet, meters), monitor the depth of the instrument as it is lowered using the cable markings. If the cable is not marked, pre-measure the length of cable needed to reach the target depth with a measuring tape or water-level indicator cable. When referencing the depth based on the top of the riser, make sure to add the stickup height of the well riser (above ground surface) to the depth of the target depth below grade. (I.e., if

the target depth is 50 feet and the stickup is 1.5 feet above grade, the cable will read 51.5 feet when the probe is at the target depth).

10. When the field meter reaches the target depth, secure the cable so that the field meter does not move from the target depth.
11. Display the water quality data according to the manufacturer's instructions.
12. Monitor and record the water quality parameters every two minutes for a maximum of ten minutes. The monitoring period can be shorter if the field parameters meet the following stabilization criteria over three consecutive readings:
 - turbidity values (if monitored) remains within 10% (or within 1 NTU if the turbidity reading is less than 10 NTU)
 - specific conductance and temperature values remain within 3%
 - pH remains within ± 0.1 unit
13. If dissolved oxygen values are above the acceptable range for the temperature of groundwater (Table 2), then slowly raise and lower the meter in an effort to remove air bubbles that may be entrained on the probe. If the dissolved oxygen value is 0.00 or less, then the meter should be serviced and re-calibrated.
14. Slowly remove the cable and field meter from the well.
15. Secure the well and properly dispose of personal protective equipment (PPE) and disposable equipment as specified in the FSP.
16. Complete decontamination procedures for the cable and field meter, as appropriate.
17. At the completion of the day's activities, perform a final calibration check of field instruments and record results.

VII. Waste Management

Materials generated during groundwater sampling activities, including disposable equipment, will be placed in appropriate containers. Containerized waste will be disposed of by the client consistent with the procedures identified in the FSP.

VIII. Data Recording and Management

Field notes from the field logbook or the groundwater sampling logs will be transmitted to the ARCADIS PM at the end of each day, unless otherwise directed by the PM. The groundwater team leader retains copies of the groundwater sampling notes and/or logs.

IX. Quality Assurance

The following quality control procedures should be observed in the field:

- Operate all monitoring instrumentation in accordance with manufacturer's instructions and calibration procedures. Calibrate instruments at the beginning of each day and verify the calibration at the end of each day. Record all calibration activities in the field notebook as detailed above.
- Clean all groundwater sampling equipment prior to use in the first well and after each subsequent well using procedure for equipment decontamination as specified in the FSP.

X. References

Vesilind, P.A., Introduction to Environmental Engineering, PWS Publishing Company, Boston, 468 pages (1996).

Table 1

Down-Hole Water Quality Meters

Meter	Water Quality Parameter Measurement Capability								Minimum Well Diameter (in)	Maximum Depth (feet)	Data Logging
	pH	Temp	EC	DO	ORP	Turb	TDS	Salinity			
Horiba U-22	X	X	X	X	X	X	X	X	2	320	YES
YSI 556 MPS	X	X	X	X	X				2	65	YES
YSI 600XL Sonde	X	X	X	X	X				2	200	YES
YSI 6920 V2 Sonde	X	X	X	X	X	X		X	3	200	YES
HydroLab Quanta G	X	X	X	X	X			X	2	320	NO
Hanna Instruments 9828	X	X	X	X	X				2	320	YES
In-Situ Troll 9500	X	X	X	X	X	X	X	X	2	300	YES

Note: T = temperature, EC = electrical conductivity (aka "specific conductance"), DO = dissolved oxygen, ORP = oxygen-reduction potential, Turb = turbidity, TDS = total dissolved solids

Table 2**Oxygen Solubility in Fresh Water**

Temperature (degrees C)	Dissolved Oxygen (mg/L)
0	14.6
1	14.19
2	13.81
3	13.44
4	13.09
5	12.75
6	12.43
7	12.12
8	11.83
9	11.55
10	11.27
11	11.01
12	10.76
13	10.52
14	10.29
15	10.07
16	9.85
17	9.65
18	9.45
19	9.26
20	9.07
21	8.9
22	8.72
23	8.56
24	8.4
25	8.24
26	8.09
27	7.95
28	7.81
29	7.67
30	7.54
31	7.41
32	7.28
33	7.16
34	7.05
35	6.93

Reference: Vesilind, P.A., *Introduction to Environmental Engineering*, PWS
Publishing Company, Boston, 468 pages (1996).

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Field Equipment Decontamination

Field Equipment Decontamination

Rev. #: 3

Rev Date: April 26, 2010

I. Scope and Application

Equipment decontamination is performed to ensure that sampling equipment that contacts a sample, or monitoring equipment that is brought into contact with environmental media to be sampled, is free from analytes of interest and/or constituents that would interfere with laboratory analysis for analytes of interest. Equipment must be cleaned prior to use for sampling or contact with environmental media to be sampled, and prior to shipment or storage. The effectiveness of the decontamination procedure should be verified by collecting and analyzing equipment blank samples.

The equipment cleaning procedures described herein includes pre-field, in the field, and post-field cleaning of sampling tools which will be conducted at an established equipment decontamination area (EDA) on site (as appropriate). Equipment that may require decontamination at a given site includes: soil sampling tools; groundwater, sediment, and surface-water sampling devices; water testing instruments; down-hole instruments; and other activity-specific sampling equipment. Non-disposable equipment will be cleaned before collecting each sample, between sampling events, and prior to leaving the site. Cleaning procedures for sampling equipment will be monitored by collecting equipment blank samples as specified in the applicable work plan or field sampling plan. Dedicated and/or disposable (not to be re-used) sampling equipment will not require decontamination.

II. Personnel Qualifications

ARCADIS field sampling personnel will have current health and safety training, including 40-hour HAZWOPER training, site supervisor training, and site-specific training, as needed. In addition, ARCADIS field sampling personnel will be versed in the relevant SOPs and possess the skills and experience necessary to successfully complete the desired fieldwork. The project HASP and other documents will identify any other training requirements such as site specific safety training or access control requirements.

III. Equipment List

- health and safety equipment, as required in the site Health and Safety Plan (HASP)
- distilled water

- Non-phosphate detergent such as Alconox or, if sampling for phosphorus phosphorus-containing compounds, Luminol (or equivalent).
- tap water
- rinsate collection plastic containers
- DOT-approved waste shipping container(s), as specified in the work plan or field sampling plan (if decontamination waste is to be shipped for disposal)
- brushes
- large heavy-duty garbage bags
- spray bottles
- (Optional) – Isopropyl alcohol (free of ketones) or methanol
- Ziploc-type bags
- plastic sheeting

IV. Cautions

Rinse equipment thoroughly and allow the equipment to dry before re-use or storage to prevent introducing solvent into sample medium. If manual drying of equipment is required, use clean lint-free material to wipe the equipment dry.

Store decontaminated equipment in a clean, dry environment. Do not store near combustion engine exhausts.

If equipment is damaged to the extent that decontamination is uncertain due to cracks or dents, the equipment should not be used and should be discarded or submitted for repair prior to use for sample collection.

A proper shipping determination will be performed by a DOT-trained individual for cleaning materials shipped by ARCADIS.

V. Health and Safety Considerations

Review the material safety data sheets (MSDS) for the cleaning materials used in decontamination. If solvent is used during decontamination, work in a well-ventilated area and stand upwind while applying solvent to equipment. Apply solvent in a manner that minimizes potential for exposure to workers. Follow health and safety procedures outlined in the HASP.

VI. Procedure

A designated area will be established to clean sampling equipment in the field prior to sample collection. Equipment cleaning areas will be set up within or adjacent to the specific work area, but not at a location exposed to combustion engine exhaust. Detergent solutions will be prepared in clean containers for use in equipment decontamination.

Cleaning Sampling Equipment

1. Wash the equipment/pump with potable water.
2. Wash with detergent solution (Alconox, Liquinox or equivalent) to remove all visible particulate matter and any residual oils or grease.
3. If equipment is very dirty, precleaning with a brush and tap water may be necessary.
4. (Optional) – Flush with isopropyl alcohol (free of ketones) or with methanol. This step is optional but should be considered when sampling in highly impacted media such as non-aqueous phase liquids or if equipment blanks from previous sampling events showed the potential for cross contamination of organics.
5. Rinse with distilled/deionized water.

Decontaminating Submersible Pumps

Submersible pumps may be used during well development, groundwater sampling, or other investigative activities. The pumps will be cleaned and flushed before and between uses. This cleaning process will consist of an external detergent solution wash and tap water rinse, a flush of detergent solution through the pump, followed

by a flush of potable water through the pump. Flushing will be accomplished by using an appropriate container filled with detergent solution and another contained filled with potable water. The pump will run long enough to effectively flush the pump housing and hose (unless new, disposable hose is used). Caution should be exercised to avoid contact with the pump casing and water in the container while the pump is running (do not use metal drums or garbage cans) to avoid electric shock. Disconnect the pump from the power source before handling. The pump and hose should be placed on or in clean polyethylene sheeting to avoid contact with the ground surface.

VII. Waste Management

Equipment decontamination rinsate will be managed in conjunction with all other waste produced during the field sampling effort. Waste management procedures are outlined in the work plan or Waste Management Plan (WMP).

VIII. Data Recording and Management

Equipment cleaning and decontamination will be noted in the field notebook. Information will include the type of equipment cleaned, the decontamination location and any deviations from this SOP. Specific factors that should be noted include solvent used (if any), and source of water.

Any unusual field conditions should be noted if there is potential to impact the efficiency of the decontamination or subsequent sample collection.

An inventory of the solvents brought on site and used and removed from the site will be maintained in the files. Records will be maintained for any solvents used in decontamination, including lot number and expiration date.

Containers with decontamination fluids will be labeled.

IX. Quality Assurance

Equipment blanks should be collected to verify that the decontamination procedures are effective in minimizing potential for cross contamination. The equipment blank is prepared by pouring deionized water over the clean and dry tools and collecting the deionized water into appropriate sample containers. Equipment blanks should be analyzed for the same set of parameters that are performed on the field samples collected with the equipment that was cleaned. Equipment blanks are collected per equipment set, which represents all of the tools needed to collect a specific sample.

X. References

USEPA Region 9, Field Sampling Guidance #1230, Sampling Equipment Decontamination.

USEPA Region 1, Low Stress (low flow) Purging and Sampling Procedure for the Collection of Groundwater Samples from Monitoring Wells.

F-28

Investigation-Derived Waste
Handling and Storage

Investigation-Derived Waste Handling and Storage

Rev. #: 2

Rev Date: March 6, 2009

I. Scope and Application

The objective of this Standard Operating Procedure (SOP) is to describe the procedures to manage investigation-derived wastes (IDW), both hazardous and non-hazardous, generated during site activities, which may include, but are not limited to - drilling, trenching/excavation, construction, demolition, monitoring well sampling, soil sampling, decontamination and remediation. Please note that this SOP is intended for materials that have been deemed a solid waste as defined by 40 CFR § 261.2 (which may include liquids, solids, and sludges). In some cases, field determinations will be made based on field screening or previous data that materials are not considered a solid waste. IDW may include soil, groundwater, drilling fluids, decontamination liquids, personal protective equipment (PPE), sorbent materials, construction and demolition debris, and disposable sampling materials that may have come in contact with potentially impacted materials. IDW will be collected and staged at the point of generation. Quantities small enough to be containerized in 55-gallon drums will be taken to a designated temporary storage area (discussed in further detail under Drum Storage) onsite pending characterization and disposal. Waste materials will be analyzed for constituents of concern to evaluate proper disposal methods. PPE and disposable sampling equipment will be placed in DOT-approved drums prior to disposal and typically does not require laboratory analysis. This SOP describes the necessary equipment, field procedures, materials, regulatory references, and documentation procedures necessary for proper handling and storage of IDW up to the time it is properly disposed. The procedures for handling IDW are based on the United States Environmental Protection Agency's Guide to Management of Investigation Derived Wastes (USEPA, 1992). IDW is assumed to be contaminated with the site constituents of concern (COCs) until analytical evidence indicates otherwise. IDW will be managed to ensure the protection of human health and the environment and will comply with all applicable or relevant and appropriate requirements (ARAR). The following Laws and Regulations on Hazardous Waste Management are potential ARAR for this site.

State Laws and Regulations

- To Be Determined Based on Location of Site and Location of Treatment, Storage, and/or Disposal Facility (TSDF) to be utilized

Federal Laws and Regulations

- Resource Conservation and Recovery Act (RCRA) 42 USC § 6901-6987
- Comprehensive Environmental Response, Compensation and Liability Act (CERCLA) 42 USC § 9601-9675

- Superfund Amendments and Reauthorization Act (SARA)
- Department of Transportation (DOT) Hazardous Materials Transportation

Pending characterization, IDW will be stored appropriately within each area of contamination (AOC). Under RCRA, "storage" is defined as the holding of hazardous waste for a temporary period, at the end of which the hazardous waste is treated, disposed of, or stored elsewhere" (40 CFR § 260.10). The onsite waste staging area will be in a secure and controlled area. Waste characterization can either be based on generator knowledge, such as using materials safety data sheets (MSDS'), or can be based upon analytical results. The laboratory used for waste characterization analysis must have the appropriate state and federal certifications and be approved by ARCADIS and Client. IDW will be classified as RCRA hazardous or non-regulated under RCRA based on the waste characterization.

If IDW is characterized as RCRA hazardous waste, RCRA and DOT requirements must be followed for packaging, labeling, transporting, storing, and record keeping as described in 40 CFR § 262 and 49 CFR § 171-178. Wastes judged to potentially meet the criteria for hazardous wastes shall be stored in DOT approved packaging. Waste material classified as RCRA non-hazardous may be handled and disposed of as an industrial waste.

Liquid wastes judged to potentially meet the criteria for hazardous wastes shall be stored in DOT approved 55 gallon drums or other approved containers that are compatible with the type of material stored therein. Solid materials deemed to potentially meet hazardous criteria will be drummed where practicable. Large quantities of potentially hazardous solid materials must be containerized (such as in a roll-off box) for up to a maximum of 90 or 180 days as described in the Excavated Solids Section. Waste material classified as non-hazardous may be handled and disposed of as an industrial waste and is not subject to the 90-day or 180-day on-site storage limitation.

This is a standard (i.e., typically applicable) operating procedure which may be varied or changed as required, dependent upon site conditions, equipment limitations, or limitations imposed by the procedure. The ultimate procedure employed will be documented in the project work plans or reports. If changes to the sampling procedures are required due to unanticipated field conditions, the changes will be discussed with the Project Manager and Client as soon as practicable and documented in the report.

II. Personnel Qualifications

ARCADIS field sampling personnel will have current health and safety training including 40-hour HAZWOPER training, site supervisor training, site-specific training, first aid, and CPR, as needed. ARCADIS personnel may sign manifests on a case-to-case basis for clients, provided the appropriate agreement is in place between ARCADIS and the client documenting that ARCADIS is not the generator, but is acting as authorized representative for the generator. ARCADIS personnel who sign hazardous waste manifests will have the current DOT hazardous materials transportation training according to 49 CFR § 172.704. ARCADIS field personnel will also comply with client-specific training such as LPS. In addition, ARCADIS field sampling personnel will be versed in the relevant SOPs and possess the required skills and experience necessary to successfully complete the desired field work.

III. Equipment List

The following materials, as required, shall be available for IDW handling and storage:

Appropriate personal protective equipment as specified in the Site Health and Safety Plan

- 55-gallon steel drums, DOT 1A2 or equivalent
- $\frac{3}{4}$ -inch socket wrench
- Hammer
- Leather gloves
- Drum dolly
- Appropriate drum labels (outdoor waterproof self adhesive)
- Polyethylene storage tank
- Appropriate labeling, packing, chain-of-custody forms, and shipping materials as specified in the *Chain-of-Custody SOP* and *Field Sampling Handling, Packing, and Shipping SOP*.
- Indelible ink and/or permanent marking pens
- Plastic sheeting

- Appropriate sample containers, labels, and forms
- Stainless-steel bucket auger
- Stainless steel spatula or knife
- Stainless steel hand spade
- Stainless steel scoop
- Digital camera
- Field logbook.

IV. Cautions

- Filled drums can be very heavy, always use appropriate moving techniques and equipment.
- Similar media will be stored in the same drums to aid in sample analysis and disposal.
- Drum lids must be secured to prevent rainwater from entering the drums.
- Drums containing solid material may not contain any free liquids.
- Waste containers stored for extended periods of time may be subject to deterioration. Drum over packs may be used as secondary containment.
- All drums must be in good condition to prevent potential leakage and facilitate subsequent disposal. Inspect the drums for dents and rust, and verify the drum has a secure lid prior to use.

V. Health and Safety Considerations

- Appropriate personal protective equipment must be worn by all field personnel within the designated work area.
- Air monitoring may be required during certain field activities as required in the Site Health and Safety Plan.

- If excavating in potentially hazardous areas is possible, contingency plans should be developed to address the potential for encountering gross contamination or non-aqueous phase liquids.
- ARCADIS field personnel will be familiar and compliant with Client-specific health and safety requirements such as Chevron's hand safety policy including the prohibition of fixed and/or folding blade knives.

VI. Procedure

Waste storage and handling procedures to be used depend upon the type of generated waste. For this reason, IDW should be stored in a secure location onsite in separate 55-gallon storage drums, solids can be stockpiled onsite (if non-hazardous), and purge water may be stored in polyethylene tanks. Waste materials such as broken sample bottles or equipment containers and wrappings will be stored in 55-gallon drums unless they were not in contact with sample media.

Management of IDW

Minimization of IDW should be considered by the Project Manager during all phases of the project. Site managers may want to consider techniques such as replacing solvent-based cleaners with aqueous-based cleaners for decontamination of equipment, reuse of equipment (where it can be decontaminated), limitation of traffic between exclusion and support zones, and drilling methods and sampling techniques that generate little waste. Alternative drilling and subsurface sampling methods may include the use of small diameter boreholes, as well as borehole testing methods such as a core penetrometer or direct push technique instead of coring (EPA, 1993).

Drum Storage

Drums containing hazardous waste shall be stored in accordance with the requirements of 40 CFR 265 Subpart I (for containers) and 265 Subpart DD (for containment buildings). All 55-gallon drums will be stored at a secure, centralized on-site location that is readily accessible for vehicular pick-up. Drums confirmed as, or believed to contain hazardous waste will be stored over an impervious surface provided with secondary containment. The storage location will, for drums containing liquid, have a containment system that can contain at least the larger of 10% of the aggregate volume of staged materials or 100% of the volume of the largest container. Drums will be closed during storage and be in good condition in accordance with the Guide to Management of Investigation-Derived Wastes (USEPA, 1992).

Hazardous Waste Determination

Waste material must be characterized to determine if it meets any of the federal definitions of hazardous waste as required by 40 CFR § 262.11. If the waste does not meet any of the federal definitions, it must then be established if any state-specific hazardous waste criteria exist/apply.

Generator Status

Once hazardous waste determination has been made, the generator status will be determined. Large quantity generators (LQG) are generators who generate more than 1,000 kilograms of hazardous waste in a calendar month. Small quantity generators (SQG) of hazardous waste are generators who generate greater than 100 kilograms but less than 1,000 kilograms of hazardous waste in a calendar month. Conditionally exempt small quantity generators (CESQG) are generators who generate less than 100 kilograms of hazardous waste per month. Please note that a generator status may change from month to month and that a notice of this change is usually required by the generator's state agency.

Accumulation Time for Hazardous Waste

A LQG may accumulate hazardous waste on site for 90 days or less without a permit and without having interim status provided that such accumulation is in compliance with specifications in 40 CFR § 262.34. A SQG may accumulate hazardous waste on site for 180 days or less without a permit or without having interim status subject to the requirements of 40 CFR § 262.34(d). CESQG requirements are found in 40 CFR § 261.5. **NOTE:** The CESQG and SQG provisions of 40 CFR § 261.5, 262.20(e), 262.42(b) and 262.44 may not be recognized by some states (e.g. Rhode Island).

State-specific regulations must be reviewed and understood prior to the generation of hazardous waste.

Satellite Accumulation of Hazardous Waste

Satellite accumulation (SAA) shall mean the accumulation of as much as fifty-five (55) gallons of hazardous waste, or the accumulation of as much as one quart of acutely hazardous waste, in containers at or near any point of generation where the waste initially accumulates, which is under the control of the operator of the process generating the waste, without a permit or interim status and without complying with the requirements of 40 CFR § 262.34(a) and without any storage time limit, provided that the generator complies with 40 CFR § 262.34(c)(1)(i).

Once more than 55 gallons of hazardous waste accumulates in SAA, the generator has three days to move this waste into storage.

Storage recommendations for hazardous waste include:

- Ignitable Hazardous wastes must be >50 feet from the property line per 40 CFR § 265.176 (LQG generators only).
- Hazardous waste must be stored on a concrete slab (asphalt is acceptable if there are no free liquids in the waste) per 40 CFR § 265.176.
- Drainage must be directed away from the accumulation area.
- Area must be properly vented.
- Area must be secure.

Drum/Container Labeling

Drums will be labeled on both the side and lid of the drum using a permanent marking pen. Old drum labels must be removed to the extent possible, descriptions crossed out should any information remain, and new labels affixed on top of the old labels. Other containers used to store various types of waste (polyethylene tanks, roll-off boxes, end-dump trailers, etc.) will be labeled with an appropriate "Waste Container" or "Testing in Progress" label pending characterization. Drums and containers will be labeled as follows:

- Appropriate waste characterization label (Testing In Progress, Hazardous, or Non-Hazardous)
- Waste generator's name (e.g., client name)
- Project name
- Name and telephone number of ARCADIS project manager
- Composition of contents (e.g., used oil, acetone 40%, toluene 60%)
- Media (e.g., solid, liquid)
- Accumulation start date

- Drum number of total drums as reconciled with the Drum Inventory maintained in the field log book.

IDW containers will remain closed except when adding or removing waste. Immediately upon beginning to place waste into the drum/container, a "Waste Container" or "Testing in Progress" label will be filled out to include the information specified above, and affixed to the container. Once the contents of the container are identified as either non-hazardous or hazardous, the following additional labels will be applied. Containers with waste determined to be non-hazardous will be labeled with a green and white "Non-Hazardous Waste" label over the "Waste Container" label. Containers with waste determined to be hazardous will be stored in an onsite storage area and will be labeled with the "Hazardous Waste" label and affixed over the "Waste Container" label. The ACCUMULATION DATE for the hazardous waste is the date the waste is first placed in the container and is the same date as the date on the "Waste Container" label. DOT hazardous class labels must be applied to all hazardous waste containers for shipment offsite to an approved disposal or recycling facility. In addition a DOT proper shipping name shall be included on the hazardous waste label. The transporter should be equipped with the appropriate DOT placards. However, placarding or offering placards to the initial transporter is the responsibility of the generator per 40 CFR § 262.33.

Inspections and Documentation

All IDW will be documented as generated on a Drum Inventory Log maintained in the field log book. The Drum Inventory will record the generation date, type, quantity, matrix and origin (e.g. Boring-1, Test Pit 3, etc) of materials in every drum, as well as a unique identification number for each drum. The drum inventory will be used during drum pickup to assist with labeling of drums. The drum storage area and any other areas of temporarily staged waste, such as soil/debris piles, will be inspected weekly. The weekly inspections will be recorded in the field notebook or on a Weekly Inspection Log. Digital photographs will be taken upon the initial generation and drumming/staging of waste, and final labeling after characterization to document compliance with labeling and storage protocols, and condition of the container. Evidence of damage, tampering or other discrepancy should be documented photographically.

Emergency Response and Notifications

Specific procedures for responding to site emergencies will be detailed in the HASP. If the generator is designated as a LQG, a Contingency Plan will need to be prepared to include emergency response and notification procedures per 40 CFR § 265 Subpart D. In the event of a fire, explosion, or other release which could threaten human health

outside of the site or when Client or ARCADIS has knowledge of a spill that has reached surface water, Client or ARCADIS must immediately notify the National Response Center (800-424-8802) in accordance with 40 CFR § 262.34. Other notifications to state agencies may also be necessary.

Drilling Soil Cuttings and Muds

Soil cuttings are solid to semi-solid soils generated during trenching activities, subsurface soil sampling, or installation of monitoring wells. Depending on the drilling method, drilling fluids known as "muds" may be used to remove soil cuttings. Drilling fluids flushed from the borehole must be directed into a settling section of a mud pit. This allows reuse of the decanted fluids after removal of the settled sediments. Soil cuttings will be labeled and stored in 55-gallon drums with bolt-sealed lids.

Excavated Solids

Excavated solids may include, but are not limited to soil, fill and construction and demolition debris. Excavated solids may be temporarily stockpiled onsite as long as the material is a RCRA non-hazardous waste and the solids will be treated onsite pursuant to a certified, authorized, or permitted treatment method, or properly disposed off-site. Stockpiled materials characterized as hazardous must be immediately containerized and removed from the site within 90 days of generation (except for soils using satellite accumulation). Excavated solids should be stockpiled and maintained in a secure area onsite. At a minimum, the floor of the stockpile area will be covered with a 20-mil high density polyethylene liner that is supported by a foundation or at least a 60-mil high density polyethylene liner that is not supported by a foundation. The excavated material will not contain free liquids. The owner/operator will provide controls for windblown dispersion, run-on control, and precipitation runoff. The run-on control system will prevent flow onto the active portion of the pile during peak discharge from at least a 25-year storm and the run-off management system will collect and control at least the water volume resulting from a 24-hour, 25-year storm (EPA, 1992). Additionally, the stockpile area will be inspected on a weekly basis and after storm events. Individual states may require that the stockpile be inspected/certified by a licensed professional engineer. Stockpiled material will be covered with a 6-mil polyvinyl chloride (PVC) liner. The stockpile cover will be secured in place with appropriate material (concrete blocks, weights, etc.) to prevent the movement of the cover. Excavated solids may also be placed in roll off containers and covered with a 6-mil PVC liner pending results for waste characterization.

Decontamination Solutions

Decontamination solutions are generated during the decontamination of personal protective equipment and sampling equipment. Decontamination solutions may range from detergents, organic solvents and acids used to decontaminate small field sampling equipment to steam cleaning rinsate used to wash heavy field equipment. These solutions are to be labeled and stored in 55-gallon drums with bolt-sealed lids.

Disposable Equipment

Disposable equipment includes personal protective equipment (tyvek coveralls, gloves, booties and APR cartridges) and disposable sampling equipment such as trowels or disposable bailers. If the media sampled exhibits hazardous characteristics per results of waste characterization sampling, disposable equipment will also be disposed of as a hazardous waste. These materials will be stored onsite in labeled 55-gallon drums pending analytical results for waste characterization.

Purge Water

Purge water includes groundwater generated during well development, groundwater sampling, or aquifer testing. The volume of groundwater generated will dictate the appropriate storage procedure. Monitoring well development and groundwater sampling may generate three well volumes of groundwater or more. This volume will be stored in labeled 55-gallon drums. Aquifer tests may generate significantly greater volumes of groundwater depending on the well yield and the duration of the test. Therefore, large-volume portable polyethylene tanks will be considered for temporary storage pending groundwater-waste characterization.

Purged Water Storage Tank Decontamination and Removal

The following procedures will be used for inspection, cleaning, and offsite removal of storage tanks used for temporary storage of purge water. These procedures are intended to be used for rented portable tanks such as Baker Tanks or Rain for Rent containers. Storage tanks will be made of inert polyethylene materials.

The major steps for preparing a rented tank for return to a vendor include characterizing the purge water, disposing of the purge water, decontaminating the tank, final tank inspection, and mobilization. Decontamination and inspection procedures are describe in further detail below.

- Tank Cleaning: Most vendors require that tanks be free of any sediment and water before returning, a professional cleaning service may be required. Each

specific vendor should be consulted concerning specific requirements for returning tanks.

- Tank Inspection: After emptying the tank, purged water storage tanks should be inspected for debris, chemical staining, and physical damage. The vendors require that tanks be returned in the original condition (i.e., free of sediment, staining and no physical damage).

VII. Waste Characterization Sampling and Shipping

Soil/Solids Characterization

Waste characterization will be conducted in accordance with waste hauler, waste handling facility, and state/federal requirements. In general, RCRA hazardous wastes are those solid wastes determined by a Toxicity Characteristic Leaching Procedure (TCLP) test or to contain levels of certain toxic metals, pesticides, or other organic chemicals above specific federally regulated thresholds. If the one or more of 40 toxic compounds listed in Table I of 40 CFR § 261.24 are detected in the sample at levels above the maximum unregulated concentrations, the waste must be characterized as a toxic hazardous waste. Wastes can also be considered "listed" hazardous waste depending on site-specific processes.

Composite soil samples will be collected at a frequency of one sample per 10 cubic yard basis for stockpiled soil or one per 55-gallon drum for containerized. A four point composite sample will be collected per 10 cubic yards of stockpiled material and for each drum. Sample and composite frequencies may be adjusted in accordance with the waste handling facility's requirements. Waste characterization samples may be analyzed for the TCLP volatile organic compounds (VOCs), TCLP semi-volatile organic compounds (SVOCs), TCLP RCRA metals, and polychlorinated biphenyls, as well as corrosivity (pH), reactivity and flammability (flashpoint). Additional samples may be collected and analyzed by the laboratory on a contingency basis.

Wastewater Characterization

Waste characterization will be conducted in accordance with the requirements of the waste hauler, waste handling facility, and state/federal governments. In general, purge water should be analyzed by methods appropriate for the known contaminants, if any, that have been historically detected in the monitoring wells. Samples will be collected and analyzed in accordance with the requirements of the waste disposal facility.

Wastewater characterization samples may be analyzed for TCLP volatile organic compounds (VOCs), TCLP semi-volatile organic compounds (SVOCs), TCLP RCRA

metals, and polychlorinated biphenyls, as well as corrosivity (pH), reactivity and flammability (flashpoint). Additional samples may be collected and analyzed by the laboratory on a contingency basis.

Sample Handling and Shipping

All samples will be appropriately labeled, packed, and shipped, and the chain-of-custody will be filled out in accordance with the Chain-of-Custody SOP and Field Sampling Handling, Packing, and Shipping SOP and Hazardous Materials Packaging and Shipping SOP.

It should be noted that additional training is required for packaging and shipping of hazardous and/or dangerous materials. Please reference the following ARCADIS intranet team page for more information: <http://team/sites/hazmat/default.aspx>.

Preparing Waste Shipment Documentation (Hazardous and Non-Hazardous)

Waste profiles will be prepared by the ARCADIS PM and forwarded, along with laboratory analytical data to the Client PM for approval/signature. The Client PM will then return the profile to ARCADIS who will then forward to the waste removal contractor for preparation of a manifest. The manifest will be reviewed by ARCADIS prior to forwarding to the Client PM for approval. Upon approval of the manifest, the Client PM will return the original signed manifest directly to the waste contractor or to the ARCADIS PM for forwarding to the waste contractor.

Final drum labeling and pickup will be supervised by an ARCADIS representative who is experienced with waste labeling procedures. The ARCADIS representative will have a copy of the drum inventory maintained in the field book and will reconcile the drum inventory with the profile numbers on the labels and on the manifest. Different profile numbers will be generated for different matrices or materials in the drums. For example, the profile number for drill cuttings will be different than the profile number for purge water. **When there are multiple profiles it is critical that the proper label, with the profile number appropriate to a specific material be affixed to the proper drums.** A copy of the ARCADIS drum inventory will be provided to the waste transporter during drum pickup and to the facility receiving the waste.

VIII. Data Recording and Management

Waste characterization sample handling, packing, and shipping procedures will be documented in accordance with the *Quality Assurance Project Plan*, if one exists. Copies of the chains-of-custody forms will be maintained in the project file.

Following waste characterization, IDW containers will be re-labeled with the appropriate waste hazardous or non-hazardous waste labels and the client will initiate disposal at the appropriate waste disposal facility.

IX. Quality Assurance

The chain-of-custody and sample labels for waste characterization samples will be filled out in accordance with the *Quality Assurance Project Plan*.

X. References

United States Environmental Protection Agency (USEPA). 1992. Guide to Management of Investigation-Derived Wastes. Office of Remedial and Emergency Response. Hazardous Site Control Division. January 1992.

USEPA. 1991. *Guide to Discharging CERCLA Aqueous Wastes to Publicly Owned Treatment Works (POTWs)*. Office of Remedial and Emergency Response. Hazardous Site Control Division OS-220W. March 1991.

Appendix B

Test America - Denver Department of
Defense Environmental Laboratory
Accreditation Program Certificate



SCOPE OF ACCREDITATION TO ISO/IEC 17025:2005

TESTAMERICA DENVER
4955 Yarrow Street
Arvada, CO 80002
Karen Kuoppala Phone: 303-736-1203
www.testamericainc.com

ENVIRONMENTAL

Valid To: October 31, 2013

Certificate Number: 2907.01

In recognition of the successful completion of the A2LA evaluation process, (including an assessment of the laboratory's compliance with ISO IEC 17025:2005, the 2003 NELAC Chapter 5 Standard, the requirements of the DoD Environmental Laboratory Accreditation Program (DoD ELAP) as detailed in version 4.2 of the DoD Quality Systems Manual for Environmental Laboratories), and for the test methods applicable to the Wyoming Storage Tank Remediation Laboratory Accreditation Program, accreditation is granted to this laboratory to perform recognized EPA methods using the following testing technologies and in the analyte categories identified below:

Testing Technologies

Atomic Absorption/ICP-AES Spectrometry, ICP/MS, Gas Chromatography, Gas Chromatography/Mass Spectrometry, Gravimetry, High Performance Liquid Chromatography, Ion Chromatography, Misc.- Electronic Probes (pH, O₂), Oxygen Demand, Hazardous Waste Characteristics Tests, Spectrophotometry (Visible), Spectrophotometry (Automated), Titrimetry, Total Organic Carbon, Total Organic Halide

<u>Parameter/Analyte</u>	<u>WY Storage Tank Program</u>	<u>Non-Potable Water</u>	<u>Solid Hazardous Waste (Water)</u>	<u>Solid Hazardous Waste (Solid)</u>
<u>Metals</u>				
Aluminum	-----	-----	EPA 6010B / 6010C	EPA 6010B / 6010C
Antimony	-----	-----	EPA 6010B / 6010C / 6020 / 6020A	EPA 6010B / 6010C / 6020 / 6020A
Arsenic	-----	-----	EPA 6010B / 6010C / 6020 / 6020A	EPA 6010B / 6010C / 6020 / 6020A
Barium	-----	-----	EPA 6010B / 6010C / 6020 / 6020A	EPA 6010B / 6010C / 6020 / 6020A
Beryllium	-----	-----	EPA 6010B / 6010C / 6020 / 6020A	EPA 6010B / 6010C / 6020 / 6020A
Boron	-----	-----	EPA 6010B / 6010C	EPA 6010B / 6010C

<u>Parameter/Analyte</u>	<u>WY Storage Tank Program</u>	<u>Non-Potable Water</u>	<u>Solid Hazardous Waste (Water)</u>	<u>Solid Hazardous Waste (Solid)</u>
Cadmium	EPA 6010C	-----	EPA 6010B / 6010C / 6020 / 6020A	EPA 6010B / 6010C / 6020 / 6020A
Calcium	-----	-----	EPA 6010B / 6010C	EPA 6010B / 6010C
Chromium	EPA 6010C	-----	EPA 6010B / 6010C / 6020 / 6020A	EPA 6010B / 6010C / 6020 / 6020A
Cobalt	-----	-----	EPA 6010B / 6010C / 6020 / 6020A	EPA 6010B / 6010C / 6020 / 6020A
Copper	-----	-----	EPA 6010B / 6010C / 6020 / 6020A	EPA 6010B / 6010C / 6020 / 6020A
Iron	-----	-----	EPA 6010B / 6010C	EPA 6010B / 6010C
Lead	EPA 6010C	-----	EPA 6010B / 6010C / 6020 / 6020A	EPA 6010B / 6010C / 6020 / 6020A
Lithium	-----	-----	EPA 6010B / 6010C	EPA 6010B / 6010C
Magnesium	-----	-----	EPA 6010B / 6010C	EPA 6010B / 6010C
Manganese	-----	-----	EPA 6010B / 6010C / 6020 / 6020A	EPA 6010B / 6010C / 6020 / 6020A
Mercury	-----	-----	EPA 7470A	EPA 7471A / 7471B
Molybdenum	-----	-----	EPA 6010B / 6010C / 6020 / 6020A	EPA 6010B / 6010C / 6020 / 6020A
Nickel	-----	-----	EPA 6010B / 6010C / 6020 / 6020A	EPA 6010B / 6010C / 6020 / 6020A
Potassium	-----	-----	EPA 6010B / 6010C	EPA 6010B / 6010C
Selenium	-----	-----	EPA 6010B / 6010C / 6020 / 6020A	EPA 6010B / 6010C / 6020 / 6020A
Silica	-----	-----	EPA 6010B / 6010C	EPA 6010B / 6010C
Silicon	-----	-----	EPA 6010B / 6010C	EPA 6010B / 6010C
Silver	-----	-----	EPA 6010B / 6010C / 6020 / 6020A	EPA 6010B / 6010C / 6020 / 6020A
Sodium	-----	-----	EPA 6010B / 6010C	EPA 6010B / 6010C
Strontium	-----	-----	EPA 6010B / 6010C	EPA 6010B / 6010C
Thallium	-----	-----	EPA 6010B / 6010C / 6020 / 6020A	EPA 6010B / 6010C / 6020 / 6020A

<u>Parameter/Analyte</u>	<u>WY Storage Tank Program</u>	<u>Non-Potable Water</u>	<u>Solid Hazardous Waste (Water)</u>	<u>Solid Hazardous Waste (Solid)</u>
Tin	-----	-----	EPA 6010B / 6010C	EPA 6010B / 6010C
Titanium	-----	-----	EPA 6010B / 6010C	EPA 6010B / 6010C
Vanadium	-----	-----	EPA 6010B / 6010C / 6020 / 6020A	EPA 6010B / 6010C / 6020 / 6020A
Zinc	-----	-----	EPA 6010B / 6010C / 6020 / 6020A	EPA 6010B / 6010C / 6020 / 6020A
<u>Nutrients</u>				
Nitrate (as N)	-----	By calculation	By calculation / EPA 9056 / 9056A	By calculation / EPA 9056 / 9056A
Nitrate-nitrite (as N)	-----	EPA 353.2	EPA 353.2 / 9056 / 9056A	EPA 9056 / 9056A
Nitrite (as N)	-----	SM 4500-NO2 B	SM 4500-NO2 B; EPA 9056 / 9056A	EPA 9056 / 9056A
Orthophosphate (as P)	-----	-----	EPA 9056 / 9056A	EPA 9056 / 9056A
Total phosphorus	-----	-----	EPA 6010B / 6010C	EPA 6010B / 6010C
<u>Demands</u>		-----		
Total organic carbon	-----	-----	EPA 9060 / 9060A	EPA 9060 / 9060A
Total organic halides	-----	-----	EPA 9020B	-----
<u>Wet Chemistry</u>				-----
Alkalinity	-----	SM 2320 B	SM 2320 B	SM 2320 B
Ammonia	-----	EPA 350.1	EPA 350.1	-----
Biological Oxygen Demand	-----	SM 5210B	SM 5210B	-----
Bromide	-----	-----	EPA 9056 / 9056A	EPA 9056 / 9056A
Total organic carbon	-----	-----	EPA 9060/9060A	EPA 9060 / 9060A
Chloride	-----	-----	EPA 9056 / 9056A	EPA 9056 / 9056A
Chemical Oxygen Demand	-----	EPA 410.4	EPA 410.4	
Conductivity	-----	-----	EPA 9050 / 9050A	EPA 9050 / 9050A
Cyanide	-----	-----	EPA 9010B / 9012A / 9012B	EPA 9010B / 9012A / 9012B
Ferrous Iron	-----	SM 3500 Fe B, D	SM 3500 Fe B, D	
Fluoride	-----	-----	EPA 9056 / 9056A	EPA 9056 / 9056A
Hexavalent Chromium	EPA 7196A	-----	EPA 7196A	EPA 7196A / 3060A
pH	-----	-----	EPA 9040B / 9045C	EPA 9040B / 9045C
Oil and Grease (HEM and SGT-HEM)	-----	-----	EPA 1664A	9071B
Percent moisture	-----	-----	-----	ASTM D2216
Perchlorate	-----	-----	EPA 6850 / 6860	EPA 6850 / 6860
Phenols	-----	-----	EPA 9066	EPA 9066
Solids, Total	-----	SM 2540 B	SM 2540 B	SM 2540 B
Solids, Total Suspended	-----	SM 2540 D	SM 2540 D	SM 2540 D
Solids, Total Dissolved	-----	SM 2540 C	SM 2540 C	SM 2540 C

<u>Parameter/Analyte</u>	<u>WY Storage Tank Program</u>	<u>Non-Potable Water</u>	<u>Solid Hazardous Waste (Water)</u>	<u>Solid Hazardous Waste (Solid)</u>
Sulfate	-----	-----	EPA 9038 / 9056 / 9056A	EPA 9038 / 9056 / 9056A
Sulfide, Total	-----	-----	EPA 9034	EPA 9034
Sulfide	-----	-----	EPA 9030B	EPA 9030B
Total Kjeldahl Nitrogen	-----	-----	EPA 351.2	-----
<u>Purgeable Organics (volatiles)</u>				-----
Acetone	-----	-----	EPA 8260B	EPA 8260B
Acetonitrile	-----	-----	EPA 8260B	EPA 8260B
Acrolein	-----	-----	EPA 8260B	EPA 8260B
Acrylonitrile	-----	-----	EPA 8260B	EPA 8260B
Allyl Chloride	-----	-----	EPA 8260B	EPA 8260B
tert-Amyl Methyl Ether	EPA 8260B			
Benzene	EPA 8260B / 8021B	-----	EPA 8260B / 8021B / AK101/ OK DEQ GRO	EPA 8260B / 8021B / AK101/ OK DEQ GRO
Bromobenzene	-----	-----	EPA 8260B	EPA 8260B
Bromochloromethane	-----	-----	EPA 8260B	EPA 8260B
Bromodichloromethane	-----	-----	EPA 8260B	EPA 8260B
Bromoform	-----	-----	EPA 8260B	EPA 8260B
Bromomethane	-----	-----	EPA 8260B	EPA 8260B
2-Butanone	-----	-----	EPA 8260B	EPA 8260B
n-Butyl alcohol	-----	-----	EPA 8260B / 8015B / 8015C	EPA 8260B / 8015B / 8015C
tert-Butyl alcohol	EPA 8260B			
n-Butylbenzene	-----	-----	EPA 8260B	EPA 8260B
Sec-Butylbenzene	-----	-----	EPA 8260B	EPA 8260B
Tert-Butylbenzene	-----	-----	EPA 8260B	EPA 8260B
Carbon disulfide	-----	-----	EPA 8260B	EPA 8260B
Carbon tetrachloride	-----	-----	EPA 8260B	EPA 8260B
Chlorobenzene	-----	-----	EPA 8260B / 8021B	EPA 8260B / 8021B
2-Chloro-1,3-butadiene	-----	-----	EPA 8260B	EPA 8260B
Chloroethane	-----	-----	EPA 8260B	EPA 8260B
2-Chloroethyl vinyl ether	-----	-----	EPA 8260B	EPA 8260B
Chloroform	-----	-----	EPA 8260B	EPA 8260B
1-Chlorohexane	-----	-----	EPA 8260B	EPA 8260B
Chloromethane	-----	-----	EPA 8260B	EPA 8260B
Chloroprene	-----	-----	EPA 8260B	EPA 8260B
3-Chloroprene	-----	-----	EPA 8260B	EPA 8260B
4-Chlorotoluene	-----	-----	EPA 8260B	EPA 8260B
2-Chlorotoluene	-----	-----	EPA 8260B	EPA 8260B
Cyclohexane	-----	-----	EPA 8260B	EPA 8260B
Cyclohexanone	-----	-----	EPA 8260B	EPA 8260B
Dibromochloromethane	-----	-----	EPA 8260B	EPA 8260B
1,2-Dibromo-3-chloropropane (DBCP)	-----	EPA 504	EPA 504 / 8260B / 8011	EPA 8260B / 8011
Dibromochloromethane	-----	-----	EPA 8260B	EPA 8260B
Dichlorodifluoromethane	-----	-----	EPA 8260B	EPA 8260B
Dibromomethane	-----	-----	EPA 8260B	EPA 8260B

<u>Parameter/Analyte</u>	<u>WY Storage Tank Program</u>	<u>Non-Potable Water</u>	<u>Solid Hazardous Waste (Water)</u>	<u>Solid Hazardous Waste (Solid)</u>
1,2 Dibromoethane (EDB)	EPA 8011	EPA 504	EPA 504 / 8260B / 8011	EPA 8260B / 8011
1,2-Dichlorobenzene	-----	-----	EPA 8260B / 8021B	EPA 8260B / 8021B
1,3-Dichlorobenzene	-----	-----	EPA 8260B / 8021B	EPA 8260B / 8021B
1,4-Dichlorobenzene	-----	-----	EPA 8260B / 8021B	EPA 8260B / 8021B
cis-1,4-Dichloro-2-butene	-----	-----	EPA 8260B	EPA 8260B
trans-1,4-Dichloro-2-butene	-----	-----	EPA 8260B	EPA 8260B
1,1-Dichloroethane	-----	-----	EPA 8260B	EPA 8260B
1,2-Dichloroethane	EPA 8260B	-----	EPA 8260B	EPA 8260B
1,1-Dichloroethene	-----	-----	EPA 8260B	EPA 8260B
1,2-Dichloroethene	-----	-----	EPA 8260B	EPA 8260B
cis-1,2-Dichloroethene	-----	-----	EPA 8260B	EPA 8260B
trans-1,2-Dichloroethene	-----	-----	EPA 8260B	EPA 8260B
Dichlorofluoromethane	-----	-----	EPA 8260B	EPA 8260B
1,2-Dichloropropane	-----	-----	EPA 8260B	EPA 8260B
1,3-Dichloropropane	-----	-----	EPA 8260B	EPA 8260B
2,2-Dichloropropane	-----	-----	EPA 8260B	EPA 8260B
1,1-Dichloropropene	-----	-----	EPA 8260B	EPA 8260B
1,3-Dichloropropene	-----	-----	EPA 8260B	EPA 8260B
cis-1,3-Dichloropropene	-----	-----	EPA 8260B	EPA 8260B
trans-1,3-Dichloropropene	-----	-----	EPA 8260B	EPA 8260B
Diethyl ether	-----	-----	EPA 8260B	EPA 8260B
Di-isopropylether	EPA 8260B	-----	EPA 8260B	EPA 8260B
1,4-Dioxane	-----	-----	EPA 8260B / 8260B SIM	EPA 8260B / 8260B SIM
Ethanol	-----	-----	EPA 8260B / 8015B / 8015C	EPA 8260B / 8015B / 8015C
Ethyl acetate	-----	-----	EPA 8260B	EPA 8260B
Ethyl benzene	EPA 8260B/8021B	-----	EPA 8260B / 8021B / AK101 / OK DEQ GRO	EPA 8260B / 8021B / AK101 / OK DEQ GRO
Ethyl methacrylate	-----	-----	EPA 8260B	EPA 8260B
Ethyl tert-Butyl Ether	EPA 8260B			
Ethylene Glycol	-----	-----	EPA 8015C	EPA 8015C
Gas Range Organics (GRO)	EPA 8015C	-----	EPA 8015B / 8015C / AK101 / 8015D	EPA 8015B / 8015C / AK101 / 8015D
Hexane	-----	-----	EPA 8260B	EPA 8260B
2-Hexanone	-----	-----	EPA 8260B	EPA 8260B
Hexachlorobutadiene	-----	-----	EPA 8260B	EPA 8260B
Isobutyl alcohol (2-Methyl-1-propanol)	-----	-----	EPA 8260B / 8015B / 8015C	EPA 8260B / 8015B / 8015C
Isopropyl alcohol	-----	-----	EPA 8260B	EPA 8260B
Isopropylbenzene	-----	-----	EPA 8260B	EPA 8260B
1,4-Isopropyltoluene	-----	-----	EPA 8260B	EPA 8260B
Iodomethane	-----	-----	EPA 8260B	EPA 8260B
Methacrylonitrile	-----	-----	EPA 8260B	EPA 8260B
Methanol	-----	-----	EPA 8015B / 8015C	EPA 8015B / 8015C

<u>Parameter/Analyte</u>	<u>WY Storage Tank Program</u>	<u>Non-Potable Water</u>	<u>Solid Hazardous Waste (Water)</u>	<u>Solid Hazardous Waste (Solid)</u>
Methyl acetate	-----	-----	EPA 8260B	EPA 8260B
Methyl cyclohexane	-----	-----	EPA 8260B	EPA 8260B
Methylene chloride	-----	-----	EPA 8260B	EPA 8260B
Methyl ethyle ketone (MEK)	-----	-----	EPA 8260B	EPA 8260B
Methyl isobutyl ketone	-----	-----	EPA 8260B	EPA 8260B
Methyl methacrylate	-----	-----	EPA 8260B	EPA 8260B
Methyl tert-butyl ether (MtBE)	EPA 8260B / 8021B	-----	EPA 8260B / 8021B / OK DEQ GRO	EPA 8260B / 8021B / OK DEQ GRO
4-Methyl-2-pentanone	-----	-----	EPA 8260B	EPA 8260B
Naphthalene	EPA 8260B / 8021B	-----	EPA 8260B / OK DEQ GRO	EPA 8260B / OK DEQ GRO
2-Nitropropane	-----	-----	EPA 8260B	EPA 8260B
2,2' Oxybisethanol	-----	-----	EPA 8015C	EPA 8015C
2-Pentanone	-----	-----	EPA 8260B	EPA 8260B
2-Propanol	-----	-----	EPA 8260B	EPA 8260B
Propionitrile	-----	-----	EPA 8260B	EPA 8260B
n-Propylbenzene	-----	-----	EPA 8260B	EPA 8260B
Propylene Glycol	-----	-----	EPA 8015C	EPA 8015C
Styrene	-----	-----	EPA 8260B	EPA 8260B
1,1,1,2-Tetrachloroethane	-----	-----	EPA 8260B	EPA 8260B
1,1,2,2-Tetrachloroethane	-----	-----	EPA 8260B	EPA 8260B
Tetrachloroethene	-----	-----	EPA 8260B	EPA 8260B
Tetrahydrofuran	-----	-----	EPA 8260B	EPA 8260B
Toluene	EPA 8260B / 8021B	-----	EPA 8260B / 8021B / AK101 / OK DEQ GRO	EPA 8260B / 8021B / AK101 / OK DEQ GRO
Total Petroleum Hydrocarbons (TPH)	-----	EPA 1664A	EPA 1664A	-----
1,2,3-Trichlorobenzene	-----	-----	EPA 8260B	EPA 8260B
1,1,1-Trichloroethane	-----	-----	EPA 8260B	EPA 8260B
1,1,2-Trichloroethane	-----	-----	EPA 8260B	EPA 8260B
Trichloroethene	-----	-----	EPA 8260B	EPA 8260B
Trichlorofluoromethane	-----	-----	EPA 8260B	EPA 8260B
1,2,3-Trichlorobenzene	-----	-----	EPA 8260B	EPA 8260B
1,2,4-Trichlorobenzene	-----	-----	EPA 8260B	EPA 8260B
1,2,3-Trichloropropane	-----	EPA 504.1	EPA 504.1 / 8260B / 8011	EPA 8260B / 8011
1,1,2-Trichloro-1,2,2-trifluoroethane	-----	-----	EPA 8260B	EPA 8260B
Triethylene Glycol	-----	-----	EPA 8015C	EPA 8015C
1,2,3-Trimethylbenzene	-----	-----	EPA 8260B	EPA 8260B
1,2,4-Trimethylbenzene	-----	-----	EPA 8260B	EPA 8260B
1,3,5-Trimethylbenzene	-----	-----	EPA 8260B	EPA 8260B
Vinyl acetate	-----	-----	EPA 8260B	EPA 8260B
Vinyl chloride	-----	-----	EPA 8260B	EPA 8260B
Xylenes, total	EPA 8260B / 8021B	-----	EPA 8260B / 8021B / AK101 / OK DEQ GRO	EPA 8260B / 8021B / AK101 / OK DEQ GRO
1,2-Xylene	EPA 8260B / 8021B	-----	EPA 8260B / 8021B / AK101 / OK DEQ GRO	EPA 8260B / 8021B / AK101 / OK DEQ GRO

<u>Parameter/Analyte</u>	<u>WY Storage Tank Program</u>	<u>Non-Potable Water</u>	<u>Solid Hazardous Waste (Water)</u>	<u>Solid Hazardous Waste (Solid)</u>
M+P-Xylene	EPA 8260B / 8021B	-----	EPA 8260B / 8021B / AK101 / OK DEQ GRO	EPA 8260B / 8021B / AK101 / OK DEQ GRO
Methane	-----	-----	RSK-175	-----
Ethane	-----	-----	RSK-175	-----
Ethylene (Ethene)	-----	-----	RSK-175	-----
Acetylene	-----	-----	RSK-175	-----
Acetylene Ethane	-----	-----	RSK-175	-----
<u>Extractable Organics (semivolatiles)</u>				
Acenaphthene	-----	-----	EPA 8270C / 8270D / 8270SIM	EPA 8270C / 8270D / 8270SIM
Acenaphthylene	-----	-----	EPA 8270C / 8270D / 8270SIM	EPA 8270C / 8270D / 8270SIM
Acetophenone	-----	-----	EPA 8270C / 8270D	EPA 8270C / 8270D
2-Acetylaminofluorene	-----	-----	EPA 8270C / 8270D	EPA 8270C / 8270D
Alachlor	-----	-----	EPA 8270C / 8270D	EPA 8270C / 8270D
4-Aminobiphenyl	-----	-----	EPA 8270C / 8270D	EPA 8270C / 8270D
Aniline	-----	-----	EPA 8270C / 8270D	EPA 8270C / 8270D
Anthracene	-----	-----	EPA 8270C / 8270D / 8270SIM	EPA 8270C / 8270D / 8270SIM
Aramite	-----	-----	EPA 8270C / 8270D	EPA 8270C / 8270D
Atrazine	-----	-----	EPA 8270C / 8270D	EPA 8270C / 8270D
Azobenzene	-----	-----	EPA 8270C / 8270D	EPA 8270C / 8270D
Benzaldehyde	-----	-----	EPA 8270C / 8270D	EPA 8270C / 8270D
Benidine	-----	-----	EPA 8270C / 8270D	EPA 8270C / 8270D
Benzoic acid	-----	-----	EPA 8270C / 8270D	EPA 8270C / 8270D
Benzo (a) anthracene	-----	-----	EPA 8270C / 8270D / 8270SIM	EPA 8270C / 8270D / 8270SIM
Benzo (b) fluoranthene	-----	-----	EPA 8270C / 8270D / 8270SIM	EPA 8270C / 8270D / 8270SIM
Benzo (k) fluoranthene	-----	-----	EPA 8270C / 8270D / 8270SIM	EPA 8270C / 8270D / 8270SIM
Benzo (ghi) perylene	-----	-----	EPA 8270C / 8270D / 8270SIM	EPA 8270C / 8270D / 8270SIM
Benzo (a) pyrene	-----	-----	EPA 8270C / 8270D / 8270SIM	EPA 8270C / 8270D / 8270SIM
Benzyl alcohol	-----	-----	EPA 8270C / 8270D	EPA 8270C / 8270D

<u>Parameter/Analyte</u>	<u>WY Storage Tank Program</u>	<u>Non-Potable Water</u>	<u>Solid Hazardous Waste (Water)</u>	<u>Solid Hazardous Waste (Solid)</u>
Bis (2-chloroethoxy) methane	-----	-----	EPA 8270C / 8270D	EPA 8270C / 8270D
Bis (2-chloroethyl) ether	-----	-----	EPA 8270C / 8270D	EPA 8270C / 8270D
Bis (2-chloroisopropyl) ether (2,2'Oxybis(1-chloropropane)	-----	-----	EPA 8270C / 8270D	EPA 8270C / 8270D
Bis (2-ethylhexyl) phthalate	-----	-----	EPA 8270C / 8270D	EPA 8270C / 8270D
4-Bromophenyl phenyl ether	-----	-----	EPA 8270C / 8270D	EPA 8270C / 8270D
Butyl benzyl phthalate	-----	-----	EPA 8270C / 8270D	EPA 8270C / 8270D
2-sec-Butyl-4,6-dinitrophenol	-----	-----	EPA 8270C / 8270D	EPA 8270C / 8270D
Carbazole	-----	-----	EPA 8270C / 8270D	EPA 8270C / 8270D
4-Chloroaniline	-----	-----	EPA 8270C / 8270D	EPA 8270C / 8270D
Chlorobenzilate	-----	-----	EPA 8270C / 8270D	EPA 8270C / 8270D
4-Chloro-3-methylphenol	-----	-----	EPA 8270C / 8270D	EPA 8270C / 8270D
1-Chloronaphthalene	-----	-----	EPA 8270C / 8270D	EPA 8270C / 8270D
2-Chloronaphthalene	-----	-----	EPA 8270C / 8270D	EPA 8270C / 8270D
2-Chlorophenol	-----	-----	EPA 8270C / 8270D	EPA 8270C / 8270D
4-Chlorophenyl phenyl ether	-----	-----	EPA 8270C / 8270D	EPA 8270C / 8270D
Chrysene	-----	-----	EPA 8270C / 8270D / 8270SIM	EPA 8270C / 8270D / 8270SIM
Cresols	-----	-----	EPA 8270C / 8270D	EPA 8270C / 8270D
Diallate	-----	-----	EPA 8270C / 8270D	EPA 8270C / 8270D
Dibenzo (a,h) anthracene	-----	-----	EPA 8270C / 8270D / 8270SIM	EPA 8270C / 8270D / 8270SIM
Dibenzofuran	-----	-----	EPA 8270C / 8270D	EPA 8270C / 8270D
1,2-Dichlorobenzene	-----	-----	EPA 8270C / 8270D	EPA 8270C / 8270D
1,3-Dichlorobenzene	-----	-----	EPA 8270C / 8270D	EPA 8270C / 8270D
1,4-Dichlorobenzene	-----	-----	EPA 8270C / 8270D	EPA 8270C / 8270D
3,3'-Dichlorobenzidine	-----	-----	EPA 8270C / 8270D	EPA 8270C / 8270D
2,4-Dichlorophenol	-----	-----	EPA 8270C / 8270D	EPA 8270C / 8270D

<u>Parameter/Analyte</u>	<u>WY Storage Tank Program</u>	<u>Non-Potable Water</u>	<u>Solid Hazardous Waste (Water)</u>	<u>Solid Hazardous Waste (Solid)</u>
2,6-Dichlorophenol	-----	-----	EPA 8270C / 8270D	EPA 8270C / 8270D
Diethyl phthalate	-----	-----	EPA 8270C / 8270D	EPA 8270C / 8270D
Dimethoate	-----	-----	EPA 8270C / 8270D	EPA 8270C / 8270D
3,3-Dimethylbenzidine	-----	-----	EPA 8270C / 8270D	EPA 8270C / 8270D
p-Dimethylaminoazobenzene	-----	-----	EPA 8270C / 8270D	EPA 8270C / 8270D
7,12-Dimethylbenz(a)anthracene	-----	-----	EPA 8270C / 8270D	EPA 8270C / 8270D
Alpha-,alpha-Dimethylphenethylamine	-----	-----	EPA 8270C / 8270D	EPA 8270C / 8270D
2,4-Dimethylphenol	-----	-----	EPA 8270C / 8270D	EPA 8270C / 8270D
Dimethyl phthalate	-----	-----	EPA 8270C / 8270D	EPA 8270C / 8270D
Di-n-butyl phthalate	-----	-----	EPA 8270C / 8270D	EPA 8270C / 8270D
Di-n-octyl phthalate	-----	-----	EPA 8270C / 8270D	EPA 8270C / 8270D
1,3-Dinitrobenzene	-----	-----	EPA 8270C / 8270D	EPA 8270C / 8270D
1,4-Dinitrobenzene	-----	-----	EPA 8270C / 8270D	EPA 8270C / 8270D
2,4-Dinitrophenol	-----	-----	EPA 8270C / 8270D	EPA 8270C / 8270D
2,4-Dinitrotoluene	-----	-----	EPA 8270C / 8270D	EPA 8270C / 8270D
2,6-Dinitrotoluene	-----	-----	EPA 8270C / 8270D	EPA 8270C / 8270D
1,4-Dioxane	-----	-----	EPA 8270C / 8270D	EPA 8270C / 8270D
Diphenylamine	-----	-----	EPA 8270C / 8270D	EPA 8270C / 8270D
1,2-Diphenylhydrazine	-----	-----	EPA 8270C / 8270D	EPA 8270C / 8270D
Disulfoton	-----	-----	EPA 8270C / 8270D	EPA 8270C / 8270D
Diesel Range Organics (DRO)	EPA 8015C	-----	EPA 8015B / 8015C, AK102, TX 1005 / 8015D / OK DEQ DRO	EPA 8015B / 8015C, AK102, TX 1005 / 8015D / OK DEQ DRO
Ethyl methanesulfonate	-----	-----	EPA 8270C / 8270D	EPA 8270C / 8270D
Famphur	-----	-----	EPA 8270C / 8270D	EPA 8270C / 8270D
Fluoroanthene	-----	-----	EPA 8270C / 8270D / 8270SIM	EPA 8270C / 8270D / 8270SIM
Fluorene	-----	-----	EPA 8270C / 8270D / 8270SIM	EPA 8270C / 8270D / 8270SIM

<u>Parameter/Analyte</u>	<u>WY Storage Tank Program</u>	<u>Non-Potable Water</u>	<u>Solid Hazardous Waste (Water)</u>	<u>Solid Hazardous Waste (Solid)</u>
Gasoline Range Organics	-----	-----	TX 1005 / OK DEQ GRO	TX 1005 / OK DEQ GRO
Hexachlorobenzene	-----	-----	EPA 8270C / 8270D	EPA 8270C / 8270D
Hexachlorobutadiene	-----	-----	EPA 8270C / 8270D	EPA 8270C / 8270D
Hexachlorocyclopentadiene	-----	-----	EPA 8270C / 8270D	EPA 8270C / 8270D
Hexachloroethane	-----	-----	EPA 8270C / 8270D	EPA 8270C / 8270D
Hexachloropropene	-----	-----	EPA 8270C / 8270D	EPA 8270C / 8270D
Indeno (1,2,3-cd) pyrene	-----	-----	EPA 8270C / 8270D / 8270SIM	EPA 8270C / 8270D / 8270SIM
Isodrin	-----	-----	EPA 8270C / 8270D	EPA 8270C / 8270D
Isophorone	-----	-----	EPA 8270C / 8270D	EPA 8270C / 8270D
Isosafrole	-----	-----	EPA 8270C / 8270D	EPA 8270C / 8270D
Methapyrilene	-----	-----	EPA 8270C / 8270D	EPA 8270C / 8270D
3-Methylcholanthrene	-----	-----	EPA 8270C / 8270D	EPA 8270C / 8270D
2-Methyl-4,6-Dinitrophenol	-----	-----	EPA 8270C / 8270D	EPA 8270C / 8270D
Methyl methane sulfonate	-----	-----	EPA 8270C / 8270D	EPA 8270C / 8270D
2-Methylcholanthrene	-----	-----	EPA 8270C / 8270D	EPA 8270C / 8270D
1-Methylnaphthalene	-----	-----	EPA 8270C / 8270D / 8270SIM	EPA 8270C / 8270D / 8270SIM
2-Methylnaphthalene	-----	-----	EPA 8270C / 8270D / 8270SIM	EPA 8270C / 8270D / 8270SIM
2-Methylphenol	-----	-----	EPA 8270C / 8270D	EPA 8270C / 8270D
3+4-Methylphenol	-----	-----	EPA 8270C / 8270D	EPA 8270C / 8270D
Naphthalene	-----	-----	EPA 8270C / 8270D / 8270SIM	EPA 8270C / 8270D / 8270SIM
1,4-Naphthoquinone	-----	-----	EPA 8270C / 8270D	EPA 8270C / 8270D
1-Naphthylamine	-----	-----	EPA 8270C / 8270D	EPA 8270C / 8270D
2-Naphthylamine	-----	-----	EPA 8270C / 8270D	EPA 8270C / 8270D
2-Nitroaniline	-----	-----	EPA 8270C / 8270D	EPA 8270C / 8270D
3-Nitroaniline	-----	-----	EPA 8270C / 8270D	EPA 8270C / 8270D
4-Nitroaniline	-----	-----	EPA 8270C / 8270D	EPA 8270C / 8270D

<u>Parameter/Analyte</u>	<u>WY Storage Tank Program</u>	<u>Non-Potable Water</u>	<u>Solid Hazardous Waste (Water)</u>	<u>Solid Hazardous Waste (Solid)</u>
Nitrobenzene	-----	-----	EPA 8270C / 8270D	EPA 8270C / 8270D
2-Nitrophenol	-----	-----	EPA 8270C / 8270D	EPA 8270C / 8270D
4-Nitrophenol	-----	-----	EPA 8270C / 8270D	EPA 8270C / 8270D
Nitroquinoline-1-oxide	-----	-----	EPA 8270C / 8270D	EPA 8270C / 8270D
N-Nitrosodiethylamine	-----	-----	EPA 8270C / 8270D	EPA 8270C / 8270D
N-Nitrosodimethylamine	-----	-----	EPA 8270C / 8270D	EPA 8270C / 8270D
N-Nitrosodi-n-butylamine	-----	-----	EPA 8270C / 8270D	EPA 8270C / 8270D
N-Nitrosodi-n-propylamine	-----	-----	EPA 8270C / 8270D	EPA 8270C / 8270D
N-Nitrosodiphenylamine	-----	-----	EPA 8270C / 8270D	EPA 8270C / 8270D
N-Nitrosomethylethylamine	-----	-----	EPA 8270C / 8270D	EPA 8270C / 8270D
N-Nitrosomorpholine	-----	-----	EPA 8270C / 8270D	EPA 8270C / 8270D
N-Nitrosopiperidine	-----	-----	EPA 8270C / 8270D	EPA 8270C / 8270D
N-Nitrosopyrrolidine	-----	-----	EPA 8270C / 8270D	EPA 8270C / 8270D
5-Nitro-o-toluidine	-----	-----	EPA 8270C / 8270D	EPA 8270C / 8270D
2,2-oxybis(1-chloropropane)	-----	-----	EPA 8270C / 8270D	EPA 8270C / 8270D
Parathion, methyl	-----	-----	EPA 8270C / 8270D	EPA 8270C / 8270D
Parathion, ethyl	-----	-----	EPA 8270C / 8270D	EPA 8270C / 8270D
Pentachlorobenzene	-----	-----	EPA 8270C / 8270D	EPA 8270C / 8270D
Pentachloroethane	-----	-----	EPA 8270C / 8270D	EPA 8270C / 8270D
Pentachloronitobenzene	-----	-----	EPA 8270C / 8270D	EPA 8270C / 8270D
Pentachlorophenol	-----	-----	EPA 8270C / 8270D / 8321A / 8321B	EPA 8270C / 8270D / 8321A / 8321B
Phenacetin	-----	-----	EPA 8270C / 8270D	EPA 8270C / 8270D
Phenanthrene	-----	-----	EPA 8270C / 8270D / 8270SIM	EPA 8270C / 8270D / 8270SIM
Phenol	-----	-----	EPA 8270C / 8270D	EPA 8270C / 8270D
1,4-Phenylenediamine	-----	-----	EPA 8270C / 8270D	EPA 8270C / 8270D

<u>Parameter/Analyte</u>	<u>WY Storage Tank Program</u>	<u>Non-Potable Water</u>	<u>Solid Hazardous Waste (Water)</u>	<u>Solid Hazardous Waste (Solid)</u>
Phorate	-----	-----	EPA 8270C / 8270D	EPA 8270C / 8270D
2-Picoline	-----	-----	EPA 8270C / 8270D	EPA 8270C / 8270D
Pronamide	-----	-----	EPA 8270C / 8270D	EPA 8270C / 8270D
Pyrene	-----	-----	EPA 8270C / 8270D / 8270SIM	EPA 8270C / 8270D / 8270SIM
Pyridine	-----	-----	EPA 8270C / 8270D	EPA 8270C / 8270D
Safrole	-----	-----	EPA 8270C / 8270D	EPA 8270C / 8270D
Sulfotepp	-----	-----	EPA 8270C / 8270D	EPA 8270C / 8270D
1,2,4,5-Tetrachlorobenzene	-----	-----	EPA 8270C / 8270D	EPA 8270C / 8270D
2,3,4,6-Tetrachlorophenol	-----	-----	EPA 8270C / 8270D	EPA 8270C / 8270D
Thionazin	-----	-----	EPA 8270C / 8270D	EPA 8270C / 8270D
o-Toluidine	-----	-----	EPA 8270C / 8270D	EPA 8270C / 8270D
1,2,4-Trichlorobenzene	-----	-----	EPA 8270C / 8270D	EPA 8270C / 8270D
2,4,5-Trichlorophenol	-----	-----	EPA 8270C / 8270D	EPA 8270C / 8270D
2,4,6-Trichlorophenol	-----	-----	EPA 8270C / 8270D	EPA 8270C / 8270D
o,o,o-Triethyl phosphorothioate	-----	-----	EPA 8270C / 8270D	EPA 8270C / 8270D
1,3,5-Trinitrobenzene	-----	-----	EPA 8270C / 8270D	EPA 8270C / 8270D
Tris(2,3-Dibromopropyl) phosphate	-----	-----	EPA 8270C / 8270D	EPA 8270C / 8270D
Motor Oil (Residual Range Organics)	-----	-----	EPA 8015B / 8015C, AK103 / OK DEQ RRO	EPA 8015B / 8015C, AK103 / OK DEQ RRO
<u>Pesticides/Herbicides/PCBs</u>				
Aldrin	-----	-----	EPA 8081A / 8081B	EPA 8081A / 8081B
Atrazine	-----	-----	EPA 8141A / 8141B	EPA 8141A / 8141B
Azinophos ethyl	-----	-----	EPA 8141A / 8141B	EPA 8141A / 8141B
Azinophos methyl	-----	-----	EPA 8141A / 8141B	EPA 8141A / 8141B
alpha-BHC	-----	-----	EPA 8081A / 8081B	EPA 8081A / 8081B
Beta-BHC	-----	-----	EPA 8081A / 8081B	EPA 8081A / 8081B

<u>Parameter/Analyte</u>	<u>WY Storage Tank Program</u>	<u>Non-Potable Water</u>	<u>Solid Hazardous Waste (Water)</u>	<u>Solid Hazardous Waste (Solid)</u>
delta-BHC	-----	-----	EPA 8081A / 8081B	EPA 8081A / 8081B
Gamma-BHC	-----	-----	EPA 8081A / 8081B	EPA 8081A / 8081B
Bolstar	-----	-----	EPA 8141A / 8141B	EPA 8141A / 8141B
Alpha-Chlordane	-----	-----	EPA 8081A / 8081B	EPA 8081A / 8081B
Gamma-Chlordane	-----	-----	EPA 8081A / 8081B	EPA 8081A / 8081B
Chlordane (technical)	-----	-----	EPA 8081A / 8081B	EPA 8081A / 8081B
Chloropyrifos	-----	-----	EPA 8081A / 8081B / 8141A / 8141B	EPA 8081A / 8081B / 8141A / 8141B
Coumaphos	-----	-----	EPA 8141A / 8141B	EPA 8141A / 8141B
2,4-D	-----	-----	EPA 8151A / 8321A	EPA 8151A / 8321A
Dalapon	-----	-----	EPA 8151A / 8321A	EPA 8151A / 8321A
2,4-DB	-----	-----	EPA 8151A / 8321A	EPA 8151A / 8321A
4,4'-DDD	-----	-----	EPA 8081A / 8081B	EPA 8081A / 8081B
4,4'-DDE	-----	-----	EPA 8081A / 8081B	EPA 8081A / 8081B
4,4',-DDT	-----	-----	EPA 8081A / 8081B	EPA 8081A / 8081B
Demeton-O	-----	-----	EPA 8141A / 8141B	EPA 8141A / 8141B
Demeton-S	-----	-----	EPA 8141A / 8141B	EPA 8141A / 8141B
Demeton, total	-----	-----	EPA 8141A / 8141B	EPA 8141A / 8141B
Diazinon	-----	-----	EPA 8141A / 8141B	EPA 8141A / 8141B
Dicamba	-----	-----	EPA 8151A / 8321A	EPA 8151A / 8321A
Dichlorovos	-----	-----	EPA 8141A / 8141B	EPA 8141A / 8141B
Dichloroprop	-----	-----	EPA 8151A / 8321A	EPA 8151A / 8321A
Dicofol	-----	-----	EPA 8081A / 8081B	EPA 8081A / 8081B
Dieldrin	-----	-----	EPA 8081A / 8081B	EPA 8081A / 8081B
Dimethoate	-----	-----	EPA 8141A / 8141B	EPA 8141A / 8141B
Dinoseb	-----	-----	EPA 8151A / 8321A	EPA 8151A / 8321A

<u>Parameter/Analyte</u>	<u>WY Storage Tank Program</u>	<u>Non-Potable Water</u>	<u>Solid Hazardous Waste (Water)</u>	<u>Solid Hazardous Waste (Solid)</u>
Disulfoton	-----	-----	EPA 8141A / 8141B	EPA 8141A / 8141B
Endosulfan I	-----	-----	EPA 8081A / 8081B	EPA 8081A / 8081B
Endosulfan II	-----	-----	EPA 8081A / 8081B	EPA 8081A / 8081B
Endosulfan sulfate	-----	-----	EPA 8081A / 8081B	EPA 8081A / 8081B
Endrin	-----	-----	EPA 8081A / 8081B	EPA 8081A / 8081B
Endrin aldehyde	-----	-----	EPA 8081A / 8081B	EPA 8081A / 8081B
Endrin ketone	-----	-----	EPA 8081A / 8081B	EPA 8081A / 8081B
EPN	-----	-----	EPA 8141A / 8141B	EPA 8141A / 8141B
Ethoprop	-----	-----	EPA 8141A / 8141B	EPA 8141A / 8141B
Ethyl parathion	-----	-----	EPA 8141A / 8141B	EPA 8141A / 8141B
Famphur	-----	-----	EPA 8141A / 8141B	EPA 8141A / 8141B
Fensulfothion	-----	-----	EPA 8141A / 8141B	EPA 8141A / 8141B
Fenthion	-----	-----	EPA 8141A / 8141B	EPA 8141A / 8141B
Heptachlor	-----	-----	EPA 8081A / 8081B	EPA 8081A / 8081B
Heptachlor epoxide	-----	-----	EPA 8081A / 8081B	EPA 8081A / 8081B
Hexachlorobenzene	-----	-----	EPA 8081A / 8081B	EPA 8081A / 8081B
Malathion	-----	-----	EPA 8141A / 8141B	EPA 8141A / 8141B
MCPA	-----	-----	EPA 8151A / 8321A	EPA 8151A / 8321A
MCPP	-----	-----	EPA 8151A / 8321A	EPA 8151A / 8321A
Merphos	-----	-----	EPA 8141A / 8141B	EPA 8141A / 8141B
Methoxychlor	-----	-----	EPA 8081A / 8081B	EPA 8081A / 8081B
Methyl parathion	-----	-----	EPA 8141A / 8141B	EPA 8141A / 8141B
Mevinphos	-----	-----	EPA 8141A / 8141B	EPA 8141A / 8141B
Naled	-----	-----	EPA 8141A / 8141B	EPA 8141A / 8141B
PCB-1016 (Arochlor)	-----	-----	EPA 8082 / 8082A	EPA 8082 / 8082A
PCB-1221	-----	-----	EPA 8082 / 8082A	EPA 8082 / 8082A
PCB-1232	-----	-----	EPA 8082 / 8082A	EPA 8082 / 8082A
PCB-1242	-----	-----	EPA 8082 / 8082A	EPA 8082 / 8082A

<u>Parameter/Analyte</u>	<u>WY Storage Tank Program</u>	<u>Non-Potable Water</u>	<u>Solid Hazardous Waste (Water)</u>	<u>Solid Hazardous Waste (Solid)</u>
PCB-1248	-----	-----	EPA 8082 / 8082A	EPA 8082 / 8082A
PCB-1254	-----	-----	EPA 8082 / 8082A	EPA 8082 / 8082A
PCB-1260	-----	-----	EPA 8082 / 8082A	EPA 8082 / 8082A
PCB-1262	-----	-----	EPA 8082 / 8082A	EPA 8082 / 8082A
PCB-1268	-----	-----	EPA 8082 / 8082A	EPA 8082 / 8082A
Phorate	-----	-----	EPA 8141A / 8141B	EPA 8141A / 8141B
Phosmet	-----	-----	EPA 8141A / 8141B	EPA 8141A / 8141B
Propazine	-----	-----	EPA 8141A / 8141B	EPA 8141A / 8141B
Ronnel	-----	-----	EPA 8141A / 8141B	EPA 8141A / 8141B
Simazine	-----	-----	EPA 8081A / 8081B / 8141A / 8141B	EPA 8081A / 8081B / 8141A / 8141B
Stirophos	-----	-----	EPA 8141A / 8141B	EPA 8141A / 8141B
Sulfotepp	-----	-----	EPA 8141A / 8141B	EPA 8141A / 8141B
2,4,5-T	-----	-----	EPA 8151A / 8321A	EPA 8151A / 8321A
Thionazin	-----	-----	EPA 8141A / 8141B	EPA 8141A / 8141B
Tokuthion	-----	-----	EPA 8141A / 8141B	EPA 8141A / 8141B
2,4,5-TP	-----	-----	EPA 8151A / 8321A	EPA 8151A / 8321A
Toxaphene	-----	-----	EPA 8081A / 8081B	EPA 8081A / 8081B
Trichloronate	-----	-----	EPA 8141A / 8141B	EPA 8141A / 8141B
o,o,o-triethylphosphorothioate	-----	-----	EPA 8141A / 8141B	EPA 8141A / 8141B
<u>Explosives</u>				
1,3,5-Trinitrobenzene	-----	-----	EPA 8330A / 8330B / 8321A / 8321B	EPA 8330A / 8330B / 8321A / 8321B
1,3-Dinitrobenzene	-----	-----	EPA 8330A / 8330B / 8321A / 8321B	EPA 8330A / 8330B / 8321A / 8321B
2,4,6-Trinitrotoluene	-----	-----	EPA 8330A / 8330B / 8321A / 8321B	EPA 8330A / 8330B / 8321A / 8321B
3,5-Dinitroaniline	-----	-----	EPA 8330B	EPA 8330B
2,4-Dinitrotoluene	-----	-----	EPA 8330A / 8330B / 8321A / 8321B	EPA 8330A / 8330B / 8321A / 8321B
2,6-Dinitrotoluene	-----	-----	EPA 8330A / 8330B / 8321A / 8321B	EPA 8330A / 8330B / 8321A / 8321B

<u>Parameter/Analyte</u>	<u>WY Storage Tank Program</u>	<u>Non-Potable Water</u>	<u>Solid Hazardous Waste (Water)</u>	<u>Solid Hazardous Waste (Solid)</u>
2-Amino-4,6-dinitrotoluene	-----	-----	EPA 8330A / 8330B / 8321A / 8321B	EPA 8330A / 8330B / 8321A / 8321B
2-Nitrotoluene	-----	-----	EPA 8330A / 8330B / 8321A / 8321B	EPA 8330A / 8330B / 8321A / 8321B
3-Nitrotoluene	-----	-----	EPA 8330A / 8330B / 8321A / 8321B	EPA 8330A / 8330B / 8321A / 8321B
4-Amino-2,6-dinitrotoluene	-----	-----	EPA 8330A / 8330B / 8321A / 8321B	EPA 8330A / 8330B / 8321A / 8321B
4-Nitrotoluene	-----	-----	EPA 8330A / 8330B / 8321A / 8321B	EPA 8330A / 8330B / 8321A / 8321B
Nitrobenzene	-----	-----	EPA 8330A / 8330B / 8321A / 8321B	EPA 8330A / 8330B / 8321A / 8321B
Nitroglycerin	-----	-----	EPA 8330A / 8330B / 8321A / 8321B	EPA 8330A / 8330B / 8321A / 8321B
Octahydro-1,3,5,7-tetrabromo- 1,3,5,7-tetrazocine (HMX)	-----	-----	EPA 8330A / 8330B / 8321A / 8321B	EPA 8330A / 8330B / 8321A / 8321B
Pentaerythritoltetranitrate (PETN)	-----	-----	EPA 8330A / 8330B / 8321A / 8321B	EPA 8330A / 8330B / 8321A / 8321B
Picric acid	-----	-----	EPA 8330A / 8330B / 8321A / 8321B	EPA 8330A / 8330B / 8321A / 8321B
RDX (hexahydro-1,3,5- trinitro-1,3,5-triazine)	-----	-----	EPA 8330A / 8330B / 8321A / 8321B	EPA 8330A / 8330B / 8321A / 8321B
Tetryl (methyl 2,4,6- trinitrophenylnitramine)	-----	-----	EPA 8330A / 8330B / 8321A / 8321B	EPA 8330A / 8330B / 8321A / 8321B
<u>Hydrazines</u>				
Hydrazine	-----	SOP DV WC- 0077	SOP DV WC-0077	SOP DV WC-0077
Monomethyl hydrazine	-----	SOP DV WC- 0077	SOP DV WC-0077	SOP DV WC-0077
1,1-Dimethylhydrazine	-----	SOP DV WC- 0077	SOP DV WC-0077	SOP DV WC-0077
<u>Perfluorinated Hydrocarbons (PFCs) and Perfluorinated Sulfonates (PFSs)</u>				
Perfluorobutanoic acid	-----	SOP DV-LC-0012	SOP DV-LC-0012	SOP DV-LC-0012
Perfluoropentanoic acid	-----	SOP DV-LC-0012	SOP DV-LC-0012	SOP DV-LC-0012
Perfluorohexanoic acid	-----	SOP DV-LC-0012	SOP DV-LC-0012	SOP DV-LC-0012
Perfluoroheptanoic acid	-----	SOP DV-LC-0012	SOP DV-LC-0012	SOP DV-LC-0012
Perfluorooctanoic acid	-----	SOP DV-LC-0012	SOP DV-LC-0012	SOP DV-LC-0012

<u>Parameter/Analyte</u>	<u>WY Storage Tank Program</u>	<u>Non-Potable Water</u>	<u>Solid Hazardous Waste (Water)</u>	<u>Solid Hazardous Waste (Solid)</u>
Perfluorononanoic acid	-----	SOP DV-LC-0012	SOP DV-LC-0012	SOP DV-LC-0012
Perfluorodecanoic acid	-----	SOP DV-LC-0012	SOP DV-LC-0012	SOP DV-LC-0012
Perfluoroundecanoic acid	-----	SOP DV-LC-0012	SOP DV-LC-0012	SOP DV-LC-0012
Perfluorododecanoic acid	-----	SOP DV-LC-0012	SOP DV-LC-0012	SOP DV-LC-0012
Perfluorotridecanoic acid	-----	SOP DV-LC-0012	SOP DV-LC-0012	SOP DV-LC-0012
Perfluorotetradecanoic acid	-----	SOP DV-LC-0012	SOP DV-LC-0012	SOP DV-LC-0012
Perfluorobutane Sulfonate	-----	SOP DV-LC-0012	SOP DV-LC-0012	SOP DV-LC-0012
Perfluorohexane Sulfonate	-----	SOP DV-LC-0012	SOP DV-LC-0012	SOP DV-LC-0012
Perfluorooctane Sulfonate	-----	SOP DV-LC-0012	SOP DV-LC-0012	SOP DV-LC-0012
Perfluorodecane Sulfonate	-----	SOP DV-LC-0012	SOP DV-LC-0012	SOP DV-LC-0012
Perfluorooctane Sulfonamide	-----	SOP DV-LC-0012	SOP DV-LC-0012	SOP DV-LC-0012
N-Nitrosodimethylamine (NDMA)	-----	SOP DV-LC-0019	SOP DV-LC-0019	SOP DV-LC-0019
<u>Hazardous Waste Characteristics</u>				
Conductivity	-----	-----	EPA 9050A	EPA 9050A
Corrosivity	-----	-----	EPA 9040B	9045C
Ignitibility	-----	EPA 1010/EPA 1010A	EPA 1010 / 1010A	EPA 1010 / 1010A
Paint Filter Liquids Test	-----	-----	EPA 9095A	EPA 9095A
Synthetic Precipitation Leaching Procedure (SPLP)	-----	-----	EPA 1312	EPA 1312
Toxicity Characteristic Leaching Procedure	-----	-----	EPA 1311	EPA 1311
<u>Organic Prep Methods</u>				
Separatory Funnel Liquid-Liquid Extraction	-----	-----	EPA 3510C	-----
Continuous Liquid-Liquid Extraction	-----	-----	EPA 3520C	-----
Soxhlet Extraction	-----	-----	-----	EPA 3540C
Large Volume Injection (Micro-extraction)	-----	-----	EPA 3511	-----
Microwave Extraction	-----	-----	-----	EPA 3546
Ultrasonic Extraction	-----	-----	-----	EPA 3550B
Ultrasonic Extraction	-----	-----	-----	EPA 3550C
Waste Dilution	-----	-----	EPA 3580A	EPA 3580A
Solid Phase Extraction Volatiles Purge and trap Volatiles purge and trap for soils	-----	-----	EPA 3535A EPA 5030B	EPA 5030B EPA 5035
<u>Organic Cleanup Procedures</u>				
Florisil Cleanup	-----	-----	EPA 3620B	EPA 3620B
Florisil Cleanup	-----	-----	EPA 3620C	EPA 3620C
Sulfur Cleanup	-----	-----	EPA 3660B	EPA 3660B
Sulfuric Acid/Permanganate Cleanup	-----	-----	EPA 3665A	EPA 3665A
<u>Metals Digestion</u>				

<u>Parameter/Analyte</u>	<u>WY Storage Tank Program</u>	<u>Non-Potable Water</u>	<u>Solid Hazardous Waste (Water)</u>	<u>Solid Hazardous Waste (Solid)</u>
Acid Digestion Total Recoverable or Dissolved Metals	-----	-----	EPA 3005A	-----
Acid Digestion for Total Metals	-----	-----	EPA 3010A	-----
Acid Digestion for Total Metals	-----	-----	EPA 3020A	-----
Acid Digestion of Sediments, Sludges and Soils	-----	-----	-----	EPA 3050B



The American Association for Laboratory Accreditation

Accredited DoD ELAP Laboratory

A2LA has accredited

TESTAMERICA DENVER

Arvada, CO

for technical competence in the field of

Environmental Testing

In recognition of the successful completion of the A2LA evaluation process that includes an assessment of the laboratory's compliance with ISO/IEC 17025:2005, the 2003 NELAC Chapter 5 Standard, and the requirements of the Department of Defense Environmental Laboratory Accreditation Program (DoD ELAP) as detailed in version 4.2 of the DoD Quality System Manual for Environmental Laboratories (QSM); accreditation is granted to this laboratory to perform recognized EPA methods as defined on the associated A2LA Environmental Scope of Accreditation. This accreditation demonstrates technical competence for this defined scope and the operation of a laboratory quality management system (refer to joint ISO-ILAC-IAF Communiqué dated 8 January 2009).

Presented this 5th day of October 2011.





President & CEO

For the Accreditation Council
Certificate Number 2907.01
Valid to October 31, 2013
Revised June 1, 2012

For the tests or types of tests to which this accreditation applies, please refer to the laboratory's Environmental Scope of Accreditation.

Appendix C

Test America SOP No. DV-LC-0012
for the Analysis of PFOA and other
PFCs in Water and Soil Using Liquid
Chromatography / Tandem Mass
Spectrometry

Test America SOP No. DV-LC-0012 is Proprietary
and Available Upon Request

Appendix D

Uniform Federal Policy (UFP)
Worksheets for PFC Investigation

Quality Assurance Project Plan (QAPP) Worksheet #3 – Distribution List
Worksheet #3 Contains 2 Page(s)

QAPP Recipients	Title	Organization	Telephone Number	Fax Number	E-mail Address	Document Control Number
David DeCamp	Contracting Officer's Representative/ Project Manager	Air Force Civil Engineer Center (AFCEC)	210.395.8612	Not available (NA)	David.Decamp@us.af.mil	MAFBPBR-001
Jim Holley	Restoration Program Manager AFCEC/CZR	AFCEC	210.395.8568	NA	jim.holley@us.af.mil	MAFBPBR-001
Lori Burnam	Moody Air Force Base (MAFB) Restoration Program Manager	MAFB	229.257.5812	229.257.5811	Lori.Burnam@moody.af.mil	MAFBPBR-001
Lee Ann Smith	Program Director	ARCADIS U.S., Inc. (ARCADIS)	410.923.7827	410.987.4392	Leeann.Smith@arcadis-us.com	MAFBPBR-001
Chuck Bertz	Project Manager	ARCADIS	919.415.2325	919.854.5448	Chuck.Bertz@arcadis-us.com	MAFBPBR-001
Chris Kalinowski	Associate Project Manager / Phase Manager	ARCADIS	919.415.2277	919.854.5448	Chris.Kalinowski@arcadis-us.com	MAFBPBR-001
Andy Davis	Phase Manager	ARCADIS	864.987.3917	864.987.5833	Andrew.Davis@arcadis-us.com	MAFBPBR-001
To be determined (TBD)	Field Manager	ARCADIS	TBD	TBD	TBD	MAFBPBR-001
Ted Sauer	Project Chemist	ARCADIS	919.415.2262	919.854.5448	Ted.Sauer@arcadis-us.com	MAFBPBR-001
Maribel Vital	Project Database Manager	ARCADIS	303.471.3425	720.344.3535	Maribel.Vital@arcadis-us.com	MAFBPBR-001
Todd Church	Project Data Validation Coordinator	ARCADIS	315.671.9627	315.449.4111	Todd.Church@arcadis-us.com	MAFBPBR-001

Quality Assurance Project Plan (QAPP) Worksheet #3 – Distribution List
Worksheet #3 Contains 2 Page(s)

QAPP Recipients	Title	Organization	Telephone Number	Fax Number	E-mail Address	Document Control Number
Lauren Edwards	Health and Safety Manager	ARCADIS	317.236.2805	317.231.6514	Lauren.Edwards@arcadis-us.com	MAFBPBR-001
Donna Rydberg	Laboratory Project Manager	TestAmerica	303.736.0192	NA	Donna.Rydberg@testamericainc.com	MAFBPBR-001
John Morris	Laboratory Quality Assurance Manager	TestAmerica	303.736.0117	NA	John.Morris@testamericainc.com	MAFBPBR-001

Quality Assurance Project Plan (QAPP) Worksheet #4 – Project Personnel Sign-Off
Worksheet #4 Contains 2 Page(s)

Organization/ Project Personnel	Title	Telephone Number	Signature	QAPP Read
Air Force Civil Engineer Center (AFCEC) David DeCamp	Contracting Officer's Representative AFCEC/CZRE	210.395.8612		
AFCEC Jim Holley	Restoration Program Manager AFCEC/CZRE	210.395.8568		
Moody Air Force Base Lori Burnam	Restoration Program Manager	229.257.5812		
ARCADIS U.S., Inc. (ARCADIS) Lee Ann Smith	Program Director	410.923.7827		
ARCADIS Chuck Bertz	Project Officer	919.415.2325		
ARCADIS Chris Kalinowski	Associate Project Manager/ Phase Manager	919.415.2277		
ARCADIS Andy Davis	Phase Manager	864.987.3917		
ARCADIS Catherine Hajcak	Phase Manager	904.238.2908		
ARCADIS Ted Sauer	Project Chemist	919.415.2262		
ARCADIS Maribel Vital	Project Database Manager	303.471.3425		

Quality Assurance Project Plan (QAPP) Worksheet #4 – Project Personnel Sign-Off
Worksheet #4 Contains 2 Page(s)

Organization/ Project Personnel	Title	Telephone Number	Signature	QAPP Read
ARCADIS Todd Church	Project Data Validation Coordinator	315.671.9627		
ARCADIS To Be Determined (TBD)	Field Manager 1	TBD		
Shealy Environmental Services Nisreen Saikaly	Lab Project Manager	803.791.9700		
Shealy Environmental Services Jami Savje	Lab Quality Assurance Manager	803.791.9700		
TestAmerica Donna Rydberg	Test America Denver Project Manager	303.736.0192		
TestAmerica John Morris	Test America Denver Quality Assurance Project Manager	303.736.0117		

Quality Assurance Project Plan (QAPP) Worksheet #6 – Communication Pathways
Worksheet #6 Contains 2 Page(s)

Communication Drivers	Responsible Entity	Name	Phone Number	Procedure (e.g., Timing, Pathways)
Point of Contact with Air Force Civil Engineer Center (AFCEC)	AFCEC Contracting Officer's Representative (COR) / Project Manager (PM)	David DeCamp AFCEC	210.395.8612	AFCEC COR will be notified by ARCADIS U.S., Inc. (ARCADIS) if analytical data or field sampling irregularities are observed, or problems with analytical data or sampling are encountered.
AFCEC Chemistry Contact	AFCEC Chemistry Contact	Seb Gillette AFCEC	402.995.2266	AFCEC Chemistry Contact will be notified by ARCADIS if analytical data or field sampling irregularities are observed, or problems with analytical data or sampling are encountered.
Point of Contact with MAFB	MAFB RPM	Lori Burnam MAFB	229.257.5812	MAFB RPM will be notified by ARCADIS and/or AFCEC PM if analytical data or field sampling irregularities are observed, or problems with analytical data or sampling are encountered.
Manage all Project Phases	ARCADIS PM	Chuck Bertz ARCADIS	919.415.2325	Will serve as the ARCADIS liaison to AFCEC COR / PM.
Coordinate Field Program	Phase Managers / Field Team Leaders	Chris Kalinowski Andy Davis Catherine Hajcak ARCADIS	919.415.2277 864.987.3917 904.238.2908	To be notified by field personnel of field-related questions or problems by phone or e-mail by close-of-business (COB) the next business day.
QAPP Changes in the Field	Project Chemist	Ted Sauer ARCADIS	919.415.2262	To be notified by ARCADIS Phase Managers/Field Team Leaders of any changes to QAPP made in the field and the reasons by phone or e-mail within two business days. Will promptly notify the ARCADIS PM of any such changes.
Reporting Lab Data Quality Issues	Laboratory Quality Assurance (QA) Managers	John Morris TestAmerica	303.736.0117	Will report all QA/Quality Control (QC) issues with project field samples submitted to TestAmerica to the ARCADIS PM and ARCADIS QA Manager within two business days. The ARCADIS QA Manager will communicate data quality issues to the AFCEC Chemistry Contact.

Quality Assurance Project Plan (QAPP) Worksheet #6 – Communication Pathways
Worksheet #6 Contains 2 Page(s)

Communication Drivers	Responsible Entity	Name	Phone Number	Procedure (e.g., Timing, Pathways)
Field and Analytical Corrective Actions	Project Data Validation Coordinator	Todd Church ARCADIS	315.671.9627	Will evaluate the need for corrective action for field and analytical issues in conjunction with the ARCADIS PM, the Field Team Leaders, ARCADIS Project Chemist, or the Laboratory QA Manager, as appropriate.
Release of Analytical Data	Project Data Validation Coordinator	Todd Church ARCADIS	315.671.9627	Will approve release of final analytical data following completion of validation.
QAPP Amendments	AFCEC COR/PM	David DeCamp AFCEC	210.395.8612	Will approve major changes to the QAPP before the changes are implemented.

Quality Assurance Project Plan (QAPP) Worksheet #7 – Personnel Responsibilities and Qualifications
Worksheet #7 Contains 3 Page(s)

Name	Title	Organizational Affiliation	Education and Experience Qualifications
David DeCamp	Contracting Officer's Representative (COR) Air Force Civil Engineer Center (AFCEC)/CZRE	AFCEC	Designated as the AFCEC COR
Jim Holley	Restoration Program Manager (RPM) AFCEC/CZR	AFCEC	Designated as the AFCEC RPM
Lori Burnam	Moody Air Force Base (MAFB) Restoration Program Manager (RPM)	MAFB	Designated as the MAFB RPM
Lee Ann Smith	Program Director	ARCADIS U.S., Inc. (ARCADIS)	B.A. Biological Sciences; 32 years of experience
Chuck Bertz	Project Manager (PM)	ARCADIS	B.S. Civil Engineering; 20 years of experience
Chris Kalinowski	Associate Project Manager (APM) / Phase Manager	ARCADIS	B.S. Environmental Engineering; 11 years of experience
Lauren Edwards	Health and Safety Manager	ARCADIS	B.A. Continued Studies – Environmental Management Focus; 8 years of experience
Ted Sauer	Project Chemist	ARCADIS	M.S. Chemical Engineering, Ph.D. Chemical Oceanography; 25 years of experience
Andy Davis	Phase Manager	ARCADIS	B.S. Civil Engineering; 15 years of experience
Catherine Hajcak	Phase Manager	ARCADIS	M.S. Geology; 20 years of experience
Maribel Vital	Project Database Manager	ARCADIS	B.S. Environmental Sciences; 14 years of experience
Todd Church	Project Data Validation Coordinator	ARCADIS	B.S. Environmental Management; 25 years of experience
To be determined (TBD)	Field Leader	ARCADIS	TBD
Donna Rydberg	Laboratory PM	TestAmerica Denver	B.S. Applied Science; 25 years of experience
John Morris	Laboratory QA Manager	TestAmerica Denver	B.S. Environmental Science; 15 years of experience

Notes:

Except for AFCEC, GA EPD, and MAFB team members, the responsibilities of the various team members are summarized below by organization.

ARCADIS

Program Manager/APM

Responsibilities and duties include:

- Verifying that the Performance-Based Remediation contract is adhered to throughout project performance
- Acting as primary liaison with the AFCEC PM and MAFB RPM and conducts regular active status meetings
- Confirming that all activities are conducted in accordance with contractual specifications
- Verifying compliance with project scope, schedule, and budget
- Coordinating project team
- Managing subcontractors
- Managing staff, materials, and equipment
- Confirming that personnel assigned the project, including subcontractors, review the technical plans before any task associated with the project is initiated and possess requisite training and certification
- Participate in the development of the field program, evaluation of data, and reporting, as well as the development of conclusions and recommendations.

QA Manager

Responsibilities and duties include:

- Verifying that the QA procedures and objectives in the project-specific work plans are met
- Confirming that management and staff are cognizant of associated QA policies and procedures
- Reviewing field and analytical data for adherence to QA/Quality Control (QC) procedures
- Verifying the quality of data before inclusion into associated reports
- Assessing field and laboratory audits during the investigation
- Reviewing, evaluating, and validating analytical data for the project and participating in interpreting and presenting analytical data
- Providing technical guidance to direct the task leaders on a day-to-day or as-needed basis to facilitate the application of QA/QC procedures.

Health and Safety Manager

Responsibilities and duties include:

- Developing, implementing, and monitoring procedures for the Program Health and Safety Plan (HASP)
- Coordinating health and safety training and medical monitoring
- Verifying that field activities are in compliance with health and safety requirements and the HASP
- Stopping work due to health and safety concerns, if necessary
- Implementing corrective actions to establish an accident-free work environment.

Field Team Leaders

Responsibilities and duties include:

- (or designee) Supervising day-to-day, on-site remediation operations
- Providing field and QA/QC oversight during remediation activities
- Updating project tracking system to meet project schedule
- Coordinating on-site subcontractor activities
- Controlling on-site materials and confirming that they are stored properly
- Providing effective day-to-day management of the entire on-site project staff
- Designing field procedures and confirming proper implementation of the field procedures by the project team
- Maintaining consistent communication with the PM/APM regarding remediation operations progress
- Verifying that accurate field data is produced by sampling personnel under their supervision

- Confirming that QC procedures are followed and documented
- Coordinating field and laboratory schedules pertaining to relevant site activities
- Reviewing field instrumentation, maintenance, and calibration to meet quality objectives
- Preparing reports pertaining to relevant field activities
- Coordinating field activities with ARCADIS field personnel.

Field Personnel

Responsibilities and duties include:

- Performing field procedures associated with the remediation, as set forth in work plans
- Performing field analyses and collecting QA samples
- Calibrating, operating, and maintaining field equipment
- Reducing field data
- Maintaining sample custody
- Preparing field records and logs.

ARCADIS Subcontractors (e.g., Laboratories)

Analytical Laboratories

General responsibilities and duties of the analytical laboratories include:

- Performing sample analyses and associated laboratory QA/QC procedures
- Supplying sampling containers and shipping cartons
- Maintaining laboratory custody of sample
- Adhering to all protocols in the QAPP.

Laboratory PM

Responsibilities and duties include:

- Serving as primary communication link between ARCADIS and laboratory technical staff
- Monitoring workloads and maintaining availability of resources
- Overseeing preparation of analytical reports
- Supervising in-house chain of custody procedures.

Laboratory QA Manager

Responsibilities and duties include:

- Monitoring the day-to-day quality of data produced by the laboratory for this project
- Verifying and documenting the reliability of the data
- Maintaining and reviewing QC data
- Conducting audits of laboratory activities and data packages and deliverables.

Quality Assurance Project Plan (QAPP) Worksheet #8 – Special Personnel Training Requirements
Worksheet #8 Contains 2 Page(s)

Project Function	Specialized Training	Training Provider	Training Date	Personnel/Groups Receiving Training	Personnel Titles / Organizational Affiliation	Location of Training Records / Certificates
Field Activities	40-hour Hazardous Waste Operations and Emergency Response (HAZWOPER) and ARCADIS U.S., Inc. (ARCADIS) Health and Safety Training	ARCADIS Certified Training Professionals	Not applicable (NA)	Field Operations Personnel	ARCADIS personnel: To be determined (TBD)	ARCADIS Project Offices Certificates Available upon Request
Field Activities	First Aid Training Cardiopulmonary Resuscitation Training Blood Borne Pathogens Training	ARCADIS	NA	Field Operations Personnel	ARCADIS personnel: TBD	ARCADIS Project Offices Certificates Available upon Request
Field Activities	Defensive Driving	Smith On-Line	NA	All ARCADIS Employees	ARCADIS personnel: TBD	ARCADIS Project Offices Certificates Available upon Request
Sample Packaging and Shipment	U.S. Department of Transportation (USDOT) Hazardous Materials (HazMat)#1 – USDOT/ International Air Transportation Association (IATA) HazMat Shipping and Transportation	ARCADIS Certified Training Professionals	NA	Field Operations Personnel	ARCADIS personnel: TBD	ARCADIS Project Offices Certificates Available upon Request
Access to FT-07 Secured Areas	Air Field Driver Training	Moody Air Force Base	NA	Field Operations Personnel	ARCADIS Personnel: TBD	Copies of certificates will be maintained by trained personnel. Copies will be maintained at ARCADIS Project Offices.

Quality Assurance Project Plan (QAPP) Worksheet #8 – Special Personnel Training Requirements
Worksheet #8 Contains 2 Page(s)

Project Function	Specialized Training	Training Provider	Training Date	Personnel/Groups Receiving Training	Personnel Titles / Organizational Affiliation	Location of Training Records / Certificates
Analytical Chemistry	National Environmental Laboratory Accreditation Program (NELAP) Accreditation	Primary Accrediting State	NA	NA	TestAmerica, Inc. 4955 Yarrow Street Arvada, CO 80002 303.736.0192 Contact: Donna Rydberg	TestAmerica, Inc. 4955 Yarrow Street Arvada, CO 80002 303.736.0192 Contact: Donna Rydberg
Analytical Chemistry	Department of Defense (DoD) Environmental Laboratory Accreditation Program (ELAP) Accreditation	DoD-Approved Accrediting Body	NA	NA	TestAmerica, Inc. 4955 Yarrow Street Arvada, CO 80002 303.736.0192 Contact: Donna Rydberg	TestAmerica, Inc. 4955 Yarrow Street Arvada, CO 80002 303.736.0192 Contact: Donna Rydberg
Additional training/certification requirements are listed in the Base-Wide Health and Safety Plan.						

Note:

Current HAZWOPER training certificates will be maintained electronically in a company database for each employee performing work at the site where 40-hour training is required for the position assignment. Certificates for field personnel will be made available to the Air Force Civil Engineer Center when the field work commences.

**Quality Assurance Project Plan (QAPP) Worksheet #12-18 – Measurement Performance Criteria
(Perfluoro-n-octanoic acid (PFOA) and Other Perfluorinated Hydrocarbons (PFCs) and Perfluoro Hydrocarbon Sulfonates (PFSS)in Water)
Worksheet #12-18 Contains 1 Page(s)**

Matrix	Water				
Analytical Group	PFOA, PFCs, and PFSS				
Concentration Level	All				
Sampling Procedure¹	Analytical Method/Standard Operating Procedure (SOP)²	Data Quality Indicators	Measurement Performance Criteria	Quality Control (QC) Sample and/or Activity Used to Assess Measurement Performance	QC Sample Assesses Error for Sampling (S), Analytical (A) or both (S&A)
F-08, F-16, F-17	DV-LC-0012/DV-OP-0019 L-30	Precision – Overall	Relative percent difference (RPD) <35%	Field duplicate	S&A
		Accuracy/Bias	Percent recovery (%R) 25-150%	Surrogate	A
		Accuracy/Bias Contamination	< ½ Limit of Quantitation	Blanks (equipment, method)	S&A
		Accuracy/Bias	%R – 60-140%	Laboratory control sample (LCS)	A
		Accuracy/Bias and Precision	Retention times, see analytical SOP	Retention time windows	A
		Accuracy/Bias	%R – 60-140%	Matrix spike (MS) ³	A
		Accuracy/Bias	%R – 60-140%	Matrix spike duplicate (MSD) or laboratory control sample duplicate (LCSD) ³	A
		Precision	RPD <30%	MS/MSD or LCS/LCSD ³	A

Notes:¹Reference number from Base-Wide QAPP Worksheet #21.²Reference number from QAPP Worksheet #23.³MS and MSD provided by field team. LCS/LCSD performed when no MS/MSD are supplied.

Quality Assurance Project Plan (QAPP) Worksheet #15-1 – Reference Limits and Evaluation (Water)
Worksheet #15-1 Contains 1 Page(s)

Analyte ¹	Chemical Abstracts Service Number	Water Reference Limits ² (µg/L)		
		Limit of Quantitation	Limit of Detection	Detection Limit
Specialty Analyses				
Perfluoro-n-octanoic acid (PFOA)	335-67-1	0.02	0.01	0.00979
Perfluoro-1-octanesulfonate (PFOS)	1763-23-1	0.03	0.01	0.0133
Perfluorobutane Sulfonate (PFBS)	29420-43-3	0.02	0.01	0.00824
Perfluoroheptanoic acid (PFHpS)	375-85-9	0.03	0.015	0.0132
Perfluorohexane Sulfonate (PFHxS)	108427-53-8	0.03	0.015	0.00697
Perfluorononanoic acid (PFNA)	1763-23-1	0.04	0.02	0.0174

Notes:

¹Site Specific Screening Criteria for groundwater and surface water analytes are provided for in the Corrective Action Plan for each site and generally correspond to the U.S. Environmental Protection Agency (USEPA) Drinking Water Maximum Contaminant Level (MCL), if available. General water quality analytes that do not have specific screening criteria will be used to evaluate monitored natural attenuation processes and remedial performance.

²Concentrations detected less than the limit of detection but greater than the detection limit must be reported with the appropriate qualifier.

Quality Assurance Project Plan (QAPP) Worksheet #17 – Sampling Design and Rationale
Worksheet #17 Contains 1 Page(s)

Describe and provide a rationale for choosing the sampling approach (e.g., grid system or biased statistical approach):

The Perfluorinated Compound Monitoring Programs will be conducted in accordance with Phase I of the Environmental Restoration Program USAF-wide strategy for addressing potential environmental contamination of PFCs above the USEPA PHA levels (AFCEE 2012). Despite the lack of regulatory guidance or standards, AFCEC is moving forward to characterize the nature and extent of PFCs in accordance with Phase I of the Environmental Restoration Program USAF-wide strategy for addressing potential environmental contamination of PFCs above the USEPA PHA levels (AFCEE 2012).

PFC-affected groundwater at the FTA would originate from one or more historical burn pit locations and flow eastward, consistent with the historical groundwater flow direction. A suite of wells located downgradient of these historical burn pits has been selected for sampling during Phase I of the investigation. Wells selected are screened in both the shallow and intermediate water bearing zones. In addition, one upgradient monitoring well will be sampled to confirm background concentrations in the vicinity of the former burn pits. Additional details of the sampling plan are included in Sections 2 and 3 of the Work Plan.

Quality Assurance Project Plan (QAPP) Worksheet #18 – Sampling Locations and Methods/Standard Operating Procedure (SOP) Requirements
Worksheet #18 Contains 1 Page(s)

Sampling Location/ ID Number	Matrix	Sample Type and Number	Analytical Group	Concentration Level	Number of Samples (plus field duplicates) ¹	SOP Reference Number ²	Rationale for Sampling Locations ⁴
FT-07	GW	14	Perfluoro-n-octanoic acid (PFOA) and Other Perfluorinated Hydrocarbons (PFCs) and Perfluoro Hydrocarbon Sulfonates (PFSS) in Water	Low	20	F-08, F-16, F-17, and L-30	See Work Plan

Notes:

¹One blind duplicate sample will be collected for every 10 samples.

²Sampling SOP reference number from QAPP Worksheet #21.

⁴Site characterization activities will be identified in activity-specific work plans/QAPPs.

**Quality Assurance Project Plan (QAPP) Worksheet #19 – Analytical Standard Operating Procedure (SOP) Requirements
(Sample Containers, Preservation and Holding Times)
Worksheet #19 Contains 1 Page(s)**

Parameter	Analytical and Preparation Method/SOP Reference	Method	Bottle Type	Preservation ¹	Holding Time ²
Groundwater/Surface Water					
Perfluoro-n-octanoic acid (PFOA) and Other Perfluorinated Hydrocarbons (PFCs) and Perfluoro Hydrocarbon Sulfonates (PFSS) in Water	DV-LC-0012 / DV-OP-0019 SOP: L-30	TestAmerica Denver	4 × 250-mL HDPE bottle	Cool to <6°C	7 days to extraction

Notes:

¹ Each sample cooler shipped to the laboratory will contain a dedicated temperature blank to verify thermal preservation requirements have been maintained during shipment.

² All holding times are measured from date of collection.

Quality Assurance Project Plan (QAPP) Worksheet #20 - Sample Quantities and Control Frequencies

Worksheet #20 Contains 1 Page(s)

Matrix/Analysis	Laboratory ¹	Analytical and Preparation Standard Operating Procedure (SOP) ²	Estimated Sample Quantity ³	Field Quality Control (QC) Analyses						Laboratory QC Sample				Laboratory Duplicate		Total
				Trip Blank		Field Blank		Field Duplicate		Matrix Spike		Matrix Spike Duplicate				
				Frequency (Freq.)	Number (No.)	Freq.	No.	Freq.	No.	Freq. ⁴	No.	Freq. ⁴	No.	Freq. ⁴	No.	
Groundwater and Surface Water																
Perfluoro-n-octanoic acid (PFOA) and Other Perfluorinated Hydrocarbons (PFCs) and Perfluoro Hydrocarbon Sulfonates (PFSS) in Water	TestAmerica, Denver	L-30	14	1/10	1	1/day	1	1/10	1	1/20	1	1/20	1	1/20	1	20

* Dedicated temperature blanks will be included in every sample cooler shipped to the laboratories so that the laboratory may evaluate whether the thermal preservation requirements have been maintained during shipment.

Notes:

¹See QAPP Worksheet #30 for contact information.

²See QAPP Worksheet #23 for SOP title, revision number, and date details.

³Sample quantities are approximate.

⁴Frequency for Matrix Spike, Matrix Spike Duplicate, and Laboratory Duplicate samples is 1 per 20 field samples, not including field blanks and field duplicates.

Quality Assurance Project Plan (QAPP) Worksheet #23 – Analytical Standard Operating Procedure (SOP) References
Worksheet #23 Contains 1 Page(s)

SOP Reference Number	Title, Revision Date, and/or Number	Definitive or Screening Data	Analytical Group	Instrument	Organization Performing Analysis	Modified for Project Work? (Yes/No)
L-30	Analysis of Perfluorooctanoic Acid (PFOA) and other Perfluorinated Hydrocarbons (PFCs) and Perfluorinated Hydrocarbon Sulfonates (PFSS) in Water and Soil by LC/MS/MS	Definitive	PFCs in Water and Soil	Liquid chromatography (LC)/MS	TestAmerica Denver	No

Notes:

Laboratory SOPs are located in Appendix C of this Work Plan

Quality Assurance Project Plan (QAPP) Worksheet #24 – Analytical Instrument Calibration
Worksheet #24 Contains 2 Page(s)

Instrument	Calibration Procedure	Frequency of Calibration	Acceptance Criteria	Corrective Action (CA)	Person Responsible for CA	SOP Reference ¹
Perfluorinated Compounds (PFCs)	ICAL. Minimum of five points initial calibration for all target analytes	Initial calibration prior to sample analysis. Perform instrument re-calibration once per year minimum.	Coefficient of calibration: r>0.990 linear. R ² >0.990 2 nd order RSD<15%	Instrument and standards are checked. Correct problem. Repeat initial calibration.	Lab Manager/ Analyst	DV-LC-0012
	ICV. Initial calibration verification from 2 nd source.	Immediately following minimum five-point initial calibration	All analytes within 70-130% recovery	Correct problem then repeat initial calibration.	Lab Manager/	DV-LC-0012
	Detection Limit Calibration Verification (DLCK)	0.2 µg/L standard analyzed	70 – 130%	Correct problem then repeat initial calibration.	Analyst	DV-LC-0012
	CCV. Continuing calibration verification	50 µg/L and 100 µg/L alternately before sample analysis and after every 10 samples	70 – 130%	Recalibrate the instrument; reanalyze any samples associate with failed CCV. If CCV>130% and samples non-detect, the samples can be reported and flagged without reanalysis	Lab Manager/	DV-LC-0012
	IS. Internal Standard recovery	All samples and standards	50- 150% Historical limits – see individual analytes for	Re-extract if no matrix effect is obvious. Dilute if matrix effect	Analyst	DV-LC-0012

Quality Assurance Project Plan (QAPP) Worksheet #24 – Analytical Instrument Calibration
Worksheet #24 Contains 2 Page(s)

Instrument	Calibration Procedure	Frequency of Calibration	Acceptance Criteria	Corrective Action (CA)	Person Responsible for CA	SOP Reference ¹
			specific limits.	is obvious.		
	Mass Calibration with PEG or other appropriate material bracketing mass calibration range	Annually or after major maintenance or if large amounts of drift are observed in the tune.	+/- 0.5 amu for all compounds	Re-calibrate	Lab Manager/	DV-LC-0012
	Tune (while infusing or evaluation of analyte response in low standard). Check mass of spectral ion intensities	Prior to ICAL	+/- 0.5 amu for all compounds	Perform mass calibration		DV-LC-0012

Note:

¹ SOP reference numbers correspond to the analytical SOPs in QAPP Worksheet #23.

Quality Assurance Project Plan (QAPP) Worksheet #25 – Analytical Instrument and Equipment Maintenance, Testing, and Inspection
Worksheet #25 Contains 1 Page(s)

Instrument/ Equipment	Maintenance Activity	Testing Activity	Inspection Activity	Frequency	Acceptance Criteria	Corrective Action	Responsible Person	SOP Reference ¹
LC/MS, IC/MS/MS & LC/MS/MS	<ul style="list-style-type: none"> • Replace column as needed • Change filters and seals • Clean lenses and needles • Check eluent reservoirs 	Sensitivity check	Instrument performance and sensitivity	Daily or as needed	CCV pass criteria	Recalibrate	Analyst	L-30

Note:

¹SOP reference numbers correspond to analytical SOPs listed in QAPP Worksheet #23..

**Quality Assurance Project Plan (QAPP) Worksheet #28-18 – Quality Control (QC) Samples –
Perfluoro-n-octanoic acid (PFOA) and Other Perfluorinated Hydrocarbons (PFCs) and Perfluoro Hydrocarbon Sulfonates (PFSS) in Water
Worksheet #28-18 Contains 1 Page(s)**

Matrix	Water	Analytical Method/ SOP Reference	PFCs DV-LC-0012 L-30	No. of Sample Locations	14 (see Table 1 of Work Plan)	
Analytical Group	PFOA/PFOS	Sampler's Name	TBD			
Concentration Level	All	Field Sampling Organization	ARCADIS U.S., Inc. Field Personnel			
Sampling SOP	F-08, F-16, and F-17	Analytical Organization	Test America - Denver			
QC Sample	Frequency/Number¹	Method/SOP QC Acceptance Limits	Corrective Action	Person(s) Responsible for Corrective Action	Data Quality Indicator	Measurement Performance Criteria
Field duplicate	One per 20 field samples of similar matrix	Relative percent difference (RPD) <35%	Qualify data as needed	Data Validator	Precision – Overall	RPD <35%
Surrogates	Every Sample and Standards	Refer to the DV-LC- 0012 Attachment for Surrogate control limits	Reanalysis or reextraction/reanalysis of sample	Lab personnel	Accuracy/bias	Laboaratory % Recovery Control Limits
Method blanks	One per analytical batch	No Target Compounds>1/2 RL; no common lab contaminants >RL	Qualify data as needed or reanalyze batch	Lab personnel and/or Data Validator	Accuracy/bias contamination	No Target Compounds>1/2 RL; no common lab contaminants >RL
Laboratory control sample/laboratory control sample duplicate (LCS/LCSD) ²	One per analytical batch	Refer to the DV-LC- 0012 Attachment for Surrogate control limits	Reanalysis or reextraction/reanalysis of batch	Lab personnel	Accuracy/bias	Laboaratory % Recovery Control Limits
Matrix spike/matrix spike duplicate (MS/MSD) ²	One per analytical batch	Refer to the DV-LC- 0012 Attachment for Surrogate control limits	Qualify data as needed	Lab and/or Data Validator	Accuracy/bias	Laboaratory % Recovery Control Limits

Notes:

¹An analytical batch is defined as no more than 20 analytical samples, including field samples and field blanks.

²LCS/LCSD used when MS/ MSD are not provided by field team.

Quality Assurance Project Plan (QAPP) Worksheet #30 – Analytical Services
Worksheet #30 Contains 1 Page(s)

Matrix	Analytical Group	Concentration Level	Analytical Standard Operating Procedure	Data Package Turnaround Time (calendar days)	Laboratory/Organization (name and address, contact person, and telephone number)	Backup Laboratory/Organization (name and address, contact person, and telephone number)
Water	Perfluoro-n-octanoic acid (PFOA) and Other Perfluorinated Hydrocarbons (PFCs) and Perfluoro Hydrocarbon Sulfonates (PFSS)	All	See QAPP Worksheet #23	21 days	TestAmerica Denver 4955 Yarrow Street Arvada, CO 80002 303.736.0192 Contact: Donna Rydberg	NA