FINAL

Groundwater Investigation: Site SS001 Work Plan
North River Radio Relay Station, Alaska

Prepared for:

Air Force Civil Engineer Center

Prepared by:

Oneida Total Integrated Enterprises

Stantec

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ACRONYMS AND ABBREVIATIONS

°C	degrees Celsius
°F	degrees Fahrenheit
AAC	Alaska Administrative Code
ADEC	Alaska Department of Environmental Conservation
AFCEC	Air Force Civil Engineer Center
AFI	Air Force Instruction
AFICA	Air Force Installation Contracting Agency
AFW-ERPIMS	Air Force Wide – Environmental Restoration Program Management System
ATV	all-terrain vehicle
bgs	below ground surface
BMP	best management practice
CERCLA	Comprehensive Environmental Response, Compensation, and Liability Act
CoC	chain-of-custody
COC	contaminants of concern
CO	Contracting Officer
COR	Contracting Officer's Representative
CPR	cardiopulmonary resuscitation
DEW	Distant Early Warning
DD	Decision Document
DoD ELAP	Department of Defense Environmental Laboratory Accreditation Program
DoD QSM	Department of Defense Quality Systems Manual
DQO	data quality objective
EPA	U.S. Environmental Protection Agency
FOPR	Fair Opportunity Proposal Request
ft	feet
FTL	Field Team Lead
FYR	Five-Year Review
GeoTek	GeoTek Alaska, Inc.
GIS	geographic information system
GPS	global positioning system
HSP	Health and Safety Plan
IDW	investigation-derived waste
LTM	long term management
LUC	land use control
mg/kg	milligrams per kilogram
MS	matrix spike
MSD	matrix spike duplicate
OSHA	Occupational Safety and Health Administration
OTIE	Oneida Total Integrated Enterprises
PCE	tetrachloroethene
PCB	polychlorinated biphenyl
PID	photoionization detector
PM	Project Manager
POC	point of contact
POL	petroleum, oil, and lubricant
PTL	Project Technical Lead

PVC	polyvinyl chloride
PWS	performance work statement
QA	quality assurance
QAO	Quality Assurance Officer
QAPP	Quality Assurance Project Plan
QC	quality control
ROD	Record of Decision
RPM	Remedial Project Manager
RRS	radio relay station
SGS	SGS North America Inc.
SSHO	Site Safety and Health Officer
Stantec	Stantec Consulting Services Inc.
TCE	trichloroethylene
TSCA	Toxic Substances Control Act
TO	task order
UFP	Uniform Federal Policy
USAF	U.S. Air Force
UXO	unexploded ordnance
VMF	Vehicle Maintenance Facility
VOC	volatile organic compound
WACS	White Alice Communication System

1.0 INTRODUCTION

This Groundwater Investigation Work Plan has been prepared by Oneida Total Integrated Enterprises (OTIE) and Stantec Consulting Services Inc. (Stantec) [OTIE/Stantec Team] for the U.S. Air Force (USAF) under Contract No. FA8903-17-D-0059, Task Order (TO) FA8903-22-F0086.

On 14 March 2022, the Air Force Installation Contracting Agency (AFICA) issued a Fair Opportunity Proposal Request (FOPR) on behalf of the Air Force Civil Engineering Center (AFCEC) to provide long term management (LTM) at North River Radio Relay Station (RRS). The Performance Work Statement (PWS), dated 21 February 2022, describes specific tasks to be performed under TO FA8903-22-F0086 (AFICA, 2022). The PWS consists of Project Number SACW20227327 for North River RRS. The cost proposal, dated 14 March 2022, presented the response of the OTIE/Stantec Team to fulfill the requirements of the FOPR and technical approach to the scope of work.

The purpose of this Work Plan is to establish procedures for fieldwork and documentation associated with LTM activities at North River RRS.

The first Five-Year Review (FYR) for Site SS001 (Project) at the North River RRS (USAF, 2021) gave a Protectiveness Deferred determination. It was identified that further information was required including further sampling of groundwater before a protectiveness determination could be made. The work in this project is being conducted to satisfy this requirement and characterize environmental conditions at SS001.

This Work Plan contains the information necessary to conduct the groundwater investigation at North River RRS, including background information about the types and concentrations of contaminants, proposed scope of the groundwater investigation tasks, proposed field procedures, and quality assurance (QA) and quality control (QC) procedures.

This project is being conducted under the Alaska Department of Environmental Conservation (ADEC) Alaska Administrative Code (AAC), Title 18, Chapter 75 (18 AAC 75); (ADEC, 2023), following guidance from the Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA) and the U.S. Environmental Protection Agency (EPA) (EPA, 1988).

1.1 PROJECT AREA LOCATION

The North River RRS is located on 26 acres of land atop a bluff approximately 12 miles east of the city of Unalakleet, Alaska, and north of the Unalakleet River (Figure 1-1). Unalakleet, population 750, is located on the Norton Sound at the mouth of the Unalakleet River 148 miles southeast of Nome, Alaska and 395 miles northwest of Anchorage, Alaska. Gravel roads connect Unalakleet with the North River RRS (USAF, 2010).

The North River RRS was constructed in 1957 and was one of the original 31 White Alice Communication System (WACS) facilities used for defense and civilian communications. The North River RRS relayed radio information between similar stations at Granite Mountain, Anvil Mountain, and Kotzebue. Through these connections, Aircraft Control and Warning system sites could link with the Distant Early Warning (DEW) system relaying critical information to Elmendorf and Eielson Air Force Bases. Four dish antennas were situated on the hilltop of Site OT001, approximately 8 miles east of Unalakleet. Support facilities consisting of a composite building, barracks, petroleum storage and distribution facilities, equipment maintenance building, water tower, and temporary garage surrounded the hilltop antennas (USAF, 2010).

1.2 Project Objectives

The Project objective is to conduct a groundwater investigation to satisfy FYR requirements and characterize environmental conditions at Site SS001. Specific objectives consist of the following:

- Installing five groundwater monitoring wells, including subsurface soil sampling.
- Collecting groundwater samples from the newly installed monitoring wells and three existing wells.
- Preparing a Groundwater Characterization Report to document field and laboratory data and characterize environmental conditions at SS001, including VOCs in groundwater.

1.3 Project Organization

Stantec will perform the technical aspects of the Project. The Project execution team is based in the Anchorage, Alaska, office of Stantec. Fieldwork will be performed by Stantec personnel based in Anchorage and familiar with work in remote Alaskan locations. As the managing partner, OTIE will provide contract administration, oversight, and management, as well as invoicing.

The primary personnel involved in the field investigations are the Project Manager (PM); Project Technical Lead (PTL); Project Chemist; Resource and Logistics Lead; Health and Safety Manager; and Field Team Lead (FTL) / Site Safety and Health Officer (SSHO). A project organization chart is provided on Figure 1-2.

1.3.1 Project Manager

The PM will set and maintain the performance standards for execution of work, including technical project performance, internal QC, and adherence to the schedule and budget. The PM is also responsible for subcontractor management and procurement, resource allocation, problem resolution, and schedule reporting. The USAF Contracting Officer's Representative (COR) will approve, in writing, any proposed modification to, or deviation from, any activities described in the Work Plan, as provided by the PM, following approval by the USAF Contracting Officer (CO).

1.3.2 Project (Field) Technical Lead

The PTL is responsible for managing the technical scope of the Project and working closely with the field teams during the implementation phases. Along with the PM, the PTL will attend progress meetings, as well as any technical review meeting.

Figure 1-1 Project Location and Vicinity Map

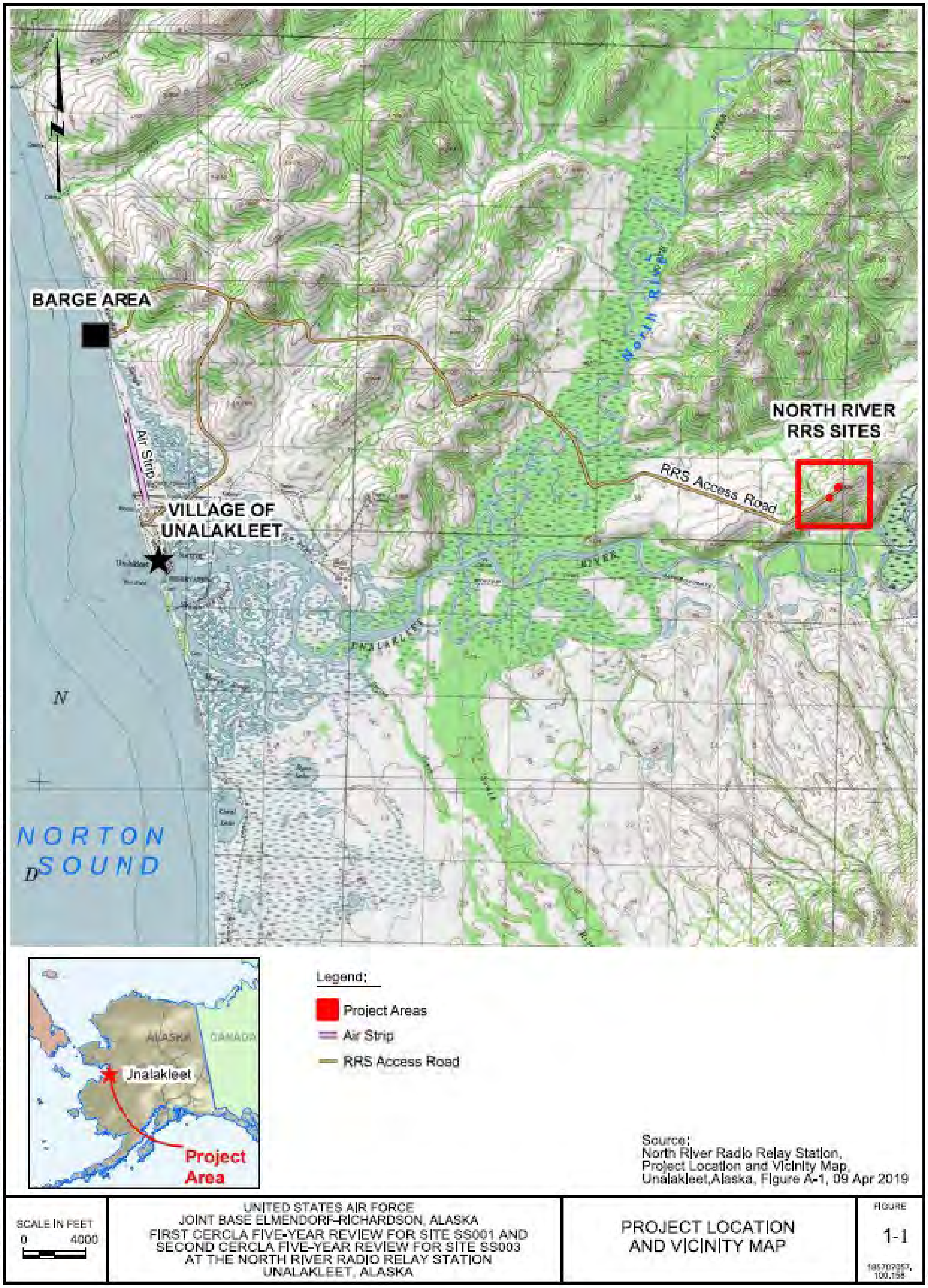

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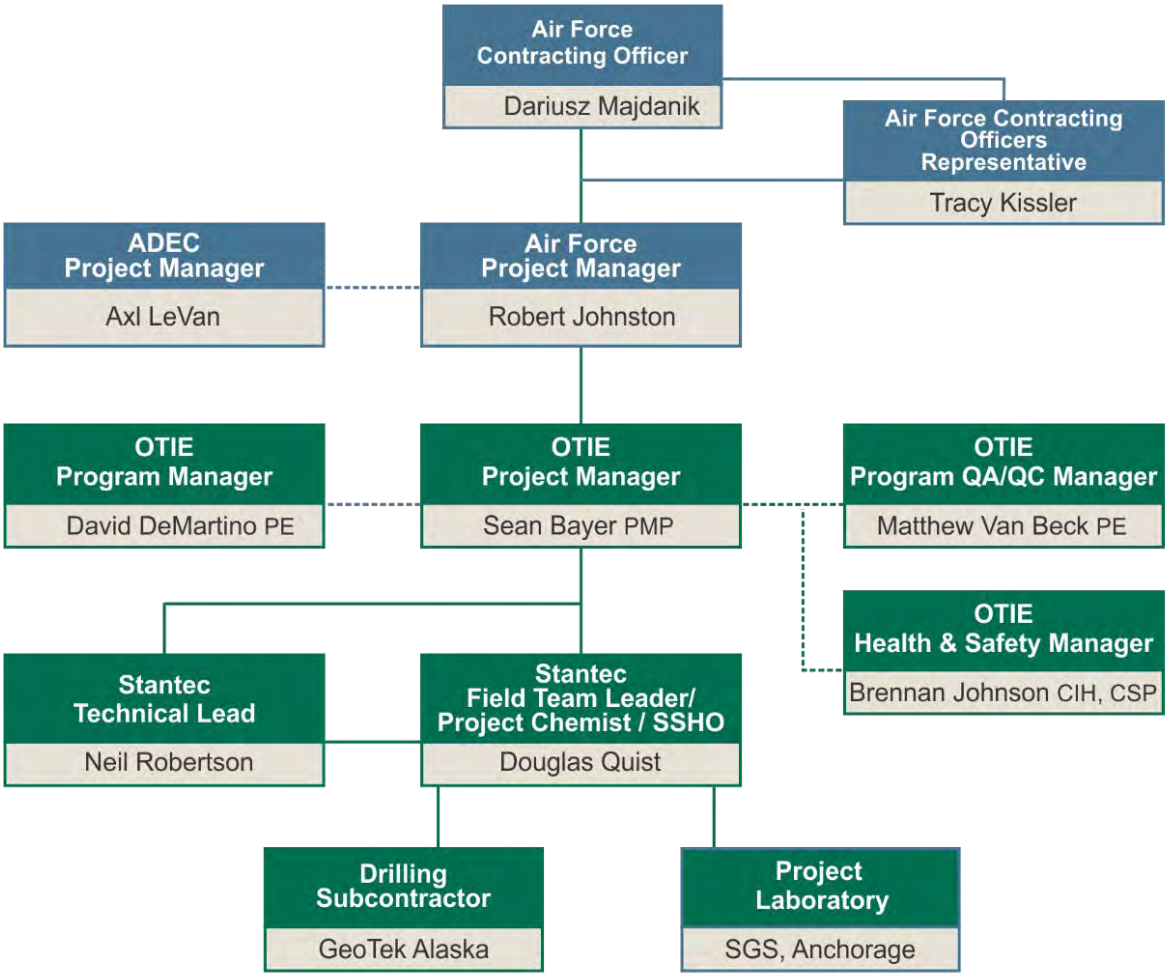
Figure 1-2 Project Organization Chart



Key:
ADEC – Alaska Department of Environmental Conservation
CIH – Certified Industrial Hygienist
CSP – Certified Safety Professional
PE – Pofessional Engineer
PMP – Project Management Professional
OTIE – Oneida Total Integrated Enterprises
QA/QC – Quality Assurance / Quality Control
SGS – SGS North America
SSHO – Site Safety Health Officer
Stantec – Stantec Consulting Services, Inc.

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1.3.3 Project Chemist

The Project Chemist is responsible for ensuring that chemistry-related tasks are conducted in accordance with this Work Plan and the Uniform Federal Policy (UFP) Quality Assurance Project Plan (QAPP; Attachment 1), and for ensuring that all Data Quality Objectives (DQOs) are met. The UFP-QAPP (Attachment 1) was developed using the UFP-QAPP Manual issued by the Intergovernmental Data Quality Task Force (IDQTF) in 2005 (IDQTF, 2005), and follows the March 2012 Optimized UFP-QAPP Worksheets format (IDQTF, 2012). Attachment 2 includes the Laboratory Accreditations/Certifications and ADEC Approvals. The Project Chemist will ensure that project samples are analyzed in accordance with the QAPP, and that the chain-of-custody (CoC) record is completed for each sample with appropriate information. The Project Chemist will oversee sample handling and ensure that samples are preserved, packed, and shipped according to this Work Plan. The Project Chemist will act as a point of contact (POC) on all chemistry-related issues.

1.3.4 Resource and Logistics Lead

The Resource and Logistics Lead is responsible for working closely with the PM on subcontractor management and procurement, resource allocation, and schedule reporting. The Resource and Logistics Lead also works with the other primary Stantec personnel to coordinate the logistical aspects of the Project, such as travel, housing, field equipment and other needs.

1.3.5 Health and Safety Manager

The Health and Safety Manager is responsible for developing, instituting, coordinating, and supervising the health and safety program for the Project. The Health and Safety Manager’s responsibilities include ensuring that the Health and Safety Plan (HSP) complies with all Federal, State, and local health requirements, and coordinating with the SSHO on all modifications to the HSP. The HSP will be provided in a separate document prior to commencing the fieldwork.

1.3.6 Field Team Lead / Site Safety and Health Officer

The FTL will coordinate all field activities during the survey and characterization tasks and will be the primary field contact. The responsibilities of the FTL include: coordinating all field activities with the PM, PTL, and laboratory; maintaining a detailed Field Activity Log Book; establishing and maintaining a field records system; monitoring compliance of the sample custody procedures; and performing other responsibilities as directed by the PM and PTL. The FTL will communicate with the PM and/or PTL for any necessary fieldwork clarification.

The SSHO will direct all personnel with respect to site health and safety. It is the responsibility of the SSHO to ensure that all requirements and protocols set forth in the HSP are followed by all field personnel.

1.4 WORK PLAN ORGANIZATION

This Work Plan is organized in the following sections, appendices, and attachments:

- Section 1 – Introduction
- Section 2 – Site Description and Background
- Section 3 – General Sampling and Field Procedures for Survey and Site Characterization Activities
- Section 4 – Groundwater Investigation
- Section 5 – References

- Appendix A – Field Forms
- Appendix B – Standard Work Procedures
- Attachment 1 – UFP QAPP
- Attachment 2 – Laboratory Accreditations/Certifications and ADEC Approvals

2.0 SITE DESCRIPTION AND BACKGROUND

This section provides a description of the North River RRS installation and discusses the physical characteristics (climate, geology and soils, hydrology, vegetation, and biology) and previous investigations.

2.1 PHYSICAL CHARACTERISTICS

The North River RRS is located on 26 acres of land on a plateau approximately 500 feet (ft) above sea level near the Unalakleet River. Surrounding areas have relatively flat topography.

2.1.1 Climate

The Village of Unalakleet and its surrounding area have a subarctic climate influenced by the Norton Sound when it is ice free, typically between May and October. Winters are cold and dry. Average temperatures range from -4 to 11 degrees Fahrenheit (°F) in winter and from 47°F to 62°F in summer. Annual precipitation averages 14 inches, and the area receives an annual average of 41 inches of snow (USAF, 2019).

2.1.2 Geology and Soils

Cenozoic gravel, silts, and basalt underlie the coastal area of the Lower Yukon subregion where North River RRS is located. The surrounding Nulato Hills consist of folded Cretaceous graywacke and slate with Mesozoic and Paleozoic volcanic intrusions at the east and south ends. At higher elevations, soil borings indicate mostly sand and gravel as overlying sediment. At lower elevations, soil borings indicate thick peaty organics, sandy clay, sandy gravel, and poorly graded gravel. Sedimentary and metasedimentary bedrock is encountered at shallow depths ranging from 3 ft to 15 ft below ground surface (bgs). Discontinuous permafrost exists in this area and has been encountered during previous drilling activities (USAF, 2019).

The Kaltag Fault, a major structural feature that trends north-northwest between Unalakleet and Kaltag, transects the subregion. Most of the rocks are intensely folded and faulted. North River is in Seismic Zone 3 and subject to earthquakes of magnitude 6.0 or greater (USAF, 2019).

2.1.3 Hydrology

North River RRS is located on a plateau approximately 500 ft above sea level near the Unalakleet River. Surface water runoff to the north and west of the site drains into the Little North River, and runoff to the south and east drains into the Unalakleet River. Rivers in the area meander over relatively flat topography.

In 2016, groundwater was encountered between 2.3 and 7.5 ft bgs at Site SO001 (Vehicle Maintenance Facility [VMF]) and between 3.6 and 7.8 ft bgs at Site SS001 (Area C). No seeps or surface water have been observed on site. Site contamination is not likely to migrate to streams, rivers, or water bodies located outside of the North River RRS site boundaries.

2.1.4 Vegetation

Flora at the North River RRS primarily consists of sparse forests spruce, paper birch, balsam poplar, aspen, willow, and alder. Other plant life includes shrubs, sedges, flowers, berries, mushrooms, lichens, and mosses. Dry soil is covered with tall grasses. Muskeg and bogs occur in low-lying areas (USAF, 2019).

2.1.5 Biology

At its closest point, the Unalakleet River is ½-mile from the North River RRS. The Unalakleet River experiences excellent runs of king and silver salmon, as well as resident populations of Arctic grayling and Dolly Varden. The river and other fresh water bodies also provide habitat for chum and pink salmon, whitefish, burbot, stickleback, Arctic char, and Alaska blackfish (USAF, 2019).

Large mammals that inhabit the Unalakleet and North River RRS area include gray wolf, moose, caribou, musk oxen, brown bear, and black bear. Small mammals include red fox, lynx, muskrat, beaver, land otter, marten, porcupine, ground squirrel, tree squirrel, wolverine, weasel, hare, and several species of small rodents. Waterfowl and shorebirds migrate through the area or reside there seasonally (USAF, 2019).

2.2 AREA DESCRIPTIONS AND PREVIOUS INVESTIGATIONS

Several investigations occurred at the North River RRS between 1985 and 2005. These activities included building demolition, debris removal, and soil cleanup activities. Site investigations and sampling events were first performed in 1985 by Woodward-Clyde Consultants, then in 1989 by J.M. Montgomery Consulting Engineers, Inc. The majority of the demolition activities were conducted in 1995. Permitted landfill cells were created on site to hold demolition waste. Site-specific investigations and removal actions at SS001 (Area C) and neighboring Site SO001 (VMF) are presented below (USAF, 2019).

In 2002, while on site to investigate drums located at the North River RRS landfill, an area of exceptionally high polychlorinated biphenyl (PCB) contamination was found on the road to a cabin. This area was identified as SS001. In 2003, the area within the site exhibiting the highest PCB concentrations was excavated. However, additional PCB contamination remained, possibly as a result of vehicle traffic. In 2004, tissue samples were collected from key subsistence animal species and analyzed for total PCBs to determine whether hunting near SS001 was an exposure pathway of concern. No PCBs were detected in any of the sample tissues. In 2004 and 2005, PCB-contaminated soil was further excavated and samples collected. In 2007, site characterization detected fuels in soil at concentrations below cleanup levels and PCBs with a maximum concentration of 1.6 milligrams per kilogram (mg/kg) (USAF, 2019).

In 2010 a Record of Decision (ROD) was finalized for Site SS001. In 2012, PCB-contaminated soil excavation was initiated, and approximately 300 tons of PCB-contaminated soil was removed from SS001. However, PCB contamination was still prevalent, and soil sample results indicated nearly half of the remaining soil exceeded Toxic Substances Control Act (TSCA) hazardous waste thresholds.

In 2013, excavation of PCB-contaminated soil continued. During activities at the main excavation, an odor was noted that led to further sampling and a review of site history, resulting in the discovery of 1,2,4-trichlorobenzene (TCB) at concentrations above cleanup levels. Excavation activities removed 1,252 cubic yards of PCB-contaminated soil from SS001, but PCB and 1,2,4-TCB concentrations were still present at the main excavation. Additional work at SS001 in 2013 included the collection of PCB samples from soil along the all-terrain vehicle (ATV) trail and nearby cabin. The wipe sample results from the cabin were non-detect for PCBs. Concentrations in soil samples from the trail were all below the cleanup level. In addition, a drum was discovered near the cabin. Field screening and analytical samples were collected from the area of the drum and analyzed for fuel constituents. The drum was emptied, removed, decontaminated, and disposed in the local landfill. The drum contents were containerized and disposed offsite (USAF, 2019).

In 2014, vegetation samples were collected from the roots, leaves, and fruits of various plants at SS001 and analyzed for PCBs. None of the vegetation sample results exceeded the ADEC direct contact soil cleanup level of 1 mg/kg. Two samples were collected from berries, both of which were non-detect for PCBs.

In 2015, activities at SS001 consisted of lining and backfilling the existing excavation, drilling, and site restoration. Five soil borings were advanced. Soil samples were collected from each boring and analyzed for PCBs and 1,2,4-TCB, and monitoring wells and/or test wells were installed to determine if site contamination had migrated to groundwater. Groundwater samples were analyzed for PCBs and 1,2,4-TCB. All groundwater results were below ADEC cleanup levels (USAF, 2019).

In 2016, a stockpile cell for petroleum, oil, and lubricant (POL)-contaminated soil excavated from neighboring Site SO001 was constructed at Site SS001. Five pre-construction soil samples were collected from the footprint of the long-term stockpile and analyzed for the contaminants of concern (COCs) identified in the Decision Document (DD) for SO001. All preconstruction sample results were less than ADEC cleanup levels for site COCs. In addition, groundwater samples were collected from four monitoring wells at SS001 following completion of the 2016 excavation activities; analytical results did not exceed the ADEC groundwater cleanup levels. Two consecutive annual groundwater sampling events at SS001 indicated that contaminants were not present in site groundwater above the ADEC groundwater cleanup levels; therefore, it was recommended that groundwater monitoring be discontinued at SS001 (USAF, 2019).

In 2017, the long-term stockpile located at SS001 was inspected during the field effort and rips to the reinforced liner were repaired. In 2018, the stockpile cell at Site SS001 was decommissioned and the contaminated soil was transported to the landfarm constructed at OT001 (WACS). Excavation at SO001 continued until the landfarm at OT001 was full. Contaminated soil remained at SO001 and a landfarm was constructed at SS001 to hold the remaining POL-contaminated soil. Additional pre-construction soil samples were collected within the footprint of the landfarm area and analyzed for COCs identified for SO001 (USAF, 2019).

In June 2019, groundwater samples from monitoring wells C-MW07 and C-MW09 had detections of five VOCs above their respective ADEC groundwater cleanup standards: bromodichloromethane, cis-1,2-dichloroethene, tetrachloroethene (PCE), 1,1,2-trichloroethane, and trichloroethylene (TCE).

In 2020, a ROD amendment was signed to revise the remedy at Site SS001. The revised remedy included: land use controls (LUCs); lining and capping of excavations, which was completed in 2015; and a statement noting that residual PCB, 1,2,4-TCB, and residual range organics contamination in fractured bedrock would remain onsite (USAF, 2019).

In 2021, the first FYR was conducted for Site SS001. The protectiveness determination for SS001 was Protectiveness Deferred pending the acquisition of further data. This Work Plan for a Groundwater Investigation at SS001 addresses the elements noted in the FYR for the five volatile organic compounds (VOCs) that were not included in the ROD and additional site characterization (USAF, 2021).

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3.0 GENERAL SAMPLING AND FIELD PROCEDURES FOR SURVEY AND SITE CHARACTERIZATION ACTIVITIES

This section describes site logistics and site surveying; data management; field equipment calibration and maintenance; documentation and sample handling procedures (sample labeling, Chain-of-Custody [CoC] record, QA/QC samples, and sample storage and shipping); decontamination procedures; investigation derived waste (IDW) management; site restoration; and an emergency spill contingency plan. This information will be utilized for the groundwater investigation activities under this TO.

3.1 SITE LOGISTICS

3.1.1 Work Site Coordination

Stantec will coordinate work site activities to ensure the protection of human health and the environment; prevention of damage to property, utilities, materials, supplies, and equipment; and avoidance of work interruptions.

The work site will be secured, and oversight will be maintained by Stantec personnel during all activities conducted on-site. A bear guard will be hired locally for the duration of the work on-site in order to provide warning of and protection from brown bears. Transportation to and from the site will be coordinated through a truck rental in Unalakleet.

Drilling services will be provided by GeoTek Alaska Inc. (GeoTek) as a Stantec subcontractor.

All activities will comply with Occupational Safety and Health Administration (OSHA) safety and health regulations and local safety office requirements.

3.1.2 Notification Requirements

Stantec will notify the CO and COR of critical issues that may affect the performance of this TO and/or human health and the environment. The types of issues that require notification include, but are not limited to health risks, spills, unexpected utility crossings, unusual weather conditions, unacceptable materials, changes in critical personnel, and unexploded ordnance (UXO). As an example, if unanticipated UXO were discovered during field activities, Stantec would immediately stop work, report the discovery to the USAF POC and COR, and implement the appropriate safety precautions. Field activities would not resume until clearance was received from the CO. On critical issues, oral notifications will be made immediately, followed by written notification as soon as practical.

3.1.3 Mobilization and Permits

This Project will be managed and staffed out of the Stantec Anchorage, Alaska, office to ensure coordination and communication of the USAF contract requirements. Mobilization will consist of transportation of personnel, equipment, and materials from Anchorage to North River RRS. Mobilization is anticipated to require approximately one day.

The team will mobilize from Anchorage to Unalakleet on Ravn Air. Stantec will mobilize a total of two Stantec personnel and two drilling subcontractors to the installation. Accommodations will be arranged in Unalakleet. Site equipment, including the drilling rig, will be mobilized by airplane to North River RRS. It is anticipated that the work will require 1 week on site.

As part of the mobilization effort and prior to commencement of field activities, Stantec will obtain all notifications and clearances required to perform the work (such as utility locates, site arrival, and work notifications) and provide for proper coordination with the AFCEC PM and/or any designated installation POC.

Stantec will also procure all necessary State, Federal, and local project permits to access the installation and complete the fieldwork activities prior to arrival. Permits may include, but are not limited to, a State of Alaska Department of Fish and Game Public Safety (Hazing) Permit. Copies of all required permits will be provided to the USAF RPM prior to Stantec initiation of the work.

A staging area will be established with proper authorization from the USAF RPM and/or any designated installation POC.

3.1.4 Housekeeping

All work areas will be kept clean and orderly. Housekeeping will be done on a regular basis. All garbage and waste materials will be picked up and appropriately bagged in a timely manner. Smoking is not allowed in temporary or permanent buildings.

The accumulation of rags and other combustible materials in uncontrolled areas is prohibited. Flammable liquids will only be stored in approved containers and locations. Access routes, particularly emergency access routes, will be free of all obstructions. Failure to comply with the combustible and flammable storage and emergency access requirements of this section will be considered an imminent danger, resulting in immediate cessation of affected operations until acceptable conditions are met.

3.1.5 Site Sanitation

Sanitation will be facilitated as follows:

- Drinking water: source will be commercially available bottled water.
- Toilet facilities: toilet facilities are available at the lodging facility.
- Washing facilities: washing facilities are available at the lodging facility.
- Waste storage: incidental project wastes will be collected at the end of each day and taken back to Unalakleet for deposition into the local landfill. No hazardous wastes are anticipated, and if they should be produced (e.g., oily waste from drill rig hose break, etc.) they will be managed appropriately and transported off-site to Anchorage for waste consolidation and disposal.

Additional information regarding health and safety can be found in the HSP.

3.1.6 First Aid

At least two persons trained in first aid/cardiopulmonary resuscitation (CPR) will be on site at all times. Certifications of CPR will be updated in the HSP prior to mobilization in summer 2023. Emergency telephone numbers and evacuation routes will be posted on site. Portable eye wash stations and first aid kits will also be maintained on site at all times in an accessible location. Additional information regarding health and safety can be found in the HSP.

3.1.7 Utility Locates

Utility locates will not be required as there are no utilities in the vicinity of the planned monitoring wells.

3.1.8 Best Management Practices

Best management practices (BMPs) will be implemented in order to ensure that, during the survey and site characterization activities, impacts to the site and surrounding areas are minimized as much as possible.

BMPs include providing appropriate and securable U.S. Department of Transportation-approved packaging and labeling of containers for consolidation of hazardous materials and universal wastes anticipated to be removed from the Facilities. Additionally, spill preparedness and containment also constitute BMPs and are included in Section 3.8.

All on-site storage and off-site disposal of hazardous waste will be coordinated with the USAF RPM.

3.1.9 Field Documentation

Information will be documented in the Field Activity Log Book, and a Daily Activity Report will be generated. Field forms required by Stantec will also be completed. Photographic documentation will be performed, to include facilities under investigation, all field activities, and sample locations.

3.1.10 Reporting

The Groundwater Investigation Report is discussed in Section 4.4.

3.1.11 Demobilization

Demobilization from the installation will occur when the Groundwater Investigation is complete. Demobilization is anticipated to require one day, again utilizing Ravn Air for Stantec personnel and subcontractors.

3.1.12 Project Contacts

The FTL will provide daily updates to the OTIE Team PM. A list of contact names, titles, affiliations, office telephone numbers, and email addresses are presented in Table 3-1, and are also provided in the UFP-QAPP (Attachment 1).

3.2 SITE SURVEYING AND DATA MANAGEMENT

Data will be collected for each sample location. Geographic information system (GIS) data will be compliant with DQOs established in the UFP QAPP. Data points will be acquired with handheld global positioning system (GPS) instrumentation. The GIS data will be used to present data and information to evaluate compliance with DQOs.

New analytical data and field data gathered during this Project will be imported into a Project database. This database will be based on OTIE Team's (Stantec's) Envision data structure, based on the Air Force Wide - Environmental Restoration Program Information Management System (AFW -ERPIMS) Version 6.1.

Data validation and verification services will be conducted in accordance with the UFP-QAPP. Stantec will provide data validation services for samples collected as part of this TO, as well as submittal of the AFW-ERPIMS data generated from the project in accordance with Air Force Instruction (AFI) 32-7020.

Table 3-1 Team Contact Information

Name	Title	Organization	Office Telephone Number	E-mail Address
Axl LeVan	Agency Project Manager	ADEC	(907)451-2156	Axl.levan@alaska.gov
Robert Johnston	AFCEC Project Manager	AFCEC	(907)552-7193	Robert.johnston.17@us.af.mil
Tracy Kissler	Contracting Officer's Representative	AFCEC	(907) 552-9762	tracy.kissler@us.af.mil
Dariusz Majdanik	Contracting Officer	AFCEC	(210) 395-9687	dariusz.majdanik @us.af.mil
Sean Bayer	OTIE Project Manager	OTIE	(402) 250-6318	sbayer@oescgroup.com
Neil Robertson	Stantec Project Manager / Project Technical Lead / QAO	Stantec	(907) 266-1116	neil.robertson@stantec.com
Douglas Quist	Field Team Leader / Project Chemist / SSHO	Stantec	(907) 266-1148	douglas.quist@stantec.com
William Wesley	SGS Laboratory Director	SGS	(907) 562-2343	William.wesley@sgs.com
Mary McDonald	SGS Laboratory QAO	SGS	(907) 550-3203	Mary.mcdonald@sgs.com

Key:

ADEC	Alaska Department of environmental Conservation
AFCEC	Air Force Civil Engineer Center
OTIE	Oneida Total Integrated Enterprises
QAO	Quality Assurance Officer
SGS	SGS North America Inc.
SSHO	Site Safety and Health Office
Stantec	Stantec Consulting Services Inc.

3.3 Field Equipment Calibration And Maintenance

All field equipment will be calibrated and maintained according to manufacturer's specifications. The model and serial number for each piece of equipment used will be recorded in the Field Activity Log Book, or on appropriate field forms / field data sheets, along with its associated calibration readings. An adequate supply of critical supplies, consumable materials, and calibration standards will be present on site.

3.4 Documentation And Sample Handling Procedures

Field Activity Log Books and/or field forms / field data sheets will be used to document vital project information and daily tasks. Entries will be complete and contain sufficient detail to permit reconstruction of field activities. All entries will be written in ink and initialed or signed by the individual making the entry. At a minimum, the following information will be recorded during the collection of each sample:

- Sample location and description
- Site sketch showing sample location
- GPS coordinates
- Swing tie information, where feasible
- Sampler's name
- Date and time of sample collection

- Type of sample (grab or composite) and analytical methods requested
- Field instrument readings
- Sample identification number
- Deviations from sampling or QA/QC procedures
- Calibration readings of any equipment used, and equipment model and serial number

Additionally, all major tasks will be photographed to verify information entered in the Field Activity Log Book. Copies of the photographs will be provided in the final report and will include descriptions of the pertinent information.

3.4.1 Sample Labeling

Each sample collected will be assigned a unique alphanumeric identifier code by the field team to track samples through all phases of the project. The numbering system will allow project personnel to easily catalog all samples collected and provide an accurate means for database manipulation after the field investigation is completed.

Sample identifiers will be comprised of six elements:

1. Two-digit year designation: 23.
2. Three-letter project site designation: NRR for North River RRS.
3. Three-digit sample number. Numbering will start from 001 at each location:
   A. 001 through 099 for primary samples
   B. 201 through 299 for duplicate samples
4. Two-letter sample media designation:
   A. GW = Groundwater
   B. SS = Surface soil (0.0 to 1.0 ft)
   C. SL = Subsurface soil (greater than 1.0 ft)
   D. LM = Multiple phase liquid waste sample
   E. ST = Solid waste
   F. WQ = Equipment rinsate
   G. WW = Wastewater
5. Two number depth indicator (XX).

The following examples illustrate the sample identifier scheme:

- Sample 23NRR001GW01 will be the first groundwater sample collected from Monitoring Well 1.
- Sample 23NRR201GW01 will be the first QC sample collected from Monitoring Well 1.

Samples will be tracked using a sample label that includes the following information:

- Project name and number

- Sample designation (number)
- Date and time of sample collection
- Initials of the sampler
- Analyses to be performed on the sample
- Preservative used, if any

Labels will be affixed to the sample containers and covered with clear tape to prevent removal.

3.4.2 Chain-of-Custody Record

Sample custody is maintained by a CoC record. The CoC is completed by the individual collecting the sample and will be completed for all samples.

A sample will be considered under proper custody if:

- It is in actual possession of the responsible person
- It is in view, following physical possession
- It is in the possession of a responsible person and is locked or sealed to prevent tampering
- It is in a secure area

The CoC is a continuously maintained custody record that travels with the samples at all times. The CoC must be signed off by each person responsible for collecting, checking, or otherwise handling the samples, or transporting the samples to a laboratory or other agency.

The CoC will include the following:

- Corporate name
- Sampler name and signature
- The site designation
- Sample designations
- Sampling date
- Sample collection times
- Analyses to be performed on the samples
- Number of containers submitted for each sample set
- Cooler/CoC number

The person(s) collecting the samples must sign the CoC in the appropriate block at the end of the sampling day. At this time, the labels on the sample containers will be checked against the CoC to make sure there are no discrepancies between any of the information recorded on both. If an error is found on a label or the CoC, it will be lined through once, in ink, so the initial entry can still be read. The correction will then be made, in ink, and initialed by the person making it.

When samples are held at the project area overnight or longer, the comparison check described above will be made again by the person responsible for transporting samples.

The person responsible for transporting the samples must:

- Sign the topmost "relinquished by" block

- Fill in the shipping date and time
- Tally the number of sample containers
- Note the shipping bill number
- Record the storage time and temperature (if applicable)

It is anticipated that the work will require one week on site. Samples will be transported to Anchorage for transport to the project laboratory at the end of the fieldwork.

A copy of the CoC must be retained for return to the Project Office. All samples will be delivered by a responsible person to SGS North America Inc. (SGS). SGS is a fully accredited by Department of Defense Environmental Laboratory Accreditation Program (DoD ELAP). All sampling, analysis, and data review validations will comply with the requirements of the Department of Defense Quality Systems Manual (DoD QSM) for Environmental Laboratories, Version 5.4 (DoD, 2021); and DoD General Data Validation Guidelines (DoD, 2019) and Module 1 Data Validation Procedure of Organic Analysis by GC/MS (DoD, 2020). Additionally, the QAPP, provided as Attachment 1 to this Work Plan, details the laboratory analysis, performance, and data reporting requirements.

3.4.3 Quality Assurance / Quality Control Samples

QA/QC samples will include:

- Duplicate samples will be collected at a minimum frequency of 10 percent.
- Based on field considerations, the field team will select the locations for collection of duplicate, matrix spike (MS), and MS duplicate (MSD) samples. These QA/QC samples will be submitted for the same analyses as the primary sample.
- MS and MSD samples will be collected at a minimum frequency of 20 percent.
- Trip blanks for VOCs for both soil and water will be included, a total of 2 soil and 1 water matrix trip blanks are anticipated.
- Equipment blanks will be included for both water and soil matrices at a minimum rate of 1 equipment blanks per 20 primary samples,

3.4.4 Sampling for both subsurface soil and groundwater will follow the requirements in the ADEC Field Sampling Guidance (ADEC, 2022a).Sample Storage and Shipping

At the conclusion of each workday, preserved samples will be securely stored in a dedicated refrigerator or other container(s) until delivered to the lab. For this project, samples will be stored at 4 degrees Celsius (°C) until the field team completes their scheduled work.

Each cooler will contain one clearly labeled temperature blank, consisting of tap water in a small plastic bottle.

A sample shipping notebook will be maintained at the site by the FTL, or else shipping details will be recorded in the Field Activity Log Book. The sample shipping notebook or Field Activity Log Book is a permanent record of the samples stored or delivered from the site. All notebook entries will be initialed.

When preparing samples for transportation, the following will be recorded in the sample shipping notebook or Field Activity Log Book:

- Time
- Date

- Sample numbers
- Laboratory to which they are being delivered
- Analyses requested

When preparing stored samples for transport, the cooler will be repacked with fresh gel ice and the temperature checked and recorded on the CoC and in the sample shipping notebook or Field Activity Log Book. The best way to check the temperature is to open one of the temperature blanks and insert the thermometer in the water (only valid if the temperature blank has been in the cooler long enough to be at the same temperature as the cooler and samples).

3.4.4.1 Sample Packing

Procedures for packing samples are as follows:

- Check all container labels against the CoC to make sure there are no discrepancies, and to ensure that both the labels and CoC are complete and legible.
- Count containers to make sure the number is recorded correctly on the CoC.
- Make sure all bottle caps are on tight.
- If any samples were handled or treated in an unusual manner, make sure this is noted on both the sample bottle and CoC.
- One-liter bottles should be placed upright in the cooler, not stacked horizontally.
- Place a temperature blank in each cooler being transported.
- Place 8 to 10 pounds of completely frozen blocks of gel ice in each cooler, distributing them evenly among the samples to ensure an even temperature distribution. Dry ice should not be used, because it will tend to freeze the samples.
- Discard any gel ice that shows signs of leakage.
- Fill all void spaces in the ice chests with clean packing material to prevent breakage during transport. Paper or cardboard should never be used as packing material.
- Retain a copy of the CoC.
- Put the CoC in a zippered plastic freezer bag and tape to the inside lid of the corresponding cooler.
- Remove old labels, tape, or other attached information from the cooler.

3.4.4.2 Transportation Containers (Coolers)

Procedures for preparing transportation containers are as follows:

- Attach address labels to all shipping containers.
- Mark container with cooler/CoC number.
- Attach custody seals across the ends of the cooler.

3.5 DECONTAMINATION PROCEDURES

Work areas will be maintained to: prevent the spread of contamination as a result of investigation procedures, provide for the integrity of the samples obtained, and provide for the safety of field workers. Where possible, disposable sampling equipment will be used. Non-disposable sampling equipment will be decontaminated as described in Section 3.6.2.

Reusable field equipment to be decontaminated includes:

- Soil boring augers and/ direct push drive heads
- Shovels
- Split spoons (if direct push techniques are not able to advance the boring)

Reusable equipment will be scrubbed with a stiff brush in a solution of hot water and laboratory grade, critical cleaning detergent such as Alconox or a similar product, followed by two potable water rinses, and a final rinse with deionized water.

3.6 Investigation-Derived Waste Management

Investigative Derive Waste (IDW) will consist of soil cuttings from the soil borings; decontamination fluids, monitoring well development and sampling purge water; and granulated activated carbon filter media. Prior to off-site transportation of any IDW, the ADEC *Contaminated Media Transport and Treatment of Disposal Form* will be completed and submitted by the Air Force to ADEC for approval.

3.6.1 Soil Cuttings

IDW Soil Cuttings produced during the soil boring advancement and monitoring well installations will be containerized in U.S. Department of Transportation (DOT) type-H open-top 55-gallon drums. Drummed soil IDW will be stored at the site until the laboratory data is available to characterize the contents for disposal. Disposal at an appropriate Treatment Storage and Disposal Facility (TSDF) will be arranged through the USAF with ADEC approval.

3.6.2 Decontamination Water and Development and Sampling Purge Water

Decontamination water associated with soil boring auger cleaning will be treated through a granular activated carbon (GAC) filter along with well development and well sampling purge water and discharged to the ground surface off the gravel pad in a location greater than 100 ft from standing water.

Based on previous site information the presence of free-product is unlikely, however, if free-product or heavy sheen is noted, the water will be containerized for off-site treatment or disposal, and will not be disposed on-site through GAC directly.

3.6.3 Granulated Activated Carbon (GAC) Filter

After the sampling has been completed, and all project water has been treated and discharged through it, the GAC filter drum will be sealed, and labeled pending analysis for off-site waste disposal.

3.6.4 Personal Protective Equipment and Disposable Sampling Materials

Personal protective equipment and incidental materials (e.g., gloves) and disposable sampling equipment (e.g., sampling spoons and tubing) will be bagged and disposed of as non-hazardous waste.

3.7 Site Restoration

Monitoring wells will be left secure and in good condition.

3.8 Emergency Spill Contingency Plan

Stantec will bring absorbent pads and boom to North River RRS as part of the field mobilization. Subcontractors will also be required to bring sufficient absorbent pads and boom to the site to contain any potential leaks from their equipment.

In the unlikely event that there is a release to the environment of fuels, chemicals, or wastes (i.e., from vehicle fuel, hydraulic fluid leaks, glycol leaks, fuel cans, drums, or other containers), the following protocols will be followed:

1. Isolate the leak and prevent it from continuing and/or migrating.
2. Deploy absorbent materials, boom, pads, or to the area affected to absorb as much product as possible.
3. Once the spill is contained or stopped, clearly mark the entire area affected.
4. Contact North River RRS PM immediately so they can come to the site, assess the spill, and respond appropriately.
5. If the spill is of reportable quantity based on the material released, Stantec will coordinate with the North River RRS PM to prepare the notification to ADEC. The following requirements apply to reportable quantity spills:
    A. Alaska state law requires all oil and hazardous substance releases to be reported to ADEC (ADEC, 2022b).
    B. Notification requirements for hazardous substance releases: Any release of a hazardous substance must be reported as soon as the person has knowledge of the discharge.
    C. Notification requirements for oil/petroleum releases: Any release of oil to water must be reported as soon as the person has knowledge of the discharge. Any release of oil to land in excess of 55 gallons must be reported as soon as the person has knowledge of the discharge. Any release of oil to land in excess of 10 gallons but less than 55 gallons must be reported within 48 hours after the person has knowledge of the discharge.
    D. Placards and forms are provided on the ADEC website at: https://dec.alaska.gov/spar/ppr/spill-information/reporting.

In the event a spill from an unknown source is discovered, such as a container exposed while digging or drilling, the North River RRS PM will be contacted immediately, and the area will be isolated until his/her arrival. No effort to contain or mitigate a release from an unknown source will be undertaken by Stantec or its subcontractors. Any historic or unknown source spills will also require reporting to ADEC by the North River RRS PM.

4.0 GROUNDWATER INVESTIGATION

The groundwater investigation portion of this TO includes the approach, field activities, sampling methodology, and laboratory analyses to be utilized while installing groundwater monitoring wells and characterizing groundwater.

4.1 APPROACH TO INVESTIGATION

The groundwater investigation will be conducted to advance soil borings and install monitoring wells, collect subsurface soil and groundwater samples, submit them for analysis of VOCs, and evaluate the five VOCs: bromodichloromethane, cis-1,2-dichloroethene, PCE, 1,1,2-trichloroethane, and TCE.

Five monitoring wells will be installed using direct push drilling (Figure 4-1). Subsequently, eight monitoring wells—three existing, five newly installed—will be sampled and analyzed for VOCs. Well locations were based on information collected previous investigations in 2019 and 2020 (Figure 4-2).

Samples and IDW will be managed in accordance with this Work Plan and associated documents, in addition to all relevant and appropriate regulatory standards.

4.2 FIELD ACTIVITIES AND SAMPLING METHODOLOGY

Sampling for both subsurface soil and groundwater will follow the ADEC Field Sampling Guidance (ADEC, 2022a).

4.2.1 Monitoring Well Installation

Five new monitoring wells will be installed at Site SS001. Wells will be installed on the down-gradient side of SS001; the actual location of each well is subject to determination in the field. There are no utilities in the vicinity of the borings; utility locates will not be required. Monitoring well installations will follow The Standard Operating Procedure, SOP ES3.01 and comply with the ADEC Monitoring Well Guidance document for both installations and abandonments (ADEC, 2013).

The depth to groundwater is assumed to be 10 ft bgs and the total well depth for each well will be 30 ft; however, drilling will stop short of 30 ft if refusal is encountered. The wells will be constructed of 2-inch polyvinyl chloride (PVC) Schedule 40, screened from approximately 5 ft to 15 ft, depending upon site conditions encountered at the time of drilling. Wells will include guard posts and all well locations will be surveyed using a handheld GPS. Soil boring logs will be recorded during installation and provided in the final report.

A 24-hour wait period will commence after well installation and prior to well development. After development is completed following SOP ES3.03, wells will be sampled immediately. Development water will be treated on-site using a granular activated carbon filter and discharged to site.

4.2.2 Subsurface Soil Sampling

During the drilling process, two soil samples will be collected from each borehole for VOC analysis. A photoionization detector (PID) will be used to screen soil regularly at 2-foot intervals, and the two soil samples with the highest PID readings from each borehole will be submitted to the laboratory for analysis. PID samples will be collected in single use re-sealable polyethylene bags and warmed prior to reading the headspace in accordance with the ADEC Field Sampling Guidance (ADEC, 2022). A field blank of the polyethylene bags will be tested prior to the field screening to account for potential interferences caused by the bags themselves. VOC samples will be collected from each interval at the same time the PID samples are collected. Only the two intervals exhibiting the highest PID reading will be analyzed.

4.2.3 Groundwater Sampling

Groundwater samples will be collected from eight monitoring wells in one sampling event after the installation and development of the five new wells. The eight wells to be sampled will be made up of the five newly installed wells and three existing wells: C-MW07, C-MW09, and C-TW10. Sampling will be conducted using low stress (low-flow) purging and sampling techniques at an average depth of 15 ft bgs in compliance with the methods outlined in the ADEC Field Sampling Guidance (ADEC, 2022) and following SOP ES4.03. Removal of at least one well volume and stabilization of water quality parameters is required prior to sampling. Water quality parameters are considered stabled when three successive readings collected 2-5 minutes apart are within the following ranges:

- ± 3% temperature,
- ± 0.1 pH,
- ± 3% conductivity,
- ± 10 mV redox potential
- ± 10% dissolved oxygen
- ± 10% turbidity

A minimum of three of these parameters will be monitored and recorded. If a well is low yield and is purged dry, sampling will not occur until it has recharged to approximately 80% of its pre-purge volume.

The groundwater samples will be analyzed for VOCs.

4.3 LABORATORY ANALYSES

Table 4-1 provides the Sample Plan Checklist for the North River RRS Groundwater Investigation sampling.

Subsurface soil and groundwater samples collected during the groundwater investigation at SS001 will be submitted for analysis of VOCs using EPA Method Solid Waste (SW) 846 Method 8260D.

These analyses will be completed using a standard 14-day turnaround.

4.4 REPORT

Upon completion of the groundwater investigation activities at Site SS001, Stantec will provide a Groundwater Characterization Report detailing the findings of the investigation, including:

- Documentation of field and laboratory data.
- Characterization of environmental conditions utilizing collected and applicable historical data, including previously collected data, this includes the VOCs not previously included in the ROD, or ROD amendment, namely: bromodichloromethane, cis-1,2-dichloroethene, PCE, 1,1,2-trichloroethane, and TCE.
- Deviations from the approved work plan.

SCALE IN FEET
0 20

UNITED STATES AIR FORCE
NORTH RIVER RADIO RELAY STATION
GROUNDWATER INVESTIGATION: SITE SS001
WORK PLAN

SS001
GROUNDWATER INVESTIGATION

FIGURE 4-1

185706127

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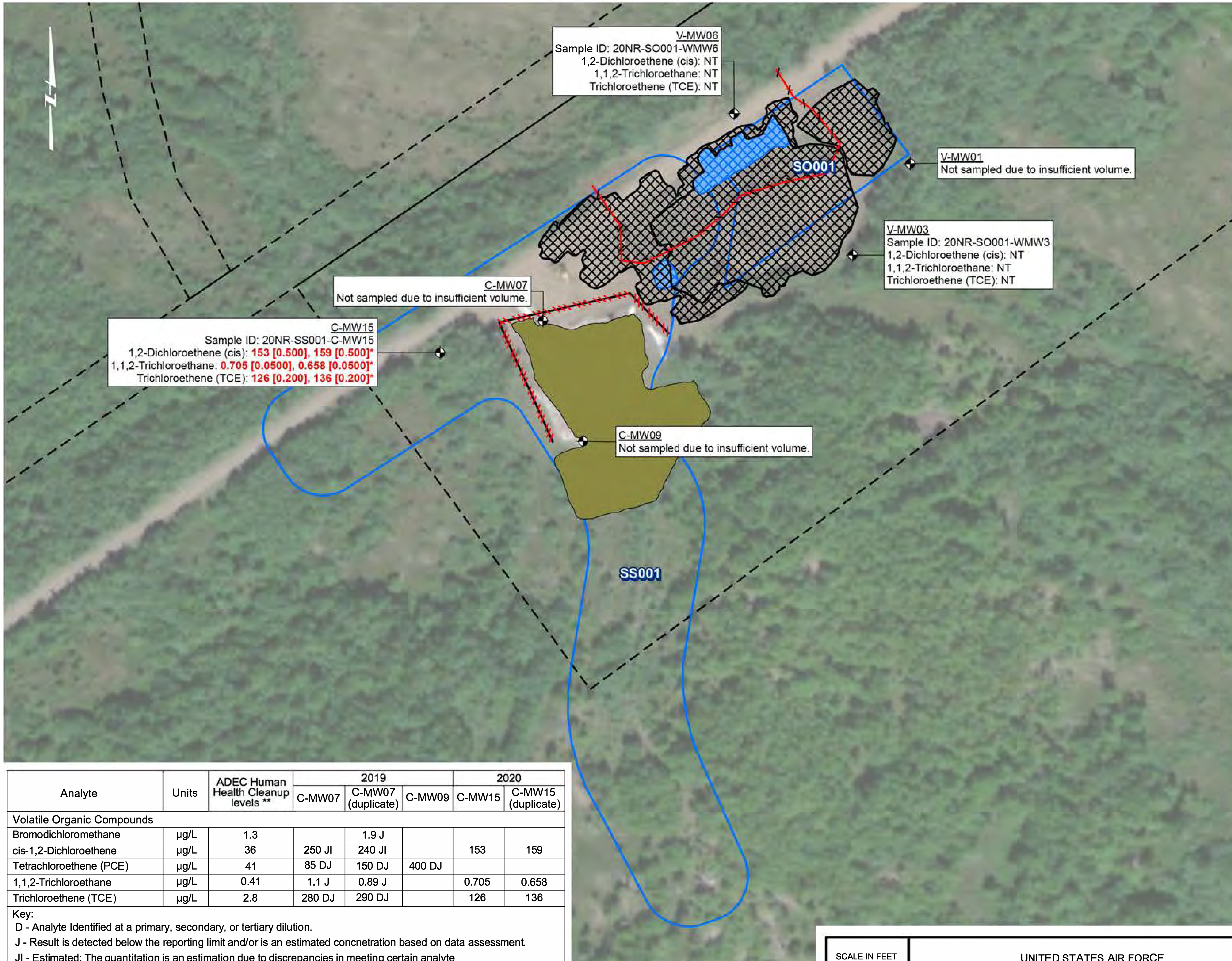

Analyte	Units	ADEC Human Health Cleanup levels **	2019			2020	
			C-MW07	C-MW07 (duplicate)	C-MW09	C-MW15	C-MW15 (duplicate)
Volatile Organic Compounds							
Bromodichloromethane	µg/L	1.3		1.9 J			
cis-1,2-Dichloroethene	µg/L	36	250 JI	240 JI		153	159
Tetrachloroethene (PCE)	µg/L	41	85 DJ	150 DJ	400 DJ		
1,1,2-Trichloroethane	µg/L	0.41	1.1 J	0.89 J		0.705	0.658
Trichloroethene (TCE)	µg/L	2.8	280 DJ	290 DJ		126	136

Key:
D - Analyte Identified at a primary, secondary, or tertiary dilution.
J - Result is detected below the reporting limit and/or is an estimated concnetration based on data assessment.
JI - Estimated: The quantitation is an estimation due to discrepancies in meeting certain analyte specific quality control criteria.

Legend:
- Land Use Control Restriction
- Fenching
- Silt Fencing
- Groundwater area
- Previous Excavation Area
- Area C Landfarm Area
- Installation Boundary
- Monitoring Well/Groundwater Sample Location

Notes:
1. Results are reported with the limit of detection (LOD) in brackets [ ].
2. Results shown in **bold red** exceed the screening levels.
3. An asterisk denotes a duplicate sample.

** Alaska Department of Environmental Conservation (ADEC) Groundwater Cleanup Levels, Alaska Administrative Code Title 18, Chapter 75.345, Table C for Human Health.

NT = Not tested
RRS = Radio Relay Station
µg/L = Microgram(s) per liter

Source:
2020 Remedial Action Operations, Institutional Control/Land Use Control Report, North River RRS, Alaska, Sites SO001, SS001, and SS003. Figure 2.

SCALE IN FEET
0 50

UNITED STATES AIR FORCE
NORTH RIVER RADIO RELAY STATION
GROUNDWATER INVESTIGATION: SITE SS001
WORK PLAN

2019 and 2020 GROUNDWATER SAMPLE RESULTS

FIGURE
4-2
185707057.100.158

TIME: 29-OCT-2021 12:19 FILE: C:\D\CAD\Proj\Stantec Cardno Baker JV\2020 North River_Unalakleet_185707057\2020 North River_Unalakleet FYR\November 2020\Fig03_grndwtr samples.dgn

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Table 4-1 Sample Plan Checklist

	Volatile Organic Compounds (VOCs) by EPA Method 8260D	
	Soil	Water
Total Primary Samples	10	8
Duplicates	2	1
MS	1	1
MSD	1	1
Rinsate	2	
Trip Blanks	2	1
Total Sample Count	18	12

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5.0 REFERENCES

AFICA. 2022. Performance Work Statement for Environmental Services and Construction (ESC) to Provide Long Term Management at Point Lay Long Range Radar Site, Alaska and North River Radio Relay Station, Alaska. Project Numbers: TKUH20227500, SACW20227327. 28 March 2022.

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USAF. 2021. Final First CERCLA Five-Year Review for Site SS001 and Second CERCLA Five-Year Review for Site SS003 at the North River Radio Relay Station, Unalakleet, Alaska. December.

U.S. Environmental Protection Agency (USEPA). 1988. Guidance for Conducting Remedial Investigations and Feasibility Studies under CERCLA. Interim Final. EPA/540/G 89/004, OSWER Directive 9355.3-01. October 1988.

USEPA. 2005. Uniform Federal Policy for Quality Assurance Project Plans. Final, Version 1. EPA-505-B-04-900A. March.

APPENDIX A

FIELD FORMS

Daily Quality Control Report

DATE ____________________

DAY	Sun	Mon	Tues	Wed	Thurs	Fri	Sat

Project Manager	Neil Robertson	Weather	Bright Sun	Clear	Overcast	Rain	Snow
Project	North River RRS	Temperature (^{0}F)	Below 32	32 to 50	50 to 70	70 to 85	above 85
Job No.	185706127	Wind	Still	Moderate	High	Report No.	
Contract No.	FA8903-17-D-0059	Humidity	Dry	Moderate	Humid		

SUBCONTRACTORS ON SITE:

EQUIPMENT ON SITE:

WORK PERFORMED (INCLUDING SAMPLING):

PROJECT	North River RRS Site SS001 Groundwater Characterization	REPORT NO.:	

Daily Quality Control Report

Project: North River RRS Site SS001 Groundwater Characterization **Date:**

QUALITY CONTROL ACTIVITIES (INCLUDING FIELD CALIBRATION AND STANDARDIZATION):
HEALTH AND SAFETY LEVELS AND ACTIVITIES:
PROBLEMS ENCOUNTERED/CORRECTIVE ACTION TAKEN:
FIELD CHANGES:
SPECIAL NOTES:
TOMORROW'S EXPECTATIONS:

BY:	TITLE:

LOG OF DRILLING OPERATIONS

Project Number: 185706127

Boring Number:

Sheet 1 of 1

Project: North River RRS   Site: Client: AFCEC

Start Date: Finish Date: Geologist:

Drilling Company: GeoTek Alaska   Drilling Method: Direct Push   Rig Type: GeoProbe

Boring Size: (in) OD   Total Depth: (ft)   Depth to First Water: (ft)   Depth to SWL: (ft)

Sampler Type: 5-foot tube liner   Diameter: (in) 2.0   Hammer Drop: (in)   Hammer Weight: (lbs)

AK State Plane Coordinates: Northing (ft):   Easting (ft):   Top of Hole Elevation (ft):   Elevation Datum:

Depth (ft bgs)	Time	Sample Interval	Blows/6 in	PID (ppm)	% Gravel	% Sand	% Fines	Max Size (in)	Lithologic Description/ Drilling Remarks	Soil Class	Graphic Log
0											0
1											1
2											2
3											3
4											4
5											5
6											6
7											7
8											8
9											9
10											10
11											11
12											12
13											13
14											14
15											15
16											16
17											17
18											18
19											19
20											20

APPENDIX B

STANDARD OPERATING PROCEDURES

SOP 1

Drilling Methods

STANDARD OPERATING PROCEDURES
SOP 1: DRILLING METHODS

1.0 INTRODUCTION

Drilling is a common activity associated with all phases of environmental investigations. Drilling methods are most commonly used to collect site data during site investigations (SIs) and remedial investigations (RIs), but are also used to install vapor extraction or water wells associated with remedial actions (RAs) and, to a lesser extent, feasibility studies (FSs).

Field investigations usually require invasive types of activities to gather information to evaluate the site. The investigation may require the analysis of soil and/or groundwater samples which would be accomplished by drilling a borehole. Many times the borehole is converted into a well for the evaluation of vapor or groundwater conditions over time. In addition to the collection of samples for analyses, other data such as physical parameters of soils can be obtained from boreholes.

For determining the most appropriate drilling method for an SI or an RI, primary consideration must be given to obtaining information that is representative of existing conditions and the collection of samples that are valid for chemical analysis. The samples must not be contaminated or adversely affected by the drilling method.

Drilling associated with RAs and FSs may include the installation of vapor or water extraction and/or injection wells. In selecting the most appropriate drilling method for RAs and FSs, primary consideration must be given to completion of a well which will perform as designed.

This SOP provides a description of the principles of operation and the applicability and implementability of standard drilling methods used during field investigations. The purpose of this document is to aid in the selection of drilling methods that are appropriate for site-specific conditions. It is intended to be used by the Project Manager (PM), Project Engineer (PE), Field Team Leader (FTL), and site hydrogeologist to develop an understanding of each method sufficient to permit work planning, scheduling, subcontracting, and resource planning.

This document focuses on methods and equipment that are readily available and typically applied. It is not intended to provide an all inclusive discussion of drilling methods. Two general drilling methods are discussed: 1) methods that do not use circulating fluids, and 2) methods requiring the circulation of drilling fluids to transport cuttings to the surface.

2.0 DEFINITIONS

<u>Bailer</u>: A cylindrical tool designed to remove material, both solid and liquid, from a well or borehole. A valve at the bottom of the bailer retains the material in the bailer. The three types of bailers are flat-valve bailer, a dart-valve bailer, and the sand pump with rod plunger.

Cone Penetrometer: An instrument used to identify the underground conditions by measuring the differences in the resistance and other physical parameters of the strata. The cone penetrometer consists of a conical point attached to a drive rod of smaller diameter. Penetration of the cone into the formation forces the soil aside, creating a complex shear failure. The cone penetrometer is very sensitive to small differences in soil consistency.

Cuttings: Formation particles obtained from a borehole during the drilling process.

Drilling Fluids or Muds: A water-based or air-based fluid used in the well drilling operation to remove cuttings from the borehole, to clean and cool the bit, to reduce friction between the drill string and the sides of the borehole, and to seal the borehole.

Dual-Purpose Well: A well that can be used as both a monitoring and extraction or injection well.

Flight: A individual auger section, usually 5 feet in length.

Heaving Formation: Unconsolidated saturated substrate encountered during drilling where the hydrostatic pressure of the formation is greater than the borehole pressure causing the sands to move up into the borehole.

Kelly Bar: A hollow steel bar or pipe that is the main section of drill string to which the power is directly transmitted from the rotary table to rotate the drill pipe and bit. The cross section of the kelly is either square, hexagonal, or grooved. The kelly works up and down through drive bushings in the rotary table.

Pitch: The distance along the axis of an auger flight that it takes for the helix to make one complete 360 degree turn.

Rotary Table: A mechanical or hydraulic assembly that transmits rotational torque to the kelly, which is connected to the drill pipe and the bit. The rotary table has a hole in the center through which the kelly passes.

Split-Spoon Sampler: A thick-walled steel tube split lengthwise used to collect soil samples. The sampler is commonly lined with metal sample sleeves and is driven or pushed downhole by the drill rig to collect samples.

Thin-Walled Sampler: A sampling devise used to obtain undisturbed soil samples made from thin-wall tubing. The sampler is also known as a Shelby tube. The thin-wall sampler minimizes the most serious sources of disturbance: displacement and friction.

3.0 RESPONSIBILITIES

Field Team Leader: Implements selected drilling program. Aids in the selection of drilling methods and preparation of subcontracts.

Project Manager: Selects site-specific drilling methods with input from the Field Team Leader and Site Hydrogeologist, and oversees and/or prepares drilling subcontracts.

Site Hydrogeologist: Selects site-specific drilling options. Helps prepare technical provisions of drilling subcontracts.

4.0 DRILLING METHODS

Drilling methods can be separated into two general types; techniques that use circulating fluids and techniques that do not use circulating fluids. The following sections discusses the drilling methods that fall into these two general categories.

4.1 METHODS WITHOUT CIRCULATING FLUIDS

4.1.1 Augering

Auger drilling is accomplished by rotating a pipe or rod that has a cutting bit. The common auger drilling methods discussed in this section are hand, continuous-flight, hollow-stem, and bucket.

4.1.1.1 Hand Auger

A hand auger typically cuts a hole 3 to 9 inches in diameter and, depending on the geologic materials, may be advanced to about 15 feet. Generally, the borehole cannot be advance below the water table because the hole collapses. Soil samples for chemical or geotechnical analyses should not be collected directly from a hand auger because the samples are disturbed and cross contamination may occur. Samples for chemical or geotechnical analyses should be taken with a sampling tool such as a drive sampler applied at the desired depth. Samples for lithologic logging purposes may be taken directly from the auger.

Applications

- Shallow soil investigations
- Soil samples
- Water-bearing zone identification

Limitations

- Limited to very shallow depths
- Unable to penetrate dense or rocky soil
- Borehole stability difficult to maintain
- Labor intensive

4.1.1.2 Continuous-Flight Augers

Continuous-flight augers consist of a plugged tubular steel center shaft around which is welded a continuous steel strip in the form of a helix. An individual auger is known as a "flight" and is generally 5 feet long. Auger drill heads are generally designed to cut a hole 10 percent greater in diameter than the actual diameter of the auger they serve. In addition to diameter, augers are specified by the pitch of the auger and the shape and dimension of the connections.

Applications

- Shallow soils investigations
- Soil samples
- Vadose zone monitoring wells
- Monitoring wells in saturated, stable soils
- Identification of depth to bedrock
- Fast and mobile

Limitations

- Soil sampling difficult
- Soil sampling limited to areas of stable soils
- Difficult to build monitoring wells in unstable soils
- Depth capability decreases as diameter of auger increases
- Monitoring well diameter limited by auger diameter

4.1.1.3 Hollow-Stem Augers

Hollow-stem augers are commonly used in unconsolidated materials to depths of about 150 feet. An advantage of this method is that undisturbed soil samples can be collected and the augers act as a temporary outer casing when installing a monitoring well.

Hollow-stem augers are generally made of two pieces: an annular outer head attached to the bottom of the lead auger and an inner pilot or center bit mounted in a plug which is removable from the center of the auger to the surface. The removable inner plug is the primary advantage of this drilling method. Withdrawing the plug while leaving the auger in place provides an open, cased hole into which samplers, down-hole drive hammers, instruments, casing, wire, pipe, or numerous other items can be inserted. Replacing the center bit and plug allows for continuation of the borehole.

Hollow-stem augers are specified by the inside diameter of the hollow stem, not by the hole size it drills. Hollow-stem augers are available with inside diameters of 2.5, 3.25, 3.375, 4.0, 4.25, 6.25, 6.625, 8.25, and 10.25 inches. The most commonly used sizes are 3.25 inches and 4.25 inches for 2-inch monitoring wells and 6.625 inches for 4-inch monitoring wells. The larger diameter augers, 8.25 and 10.25 inches, are not generally used for monitoring well installation although they have been utilized for the installation of dual-purpose wells.

The rotation of the augers causes the cuttings to move upward and be "smeared" along the borehole walls. This smearing may effectively seal off the upper zones thereby reducing the possibility of cross contamination of the upper zones to the deeper zones but increases the possibility of deep to shallow contamination.

Drilling speed with hollow-stem augers is dependent upon the types of materials encountered. Heavy formations such as "fat" clays should be drilled at 30 to 50 revolutions per minute (RPM). Good clean sand that will stand open can be successfully augered at 75 RPM.

Applications

- All types of soils investigations
- Permits good soil sampling with split-spoon or thin-wall samplers
- Monitoring well installation in all unconsolidated formations
- Can serve as temporary casing
- Can be used in stable formations to set surface casing

Limitations

- Difficulty in preserving sample integrity in heaving formations
- Formation invasion by water or drilling mud if used to control heaving
- Possible cross contamination of aquifers where annular space not positively controlled by water or drilling mud or surface casing
- Limited diameter of augers limits casing size
- Smearing of clays may seal off aquifer to be monitored

4.1.1.4 Bucket Auger

Bucket augers have depth capacity of 30 to 75 feet and are used for large diameter holes of about 16 to 48 inches. Most bucket augers are "gravity fed" and are used for vertical holes. They are not normally used to drill monitoring wells or for soil sampling but may be used to drill production and recovery wells. They may also be used to set conductor or surface casings for production wells.

Generally, the auger bucket advances into the formation by combination of dead weight and the tooth cutting angle. The auger cuts into the formation about 1 to 2 feet at a time, filling the auger bucket. The bucket is attached to the lower end of a kelly bar that passes through and is rotated by a large ring gear that serves as a rotary table. The kelly is square in cross section and consists of two or more lengths of square tubing, one length telescoped inside the other. When the bucket is withdrawn from the hole by means of a wire-line hoist cable, it is swung to the side of the hole and the spoil is dumped out through the bottom by means of a hinge and latch device on the bucket bottom.

Applications

- Drilling of large diameter boreholes to a maximum depth of 75 feet
- Drilling in unconsolidated formations

Limitations

- Difficult to advance the borehole below the water table
- Consolidated formations and cobbles are difficult to drill
- Loose sand formations may slough during drilling

4.1.2 Percussion Drilling

Percussion drilling is a form of drilling in which the basic method of advance is hammering, striking, or beating on the formation. Common percussion methods that do not use circulating fluids are cable-tool, driven boreholes, and rotosonic drilling.

4.1.2.1 Cable-Tool Drilling

Cable-tool operates by alternately raising and dropping a bit, hammer, or other heavy tool. In consolidated formation, the drill bit breaks or crushes the formation. In unconsolidated formations, the drill bit primarily loosens when drilling. In both instances, the reciprocating action of the tools mixes the crushed or loosened particles with water to form a slurry or sludge at the bottom of the borehole. If little or no water exists in the penetrated formation, water is added to form the slurry. Slurry accumulation increases as drilling proceeds and eventually it reduces the impact of the tools. When the drop of the string of tools is hindered by the thickened slurry, the slurry is removed by a bailer. Water is then added, if needed, and drilling resumes.

Most boreholes drilled in unconsolidated formations are drilled "open hole", that is, no casing is used during part or all of the drilling operation. Drilling in unconsolidated formations differs from hard-rock drilling as pipe or well casing must follow the drill bit closely as the well is deepened to prevent caving and to keep the borehole open.

Using the cable-tool drilling technique in monitoring work is limited because the method is slow. Drilling rates of 20 to 100 feet per day are typical with the average being approximately 50 feet per day. Holes much smaller than 6-inches are impractical because of the need for a relatively large, heavy bit. The method does not use drilling muds but does allow sampling of groundwater with a drive and bail technique as the hole is advanced in high-yielding formations.

Applications

- Drilling in all types of geologic formations
- Almost any depth and diameter range
- Ease of monitoring well installation
- Ease and practicality of well development
- Excellent samples of geologic materials

Limitations

- Drilling relatively slow
- Heaving of unconsolidated materials must be controlled
- Equipment availability more common in central, north central and northeast sections of the United States

4.1.2.2 Driving

A borehole can be constructed by driving a solid probe or plugged pipe into the ground. The information obtained by this technique can be either minimal or extensive.

Driven wells, commonly referred to as wellpoints, are driven into the ground by hand or with heavy drive heads mounted on a tripod, drill rig derrick, or similar hoisting device. Wellpoints consist of a wellpoint (screen) that is attached to the bottom of a casing. Wellpoint and casing diameters generally range from 1.25 to 2 inches. Depths of 30 feet can be achieved by hand in sands or sands and gravels with thin clay seams. Depths of 50 feet or more can be achieved in loose soils with hammers weighing up to 1,000 pounds.

Driving through dense silts and clays and/or bouldery silts and clays is often extremely difficult or impossible. The well point may not be structurally strong enough and may be damaged or destroyed by driving through dense soils. Additionally, the screen may become plugged when driving through silts and clays and may be very difficult to reopen during development. Soil samples cannot be collected during this process; however, crude stratigraphic information may be obtained by recording the number of blows per foot of penetration. Driven wells or well points are usually installed for the collection of groundwater samples and the determination of static water levels to establish the regional groundwater gradient.

A large track-mounted backhoe (CAT 245) has been used to install extraction wells in a landfill to the 30-foot depth. The bucket of the backhoe is used to push a 6-inch-diameter drive pipe with a plugged bottom. When the drive pipe reaches the final depth for the well, the plug at the bottom of the drive pipe is removed and the well screen and casing materials are placed inside the drive pipe. A large 50-ton crane then pulls the drive pipe, leaving the well materials in the borehole. This technique is highly dependent upon the geologic formation and required depth. The drive pipe pushes the formation aside. This can cause a compaction of the formation which could impact the performance of the well.

Considerably more information can be obtained by driving a penetrometer or a Dutch Cone. Penetration of the soil with a cone forces the soil aside, creating a complex shear failure. The degree of resistance yields the geologic logs of the borehole. Penetrometers can also obtain groundwater samples and possibly soil samples. The borehole that the penetrometer makes is usually abandoned; however, occasionally a small-diameter piezometer can be constructed within the borehole. For more information on cone penetrometer testing, see the Standard Operating Procedures on CPT.

Applications

- Drilling of a borehole when soil samples are not needed
- Installation of a shallow well point when there are site access and work place limitations

Limitations

- Geologic formations must be conducive for driven wells
- Driven wells should be limited to shallow wells
- Formation compaction usually occurs that can affect well production

4.1.2.3 Rotasonic Drilling

Rotasonic drilling, also known as resonance drilling, is a percussion drilling technique that uses a high-frequency drive hammer. The frequency of the drive hammer varies from 150 to 250 hits per minute. The drive pipe is either closed bottom or fitted with a soil-sampling tube. If the bottom of the drive pipe is closed, the borehole is made without the removal of any formation. Instead, the formation is literally pushed to the side and out of the way of the drive pipe, which acts as well casing as the boring proceeds. The high frequency of the hammer tends to liquefy the formation in the vicinity of the bit, thus reducing the degree of difficulty of pushing pipe into the formation.

A soil sampling device, such as a split-spoon sampler or a core barrel, can be placed inside the drive pipe in lieu of the end plug. The sampler is removed at 5- or 10-foot intervals and replaced with an empty sampler. This procedure yields a continuous soil sample and produces minimal waste as only the formation within the sampler is brought to the surface. A monitoring well can be installed in the borehole by removing the sampler and setting the well screen and casing inside the drive pipe. The drive pipe is then withdrawn. This drilling technique again pushes the formation aside to create the borehole. Certain formation compaction can occur which could impact the performance of a well. Additionally, the rate of penetration of the drive pipe is very high, producing considerable heat at the bit on the drive pipe and within the sampler. The heat in the sampler may have a detrimental effect on soil samples for chemical analysis.

Applications

- Rapid drilling technique especially in difficult drilling formations
- Use when drilling in contaminated areas and disposal costs for wastes are high
- Can obtain continuous core

Limitations

- Very limited equipment availability
- Heat generated with drive pipe can compromise soil samples
- Formation compaction usually occurs that can affect well production

4.2 METHODS WITH CIRCULATING FLUIDS

Many drilling techniques uses a circulating fluid, such as water or drilling mud, gas such as air, or a combination of air, water, and a surfactant to create foam. Circulation fluids flow from the surface either through the drill pipe, out through the bit, and up the annulus between the borehole wall and the drill pipe (direct rotary) or down the borehole annulus, into the bit, and up the drill pipe (reverse rotary). Generally the up-hole velocity needed to transport cuttings to the surface is between 100 to 150 feet per minute for plain water with no additives, 80 to 120 feet per minute for high-grade bentonite drill muds, 50 to 1,000 feet per minute for foam drilling, and up to 3,000 feet per minute for air with no additives. Additives decrease the required minimum velocity. Excessive velocities can cause erosion of the borehole wall.

The use of circulating fluids may involve the addition of chemicals to the borehole. Drilling mud utilizes bentonite clay and possibly polymers. Additives to air drilling may include surfactants (detergents) and water mist to generate foam. Compressed air may also contain various amounts of hydrocarbon lubricants. Therefore, attention should be given to the circulating fluids and any possible additives that are used when using drilling methods utilizing circulation fluids.

4.2.1 Rotary Drilling Methods

Rotary drilling methods requires the rotation of the drill pipe and the drill bit to advance the borehole. The common drilling methods that uses circulating fluids to remove the drill cuttings from the borehole are presented in the following sections.

4.2.1.1 Conventional Mud Rotary Drilling

In conventional mud rotary drilling, the circulating fluid is pumped from the surface through the rotating drill pipe and bit to flush cuttings to the surface. At the surface the fluid is directed into a circulation pit or tank where the cuttings settle out. The circulating fluid is then picked up with the mud pump and again directed downhole. Bentonite is usually added to water to make the drilling mud or fluid. The functions of the drilling fluid are to:

1. Lift the cuttings from the bottom of the borehole and carry them to a settling pit.
2. Support and stabilize the borehole wall to prevent caving.
3. Seal the borehole wall to reduce fluid loss.
4. Cool and clean the drill bit.
5. Allow the cuttings to drop out in the settling pit.
6. Lubricate the bit, cone bearings, mud pump, and drill pipe.

For effective rotary drilling, the down force on the bit should be great enough to cause continuous penetration of the boring. The pounds per inch of bit weight depends upon the configuration of the bit and the formation being penetrated. Rotary speeds are generally in the range of 60 to 200 RPM.

Mud Rotary Applications

- Rapid drilling of clay, silt and reasonably compacted sand
- Allows split-spoon and thin-walled samples in unconsolidated materials
- Allows core sampling in consolidated rock
- Drilling rigs widely available
- Abundant and flexible range of tool sizes and depth capabilities
- Very sophisticated drilling and mud programs available
- Geophysical borehole logs

Mud Rotary Limitations

- Difficult to remove drilling mud and wall cake from borehole wall during development
- Bentonite and other drilling additives may influence quality of groundwater samples
- Circulated samples poor for monitoring well screen selection
- Split-spoon and thin-wall samplers are expensive and of questionable cost effectiveness at depths greater than 150 feet
- Wireline coring techniques for sampling both unconsolidated and consolidated formations often not available locally
- Difficult to identify aquifers
- Drilling fluid invasion of permeable zones may compromise validity of subsequent monitoring well samples

4.2.1.2 Air Rotary Drilling

In air rotary drilling, the circulation fluid is compressed air or a mixture of compressed air, a surfactant, and water mist, which creates a foam. As in conventional mud rotary, the drilling fluid is forced through the rotating drill pipe and bit to flush cuttings to the surface. At the surface the fluid is directed into a pit or storage container. The up-hole velocity of the air and cuttings should be approximately 3,000 feet per minute. This drilling method is primarily used in consolidated formations due to the fact that the rapidly rising cuttings would cause considerable erosion of the borehole wall in unconsolidated formations. With the air rotary drilling method, the circulating fluid is not reused again. The functions of the drilling fluid are to:

1. Lift the cuttings from the bottom of the borehole and carry them to the surface.
2. Cool and clean the drill bit.
3. Lubricate the bit, cone bearings, mud pump, and drill pipe.

Rotary speeds are generally in the range of 75 to 200 rpm. If the hardness of the formation increases to the point that roller-cone rock bits cannot successfully penetrate the formation, then a down-hole air hammer is used to penetrate the formation. The rotating speed using the down-hole air hammer is in the range of 15 to 30 rpms.

Air Rotary Applications

- Rapid drilling of semi-consolidated and consolidated rock
- Good quality/reliable formation samples
- Equipment generally available
- Allows easy and quick identification of lithologic changes
- Allows identification of most water bearing zones
- Allows estimation of yields in strong water-producing zones with short "down time"

Air Rotary Limitations

- Surface casing frequently required to protect top of hole
- Drilling restricted to semi-consolidated and consolidated formations
- Samples reliable but occur as small particles that are difficult to interpret
- Drying effect of air may mask lower yield water producing zones
- Air stream requires contaminant filtration
- Air may modify chemical or biological conditions. Recovery time uncertain.

4.2.1.3 Air Rotary Casing Hammer (Drill and Drive)

This method combines percussion and air rotary drilling methods to drill in unconsolidated formations. The borehole is drilled with the air rotary drilling method. Casing or drive pipe follows closely behind the rotary bit to prevent the erosion of the borehole wall. The casing is driven similar to a pile driver except for a hole through its axis through which a drill pipe is inserted and rotated. The drill bit is usually extended approximately 1-foot below the bottom of the drive pipe that acts as temporary casing.

Applications

- Rapid drilling of unconsolidated sands, silts, and clays
- Drilling in alluvial materials (including boulder formations)
- Casing supports borehole thereby maintaining borehole integrity and minimizing inter-aquifer cross contamination
- Eliminates circulation problems common with direct mud rotary method
- Good formation samples
- Minimal formation damage as casing pulled back

Limitations

- Thin, low pressure water bearing zones easily overlooked if drilling not stopped at appropriate places to observe whether or not water levels are recovering
- Samples pulverized as in all rotary drilling

- Air may modify chemical or biological conditions
- Difficult to obtain soil samples for chemical analysis

4.2.1.4 Center Stem Recovery Rotary Drilling (Reverse Circulation)

In reverse circulation drilling, the circulating fluid (water) flows from the surface down the borehole annulus outside the drill pipe, into the drill bit, and up the inside of the drill pipe to ground surface. The fluid carries the cuttings to the surface and discharges them into a settling pit or tank. Reverse circulation is especially advantageous in very large boreholes and also in those cases where the erosive velocity of conventional rotary circulation would be detrimental to the borehole wall. Drilling is accomplished typically with water without additives. A large and dependable water supply is required to keep the borehole full of drilling fluid to maintain sufficient hydrostatic head on the borehole walls to prevent sloughing. Reverse circulation has few applications in monitoring work except when nested wells are desired. Production wells with 18- to 24-inch-diameter casing are typically drilled by the reverse circulation drilling method. Typical borehole diameters range from 15 to 36 inches; however, 60-inch-diameter boreholes are not uncommon.

<u>Applications</u>

- Large capacity production wells
- Nested wells
- Normally does not use drilling muds (little if any mud cake is formed on the wall of the borehole)
- Drills best in unconsolidated sands, silts, and clays

<u>Limitations</u>

- Requires large and dependable source of water during drilling and well installation
- Cobbles and bedrock are difficult to drill

4.2.1.5 Dual-Tube Rotary

Dual-tube rotary is an exploratory drilling technique utilizing two concentric drill pipes. Both drill pipes are rotated during drilling. The outside of the outer drill pipe is typically 4.5 inches. The diameter of the borehole is approximately 5 inches. Compressed air is forced between the two drill pipes and is directed to the center pipe at the bit. The cuttings are carried to the surface by the returning air at a velocity of approximately 3,000 feet per minute. This is an excellent drilling method to identify lithology and the locations of aquifers in deep boreholes. It is very difficult to obtain undisturbed soil samples for chemical or geotechnical analyses; however, groundwater samples can be obtained as aquifers are encountered. Geophysical logs can be obtained if the borehole is filled with drilling mud as the drill pipe is removed. Monitoring wells are typically not installed in dual-tube rotary boreholes unless the borehole is reamed out by the mud rotary method. Depths of 1,000 feet are not uncommon for this drilling method and typically, the more consolidated the formation, the better the drilling, as unconsolidated formations cause more drag or friction on the outside of the rotating drill pipe.

Applications

- Used mostly for exploratory boreholes
- Rapid extraction of drill cuttings from the borehole
- Drill cuttings are representative of formation
- Very rapid penetration rate in all formations
- Can collect groundwater samples as aquifers are encountered

Limitations

- Equipment availability
- Cannot obtain undisturbed soil samples for chemical analysis
- Small borehole (5 inches)

4.2.2 Dual-Tube Percussion Drilling

Dual-tube percussion drilling is very similar to dual-tube rotary with the exception that the two drive pipes do not rotate during drilling. The two concentric drive pipes are driven into the ground with a hammer. The hammer is similar to units on pile drivers. The typical outside diameter of the outer drive pipe is 9 to 12 inches. The typical inside diameter of the inner pipe, where well materials would be inserted, is 6 to 8 inches. This drilling system is also a center stem recovery system. This drilling technique has been developed and is used primarily in hazardous waste investigations. This method is rapid and effective to depths of about 250 feet.

The outer pipe effectively seals off the formation while drilling, reducing the chance of cross contamination. Air is pumped between the annulus of the two pipes to the bit where it is deflected upward into the center pipe. Cuttings are transported to the surface through the center pipe.

In general, three systems are available: 7-inch OD/4.25-inch ID, 9-inch OD/6-inch ID, and 12-inch OD/8-inch ID. A 2-inch-diameter monitoring well can be constructed in the 7-inch system, a 4-inch-diameter monitoring well can be constructed in the 9-inch system, and a 5- or 6-inch-diameter monitoring well can be constructed in the 12-inch system.

Applications

- Very rapid drilling through both unconsolidated and consolidated formations
- Allows continuous sampling for lithologic logging in all types of formations
- Very good representative samples can be obtained with minimal risk of contamination of sample and/or water bearing zone

- In stable formations, wells with diameters as large as 6 inches can be installed in open hole completions
- Soil samples can be easily obtained for chemical analysis

Limitations

- Limited borehole size that limits diameter of monitoring wells
- In unstable formations wells are limited to approximately 4 inches
- Equipment availability more common in the southwest
- Air may modify chemical or biological conditions; recovery time is uncertain

4.2.3 Suction Drilling

Suction drilling has been used to drill into consolidated formations that yield little if any groundwater. This is an experimental drilling method that has been used by the USGS to drill in basalts in Idaho. The drilling technique is very similar to the reverse circulation drilling technique discussed in Section 4.2.1.4 with the exception that air is circulating, not water. To drill the borehole, a drill rig rotates a modified air rotary bit at the end of the drill pipe. The cuttings are removed by the suction from a high-pressure, high-volume air and steam ejector/eductor siphon system. The suction is directed to the interior of the drill pipe. All formation cuttings, including formation fluids, are brought to the surface via the interior of the drill pipe.

To drill a 10-inch-diameter borehole, two 600 cfm/250 psi air compressors are connected parallel to the ejector/eductor siphon device. The suction from the siphon device is directed to the 2-3/8-inch-diameter drill pipe. A 1.5-horsepower blower fan is used to direct air down the borehole.

Applications

- Allows continuous sampling for lithologic logging
- Very good representative samples can be obtained
- Drilling is not impeded in fractured formations that typically cause lost circulation problems

Limitations

- Formations must be very consolidated to prevent the borehole wall from sloughing during drilling
- Cuttings are very abrasive to the drill pipe and discharge lines
- Difficult to maintain an adequate vacuum as air leaks form easily at threaded joints of the drill pipe
- Groundwater could prevent the advancement of the borehole

The drilling contractor had numerous mechanical problems advancing the borehole to the 180-foot depth. Vacuum leaks caused a loss in suction and a plugging of the drill pipe. The drill pipe twisted off numerous times and the abrasive cuttings wore holes in hoses and pipes. This drilling method has some unique advantages; however, until the mechanical problems are solved, this technique will not be available for use.

5.0 CONSIDERATIONS FOR SELECTION OF DRILLING METHODS

Each project or drilling site has its own considerations for the selection of a particular drilling method. Prior to selecting a drilling method, several factors must be considered. The major factors that this section will address include the objective of the drilling program, site conditions, wastes generated, and client preferences. Other factors would include drilling costs, availability of trained crews and appropriate equipment, and project schedule requirements. Recognize that it may be very difficult to fulfill all of the sampling/drilling objectives with a single drilling method. The drilling method selected may compromise some of the objectives of the drilling program.

5.1 DRILLING OBJECTIVES

The primary considerations in selecting any drilling method is to ensure the selected method is capable of meeting the objective(s) of the drilling/sampling program. It is common to have more than one objective for the drilling/sampling program and it may be difficult to satisfy all the program objectives.

If sample collection (soil or groundwater) is the objective, the selected method must be capable of collecting, in an appropriate and approved manner, the necessary samples. Additionally, the contaminants of concern may have an influence on the drilling and sampling method.

If the objective of the drilling program is to install vapor or groundwater extraction wells, the selected method must be suitable for the installation of the designed well. It is important to not only consider the physical limitations of a particular drilling technique (i.e., depth and diameter), but examine the consequences of the drilling method with the drilling objective (i.e., smearing of the borehole walls rendering wells ineffective or inefficient).

If one of the objectives of the drilling program is to identify the different water-bearing zones, the drilling method must be able to accomplish this task.

5.2 SITE CONDITIONS

Site conditions can limit the drilling methods available for a particular program. Site conditions to be considered include both subsurface and surface conditions.

5.2.1 Subsurface Conditions

The subsurface stratigraphy of a site is a fundamental consideration when selecting a particular drilling method. The drilling equipment selected must be capable of effectively and economically penetrating the strata at the site to meet the project objectives. Particular stratigraphy which may pose problems for certain drilling methods include tight clayey soils, swelling clays, flowing sands, caliche, gravels, cobbles, lost circulation zones, and bedrock.

In addition to stratigraphy, the site hydrology must also be considered. If multiple water-bearing zones are expected, a conductor casing may be needed to seal off shallow water-bearing zones and prevent potential cross contamination. The need for conductor casings can affect the selection of a particular drilling method. Wells that deeply penetrate aquifers can also affect the selection of a particular drilling method.

5.2.2 Surface Conditions

Surface conditions can affect access to the site and the amount of available work space (both horizontal and vertical or overhead space). These in turn can affect the selection of a particular method or type of drill rig. Limited access and work space may require smaller or remotely powered drill rigs. The site terrain is a very important factor in choosing the drilling method as it is very expensive and difficult to mobilize large and/or heavy equipment over rugged terrain. For sites such as these, drill rigs (typically hollow-stem auger) are mounted on all-terrain equipment.

In addition to access and work space, the work environment must also be considered. This includes both weather and other site activities. Extremely hot or cold climates may require use of special drilling equipment or methods. Sites such as refineries where explosive atmospheres could exist may also require very special equipment. All site activities must also be considered as they may impact the selection of the drilling method.

5.3 WASTE GENERATION

Drilling operations typically generate significant volumes of waste which must be handled, stored, and eventually disposed. This is of particular concern when drilling into contaminated or hazardous materials. The type and volume of wastes generated during drilling differs for different drilling methods. The different handling and disposal requirements of drilling wastes can greatly affect project costs. The different drilling methods can also require vastly different volumes of groundwater be removed to fully develop the well.

5.4 CLIENT PREFERENCES

Certain clients have valid concerns regarding dust, noise, size, weight, or other nuisances related to drilling operations. For example, certain drilling methods require continuous operations until the borehole/well is completed, requiring lights for night work. This may not be possible in some situations. These site-specific or client-specific preferences must be considered when selecting a drilling method.

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SOP 6

Field Notes and Logs

STANDARD OPERATING PROCEDURES
SOP-6: SAMPLE MANAGEMENT AND PRESERVATION

1.0 INTRODUCTION

This guideline for sample management describes the requirements for sample identification, chain of custody (COC), sample handling, storage and shipping. The purpose of this SOP is to define sample management activities as performed from the time of sample collection to the time they are received by the laboratory.

2.0 DEFINITIONS

Sample: Physical evidence collected for environmental measuring and monitoring. For the purposes of this SOP, sample is restricted to solid, aqueous, air, or waste matrices. This SOP does not cover samples collected for lithologic description nor does it include remote sensing imagery or photographs.

Field Team Leader: The individual responsible for the supervision of fieldwork at the site during a given phase of investigation or monitoring.

Sampler: The individual who collects environmental samples during fieldwork.

3.0 RESPONSIBILITIES

The following is a general description of responsibilities related to sample management; specific responsibilities are described in project work plans.

Program QC Coordinator: The program QC coordinator (QCC) is responsible for ensuring that client sample management requirements can be accommodated within Stantec quality requirements.

Project Manager: The project manager is responsible for ensuring that the requirements for sample management are included in the appropriate project plans. The project manager is responsible for fully communicating the sample management requirements to the Field Team Leader (FTL) by providing a copy of project plans or issuing written notice that the SOP is to be used exclusively.

Project QC Coordinator: The project QC coordinator is responsible for reviewing documentation developed from sample management to determine compliance with this SOP and project plan requirements.

Field Team Leader: The FTL is responsible for conducting the procedures described herein and, if applicable, the requirements of the project plan. Any variance from these procedures is considered a nonconformance, and written documentation is required, at a minimum, as described in the SOP for Corrective Action.

4.0 PROCEDURES

4.1 APPLICABILITY

These procedures apply to all work conducted for Stantec clients, by Stantec, or under the direction of Stantec. The information in this SOP may be incorporated into project-specific plans. Deviations or modifications to procedures not addressed in the project plans must be handled as a corrective action (see SOP for Corrective Action).

4.2 SAMPLE MANAGEMENT

4.2.1 Sample Containers

The sample containers to be used will be dependent on the sample matrix and analyses desired. The containers to be used for various analyses are specified in the project plan. Sample containers are to be filled (approximately 90 percent), with adequate headspace for safe handling upon opening, except containers for volatile organic compound (VOC) analyses, which are to be filled completely with no headspace. This applies to soil samples and water samples.

Once opened, the containers are to be used immediately. If the container has been received unsealed or is not used upon opening, it is to be recycled. If the container is used for any reason in the field (i.e., screening) and not sent to the laboratory for analysis, it should be discarded. The contents of the used container and the container itself may require disposal as a hazardous material. When storing before and after sampling, the containers must remain separate from solvents. Sample containers with preservatives added by the laboratory should not be used if held for an extended period on the job site or exposed to extreme conditions.

4.2.2 Numbering and Labeling

<u>Sample Label</u>: A sample label will be affixed to all sample containers except those pre-weighed for analysis of volatile compounds in soil. Pre-weighed containers will be sealed in "ziplock"-type bags, with the sample label affixed to the bag. Labels provided by the laboratory may be used. Each sample label will be completed with the following information:

Client name, project title, or project location (sufficiently specific for data management; e.g., Bayou Chemical Corp., East Suburbs Interceptor, Sawatch AFB).

- Sample location
- Sample identification number
- Date and time of sample collection
- Initials of sampler
- Preservative used
- Analyte(s) of interest

After labeling, each sample will be refrigerated or placed in a cooler containing ice or to maintain the sample temperature of 4 degrees Celsius (℃).

Custody Seals: Custody seals will be used on each sample and/or shipping container to ensure custody. Custody seals used during the course of the project will consist of security tape with the date and initials of the sampler. As a minimum, one custody seal will be placed on the front of the cooler overlapping the tape and one on the side of the cooler. If required by the client, a seal will be placed on each sample container so that it must be broken to gain access to the contents. Since VOC samples may be subject to contamination by the tape, VOC sample containers will first be secured in a "ziplock"-type plastic bag. The plastic bag will be sealed with a completed custody seal.

4.2.3 Chain of Custody

COC procedures require a written record of the possession of individual samples from the time of collection through laboratory analyses. A sample is considered to be in custody if it is:

- In a person's possession
- In view after being in physical possession
- In a secured condition after having been in physical custody
- In a designated secure area, restricted to authorized personnel

The COC record shall be used to document the samples collected and the analyses requested. Information recorded by field personnel on the COC record includes the following:

- Client name
- Project name
- Project location
- Sampling location
- Signature of sampler(s)
- Sample identification number
- Date and time of collection
- Sample matrix
- Signature of individuals involved in custody transfer (including date and time of transfer)
- Airbill number (if appropriate)
- Number and type of bottles collected for each analysis
- Type of analysis and laboratory method number
- Any comments regarding individual samples (e.g., HNU readings, special instructions)

COC records will be placed in a plastic bag, secured to the inside of the cooler lid, and transported with the samples. When the sample(s) are transferred, the record is signed by both the receiving and relinquishing individuals. Signed airbills will serve as evidence of custody transfer between the field sampler and courier as well as courier and laboratory. If a carrier service is used to ship the samples (e.g., Federal Express), custody will remain with the sampler until it is relinquished to the laboratory. Copies of the COC record and airbill will be retained by the sampler. If the COC records are sequentially numbered, the record number and airbill number will be cross-referenced in both the field logbook and the sample register. If the COC record is not previously numbered, a tracking number of four digits or more should be added to the top of the form and recorded as above.

4.2.4 Sample Register/Sample Tracking

The sample register is a bound logbook with sequentially numbered pages used to document which samples were collected on a particular day. The sample register is also used as the key to correlate field samples with duplicate samples. Information that should be recorded in the sample register includes the following:

- Client name
- Project name and location
- Job number
- Date and time of collection
- Sample identification number
- Sample matrix
- Number and type of bottles
- Type of analysis
- Sample destination
- Sampler's initials

A sample tracking database, which includes the above information, may be substituted for a handwritten sample register. However, a hardcopy of each day's sampling activities should be maintained in the field files.

4.2.5 Sample Preservation/Storage

The requirements for sample preservation are dependent on the analyses desired and the sample matrix. Sample preservation requirements are provided in the project plan.

4.2.6 Shipping

Procedures for packaging and transporting samples to the laboratory are based on the actual chemical, physical, and hazard properties of the material. The procedures may also be based on an estimation of contaminant concentrations/properties in the samples to be shipped. Samples will be identified as either environmental samples, excepted quantities samples, limited quantities samples, or standard hazardous materials. Environmental samples are defined as soil or water samples that are not saturated or grossly contaminated with product material. Excepted quantities involve the shipment of a few milliliters of either an acid or base preservative in an otherwise empty sample container. Limited quantities are restricted amounts of hazardous materials that may be shipped in generic, sturdy containers. Standard hazardous material shipments require the use of stamped/certified container.

The following instructions pertain to shipments on Federal Express (FedEx).

4.2.6.1 Environmental Samples

Environmental samples, such as soil or water that are not saturated or grossly contaminated are not considered hazardous substances/dangerous goods by U.S. Department of Transportation guidelines. Except for pure product, environmental samples may be shipped in the following manner:

- Each sample will be placed in a separate plastic or "bubble-wrap" bag. As much air as possible is squeezed from the bag before sealing. Bags may be sealed with evidence tape for additional security. If brass or stainless steel tubes are used, bubble wrap is not required.
- An ice chest (sturdy construction) is typically used as the shipping container. In preparation for shipping samples, the drain plug is taped shut from the outside and a large plastic bag is used as a liner for the cooler. Approximately 1 inch of packing material, such as vermiculite or other type absorbent sufficient to retain any liquid that may be spilled, is placed in the bottom of the liner. Sufficient packing material should be used to prevent sample containers from making contact during shipment.
- The bottles are placed in the lined ice chest. Cardboard or foam separators may be placed between the bottles at the discretion of the shipper.
- Water samples for organic analysis and inorganic analysis will be cooled to 4°C with ice during shipment. If ice is used, it will be contained such that the water will not fill the cooler as the ice melts. Dry ice should not be used as it has a tendency to freeze samples. If dry ice is used, however, it needs to be noted in the box in Section 6 of the FedEx USA Airbill (i.e., number of packages and weight in kilograms of dry ice per package).
- As described previously, the COC record will be placed inside a plastic bag, sealed, and taped to the inside of the cooler lid. For Federal Express, the COC record should be placed in a pouch or plastic bag attached to the top of the cooler. The airbill will be filled out before the samples are handed over to the carrier. The laboratory will be notified if the shipper suspects that the sample contains any substance for which the laboratory personnel should take safety precautions.
- The cooler is closed and taped shut around the lid and around both ends.
- Two signed custody seals will be placed on the cooler, one on the front and one on the side overlapping tape if possible. Additional seals may be used if the sampler and shipper think more seals are necessary. Wide clear tape will be placed over the seals to ensure against accidental breakage.
- The cooler is handed over to FedEx, a cargo-only air service. A standard airbill is sufficient for shipping environmental samples.

4.2.6.2 Excepted Quantities

Usually, corrosive preservatives (i.e., hydrochloric acid, sulfuric acid, nitric acid, or sodium hydroxide) are added to otherwise empty sample bottles by the analytical laboratory prior to shipment to field sites. However, if there is an occasion whereby MW personnel are required to ship bottles with these undiluted preservatives, the containers must be shipped in the following manner:

- Each individual sample container must have not more than 30 milliliters of preservative.
- Collectively, these individual containers must not exceed 500 milliliters in the same outer box or package.
- Despite the small quantities, only chemically compatible material may be placed in the same outer box, i.e., sodium hydroxide, a base, must be packaged separately from the acids.
- Federal Express will transport nitric acid only in concentrations of 40% or less.
- A "Dangerous Goods in Excepted Quantities" Label must be affixed to the outside of the outer box or container. Information required on the label includes:
- Signature of Shipper
- Title of Shipper
- Date
- Name and Address of Shipper
- Check of Applicable Hazard Class
- Listing of UN Numbers for Materials in Hazard Classes

4.2.6.3 Limited Quantities

Occasionally, it may become necessary to ship known hazardous materials, such as pure or floating product. DOT regulations still permit the shipment of many hazardous materials in merely "sturdy" packages, such as an ice chest or cardboard box (not a specially constructed and certified container), provided that certain conditions are met. This option permits a more convenient and economical method for shipping hazardous materials. Instructions for shipping most liquid samples include the following:

- Each sample bottle is placed in a plastic bag, and the bag is sealed. Each VOC vial is wrapped in a paper towel and placed in a plastic bag. As much air as possible is squeezed from the bag before sealing. Bags may be sealed with evidence tape for additional security.
- Each bottle is placed in a separate paint can, the paint can is filled with vermiculite, and the lid is fixed to the can. The lid must be sealed with metal clips, filament, or evidence tape. If clips are used, the manufacturer typically recommends six clips.
- The cans will be placed upright in a cooler that has had the drain plug taped shut inside and outside, and the cooler is lined with a large plastic bag. Approximately 1 inch of packing material, such as vermiculite or other type absorbent sufficient to retain any liquid that may be spilled, is placed in the bottom of the liner. Three sizes of paint cans are used: pint, half-gallon, and gallon. The pint or half-gallon paint cans can be stored on top of each other; however, the gallon cans are too high to stack. The cooler will be filled with additional packing material, and the liner will be taped shut. Only containers having chemically compatible material may be packaged in each cooler or other outer container.

- As mentioned, the COC record going to the laboratory via FedEx will be sealed inside a plastic bag and attached to the inside lid of the cooler. The sampler retains one copy of the COC record. The laboratory will be notified if the sample is suspected of containing any substance for which the laboratory personnel should take safety precautions.
- The cooler is shut and sealed with tape around the lid and around both ends. Two signed custody seals will be placed on the cooler, one on the front and one on the back. Additional seals may be used if the sampler and shipper think more seals are necessary. Wide clear tape will be placed over the seals to ensure against accidental breakage.

The following markings are placed on the side of the cooler:

- Proper Shipping Name (Column B, List of Dangerous Goods, Section 4, IATA Dangerous Goods Regulations [DGR])
- UN Number (Column A, List of Dangerous Goods, Section 4, IATA DGR)
- Shipper's name and address
- Consignee's name and address
- The words "LIMITED QUANTITY"
- Hazard Labels (Column E, List of Dangerous Goods, Section 4, IATA DGR)
- Two Orientation (Arrow) labels placed on opposite sides
- The FedEx Airbill/Declaration of Dangerous Goods form should be completed as follows:
- Shipper's name and address
- Consignee's name and address
- Services, Delivery & Special Handling Instructions
- Cross out "Cargo Aircraft Only" in the Transport Details Box
- Cross out "Radioactive" under Shipment Type
- Nature and Quantity of Dangerous Goods
- Proper Shipping Name (Column B, List of Dangerous Goods, Section 4, IATA DGR)
- Class or Division (Column C, List of Dangerous Goods, Section 4, IATA DGR)
- UN Number (Column A, List of Dangerous Goods, Section 4, IATA DGR)
- Packing Group (Column F, List of Dangerous Goods, Section 4, IATA DGR)
- Subsidiary Risk, if any (Column D, List of Dangerous Goods, Section 4, IATA DGR)
- Quantity and type of packing (number and type of containers: for example, "3 plastic boxes", and the quantity per container, "2 L", is noted as "3 Plastic boxes X 2 L". This refers to 3 plastic boxes (coolers are referred to as plastic boxes) with 2 liters in each box.
- Packing Instructions (Column G, List of Dangerous Goods, Section 4, IATA DGR)
- Note: Only those Packing Instructions in Column G that begin with the letter "Y" may be used. These refer specifically to the Limited Quantity provisions.

- Authorization (Write in the words Limited Quantity)
- Emergency Telephone Number (List 800-535-5053. This is the number for INFOTRAC, to whose emergency response services we subscribe.)
- Printed Name and Title, Place and Date, Signature

All DOT regulations will be followed for packaging and shipping.

4.2.6.4 Standard Hazardous Materials

Shipment of hazardous materials using this option presents the most difficulty and expense. However, there may be occasion whereby a hazardous material cannot be shipped under the Limited Quantity provisions, e.g., where there is no Packing Instruction in Column G, List of Dangerous Goods, IATA Dangerous Goods Regulations, that is preceded by the letter "Y".

If this is the case, the general instructions noted in 4.2.6.3 above but for non-Limited Quantity materials would apply, and with one other important difference. Standard hazardous materials shipment would require the use of certified outer shipping containers. These containers have undergone rigorous testing and are, therefore, so designated by a "UN" stamp on the outside, usually along the bottom of a container's side. The UN stamp is also accompanied by codes specifying container type, packing group rating, gross mass, density, test pressure, year of manufacturer, state of manufacturer, and manufacturer code name.

The transport of lithium batteries in Hermit Data Loggers is an example of a standard hazardous material, and where only a designated outer shipping container may be used. Contact the Group or Corporate Health & Safety Office for a copy of the latest approved shipping procedure.

4.2.7 Prohibited Samples

Stantec prohibits the collection of the following types of samples:

- Gasses in compressed gas cylinders
- Radioactive substances
- Biohazards and infectious agents
- Chemical warfare agents
- Drugs (controlled substances)
- Explosive ordnance
- Explosives (DOT Hazard Class 1)
- Shock-sensitive materials

4.2.8 Holding Times

The holding times for samples will depend on the analysis and the sample matrix. Holding times are specified in the project plan

4.2.9 Ground Transport

Employees may on occasion be asked to transport small quantities of hazardous materials in a company vehicle or personal vehicle. This is permissible, but the employee must perform the following:

- Complete a simple manifest
- Who (MW name and address)
- Where (Destination name and address)
- What (Name of chemical transported)
- How Much (Quantity of chemical)
- When (Date)
- Store chemicals (group or segregate) according to chemical compatibility
- Secure containers against rolling, tipping, or falling

4.2.10 Training

The U.S. Department of Transportation requires that all employees involved in any aspect of hazardous materials transport (shipping, transport, receipt, preparing documents) receive training at least bi-annually. The company has a formal training program that conforms to these requirements; participation and completion are mandatory.

4.2.11 Additional Information

General questions regarding this SOP, or inquiries on the safe transport of other specific chemicals or by other carriers should be referred to the Group or Corporate Health & Safety Office.

5.0 REFERENCES

Enforcement Considerations for Evaluations of Uncontrolled Hazardous Waste Disposal Sites by Contractors, Draft, Appendix D. April 1980.

STANDARD OPERATING PROCEDURES: ENVIRONMENTAL BOREHOLE DRILLING AND SOIL SAMPLING

SOP ES2.03

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1 PURPOSE AND SCOPE

This document defines standard procedures for borehole drilling and collecting soil samples below depths of 1.5 m. Boreholes are typically used to investigate the geology, obtain soil data, and facilitate the installation of monitoring wells for the subsequent recovery of groundwater samples. This method gives descriptions of equipment and field methods necessary to supervise drilling programs and collect and classify soil samples. Refer to SOP *ES2.04 – Environmental Rock Coring and Classification* for drilling in bedrock and SOP *ES3.01 Monitoring Well Installation*, *ES3.02 Production/Test Well Installation*, and *ES3.04 Borehole/Monitoring Well Abandonment* for borehole completion.

2 PRE-MOBILIZATION

2.1 HEALTH AND SAFETY

Confirm RMS1 and RMS2 forms and other applicable safety forms are reviewed, filled in, updated and followed. Review applicable Safe Work Practices (SWPs) as required. Confirm field staff has the necessary training to complete the work safely.

2.2 PLANNING

Identify and obtain required permits for activities such as working in a roadway or working near a water body.

- A road-occupancy permit, including a traffic-control plan and traffic-control subcontractor, is usually needed on a road allowance.
- No subsurface work is to be completed without underground locates regardless of the area in which the work is being completed.
- Depending on jurisdiction, waste-generator registration, for off-site disposal of contaminated or suspect soil generated during drilling, may be needed.

Discuss program purpose and scope of work with the project manager; review proposal and all proposed borehole locations. If available, review site photographs, field records, borehole or test pit logs, cross sections, and data from previous subsurface investigations to determine expected soil types and site conditions. Determine approximate ground surface elevation for comparison to expected subsurface stratigraphy and installation depths.

2.3 BOREHOLE LAYOUT AND PROGRAM DETAILS

Obtain all necessary public and private utility locate information prior to confirming final borehole locations (refer to SWP 213).

Carefully mark planned borehole locations on a site plan or map. If precise positioning of the borehole locations is required to permit accurate delineation of subsurface conditions, GPS coordinates can be determined and loaded into a GPS unit of sufficient accuracy to locate the points, or sampling locations can be determined relative to known reference points. Alternatively, arrangements can be made to survey the subsurface soil sampling locations. See *SOP ES3.05 Surveying* for instructions on elevation surveying. If structures are present on the site, 1m x 1m reference grids can be added to site plans so field staff can line up their sample locations in the field, relative to the structures.

If the boreholes cannot be surveyed immediately, a stake should be placed in the ground at the borehole location for subsequent surveying. Boreholes that will not be surveyed should be located relative to a known reference point(s) using a tape and the location plotted on the site plan or map. The surface elevation of the boreholes may be determined using survey methods (preferred method) or obtained from a detailed contour plan of the area. Sample depths and the total borehole depths should be related to this known surface elevation. A GPS measurement may be required for remote and/or large sites.

2.4 FLOWING BOREHOLES

Deep boreholes located in low-lying areas can produce groundwater discharge that, if left uncontrolled, could result in loss of the upper bentonite seal, local land erosion, property damage or local aquifer depressurization. Some jurisdictions require that abandoned flowing boreholes be properly plugged to prevent artesian discharge. In such situations, it may be necessary to grout the borehole from bottom to top, place a packer seal above the water source, or abandon the hole with alternating layers of silica sand and bentonite. Before commencing drilling, discuss with the Project Manager if this may be a concern and what measures should be taken if flowing boreholes are encountered.

2.5 SOIL SAMPLING

The Project Manager should determine sample analysis and preservation requirements before the start of the program, along with the need for, and the type of, QA/QC samples that will be collected. Sample naming conventions will be determined by the Project Manager in accordance with *SOP ES4.02 Sample Naming Protocol.*

2.6 EXCESS SOIL STORAGE AND DISPOSAL

The Project Manager must determine methods for addressing excess soil generated during borehole drilling, in consultation with the client and/or property owner, before starting the program. If required, this plan could include storing the excess soil on polyethylene sheeting, in drums or used as backfill (pending Provincial requirements). Any offsite transportation and disposal must be conducted in accordance with provincial and federal legislation.

2.7 DRILLING DISCHARGE

A plan to address the discharge of drilling fluids generated as part of the drilling program must be determined by the project manager, in consultation with the Client and/or property owner, prior to commencing the drilling program. If required, this plan could include storing the excess drilling fluids in drums (pending Provincial requirements). Any offsite transportation and disposal must be conducted in accordance with provincial and federal legislation. For sites where contamination is not a concern the drilling fluid could usually be allowed to infiltrate on site.

2.8 ITEMS TO TAKE INTO THE FIELD

2.8.1 Mandatory Items

- Proper clothing for the activity and weather conditions
- All applicable HSE Forms
- All necessary permits
- Required PPE (SWP 105)
- Site plan with proposed borehole locations
- Any other relevant site/project information
- Field forms (Section 5.2)
- Completed Utility Clearance Forms (SWP 213)

2.8.2 Consumables

- Waterproof permanent markers
- Laboratory-prepared/supplied sample bottles
- Survey stakes and/or spray paint
- Clean cooler and ice
- Laboratory chain-of-custody forms
- De-ionized water
- Phosphate-free detergent
- Paper towels or Kimwipes

- Garbage bags
- Plastic soil sample collection bags (Ziploc or equivalent)
- Latex or Nitrile gloves
  - (*Note:* If potential contaminants of concern include VOC, BTEX or other light petroleum hydrocarbons, Nitrile gloves *must* be used).

2.8.3 Non-Consumables

Confirm all required equipment is available, clean and operational. Calibrate, handle, store and maintain equipment according to manufacturers' recommendations. Record the calibration results on *ESFF2.07 Field Instrument Calibration*. Confirm you have spare batteries and/or chargers as required. Following use, clean, maintain and store all equipment according to manufacturers' recommendations, and fill in and submit a Technical Recovery Form to confirm equipment costs are appropriately charged to the project. Equipment that may be required to complete this task includes:

- Battery-operated water level meter
- Photoionization Detector (PID, e.g. MiniRAE) and/or Organic Vapour Meter (OVM, e.g. RKI Eagle)
- Camera (or camera-equipped smart phone)
- Weighted measuring tape and/or measuring wheel
- Survey equipment
- Traffic control equipment (e.g., traffic cones, caution tape etc.)
- GPS unit
- Field Tablet
- Laminated "Field Guide for Soil and Stratigraphic Analysis"
- Stainless steel hand sampling tools (e.g., trowel)
- Two pails (for washing and rinsing sampling equipment)
- Calculator
- Scrub brush / wash tools

3 FIELD PROCEDURES

3.1 QUALITY ASSURANCE / QUALITY CONTROL

The following QA/QC procedures apply to borehole drilling and sample collection:

- To reduce the potential for cross-contamination, decontaminate non-dedicated equipment shall be decontaminated before use and between samples, in accordance with *SOP ES4.08 Equipment Decontamination.*
- All monitoring equipment (e.g., meters) should be calibrated in accordance with the manufacturers' instructions.
- Daily review and discussion of field forms with the Project Manager or Project Hydrogeologist. Sign off on field forms once reviewed for completeness.
- Confirm collection of field duplicates, trip blanks, field blanks, and rinsate samples per project requirements.
- Review of completed borehole logs and comparison with provincial water well record (if applicable) to confirm consistency.

3.2 BOREHOLE DRILLING METHODS

The borehole drilling methodology that will be used will be determined by the Project Manager. The following are the typical methodologies used, and information about which field staff should be aware.

3.2.1 Solid-Stem Auger Drilling

- Used to advance borings through overburden; not suitable in competent bedrock.
- Sampling soil using this method is not ideal because of formation disturbance.
- Augers must be removed from the borehole to permit access of a sampling device; therefore, the formation must be stable (e.g., silt or clay), or it may collapse. It is difficult to collect representative soil samples using solid stem augers when the borehole is subject to sloughing.
- This method can be used to install groundwater monitoring wells provided the saturated zone is comprised of fine-textured and stable soils. If the saturated zone is comprised of coarse-textured soils, the soils below the water table will likely collapse to the level of the water table as the augers are withdrawn.
- If auger refusal is encountered as the result of bedrock or boulders, the only way to absolutely distinguish between the bedrock and boulders is by coring.

3.2.2 Hollow-Stem Auger Drilling

- Used to advance borings through overburden; not suitable in competent bedrock.
- Provides a temporary casing in the borehole through which well pipes, sand-back backfill, bentonite seals, or more elaborate sampling equipment or instrumentation can be installed; therefore, preferable to solid-stem for installing wells.
- Each auger is typically 1.52 m (5 ft.) long and has a 108 mm (4.25 in.) ID and a 210 mm (8.25 in.) OD. The augers are connected together with bolts and are generally not water-tight.
- When advancing the augers, a cylindrical steel center plug is attached to drill rods, lowered inside the augers, and positioned at the tip of the lead auger. The center plug is held in the same relative position as the lead auger by advancing the drill rods along with the augers.
- The center plug is removed from the boring as required to permit soil sampling and reinstalled after sampling has been completed.
- Soil sampling is often completed using a split-barrel sampler, also referred to as a split spoon sampler. This sampling technique also provides standard penetration test (SPT) data. SPT involves driving a standard split-barrel sampler into the ground at the bottom of the borehole by blows from a slide hammer with a standard weight and falling distance. The split-barrel is driven 150 mm (6 inches) into the ground and the number of blows needed for the tube to penetrate each 150 mm interval up to a depth of 450 mm (18 inches) is recorded. The sum of the number of blows required for the second and third 150 mm of penetration is reported as SPT blow count value (commonly termed N-Value).
- Split-barrel samplers range in length from 0.46 m (1.5 ft.) to 0.76 m (2.5 ft.) and are typically 35 mm (1 3/8 in.) inside diameter (ID). Unless otherwise indicated by the Project Manager, split-barrel samples should be obtained at 0.76 m (2.5 ft.) depth intervals. If using a 0.61 m (2 ft) long sampler, 0.15 m (6 in.) of soil from each interval would remain unsampled.
- Alternatively, the center plug is not required when CME™ continuous samplers are used. The continuous sampler consists of a 1.52 m (5 ft.) long core-barrel sampler that is inserted through the annulus of the hollow stem augers. The sampler does not rotate with the augers. The open end of the sampler extends a short but adjustable distance beyond the auger head.
- Unlike the split-barrel sampler, the continuous sample is collected as the augers are advanced. After the augers and sampler have been advanced the desired depth, the loaded sampler is removed from the auger and replaced with an empty sampler. A continuous sampler is preferred to the split-barrel sampler when standard penetration test data are not required because of sample continuity and a greater sample volume is obtained.
- The CME™ continuous sampler is best suited to cohesive soils; however, relatively undisturbed samples of sand and non-cohesive deposits can sometimes be collected with this sampling

system. Adjustment of the distance the continuous sampler extends beyond the auger head may assist in sample recovery in non-cohesive soils.

- Sampling often completed using a split-spoon (also known as split barrel) sampler. This also allows for the collection of standard penetration test (SPT) data.
- Thin-walled tubes or Shelby tubes can also be used for sampling.
- If poor sample recovery is experienced in non-cohesive soils, a plastic or stainless steel sand trap may improve recovery.
- If heaving sands (sands under hydrostatic pressure) are encountered, potable water, if available, can be pumped down the augers to maintain a positive pressure head within the auger column.
- If auger refusal is encountered as the result of bedrock or boulders, the only way to absolutely distinguish between the bedrock and boulders is by coring.
- With most conventional drilling rigs (e.g. CME 75), drilling with augers is generally limited to depths of less than 46 m (150 ft.).

3.2.3 Direct Push

3.2.3.1 Geoprobe

- Uses a hydraulically powered percussion machine to install different types of sampling devices in unconsolidated materials.
- Sampling devices to collect soil, soil gas or groundwater can be installed.
- Soil recovery is generally good; use of casing facilitates well installation.
- Typical depths that can be achieved using this system are 10 m below ground surface (BGS) to 15 m BGS.
- Typically, a 19 mm ID monitoring well may be installed through the casing; however, 32 mm ID well materials may be installed through the open borehole.

3.2.3.2 Pionjar

- Uses a portable pneumatic hammer to advance a 0.76 m split-spoon sampler through overburden.
- A 32 mm ID monitoring well may be installed in the borehole annulus. Some contractors can overdrill the borehole using portable hollow stem augers to allow a 50 mm ID monitoring well to be installed.

3.2.3.3 Sonic Drilling

- Refers to slow rotary action and high frequency resonance down the drill stem or casing to the cutting bit.
- Generally produces undisturbed samples (102 mm ID core is standard); excellent for establishing detailed stratigraphy.
- Can be used in cobbly/boulder material, where augers would encounter refusal.
- As with hollow-stem, use of casing allows for well installation in formations that would otherwise collapse.
- Usually requires that water be brought to site, or on-site water supply used, to reduce drilling friction.

3.2.4 Mud Rotary Drilling

- Mud rotary drilling allows increased drilling speeds and the ability to reach greater depths in most formations. Can be used in consolidated or unconsolidated formations.
- Suitable for deep boreholes in overburden with cobbles or boulders, in formations where sands under hydrostatic pressure tend to heave upward, and in bedrock
- Borings are drilled using a truck-mounted drilling rig equipped with a system for circulating fluids (water or drilling fluids).
- Aqueous drilling fluids (drilling mud) prepared using specially manufactured products and water. The purpose of drilling mud is to cool and lubricate the bit, stabilize the borehole wall, limit the inflow of formation water, and remove drill cuttings.
- The borehole is advanced by rotating a bit (typically a tri-cone roller bit) attached to a drill rod through drill casing. HW sized casing (102 mm ID) is typically used with a 95 mm OD tri-cone bit when a 51 mm ID monitoring well is to be installed. Tri-cone bits are appropriate for use in consolidated formations. A drag bit is frequently used in unconsolidated formations.
- Drill cuttings are removed by water circulation. Water is injected inside the drill rods, down through the bit and out through the annulus and up to the surface. Unless there is loss to the formation, cuttings and drill water return to the surface outside of the drill rods within the borehole annulus.
- Typically, a mud pit is used to collect the return water and feed to fluid circulation system. It is possible to collect samples using a sieve as the return water discharges from the borehole; however, the samples are not representative of actual conditions since a significant portion of the fines are lost and the coarser fractions are broken down by the bit.

- Lithological changes are recognized by description of the samples returned in the drilling fluid. The depth of the changes may be identified by changes in hardness and changes in the rate of advancement of the drilling.

- Collection of in-situ, relatively undisturbed samples is possible using a split-spoon sampling device adapted to the drill rods or a wire-line; sampling slows drilling progress significantly; without split-spoon equipment, use of mud rotary for soil characterization not recommended.

- Suitable for deep boreholes in overburden with cobbles or boulders, in formations where sands under hydrostatic pressure tend to heave upward, and in bedrock.

- The use of circulated water or drilling mud should be considered with respect to its applicability for environmental projects. Generally, the volume of water or drilling mud introduced to the subsurface and not recovered (fluid loss) should be removed prior to groundwater sampling. The reason for this is that fluids, drilling mud in particular, may alter the water quality of the formation. Fluid loss can be calculated by recording the initial volume of water in the mud pit and subtracting the volume of water remaining in the mud pit upon completion of drilling. Another means to verify that all of the circulated drilling fluid has been recovered is to spike the drilling fluids with a known concentration (above background) of an inert tracer chemical. Tracer concentrations can be monitored during well development until background concentrations (indicative of a return to natural formation conditions) are achieved.

- The use of mud rotary drilling adjacent to production or residential wells is not recommended due to the possibility of the migration of drilling fluids through the aquifer.

3.2.5 Air Rotary Drilling

- Direct air rotary drilling is similar to mud rotary drilling except that the circulation medium is air rather than water or drilling mud. In this method, a large compressor is used to supply air through the drill rods to the drill bit.

- Direct air rotary drilling incorporating a casing driver (hammer) permits drilling in unstable overburden. Borehole is fully stabilized during drilling.

- Also, can be used in hard dense material (basal till, cobbles, boulders, bedrock).

- Cuttings are blown out through the top of the borehole and can be collected; however, these cuttings are generally not representative of in-situ conditions.

- Air rotary drilling in overburden is difficult due to the high potential for the hole caving in. Therefore, air rotary drilling is most appropriate for consolidated or semi-consolidated materials unless casing is used to prevent borehole collapse.

- Advantages of air rotary methods include: high penetration rates; not affected by cold weather; no plugging of aquifer with drilling fluids; estimates of formation water yield can be obtained during drilling; better identification of drill cuttings.

3.2.5.1 Direct Air Rotary with Down-the Hole Air Hammer

- Uses a pneumatic drill (hammer) operated at the bottom of the drill rods. Compressed air drives the hammer to provide a percussion effect and simultaneously removes the cuttings.
- Produces disturbed samples; not recommended when analyzing for volatiles.

3.2.5.2 Reverse Circulation

- Adaptation of the direct rotary (liquid or air) drilling method using a dual walled casing.
- Circulating medium (air, water, or mud) is pumped down between the outer casing and inner drill pipe, out through the drill bit and back up the inside of the inner drill pipe.
- Fluid loss can be minimized; however, samples are highly disturbed; not recommended when analyzing for volatiles.

3.3 BOREHOLE DRILLING SUPERVISION

Stantec field investigators engaged in supervising borehole drilling operations should:

1. Complete the top section of *ESFF2.02 Daily Activity Record*, *ESFF2.09 Sample Collection Record* and *ESFF2.23 Headspace Measurements*, as required.
2. Check in with property owner / client (if present) upon arrival at the site to discuss testing locations, schedule and work program. Accommodate the needs of the client / property owner as much as possible. Communicate any potential problems to the Project Manager as soon as possible.
3. Locate the boreholes according to the Project Manager's instructions after ensuring that the specified locations are within the subject property boundaries; can be drilled safely; and are clear of overhead and underground utilities or other structures (refer to *SWP 213* and *SWP 406*).
4. Confirm the driller and helper are using appropriate personal protective equipment. As a minimum, the Stantec field investigator should request Level D protective equipment.
5. Record sample ID number and sample location on a site plan and on applicable field forms.

6. Complete *ESFF2.18 Overburden Log*. Keep track of borehole ID and location using GPS instrument.

7. Use a consistent, systematic borehole naming system as directed by the Project Manager. Care should be taken to use unique borehole names, especially when completing supplemental investigations (e.g., avoid having two boreholes named BH1 on site).

8. Record all relevant observations / events related to drilling such as loss of equipment down-hole or volume of fluid added to the borehole, together with date and times.

9. Specify to driller appropriate sample depths and type and borehole completion depths.

10. Put on a clean pair of latex or Nitrile gloves (depending on the type of contaminant).

11. Once the sample has been obtained, the soil must be removed from the sampling device. Take care not to contaminate the sample through contact with either equipment or tools that have not been decontaminated, or with ungloved hands.

    - If sampling directly from the auger, carefully remove the soil from the auger, trimming about 1.0 cm from all sides of the sample prior to logging and storing.

    - If using a split spoon, place the split spoon on a flat surface and open the split spoon, taking care to disturb the sample as little as possible. Measure and record the soil recovery. Remove the soil from the upper end of the split spoon (most likely slough) and log the sample as described below.

    - If using a thin-walled tube or Shelby tube, measure and record the true soil recovery. Place the Shelby tube on a flat surface and carefully cut open the tube, taking care to disturb the sample as little as possible. Remove the soil from the upper end of the tube (most likely slough) and log the sample as described below. Alternatively, the tube ends can be trimmed and sealed, e.g. double bagged and taped (if less than 24 hours to extrusion is anticipated) for transport to the laboratory.

12. Identify, label, package and handle samples as described in *SOP ES4.02 Sample Naming Protocol.*

13. Log and classify soils according to the Unified Soil Classification System (USCS; ASTM 2488).

14. Fill the appropriate (lab-provided) containers with representative soil. As far as possible, confirm there is no headspace between the top of the soil and the inside of the lid, especially when

sampling for volatiles. Put remaining soil in plastic bag and/or core box if retaining remaining sample.

15. Label the soil sample containers with the following information:
    - Project number
    - Location
    - Date (year/month/day/time)
    - Borehole number (e.g., BH101, BH102, etc.)
    - Depth (metres)
    - Sample number
    - Field investigator responsible for sampling
    - If using core boxes or PVC splits, top and bottom should be marked
16. Store samples in a cooler at a maximum temperature of 10ºC, and preferably at a minimum temperature of 4ºC, except where otherwise required for testing.
17. Complete (including *signing and dating*) the laboratory-provided Chain of Custody form. As this is a legal document, it must be complete and accurate.
18. Upon completion of the borehole, check bottom depth with a tape measure before the augers are removed and check initial water level in the open borehole with a water level meter. Record these observations on the *ESFF2.21 Borehole/Monitoring Well/Drive-Point/Test Pit Completion Details*.

3.4 SITE PHOTOGRAPHS

Photographs should be taken of site conditions before any work is conducted and again just prior to leaving the site to confirm the site was left in an appropriate state. The requirement for other photographs will be determined by the Project Manager. If required, all significant geological and/or contaminant related features exposed at the sampling location should be photographed, with a scale included in the photographs to indicate dimension. After field work is completed, requirements like labelling and organization of photographs including things such as project number, sample name and the date of the photograph, indexing and use of *ESFF2.26 Photograph Log,* will be determined by the Project Manager.

4 DOCUMENTATION

4.1 MANUAL AND DIGITAL DATA STORAGE REQUIREMENTS

4.1.1 Hard Copy Notes

Confirm that field notes are accurate and complete. Provide them to the project manager for review and signature. Scan hard copy notes. Store hard copies in the project file.

4.1.2 Digital Data

Upload photographs to the server project file. Save data spreadsheets/databases and scanned hard copy notes in the server project file. If the local server is not automatically backed up regularly, save a back-up copy of data in another location.

4.2 GENERAL

Information to be documented will include the following, as applicable:

- Site name, project number and task number(s)
- Field investigator's name
- Borehole number
- Date and time of soil sample collection
- Sample numbers, locations, and depths
- Sampling method(s)
- Observations at the sampling site
- Unusual conditions (i.e., those that could affect observation and/or samples)
- Decontamination observations
- Weather conditions
- Names/contact information of all field crew members and of any site visitors should be noted on the *RMS2* form and the form should be signed as required by SWP procedures Location, description, and log of photographs
- References for all maps and photographs
- Information concerning sampling or scheduling changes, and any change orders

- Summary of daily tasks and documentation on any cost or scope of work changes required by field conditions List of field equipment used
- Signature (dated) of personnel responsible for observations

4.3 BOREHOLE RECORDS

Borehole records will be completed by the field investigator for each borehole completed. The borehole records will include the following information:

- Client
- Site Location
- Job and task numbers
- Borehole number
- Datum
- Field investigator
- Driller and company affiliation
- Borehole drilling equipment, method, and diameter
- Date started and completed (month/day/year)
- Completion depth
- Samples collected for laboratory analysis by depth of sample below surface, sample type, number and sample interval will be recorded
- Field screening results for soil headspace vapor measurements
- Origin of the lithologies (e.g., fill, glacial till, glacial outwash or alluvium, etc.), as well as descriptions of stratigraphy (lithology, grain size, sorting, texture, structure, bedding, colour, moisture content)
- Contaminant observations, if applicable (e.g., soil staining, presence of product, noticeable odours)
- Observations of any groundwater seepage into the borehole
- Borehole backfilling details (if monitoring well is not installed)

- Any other pertinent information

5 RESOURCES

5.1 RELATED SOPS

- SOP ES2.04 – Environmental Rock Coring and Classification
- SOP ES3.01 – Monitoring Well Installation
- SOP ES3.02 – Production/Test Well Installation
- SOP ES3.04 – Borehole/Monitoring Well Abandonment
- SOP ES2.01 – Environmental Surface Soil Sampling
- SOP ES3.05 – Surveying
- SOP ES4.08 – Equipment Decontamination
- SOP ES4.02 – Sample Naming Protocol

5.2 STANDARD FORMS

- ESFF2.02 – Daily Activity Record
- ESFF2.07 – Field Instrument Calibration
- ESFF2.16 – Underground Utility Locate Request
- ESFF2.18 – Overburden Log
- ESFF2.21 – Borehole - Monitoring Well - Drive Point - Test Pit Completion Details
- ESFF2.22 – Elevation Survey
- ESFF2.23 – Headspace Measurements
- ESFF2.26 – Photograph Log
- ESFF2.35 – Working Alone

SOP ES 3.01

Monitoring Well Installation

STANDARD OPERATING PROCEDURES: **MONITORING WELL INSTALLATION**

SOP ES3.01
Version: 2.0 (Last revised May 14, 2020)
Approved by:
Don Carey, M.Sc., P.Eng., National Technical Leader, Site Investigation
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Discipline(s): Site Investigation, Hydrogeology

1 PURPOSE AND SCOPE

This document defines the standard procedures for installing monitoring wells.

2 PRE-MOBILIZATION

2.1 HEALTH AND SAFETY

Confirm that *RMS1* and *RMS2* forms and all other applicable safety forms are reviewed, filled in, updated and followed. Review applicable SWPs as required. Confirm that field staff have the necessary training to complete the work safely.

2.2 PLANNING

Identify and obtain any required permits for activities such as working in a roadway or working near a water body. For example, some jurisdictions may require a licensed well contractor, and/or a waste generator registration for disposal of soil generated during borehole drilling activities.

Discuss the purpose of the monitoring well installation program and scope of work with the Project Manager and review the proposal and all proposed monitoring well construction details.

If available, review site photos, field records, logs and cross sections from previous on-site or nearby subsurface investigations to determine expected water levels.

2.3 MONITORING WELL LAYOUT AND PROGRAM DETAILS

The locations of the monitoring wells will be determined based on the locations of the boreholes (see SOP ES2.03 *Environmental Borehole Drilling and Soil Sampling* and/or *SOP ES2.04 Environmental Rock Coring and Classification*). The Project Manager should determine monitoring well construction details (diameter, screen length, screen depth, sand pack location, bentonite seal location, surface completion, etc.), prior to the commencement of the field program. These monitoring well components are illustrated on Figure 2-1.

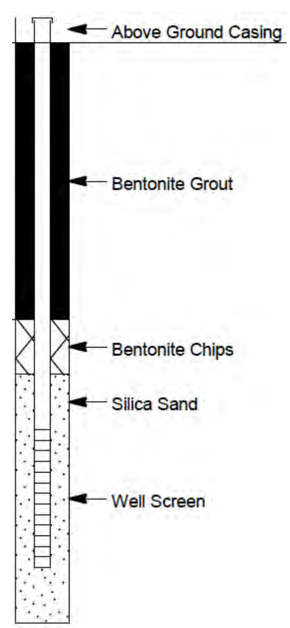

Figure 2-1 Schematic of Monitoring Well

2.4 MONITORING WELL COMPONENTS

The following provides an overview of the components of a monitoring well. Details regarding each component will be confirmed by the Project Manager.

2.4.1 Well Casings/Standpipes

The well casing will consist of new material and of a diameter as specified by the Project Manager. For PVC well casing, only threaded, flush-joint, material will be used. Schedule 40 PVC is suitable for depths less than 50 m. For depths greater than 50 m, Schedule 80 PVC well casing is recommended. Heat-welded joints and/or gaskets or solvent based couplings are not to be used. The tops of all well casings will be fitted with threaded plugs or J-caps, as per site requirements. Venting should be provided to allow the wells to equilibrate with the atmosphere, unless they are interior monitoring wells with potential vapour risks.

2.4.2 Well Screens

Well screen slot-size, length and placement are important design variables that should be discussed with the Project Manager and/or Project Hydrogeologist before selecting a design; some considerations affecting design are:

- The slot-size of the well screen should be determined based on anticipated drilling conditions and needs to be confirmed prior to arrival on-site. Typically a 10 slot well screen is sufficient for most monitoring purposes. For finer grained formations, the grain size of the sand pack can be selected to try to reduce the turbidity of the well and migration of formation material during sampling.
- Well design and spatial placement should not present a significant pathway for the vertical migration of chemicals (i.e., should not install long well screens across multiple aquifer units).
- For comparability of water elevations, well screens should be in the same geologic unit.
- For determination of vertical hydraulic gradients, nested or clustered well screens should be placed at a single location.
- Well screens intersecting the water table should account for seasonal fluctuations in water elevations.
- Wells with water columns less than 1 m in length are more difficult to sample.
- Well screen placement should consider the texture of soil samples collected.
- The total borehole depth and static water level should be confirmed using the weighted tape measure and water level meter prior to designing the well.

Well screens will consist of new threaded PVC (or other material specified by the Project Manager) with factory machined slots. The screen slot size will generally be No. 10 slot or as specified by the Project Manager. The screen length of the monitoring wells will typically be 1.5 or 3.0 m, unless otherwise required by the Project Manager. All screen bottoms will be fitted with a PVC flush or slip cap.

2.4.3 Sand Pack

The grain size of the sand pack and type are important design variables that should be discussed with the Project Manager and/or Project Hydrogeologist while planning the monitoring well installation. The sand pack material for the monitoring wells will generally consist of silica sand or equivalent. The primary filter pack material should consist of clean, rounded, sand (typically coarse-grained). The size of the filter pack material should be selected based on the texture of the formation in which the well is screened and the slot size of the well screen (see table below for general guidelines). The filter sands should have a maximum of 2 percent passing through the screen slots. In addition, the filter sands should be primarily siliceous in composition with less than 5 percent calcareous particles.

The sand pack should extend a minimum of 0.3 m above the top of the screened internal.

Typical Unconsolidated Aquifer Material	Ideal Sand Pack (effective size)
Medium to Coarse Sand	No. 03 (1.6 to 2.0 mm)
Fine to Medium Sand	No. 02 (1.0 to 1.5 mm)
Fine Sand	No. 01 (0.8 to 1.2 mm)
Silt to Fine Sand and heterogeneous material that includes silt and/or clay lenses/layers	No. 00 (0.4 to 0.5 mm)

Notes:

- General guidelines only, construction details for each individual well should be determined with the Project Manager.
- All sand packs are applicable for a No. 10 slot screen. If using a different slot screen consult with the Project Manager regarding appropriate sand pack size.

2.4.4 Annular Seal

An annular seal shall be installed above the sand pack in the monitoring wells. The seal will consist of a layer of commercially available bentonite pellets or chips that is approximately 0.3 m to 0.5 m thick as measured immediately after placement, without allowance for swelling. Bentonite slurry seals will be used when bentonite pellets or chips cannot be placed in the annulus (deeper wells) and the slurry should have a thick batter-like consistency. Slurry seals will be emplaced using the tremie method above the sand pack and will have a maximum placement thickness of 1.5 m. If bentonite pellets or chips are used, about 4 litres of water (of known chemistry) per 0.3 m of pellets or chips will be added as needed to initiate hydration of the bentonite if no water is present in the well at time of installation.

2.4.5 Cement/Bentonite Grout

The annular space between the PVC well casing and the boring wall will be grouted from the top of the bentonite seal. The grout mixture will consist of high-yield bentonite grout in proportions specified by the Project Manager. The grout will be prepared in an above-ground rigid container by first thoroughly mixing the high-yield bentonite with water and then, if appropriate, mixing in cement. Typically cement is not used to seal PVC wells due to the heat released during curing.

Grout will be placed in the well annulus with a tremie pipe. The grout will be pumped through the pipe which will be pulled up incrementally until the required depth has been reached. All grout will be pumped into place. Manual placement of grout will not be permitted.

2.4.6 Backfill

The use of drill cuttings to backfill boreholes or the annular space between well casing and the borehole wall is generally not allowed and should be discussed with the Project Manager. It should also be noted that some jurisdictions prohibit the use of cuttings as backfill.

2.4.7 Surface Seal

The surface seal will depend upon whether a flush or above ground completion is required. The type of completion will be specified by the Project Manager. Note that in some jurisdictions flush mounted wells are not allowed.

For either type of well casing installation, following the placement of the backfill, the boring diameter of the upper 0.4 m may be filled with concrete. The concrete will consist of a cement and sand mix.

2.4.7.1 Ground Surface (Flush) Completion

During placement of the concrete surface seal, a water tight maintenance hole shall be imbedded in the concrete. Maintenance holes installed on paved surfaces will be completed flush, while those installed on unpaved areas will be completed with a slight mound above the ground surface. A locking water-tight security plug (i.e., J-plug) will be installed on top of the PVC riser. A metal well tag or label identifying the well will be placed inside the flush maintenance holes by the licensed well contractor or by Stantec field staff.

2.4.7.2 Above Ground Completion

A protective steel casing with a lockable steel cap shall be installed over the monitoring well casing that projects above the ground surface. The protective casing will be placed about 0.5 m below the ground surface, leaving about 0.7 m above ground (with well casing having been cut to a length to take this in=to account). Additional measures may need to be taken to stop casing settlement or frost heaving. In some locations, it may be necessary to install bollards to protect the integrity of the monitoring well. If required, at least three steel or concrete bollards will be installed around the wells with above-ground completions. The bollards will be located radially from the well casing at a distance of approximately 1.0 m. They will be founded approximately 0.75 m BGS and extend a minimum of 0.5 m above the ground surface. In areas of high vegetation, the protective casings will be flagged.

The top of the standpipe should be a maximum of 0.1 m below the top of the steel casing to allow for water level measurements.

2.5 ITEMS TO TAKE INTO THE FIELD

2.5.1 Mandatory Items

- Proper clothing for the activity and weather conditions
- All applicable HSE Forms
- All necessary permits and approvals
- Required PPE (*SWP 105*)
- Site plan with relevant site features, ground surface elevation and proposed monitoring well locations.
- Any relevant site/project information
- Field forms (Section 5.2)

2.5.2 Consumables

- Well Materials (PVC pipe, caps;/plugs, sand, bentonite, protective casing, concrete)*
- Distilled water
- Paper towels or Kimwipes
- Latex or nitrile gloves
- Padlock

*Materials usually supplied by drilling contractor

2.5.3 Non-consumables

Confirm all required equipment is available, clean and operational. Calibrate, handle, store and maintain equipment according to manufacturers' recommendations. Record the calibration results on *ERFF2.07 Field Instrument Calibration.* Confirm you have spare batteries and/or chargers as required. Following use, clean, maintain and store all equipment according to manufacturers' recommendations and fill in and submit the Technical Recovery Form to confirm that equipment costs are appropriately charged to the project. Equipment that may be required to complete this task is identified below:

- Camera
- GPS
- Computer
- Weighted measuring tape and/or measuring wheel
- Battery-operated water level meter
- Survey gear
- Traffic control equipment including safety cones/ribbon etc.
- Photoionization Detector (e.g., MiniRAE)
- Combustible Vapor Analyzer (Gastechtor™ or RKI Eagle)
- Waterproof permanent marker
- Hacksaw and / or down-hole well cutter
- Calculator

3 FIELD PROCEDURES

3.1 QUALITY ASSURANCE / QUALITY CONTROL

1. Before any monitoring well installation begins, non-dedicated equipment shall be decontaminated in accordance with *SOP ES4.08 Equipment Decontamination*.
2. If dedicated equipment is used, it should come in polyethylene wrap prior to use.
3. Daily review and discussion of field forms with the Project Manager or Project Hydrogeologist.
4. Sign off on all field forms once reviewed for completeness.

5. Review of completed borehole logs and comparison with Water Well Record to confirm consistency.

3.2 MONITORING WELL INSTALLATION

Borehole completion shall be undertaken in accordance with applicable local, state / provincial and/or federal requirements. Upon completion of boreholes the following steps should be taken when installing monitoring wells:

1. Complete top section of *ESFF2.21 Borehole - Monitoring Well - Drive-Point - Test Pit Completion Details*.

2. Keep track of borehole ID and location using GPS instrument.

3. Measure depth of completed boring using a weighted tape.

4. It is assumed that well materials arrive at the site in an uncontaminated condition and protected with factory-wrapping. All personnel that handle the well casing will wear a new clean pair of latex or nitrile gloves.

5. Measure each joint of casing, screen, and end cap to the nearest 0.01 m.

6. Assemble screen and casing as it is lowered into the boring. Attach stainless steel centralizers if required (as per instructions from the Project Manager) for deep wells.

7. Lower screen and casing into hole, until the assembly is about 0.15 m above the bottom of the boring. In borings drilled to the surface of the bedrock, the end cap will be set at the bedrock surface.

8. Record level of top of casing and screened interval. Adjust screen interval by raising assembly to desired interval, if necessary, otherwise add 0.15 m of sand to raise the bottom of the boring to the base of the end cap.

9. Calculate and record the volume of the sand pack, bentonite seal, and backfill and/or grout required for existing boring conditions.

10. Begin adding filter pack sand around the annulus of the casing in 1.5 m increments. Repeated depth soundings shall be taken during placement to monitor the level of the sand. A tremie pipe should be used for deeper well installations.

11. Allow sufficient time for the filter sand to settle through the water column outside the casing (if present) before measuring the sand level.

12. Extend the filter pack sand to about 0.3 m to 0.5 m above the top of the well screen, or as directed by the Project Manager.

13. Temporary casing or hollow stem augers should be removed as the filter pack is placed. Care should be exercised to avoid bridging the filter sands inside of the casing or augers. Bridging can be limited by plumbing the top of the filter pack frequently using a weighted tape measure as the casing or augers are slowly raised. The casing or augers should not be withdrawn faster than the filter pack is installed.

14. Following sand filter pack placement, install a 0.3 m to 0.5 m thick bentonite seal on top of the sand filter. Slowly add the bentonite pellets or chips to avoid bridging. The completed bentonite seal shall be allowed to hydrate for approximately 10 minutes.

15. If the bentonite seal is above the water table, add water to hydrate (4 L per 0.3 m of pellets).

16. Add a 0.3 m thick layer of sand to facilitate identifying the top of the bentonite seal.

17. Backfill the annular space using a combination of bentonite pellets or bentonite grout as the augers are pulled. Repeated depth soundings shall be taken to monitor the level of backfilling and detect possible bridging. The final level of backfilling should be approximately 1.0 m below ground surface.

18. After the backfilling, the surface seal will be installed using concrete or bentonite pellets.

19. Following the installation of the monitoring well, the elevation of the ground surface and top of well casing (i.e., PVC pipe, not the protective casing), shall be surveyed and a survey mark installed on the well casing to indicate the reference point of the well for future water level monitoring.

20. Where required by regulations, a well tag or identification plate will be installed on the completed well by the drilling contractor.

Tips:

- PVC cements, solvents or lubricants shall not be used in the construction of wells.
- For deeper wells (e.g., 20 m or more), a stainless steel centralizer may be attached to the lowermost length of riser pipe to position the well in the center of the borehole; however, the

weighted measuring tape can get caught on the centralizer when plumbing the top of the filter pack material and for this reason, centralizers tend not to be used.

- Well materials are lowered through the hollow stem augers or drill rods/casings, which are left in place to prevent the borehole from collapsing.
- A finer-textured, secondary filter pack, 0.15 m to 0.30 m thick, may be installed above the primary filter pack if the bentonite seal will be installed using a bentonite slurry (as opposed to granular chips or pellets).

3.3 SITE PHOTOGRAPHS

Photographs should be taken of site conditions before any work is conducted and again just prior to leaving the site to confirm the site was left in an appropriate state. The requirement for other photographs will be determined by the Project Manager. After field work is completed, requirements like labelling and organization of photographs including things such as project number, sample name and the date of the photograph, indexing and use of *ESFF2.26 Photograph Log,* will be determined by the Project Manager.

4 DOCUMENTATION

4.1 MANUAL AND DIGITAL DATA STORAGE REQUIREMENTS

4.1.1 Hard Copy Notes

Confirm that field notes are accurate and complete. Provide them to the Project Manager for review and signature. Scan hard copy notes. Store hard copies in the project file.

4.1.2 Digital Data

Upload photographs to the server project directory. Save data spreadsheets/databases and scanned hard copy notes in the server project directory. If the local server is not backed up regularly, save a back-up copy in another location (e.g., computer hard disk).

4.2 GENERAL

Information to be documented will include the following, as applicable:

- Site name, project number and task number(s)
- Field investigator's name
- Monitoring Well number
- Datum

- Driller and company affiliation
- Drilling equipment and method
- Date started and completed (month/day/year)
- Completion Depth
- Borehole diameter
- The type and amount of well materials used, depths of placement, confirmatory measurements, and well stick-up should be documented on *ESFF2.21 Borehole - Monitoring Well - Drive Point - Test Pit Completion Details*
- Unusual conditions (i.e., those that may affect observation and/or samples)
- Decontamination observations
- Weather conditions
- Names/contact information of all field crew members and of any site visitors should be noted on the *RMS2* form and the form should be signed as required by SWP procedures.
- Location, description, and log of photographs
- References for all maps and photographs
- Information concerning installation changes or scheduling modification, and any change orders
- Summary of daily tasks and documentation on any cost or scope of work changes required by field conditions
- Signature and date by personnel responsible for observations
- Field equipment used
- Review of Water Well Record provided by drillers to confirm it is consistent with details collected in the field

5 RESOURCES

5.1 RELATED SOPS

- *SOP ES2.03 – Environmental Borehole Drilling and Soil Sampling*
- *SOP ES2.04 – Environmental Rock Coring and Classification*

- *SOP ES3.03– Monitoring Well Development*
- *SOP ES3.04– Borehole/Monitoring Well Abandonment*
- *SOP ES3.01 – Monitoring Well Installation*
- *SOP ES3.05 – Surveying*
- *SOP ES4.08 – Equipment Decontamination*

5.2 STANDARD FORMS

- *ESFF2.02 – Daily Activity Record*
- *ESFF2.07 – Field Instrument Calibration*
- *ESFF2.21 – Borehole - Monitoring Well - Drive Point - Test Pit Completion Details*
- *ESFF2.23 – Headspace Measurement*
- *ESFF2.26 – Photograph Log*

STANDARD OPERATING PROCEDURES: MONITORING WELL DEVELOPMENT

SOP ES3.03
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1 PURPOSE AND SCOPE

This document defines the standard operating procedures for monitoring well development.

2 PRE-MOBILIZATION

2.1 HEALTH AND SAFETY

Confirm that *RMS1* and *RMS2* forms and all other applicable safety forms are reviewed, filled in, updated and followed. Review applicable SWPs as required. Confirm field staff has the necessary training to complete the work safely.

2.2 PLANNING

Identify and obtain any required permits for activities such as working in a roadway or working near a water body. For example, some jurisdictions may require a licensed well contractor, and/or a waste generator registration for disposal of water generated during monitoring well development activities.

Discuss the purpose of the monitoring well development program and scope of work with the Project Manager. Review the proposal and all proposed monitoring well locations.

Review monitoring well construction details, and if available (e.g., when wells are being redeveloped), review field records from previous sampling rounds to determine expected well yield, static water level, presence/absence of free phase product, etc. The Project Manager should determine the development protocols (volume of groundwater to be removed, disposal methodology, etc.).

2.3 DEVELOPMENT WATER STORAGE AND DISPOSAL

The methods to be used to address development water removed from the monitoring well must be determined by the Project Manager, in consultation with the Client and/or property owner, and in consideration of any permit/license conditions, prior to commencing the program. If required, this plan could include storing the water in 45 gallon drums for testing and/or later off-site disposal, or discharge to surface. If separate phase liquid (LNAPL or DNAPL) is present or if impacts are known, the purge water must be contained for subsequent disposal. If there is LNAPL or DNAPL present in the well or within the purged water, a sample of water should not be collected for laboratory analysis unless the purpose is for product characterization. If water quality is not impacted (consistent with background water quality at the site) and if turbidity and/or sediment are low, water could be discharged to a permeable surface prior to infiltration. If well development is anticipated to generate significant quantities of water, provisions for erosion and sediment control should be considered to prevent mobilization of sediments and subsequent transport into receiving waterbodies. Discuss with the Project Manager the required handling of purge water for the given site conditions.

2.4 ITEMS TO TAKE INTO THE FIELD

2.4.1 Mandatory Items

- Proper clothing for the activity and weather conditions
- All applicable HSE Forms
- All necessary permits and approvals
- Required PPE (*SWP 105*)
- Site plan with relevant monitoring well locations
- Any relevant site/project information
- Field forms (Section 5.2)

2.4.2 Consumables

- Delrin™ or stainless steel Waterra™ foot valves
- Polyethylene tubing
- Polyethylene or Teflon bailer, nylon rope
- Distilled water
- Paper towels or Kimwipes
- Latex or nitrile gloves
- Waterproof permanent markers
- Decontamination supplies

2.4.3 Non-consumables

Confirm that all required equipment is available, clean and operational. Calibrate, handle, store and maintain equipment according to manufacturers' recommendations. Record the calibration results on *ESFF2.07 Field Instrument Calibration.* Confirm that you have spare batteries and/or chargers as required. Following use, clean, maintain and store all equipment according to manufacturers' recommendations and fill in and submit the Technical Recovery Form to confirm that equipment costs are appropriately charged to the project. Equipment that may be required to complete this task is identified below:

- Camera

- GPS
- Computer
- Traffic control equipment including safety cones/ribbon etc.
- Flow-through cell
- pH meter
- Eh meter
- Specific conductance meter
- Turbidity meter
- Oxidation Reduction Potential (ORP) meter
- Water level meter
- Thermometer (non-mercury)
- Interface probe
- Graduated bucket
- Calculator
- Mechanical purging equipment

3 FIELD PROCEDURES

3.1 QUALITY ASSURANCE / QUALITY CONTROL

The following QA/QC procedures apply to well development.

- All monitoring equipment (e.g., meters) should be calibrated in accordance with the manufacturer's instructions.
- To reduce the potential for cross-contamination, non-dedicated equipment shall be decontaminated in accordance with SOP *ES4.08 Equipment Decontamination.*
- If dedicated equipment is used, it should be wrapped in polyethylene prior to use.
- Sign off on all field forms once reviewed for completeness.
- Daily review and discussion of field forms with the Project Manager or Project Hydrogeologist.

3.2 MONITORING WELL DEVELOPMENT

3.2.1 Calculation of Development Volume

The following steps should be taken to calculate the development volume (casing volume) for each well, to be used in subsequent sections:

1. Measure the depth to water in the well from a fixed measuring point. Make sure that this measuring point is marked on the well casing.

2. Measure the total depth of the well from the same measuring point.

3. Calculate the height of water in the well casing by subtracting the depth to water from depth to the base of the well.

Calculate the number of litres of water corresponding to one casing volume by using the diameter, total depth, and a measurement of the static water level in the well using the formula shown on *ESFF2.08 Well Development / Purging*. For a 50 mm (2 inch) diameter well one casing volume is equivalent to the height of water in the well multiplied by a factor of 2 L/m.

3.2.2 Development

The following steps should be taken to develop each well:

1. Complete top section of *ESFF2.08 Well Development / Purging*.

2. Confirm monitoring well number.

3. Complete a monitoring well inspection and document on *ESFF2.03 Well Condition Inspection*.

4. Before development begins, a small volume of groundwater from the surface of the groundwater table should be recovered and inspected for free hydrocarbon product sheens and the possible presence of hydrocarbon odors. If there are no LNAPLs present, the presence of DNAPLs should be investigated by lowering a bailer to the bottom of the well. These observations should be recorded. If there are other potential contaminants, this should have been noted by the Project Manager and appropriate inspection should be carried out by the field personnel. The Project Manager should indicate what criteria are to be used for determining the discharge point of the development water. If there is any free hydrocarbon product (LNAPL and/or DNAPL), the well should not be developed.

5. Measure and record initial water quality parameters (Eh, pH, specific conductance, ORP, temperature, and turbidity). Check field values to verify that they are within expected ranges for the given site. Should anomalous measurements be identified, contact the Project Manager to discuss procedures for disposal of the purged water.

6. Development should take place across the entire screened interval in the monitoring well and should continue for 10 well volumes until the water removed from the well is as clear of sediment as is practical or until the well is dry. Refer to Section 3.2.1 above for calculation of well volume.

7. If water was added to the borehole during drilling, at least 3 times the volume of water added will be removed, in addition to the 10 well volumes. If the well does not provide sufficient yield to remove 10 well volumes, it should be pumped dry and allowed to recover 3 times.

8. In addition, development should continue until the water removed from the well is as clear of sediment as is practical and three consecutive readings within 10% of pH/electrical conductivity (EC) is achieved.

9. Measure and record the water quality parameters following the removal of each well volume. If there is sufficient flow, the Project Manager may require field parameters to be measured using a flow-through cell.

10. The results of all field measurements of water quality parameters, observations of physical appearance of the purged water, volume removed, pumping rate and pump intake location are recorded on *ESFF2.08 Well Development / Purging*.

11. The site should be cleared of all debris and waste generated during purging prior to leaving.

Tips:

- Automated pumps such as a Waterra™ Hydrolift II, a Grundfos Redi-Flo 2, a Whale submersible pump or a Masterflex peristaltic pump can facilitate developing and purging activities and, in the case of the Hydrolift II or the peristaltic pumps, may permit sampling.

- Mechanical purging methods should be considered with deeper monitoring wells that have a low static water level to avoid the potential for a repetitive stress injury due to the heavy weight of water within the Watterra™ tubing.

- Pump placement within the well is dependent on well yield. Proper pump placement allows proper well development. Initially, the pump is placed at the bottom of the well screen. In wells that can yield water at rates exceeding about 4 Lpm (1 gpm), the pump is slowly raised through the column of water in the well such that the pump is located at the top of the water column after approximately two casing volumes have been removed. In wells that can yield water at rates less than about 2 Lpm (0.5 gpm), the pump is placed at the bottom of the well during development and the water level is drawn down in the well as development proceeds.

- Surge blocks enhance well development by creating a piston-like action that alternately forces water to flow out of the well (downstroke) and into the well (upstroke). Water forced out of the well effectively backwashes the formation and loosens bridges in the formation or filter pack. Water pulled into the well dislodges fine-grained material in the filter pack, which can be then be purged from the well.

- Surge blocks should be sized to be within 6 mm of the inside diameter of the well casing because anything much smaller than the casing diameter would not create a good piston-like action.
- If surging is performed within the screen, care should be taken to avoid “sandlocking” the surge block. Sandlocking occurs when the fine-grained material accumulates around the surge block preventing further movement of the equipment.
- It is recommended that surging begin above the well screen (depending upon the water level within the well) with gentle surging movement. As development proceeds, the surge block can be gradually lowered into the screened interval and the surging movement can be increased. If initial development is too vigorous, the well could collapse due to the creation of a significant pressure differential. Similarly, surging should not be attempted if the screened interval is completely plugged or if the well is dry.
- Bailers are not the preferred method for well development because their use can be time consuming and labour intensive; however, their use may be appropriate under certain conditions. Bailers are generally used when a well is not expected to yield much water or if the column of water inside the well is less than about 0.6 m. In both cases, there would likely be insufficient water to permit water to fill and discharge from the tubing.
- If flow appears to decrease while pumping with the Waterra™, the foot valve may be clogged with silt. The following procedure can be used to restore the foot valve:
  - Pull tubing out of the monitoring well and either place it on a clean tarp or into a plastic garbage bag. Do not allow tubing to contact the ground surface to avoid contamination
  - Remove foot valve and tap to remove silt
  - Reinstall Waterra™ tubing into the monitoring well
- If the head of water in the tubing is decreasing, there may be a foreign object caught in the foot valve that is preventing it from closing. Follow the procedure described above to attempt to remove the obstruction.
- If the tubing drops into the monitoring well below the top of the casing, several methods exist to attempt to retrieve the tubing, as follows:
  - Gently push end of water level tape into the tubing - there should be enough friction to pull the tubing up enough to reach with your hand
  - If the top of the tubing is greater than 0.1 m below the top of the casing, use a bent wire coat hanger to fish the tubing
  - If the top of the tubing is greater than 1 m below the top of the casing attach an appropriate length of tubing to a wood dowel to extend the reach, or

  - If the top of the tubing is greater than 5 m below the top of the casing, try to attach a die tap instrument to an appropriate length of tubing. Attempt to screw die tap into top of tubing.

- If the tubing has been folded over and has dropped into the monitoring well below the top of the casing, a piece of stiff wire (such as a coat hanger) with one end bent into a hook, can be used to "fish" the tubing out of the well.

3.3 SITE PHOTOGRAPHS

Photographs should be taken of site conditions before any work is conducted and again just prior to leaving the site to confirm the site was left in an appropriate state. The requirement for other photographs will be determined by the Project Manager.

After field work is completed, requirements like labelling and organization of photographs including things such as project number, sample name and the date of the photograph, indexing and use of *ESFF2.26 Photograph Log,* will be determined by the Project Manager.

4 DOCUMENTATION

4.1 MANUAL AND DIGITAL DATA STORAGE REQUIREMENTS

4.1.1 Hard Copy Notes

Confirm that field notes are accurate and complete. Provide them to the Project Manager for review and signature. Scan hard copy notes. Store hard copies in the project file.

4.1.2 Digital Data

Upload photographs to the server project directory. Save data spreadsheets/databases and scanned hard copy notes in the server project directory. If the local server is not backed up regularly, save a back-up copy in another location (e.g., computer hard disk).

4.2 GENERAL

Information to be documented will include the following, as applicable:

- Site name, project number and task number(s)
- Field investigator's name
- Monitoring Well number
- Well condition
- Depth to groundwater, depth of monitoring well

- Calculated well volume
- LNAPL and DNAPL observations
- Initial groundwater field chemistry (pH, Eh, specific conductance, dissolved oxygen, ORP, temperature, turbidity)
- Number of well volumes removed, and removal methodology
- Groundwater field chemistry during removal
- Description of physical appearance of development water removed from the well
- How development water was disposed (i.e. allowed to naturally infiltrate surrounding vegetation, collected in drums, etc.)
- Unusual conditions (i.e., those that may affect observation and/or samples)
- Decontamination observations
- Weather conditions
- Names/contact information of all field crew members and of any site visitors should be noted on the *RMS2* form and the form should be signed as required by SWP procedures.
- Location, description, and log of photographs
- References for all maps and photographs
- Information concerning sampling or scheduling changes, and any change orders
- Summary of daily tasks and documentation on any cost or scope of work changes required by field conditions
- Signature and date by personnel responsible for observations
- Field equipment used

5 RESOURCES

5.1 RELATED SOPS

- *SOP ES4.01 – Monitoring Well Fluid Level Measurements*
- *SOP ES4.08 – Equipment Decontamination*

5.2 STANDARD FORMS

- *ESFF2.02 – Daily Activity Record*
- *ESFF2.03 – Well Condition Inspection*
- *ESFF2.04 – Water Levels*
- *ESFF2.05 – Monitoring Water / Product Levels and Vapour Concentrations*
- *ESFF2.07 – Field Instrument Calibration*
- *ESFF2.08 – Well Development / Purging*
- *ESFF2.24 – Drum Tracking*
- *ESFF2.26 – Photograph Log*
- *ESFF2.35 – Working Alone*

SOP ES 4.03

Low Flow Groundwater Sampling

1.0 PURPOSE & APPLICABILITY

The purpose of this document is to define the standard operating procedure (SOP) for collecting low flow groundwater samples. The ultimate goal of the sampling program is to obtain samples that meet acceptable standards of accuracy, precision, comparability, representativeness, and completeness. All steps that could affect tracking, documentation, or integrity of samples have been explained in sufficient detail to allow different sampling personnel to collect samples that are equally reliable and consistent.

This procedure gives descriptions of equipment, field procedures, sample containers, decontamination, documentation, storage and holding times, and field QA/QC procedures necessary to collect soil samples.

This procedure may apply to all sampling by Stantec personnel or their subcontractors by the aforementioned sampling methods.

It must be recognized that field conditions may force some modifications to the SOP. Any modification to the procedure shall be approved by the Project Manager or Task Leader in advance and sufficiently documented so that the reason for the deviation can be clearly articulated to our clients and regulators, as necessary. Where SOP modification is planned sufficiently in advance, regulatory agency concurrence will be sought prior to conducting the specific activity.

2.0 DEFINITIONS

FSP	Field Sampling Plan
HASP	Health and Safety Plan
OSHA	Occupational Safety and Health Administration
QA/QC	Quality Assurance/Quality Control
QAPP	Quality Assurance Project Plan
SOP	Standard Operating Procedure
WP	(Project) Work Plan

3.0 HEALTH AND SAFETY CONSIDERATIONS

Consideration of Health and Safety risks prior to performing this work is paramount. This risk review may be performed by modifying a generic or existing Job Safety Analysis in the HASP. There are many items to be considered. Following is a short list of the items for consideration. Careful review of these items and other site-specific conditions by the project team is essential.

- Traffic guidance and control. Even plans developed by outside traffic control contractors need to be carefully evaluated to make sure they are protective of our staff and contractors.
- Personal protective equipment, including hard hats, high-visibility traffic vest, gloves, appropriate clothing.
- Heat and cold stress.

- Biological hazards such as insects and spiders. Appropriate clothing is required such as long-sleeved shirts and long pants.
- Bloodborne pathogens. Some of our sites may have syringes and other drug paraphernalia that must be carefully avoided.
- Chemical exposure on sites with open contamination. Respiratory protection may be necessary. Proper selection of respiratory protection is essential and an understanding of its limitation (i.e., negative pressure respiratory protection does not supply oxygen in an oxygen-deficient atmosphere). Staff should familiarize themselves with exposure limits for contaminants of concern.
- Emergency action plan must be carefully coordinated in advance between Stantec, our subcontractors, the client, and emergency responders.

All of these risks and others must be discussed with our subcontractors and clients to be sure they are properly addressed. Once the issues have been addressed at a project management level, they must be communicated to the staff that will actually perform the work. Details of procedures, instrument measurements and calibration, and other activities must be recorded in the field log and/or on data collection forms.

4.0 RESPONSIBILITIES

The Project Manager or Task Leader will be responsible for assigning project staff to complete low flow groundwater sampling activities. The Task Leader will also be responsible for assuring that this and any other appropriate procedures are followed by all project personnel.

The project staff assigned to the low flow sampling tasks will be responsible for completing their tasks according to this and other appropriate procedures. All staff will be responsible for reporting deviations from the procedure or nonconformance to the Task Leader, Project Manager, or Project QA/QC Officer.

Only qualified personnel shall be allowed to perform this procedure. At a minimum, Stantec employees qualified to perform groundwater sampling will be required to have:

- Read this SOP.
- Read project-specific QAPP.
- Indicated to the Task Leader that all procedures contained in this SOP are understood.
- Completed the OSHA 40-hour training course and 8-hour refresher course, as appropriate.
- Previously performed low flow groundwater sampling activities generally consistent

with those described in this SOP.

5.0 TRAINING/QUALIFICATIONS

Stantec employees who do not have previous experience with low flow groundwater sampling will be trained on site by a qualified Stantec employee and supervised directly by that employee until they have demonstrated an ability to perform the procedures.

6.0 REQUIRED MATERIALS

The following is a typical list of equipment that may be needed to perform low flow groundwater sampling:

- Photoionization detector (PID) or other air monitoring instrumentation as needed.
- Sample containers with lids.
- Sample labels.
- Waterproof marking pens, such as the Staedtler Lumocolor.
- Coolers (with ice) for sample storage and shipment.
- Sample data forms/clip board.
- Decontamination supplies.
- Nitrile gloves, or other specified chemical-resistant gloves.
- Work gloves.
- Camera and film or disks.
- Blank groundwater parameter forms or a field-logging PDA.
- Personal safety gear (hard hat, steel-toed boots, etc.).
- Water level indicator or product-water interface probe.
- Centrifugal pump, bladder pump, Grundfos pump (or equivalent).
- Appropriately sized tubing (Teflon or equivalent).
- YSI 556 meter with flow-through cell (or equivalent).
- Turbidity meter, Hatch ferrous iron test kit (or equivalent) as needed.
- Buckets, drums or other containers for purge water.

7.0 METHODS

7.1 Purging Methods

Wells will be purged and sampled according to the following procedures:

- After the water levels and the depth of the wells have been measured, the monitoring wells will be purged at a low-flow rate using a centrifugal pump, bladder pump, Grundfos pump (or equivalent) and dedicated down-hole tubing while measurements of oxygen reduction potential (ORP), dissolved oxygen (DO), standard conductivity (SC), pH, temperature, ferrous iron and/or turbidity (as needed) are monitored using a YSI 556 meter with flow-through cell, appropriate meters and test kits. (The meters will be checked and calibrated prior to use as specified in the operations manuals.) After purging is initiated, the flow will be adjusted to a rate that results in minimal well draw down.

- The pump intake will be located near the middle of the screened interval of each well. Non-dedicated equipment will be decontaminated appropriately before use at each monitoring well.

- Purge rates for low-flow sampling must be within 50 - 500 milliliters per minute (mL/min). At no point should the purge rate cause a change in water level of greater than 0.3 feet.

- When using a bladder pump, the pump should be set so that one pulse delivers the entire 40ml vial amount (not mandatory but "best practice").

- Peristaltic pumps must not be used for volatile analysis or dissolved gases due to the loss of volatiles from the creation of a vacuum in the intake line that draws the sample to the surface.

- The well will be purged until water quality parameters (ORP, DO, SC, pH, temperature, and/or turbidity) have stabilized (generally within 10 percent) for three consecutive measurements taken at 3 to 5 minutes intervals or three (3) complete well volumes have been removed. USEPA recommendations for stability parameters are:

  - ❖ Turbidity - ±10%
  - ❖ DO - ±10%
  - ❖ Specific Conductance - ±3%
  - ❖ Temperature - ±3% (minimum of ±0.2 deg C)
  - ❖ pH - ±0.1
  - ❖ Redox Potential - ± 10mV

A minimum of three (four if using temperature) of these parameters must be monitored and recorded. If a well has a low yield and is purged dry, do not collect a sample until it has recharged to approximately 80% of its pre-purge volume, when practical.

- Once the water quality parameters have stabilized, a groundwater sample will be collected in appropriate sample containers, or sampled with the appropriate test kit.

- Documentation of all purge data, including volumes (both of water purged and water sampled), elapsed times, pump-flow rates, water level and geochemical parameter measurements will be recorded on the sampling form.

7.2 Decontamination Methods

The following steps will be used to decontaminate sampling equipment:

- Ensure that the decontamination process has been carefully designed so that the solutions used are appropriate for the chemicals of concern.
- Personnel will don appropriate safety equipment to reduce personal exposure.
- Equipment that will not be damaged by water will be placed in a wash tub containing an Alconox™ (or equivalent) solution and scrubbed with a brush or clean cloth. Equipment will be rinsed in a second wash tub.
- Equipment that may be damaged by water will be carefully wiped clean using a sponge and detergent water, and wiped with organic-free deionized water. Care will be taken to prevent any equipment damage.

Following decontamination, equipment will be placed in a clean area or on clean plastic sheeting to prevent possible contamination. Single use equipment and consumables will be discarded in an appropriate manner.

8.0 QUALITY CONTROL CHECKS AND ACCEPTANCE CRITERIA

Refer to the Quality Assurance Project Plan for specific quality control checks and acceptance criteria.

9.0 DOCUMENTATION

A monitoring well low-flow groundwater sampling log will be completed for each monitoring well. The field notebook and/or data collection forms will contain the following information:

- Project name and number.
- Field staff/sampler's name.
- Date and time sampling started and finished.
- Type of equipment for air monitoring and air monitoring data (if applicable).
- Type, make and model number of low flow and sampling equipment used.
- YSI meter (or equivalent), calibration and measurements.
- Depth to groundwater, well bottom and dense non-aqueous phase liquid levels, if applicable.

- Monitoring well purge volume.
- Surface elevation (if available).
- Flow rates.
- ORP, DO, SC, pH, temperature, and/or turbidity measurements or results and time.
- Additional sample analytical method or analytes and sample identification.
- Sample collection time.
- Sampler's observations.
- Description of monitoring well condition.

SOP 35

Investigation Derived Waste Management

STANDARD OPERATING PROCEDURES
SOP-35: INVESTIGATION DERIVED WASTE MANAGEMENT

1.0 INTRODUCTION

The purpose of this Standard Operating Procedure (SOP) is to describe the policy, organization, functional activities, and investigation-derived waste (IDW) management control to be implemented for field investigation activities. The plan should be used as a guideline for future waste management. More detailed, site-specific information should be presented in the Sampling and Analysis Plans (SAPs) prepared for individual investigations conducted at each site. The objective of the plan is to describe the procedures required to manage IDW. In addition, the SOP establishes the sampling and analytical procedures to be followed to manage the IDW as required by CERCLA, Superfund Amendments and Reauthorization Act (SARA), and Resource Conservation and Recovery Act (RCRA) guidance. Detailed information presented in this SOP addresses the following:

- Typical types of IDW that will be generated and managed during investigation activities at the three OUs
- Typical specific activities expected to be conducted that may generate IDW.
- Specific waste parameters or characteristics that need to be quantified to ensure safe and effective management of IDW
- Methods of obtaining necessary data to assess IDW, such as sampling and analysis procedures
- Options for disposal of IDW
- Applicable or relevant and appropriate requirements (ARARs) to be considered during the implementation of the SOP

1.1 PLAN ORGANIZATION

The organization of the SOP is designed to facilitate the decision-making process, presenting a logical approach to be used in determining the proper handling and treatment or disposal of IDW. Section 2.0 presents information on the types, typical volumes, and containment of wastes generated during field investigations as well as the field activities that are expected to generate IDW at the three OUs. Section 3.0 outlines the intermediate handling and management of waste soils, liquid wastes, personal protective equipment, and disposable equipment. Record-keeping practices, containerization, storage, characterization, and sampling and analysis protocols for the IDW also included in Section 3.0. Section 4.0 details the disposal options available for the IDW. Section 5.0 discusses ARARs to be considered for implementation of the SOP during the field investigations.

2.0 GENERATION OF INVESTIGATION-DERIVED WASTES

During field programs, a variety of potentially contaminated IDWs will be generated. Potential field activities include drilling, trenching or test pits, groundwater sampling, surface water sampling, aquifer testing, soil-gas surveys, geophysical surveys, and location surveys. The National Contingency Plan (NCP), codified in 40 Code of Federal Regulations (CFR) 300, requires that the handling of IDW attains all the ARARs to the extent practicable considering the urgency of the situation.

2.1 TYPES OF IDW

IDW generated during field activities may include the following media and waste types:

- Soil
- Drilling mud
- Groundwater
- Decontamination fluids
- Personal protective equipment (PPE)
- Disposable equipment

The above wastes may or may not be considered hazardous for the purposes of handling and disposal. Section 3.6 details how the wastes will be characterized prior to determining the appropriate disposal option. In addition to the IDW listed above, refuse may be generated during field activities. This could include, for example, packaging materials and broken or cut-off well screening and casing. Typically, this refuse can be treated as nonhazardous material and disposed of as appropriate, such as in an on-base industrial dumpster.

2.2 IDW GENERATION ACTIVITIES

The various activities conducted during field investigations will result in the generation of IDW. Field activities may include soil-gas and geophysical surveys; drilling of soil borings; trenching or test pits; monitoring well installation and development; aquifer testing; collection of soil surface water and groundwater samples; and location surveys. The IDW generated during these activities could potentially be contaminated with various hazardous substances. Estimated volumes of IDW generated from various field activities are presented in the sections that follow. As part of the preplanning procedures prior to the initiation of any field effort, the individual contractors should perform site-specific calculations of the total volumes of IDW expected to be generated based on the anticipated activities as part of their project planning.

An effort should be made to reduce the amount of IDW generated during field activities because the quantity of IDW will affect the overall cost of the remedial action and potentially increase liability or exposure. IDW can be minimized through proper planning of all activities that generate IDW. The sampling equipment and method of decontamination should be selected with consideration to the volume of IDW that will be generated. Whenever possible, the number of activities conducted at a site should be reduced.

2.2.1 Soil-Gas and Geophysical Surveys

Soil-gas and geophysical surveys are conducted to identify and locate anomalies, potential "hot spots," and source areas. These activities potentially generate a small volume of decontamination fluid and PPE.

2.2.2 Drilling

Two drilling techniques are typically used for soil boring or monitoring well installation at the hollow-stem auger (HSA) or mud rotary. The preferred method is HSA drilling; however, problems have been encountered using this drilling method for installation of deeper monitoring wells or large diameter extraction wells. To collect shallow soil samples using HSA, a borehole will typically be drilled using an 8.25-inch outside-diameter (OD) auger to collect soil samples. A minimum of 0.37 cubic feet (cu. ft.) (2.8 gallons) of soil cuttings per linear foot of borehole will be generated. A 25-foot soil boring would therefore generate a minimum of 9.3 cu. ft. (70 gallons) of soil cuttings (filling approximately one and one-half 55-gallon drums). Additional quantities of soil should be expected when using the HSA due to reworking of the soil during removal from the borehole, known as the "fluff" factor, and due to slough created during drilling, especially if poorly consolidated materials are encountered. An estimated 30 percent increase in soil-cutting volumes will be generated due to the "fluff" factor. Table 2-1 shows the relationship between the diameter of borehole and the potential volume of soil cuttings generated from drilling using HSA. The installation of larger diameter soil borings will generate proportionally larger quantities of soil.

The volume of drilling mud generated from the mud rotary drilling method is difficult to estimate because many variables are involved. Mud rotary drilling includes the addition of a drilling fluid, water, to remove the pieces of formation that were broken by the drill bit. The water and soil are together referred to as drilling mud. Typically, the drilling mud is separated to remove sand and gravel, and the liquid mud is recycled through the system. The solids (sand and gravel) are deposited in a bin or drum. When the borehole is completed, the mud is flushed out of the borehole and deposited in a tank. The volume of drilling mud generated depends on the stratigraphy encountered, fluid loses during drilling, and solids added to the mud.

Drilling by both HSA and mud rotary could also potentially generate large volumes of PPE and decontamination fluid. These volumes are difficult to estimate because they depend on many site-specific factors.

2.2.3 Hand Augering, Surface Soil Sampling Activities

Typically, hand augering is conducted using a 3.25-inch inside-diameter (ID) auger. Surface soil sampling is usually completed using hand-held sampling tools. Due to small diameter and limited drilling depth, a small volume of soil cuttings is estimated to be generated during these activities, and a small volume of PPE would also be generated.

2.2.4 Trenches or Test Pits

Trenches or test pits may be excavated at sites. Following the soil sampling and visual observations of the pit, the excavated soil will generally be placed back into the test pit. Depending on specific site conditions, the need may arise to remove the excavated soil from the area of contamination (AOC). This could potentially generate large volumes of soil to be treated and/or disposed. Decontamination of the excavation and sampling equipment could potentially generate large volumes of decontamination fluid. PPE will also be generated.

2.2.5 Location Surveys

Following the completion of sampling activities, the coordinates and elevations of all sampling points, including soil borings, monitoring wells, soil-gas points, and geophysical survey grids, will be surveyed. Small volumes of PPE could potentially be generated.

2.2.6 Monitoring Well Development, Groundwater Sampling, and Aquifer Testing

The volume of groundwater generated through monitoring well development, groundwater sampling, and aquifer testing is dependent upon a number of variables, including well diameter, length of the screened interval, saturated thickness of the well, porosity of the material used as filter packing, duration and rate of pumping. PPE and decontamination fluid would also be generated as a result of these activities, but the volume is dependent on the type and duration of the activity.

Complete well development requires the removal of at least three times the amount of source water used during drilling and construction of the well plus a minimum of three times the volume of standing groundwater within the well. For example, during the development of a 4-inch-ID well with 30 feet of standing water, a minimum of 58 gallons of groundwater plus three times the amount of the source water used during drilling and construction of the well would be generated. An additional 58 gallons of groundwater would be generated while purging the well prior to groundwater sampling.

Aquifer pump testing will generate much larger volumes of groundwater than well purging. Typical volumes cannot be estimated because they depend on the well construction and the duration of the test.

In general, purge water should be segregated by well and containerized in Department of Transportation (DOT)-approved, 55-gallon drums. If the on-installation treatment system is approved as a disposal mechanism, an option is to cut costs by consolidating purge water in on-installation Baker tanks for temporary storage prior to discharge to the treatment system.

2.2.7 Surface Water Sampling

Surface water sampling may be conducted to determine the constituents of the surface water at the site. This activity could potentially generate a small volume of decontamination fluid and PPE.

2.2.8 Decontamination Fluid

The volume of IDW generated as decontamination fluid will be dependent upon a number of site-specific factors, and therefore, will vary in quantity. Site-specific factors include the number and type of field activities per site and the total number of sites being investigated. Decontamination fluid can vary from a few gallons a day for decontamination of instruments to several hundred gallons a day for decontamination of large field equipment such as drill rigs.

2.2.9 PPE and Disposable Equipment

The volume of IDW generated as PPE and disposable equipment will be dependent upon a number of site-specific factors and therefore, will vary in quantity. Site-specific factors include the U.S. Environmental Protection Agency (USEPA) health and safety work level (Level D versus Levels C or B), number and type of field activities per site, number of people working on site, total number of sites being investigated, and the amount of disposable equipment that is required. PPE waste volumes generated per day will typically account for one-half of a 55-gallon drum for a crew of four.

2.3 IDW CONTAINMENT

IDW generated during field activities will be contained at the site of generation or at a designated central location. DOT-approved, 55-gallon drums for the handling of hazardous waste (DOT, USEPA-approved DOT-17-H) should be used for the containment of some of the IDW including PPE, and disposable sampling equipment. Roll-off boxes and Baker tanks may be used to contain soil and liquid wastes, respectively. However, DOT-approved, 55-gallon drums may be used to containerize soil and liquid wastes if preferred. The number of each type of container required at each site should be estimated before field work commences.

Soil cuttings and/or drilling mud will either be contained in DOT-approved, 55-gallon drums or placed in roll-off boxes located in the general area of sites being investigated. If soil cuttings are determined to be potentially hazardous while in the field (i.e., HNU readings above designated levels or visible staining), soil cuttings should be segregated by site or boring, containerized in DOT-approved 55-gallon drums lined with polyethylene, and immediately secured with lids. Each drum or roll-off box will be labeled as discussed in Section 3.4. Drums or roll-off boxes will be stored at the site of generation or transported from the AOC following drilling and stored at a central location as instructed by the base environmental coordinator. Drums or roll-off boxes will be held until adequate characterization of the site or the contained soil or drilling mud is completed (Section 3.6.1).

Liquid wastes will either be stored within the AOC or transported to a central location. Liquid wastes generated during field investigation activities include fluids generated during well installation, development, purging and sampling, aquifer testing, surface water sampling, and decontamination of equipment. The base may consolidate liquid wastes in on-installation Baker tanks if the liquids are generated from wells located in areas where previous investigations have shown no contamination or contaminants at levels that would not adversely affect the existing on-installation groundwater treatment facility. If liquid wastes are determined to be potentially hazardous while in the field (i.e., HNU readings above designated levels) or if previous investigations have indicated contamination at that location, DOT-approved, 55-gallon drums lined with polyethylene will be used for containment until the liquid can be characterized (see Section 3.6). Liquid wastes may also be stored in 55-gallon drums if drums are more convenient than Baker Tanks. Each drum will be labeled as discussed in Section 3.4. Drums will be stored at the site of generation or transported from the AOC and stored at a central location as instructed by the base environmental coordinator. Liquid wastes will be stored pending IDW characterization (Section 3.6).

Depending upon the suspected contaminants present, decontamination fluid generated at each site may be segregated by site and containerized in DOT-approved, 55-gallon drums or stored with other liquid wastes generated at the same site. The decontamination fluid will be stored within the AOC or a designated central location as instructed by the base environmental coordinator. Decontamination fluid will be held until adequate characterization is complete (Section 3.6.2). However, if the on-installation treatment system is approved as a disposal mechanism, decontamination fluid may be transported to Baker tanks for temporary storage and eventual disposal into the system.

PPE and disposable equipment produced through field activities will be segregated by site, double-bagged in plastic bags, secured and labeled using a wire tag. The bags will then be placed in DOT-approved, 55-gallon drums and labeled as discussed in Section 3.4. Partially filled drums will be secured with lids at the completion of field activities or at the end of the work day. PPE and disposable equipment will be held at the site of generation or a designated central location as instructed by the base environmental coordinator. PPE and disposable equipment will be held until adequate characterization of the site or of the containerized PPE and disposable equipment is completed (Section 3.6).

3.0 IDW HANDLING AND MANAGEMENT OPTIONS

This section discusses the proper IDW management procedures to be followed in record-keeping practices, requirements for compliance with storage time limitations, and characterization of IDW. The protocols established for sampling and analysis of contaminated IDW, if required, are also presented in this section.

Following the field activities, including proper labeling and temporary storage of IDW as appropriate, the first task will be to characterize the IDW generated. Proper characterization is required to determine if disposal is necessary and, if so, the appropriate disposal options. These options include both on-installation and off-installation disposal or treatment and are discussed in detail in Section 4.0. Initially, the IDW will be characterized based on a review of analytical data generated from environmental samples collected during field activities. This data will be compared to the background data collected during the OU 3 remedial investigation. Based on this comparison, the characteristics of the IDW will be inferred. In some cases, testing containerized IDW may be required to further define disposal options. The management of investigation-derived wastes including containerization and required analyses are presented in Sections 3.1, 3.2, and 3.3 for soil, liquids wastes, and PPE, respectively. The methods for accurately characterizing IDW are presented in Section 3.6.

Initially, soil and liquid IDW will be characterized based on the background data. To identify potential contamination, analytical results should be compared to the 95% Upper Tolerance Level for the background samples.

Proper IDW management requires that the following steps be completed:

- Characterize the waste generated
- Determine the quantity of waste that is hazardous
- Evaluate available on-installation and off-installation disposal/treatment methods
- Identify ARARs of concern
- Select a disposal option
- If off-installation disposal or treatment is required or selected, schedule testing and transport of wastes

The investigation team members will conduct the field activities that generate the IDW (Section 2.2), place the IDW in appropriate containers (Section 2.3), and complete record-keeping responsibilities (Section 3.4). Once the waste has been adequately characterized, the investigation team will also arrange for the appropriate treatment or disposal of the IDW. Analytical results of environmental samples and recommended disposal options for IDW will be summarized in a technical memorandum submitted to the Remedial Project Managers (RPMs) and the USACE by the investigation team. The RPM and USACE approval will be required prior to proceeding with the recommended disposal options. The technical memorandum will document the status of containerized IDW with the following information:

- A complete list of containers stored at each site of generation or at the central area
- Unique identification of each container
- Contents of each container
- Analytical results of the environmental samples
- Volume of potentially contaminated material
- Potential contaminant(s) of concern
- Site maps showing the location of each container at the site
- Recommended treatment and/or disposal options for each container

If off-installation treatment and disposal of containerized IDW is required, the investigation team would be responsible for sampling containerized IDW, if required, for further characterization or disposal. The investigation team should provide documentation to the USACE. Handling and managing the off-installation treatment and disposal of IDW after the containers have been characterized for off-installation removal would also be required. Additional tasks that would be performed include, but may not be limited to, preparing manifests, tracking containers, tracking 90-day storage limits, arranging the transport of containers, and arranging the ultimate disposal to a RCRA-permitted off-installation treatment, storage, and disposal facility (TSDF).

3.1 CHARACTERIZATION AND MANAGEMENT OF INVESTIGATION DERIVED SOILS AND DRILLING MUD

The containerization of, and proposed analyses for, investigation-derived soils and/or drilling mud generated during field investigations are described in the following sections. Figure 3-1 presents the step by step process that will be followed for characterization of the soils and drilling mud.

3.1.1 Containerization

Investigation-derived soils and/or drilling mud generated during field activities will be containerized on-site within individual AOCs. Details for containerization of investigation-derived soils and/or drilling mud are presented in Section 2.3 of this document, but in general the IDW soils will be contained in either bins or 55-gallon drums. Possible exceptions to leaving IDW soil and/or drilling mud at the AOC would include areas with a high degree of public access or sites where leaving the IDW on site would result in increased risks to human health and/or the environment. In such cases, the IDW may be moved to a secured central location. The base environmental coordinator will instruct the field team where to store contained IDW.

3.1.2 Analyses

Any available information from previous investigations should be reviewed along with background samples and analytical results of environmental soil samples collected on site within the AOC to determine the potential contaminants of concern and probable characteristics of containerized IDW. If environmental samples are determined to be nonhazardous (see Figure 3-1), investigation-derived soil and/or drilling mud will be disposed as described for nonhazardous soils in Section 4.0.

If the IDW is characterized as nonhazardous at any level of the characterization process, it will be disposed as described for nonhazardous soils (Section 4.0). If analyses show contaminant concentrations of the soil samples collected within the AOC to be above background concentrations (Table 3-1), results will be compared to Total Threshold Limit Concentrations (TTLC), 10 times the Soluble Threshold Limit Concentration (STLC), and 20 times the Toxic Characteristic Leaching Procedure (TCLP) regulatory limits. At this point, if soil samples are determined to be hazardous (under RCRA or California Code of Regulations [CCR] Title 26), the collection of composite samples from IDW containers for analysis may be necessary. Specific sampling and analysis methods are described in detail in Section 3.7. The samples will be analyzed by STLC or TCLP procedures to determine if the IDW is hazardous, and to evaluate potential land disposal restrictions (LDRs). If the containerized composite samples are again determined to be hazardous, options for disposal need to be considered (Section 4.0).

If no environmental samples were taken during the waste generation, composite samples should be collected from IDW containers. The samples will be analyzed by STLC or TCLP procedures. If the containerized composite samples are determined to be hazardous, disposal options need to be considered (Section 4.0). Additional sampling and testing of IDW may be initiated as appropriate based on the intended method of disposal (Section 4.0) and standards determined by individual TDU or TSDF locations.

3.2 CHARACTERIZATION AND MANAGEMENT OF INVESTIGATION DERIVED LIQUID WASTES

The containerization of, and proposed analyses for, investigation-derived liquid wastes generated during field investigations at the site are described in the following sections. Figure 3-2 presents the step by step process that will be followed for characterization of the liquid IDW.

3.2.1 Containerization

Liquid wastes generated during field activities may include fluids generated during well installation, well purging and sampling, aquifer testing, and the decontamination of drilling and sampling equipment. These investigation-derived liquid wastes will be containerized and may be segregated by source or by site, dependent upon the anticipated contamination and volume of liquids generated. The segregated liquids will remain within the AOC or will be transported to a central location, pending determination of IDW status with respect to RCRA and other pertinent ARARs as well as the disposal methodologies available. Details for containerization of investigation-derived liquid wastes are presented in Section 2.3 of this document, but in general, liquid waste will be contained in either Baker Tanks or 55-gallon drums. Possible exceptions to leaving IDW liquid wastes at the AOC will include public access considerations or if leaving the IDW on site will create increased risks to human health and/or the environment. In such cases, the IDW may be moved to a secured central location. The base environmental coordinator will instruct field team members where to store contained IDW.

3.2.2 Analyses

Information from previous studies, background data, and analytical results of environmental samples collected at each site will be reviewed to determine contaminants of concern and the characteristics of the containerized IDW (Figure 3-2). If aqueous samples are determined to be nonhazardous (analytical concentrations are below the 95% Upper Tolerance Level for background samples), the liquid wastes will be disposed as described for nonhazardous liquids in Section 4.0.

If contaminant concentrations in the aqueous samples collected within a given AOC are above background concentrations, results will then be compared to STLC and TCLP regulatory limits. At this point, if the samples are determined to be hazardous (under RCRA and/or CCR Title 22), the containerized IDW liquid should be sampled according to the procedures described in

Section 3.7, and the analytical results should be compared to the STLC and TCLP regulatory limits. If analytical results of the containerized IDW liquid determine the liquid to be nonhazardous (Figure 3-2), the liquid will be disposed of as nonhazardous liquid IDW. However, if samples of the containerized waste are determined to be hazardous, the options for disposal may be considered as discussed in Section 4.0.

If no environmental samples were taken during waste generation, composite samples should be collected from IDW containers. The sample results should be compared to the STLC and TCLP regulatory limits to determine if the waste should be disposed as hazardous or nonhazardous liquid IDW.

If the activities that generated the liquid wastes were associated with one of the OUs with a treatment system that is able to handle the types and concentrations of compounds detected, the liquid waste may be discharged to the system for treatment and eventual discharge to the groundwater recharge basin. If the treatment system is unable to handle the IDW, or if an on-installation treatment system is not available, required sampling and testing of IDW should be initiated as appropriate for the intended method of disposal and standards determined by individual off-installation TDU, TSDF, or POTW locations.

3.3 CHARACTERIZATION AND MANAGEMENT OF DISPOSABLE PPE AND DISPOSABLE EQUIPMENT

The following sections present various options that are available for the management of investigation-derived disposable PPE and disposable equipment. These options are intended to be considered following a review of all available information concerning the environmental samples collected within the AOC where the PPE and/or disposable equipment was generated.

3.3.1 Decontaminated Equipment

If disposable PPE and disposable equipment are decontaminated following use and are therefore designated as nonhazardous waste, the IDW will be placed in plastic bags and disposed of in an on-installation industrial dumpster. A second option is to remove the IDW to an off-installation Subtitle D landfill. Further details for disposal options of decontaminated disposable PPE and disposable equipment are presented in Section 4.0.

3.3.2 Potentially Contaminated Equipment

If disposable PPE and disposable equipment are not decontaminated following use, they may represent potentially hazardous waste. Disposable PPE and disposable equipment will be containerized and segregated by individual site (e.g., by boring or site number) and stored within the AOC, pending determination of RCRA status and disposal. Possible exceptions to leaving the IDW at the AOC include public access considerations or the potential for increased risks to human health and the environment.

Following a review of pertinent information concerning the site of generation, including analytical results and regulatory provisions, the disposal options for the PPE and disposable equipment will be assessed. If the results of environmental samples collected during field sampling activities are determined to be nonhazardous, the disposable PPE and disposable equipment will be disposed as nonhazardous IDW. Further details for disposal options of nonhazardous disposable PPE and disposable equipment are presented in Section 4.0.

If the results of environmental samples from the AOC are determined to be hazardous, the containers will be disposed of as hazardous IDW. Disposal options for hazardous IDW are presented in Section 4.0.

3.4 CONTAINER LABELING AND RECORD KEEPING

Container labeling and record-keeping requirements include: (1) proper labeling of containers as waste pending receipt of analytical test results (proper labeling includes information such as source site number, boring or well number, and permissible storage period); and (2) date(s) of waste generation and type of IDW stored in the container. Drum labels will be placed on the side of the drum, not on the lid, to reduce breakdown of the label by environmental conditions and to prevent the possibility of interchanging labels if lids are reused. Plastic bags used to contain disposable PPE and disposable equipment will be identified with a drum label wrapped around a piece of wire to produce a wire tag that will be used to seal the bag. An example of a container label to be used for identifying containerized IDW is shown on Figure 3-3.

IDW containers should be tracked using a form similar to that shown on Figure 3-4. The form should be completed once each container is filled. Information recorded should include site name, location identification, storage location, contents, source, dates of operation, and capacity of container. The quantity (volume) of material in each container should be measured and recorded on the IDW container data sheet prior to sealing the container.

In addition to complying with the above requirements, as appropriate, the contractor will notify the engineer-in-charge (EIC) and provide the USACE with an inventory of wastes generated, including source, media, storage location, analytical results, and final treatment or disposal. Storage locations for containerized wastes will be designated by the base environmental coordinator. Hazardous waste manifests and material safety data sheets will be completed by Stantec or the generator as appropriate. All manifests will be signed by the generator (Installation).

Entries will be made by the EIC in a field log book during the waste management activities. The quantities of wastes generated at each site, visual observations of the wastes, odor characteristics, and HNu readings should be included in the field log book.

3.5 STORAGE TIME LIMITS

Several storage and disposal requirements are subject to time limits that begin when the IDW is generated. These include: (1) removal of waste from the site (unless wastes will be stored on site within the AOC); (2) notification of the USACE by the contractor following initial characterization of the IDW; and (3) final treatment or disposal of the IDW.

Within 60 days of waste generation, the investigation team should provide a memorandum to the USACE documenting the initial characterization of the IDW. Sixty days is required to receive analytical results from the laboratory, review the data, interpret the data, and prepare the memorandum. The memorandum will assist the USACE in RI/FS planning and compliance with environmental regulations. Documentation should contain information on quantity of waste, type (soil, water, etc.), site, source (borehole, monitoring well, etc.), contaminants detected, and concentrations. This information will be used to make an initial classification of waste (potentially hazardous, designated, or nonhazardous). The memorandum should include proposed actions to be taken concerning additional sampling and disposal.

As discussed in Section 3.6, if IDW is characterized to be potentially hazardous, additional sampling of IDW containers will be required to determine if the IDW is hazardous. If the material is defined as RCRA hazardous waste, RCRA regulations (40 CFR 262.34) requires the waste to be transported off site in 90 days. In addition, RCRA regulations (40 CFR 262.34) require that, unless IDW will be stored within the AOC, IDW will be transported to the designated storage area within 3 days. If additional sampling is performed, it is likely that the 90-day limit on RCRA waste will be exceeded. CERCLA-derived wastes may be stored at an area longer than 90 days as long as the storage area complies with RCRA substantive storage requirements (the administrative process for obtaining a permit is not required). The intent of the waste management program will be to dispose of IDW as soon as is practicable. Factors that may influence the length of time of storage include laboratory turnaround time, duration of investigations at the site, storage area volume limitations, time requirements to arrange for off-site disposal, and the degree of risk that the IDW poses to human health and the environment. If IDW is generated that is deemed by the USACE, regulatory agencies, or the contractor to present a high degree of risk by storing the IDW, arrangements will be made for immediate transfer or disposal.

3.6 IDW CONTAINER SAMPLING AND ANALYSIS METHODS

Analytical samples collected during field activities will be analyzed and the results compared to background and regulatory limits before IDW container sampling occurs. Data collection efforts completed during the field investigation should be sufficient for determining whether IDW is potentially hazardous. The basic objective of IDW sampling is to produce a set of samples representative of the contained IDW media under investigation and suitable for subsequent analysis, if required. Containerized soil and liquid wastes can be returned to the source at any time during the investigation, contingent upon compliance with ARARs. ARARs are discussed in Section 5.0. PPE and disposable equipment found to be potentially hazardous will be disposed as hazardous materials. The methods, techniques, and analyses used for testing hazardous field-generated wastes that will be disposed of off-installation to a RCRA-permitted facility or Class I disposal facility are presented in the following sections.

The sampling technique chosen for sampling activities will, in part, be dependent upon the physical state of the IDW media to be sampled. The physical state of the IDW will affect most aspects of the sampling effort. The sampling technique will vary according to whether the sample is liquid, solid, or multiphasic. The generation of decontamination fluids through IDW sampling should be minimized and should be a factor considered in the final choice of sampling technique. The decontamination fluids will be minimized through selection of appropriate technique to sample the media in question and ease of cleaning. Care should be exercised to avoid the use of sampling devices plated with chrome or other materials that might contaminate the sample.

If IDW is characterized to be potentially hazardous after review of analytical data generated during field activities, IDW container sampling will be conducted. Testing is required prior to on- or off-installation treatment, storage, or disposal of contaminated material. However, IDW container testing is not required if the IDW is determined to be nonhazardous. Criteria for testing protocol are presented in Sections 3.1 through 3.3. The description of sampling techniques for containerized media is divided into two sections, which address soil and drilling mud, and containerized liquids.

3.6.1 Containerized Soil and Drilling Mud Sampling

Available options for sampling devices suitable for soil and drilling mud sampling include scoops, thin-walled tube samplers, hand augers, core samplers, and sampling triers. The presence of rocks, debris, or other sampling-specific considerations will dictate the most suitable sampling method. The sampling technique will also vary according to whether the solid is hard or soft, powdery or clay-like (USEPA, 1986).

If the soil or drilling mud is stored in bins, one composite sample should be collected from each bin. If the IDW is stored in drums, one composite sample should be collected from the cuttings from each boring or from each site.

3.6.2 Containerized Liquid Waste Sampling

Beakers, glass tubes, extended bottle samplers, and Composite Liquid Waste Samplers (COLIWASA) are devices that may potentially be used to sample containerized liquid media. Site-specific conditions may necessitate a variety of sampling options. Site-specific conditions will include the homogeneity or heterogeneity of the liquid to be sampled and stratification and the physical nature of the liquid such as viscosity. Sampling techniques will be chosen based on properties of the liquid medium and ease of decontamination of sampling equipment. Surface water samples from drums can also be readily collected by merely submerging a sample bottle.

If the liquid waste is stored in Baker Tanks, one composite sample should be collected from each Baker Tank. If the liquid waste is stored in drums, one composite sample should be collected from the drums for each sampling event.

4.0 DISPOSAL OPTIONS FOR IDW

Disposal alternatives for IDW include: (1) on-installation land disposal, (2) off-installation land disposal, (3) on-installation treatment, (4) off-installation treatment, and (5) on-installation storage and disposal within the AOC. Choosing one of these alternatives is dependent upon the type of IDW; concentrations of contaminants as determined by sampling and analysis (see

Section 3.7); and federal, state, or local regulations and ARARs (discussed in Section 5.0). The disposal option should be determined prior to site investigation activities to assess the site investigation costs and minimize on-site waste storage. Specific IDW disposal options are presented in the following sections and are shown in Table 4-1 and on Figures 4-1 through 4-3.

Ultimately, the PPE and disposable equipment will be transported to dumpsters for disposal at either a sanitary landfill, a TDU, or a RCRA-permitted TSDF as discussed in this section.

4.1 ON-INSTALLATION LAND DISPOSAL FOR NONHAZARDOUS WASTES

A significant amount of the solid waste generated during any field program will be considered nonhazardous. There are no RCRA ARARs concerning the disposal of nonhazardous solid wastes; therefore, nonhazardous solid wastes (as determined by environmental samples) may be disposed at an appropriate location on base. PPE and disposable equipment will be stored in dumpsters but will not be disposed on the base.

A significant fraction of solid waste generated during field investigations will be investigation-derived soil and drilling mud. Disposal options for soils found to be nonhazardous may include spreading around the source areas (such as spreading around borings), or transporting to a designated area on base. Soil disposal around the boring or source area within the AOC may not be feasible due to public access considerations, the location of the AOC (such as borings in or adjacent to roads or other developed areas), or more stringent, non-RCRA ARARs. If it is not feasible to spread the soil around the source area, the soil must be sent to a designated location on the site selected by the USACE, or sent to a suitable Subtitle D landfill or an off-installation TDU or TSDF.

Investigation-derived liquids that are determined to be nonhazardous would have the same on-installation disposal options as soils. However, disposal of liquids by pouring them around the source area may not be prudent due to the potential to mobilize contaminants by infiltration of water or due to public access considerations. Nonhazardous liquid wastes may also be disposed by surface discharge to a groundwater recharge basin. If it is determined that the environmental samples are nonhazardous but treatment and disposal is controlled by more stringent, non-RCRA ARARs, alternate methods of disposal would be required.

Nonhazardous trash and decontaminated PPE and disposable equipment generated during field activities can be disposed in an on-installation industrial dumpster for disposal after characterization.

On-site disposal can significantly decrease the volumes of wastes that must be transported and/or treated, thus decreasing costs of the field program. Any on-base disposal should be coordinated with the appropriate base agencies.

4.2 OFF-INSTALLATION LAND DISPOSAL

One potential alternative for IDW disposal is at an off-installation TDU or TSDF municipal landfill. The waste that is disposed at off-installation facilities may include soil, drilling mud, liquid wastes, PPE, or disposable equipment. Once waste is characterized, as discussed in Section 3.6, the appropriate "Class" of disposal unit (as defined in Title 26 of the CCR) must be selected. Class I facilities may accept hazardous, designated, and nonhazardous wastes; Class II facilities may accept designated wastes; and Class III facilities accept nonhazardous solid wastes. Selection of a particular disposal unit (hazardous or nonhazardous) is dependent on the waste type, contaminant concentration, facility acceptance criteria, geographic location, and cost.

The disposal facility should be selected prior to the instigation of the site activities. The disposal facility must be contacted prior to arriving at the TSD facility with waste to ensure acceptance of the waste by the landfill operator and to check that the facility's requirements have not changed. The contractor should obtain verification that the disposal facility is in compliance with all operational permits prior to receiving wastes from the site. Additional sampling and testing of the IDW required by the disposal facility should be initiated prior to disposal. The generator must either obtain an EPA identification number and manifest form for IDW, or prepare a bill of lading for RCRA nonhazardous IDW prior to transporting.

4.3 ON-INSTALLATION TREATMENT

On-installation treatment will be considered, as appropriate, to minimize the volume of liquid and solid waste to be sent to off-installation facilities and to reduce costs. Liquid wastes including surface water, groundwater, and decontamination fluids may be transported to an on-installation groundwater treatment system for treatment as appropriate. The treated liquids would then be discharged along with treated groundwater from the treatment system. Currently, treated water from the treatment system is discharged into the arroyo. Future discharge alternatives may include discharge to the former sewage treatment plant percolation ponds or reinjection to groundwater. Care must be taken that contaminated liquids sent to the existing treatment system do not contain contaminants that the system is not capable of removing or that will disrupt the operation of the system. On-installation treatment of contaminated solid would entail establishing centralized treatment units in compliance with applicable regulatory requirements.

4.4 OFF-INSTALLATION TREATMENT

Treatment of IDW (including soil, liquid wastes, PPE, and disposable equipment) may be required for hazardous waste that does not meet the requirements for land disposal facilities. Landfills may specify treatment to certain levels prior to acceptance of wastes. In some cases, off-installation treatment may be more cost-effective than off-installation land disposal or on-installation treatment.

4.5 DISPOSAL OF HAZARDOUS WASTES WITHIN THE AOC

In some cases, IDW may be left on site within the AOC even if waste is considered hazardous. The decision to implement this option depends on the waste characteristics, media type, and degree of threat posed by the waste to human health and the environment. If IDW consists of hazardous soils that pose no immediate threat to human health and the environment, it may be left on site within the delineated AOC unit if approved by the site RPMs. Generally, the return of soil cuttings and/or drilling mud to the location from which they were taken will comply with ARARs based on the implication that the site will be further evaluated and treated during subsequent activities at the site. If this option is selected, the following actions must be taken:

- Delineate the AOC using markers such as flagging or fencing.
- Determine locations close to the soil source, such as a boring or test pit, in the AOC for waste burial or spreading.
- Place the hazardous IDW soil in pits and cover the pits with surficial soil to prevent dispersion.

Following waste disposal at the site, the containers used to contain the soil will be decontaminated and reconditioned for further use. IDW should not be disposed within the AOC if the following conditions apply:

- IDW is hazardous water or other aqueous liquid.
- IDW is hazardous soil that may pose a substantial risk to human health and the environment if left on site.
- IDW is PPE or disposable equipment.

5.0 COMPLIANCE WITH ARARS

The NCP requires that handling of IDW meet all ARARs to the extent practicable considering the urgency of the situation. Applicable requirements are standards or criteria promulgated under federal or state law that specifically address a hazardous substance, pollutant containment, remedial action, location, or other circumstance at a project site (USEPA, 1988a). Relevant and appropriate requirements are standards or criteria promulgated under federal or state laws that are suited to a particular site because they address site scenarios sufficiently similar to those on which the regulations are based. Identification of ARARs first dictates the determination of whether a given requirement is applicable; then, if it is not applicable, a determination of whether it is both relevant and appropriate. This evaluation compares a number of site-specific factors with those addressed in the statutory or regulatory requirements. Factors considered include the hazardous substance present at the site, physical site features, or the type of remedial action.

A given requirement might be relevant, but not appropriate, for the project site; therefore, such a requirement would not be an ARAR for the site. When a requirement is deemed both relevant and appropriate in a given case, this requirement must be complied with to the same degree as if it were applicable.

To-be-considered (TBC) criteria are nonpromulgated advisories or guidance issued by federal or state government that are not legally binding and do not have the status of potential ARARs. In many circumstances, TBC criteria will be reviewed along with ARARs in determining an IDW level that is sufficiently protective of human health and the environment.

There are several different types of ARARs, including chemical-specific, action-specific, and location-specific ARARs. Chemical-specific ARARs are usually health- or risk-based numerical values or methodologies applied to site-specific conditions. These values establish the acceptance concentration of a chemical substance that may be found in or discharged to the ambient environment. Action-specific ARARs are technology- or activity-based requirements or limitations on actions taken with respect to hazardous substances. Location-specific ARARs are restrictions placed on the concentration of hazardous substances or the conduct of activities solely because they occur in special locations.

Environmental laws and regulations that are potential ARARs for IDW at CERCLA sites include RCRA, including LDRs, the Toxic Substances Control Act (TSCA), the Clean Water Act (CWA), the Safe Drinking Water Act (SDWA), and existing state ARARs.

5.1 RESOURCE CONSERVATION AND RECOVERY ACT

RCRA was passed by Congress in 1976 to meet three goals: (1) The protection of human health and the environment; (2) the reduction of waste and the conservation of energy and natural resources; and (3) the reduction or elimination of the generation of hazardous waste as expeditiously as possible. The Hazardous and Solid Waste Amendments (HSWA) of 1984 significantly expanded the scope of RCRA by adding new corrective action requirements, land disposal restrictions, and technical requirements (USEPA, 1988b).

RCRA is the most important federal ARAR for IDW generation and management, because it specifically regulates all aspects of transportation, treatment, storage, and disposal of hazardous wastes. The determination of whether a waste is or is not hazardous may be made on the basis of knowledge of the IDW and associated suspected or known contamination, rather than by direct testing (USEPA, 1991). RCRA has ten discrete sections (subtitles) that address specific waste management activities. Two of these subtitles and their implementing regulations may be ARARs for IDW handling: Subtitle C (Hazardous Waste Management) and Subtitle D (Solid Waste Management).

Under RCRA Subtitle C, wastes are defined as hazardous on the basis of their source or method of generation ("listed" wastes) or their chemical constituents or characteristics ("characteristic" wastes). For example, xylene is a listed waste, and based on the "contained-in-interpretation" (USEPA, 1986) soil or groundwater contaminated with this waste would also be considered hazardous. Characteristic hazardous wastes include those wastes that have (1) extremely high or low pH, (2) high reactivity, (3) ignitability, or (4) toxicity as measured by a leaching procedure such as TCLP, or other criteria, as listed in 40 CFR 261.

One of the most significant provisions of RCRA, with respect to the disposal of IDW, is the provision for LDRs, which are defined by RCRA Section 3004. LDRs limit the types of wastes that may be disposed to land (such as landfills and surface impoundments). An important consideration in evaluating the applicability or relevance and appropriateness of LDRs is whether land disposal of RCRA-hazardous IDW has occurred. The AOC can be used to determine whether or not LDRs are applicable; however, the AOC concept applies only to contaminated soil or sediments from the site. Contaminated PPE, disposable equipment, or decontamination fluid that may be generated by investigation activities at the site are not included in the LDR approach to AOCs. Based on the delineation of an AOC, LDRs do not occur when hazardous IDW is:

- Stored in a container within the AOC and then returned to its source
- Moved within the AOC unit, as defined for a specific site
- Capped in place
- Treated *"in situ"*
- Processed within the AOC to improve structural stability
- Left in place, moved, or stored within a single AOC unit

However, LDRs do occur when hazardous IDW is:

- Composed of wastes from different AOCs which have been consolidated into one AOC
- Moved outside of an AOC for treatment and storage and returned to the same or a different AOC
- Excavated from an AOC, removed to a separate unit such as a tank, surface impoundment, or incinerator that is within the AOC, and then redeposited into the AOC

LDRs prohibit the storage of hazardous waste beyond specified time limits, unless the purpose of storage is to accumulate sufficient quantities of waste to promote proper disposal, treatment, or recovery. However, storage of IDW until a final disposal option is selected in a record of decision (ROD) may be considered allowable storage under the LDR storage prohibition. Conditions under which such storage occurs should comply with substantive regulations pertaining to storage of hazardous waste in containers (such as the provision of secondary containment for drums containing liquid wastes). The USEPA does not require that administrative requirements such as permits of ARARs be met, as long as substantive issues are addressed (USEPA, 1988b).

All LDRs must be followed to the extent practicable if hazardous IDW cannot be held within the delineated AOC. For example, if leaving hazardous IDW within the AOC would significantly increase risks to human health and the environment through fire, explosion, or toxicity, or other hazard, the IDW should be disposed of at an off-installation RCRA Subtitle C TSDF.

Hazardous decontamination fluids, PPE, and disposable equipment will be containerized and ultimately disposed off installation, unless a properly permitted TSDF is available on the installation for such disposal. IDW storage practices are described in Section 2.3, IDW management options are discussed in Section 3.0, and disposal options are discussed in Section 4.0. Once hazardous wastes are taken outside the AOC, such wastes are subject to both the substantive and administrative requirements of RCRA.

Nonhazardous PPE or disposable equipment will be disposed of in facilities such as municipal landfills (RCRA Subtitle D). Nonhazardous IDW, such as soil cuttings, drilling mud, or sediment will be disposed of within the AOC if all other ARARs are met.

5.2 TOXIC SUBSTANCES CONTROL ACT

The TSCA was passed by Congress in 1976. This act establishes new requirements and authorities for identifying and controlling toxic chemical hazards to human health and the environment. Regulations associated with this act affect the handling and disposal of wastes containing polychlorinated biphenyls (PCBs) and asbestos. The potential impacts of these regulations on IDWs are noted below:

- Nonhazardous IDW containing PCBs or asbestos at concentrations greater than specified limits must be disposed of at facilities regulated under the TSCA (see 40 CFR 761.60). Options include incineration or disposal at TSCA chemical waste facilities.
- PCB-contaminated material such as IDW, with concentrations less than 50 parts per million (ppm), is not generally regulated under TSCA and may be disposed of in acceptable Subtitle D landfills. However, the PCB action level for the State of California is 5 ppm.

5.3 CLEAN WATER ACT

The CWA of 1977 addresses site-specific pollutant discharge limitations and performance standards for specific industries to protect surface water quality. The CWA also regulates criteria for selecting POTWs and sets Ambient Water Quality Criteria (AWQC). During field investigations, the most likely situation where the CWA will be applicable involves the indirect discharge of IDW water, regulated under CWA, to a POTW for treatment and disposal (USEPA, 1991). Prior to discharge of IDW waters to POTWs, the contractor will ensure that POTW/CWA standards are met.

5.4 STATE REQUIREMENTS

Other states have specific regulations for waste management. These regulations for waste management. These regulations will be addressed in site specific SAPs.

California regulations are provided here as an example. California Hazardous Waste Regulations - Title 26 (Toxics) of the CCR may contain ARARs for IDW management decisions. Title 26 regulations promulgate TTLCs and STLCs as potential ARARs for the handling and disposal of IDW. Hazardous wastes (characteristic or listed) defined in Title 26 would be treated in the same manner as RCRA hazardous wastes.

The State Water Resources Control Board regulates and promulgates applicable water quality objectives that are potential ARARs for IDW soil and water handling. ARAR waivers may be available for state requirements specifically aimed at CERCLA sites or for state ARARs that are inconsistently applied (CERCLA section 121[d][4][E] and 40 CFR 300.430[f][1][ii][C][5]). Nonhazardous IDW which contain trace levels of contaminants will not be disposed of on site in a manner which may impact groundwater quality. Disposal of California restricted, nonhazardous wastes will be performed in accordance with Title 26.

6.0 REFERENCES

U.S. Environmental Protection Agency (USEPA), 1984. Waste Analysis Plans. Prepared by the Office of Solid Waste, October 1984.

USEPA, 1986. Test Methods for Evaluating Solid Waste, Third Edition SW-846. Prepared by the Office of Solid Waste and Emergency Response, November 1986.

USEPA, 1988a. Guidance for Conducting Remedial Investigations and Feasibility Studies Under CERCLA, Interim Final. Prepared by the Office of Emergency and Remedial Response, October 1988.

USEPA, 1988b. CERCLA Compliance with Other Laws Manual, Draft Guidance. Prepared by the Office of Emergency and Remedial Response, August 1988.

USEPA, 1990. CERCLA Compliance with the RCRA Toxicity Characteristics (TC) Rule: Part II. Prepared by the Office of Solid Waste and Emergency Response, October 1990.

USEPA, 1991. Management of Investigation-Derived Wastes During Site Inspections. Prepared by the Office of Emergency and Remedial Response, Publication 9345.3-02FS, May 1991.

APPENDIX C

SS001 ROD AMENDMENT
CONCEPTUAL SITE MODEL

Appendix A - Human Health Conceptual Site Model
Scoping Form and Standardized Graphic

Site Name: SS001 (Area C) Drum Storage Yard and PCB Trail, North River RRS

File Number: 630.38.001

Completed by: Jacobs Engineering

Introduction

The form should be used to reach agreement with the Alaska Department of Environmental Conservation (DEC) about which exposure pathways should be further investigated during site characterization. From this information, summary text about the CSM and a graphic depicting exposure pathways should be submitted with the site characterization work plan and updated as needed in later reports.

General Instructions: Follow the italicized instructions in each section below.

1. General Information:

Sources *(check potential sources at the site)*

- ☐ USTs
- ☐ ASTs
- ☐ Dispensers/fuel loading racks
- ☒ Drums
- ☒ Vehicles
- ☐ Landfills
- ☒ Transformers
- ☐ Other:

Release Mechanisms *(check potential release mechanisms at the site)*

- ☒ Spills
- ☒ Leaks
- ☒ Direct discharge
- ☐ Burning
- ☐ Other:

Impacted Media *(check potentially-impacted media at the site)*

- ☐ Surface soil (0-2 feet bgs*)
- ☒ Subsurface soil (>2 feet bgs)
- ☒ Air
- ☐ Sediment
- ☒ Groundwater
- ☐ Surface water
- ☒ Biota
- ☐ Other:

Receptors *(check receptors that could be affected by contamination at the site)*

- ☒ Residents (adult or child)
- ☒ Commercial or industrial worker
- ☒ Construction worker
- ☒ Subsistence harvester (i.e. gathers wild foods)
- ☒ Subsistence consumer (i.e. eats wild foods)
- ☒ Site visitor
- ☒ Trespasser
- ☒ Recreational user
- ☐ Farmer
- ☐ Other:

* bgs - below ground surface

2. **Exposure Pathways:** *(The answers to the following questions will identify complete exposure pathways at the site. Check each box where the answer to the question is "yes".)*

a) Direct Contact -

1. Incidental Soil Ingestion

Are contaminants present or potentially present in surface soil between 0 and 15 feet below the ground surface? (Contamination at deeper depths may require evaluation on a site-specific basis.) ☒

If the box is checked, label this pathway complete: Complete

Comments:

PCBs are present from 10-13 feet below the original ground surface and 1,2,4-trichlorobenzene (TCB) is present at 7-8 feet below the original ground surface. The contaminants have been capped with 10-13 feet of fill material.

2. Dermal Absorption of Contaminants from Soil

Are contaminants present or potentially present in surface soil between 0 and 15 feet below the ground surface? (Contamination at deeper depths may require evaluation on a site specific basis.) ☒

Can the soil contaminants permeate the skin (see Appendix B in the guidance document)? ☒

If both boxes are checked, label this pathway complete: Complete

Comments:

PCBs are present from 10-13 feet below the original ground surface. The contaminants have been capped with 10-13 feet of fill material.

b) Ingestion -

1. Ingestion of Groundwater

Have contaminants been detected or are they expected to be detected in the groundwater, or are contaminants expected to migrate to groundwater in the future? ☒

Could the potentially affected groundwater be used as a current or future drinking water source? Please note, only leave the box unchecked if DEC has determined the ground-water is not a currently or reasonably expected future source of drinking water according to 18 AAC 75.350. ☒

If both boxes are checked, label this pathway complete: Complete

Comments:

Groundwater is present at SS001 (Area C) and was sampled in 2015 and 2016. Samples analyzed for PCBs and 1,2,4-TCB had results that were either nondetect or less than 1/10 the ADEC cleanup levels. This pathway is considered insignificant.

2. Ingestion of Surface Water

Have contaminants been detected or are they expected to be detected in surface water, or are contaminants expected to migrate to surface water in the future? ☐

Could potentially affected surface water bodies be used, currently or in the future, as a drinking water source? Consider both public water systems and private use (i.e., during residential, recreational or subsistence activities). ☐

If both boxes are checked, label this pathway complete: Incomplete

Comments:

3. Ingestion of Wild and Farmed Foods

Is the site in an area that is used or reasonably could be used for hunting, fishing, or harvesting of wild or farmed foods? ☒

Do the site contaminants have the potential to bioaccumulate (see Appendix C in the guidance document)? ☒

Are site contaminants located where they would have the potential to be taken up into biota? (i.e. soil within the root zone for plants or burrowing depth for animals, in groundwater that could be connected to surface water, etc.) ☒

If all of the boxes are checked, label this pathway complete: Complete

Comments:

Vegetation samples (root, leaf, and berry) were collected in 2014 and analyzed for PCBs. 79% (88 out of 111 samples from Sites SS001 and SS003) of all plant samples were nondetect for PCBs. All PCB concentrations were below the soil cleanup level of 1 mg/kg. The highest PCB result was 0.44 mg/kg.

c) Inhalation-

1. Inhalation of Outdoor Air

Are contaminants present or potentially present in surface soil between 0 and 15 feet below the ground surface? (Contamination at deeper depths may require evaluation on a site specific basis.) ☒

Are the contaminants in soil volatile (see Appendix D in the guidance document)? ☒

If both boxes are checked, label this pathway complete: Complete

Comments:

PCBs are present in soil at 10-13 feet below the original ground surface and 1,2,4-TCB is present in the soil at 7-8 feet below the original ground surface. The contaminants have been capped with 10-13 feet of fill material.

2. Inhalation of Indoor Air

Are occupied buildings on the site or reasonably expected to be occupied or placed on the site in an area that could be affected by contaminant vapors? (within 30 horizontal or vertical feet of petroleum contaminated soil or groundwater; within 100 feet of non-petroleum contaminted soil or groundwater; or subject to "preferential pathways," which promote easy airflow like utility conduits or rock fractures) ☐

Are volatile compounds present in soil or groundwater (see Appendix D in the guidance document)? ☒

If both boxes are checked, label this pathway complete: Incomplete

Comments:

3. **Additional Exposure Pathways:** *(Although there are no definitive questions provided in this section, these exposure pathways should also be considered at each site. Use the guidelines provided below to determine if further evaluation of each pathway is warranted.)*

Dermal Exposure to Contaminants in Groundwater and Surface Water

Dermal exposure to contaminants in groundwater and surface water may be a complete pathway if:

- o Climate permits recreational use of waters for swimming.
- o Climate permits exposure to groundwater during activities, such as construction.
- o Groundwater or surface water is used for household purposes, such as bathing or cleaning.

Generally, DEC groundwater cleanup levels in 18 AAC 75, Table C, are deemed protective of this pathway because dermal absorption is incorporated into the groundwater exposure equation for residential uses.

Check the box if further evaluation of this pathway is needed: ☐

Comments:

Inhalation of Volatile Compounds in Tap Water

Inhalation of volatile compounds in tap water may be a complete pathway if:

- o The contaminated water is used for indoor household purposes such as showering, laundering, and dish washing.
- o The contaminants of concern are volatile (common volatile contaminants are listed in Appendix D in the guidance document.)

DEC groundwater cleanup levels in 18 AAC 75, Table C are protective of this pathway because the inhalation of vapors during normal household activities is incorporated into the groundwater exposure equation.

Check the box if further evaluation of this pathway is needed: ☐

Comments:

Inhalation of Fugitive Dust

Inhalation of fugitive dust may be a complete pathway if:

- Nonvolatile compounds are found in the top 2 centimeters of soil. The top 2 centimeters of soil are likely to be dispersed in the wind as dust particles.
- Dust particles are less than 10 micrometers (Particulate Matter - PM_{10}). Particles of this size are called respirable particles and can reach the pulmonary parts of the lungs when inhaled.

DEC human health soil cleanup levels in Table B1 of 18 AAC 75 are protective of this pathway because the inhalation of particulates is incorporated into the soil exposure equation.

Check the box if further evaluation of this pathway is needed: ☐

Comments:

Direct Contact with Sediment

This pathway involves people's hands being exposed to sediment, such as during some recreational, subsistence, or industrial activity. People then incidentally ingest sediment from normal hand-to-mouth activities. In addition, dermal absorption of contaminants may be of concern if the the contaminants are able to permeate the skin (see Appendix B in the guidance document). This type of exposure should be investigated if:

- Climate permits recreational activities around sediment.
- The community has identified subsistence or recreational activities that would result in exposure to the sediment, such as clam digging.

Generally, DEC direct contact soil cleanup levels in 18 AAC 75, Table B1, are assumed to be protective of direct contact with sediment.

Check the box if further evaluation of this pathway is needed: ☐

Comments:

4. Other Comments *(Provide other comments as necessary to support the information provided in this form.)*

HUMAN HEALTH CONCEPTUAL SITE MODEL GRAPHIC FORM

Site: SS001 (Area C) Drum Storage Yard and PCB Trail
North River RRS

Completed By: Jacobs Engineering
Date Completed: 24 May 2018

***Instructions**: Follow the numbered directions below. Do not consider contaminant concentrations or engineering/land use controls when describing pathways.*

(1) *Check the media that could be directly affected by the release.*

(2) *For each medium identified in (1), follow the top arrow and check possible transport mechanisms. Check additional media under (1) if the media acts as a secondary source.*

(3) *Check all exposure media identified in (2).*

(4) *Check all pathways that could be complete. The pathways identified in this column must agree with Sections 2 and 3 of the Human Health CSM Scoping Form.*

(5) *Identify the receptors potentially affected by each exposure pathway: Enter "C" for current receptors, "F" for future receptors, "C/F" for both current and future receptors, or "I" for insignificant exposure.*

Media / Transport Mechanisms

Media	Transport Mechanisms
☐ Surface Soil (0-2 ft bgs)	Direct release to surface soil — check soil
	☐ Migration to subsurface — check soil
	☐ Migration to groundwater — check groundwater
	☐ Volatilization — check air
	☐ Runoff or erosion — check surface water
	☐ Uptake by plants or animals — check biota
	☐ Other (list):
☑ Subsurface Soil (2-15 ft bgs)	Direct release to subsurface soil — check soil
	☑ Migration to groundwater — check groundwater
	☑ Volatilization — check air
	☑ Uptake by plants or animals — check biota
	☐ Other (list):
☐ Ground-water	Direct release to groundwater — check groundwater
	☐ Volatilization — check air
	☐ Flow to surface water body — check surface water
	☐ Flow to sediment — check sediment
	☐ Uptake by plants or animals — check biota
	☐ Other (list):
☐ Surface Water	Direct release to surface water — check surface water
	☐ Volatilization — check air
	☐ Sedimentation — check sediment
	☐ Uptake by plants or animals — check biota
	☐ Other (list):
☐ Sediment	Direct release to sediment — check sediment
	☐ Resuspension, runoff, or erosion — check surface water
	☐ Uptake by plants or animals — check biota
	☐ Other (list):

Exposure Media / Exposure Pathway/Route / Current & Future Receptors

Exposure Media	Exposure Pathway/Route	Residents (adults or children)	Commercial or industrial workers	Site visitors, trespassers, or recreational users	Construction workers	Farmers or subsistence harvesters	Subsistence consumers	Other
☑ soil	☑ Incidental Soil Ingestion	F	F	C/F	F	C/F	C/F	
	☑ Dermal Absorption of Contaminants from Soil	F	F	C/F	F	C/F	C/F	
	☐ Inhalation of Fugitive Dust							
☑ groundwater	☑ Ingestion of Groundwater	I	I	I	I	I	I	
	☐ Dermal Absorption of Contaminants in Groundwater							
	☐ Inhalation of Volatile Compounds in Tap Water							
☑ air	☑ Inhalation of Outdoor Air	F	F	C/F	F	C/F	C/F	
	☐ Inhalation of Indoor Air							
	☐ Inhalation of Fugitive Dust							
☐ surface water	☐ Ingestion of Surface Water							
	☐ Dermal Absorption of Contaminants in Surface Water							
	☐ Inhalation of Volatile Compounds in Tap Water							
☐ sediment	☐ Direct Contact with Sediment							
☑ biota	☑ Ingestion of Wild or Farmed Foods	I	I	I	I	I	I	

Appendix B: Ecoscoping Form

Site Name: SS001 (Area C) Drum Storage Yard and PCB Trail, North River RRS
Completed by: Jacobs Engineering
Date: 12/20/2017

Instructions: Follow the italicized instructions in each section below. "Off-ramps," where the evaluation ends before completing all of the sections, can be taken when indicated by the instructions. Comment boxes should be used to help support your answers.

1. Direct Visual Impacts and Acute Toxicity

Are direct impacts that may result from the site contaminants evident, or is acute toxicity from high contaminant concentrations suspected? C*heck the appropriate box.*

☐ Yes – D*escribe observations below and evaluate all of the remaining sections without taking any off-ramps.*

☒ No – *Go to next section.*

Comments:

2. Terrestrial and Aquatic Exposure Routes

Check each terrestrial and aquatic route that could occur at the site.

Terrestrial Exposure Routes

☐ Exposure to water-borne contaminants as a result of wading or swimming in contaminated waters or ingesting contaminated water.

☐ Contaminant uptake in terrestrial plants whose roots are in contact with contaminated surface water.

☐ Contaminant migration via saturated or unsaturated groundwater zones and discharge at upland "seep" locations (not associated with a wetland or waterbody).

☐ Contaminant uptake by terrestrial plants whose roots are in contact with soil moisture or groundwater present within the root zone (generally no more than 4 feet below ground surface.

☐ Particulates deposited on plants directly or from rain splash.

☐ Incidental ingestion and/or exposure while animals grub for food, burrow (up to 2 feet for small animals or 6 feet for large animals), or groom.

☐ Inhalation of fugitive dust or vapors disturbed by foraging or burrowing activities.

☐ Bioaccumulatives (other than PAHs, which bioaccumulate more readily in aquatic environments) taken up by soil invertebrates, which are in turn eaten by higher food chain organisms (see the *Policy Guidance on Developing Conceptual Site Models*).

Other site-specific exposure pathways.

<u>Aquatic Exposure Routes</u>

☐ Contaminated surface runoff migration to water bodies through swales, drainage ditches, or overland flow.

☐ Aquatic receptors exposed through osmotic exchange, respiration, or ventilation of surface waters.

☐ Contaminant migration via saturated or unsaturated groundwater zones and discharge at “seep” locations along banks or directly to surface water.

☐ Deposition into sediments from upwelling of contaminated groundwater.

☐ Aquatic receptors may be exposed directly to contaminated sediments through foraging or burrowing, or indirectly exposed due to osmotic exchange, respiration, or ventilation of sediment pore water.

☐ Aquatic plants rooted in contaminated sediments.

☐ Bioaccumulatives (see the *Policy Guidance on Developing Conceptual Site Models*) taken up by sediment invertebrates, which are in turn eaten by higher food chain organisms.

☐ Other site-specific exposure pathways.

If any of the above boxes are checked, go on to the next section. If none are checked, end the evaluation and check the box below.

☒ OFF-RAMP: NO FURTHER ECOLOGICAL EVALUATION NECESSARY

Comments:

Although PCBs are bioaccumulatives, they are present in subsurface soil/fractured bedrock at 10-13 feet below the original ground surface. The contaminants have been capped with 10-13 feet of fill material. Vegetation samples (root, leaf, and berry) were collected in 2014 and analyzed for PCBs. 79% (88 out of 111 samples from Sites SS001 and SS003) of all plant samples were nondetect for PCBs. All PCB concentrations were below the soil cleanup level of 1 mg/kg. The highest PCB result was 0.44 mg/kg.

3. Habitat

Check all that may apply. See Ecoscoping Guidance for additional help.

☐ Habitat that could be affected by the contamination supports valued species (i.e., species that are regulated, used for subsistence, have ceremonial importance, have commercial value, or provide recreational opportunity).

☐ Critical habitat or anadromous stream in an area that could be affected by the contamination.

☐ Habitat that is important to the region that could be affected by the contamination.

☐ Contamination is in a park, preserve, or wildlife refuge.

If any of the above boxes are checked, go on to the next scoping factor. If none are checked, end the evaluation and check the box below.

☐ OFF-RAMP: NO FURTHER ECOLOGICAL EVALUATION NECESSARY

Comments:

4. Contaminant Quantity

Check all that may apply. See Ecoscoping Guidance for additional help.

☐ Endangered or threatened species are present.

☐ The aquatic environment is or could be affected.

☐ Non-petroleum contaminants may be present, or the total area of petroleum contaminated surface soil exceeds one-half acre.

If any of the above boxes are checked, go on to the next scoping factor. If none are checked, end the evaluation and check the box below.

☐ OFF-RAMP: NO FURTHER ECOLOGICAL EVALUATION NECESSARY

Comments:

5. Toxicity Determination

Check all that apply.

☐ Bioaccumulative chemicals are present (see *Policy Guidance on Developing Conceptual Site Models*).

☐ Contaminants exceed benchmark levels (see the Ecological Benchmark Tool in RAIS, available at: http://rais.ornl.gov/tools/eco_search.php).

If either box is checked, complete a detailed Ecological Conceptual Site Model (see DEC's Policy Guidance on Developing Conceptual Site Models*) and submit it with the form to your DEC project manager.*

If neither box is checked, check the box below and submit this form to your DEC project manager.

☐ OFF-RAMP: NO FURTHER ECOLOGICAL EVALUATION NECESSARY

Comments:

Source: This form was excerpted from the State of Alaska Department of Environmental Conservation division of Spill Prevention and Response Contaminated Sites Program *Ecoscoping Guidance A Tool of Developing an Ecological Conceptual Site Model* March 2014.

ATTACHMENT 1

UNIFORM FEDERAL POLICY - QUALITY ASSURANCE PROJECT PLAN

FINAL

Uniform Federal Policy Quality Assurance Project Plan (UFP-QAPP) for the Groundwater Investigation: Site SS001 Work Plan North River Radio Relay Station, Alaska

Prepared for:

Air Force Civil Engineer Center

Prepared by:

Oneida Total Integrated Enterprises

Stantec

Contract No. FA8903-17-D-0059

Task Order FA8903-22-F-0086

July 2023

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Introduction

This Quality Assurance Project Plan (QAPP) has been prepared by Oneida Total Integrated Enterprises (OTIE) and Stantec Consulting Services Inc. (Stantec) [OTIE/Stantec Team] for the Air Force Civil Engineer Center (AFCEC) for the North River Radio Relay Station (RRS) Groundwater Investigation.

This QAPP was prepared based on the Uniform Federal Policy (UFP) for QAPPs, Final, Version 1 March 2005, and the Integrated Data Quality Task Force UFP-QAPP Optimized Worksheets, March 2012.

The work to be performed consists of a groundwater investigation at source area SS001 to satisfy Five-Year Review requirements and characterize environmental conditions. The investigation will include:

- Installing five groundwater monitoring wells, including subsurface soil sampling.
- Collection of groundwater samples from the newly installed monitoring wells and three existing wells.
- Preparation of a Groundwater Characterization Report to document field and laboratory data and characterize environmental conditions at SS001.

The work will be conducted under U.S. Air Force (USAF) Contract No. FA8903-17-D-0059, Task Order (TO) FA8903-22-F0086. The contracted laboratory, SGS North America, Inc. (SGS), Anchorage, Alaska, will meet the requirements of the U.S. Department of Defense (DoD) *Quality Systems Manual for Environmental Laboratories*, Version 5.4, dated October 2021.

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QAPP Worksheet #1 & 2: Title and Approval Page

(UFP-QAPP Section 2.1)
(EPA 2106-G-05 Section 2.2.1)

1. **Project Identifying Information**
   a. Site Name/Project Name:

      Provide Long Term Management at Point Lay Long Range Radar Site, Alaska and North River Radio Relay Station, Alaska.

   b. Site Location:

      North River Radio Relay Station, Alaska

   c. Contract No:

   d. FA8903-17-D-0059; Task Order FA8903-22-F0086

2. **Lead Organization:** Stantec

   a. Investigative Organization's Project Manager

Sean Bayer OTIE	[signature] Signature	7/12/2023 Date

   b. Investigative Organization's Program Chemist

Douglas Quist Stantec	[signature] Signature	13 Jul 2023 Date

   c. Investigative Organization's Project QA Manager

Neil Robertson Stantec	[signature] Signature	13 Jul 2023 Date

   d. Lead Organization's AFCEC Project Manager

Robert Johnston AFCEC	Robert Johnston Signature	13 Jul 2023 Date

3. **Federal Regulatory Agency:** (not applicable)

4. **State Regulatory Agency:**

Axl LeVan Restoration Manager, Alaska Department of Environmental Conservation, Division of Spill Prevention and Response, Contaminated Sites Program	Signature	Date

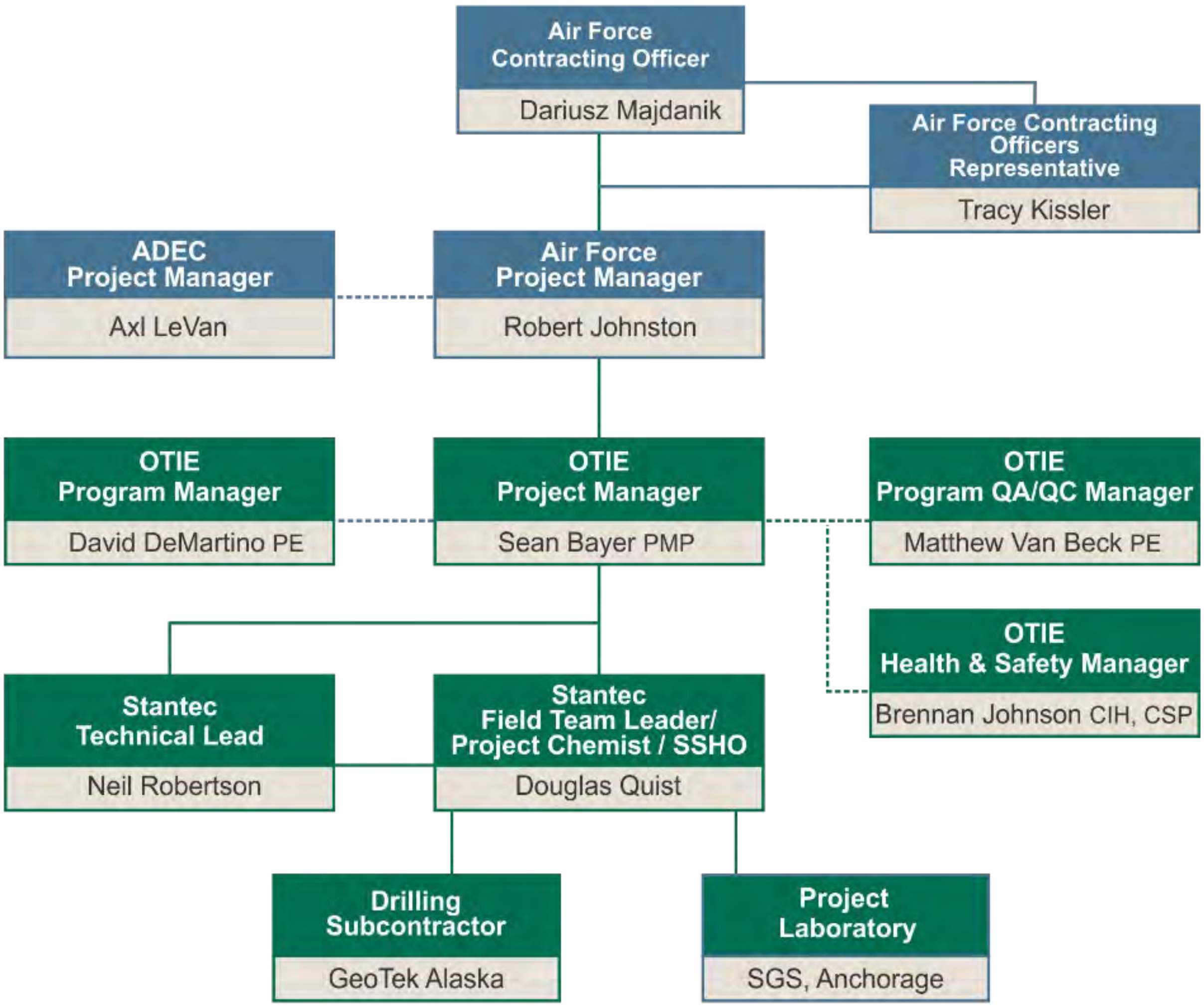
5. **Other Stakeholders:** (not applicable)

6. **List of Plans and Reports from previous investigations relevant to this project:**

    a. North River Radio Relay Station, Record of Decision Amendment, Unalakleet, Alaska, Final. 2019. U.S. Air Force (USAF), 2019.
    b. First CERCLA [Comprehensive Environmental Response, Compensation, and Liability Act] Five-Year Review for Site SS001 and Second CERCLA Five-Year Review for Site SS003 at the North River Radio Relay Station, Unalakleet, Alaska, Final, December. USAF, 2021.
    c. Final Record of Decision North River Radio Relay Station, Alaska, September. USAF 2010.
    d. Air Force Installation Contracting Agency (AFICA). Performance Work Statement for Environmental Services and Construction (ESC) to Provide Long Term Management at Point Lay Long Range Radar Site, Alaska and North River Radio Relay Station, Alaska. Project Numbers: TKUH20227500, SACW20227327. 28 March 2022.

QAPP Worksheet #3 & #5: Project Organization and QAPP Distribution List

(UFP-QAPP Manual Section 2.3.1 and 2.4)
(EPA 2106-G-05 Section 2.2.3 and 2.2.4)



Key:
ADEC – Alaska Department of Environmental Conservation
CIH – Certified Industrial Hygienist
CSP – Certified Safety Professional
PE – Pofessional Engineer
PMP – Project Management Professional
OTIE – Oneida Total Integrated Enterprises
QA/QC – Quality Assurance / Quality Control
SGS – SGS North America
SSHO – Site Safety Health Officer
Stantec – Stantec Consulting Services, Inc.

QAPP Worksheet #3 & #5: Project Organization and QAPP Distribution List
(UFP-QAPP Manual Section 2.3 and 2.4)
(EPA 2106-G-05 Section 2.2.3 and 2.2.4)

QAPP Recipients	Title	Organization	Telephone Number	E-mail Address	Document Control Number
Axl LeVan	Agency Project Manager	ADEC	(907) 451-2156	Axl.levan@alaska.gov	01
Robert Johnston	AFCEC Project Manager	AFCEC	(907) 552-7193	robert.johnston.17@us.af.mil	02
Tracy Kissler	Contracting Officer's Representative	AFCEC	(907) 552-9762	tracy.kissler@us.af.mil	03
Dariusz Majdanik	Contracting Officer	AFCEC	(210) 395-9687	dariusz.majdanik@us.af.mil	04
Sean Bayer	OTIE Project Manager	OTIE	(402) 250-6318	sbayer@oescgroup.com	05
Neil Robertson	Stantec Project Manager / QAO Project Technical Lead	Stantec	(907) 266-1116	neil.robertson@stantec.com	06
Douglas Quist	Stantec Field Team Leader / Project Chemist	Stantec	(907) 266-1148	douglas.quist@stantec.com	07
William Wesley	SGS Laboratory Director	SGS	(907) 562-2343	william.wesley@sgs.com	08
Mary McDonald	SGS Laboratory QAO	SGS	(907) 550-3203	mary.mcdonald@sgs.com	09

KEY:

ADEC Alaska Department of Environmental Conservation
QAO Quality Assurance Officer

QAPP Worksheet #4, 7 & 8: Personnel Qualifications Sign-off Sheet

(UFP-QAPP Manual Sections 2.3.2 – 2.3.4)
(EPA 2106-G-05 Section 2.2.1 and 2.2.7)

Organization: AFCEC

Name	Project Title/Role	Education/ Experience	Specialized Training/Certifications	Signature/Date
Robert Johnston	AFCEC Project Manager	N/A	N/A	
Tracy Kissler	AFCEC Contracting Officer's Representative	N/A	N/A	
Dariusz Majdanik	AFCEC Contracting Officer	N/A	N/A	

Key:
N/A Not Applicable

Organization: OTIE/Stantec Team

Name	Project Title/Role	Education/ Experience	Specialized Training/Certifications	Signature/Date
Sean Bayer	OTIE Project Manager	B.S. Civil Engineering 25 years experience	HAZWOPER, HAZWOPER Supervisor, PMP	
Neil Robertson	Stantec Project Manager / QAO / Project Technical Lead	B.S. Chemical Engineering M.S. Environmental Engineering 31 years experience	N/A	
Douglas Quist	Field Team Leader	B.S. in Chemistry (Biochemistry) 28 years experience	HAZWOPER, HAZWOPER Supervisor, ADEC Qualified Environmental Professional, ADEC Qualified Site Sampler, USACE approved CQCSM	

KEY:

B.S. Bachelor of Science
CQCSM Contractor Quality Control Systems Manager
EPA U.S. Environmental Protection Agency
HAZWOPER Hazardous Waste Operations and Emergency Response
M.S. Master of Science
N/A Not Applicable
USACE U.S. Army Corps of Engineers

QAPP Worksheet #4, 7 & 8: Personnel Qualifications Sign-off Sheet
(UFP-QAPP Manual Sections 2.3.2 – 2.3.4)
(EPA 2106-G-05 Section 2.2.1 and 2.2.7)

Organization: SGS North America (Laboratory Subcontractor)

Name	Project Title/Role	Education/Experience	Specialized Training/Certifications	Signature/Date
William Wesley	Laboratory Director	B.S. Natural Science 23 years experience	N/A	
Mary McDonald	Laboratory QAO	B.S. Chemistry 24 years experience	N/A	

QAPP Worksheet #6: Communication Pathways

(UFP-QAPP Manual Section 2.4.2)
(EPA 2106-G-05 Section 2.2.4)

Communication Driver	Organization	Name	Contact Information	Procedure (timing, pathway, documentation)
Customer Point of Contact for Project	AFCEC Project Manager	Robert Johnston	(907) 552-7193	As end user of data, AFCEC Project Manager will be copied on all technical communication. Communication requiring ADEC notification will be submitted to Robert Johnston, who will directly contact ADEC.
Maintain performance standards for execution of the work	OTIE Project Manager	Sean Bayer	(402) 250-6318	All project related communications are immediately directed to the OTIE Project Manager who will transmit communications the AFCEC Project Manager.
Manage North River RRS Groundwater Investigation	Stantec Project Manager / QAO / Project Technical Lead	Neil Robertson	(907) 266-1116	All project related communications are immediately directed to the Stantec Project Manager who will forward communications to the OTIE Project Manager.
On-Site Field Work and Daily Reporting	Stantec Field Team Leader	Douglas Quist	(907) 266-1148	Oversees all site activities, ensures all reporting is completed daily for reporting back to AFCEC and Stantec Project Manager.
Sampling Field Work and Daily Field Reports	Stantec Field Team Leader / Project Chemist	Douglas Quist	(907) 266-1148	Field concerns and communications are directed to the Stantec Field Team Leader, who will communicate directly with the Stantec Project Manager.
QAPP Changes prior to Field Work	Project Chemist and Stantec Field Team Leader	Douglas Quist	(907) 266-1148	Project Chemist will consult with AFCEC and ADEC on any changes to the QAPP prior to field work.
QAPP Changes in the Field and QAPP Amendments	QAPP Changes prior to Field Work	Douglas Quist	(907) 266-1148	Project Chemist will amend the QAPP and submit to AFCEC and Stantec Project Manager for Client approval before the changes are implemented. USAF will distribute revised QAPP to the ADEC Project Manager for review and approval.
Laboratory Data Quality Issues	SGS Laboratory QAO	Mary McDonald	(907) 550-3203	All QA/QC issues with project field samples will be reported by the Laboratory QAO to the Project Chemist. Project Chemist will communicate with the Stantec Project Manager regarding any lab issues.
Field Corrective Actions	Stantec Field Team Leader	Douglas Quist	(907) 266-1148	The need for corrective action for field issues will be determined by the Field Team Leader in consultation with the Project Manager, and AFCEC Project Manager.

Communication Driver	Organization	Name	Contact Information	Procedure (timing, pathway, documentation)
Release of Analytical Data	Project Chemist	Douglas Quist	(907) 266-1148	No final analytical data can be released until validation is completed and the Project Chemist has approved the release with review and approval from the data validator and reviewer.

QAPP Worksheet #9: Project Planning Session Summary

(UFP-QAPP Manual Section 2.5.1 and Figures 9-12)
(EPA 2106-G-05 Section 2.2.5)

Project Scoping Session Participants Sheet

Project Name: Provide LTM at Point Lay LRRS and North River RRS, Alaska. **Projected Date(s) of Sampling:** July 2023 **Project Manager:** Sean Bayer			**Site Name:** North River RRS **Site Location:** North River, Unalakleet, Alaska	
Date of Planning Session: June 7, 2022 **Location:** Teleconference **Purpose:** Project Kickoff Meeting				
Name	**Organization**	**Title/ Role**	**E-mail Address**	**Phone #**
Dariusz Majdanik	AFCEC	Contracting Officer	dariusz.majdanik@us.af.mil	(210) 395-9687
Keith VanShaick	AFCEC	Contract Administrator	keith.vanschaick.2@us.af.mil	TBD
Tracy Kissler	AFCEC	Contracting Officer's Representative	tracy.kissler@us.af.mil	(907) 552-9762
Sean Bayer	OTIE/Stantec Team	Project Manager	sbayer@oescgroup.com	(402) 250-6318
Rick Cavada	OTIE/Stantec Team	Business Unit Leader	rcavada@oescgroup.com	(210) 202-8568
Tom Welch	OTIE/Stantec Team	Regional Senior Principal	tom.welch@cardno-gs.com	(757) 604-2540
Neil Robertson	OTIE/Stantec Team	Technical Lead/ QAO Manager	neil.robertson@stantec.com	(907) 266-1161
Douglas Quist	OTIE/Stantec Team	Field Team Lead, Project Chemist	douglas.quist@stantec.com	(907) 266-1148

1. Introductions

- All present at the meeting introduced themselves.

2. Contracting Slides

- Dariusz, Keith, and Tracy ran through the contracting slides (Attachment 1). These were agreed with no questions. Robert Johnston is the AFCEC Point of Contact (POC).
  - o CPMSR Submittals will be transmitted by the 15th of the month for work completed the previous month with the first submittal within 30 calendar days of award of the task order.
  - o AFCEC requested Robert Johnston (Base POC) be included on the monthly CPSMR transmittals.
  - o AFCEC clarified if a PoP extension is required, OTIE must notify the CO, CA, and COR in writing at least 60 days prior to the PoP end date (including an additional 10 days for Task Order expiration).
  - o All correspondence including invoicing will include the contract number and task order number within the email subject line.

3. Scope of Project

- SB and NR gave a quick overview of the OTIE/Stantec Kickoff Slides (Attachment 2) meeting and pointed out key dates on the draft schedule (Attachment 2).

- All email correspondence will include the following in the email subject line: PACAF LTM FA8903-17-D-0059/TO#FA8903-22-F-0086: Email Subject

Project Name: Provide LTM at Point Lay LRRS and North River RRS, Alaska. **Projected Date(s) of Sampling:** July 2023 **Project Manager:** Sean Bayer	**Site Name:** North River RRS **Site Location:** North River, Unalakleet, Alaska

Date of Planning Session: May 9, 2023 **Location:** Teleconference
Purpose: North River UFP-QAPP Discussion

Name	Organization	Title/ Role	E-mail Address	Phone #
Robert Johnston	AFCEC	AFCEC Project Manager	robert.johnston.17@us.af.mil	(907) 552-7193
Sean Bayer	OTIE/Stantec Team	Project Manager	sbayer@oescgroup.com	(402) 250-6318
Neil Robertson	OTIE/Stantec Team	Technical Lead/ QAO Manager	neil.robertson@stantec.com	(907) 266-1161
Douglas Quist	OTIE/Stantec Team	Field Team Lead, Project Chemist	douglas.quist@stantec.com	(907) 266-1148
Axl LeVan	ADEC	ADEC Project Manager	axl.levan@alaska.gov	(907) 451-2156
Dennis Sheppard	ADEC	ADEC Program Manager	dennis.sheppard@alaska.gov	(907) 465-5250

Meeting Summary

- Discussion took place on the optimal location for the five proposed new monitoring wells. One new well will be a replacement for C-MW15. The agreed upon new well locations are documented on Figure 4-1 of the Work Plan. New wells should not be placed within the previously excavated areas. The western most new well may need to be a flushmount depending on the distance to the road.
- Sampling will be completed at the replacement well for C-MW15, the four new wells and the three existing wells for VOCs.
- Mr. Quist stated the planned field schedule is expected to be at the end of July or early August.
- Mr. LeVan stated that if any of the proposed well locations sites had to be moved in the field then an email should be sent with the proposed new location and the reason for moving.
- Mr. LeVan asked if an ESD will be done. Mr. Johnston replied the plan is to analyze the results prior to deciding.

QAPP Worksheet #10: Conceptual Site Model

(UFP-QAPP Manual Section 2.5.2)
(EPA 2106-G-05 Section 2.2.5)

Background information:
Installation description, land use, physical characteristics, climate, geology, hydrology, vegetation, and area descriptions and previous investigations for North River RRS is provided in Section 2 of the 2023 North River RRS Groundwater Investigation Work Plan (2023 Work Plan).
Sources of known or suspected hazardous waste or classes of contaminants, primary release mechanism, and secondary contamination migration:
Refer to Section 2.2 of the 2023 Work Plan.
Fate and transport considerations:
Depth to groundwater ranges from 3 to 15 feet below ground surface; discontinuous permafrost exists in the area and has been encountered during previous drilling activities.
Potential receptors and exposure pathways:
The presence in groundwater of five volatile organic compounds (VOCs): bromodichloromethane, cis-1,2-dichloroethene, tetrachloroethene, 1,1,2-trichloroethane, and trichloroethylene has been documented and requires further evaluation. These five VOCs have been highlighted green on Worksheet 15. Potentially complete pathways for groundwater include incidental ingestion and dermal absorption by future residents; commercial or industrial workers; and construction workers. However, they are considered insignificant exposure for each receptor.
Land use considerations:
The property owned by the USAF. Land use controls (LUCs) are included in the USAF Land Use Control Management Plan issued by the Pacific Air Forces Regional Support Center Installation in 2019. These include LUC boundary surveys, restrictions on digging, and notification requirements to ADEC for any activities inconsistent with the LUC objectives or restrictions.
Key physical aspects of the sites:
Soil borings in the vicinity of the indicate mostly sand and gravel overlying sediments, with shallow bedrock approximately 15 feet below ground surface. Groundwater is roughly between 2.3 and 7.8 feet below ground surface in the vicinity of the proposed borings.
Current interpretation of nature and extent of contaminant to the extent it will influence project-specific decision-making:
The nature and extent of the VOC impacted groundwater is currently not delineated.

QAPP Worksheet #11: Project/Data Quality Objectives

(UFP-QAPP Manual Section 2.6.1)
(EPA 2106-G-05 Section 2.2.6)

Problem Statement: Long-term monitoring for groundwater contaminants at Site SS001 requires installation of additional monitoring wells and subsequent sampling for volatile organic compounds (VOCs), including analytes that were not previously included in the Record of Decision (ROD) or ROD Amendment, namely bromodichloromethane, cis-1,2-dichloroethene, tetrachloroethene, 1,1,2-trichloroethane, and trichloroethene.
Goals of Groundwater Investigation: The goals of this investigation are to: install five new groundwater monitoring wells per SOP ES 3.01, collecting two soil samples at each boring during monitoring well installation from the two intervals demonstrating the highest response via photoionization detector (PID) screening per SOP ES 2.03; develop the new monitoring wells per SOP ES 3.03; and collect samples from the five new groundwater monitoring wells and three existing monitoring wells per SOP ES 4.03.
Data Inputs: Laboratory analysis of the collected samples will provide additional data to identify the nature and extent of VOC contamination in soil and groundwater.
Boundaries of the Investigation: Boundaries of the Investigation are provided in Figure 4-1 of the 2023 Work Plan.
Who will use the data? AFCEC, ADEC, and OTIE/Stantec will use the data to further delineate the nature and extent of VOC contamination in subsurface soil and groundwater. Additionally, soil data will be used to characterize wastes for disposal.
What will the data be used for? The data will be used to characterize the nature and extent of contamination associated with the VOC contamination.
What type of data are needed? (target analytes, analytical groups, field screening, onsite analytical or offsite laboratory techniques, sampling techniques) Soil will be field screened by use of a MiniRAE PID. Laboratory analysis of soil and groundwater samples will be conducted for VOCs by EPA SW8260D
How "good" do the data need to be in order to support the environmental decision? Confirmation soil samples will be collected to verify the field screening results and supply information for waste characterization and disposal. The data will be definitive data analyzed in accordance with the laboratory's standard operating procedures (SOPs) provided in this QAPP and QC limits stipulated in this QAPP. One hundred percent of the samples will undergo Level 3 data validation.
How much data are needed? (number of samples for each analytical group, matrix, and concentration): The total number of samples is listed in Worksheet 20.
Where, when, and how should the data be collected/generated? Sample collection is scheduled to begin in July 2023. Samples will be delivered to SGS via air transport. SGS will analyze the soil samples according to SOPs provided in this QAPP. ADEC laboratory data review checklists will be completed for each laboratory work order.
Who will collect and generate the data? Stantec will oversee collection of all samples for laboratory analysis. SGS will analyze the samples and generate the data. Douglas Quist of Stantec will lead the investigation.

How will the data be reported? The laboratory will supply analytical data packages including, but not limited to: all raw data for initial and continuing calibration, reconstructed ion chromatograms, sample preparation data, copies of pages from analysis notebooks, instrument run logs, case narratives, and quality control summaries and supporting raw data. All electronic data submitted by the laboratory is required to be error free and in complete agreement with the hard-copy data reports (provided in .pdf electronic format).
How will the data be archived? A copy of the final data deliverable is archived electronically on the Stantec file server. EDD disks from the laboratory will be maintained in Stantec's file system. The server is backed up daily.

QAPP Worksheet #12: Project/Data Quality Objectives

(UFP-QAPP Manual Section 2.6.2)
(EPA 2106-G-05 Section 2.2.6)

Matrix	Soil
Analytical Group	VOCs
Concentration Level	Low

Sampling Procedure	Analytical Method/SOP	Data Quality Indicators (DQIs)	Measurement Performance Criteria	QC Sample and/or Activity Used to Assess Measurement Performance	QC Sample Assesses Error for Sampling (S), Analytical (A) or Both (S&A)
See Soil Sampling in Section 3 of 2023 Work Plan	SW8260D SGS SOP 783r07 SW5035A (soil) SGS SOP 767r13	Precision	RPD < 50% when detects for both primary and duplicate samples ≥ QL.	Field duplicates (minimum of one per every 10 field samples for each matrix sampled, for each day in field, for each target analyte, minimum of one).	S & A
		Accuracy and Precision	Recovery same as LCS; RPD < 30%	Matrix Spike/Matrix Spike Duplicate	A
		Accuracy	No detections exceeding the LOQ	Method Blank	A
		Accuracy	DoD QSM Ver 5.4	Surrogates	A
		Accuracy	DoD QSM Ver 5.4	Laboratory Control Sample	A
		Sensitivity	LOQs, 1/2 the action level	Low Point Calibration Curve	A
		Field Completeness	100%	Data Completeness Check	S
		Analytical Completeness	95%	Data Completeness Check	A

KEY

LCS laboratory control sample
LOQ limit of quantitation
QL quantitation limit
RPD relative percent difference

QAPP Worksheet #12: Measurement Performance Criteria
(UFP-QAPP Manual Section 2.6.2)
(EPA 2106-G-05 Section 2.2.6)

Matrix	Water
Analytical Group	VOCs
Concentration Level	Low approximately 0.5 to 3 µg/L

Sampling Procedure	Analytical Method/SOP	Data Quality Indicators (DQIs)	Measurement Performance Criteria	QC Sample and/or Activity Used to Assess Measurement Performance	QC Sample Assesses Error for Sampling (S), Analytical (A) or Both (S&A)
See Groundwater Sampling in Section 4 of 2023 Work Plan	SW8260D SGS SOP 783r07 SGS SOP 767r13 – 8000 B and 5030 B	Precision	RPD < 30% when detects for both primary and duplicate samples ≥ QL.	Field Duplicates (minimum of one per every 10 field samples for each matrix sampled, for each day in field, for each target analyte, minimum of one).	S & A
		Accuracy and Precision	Recovery same as LCS; RPD < 50%	Matrix Spike/Matrix Spike Duplicate	A
		Accuracy	No detections exceeding the LOQ	Method Blank	A
		Accuracy	DoD QSM Ver 5.4	Surrogates	A
		Accuracy	DoD QSM Ver 5.4	Laboratory Control Sample	A
		Sensitivity	LOQs, 1/2 the action level	Low Point Calibration Curve	A
		Field Completeness	100%	Data Completeness Check	S
		Analytical Completeness	95%	Data Completeness Check	A

KEY:

µg/L micrograms per liter

QAPP Worksheet #13: Secondary Data Uses and Limitations

(UFP-QAPP Manual Section 2.7)
(EPA 2106-G-05 Chapter 3: QAPP Elements for Evaluating Existing Data)

Data Type	Source	Data uses relative to current project	Factors affecting the reliability of data and limitations on data use
Lab and Survey Data	2019. Final Record of Decision Amendment, North River Radio Relay Station.	Finding previous sample locations and sample results.	None noted
Lab and Survey Data	2020. Final Technical Project Report, 2019 Remedial Action Operations, Land Use/Institutional Control, North River Radio Relay Station, Alaska Site SO001, SS001, SS003. March.	Finding previous sample locations and sample results.	None noted
Lab and Survey Data	2021. Final 2020 Remedial Action Operations Institutional Control/Land Use Control Report, North River Radio Relay Station, Alaska SO001, SS001, SS003. October.	Finding previous sample locations and sample results.	None noted
Lab and Survey Data	2021. Final First CERCLA Five-Year Review for Site SS001 and Second CERCLA Five-Year Review for Site SS003 at the North River Radio Relay Station, Unalakleet, Alaska, December.	Finding previous sample locations and sample results.	None noted
Aerial Imagery	ArcGIS Earth. Version 1.13.0.3206 5-26-2010		None noted

QAPP Worksheet #14/16: Project Tasks & Schedule

(UFP-QAPP Manual Section 2.8.2)
(EPA 2106-G-05 Section 2.2.4)

Activity	Responsible Party	Planned Start Date	Planned Completion Date	Deliverable(s)	Deliverable Due Date
WP Submittal	OTIE/Stantec Team	January 2023	May 2023	WP with UFP QAPP, and HSP	To be Determined (TBD)
Sampling and Analysis	Stantec / SGS	July 2023	August 2023	Analytical Data	Not Applicable (NA)
Site Characterization Report	OTIE/Stantec Team	September 2023	December 2023	Report	TBD

QAPP Worksheet #15: Project Action Limits and Laboratory-Specific Detection/Quantitation Limits

(UFP-QAPP Manual Section 2.6.2.3 and Figure 15)
(EPA 2106-G-05 Section 2.2.6)

Matrix: Soil

Analytical Group: VOCs – SW8260D

Concentration Level: Low

Analyte	CAS Number	Project Action Limit [1] (mg/kg)	Limit of Quantitation (LOQ) (mg/kg)	Analytical Method		Achievable Laboratory Limits	
				LODs	Method LOQs	LODs	LOQ
1,1,1,2-Tetrachloroethane	630-20-6	0.022	0.020	0.010	0.020	0.010	0.020
1,1,1-Trichloroethane	71-55-6	32	0.025	0.0125	0.025	0.0125	0.025
1,1,2,2-Tetrachloroethane	79-34-5	0.0030	0.002	0.001	0.002	0.001	0.002
1,1,2-Trichloroethane	79-00-5	0.0014	0.001	0.0005	0.001	0.0005	0.001
1,1-Dichloroethane	75-34-3	0.092	0.025	0.0125	0.025	0.0125	0.025
1,1-Dichloroethene	75-35-4	1.2	0.025	0.0125	0.025	0.0125	0.025
1,1-Dichloropropene	563-58-6	N/A	0.025	0.0125	0.025	0.0125	0.025
1,2,3-Trichlorobenzene	87-61-6	0.15	0.100	0.050	0.100	0.050	0.100
1,2,3-Trichloropropane	96-18-4	0.000031	0.002	0.001	0.002	0.001	0.002
1,2,4-Trichlorobenzene	120-82-1	0.082	0.025	0.0125	0.025	0.0125	0.025
1,2,4-Trimethylbenzene	95-63-6	0.61	0.100	0.050	0.100	0.050	0.100
1,2-Dibromo-3-chloropropane	96-12-8	N/A	0.100	0.050	0.100	0.050	0.100
1,2-Dibromoethane	106-93-4	0.00024	0.0015	0.00075	0.0015	0.00075	0.0015
1,2-Dichlorobenzene	95-50-1	2.4	0.025	0.0125	0.025	0.0125	0.025
1,2-Dichloroethane	107-06-2	0.0055	0.002	0.001	0.002	0.001	0.002
1,2-Dichloropropane	78-87-5	0.030	0.010	0.005	0.010	0.005	0.010
1,3,5-Trimethylbenzene	108-67-8	0.66	0.025	0.0125	0.025	0.0125	0.025
1,3-Dichlorobenzene	541-73-1	2.3	0.025	0.0125	0.025	0.0125	0.025
1,3-Dichloropropane	142-28-9	N/A	0.010	0.005	0.010	0.005	0.010
1,4-Dichlorobenzene	106-46-7	0.037	0.025	0.0125	0.025	0.0125	0.025
2,2-Dichloropropane	594-20-7	N/A	0.025	0.0125	0.025	0.0125	0.025
2-Butanone (MEK)	78-93-3	15	0.250	0.125	0.250	0.125	0.250
2-Chlorotoluene	95-49-8	N/A	0.025	0.0125	0.025	0.0125	0.025
2-Hexanone	591-78-6	0.11	0.120	0.060	0.120	0.060	0.120
4-Chlorotoluene	106-43-4	N/A	0.020	0.010	0.020	0.010	0.020
4-Isopropyltoluene	99-87-6	N/A	0.080	0.040	0.080	0.040	0.080
4-Methyl-2-pentanone (MIBK)	108-10-1	18	0.250	0.125	0.250	0.125	0.250

Matrix: Soil

Analytical Group: VOCs – SW8260D

Concentration Level: Low

Analyte	CAS Number	Project Action Limit [1] (mg/kg)	Limit of Quantitation (LOQ) (mg/kg)	Analytical Method		Achievable Laboratory Limits	
				LODs	Method LOQs	LODs	LOQ
Acetone	67-64-1	38	0.250	0.125	0.250	0.125	0.250
Benzene	71-43-2	0.022	0.0125	0.00625	0.0125	0.00625	0.0125
Bromobenzene	108-86-1	0.36	0.025	0.0125	0.025	0.0125	0.025
Bromochloromethane	74-97-5	N/A	0.025	0.0125	0.025	0.0125	0.025
Bromodichloromethane	75-27-4	0.0043	0.002	0.001	0.002	0.001	0.002
Bromoform	75-25-2	0.10	0.025	0.0125	0.025	0.0125	0.025
Bromomethane	74-83-9	0.024	0.020	0.010	0.020	0.010	0.020
Carbon disulfide	75-15-0	2.9	0.100	0.050	0.100	0.050	0.100
Carbon tetrachloride	56-23-5	0.021	0.0125	0.00625	0.0125	0.00625	0.0125
Chlorobenzene	108-90-7	0.46	0.025	0.0125	0.025	0.0125	0.025
Chloroethane	75-00-3	72	0.200	0.100	0.200	0.100	0.200
Chloroform	67-66-3	0.0071	0.006	0.003	0.006	0.003	0.006
Chloromethane	74-87-3	0.61	0.025	0.0125	0.025	0.0125	0.025
cis-1,2-Dichloroethylene	156-59-2	0.12	0.025	0.0125	0.025	0.0125	0.025
cis-1,3-Dichloropropene	542-75-6	0.018	0.0125	0.00625	0.0125	0.00625	0.0125
Cyclohexane	110-82-7	150	0.005	0.0025	0.005	0.0025	0.005
Dibromochloromethane	124-48-1	0.0027	0.005	0.0025	0.005	0.0025	0.005
Dibromomethane	74-95-3	0.025	0.025	0.0125	0.025	0.0125	0.025
Dichlorodifluoromethane	75-71-8	3.9	0.025	0.0125	0.025	0.0125	0.025
Ethylbenzene	100-41-4	0.13	0.100	0.050	0.100	0.050	0.100
Freon-113	76-13-1	310	0.020	0.010	0.020	0.010	0.020
Hexachlorobutadiene	87-68-3	0.020	0.025	0.0125	0.025	0.0125	0.025
Isopropylbenzene (Cumene)	98-82-8	5.6	0.025	0.0125	0.025	0.0125	0.025
Methylene chloride	75-09-2	0.33	0.100	0.050	0.100	0.050	0.100
Methyl-t-butyl ether	1634-04-4	0.40	0.100	0.050	0.100	0.050	0.100
Naphthalene	91-20-3	0.038	0.025	0.0125	0.025	0.0125	0.025
n-Butylbenzene	104-51-8	23	0.025	0.0125	0.025	0.0125	0.025
n-Propylbenzene	103-65-1	9.1	0.025	0.0125	0.025	0.0125	0.025
o-Xylene	95-47-6	1.5	0.025	0.0125	0.025	0.0125	0.025
P & M -Xylene	106-42-3 108-38-3	1.5 1.5	0.050 0.050	0.025 0.025	0.050 0.050	0.025 0.025	0.050 0.050
sec-Butylbenzene	135-98-8	42	0.025	0.0125	0.025	0.0125	0.025

Matrix: Soil

Analytical Group: VOCs – SW8260D

Concentration Level: Low

Analyte	CAS Number	Project Action Limit [1] (mg/kg)	Limit of Quantitation (LOQ) (mg/kg)	Analytical Method		Achievable Laboratory Limits	
				LODs	Method LOQs	LODs	LOQ
Styrene	100-42-5	10	0.025	0.0125	0.025	0.0125	0.025
tert-Butylbenzene	98-06-6	11	0.025	0.0125	0.025	0.0125	0.025
Tetrachloroethylene	127-18-4	0.19	0.0125	0.00625	0.0125	0.00625	0.0125
Toluene	108-88-3	6.7	0.025	0.0125	0.025	0.0125	0.025
trans-1,2-Dichloroethene	156-60-5	1.3	0.025	0.0125	0.025	0.0125	0.025
trans-1,3-Dichloropropene	10061-02-6	N/A	0.0125	0.00625	0.0125	0.00625	0.0125
Trichloroethylene	79-01-6	0.011	0.010	0.005	0.010	0.005	0.010
Trichlorofluoromethane	75-69-4	41	0.050	0.025	0.050	0.025	0.050
Vinyl acetate	108-05-4	1.1	0.100	0.050	0.100	0.050	0.100
Vinyl chloride	75-01-4	0.00080	0.0008	0.0004	0.0008	0.0004	0.0008
Xylenes (total)	1330-20-7	1.5	0.075	0.0375	0.075	0.0375	0.075

[1] – 18 AAC 75 Table B1 Method Two – Soil Cleanup Levels Table – Migration to Groundwater (November 18, 2021)

CAS Chemical Abstracts Service
LOD limit of detection
mg/kg milligrams per kilogram

(grey box) Project Action limit is below both LOD and LOQ

(white box) Project Action Limit is below the LOQ but above the LOD

QAPP Worksheet #15: Project Action Limits and Laboratory-Specific Detection/Quantitation Limits
(UFP-QAPP Manual Section 2.6.2.3 and Figure 15)
(EPA 2106-G-05 Section 2.2.6)

Matrix: Water

Analytical Group: VOCs – SW8260D

Concentration Level: Low

Analyte	CAS Number	Project Action Limit (µg/L)	Limit of Quantitation (LOQ) (µg/L)	Analytical Method (µg/L)		Achievable Laboratory Limits (µg/L)	
				LODs	Method LOQs	LODs	LOQs
1,1,1,2-Tetrachloroethane	630-20-6	5.7	0.5	0.25	0.5	0.25	0.5
1,1,1-Trichloroethane	71-55-6	8,000	1	0.5	1	0.5	1
1,1,2,2-Tetrachloroethane	79-34-5	0.76	0.5	0.25	0.5	0.25	0.5
1,1,2-Trichloroethane	79-00-5	0.41	0.4	0.2	0.4	0.2	0.4
1,1-Dichloroethane	75-34-3	28	1	0.5	1	0.5	1
1,1-Dichloroethene	75-35-4	N/A	1	0.5	1	0.5	1
1,1-Dichloropropene	563-58-6	N/A	1	0.5	1	0.5	1
1,2,3-Trichlorobenzene	87-61-6	7.0	1	0.5	1	0.5	1
1,2,3-Trichloropropane	96-18-4	0.0075	1	0.5	1	0.5	1
1,2,4-Trichlorobenzene	120-82-1	4.0	1	0.5	1	0.5	1
1,2,4-Trimethylbenzene	95-63-6	56	1	0.5	1	0.5	1
1,2-Dibromo-3-chloropropane	96-12-8	N/A	10	5	10	5	10
1,2-Dibromoethane	106-93-4	0.075	0.075	0.0375	0.075	0.0375	0.075
1,2-Dichlorobenzene	95-50-1	300	1	0.5	1	0.5	1
1,2-Dichloroethane	107-06-2	1.7	0.5	0.25	0.5	0.25	0.5
1,2-Dichloroethane-D4 (surr)	107-06-2	N/A					
1,2-Dichloropropane	78-87-5	8.2	1	0.5	1	0.5	1
1,3,5-Trimethylbenzene	108-67-8	60	1	0.5	1	0.5	1
1,3-Dichlorobenzene	541-73-1	300	1	0.5	1	0.5	1
1,3-Dichloropropane	142-28-9	N/A	0.5	0.25	0.5	0.25	0.5
1,4-Dichlorobenzene	106-46-7	4.8	0.5	0.25	0.5	0.25	0.5
2,2-Dichloropropane	594-20-7	N/A	1	0.5	1	0.5	1
2-Butanone (MEK)	78-93-3	5,600	10	5	10	5	10
2-Chlorotoluene	95-49-8	N/A	1	0.5	1	0.5	1
2-Hexanone	591-78-6	38	10	5	10	5	10
4-Bromofluorobenzene (surr)	460-00-4	N/A					
4-Chlorotoluene	106-43-4	N/A	1	0.5	1	0.5	1

Matrix: Water

Analytical Group: VOCs – SW8260D

Concentration Level: Low

Analyte	CAS Number	Project Action Limit (µg/L)	Limit of Quantitation (LOQ) (µg/L)	Analytical Method (µg/L)		Achievable Laboratory Limits (µg/L)	
				LODs	Method LOQs	LODs	LOQs
4-Isopropyltoluene	99-87-6	N/A	1	0.5	1	0.5	1
4-Methyl-2-pentanone (MIBK)	108-10-1	6,300	10	5	10	5	10
Benzene	71-43-2	4.6	0.4	0.2	0.4	0.2	0.4
Bromobenzene	108-86-1	62	1	0.5	1	0.5	1
Bromochloromethane	74-97-5	N/A	1	0.5	1	0.5	1
Bromodichloromethane	75-27-4	1.3	0.5	0.25	0.5	0.25	0.5
Bromoform	75-25-2	33	1	0.5	1	0.5	1
Bromomethane	74-83-9	7.5	6	3	6	3	6
Carbon disulfide	75-15-0	810	10	5	10	5	10
Carbon tetrachloride	56-23-5	4.6	1	0.5	1	0.5	1
Chlorobenzene	108-90-7	78	0.5	0.25	0.5	0.25	0.5
Chloroethane	75-00-3	21,000	1	0.5	1	0.5	1
Chloroform	67-66-3	2.2	1	0.5	1	0.5	1
Chloromethane	74-87-3	190	1	0.5	1	0.5	1
cis-1,2-Dichloroethylene	156-59-2	36	1	0.5	1	0.5	1
cis-1,3-Dichloropropene	10061-01-5	N/A	0.5	0.25	0.5	0.25	0.5
Dibromochloromethane	124-48-1	8.7	0.5	0.25	0.5	0.25	0.5
Dibromomethane	74-95-3	8.3.	1	0.5	1	0.5	1
Dichlorodifluoromethane	75-71-8	200	1	0.5	1	0.5	1
Ethylbenzene	100-41-4	15	1	0.5	1	0.5	1
Freon-113	76-13-1	10,000	10	5	10	5	10
Hexachlorobutadiene	87-68-3	1.4	1	0.5	1	0.5	1
Isopropylbenzene (Cumene)	98-82-8	450	1	0.5	1	0.5	1
Methylene chloride	75-09-2	110	10	5	10	5	10
Methyl-t-butyl ether	1634-04-4	140	10	5	10	5	10
Naphthalene	91-20-3	1.7	1	0.5	1	0.5	1
n-Butylbenzene	104-51-8	1,000	1	0.5	1	0.5	1
n-Propylbenzene	103-65-1	660	1	0.5	1	0.5	1
o-Xylene	95-47-6	190	1	0.5	1	0.5	1
P & M -Xylene	106-42-3 108-38-3	190 190	1 1	1 1	2 2	1 1	2 2

Matrix: Water

Analytical Group: VOCs – SW8260D

Concentration Level: Low

Analyte	CAS Number	Project Action Limit (µg/L)	Limit of Quantitation (LOQ) (µg/L)	Analytical Method (µg/L)		Achievable Laboratory Limits (µg/L)	
				LODs	Method LOQs	LODs	LOQs
sec-Butylbenzene	135-98-8	2,000	0.5	0.5	1	0.5	1
Styrene	100-42-5	1,200	0.5	0.5	1	0.5	1
tert-Butylbenzene	98-06-6	690	0.5	0.5	1	0.5	1
Tetrachloroethylene	127-18-4	41	0.5	0.5	1	0.5	1
Toluene	108-88-3	1,100	0.5	0.5	1	0.5	1
Toluene-d8 (surr)	2037-26-5	1,100					
trans-1,2-Dichloroethene	156-60-5	360	0.5	0.5	1	0.5	1
trans-1,3-Dichloropropene	10061-02-6	N/A	0.5	0.5	1	0.5	1
Trichloroethylene	71-55-6	2.1	0.25	0.25	0.5	0.25	0.5
Trichlorofluoromethane	75-69-4	5,200	0.5	0.5	1	0.5	1
Vinyl acetate	108-05-4	410	5	5	10	5	10
Vinyl chloride	75-01-4	0.19	0.075	0.075	0.15	0.075	0.15
Xylenes (total)	1330-20-7	190	1.5	1.5	3	1.5	3

[1] – 18 AAC 75 Table C – Groundwater Cleanup Levels Table – Groundwater Human Health Cleanup Level (November 18, 2021)
µg/L micrograms per liter

Project Action limit is below both LOD and LOQ

QAPP Worksheet #17: Sampling Design and Rationale

(UFP-QAPP Section 3.1.1)
(EPA 2106-G-05 Section 2.3.1)

Physical Boundaries: See 2023 Work Plan Figures.
Time Period represented by the collected data: Data to be collected in 2023.
Description and basis for dividing site into sampling areas: See Sections 4 and 5 of the 2023 Work Plan.
Basis for the number and placement of samples within sampling areas: See Section 3 of the 2023 Work Plan.
If sample locations are specified in the QAPP, descriptions of how actual sample positions will be located once in the field: Sample locations from the three existing wells are fixed; positioning of the new wells will be done using hand-held GPS data and the 2023 Work Plan maps for placement. .
If a sample cannot be collected where planned, the decision process for changing the location: Sample locations will be predetermined. If the planned soil borings/monitoring well installation locations cannot be installed where planned due to an unknown obstruction, the locations will be shifted laterally within roughly 10-feet depending upon the nature of any obstruction. Obstructions are not anticipated.
If sample locations will be determined in the field, the decision process for doing so: The sample locations are predetermined. Sample depth intervals for soil will be determined in the field based on the two (2-foot split spoon) intervals exhibiting the highest PID response as discussed in Section 4 of the 2023 Work Plan.
Contingencies in the event field conditions are different than expected and could have an effect on the sample design: Groundwater should be present in each boring location; however, in the event of a localized absence of water, the groundwater well(s) will be completed with the 10-foot planned screened interval extending to shallow bedrock. Depth to groundwater is assumed to be 10-ft bgs with total maximum depth of monitoring wells to be approximately 30-feet.

QAPP Worksheet #18: Sampling Locations and Methods

(UFP-QAPP Manual Section 3.1.1 and 3.1.2)
(EPA 2106-G-05 Section 2.3.1 and 2.3.2)

Sample ID	Matrix	Depth (feet bgs)	Type	Analyte/ Analytical Group	Sampling SOP	Comments
See 2023 Work Plan	Subsurface Soil	Subsurface (>2 feet)	Hand collection from GeoProbe core.	See Section 4.3 of the 2023 Work Plan.	See SOP ES 2.03 in 2023 Work Plan and ADEC Field Sampling Guidance	Use disposable sampling equipment (e.g., stainless steel spoons, and single use direct push GeoProbe sampling tubes) only.
See 2023 Work Plan	Groundwater	Approximately 10 feet bgs.	Collection of groundwater samples by use of low-flow sampling techniques.	See Section 4.3 of the 2023 Work Plan.	See SOP ES 4.03 in 2023 Work Plan and ADEC Field Sampling Guidance	Use low-flow sampling pumps and disposable single use tubing.

QAPP Worksheet #19 & 30: Sample Containers, Preservation, and Hold Times

(UFP-QAPP Manual Section 3.1.2.2)
(EPA 2106-G-05 Section 2.3.2)

Laboratory: SGS North America, Inc.
Sample receipt address: 200 W. Potter Drive, Anchorage, AK 99518
Point of contact: Justin Nelson, **e-mail:** Justin.Nelson@sgs.com, **phone number:** (907) 562-2343
List of accreditations/certifications: ISO/IEC 17025:2005 Certificate Number: 2944.01
Back-up Laboratory: NA
Sample Delivery Method: Ravn Aviation from Unalakleet to Anchorage.

Analyte/ Analyte Group	Matrix	Method/SOP	Accreditation Expiration Date	Container(s) (number, size, and type per sample)	Preservation	Preparation Holding Time	Analytical Holding Time	Data Package Turnaround
VOCs	Soil	SW8260D SGS SOP 783r07	31 December 2023	1 x 4-ounce amber glass pre-weighed with Teflon lined septa cap	Methanol Field Preservation, Cool to 4ºC ± 2ºC	NA	14 days	28 days for data package
VOCs	Water	SW8260D SGS SOP 783r07	31 December 2023	3 x 40- milliliter (ml) amber glass vials with Teflon-lined septa cap	HCl Cool to 4ºC ± 2ºC	14 days	14 days	28 days for data package

QAPP Worksheet #20: Field QC Summary

(UFP-QAPP Manual Section 3.1.1 and 3.1.2)
(EPA 2106-G-05 Section 2.3.5)

Phase	Matrix	Analyte/ Analytical Group	Field Samples[1]	Field Duplicates[2]	Matrix Spikes[3]	Matrix Spike Duplicates[3]	Field Blanks	Equipment Blanks	Trip Blanks	Other	Total # analyses[1]
Investigation	Subsurface Soil	VOCs	10	2	1	1	0	2	2	0	18
Investigation	Groundwater	VOCs	8	1	1	1	0	0	1	0	12

1 = Five borehole with two samples each from the two intervals exhibiting the PID reading.
2 = Ten percent of Field Samples.
3 = Five percent of Field Samples.

QAPP Worksheet #21: Field SOPs

(UFP-QAPP Manual Section 3.1.2)
(EPA 2106-G-05 Section 2.3.2)

SOP # or Reference	Title, Revision Date and URL (if available)	Originating Organization	SOP option or Equipment Type (if SOP provides different options)	Modified for Project? Y/N	Comments
SOP-1	Drilling Methods	Stantec	Direct Push Drilling	N	
SOP-6	Sample Management/Preservation	Stantec		N	
SOP ES 2.03	Environmental Borehole Drilling and Soil Sampling	Stantec		N	
SOP ES 3.01	Monitoring Well Installation	Stantec		N	
SOP ES 3.03	Monitoring Well Development	Stantec		N	
SOP ES 4.03	Groundwater Sampling	Stantec	Low-flow technique	N	
SOP-19	Borehole Abandonment	Stantec		N	
SOP-35	Investigation Derived Waste Management	Stantec		N	
	ADEC Division of Spill Prevention and response Contaminated Sites Program Field Sampling Guidance, August 2017	ADEC		N	

QAPP Worksheet #22: Field Equipment Calibration, Maintenance, Testing, and Inspection

(UFP-QAPP Manual Section 3.1.2.4)
(EPA 2106-G-05 Section 2.3.6)

Field Equipment	Title or position of responsible person (all activities)	Calibration Activity	Maintenance Activity	Testing Activity	Inspection Activity	Frequency (all activities)	Acceptance Criteria (all activities)	Corrective Action (all activities)	SOP Reference
MiniRae 3000 Photoionization detector (10.6 eV lamp)	Field Sampling Team Leader or Field Sampler	Isobutylene gas at 100 parts per million (ppm) calibration	Charge or change batteries, keep probe clean of soil and debris	Instrument Operation Manual and Section 3 of the 2023 Work Plan.	Inspect probe to ensure no soil or debris is present	Twice per day, minimum once per 4 hours	Readings within + 5 ppm	Recalibrate / clean filter or lens	NA – Instrument Operation Manual and Section 3 of the 2023 Work Plan.

QAPP Worksheet #23: Analytical SOPs

(UFP-QAPP Manual Section 3.2.1)
(EPA 2106-G-05 Section 2.3.4)

SOP #	Title, Revision Date, URL (if available)	Definitive or Screening Data	Matrix and Analytical Group	Instrument	Organization Performing Analysis	‡Modified for Project? (Y/N)
Analytical Methods						
SW8260D SGS SOP 783r07	Purgeable Organic Compounds by GC/MS	Definitive	Soil /Water/ VOCs	GC/MS	SGS	NO

KEY:

‡A brief summary of project-specific SOP modifications must be provided on this worksheet or referenced.
GC gas chromatograph
MS mass spectrometer

QAPP Worksheet #24: Analytical Instrument Calibration

(UFP-QAPP Manual Section 3.2.2)
(EPA 2106-G-05 Section 2.3.6)

Instrument	Calibration Procedure	Calibration Range	Frequency	Acceptance Criteria	Corrective Action (CA)	Title/position Responsible for Corrective Action	SOP Reference[1]
GC - Purgeables	Minimum five-point ICAL for all analytes	0.4 → 70	ICAL prior to sample analysis.	One of the options below: Option 1: RSD for each analyte ≤ 20%; Option 2: linear least squares regression: r ≥ 0.995; Option 3: non-linear regression: COD r2 ≥ 0.99 (6 points used for second order, 7 points used for third order).	Correct problem, then repeat ICAL	Laboratory analyst	783r07

KEY

ICAL instrument calibration
RSD relative standard deviation

QAPP Worksheet #25: Analytical Instrument and Equipment Maintenance, Testing, and Inspection

(UFP-QAPP Manual Section 3.2.3)
(EPA 2106-G-05 Section 2.3.6)

Instrument/ Equipment	Maintenance Activity	Testing Activity	Inspection Activity	Frequency	Acceptance Criteria	Corrective Action	Title/position responsible for corrective action	Reference
GC-MS	Change gas purifier	NA	Visually inspect if traps are changing color	Every 6 to 12 months	No moisture	Replace indicating traps	Analyst or certified instrument technician	SGS SOP 783r07
GC-MS	Change syringes/syringe needles	NA	Visually inspect for wear or damage	Every 3 months	NA	Replace syringe if dirt is noticeable in the syringe	Analyst or certified instrument technician	SGS SOP783r07
GC-MS	Change Inlet liner, Liner O-rings, and Inlet Septum	NA	Visually inspect for dirt or deterioration	Weekly for liner, monthly for O-rings, daily for septum	NA	Replace them and check often	Analyst or certified instrument technician	SGS SOP 783r07
GC-MS	Change front-end column	NA	Check peak tailing, decreased sensitivity, retention time changes, etc.	Weekly, monthly, or when needed	NA	Remove 1/2 to 1 meter from the front of the column when experiencing problems	Analyst or certified instrument technician	SGS SOP 783r07
GC-MS	Change tune MSD, check the calibration vial, and replace the foreline pump oil	NA	Visually inspect and monitor the fluid becoming discolored	As needed, or every 6 months	In accordance with manufacturer's recommendation or lab SOP.	Keep plenty of PFTBA; refill the vial; and check the fluid. Change when the fluid becomes discolored	Analyst or certified instrument technician	SGS SOP 783r07

KEY:

% Percent
GC-MS gas chromatograph-mass spectrophotometer
LCD laboratory control duplicate
MS matrix spike
MSD matrix spike duplicate
SOP standard operating procedure
NA not applicable
NIST National Institute for Standards and Technology
PFTBA perfluorotributylamine

QAPP Worksheet #26 & 27: Sample Handling, Custody, and Disposal

(UFP-QAPP Manual Section 3.3)
(EPA 2106-G-05 Section 2.3.3)

Sampling Organization: Stantec

Laboratory: SGS North America, Anchorage, Alaska

Method of sample delivery (shipper/carrier): Grant Aviation from North River to Dutch Harbor, Penn Air from Dutch Harbor to Anchorage, Pickup by SGS from Penn Air in Anchorage.

Number of days from reporting until sample disposal: 28 Days.

Activity	Organization and title or position of person responsible for the activity	SOP Reference
Sample labeling	Field Team Leader or Field Scientist	Section 3.4.1 of the 2023 Work Plan
Chain-of-custody form completion	Field Team Lead or Field Scientist	Section 3.4.2 of the 2023 Work Plan
Packaging	Field Team Lead or Field Scientist	Section 3.4.4 of the 2023 Work Plan
Shipping coordination	Field Team Lead or Field Scientist	Section 3.4.4 of the 2023 Work Plan
Sample receipt, inspection, & log-in	SGS Sample Intake	106r23, 123r09
Sample custody and storage	SGS Sample Intake	108r13
Sample disposal	SGS Laboratory Tech	108r13

QAPP Worksheet #28: Analytical Quality Control and Corrective Action

(UFP-QAPP Manual Section 3.4 and Tables 4, 5, and 6)
(EPA 2106-G-05 Section 2.3.5)

Matrix: Soil/Aqueous

Analytical Group: VOCs

Analytical Methods/SOP: SW8260D

QC Sample	Number / Frequency	Method / SOP Acceptance Criteria	Corrective Action	Title/position of person responsible for corrective action	Data Quality Indicator	Project Specific Measurement Performance Criteria
Initial Calibration (ICAL)	As needed (see CCV passing criteria below and SW-846 8260D method)	% RSD < 15%, or Correlation coefficient R ≥ 0.995	If the acceptance criteria were not met, re-calibration is performed before any samples may be analyzed.	Analyst	Laboratory Accuracy	% RSD < 5%, or Correlation coefficient R ≥ 0.995
Initial Calibration Verification	1 per ICAL, analyzed after ICAL, before field samples	% D ≤ 20%	If the acceptance criteria were not met, re-calibration is performed before any samples may be analyzed.	Analyst	Laboratory Accuracy	% D ≤ 20%
Continuing Calibration Verification (CCV)	At the beginning of Each 12-hour period and the end of the run for DoD samples.	% D ≤ 20%	If the criterion has not achieved corrective action, re-calibration is performed before any samples may be analyzed. Corrective action may include reanalysis of the samples.	Analyst	Laboratory Accuracy	% D ≤ 10%

QC Sample	Number / Frequency	Method / SOP Acceptance Criteria	Corrective Action	Title/position of person responsible for corrective action	Data Quality Indicator	Project Specific Measurement Performance Criteria
Method Blank (MB)	1 per extraction batch	< 1/2 RL	The source of contamination is investigated and eliminated before proceeding with further analysis. Corrective actions are: Samples with results as non-detect (ND) – report without qualification. Samples > 5x contamination level – report with qualification. Samples < 5x contamination – re-extract and reanalyze. If insufficient sample – qualify and footnote.	Analyst / Prep Analyst	Absence of interference contamination	
Laboratory Control Sample (LCS)	1 per extraction batch	% Recovery = (Calculated Value / True Value)* 100%	Source of poor recovery is investigated and eliminated before proceeding with further analysis. Corrective actions are: Biased high, samples ND – report without qualifications. Biased low – re-extract and reanalyze.	Analyst / Prep Analyst	Laboratory Accuracy / Method bias in ideal matrix	% recovery = true value * 100

QC Sample	Number / Frequency	Method / SOP Acceptance Criteria	Corrective Action	Title/position of person responsible for corrective action	Data Quality Indicator	Project Specific Measurement Performance Criteria
Field Duplicate	1 per 20 field samples	All Target Compounds RPD ≤ 50% (soil) RPD ≤ 30% (aqueous)	If the criterion is not met for the field duplicates, a careful examination of the sampling techniques, sample media, and analytical procedure, in conjunction with other analytical quality control criteria, will be conducted to identify the cause of the high RPD and the usefulness of the data. If one of the duplicate pair is detected above the method reporting limit (RL) and the remaining pair iND, then the data will be qualified as estimated, or rejected, depending upon the severity (i.e., > 2*RL)	Field Personnel	Sampling Precision	All Target Compounds RPD ≤ 50%
Matrix Spike (MS) and Matrix Spike Duplicate (MSD)	1 per 20 samples or one for each extraction batch	% Recovery = (Calculated Value – Sample Value / True Value) *100% For MSD, all target compounds RPD < 20%	If the recoveries indicate that the problem is procedure related, re-extraction and reanalysis is required. If the recoveries indicate that the failures are matrix-related, refer to Blank Spike as measure of method performance in clean matrix. The Project Chemist will be contacted, and a decision will be made to either report the data as is with a notation in the analytical narrative, or if the samples should be re-extracted and reanalyzed.	Analyst / Prep Analyst	Precision and Accuracy in Field Samples	% Recovery= (Calculated Value – Sample Value / TrueValue)*100% For MSD, all target compounds RPD < 20%

QC Sample	Number / Frequency	Method / SOP Acceptance Criteria	Corrective Action	Title/position of person responsible for corrective action	Data Quality Indicator	Project Specific Measurement Performance Criteria
Cooler Temperature Blank	One per cooler	4 ± 2°C	Notify Project Chemist. Project Chemist will evaluate effect on samples and indicate to laboratory whether to proceed with analysis. Resampling may be required.	Sample Custodian / Project Chemist	Accuracy in Field Samples	4 ± 2°C

°C Degrees Celsius

QAPP Worksheet #29: Project Documents and Records

(UFP-QAPP Manual Section 3.5.1)
(EPA 2106-G-05 Section 2.2.8)

Sample Collection and Field Records				
Record	**Generation**	**Verification**	**Storage location /archival**	**Other**
Field Notes (Field Notebook, Excavation Forms, Groundwater Sampling Forms)	Stantec Field Team Leader, and/or Field Sampling Tech	Stantec Project QAO	Project File	
Chain-of-Custody records	Stantec Field Team Leader, and/or Field Sampling Tech	Stantec Project QAO	Project File	
Daily Field Reports	Stantec Field Team Leader, and/or Field Sampling Tech	Stantec Project QAO	Project File	
Corrective Action Forms	Stantec Field Team Leader, and/or Field Sampling Tech	Stantec Project QAO	Project File	
Telephone Log and e-mails	Stantec Field Team Leader, and/or Field Sampling Tech	Stantec Project QAO	Project File	
Waste Manifests and Disposal Certifications	Stantec Field Team Leader, and/or Field Sampling Tech	Stantec Project QAO	Project File	

Project Assessments				
Record	**Generation**	**Verification**	**Storage location /archival**	**Other**
Field Audit Checklists	Stantec Field Team Leader, and/or Field Sampling Tech	Stantec Project QAO	Project File	
Data verification checklists	Stantec Data Validator	Stantec Project Chemist	Project File	
Data validation report	Stantec Data Validator	Stantec Project Chemist	Project File	
Data usability assessment report	Stantec Data Validator	Stantec Project Chemist	Project File	

Laboratory Records				
Record	**Generation**	**Verification**	**Storage location /archival**	**Other**
Corrective Action Forms	SGS Analyst	SGS Project Manager	Project File	
QC Results, Standard Prep logs, Run Logs, Instrument Tuning, Calibration, and Internal Standards	SGS Analyst	SGS Project Manager	Project File	
Data usability assessment report	Stantec Data Validator	Stantec Project Chemist	Project File	

Laboratory Data Deliverables				
Record	**Generation**	**Verification**	**Storage location /archival**	**Other**
Laboratory Data Reporting	SGS Project Manager	Stantec Data Validator	Project File (SGS) Stantec Server	
Cover Page, Narrative, Sample Receipt Log, CoC, Correction Action Form, QC Result, Standard Prep Logs, Run Logs, Instrument Tuning, calibration, and Internal Standards, Raw Data.	SGS Project Manager	SGS Program Manager Stantec Data Validator and Stantec Project Chemist	Project File (SGS) Project File (Stantec)	

QAPP Worksheet #31, 32, & 33: Assessments and Corrective Action

(UFP-QAPP Manual Section 4.1.1 and 4.1.2)
(EPA 2106-G-05 Section 2.4 and 2.5.5)

Assessments:

Assessment Type	Responsible Party & Organization	Number /Frequency	Estimated Dates	Assessment Deliverable	Deliverable Due Date
Readiness Review	Stantec Project Manager	One assessment one week prior to mobilization.	July 2023	Readiness review memorandum and checklist of equipment for air transport.	24 hours following assessment.
Field Sampling Technical System Audit	Stantec Chemistry QAO or Field Team Leader	Once each on first day of soil and groundwater sampling events.	July 2023	Stantec Internal Technical Audit	24 hours following assessment.
Laboratory Performance Audit	Laboratory QAO	Annual	TBD	SGS Laboratory	7 days after Audit.

Assessment Response and Corrective Action:

Assessment Type	Responsible Party for responding to assessment findings	Assessment Response Documentation	Timeframe for Response	Responsibility for Implementing Corrective Action	Responsibility for monitoring Corrective Action implementation
Readiness Review	Stantec Project Manager	Readiness Review Corrective Action response	24 hours from receipt of Readiness Review Memo	As Directed by PM	Stantec QAO
Field Sampling Technical System Audit	Stantec Chemistry QAO or Field Team Leader	Field Sampling Corrective Action Response	24 hours from receipt of memorandum	Field Team Leader	Stantec Field Team Leader
Laboratory Performance Audit	Laboratory QAO	Lab Performance Corrective Action Response	7 days following Performance Audit findings	SGS	SGS Laboratory QAO

QAPP Worksheet #34: Data Verification and Validation Inputs

(UFP-QAPP Manual Section 5.2.1 and Table 9)
(EPA 2106-G-05 Section 2.5.1)

Item	Description	Verification (completeness)	Validation (conformance to specifications)
Planning Documents/Records			
1	Approved Remedial Action Work Plan with HSP, UFP-QAPP, WMP, EPP, and QCP	X	
2	Contract	X	
Field Records			
3	Field logbooks	X	X
4	Equipment calibration records	X	X
5	Chain-of-Custody Forms	X	X
6	Sampling diagrams/surveys	X	X
7	Relevant Correspondence	X	X
8	Change orders/deviations	X	X
9	Field audit reports	X	X
10	Field corrective action reports	X	X
Analytical Data Package			
11	Cover sheet (laboratory identifying information)	X	X
12	Case narrative	X	X
13	Internal laboratory chain-of-custody	X	X
14	Sample receipt records	X	X
15	Sample chronology (i.e., dates and times of receipt, preparation, & analysis)	X	X
16	Communication records	X	X
17	Project-specific PT sample results	X	X
18	LOD/LOQ establishment and verification	X	X
19	Standards Traceability	X	X
20	Instrument calibration records	X	X
21	Definition of laboratory qualifiers	X	X
22	Results reporting forms	X	X
23	QC sample results	X	X
24	Corrective action reports	X	X
25	Raw data	X	X
26	Electronic data deliverable	X	X

QAPP Worksheet #35: Data Verification Procedures

(UFP-QAPP Manual Section 5.2.2)
(EPA 2106-G-05 Section 2.5.1)

Records Reviewed	Requirement Documents	Process Description	Responsible Person, Organization
Field Logbook	UFP-QAPP, SAP Section 3 of 2023 WP.	Verify that records are present and complete for each day of field activities. Verify that all planned samples, including field QC samples, were collected and that sample collection locations are documented. Verify that meteorological data were provided for each day of field activities. Verify that changes/exceptions are documented and were reported in accordance with requirements. Verify that any required field monitoring was performed, and results are documented.	Daily – Stantec Field Team Leader At conclusion of field activities - Project QAO
Chain-of-custody Forms	UFP-QAPP, SAP Section 3 of 2023 WP.	Verify the completeness of CoC records. Examine entries for consistency with the field logbook. Check that appropriate methods and sample preservation have been recorded. Verify that the required volume of sample has been collected and that sufficient sample volume is available for QC samples (e.g., MS/MSD). Verify that all required signatures and dates are present. Check for transcription errors.	Daily – Stantec Field Team Leader At conclusion of field activities – Stantec Project Chemist
Laboratory Deliverable	UFP-QAPP	Verify that the laboratory deliverable contains all records specified in the QAPP. Check sample receipt records to ensure sample condition upon receipt was noted, and any missing/broken sample containers were noted and reported according to plan. Compare the data package with the CoCs to verify that results were provided for all collected samples. Review the narrative to ensure all QC exceptions are described. Check for evidence that any required notifications were provided to project personnel as specified in the QAPP. Verify that necessary signatures and dates are present.	Before release – SGS Laboratory QAO Upon receipt – Stantec Data Validator
Audit Reports, Corrective Action Reports	UFP-QAPP	Verify that all planned audits were conducted. Examine audit reports. For any deficiencies noted, verify that corrective action was implemented according to plan.	Project QAO

QAPP Worksheet #36: Data Validation Procedures

(UFP-QAPP Manual Section 5.2.2)
(EPA 2106-G-05 Section 2.5.1)

Data Validator: Stantec

Analytical Group/Method:	VOCs SW846 SW8260D
Data deliverable requirements:	Level 4 laboratory report including raw data (pdf)
Analytical specifications:	WS 28, SOP listed on WS 23
Measurement performance criteria:	WS 12
Percent of data packages to be validated:	100%
Percent of raw data reviewed:	0%
Percent of results to be recalculated:	0%
Validation procedure:	EPA Level 3
Validation code:	S3VM
Electronic validation program/version:	None

The following data qualifiers will be applied during data validation. Potential impacts on project-specific data quality objectives will be discussed in the data validation report.

J – The result is an estimated value. The nature of the bias will be discussed in the data validation report.

E – Erroneous result (e.g., improper calculation, peak integration, etc.)

QAPP Worksheet #37: Data Usability Assessment

(UFP-QAPP Manual Section 5.2.3 including Table 12)
(EPA 2106-G-05 section 2.5.2, 2.5.3, and 2.5.4)

Identify personnel (organization and position/title) responsible for participating in the data usability assessment:

- Project Technical Lead/ QAO, Neil Robertson (Stantec)
- Program Chemist, Douglas Quist (Stantec)
- Project Field Team Leader/Project Chemist, Douglas Quist (Stantec)
- Data Validator, Sarah Von Raesfeld / Mary Privitera (Stantec)

Describe how the usability assessment will be documented:

- Data usability will be documented by the Data Validator and presented in the Data Validation Report for the project.

Summarize the data usability assessment process including statistics, equations, and computer algorithms that will be used to analyze the data:

QC acceptance limits and performance criteria provided in this QAPP are consistent with DoD QSM guidance. Laboratory SOPs have been written to conform to DoD QSM requirements. The Data Validator will perform Level III validation on 100% of the data.

Measurement Performance Criteria

Measurement performance criteria describe how the Project Quality Objectives (PQOs) will be satisfied. The number of samples and analytical parameters are described in each of the previous PQO discussions. The analytical data generated during removal activities will be evaluated based on QA/QC criteria as described in this QAPP. In addition, QA/QC evaluation criteria are included on Worksheets 12, 15, 24, and 28. Only data qualified by the laboratory as unusable (R) will be omitted from data analyses, because these data are considered rejected and unusable due to QA/QC failure and/or gross holding time exceedances.

Data quality and quantity are measured by comparison of resulting data with established acceptable limits for precision, accuracy, representativeness, comparability, and completeness (PARCC), and sensitivity. Data outside PARCC/sensitivity QA objectives will be evaluated, according to DoD QSM Version 5.4 (for each parameter) of this document and the criteria contained in the specified analytical methods, to determine what, if any, aspects of the data can be defensibly used to meet the project objectives.

Precision

Precision criteria for each analysis method to be used for the removal activities are summarized on DoD QSM Version 5.4. Precision measures the reproducibility of data or measurements under specific conditions. Precision is a quantitative measure of the variability of a group of data compared to their average value. Precision is usually stated in terms of RPD or percent relative standard deviation (%RSD). Measurement of precision depends upon sampling technique and analytical method. Field duplicate and laboratory duplicate samples will be used to measure precision for project samples. Both sampling and analysis will be as consistent as possible. For a pair of measurements, RPD will be used in this project. For a series of measurements, %RSD will be used. The total precision of a series of measurements can be related by the additive nature of the variances. Equations for RPD and %RSD are presented below:

$$\text{RPD} = \frac{[\text{D1} - \text{D2}]}{(\text{D1} + \text{D2})/2} \text{ x } 100\%$$

Where:

D1 and D2 = the two replicate values

$$\%\text{RSD} = \text{S}/x \text{ x } 100\%; \text{and } \text{S} = \frac{\sqrt{\sum_{I=1}^{n} \frac{(x_i - x)^2}{n-1}}}{x}$$

Where:

S	=	standard deviation
x_i	=	each observed value
x	=	the arithmetic mean of all observed values
n	=	total number of values

Accuracy

Accuracy criteria for each analysis method to be used for the removal activities are summarized in DoD QSM Version 5.4. Accuracy measures the bias in a measurement system that may result from sampling or analytical error. Sources of error that may contribute to poor accuracy are:

- Laboratory error,
- Sampling inconsistency,
- Field and/or laboratory contamination,
- Handling,
- Matrix interference, and
- Preservation

Equipment blanks, as well as matrix spike QC samples and LCSs, will be used to measure accuracy for project samples.

Accuracy is calculated using the percent recovery (%R) equation below:

$$\%R = \frac{SSR - SR}{SA} = 100$$

Where:

%R = %recovery

SSR = spike sample result

SR = sample result

SA = amount of spike added to sample

Representativeness

Representativeness criteria for each analysis method to be used for the project activities are summarized in DoD QSM Version 5.4. Representativeness expresses the degree to which sample data represent the characteristics of the media or matrix from which they are collected. Samples that are considered representative are properly collected to accurately characterize the nature and extent of contamination at a general sample location. Representativeness will be measured by using standardized collection methods (e.g., sampling, handling, and preserving) and laboratory analytical methods. Only data qualified "R" as unusable will not be used.

Comparability

Comparability criteria for each analysis method to be used are summarized in DoD QSM Version 5.4. Comparability expresses the confidence with which one data set can be compared with another data set from a different phase or from a different program. Comparability involves a composite of the above parameters, as well as design factors such as sampling and analytical protocols. An acceptable level of comparability will be accomplished through the consistent use of accepted analytical and sampling methods.

Completeness/Usability

Completeness criteria for each analysis method to be used are summarized in DoD QSM Version 5.4. Completeness is defined as the percentage of data that is judged to be valid to achieve the objectives of the investigation compared to the total amount of data. Completeness is discussed on a per analyte basis. A sample will consist of several analytes and/or compounds and very rarely is an entire sample considered unusable. Discussing completeness on a per analyte basis allows for use of the majority of the data. Deficiencies in the data may be due to sampling techniques, poor accuracy, precision, or laboratory error. While the deficiencies may affect certain aspects of the data, usable data may still be extracted from applicable samples. An evaluation of completeness necessarily involves an evaluation of the impact of missing data on the ability of the project to achieve its goals. The goal for completeness/usability is 95%.

The equation used for completeness is presented below:

$$C\ (\%) = \frac{D}{P \times n} \times 100$$

Where:

D = number of confident quantification's

P = number of analytical parameters per sample requested for analysis

n = number of samples requested for analysis

As indicated previously, assessment of completeness alone does not provide a comprehensive evaluation of data quality. Therefore, the percentage of usable and unusable data will also be calculated by the following equations:

% Usable Data = #Unqualified Positive + U + J+ UJ / Total Number of Results

% Unusable Data = R + UR/Total Number of Results

Separate % Completeness, % Usable Data, and % Unusable Data calculations will be performed for the project data.

Sensitivity

Sensitivity is defined as the ability to achieve the project-required limits as defined in Worksheet 15. If the laboratory method reporting limits are greater than the action limits because they not technically achievable, the affected compounds will be reported to the method detection limit.

Reconciliation

The PQOs described in Worksheet 11 will be examined to determine if the objective was met. Each analysis will first be evaluated for data quality in terms of impacts from the data validation process. Based on the quality of the data, its usability will be determined. Note, only data qualified by the laboratory as "R" as unusable will be excluded from use in the project. Based on the number of unusable analyses, it will be determined if the PQOs were met. As part of the reconciliation of the objective, conclusions will be drawn and any limitations on the usability of any of the data will be described. Data will be reviewed and reported as having either positive or negative bias (as appropriate). Trends in data results will be discussed, as appropriate, and discussed with the laboratory, if necessary.

ATTACHMENT 2

LABORATORY ACCREDITATIONS/CERTIFICATIONS AND ADEC APPROVALS

SCOPE OF ACCREDITATION TO ISO/IEC 17025:2017

SGS NORTH AMERICA INC. – ALASKA DIVISION
200 W Potter Dr.
Anchorage, AK 99518
Mary McDonald Phone: (907)-550-3203
mary.mcdonald@sgs.com

ENVIRONMENTAL

Valid To: December 31, 2023 Certificate Number: 2944.01

In recognition of the successful completion of the A2LA evaluation process, (including an assessment of the laboratory's compliance with ISO/IEC 17025:2017, the 2009 TNI Environmental Testing Laboratory Standard, and the requirements of the DoD Environmental Laboratory Accreditation Program (DoD ELAP) as detailed in version 5.4 of the DoD/DOE Quality Systems Manual for Environmental Laboratories) 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

Inductively Coupled Plasma Mass Spectroscopy, Gas Chromatography, Gas Chromatography/Mass Spectrometry, Ion Chromatography, Hazardous Waste Characteristics Tests, Total Organic Carbon

Parameter/Analyte	**Solid & Chemical Materials**	
	Aqueous	**Solid**
Metals		
Aluminum	EPA 6020B	EPA 6020B
Antimony	EPA 6020B	EPA 6020B
Arsenic	EPA 6020B	EPA 6020B
Barium	EPA 6020B	EPA 6020B
Beryllium	EPA 6020B	EPA 6020B
Boron	EPA 6020B	EPA 6020B
Cadmium	EPA 6020B	EPA 6020B
Calcium	EPA 6020B	EPA 6020B
Chromium	EPA 6020B	EPA 6020B
Cobalt	EPA 6020B	EPA 6020B
Copper	EPA 6020B	EPA 6020B
Iron	EPA 6020B	EPA 6020B
Lead	EPA 6020B	EPA 6020B
Magnesium	EPA 6020B	EPA 6020B
Manganese	EPA 6020B	EPA 6020B
Mercury	EPA 6020B EPA 7470A	EPA 6020B EPA 7471A
Molybdenum	EPA 6020B	EPA 6020B

Parameter/Analyte	**Solid & Chemical Materials**	
	Aqueous	**Solid**
Nickel	EPA 6020B	EPA 6020B
Potassium	EPA 6020B	EPA 6020B
Selenium	EPA 6020B	EPA 6020B
Silver	EPA 6020B	EPA 6020B
Sodium	EPA 6020B	EPA 6020B
Strontium	EPA 6020B	EPA 6020B
Thallium	EPA 6020B	EPA 6020B
Vanadium	EPA 6020B	EPA 6020B
Zinc	EPA 6020B	EPA 6020B
Metals Digestion Methods Toxicity Characteristic Leaching Procedure	EPA 3010A EPA 1311	EPA 3050B EPA 1311
Nutrients		
Nitrate (as N)	EPA 9056A	EPA 9056A
Nitrate + Nitrite (as N)	EPA 9056A	EPA 9056A
Nitrite (as N)	EPA 9056A	EPA 9056A
Demands		
Total Organic Carbon	EPA 9060A	EPA 9060A
Wet Chemistry		
Bromide	EPA 9056A	EPA 9056A
Chloride	EPA 9056A	EPA 9056A
Fluoride	EPA 9056A	EPA 9056A
Sulfate	EPA 9056A	EPA 9056A
Purgeable Organics (Volatiles)		
Acetone	EPA 8260D	EPA 8260D
Benzene	EPA 8260D EPA 8021B	EPA 8260D EPA 8021B
Bromobenzene	EPA 8260D	EPA 8260D
Bromochloromethane	EPA 8260D	EPA 8260D
Bromodichloromethane	EPA 8260D	EPA 8260D
Bromoform	EPA 8260D	EPA 8260D
Bromomethane	EPA 8260D	EPA 8260D
2-Butanone	EPA 8260D	EPA 8260D
n-Butylbenzene	EPA 8260D	EPA 8260D
sec-Butylbenzene	EPA 8260D	EPA 8260D
tert-Butylbenzene	EPA 8260D	EPA 8260D
Carbon Disulfide	EPA 8260D	EPA 8260D
Carbon Tetrachloride	EPA 8260D	EPA 8260D
Chlorobenzene	EPA 8260D	EPA 8260D
Chloroethane	EPA 8260D	EPA 8260D
Chloroform	EPA 8260D	EPA 8260D
Chloromethane	EPA 8260D	EPA 8260D

Parameter/Analyte	**Solid & Chemical Materials**	
	Aqueous	**Solid**
2-Chlorotoluene	EPA 8260D	EPA 8260D
4-Chlorotoluene	EPA 8260D	EPA 8260D
Dibromochloromethane	EPA 8260D	EPA 8260D
1,2-Dibromo-3-chloropropane (DBCP)	EPA 8260D EPA 8260D SIM	EPA 8260D EPA 8260D SIM
Dibromomethane	EPA 8260D	EPA 8260D
1,2-Dibromoethane (EDB)	EPA 8260D EPA 8260D SIM	EPA 8260D EPA 8260D SIM
1,2-Dichlorobenzene	EPA 8260D	EPA 8260D
1,3-Dichlorobenzene	EPA 8260D	EPA 8260D
1,4-Dichlorobenzene	EPA 8260D	EPA 8260D
Dichlorodifluoromethane	EPA 8260D	EPA 8260D
1,1-Dichloroethane	EPA 8260D	EPA 8260D
1,2-Dichloroethane	EPA 8260D	EPA 8260D
1,1-Dichloroethene	EPA 8260D	EPA 8260D
cis-1,2-Dichloroethene	EPA 8260D	EPA 8260D
trans-1,2-Dichloroethene	EPA 8260D	EPA 8260D
1,2-Dichloropropane	EPA 8260D	EPA 8260D
1,3-Dichloropropane	EPA 8260D	EPA 8260D
2,2-Dichloropropane	EPA 8260D	EPA 8260D
1,1-Dichloropropene	EPA 8260D	EPA 8260D
cis-1,3-Dichloropropene	EPA 8260D	EPA 8260D
trans-1,3-Dichloropropene	EPA 8260D	EPA 8260D
1,4-Dioxane	EPA 8260D SIM	EPA 8260D SIM
Ethyl Benzene	EPA 8260D EPA 8021B	EPA 8260D EPA 8021B
Freon 113	EPA 8260D	EPA 8260D
2-Hexanone	EPA 8260D	EPA 8260D
Hexachlorobutadiene	EPA 8260D	EPA 8260D
Isopropylbenzene	EPA 8260D	EPA 8260D
4-Isopropyltoluene	EPA 8260D	EPA 8260D
Methylene chloride	EPA 8260D	EPA 8260D
4-Methyl-2-pentanone	EPA 8260D	EPA 8260D
Methyl tert-butyl ether	EPA 8260D	EPA 8260D
Naphthalene	EPA 8260D	EPA 8260D
n-Propylbenzene	EPA 8260D	EPA 8260D
Styrene	EPA 8260D	EPA 8260D
1,1,1,2-Tetrachloroethane	EPA 8260D	EPA 8260D
1,1,2,2-Tetrachloroethane	EPA 8260D	EPA 8260D
Tetrachloroethene	EPA 8260D	EPA 8260D
Toluene	EPA 8260D EPA 8021B	EPA 8260D EPA 8021B
1,2,3-Trichlorobenzene	EPA 8260D	EPA 8260D
1,2,4-Trichlorobenzene	EPA 8260D	EPA 8260D
1,1,1-Trichloroethane	EPA 8260D	EPA 8260D
1,1,2-Trichloroethane	EPA 8260D	EPA 8260D

Parameter/Analyte	Solid & Chemical Materials	
	Aqueous	Solid
Trichloroethene	EPA 8260D	EPA 8260D
Trichlorofluoromethane	EPA 8260D	EPA 8260D
1,2,3-Trichloropropane	EPA 8260D EPA 8260D SIM	EPA 8260D EPA 8260D SIM
1,2,4-Trimethylbenzene	EPA 8260D	EPA 8260D
1,3,5-Trimethylbenzene	EPA 8260D	EPA 8260D
Vinyl Acetate	EPA 8260D	EPA 8260D
Vinyl Chloride	EPA 8260D	EPA 8260D
Xylenes, Total	EPA 8260D EPA 8021B	EPA 8260D EPA 8021B
1,2-Xylene (O-Xylene)	EPA 8260D EPA 8021B	EPA 8260D EPA 8021B
1,3-Xylene & 1,4-Xylene (M+P-Xylene)	EPA 8260D EPA 8021B	EPA 8260D EPA 8021B
Toxicity Characteristic Leaching Procedure (ZHE)	EPA 1311	EPA 1311
Volatiles Preparation Methods	EPA 5030B	EPA 5035A
Total Petroleum Hydrocarbons (TPH)		
Gasoline Range Organics	EPA 8015C AK 101 (AK State Method)	EPA 8015C AK 101 (AK State Method)
GRO Preparation Methods	EPA 5030B	EPA 5035A
Diesel Range Organics	EPA 8015C AK 102 (AK State Method)	EPA 8015C AK 102 (AK State Method)
Residual Range Organics	EPA 8015C AK 103 (AK State Method)	EPA 8015C AK 103 (AK State Method)
DRO/RRO Preparation Methods	EPA 3520C Modified EPA 3630C	EPA 3550C, EPA 3630C
Extractable Organics (Semi-volatiles)		
Acenaphthene	EPA 8270D EPA 8270D SIM	EPA 8270D EPA 8270D SIM
Acenaphthylene	EPA 8270D EPA 8270D SIM	EPA 8270D EPA 8270D SIM
Aniline	EPA 8270D	EPA 8270D
Anthracene	EPA 8270D EPA 8270D SIM	EPA 8270D EPA 8270D SIM
Azobenzene	EPA 8270D	EPA 8270D
Benzoic Acid	EPA 8270D	EPA 8270D
Benzo(a)anthracene	EPA 8270D EPA 8270D SIM	EPA 8270D EPA 8270D SIM
Benzo(b)fluoranthene	EPA 8270D EPA 8270D SIM	EPA 8270D EPA 8270D SIM
Benzo(k)fluoranthene	EPA 8270D EPA 8270D SIM	EPA 8270D EPA 8270D SIM
Benzo(ghi)perylene	EPA 8270D EPA 8270D SIM	EPA 8270D EPA 8270D SIM

Parameter/Analyte	Solid & Chemical Materials	
	Aqueous	Solid
Benzo(a)pyrene	EPA 8270D EPA 8270D SIM	EPA 8270D EPA 8270D SIM
Benzyl Alcohol	EPA 8270D	EPA 8270D
Bis (2-chloroethoxy) Methane	EPA 8270D	EPA 8270D
Bis (2-chloroethyl) Ether	EPA 8270D	EPA 8270D
Bis (2-chloroisopropyl) Ether	EPA 8270D	EPA 8270D
Bis (2-ethylhexyl) Phthalate	EPA 8270D	EPA 8270D
4-bromophenylphenyl Ether	EPA 8270D	EPA 8270D
Butyl Benzyl Phthalate	EPA 8270D	EPA 8270D
Carbazole	EPA 8270D	EPA 8270D
4-Chloroaniline	EPA 8270D	EPA 8270D
4-Chloro-3-methylphenol	EPA 8270D	EPA 8270D
1-Chloronaphthalene	EPA 8270D	EPA 8270D
2-Chloronaphthalene	EPA 8270D	EPA 8270D
2-Chlorophenol	EPA 8270D	EPA 8270D
4-Chlorophenyl Phenyl Ether	EPA 8270D	EPA 8270D
Chrysene	EPA 8270D EPA 8270D SIM	EPA 8270D EPA 8270D SIM
Dibenzo(a,h)anthracene	EPA 8270D EPA 8270D SIM	EPA 8270D EPA 8270D SIM
Dibenzofuran	EPA 8270D	EPA 8270D
1,2-Dichlorobenzene	EPA 8270D	EPA 8270D
1,3-Dichlorobenzene	EPA 8270D	EPA 8270D
1,4-Dichlorobenzene	EPA 8270D	EPA 8270D
3,3'-Dichlorobenzidine	EPA 8270D	EPA 8270D
2,4-Dichlorophenol	EPA 8270D	EPA 8270D
2,6-Dichlorophenol	EPA 8270D	EPA 8270D
Diethyl Phthalate	EPA 8270D	EPA 8270D
2,4-Dimethylphenol	EPA 8270D	EPA 8270D
Dimethyl Phthalate	EPA 8270D	EPA 8270D
di-n-Butyl Phthalate	EPA 8270D	EPA 8270D
di-n-Octyl Phthalate	----------------------------	EPA 8270D
2,4-Dinitrophenol	EPA 8270D	EPA 8270D
2,4-Dinitrotoluene	EPA 8270D	EPA 8270D
2,6-Dinitrotoluene	EPA 8270D	EPA 8270D
Fluoranthene	EPA 8270D EPA 8270D SIM	EPA 8270D EPA 8270D SIM
Fluorene	EPA 8270D EPA 8270D SIM	EPA 8270D EPA 8270D SIM
Hexachlorobenzene	EPA 8270D	EPA 8270D
Hexachlorobutadiene	EPA 8270D	EPA 8270D
Hexachlorocyclopentadiene	EPA 8270D	EPA 8270D
Hexachloroethane	EPA 8270D	EPA 8270D
Indeno(1,2,3-cd)pyrene	EPA 8270D EPA 8270D SIM	EPA 8270D EPA 8270D SIM
Isophorone	EPA 8270D	EPA 8270D

Parameter/Analyte	**Solid & Chemical Materials**	
	Aqueous	**Solid**
1-Methylnaphthalene	EPA 8270D EPA 8270D SIM	EPA 8270D EPA 8270D SIM
2-Methylnaphthalene	EPA 8270D EPA 8270D SIM	EPA 8270D EPA 8270D SIM
2-Methyl-4,6-dinitrophenol	EPA 8270D	EPA 8270D
2-Methylphenol (As O cresol)	EPA 8270D	EPA 8270D
3 & 4-Methylphenol (As P & M cresol)	EPA 8270D	EPA 8270D
Naphthalene	EPA 8270D EPA 8270D SIM	EPA 8270D EPA 8270D SIM
2-Nitroaniline	EPA 8270D	EPA 8270D
3-Nitroaniline	EPA 8270D	EPA 8270D
4-Nitroaniline	EPA 8270D	EPA 8270D
Nitrobenzene	EPA 8270D	EPA 8270D
2-Nitrophenol	EPA 8270D	EPA 8270D
4-Nitrophenol	EPA 8270D	EPA 8270D
n-Nitrosodimethylamine	EPA 8270D	EPA 8270D
n-Nitrosodi-n-propylamine	EPA 8270D	EPA 8270D
n-Nitrosodiphenylamine	EPA 8270D	EPA 8270D
Pentachlorophenol	EPA 8270D	EPA 8270D
Phenanthrene	EPA 8270D EPA 8270D SIM	EPA 8270D EPA 8270D SIM
Phenol	EPA 8270D	EPA 8270D
Pyrene	EPA 8270D EPA 8270D SIM	EPA 8270D EPA 8270D SIM
Pyridine	EPA 8270D	EPA 8270D
1,2,4-Trichlorobenzene	EPA 8270D	EPA 8270D
2,4,5-Trichlorophenol	EPA 8270D	EPA 8270D
2,4,6-Trichlorophenol	EPA 8270D	EPA 8270D
Pesticides/Herbicides/PCBs		
Aldrin	EPA 8270D SIM	EPA 8270D SIM
alpha-BHC	EPA 8270D SIM	EPA 8270D SIM
alpha-Chlordane	EPA 8270D SIM	EPA 8270D SIM
beta-BHC	EPA 8270D SIM	EPA 8270D SIM
delta-BHC	EPA 8270D SIM	EPA 8270D SIM
gamma-BHC	EPA 8270D SIM	EPA 8270D SIM
gamma-Chlordane	EPA 8270D SIM	EPA 8270D SIM
Chlordane (technical)	EPA 8270D SIM	EPA 8270D SIM
4,4'-DDD	EPA 8270D SIM	EPA 8270D SIM
4,4'-DDE	EPA 8270D SIM	EPA 8270D SIM
4,4'-DDT	EPA 8270D SIM	EPA 8270D SIM
Dieldrin	EPA 8270D SIM	EPA 8270D SIM
Endosulfan I	EPA 8270D SIM	EPA 8270D SIM
Endosulfan II	EPA 8270D SIM	EPA 8270D SIM
Endosulfan Sulfate	EPA 8270D SIM	EPA 8270D SIM
Endrin	EPA 8270D SIM	EPA 8270D SIM

Parameter/Analyte	Solid & Chemical Materials	
	Aqueous	Solid
Endrin Aldehyde	EPA 8270D SIM	EPA 8270D SIM
Endrin Ketone	EPA 8270D SIM	EPA 8270D SIM
Heptachlor	EPA 8270D SIM	EPA 8270D SIM
Heptachlor Epoxide	EPA 8270D SIM	EPA 8270D SIM
Methoxychlor	EPA 8270D SIM	EPA 8270D SIM
PCB-1016 (Aroclor)	EPA 8082A	EPA 8082A
PCB-1221 (Aroclor)	EPA 8082A	EPA 8082A
PCB-1232 (Aroclor)	EPA 8082A	EPA 8082A
PCB-1242 (Aroclor)	EPA 8082A	EPA 8082A
PCB-1248 (Aroclor)	EPA 8082A	EPA 8082A
PCB-1254 (Aroclor)	EPA 8082A	EPA 8082A
PCB-1260 (Aroclor)	EPA 8082A	EPA 8082A
Semivolatile Extraction Methods	EPA 3520C Modified EPA 3535A	EPA 3550C EPA 3665A
Toxaphene	EPA 8270D SIM	EPA 8270D SIM
Toxicity Characteristic Leaching Procedure	EPA 1311	EPA 1311
Hazardous Waste Characteristics		
Corrosivity	EPA 9040C	EPA 9045D
Ignitability	EPA 1020B	----------------------------

Accredited Laboratory

A2LA has accredited

SGS NORTH AMERICA INC. - ALASKA DIVISION

Anchorage, AK

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 17025:2017, the 2009 TNI Environmental Testing Laboratory Standard, and the requirements of the Department of Defense Environmental Laboratory Accreditation Program (DoD ELAP) as detailed in version 5.4 of the DoD/DOE 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 *April 2017*).

Presented this 9th day of December 2021.

Vice President, Accreditation Services
For the Accreditation Council
Certificate Number 2944.01
Valid to December 31, 2023

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

THE STATE of ALASKA
GOVERNOR MICHAEL J. DUNLEAVY

Department of Environmental Conservation

DIVISION OF SPILL PREVENTION AND RESPONSE
Contaminated Sites Program
Laboratory Approval Program

555 Cordova Street
Anchorage, Alaska 99501
Main: 907.465.5390
Fax: 907.269.7649
cs.lab.cert@alaska.gov

January 10, 2022

Charles Homestead
SGS North America Inc. - Anchorage
200 W. Potter Drive
Anchorage, AK 99518-1605

RE: Contaminated Sites Laboratory Approval **17-021**

Thank you for submitting a completed application to the Alaska Department of Environmental Conservation's Contaminated Sites Laboratory Approval Program (CS-LAP), on January 7, 2022. Based on your lab's Department of Defense Environmental Laboratory Accreditation Program (DoD-ELAP) approval through the American Association for Laboratory Accreditation (A2LA), SGS North America Inc. - Anchorage, located at the above address, is granted ***Approved*** status to perform the analyses listed in the attached *Scope of Approval*, for Alaska contaminated sites projects, including underground storage tanks and leaking underground storage tank sites (UST/LUST), under the July 1, 2017 amendments to 18 AAC 78. This approval is effective January 10, 2022 and expires on ***January 31, 2024***.

Be aware that in accordance with 18 AAC 78.815(b) and 18 AAC 78.815(e), **any** changes in your lab's NELAP and/or DoD-ELAP approval status for **any** analytes in **any** methods or **any** matrices must be reported to the CS-LAP within 3 business days. This includes any suspension of any analyte(s) due to failed Performance Testing (PT) or Performance Evaluation (PE) samples.
FAILURE TO REPORT A CHANGE IN STATUS WILL RESULT IN REVOCATION OF ALL CS-LAP APPROVALS FOR ALL ANALYTES AND ALL METHODS IN ALL MATRICES FOR A PERIOD OF ONE YEAR.
Notification should be in writing sent to cs.lab.cert@alaska.gov. We recommend also contacting the CS-LAP by telephone to verify that the message was received.

If you have any questions, please contact the CS-LAP at (907) 465-5390, or by email at cs.lab.cert@alaska.gov. Labs are also highly encouraged to join the CS-LAP listserv by going to http://list.state.ak.us/mailman/listinfo/cs.lab.approval.

Respectfully,

Brian England

Attachment: Scope of Approval

Scope of Approval

CAS Number	Matrix	Hazardous Substance	Method	Accreditation Body
83-32-9	Soil	Acenaphthene	8270D	A2LA
83-32-9	Water	Acenaphthene	8270D	A2LA
83-32-9	Soil	Acenaphthene	8270D-SIM	A2LA
83-32-9	Water	Acenaphthene	8270D-SIM	A2LA
208-96-8	Soil	Acenaphthylene	8270D	A2LA
208-96-8	Water	Acenaphthylene	8270D	A2LA
208-96-8	Soil	Acenaphthylene	8270D-SIM	A2LA
208-96-8	Water	Acenaphthylene	8270D-SIM	A2LA
67-64-1	Soil	Acetone	8260D	A2LA
67-64-1	Water	Acetone	8260D	A2LA
309-00-2	Soil	Aldrin	8270D-SIM	A2LA
309-00-2	Water	Aldrin	8270D-SIM	A2LA
120-12-7	Soil	Anthracene	8270D	A2LA
120-12-7	Water	Anthracene	8270D	A2LA
120-12-7	Soil	Anthracene	8270D-SIM	A2LA
120-12-7	Water	Anthracene	8270D-SIM	A2LA
7440-36-0	Soil	Antimony (metallic)	6020B	A2LA
7440-36-0	Water	Antimony (metallic)	6020B	A2LA
7440-38-2	Soil	Arsenic, Inorganic	6020B	A2LA
7440-38-2	Water	Arsenic, Inorganic	6020B	A2LA
7440-39-3	Soil	Barium	6020B	A2LA
7440-39-3	Water	Barium	6020B	A2LA
56-55-3	Soil	Benz[a]anthracene	8270D	A2LA
56-55-3	Water	Benz[a]anthracene	8270D	A2LA
56-55-3	Soil	Benz[a]anthracene	8270D-SIM	A2LA
56-55-3	Water	Benz[a]anthracene	8270D-SIM	A2LA
71-43-2	Soil	Benzene	8260D	A2LA
71-43-2	Water	Benzene	8260D	A2LA
50-32-8	Soil	Benzo[a]pyrene	8270D	A2LA
50-32-8	Water	Benzo[a]pyrene	8270D	A2LA
205-99-2	Soil	Benzo[b]fluoranthene	8270D	A2LA
205-99-2	Water	Benzo[b]fluoranthene	8270D	A2LA
205-99-2	Soil	Benzo[b]fluoranthene	8270D-SIM	A2LA

Scope of Approval

CAS Number	Matrix	Hazardous Substance	Method	Accreditation Body
205-99-2	Water	Benzo[b]fluoranthene	8270D-SIM	A2LA
191-24-2	Soil	Benzo[g,h,i]perylene	8270D	A2LA
191-24-2	Water	Benzo[g,h,i]perylene	8270D	A2LA
191-24-2	Soil	Benzo[g,h,i]perylene	8270D-SIM	A2LA
191-24-2	Water	Benzo[g,h,i]perylene	8270D-SIM	A2LA
207-08-9	Soil	Benzo[k]fluoranthene	8270D	A2LA
207-08-9	Water	Benzo[k]fluoranthene	8270D	A2LA
207-08-9	Soil	Benzo[k]fluoranthene	8270D-SIM	A2LA
207-08-9	Water	Benzo[k]fluoranthene	8270D-SIM	A2LA
65-85-0	Soil	Benzoic Acid	8270D	A2LA
65-85-0	Water	Benzoic Acid	8270D	A2LA
100-51-6	Soil	Benzyl Alcohol	8270D	A2LA
100-51-6	Water	Benzyl Alcohol	8270D	A2LA
7440-41-7	Soil	Beryllium and compounds	6020B	A2LA
7440-41-7	Water	Beryllium and compounds	6020B	A2LA
111-44-4	Soil	Bis(2-chloroethyl)ether	8270D	A2LA
111-44-4	Water	Bis(2-chloroethyl)ether	8270D	A2LA
117-81-7	Soil	Bis(2-ethylhexyl)phthalate (DEHP)	8270D	A2LA
117-81-7	Water	Bis(2-ethylhexyl)phthalate (DEHP)	8270D	A2LA
108-86-1	Soil	Bromobenzene	8260D	A2LA
108-86-1	Water	Bromobenzene	8260D	A2LA
75-27-4	Soil	Bromodichloromethane	8260D	A2LA
75-27-4	Water	Bromodichloromethane	8260D	A2LA
75-25-2	Soil	Bromoform	8260D	A2LA
75-25-2	Water	Bromoform	8260D	A2LA
74-83-9	Soil	Bromomethane	8260D	A2LA
74-83-9	Water	Bromomethane	8260D	A2LA
85-68-7	Soil	Butyl Benzyl Phthalate	8270D	A2LA
85-68-7	Water	Butyl Benzyl Phthalate	8270D	A2LA
104-51-8	Soil	Butylbenzene, n-	8260D	A2LA
104-51-8	Water	Butylbenzene, n-	8260D	A2LA
135-98-8	Soil	Butylbenzene, sec-	8260D	A2LA
135-98-8	Water	Butylbenzene, sec-	8260D	A2LA

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CAS Number	Matrix	Hazardous Substance	Method	Accreditation Body
98-06-6	Soil	Butylbenzene, tert-	8260D	A2LA
98-06-6	Water	Butylbenzene, tert-	8260D	A2LA
7440-43-9	Soil	Cadmium	6020B	A2LA
7440-43-9	Water	Cadmium	6020B	A2LA
75-15-0	Soil	Carbon Disulfide	8260D	A2LA
75-15-0	Water	Carbon Disulfide	8260D	A2LA
56-23-5	Soil	Carbon Tetrachloride	8260D	A2LA
56-23-5	Water	Carbon Tetrachloride	8260D	A2LA
5103-71-9	Soil	Chlordane, α-	8270D-SIM	A2LA
5103-71-9	Water	Chlordane, α-	8270D-SIM	A2LA
5103-74-2	Soil	Chlordane, γ-	8270D-SIM	A2LA
5103-74-2	Water	Chlordane, γ-	8270D-SIM	A2LA
12789-03-6	Soil	Chlordane, Total	8270D-SIM	A2LA
12789-03-6	Water	Chlordane, Total	8270D-SIM	A2LA
106-47-8	Soil	Chloroaniline, p-	8270D	A2LA
106-47-8	Water	Chloroaniline, p-	8270D	A2LA
108-90-7	Soil	Chlorobenzene	8260D	A2LA
108-90-7	Water	Chlorobenzene	8260D	A2LA
67-66-3	Soil	Chloroform	8260D	A2LA
67-66-3	Water	Chloroform	8260D	A2LA
74-87-3	Soil	Chloromethane	8260D	A2LA
74-87-3	Water	Chloromethane	8260D	A2LA
91-58-7	Soil	Chloronaphthalene, Beta-	8270D	A2LA
91-58-7	Water	Chloronaphthalene, Beta-	8270D	A2LA
7440-47-3	Soil	Chromium (Total)	6020B	A2LA
7440-47-3	Water	Chromium (Total)	6020B	A2LA
218-01-9	Soil	Chrysene	8270D	A2LA
218-01-9	Water	Chrysene	8270D	A2LA
7440-50-8	Soil	Copper	6020B	A2LA
7440-50-8	Water	Copper	6020B	A2LA
N/A	Soil	Cresol, m- (3-Methylphenol) + Cresol, p- (4-Methylphenol)	8270D	A2LA
N/A	Water	Cresol, m- (3-Methylphenol) + Cresol, p- (4-Methylphenol)	8270D	A2LA
95-48-7	Soil	Cresol, o- (2-Methylphenol)	8270D	A2LA

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CAS Number	Matrix	Hazardous Substance	Method	Accreditation Body
95-48-7	Water	Cresol, o- (2-Methylphenol)	8270D	A2LA
72-54-8	Soil	DDD, 4,4’-	8270D-SIM	A2LA
72-54-8	Water	DDD, 4,4’-	8270D-SIM	A2LA
72-55-9	Soil	DDE, 4,4’-	8270D-SIM	A2LA
72-55-9	Water	DDE, 4,4’-	8270D-SIM	A2LA
50-29-3	Soil	DDT, 4,4’-	8270D-SIM	A2LA
50-29-3	Water	DDT, 4,4’-	8270D-SIM	A2LA
53-70-3	Soil	Dibenz[a,h]anthracene	8270D	A2LA
53-70-3	Water	Dibenz[a,h]anthracene	8270D	A2LA
132-64-9	Soil	Dibenzofuran	8270D	A2LA
132-64-9	Water	Dibenzofuran	8270D	A2LA
124-48-1	Soil	Dibromochloromethane	8260D	A2LA
124-48-1	Water	Dibromochloromethane	8260D	A2LA
106-93-4	Soil	Dibromoethane, 1,2- (Ethylene Dibromide)	8260D	A2LA
106-93-4	Water	Dibromoethane, 1,2- (Ethylene Dibromide)	8260D	A2LA
106-93-4	Soil	Dibromoethane, 1,2- (Ethylene Dibromide)	8260D-SIM	A2LA
106-93-4	Water	Dibromoethane, 1,2- (Ethylene Dibromide)	8260D-SIM	A2LA
74-95-3	Soil	Dibromomethane (Methylene Bromide)	8260D	A2LA
74-95-3	Water	Dibromomethane (Methylene Bromide)	8260D	A2LA
84-74-2	Soil	Dibutyl Phthalate	8270D	A2LA
84-74-2	Water	Dibutyl Phthalate	8270D	A2LA
95-50-1	Soil	Dichlorobenzene, 1,2-	8260D	A2LA
95-50-1	Water	Dichlorobenzene, 1,2-	8260D	A2LA
95-50-1	Soil	Dichlorobenzene, 1,2-	8270D	A2LA
95-50-1	Water	Dichlorobenzene, 1,2-	8270D	A2LA
541-73-1	Soil	Dichlorobenzene, 1,3-	8260D	A2LA
541-73-1	Water	Dichlorobenzene, 1,3-	8260D	A2LA
541-73-1	Soil	Dichlorobenzene, 1,3-	8270D	A2LA
541-73-1	Water	Dichlorobenzene, 1,3-	8270D	A2LA
106-46-7	Soil	Dichlorobenzene, 1,4-	8260D	A2LA
106-46-7	Water	Dichlorobenzene, 1,4-	8260D	A2LA
106-46-7	Soil	Dichlorobenzene, 1,4-	8270D	A2LA
106-46-7	Water	Dichlorobenzene, 1,4-	8270D	A2LA

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CAS Number	Matrix	Hazardous Substance	Method	Accreditation Body
91-94-1	Soil	Dichlorobenzidine, 3,3'-	8270D	A2LA
91-94-1	Water	Dichlorobenzidine, 3,3'-	8270D	A2LA
75-71-8	Soil	Dichlorodifluoromethane (Freon-12)	8260D	A2LA
75-71-8	Water	Dichlorodifluoromethane (Freon-12)	8260D	A2LA
75-34-3	Soil	Dichloroethane, 1,1-	8260D	A2LA
75-34-3	Water	Dichloroethane, 1,1-	8260D	A2LA
107-06-2	Soil	Dichloroethane, 1,2-	8260D	A2LA
107-06-2	Water	Dichloroethane, 1,2-	8260D	A2LA
75-35-4	Soil	Dichloroethylene, 1,1-	8260D	A2LA
75-35-4	Water	Dichloroethylene, 1,1-	8260D	A2LA
156-59-2	Soil	Dichloroethylene, 1,2-cis-	8260D	A2LA
156-59-2	Water	Dichloroethylene, 1,2-cis-	8260D	A2LA
156-60-5	Soil	Dichloroethylene, 1,2-trans-	8260D	A2LA
156-60-5	Water	Dichloroethylene, 1,2-trans-	8260D	A2LA
120-83-2	Soil	Dichlorophenol, 2,4-	8270D	A2LA
120-83-2	Water	Dichlorophenol, 2,4-	8270D	A2LA
78-87-5	Soil	Dichloropropane, 1,2-	8260D	A2LA
78-87-5	Water	Dichloropropane, 1,2-	8260D	A2LA
10061-01-5	Soil	Dichloropropene, cis-1,3-	8260D	A2LA
10061-01-5	Water	Dichloropropene, cis-1,3-	8260D	A2LA
10061-02-6	Soil	Dichloropropene, trans-1,3-	8260D	A2LA
10061-02-6	Water	Dichloropropene, trans-1,3-	8260D	A2LA
60-57-1	Soil	Dieldrin	8270D-SIM	A2LA
60-57-1	Water	Dieldrin	8270D-SIM	A2LA
N/A	Soil	Diesel Range Organics (C10 – C25)	AK 102	A2LA
N/A	Water	Diesel Range Organics (C10 – C25)	AK 102	A2LA
84-66-2	Soil	Diethyl Phthalate	8270D	A2LA
84-66-2	Water	Diethyl Phthalate	8270D	A2LA
105-67-9	Soil	Dimethylphenol, 2,4-	8270D	A2LA
105-67-9	Water	Dimethylphenol, 2,4-	8270D	A2LA
131-11-3	Soil	Dimethylphthalate	8270D	A2LA
131-11-3	Water	Dimethylphthalate	8270D	A2LA
51-28-5	Soil	Dinitrophenol, 2,4-	8270D	A2LA

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CAS Number	Matrix	Hazardous Substance	Method	Accreditation Body
51-28-5	Water	Dinitrophenol, 2,4-	8270D	A2LA
121-14-2	Soil	Dinitrotoluene, 2,4- (2,4-DNT)	8270D	A2LA
121-14-2	Water	Dinitrotoluene, 2,4- (2,4-DNT)	8270D	A2LA
606-20-2	Soil	Dinitrotoluene, 2,6- (2,6-DNT)	8270D	A2LA
606-20-2	Water	Dinitrotoluene, 2,6- (2,6-DNT)	8270D	A2LA
123-91-1	Soil	Dioxane, 1,4-	8260D-SIM	A2LA
123-91-1	Water	Dioxane, 1,4-	8260D-SIM	A2LA
959-98-8	Soil	Endosulfan I	8270D-SIM	A2LA
959-98-8	Water	Endosulfan I	8270D-SIM	A2LA
33213-65-9	Soil	Endosulfan II	8270D-SIM	A2LA
33213-65-9	Water	Endosulfan II	8270D-SIM	A2LA
1031-07-8	Soil	Endosulfan sulfate	8270D-SIM	A2LA
1031-07-8	Water	Endosulfan sulfate	8270D-SIM	A2LA
72-20-8	Soil	Endrin	8270D-SIM	A2LA
72-20-8	Water	Endrin	8270D-SIM	A2LA
75-00-3	Soil	Ethyl Chloride	8260D	A2LA
75-00-3	Water	Ethyl Chloride	8260D	A2LA
100-41-4	Soil	Ethylbenzene	8260D	A2LA
100-41-4	Water	Ethylbenzene	8260D	A2LA
206-44-0	Soil	Fluoranthene	8270D	A2LA
206-44-0	Water	Fluoranthene	8270D	A2LA
86-73-7	Soil	Fluorene	8270D	A2LA
86-73-7	Water	Fluorene	8270D	A2LA
N/A	Soil	Gasoline Range Organics (C6 – C10)	AK 101	A2LA
N/A	Water	Gasoline Range Organics (C6 – C10)	AK 101	A2LA
76-44-8	Soil	Heptachlor	8270D-SIM	A2LA
76-44-8	Water	Heptachlor	8270D-SIM	A2LA
1024-57-3	Soil	Heptachlor Epoxide	8270D-SIM	A2LA
1024-57-3	Water	Heptachlor Epoxide	8270D-SIM	A2LA
118-74-1	Soil	Hexachlorobenzene	8270D	A2LA
118-74-1	Water	Hexachlorobenzene	8270D	A2LA
87-68-3	Soil	Hexachlorobutadiene	8260D	A2LA
87-68-3	Water	Hexachlorobutadiene	8260D	A2LA

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CAS Number	Matrix	Hazardous Substance	Method	Accreditation Body
87-68-3	Soil	Hexachlorobutadiene	8270D	A2LA
87-68-3	Water	Hexachlorobutadiene	8270D	A2LA
77-47-4	Soil	Hexachlorocyclopentadiene	8270D	A2LA
77-47-4	Water	Hexachlorocyclopentadiene	8270D	A2LA
67-72-1	Soil	Hexachloroethane	8270D	A2LA
67-72-1	Water	Hexachloroethane	8270D	A2LA
591-78-6	Soil	Hexanone, 2-	8260D	A2LA
591-78-6	Water	Hexanone, 2-	8260D	A2LA
193-39-5	Soil	Indeno[1,2,3-cd]pyrene	8270D	A2LA
193-39-5	Water	Indeno[1,2,3-cd]pyrene	8270D	A2LA
78-59-1	Soil	Isophorone	8270D	A2LA
78-59-1	Water	Isophorone	8270D	A2LA
7439-92-1	Soil	Lead, Total	6020B	A2LA
7439-92-1	Water	Lead, Total	6020B	A2LA
7439-96-5	Soil	Manganese	6020B	A2LA
7439-96-5	Water	Manganese	6020B	A2LA
7439-97-6	Soil	Mercury (elemental)	6020B	A2LA
7439-97-6	Water	Mercury (elemental)	6020B	A2LA
72-43-5	Soil	Methoxychlor	8270D-SIM	A2LA
72-43-5	Water	Methoxychlor	8270D-SIM	A2LA
78-93-3	Soil	Methyl Ethyl Ketone (2-Butanone)	8260D	A2LA
78-93-3	Water	Methyl Ethyl Ketone (2-Butanone)	8260D	A2LA
108-10-1	Soil	Methyl Isobutyl Ketone (4-methyl-2-pentanone)	8260D	A2LA
108-10-1	Water	Methyl Isobutyl Ketone (4-methyl-2-pentanone)	8260D	A2LA
1634-04-4	Soil	Methyl tert-Butyl Ether (MTBE)	8260D	A2LA
1634-04-4	Water	Methyl tert-Butyl Ether (MTBE)	8260D	A2LA
75-09-2	Soil	Methylene Chloride	8260D	A2LA
75-09-2	Water	Methylene Chloride	8260D	A2LA
90-12-0	Soil	Methylnaphthalene, 1-	8270D	A2LA
90-12-0	Water	Methylnaphthalene, 1-	8270D	A2LA
90-12-0	Soil	Methylnaphthalene, 1-	8270D-SIM	A2LA
90-12-0	Water	Methylnaphthalene, 1-	8270D-SIM	A2LA
91-57-6	Soil	Methylnaphthalene, 2-	8270D	A2LA

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CAS Number	Matrix	Hazardous Substance	Method	Accreditation Body
91-57-6	Water	Methylnaphthalene, 2-	8270D	A2LA
91-57-6	Soil	Methylnaphthalene, 2-	8270D-SIM	A2LA
91-57-6	Water	Methylnaphthalene, 2-	8270D-SIM	A2LA
91-20-3	Soil	Naphthalene	8260D	A2LA
91-20-3	Water	Naphthalene	8260D	A2LA
91-20-3	Soil	Naphthalene	8270D	A2LA
91-20-3	Water	Naphthalene	8270D	A2LA
91-20-3	Soil	Naphthalene	8270D-SIM	A2LA
91-20-3	Water	Naphthalene	8270D-SIM	A2LA
7440-02-0	Soil	Nickel, Total	6020B	A2LA
7440-02-0	Water	Nickel, Total	6020B	A2LA
98-95-3	Soil	Nitrobenzene	8270D	A2LA
98-95-3	Water	Nitrobenzene	8270D	A2LA
62-75-9	Soil	Nitrosodimethylamine, N-	8270D	A2LA
62-75-9	Water	Nitrosodimethylamine, N-	8270D	A2LA
621-64-7	Soil	Nitroso-di-N-propylamine, N-	8270D	A2LA
621-64-7	Water	Nitroso-di-N-propylamine, N-	8270D	A2LA
86-30-6	Soil	Nitrosodiphenylamine, N-	8270D	A2LA
86-30-6	Water	Nitrosodiphenylamine, N-	8270D	A2LA
12674-11-2	Soil	PCB - Aroclor-1016	8082A	A2LA
12674-11-2	Water	PCB - Aroclor-1016	8082A	A2LA
11104-28-2	Soil	PCB - Aroclor-1221	8082A	A2LA
11104-28-2	Water	PCB - Aroclor-1221	8082A	A2LA
11141-16-5	Soil	PCB - Aroclor-1232	8082A	A2LA
11141-16-5	Water	PCB - Aroclor-1232	8082A	A2LA
53469-21-9	Soil	PCB - Aroclor-1242	8082A	A2LA
53469-21-9	Water	PCB - Aroclor-1242	8082A	A2LA
12672-29-6	Soil	PCB - Aroclor-1248	8082A	A2LA
12672-29-6	Water	PCB - Aroclor-1248	8082A	A2LA
11097-69-1	Soil	PCB - Aroclor-1254	8082A	A2LA
11097-69-1	Water	PCB - Aroclor-1254	8082A	A2LA
11096-82-5	Soil	PCB - Aroclor-1260	8082A	A2LA
11096-82-5	Water	PCB - Aroclor-1260	8082A	A2LA

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CAS Number	Matrix	Hazardous Substance	Method	Accreditation Body
N/A	Soil	PCB – Total	8082A	A2LA
N/A	Water	PCB – Total	8082A	A2LA
87-86-5	Soil	Pentachlorophenol	8270D	A2LA
87-86-5	Water	Pentachlorophenol	8270D	A2LA
85-01-8	Soil	Phenanthrene	8270D	A2LA
85-01-8	Water	Phenanthrene	8270D	A2LA
85-01-8	Soil	Phenanthrene	8270D-SIM	A2LA
85-01-8	Water	Phenanthrene	8270D-SIM	A2LA
108-95-2	Soil	Phenol	8270D	A2LA
108-95-2	Water	Phenol	8270D	A2LA
103-65-1	Soil	Propyl benzene	8260D	A2LA
103-65-1	Water	Propyl benzene	8260D	A2LA
129-00-0	Soil	Pyrene	8270D	A2LA
129-00-0	Water	Pyrene	8270D	A2LA
129-00-0	Soil	Pyrene	8270D-SIM	A2LA
129-00-0	Water	Pyrene	8270D-SIM	A2LA
N/A	Soil	Residual Range Organics (C25 – C36)	AK 103	A2LA
N/A	Water	Residual Range Organics (C25 – C36)	AK 103	A2LA
7782-49-2	Soil	Selenium	6020B	A2LA
7782-49-2	Water	Selenium	6020B	A2LA
7440-22-4	Soil	Silver	6020B	A2LA
7440-22-4	Water	Silver	6020B	A2LA
7440-24-6	Soil	Strontium	6020B	A2LA
7440-24-6	Water	Strontium	6020B	A2LA
100-42-5	Soil	Styrene	8260D	A2LA
100-42-5	Water	Styrene	8260D	A2LA
630-20-6	Soil	Tetrachloroethane, 1,1,1,2-	8260D	A2LA
630-20-6	Water	Tetrachloroethane, 1,1,1,2-	8260D	A2LA
79-34-5	Soil	Tetrachloroethane, 1,1,2,2-	8260D	A2LA
79-34-5	Water	Tetrachloroethane, 1,1,2,2-	8260D	A2LA
127-18-4	Soil	Tetrachloroethylene	8260D	A2LA
127-18-4	Water	Tetrachloroethylene	8260D	A2LA
7440-28-0	Soil	Thallium, Total	6020B	A2LA

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CAS Number	Matrix	Hazardous Substance	Method	Accreditation Body
7440-28-0	Water	Thallium, Total	6020B	A2LA
108-88-3	Soil	Toluene	8260D	A2LA
108-88-3	Water	Toluene	8260D	A2LA
8001-35-2	Soil	Toxaphene	8270D-SIM	A2LA
8001-35-2	Water	Toxaphene	8270D-SIM	A2LA
76-13-1	Soil	Trichloro-1,2,2-trifluoroethane, 1,1,2- (Freon 113)	8260D	A2LA
76-13-1	Water	Trichloro-1,2,2-trifluoroethane, 1,1,2- (Freon 113)	8260D	A2LA
87-61-6	Soil	Trichlorobenzene, 1,2,3-	8260D	A2LA
87-61-6	Water	Trichlorobenzene, 1,2,3-	8260D	A2LA
120-82-1	Soil	Trichlorobenzene, 1,2,4-	8260D	A2LA
120-82-1	Water	Trichlorobenzene, 1,2,4-	8260D	A2LA
120-82-1	Soil	Trichlorobenzene, 1,2,4-	8270D	A2LA
120-82-1	Water	Trichlorobenzene, 1,2,4-	8270D	A2LA
71-55-6	Soil	Trichloroethane, 1,1,1-	8260D	A2LA
71-55-6	Water	Trichloroethane, 1,1,1-	8260D	A2LA
79-00-5	Soil	Trichloroethane, 1,1,2-	8260D	A2LA
79-00-5	Water	Trichloroethane, 1,1,2-	8260D	A2LA
79-01-6	Soil	Trichloroethylene	8260D	A2LA
79-01-6	Water	Trichloroethylene	8260D	A2LA
75-69-4	Soil	Trichlorofluoromethane	8260D	A2LA
75-69-4	Water	Trichlorofluoromethane	8260D	A2LA
95-95-4	Soil	Trichlorophenol, 2,4,5-	8270D	A2LA
95-95-4	Water	Trichlorophenol, 2,4,5-	8270D	A2LA
88-06-2	Soil	Trichlorophenol, 2,4,6-	8270D	A2LA
88-06-2	Water	Trichlorophenol, 2,4,6-	8270D	A2LA
96-18-4	Soil	Trichloropropane, 1,2,3-	8260D	A2LA
96-18-4	Water	Trichloropropane, 1,2,3-	8260D	A2LA
96-18-4	Soil	Trichloropropane, 1,2,3-	8260D-SIM	A2LA
96-18-4	Water	Trichloropropane, 1,2,3-	8260D-SIM	A2LA
95-63-6	Soil	Trimethylbenzene, 1,2,4-	8260D	A2LA
95-63-6	Water	Trimethylbenzene, 1,2,4-	8260D	A2LA
108-67-8	Soil	Trimethylbenzene, 1,3,5-	8260D	A2LA
108-67-8	Water	Trimethylbenzene, 1,3,5-	8260D	A2LA

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CAS Number	Matrix	Hazardous Substance	Method	Accreditation Body
7440-62-2	Soil	Vanadium, Total	6020B	A2LA
7440-62-2	Water	Vanadium, Total	6020B	A2LA
108-05-4	Soil	Vinyl Acetate	8260D	A2LA
108-05-4	Water	Vinyl Acetate	8260D	A2LA
75-01-4	Soil	Vinyl Chloride	8260D	A2LA
75-01-4	Water	Vinyl Chloride	8260D	A2LA
179601-23-1	Soil	Xylene, m+p-	8260D	A2LA
179601-23-1	Water	Xylene, m+p-	8260D	A2LA
95-47-6	Soil	Xylene, o-	8260D	A2LA
95-47-6	Water	Xylene, o-	8260D	A2LA
1330-20-7	Soil	Xylene, Total	8260D	A2LA
1330-20-7	Water	Xylene, Total	8260D	A2LA
7440-66-6	Soil	Zinc, Total	6020B	A2LA
7440-66-6	Water	Zinc, Total	6020B	A2LA

THE STATE of ALASKA
GOVERNOR MICHAEL J. DUNLEAVY

Department of Environmental Conservation

DIVISION OF SPILL PREVENTION AND RESPONSE
Contaminated Sites Program
Laboratory Approval Program

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March 7, 2023

Charles Homestead
SGS North America Inc. - Anchorage
200 W. Potter Drive
Anchorage, AK 99518-1605

RE: Amendment #2 to Contaminated Sites Laboratory Approval **17-021**

On January 10, 2022, SGS North America Inc. – Anchorage received an approval letter from the Alaska Department of Environmental Conservation's Contaminated Sites Laboratory Approval Program (CS-LAP). That approval inadvertently omitted the compounds in the attached scope of approval. This approval amendment adds those compounds to your existing approval.

Please note that for the compounds added to your approval, the effective date is January 10, 2022. These compounds are retroactively added to cover the period between January 10, 2022, and March 7, 2023.

If you have any questions, please contact me at (907) 269-7526, or by email at brian.englund@alaska.gov.

Respectfully,

Brian Englund

Brian Englund
CS-LAP Approval Officer

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CAS Number	Matrix	Hazardous Substance	Method	Accreditation Body
71-43-2	Soil	Benzene	8021B	A2LA
71-43-2	Water	Benzene	8021B	A2LA
50-32-8	Soil	Benzo[a]pyrene	8270D-SIM	A2LA
50-32-8	Water	Benzo[a]pyrene	8270D-SIM	A2LA
218-01-9	Soil	Chrysene	8270D-SIM	A2LA
218-01-9	Water	Chrysene	8270D-SIM	A2LA
98-82-8	Soil	Cumene (Isopropylbenzene)	8260D	A2LA
98-82-8	Water	Cumene (Isopropylbenzene)	8260D	A2LA
53-70-3	Soil	Dibenz[a,h]anthracene	8270D-SIM	A2LA
53-70-3	Water	Dibenz[a,h]anthracene	8270D-SIM	A2LA
100-41-4	Soil	Ethylbenzene	8021B	A2LA
100-41-4	Water	Ethylbenzene	8021B	A2LA
206-44-0	Soil	Fluoranthene	8270D-SIM	A2LA
206-44-0	Water	Fluoranthene	8270D-SIM	A2LA
86-73-7	Soil	Fluorene	8270D-SIM	A2LA
86-73-7	Water	Fluorene	8270D-SIM	A2LA
193-39-5	Soil	Indeno[1,2,3-cd]pyrene	8270D-SIM	A2LA
193-39-5	Water	Indeno[1,2,3-cd]pyrene	8270D-SIM	A2LA
108-88-3	Soil	Toluene	8021B	A2LA
108-88-3	Water	Toluene	8021B	A2LA
179601-23-1	Soil	Xylene, m+p-	8021B	A2LA
179601-23-1	Water	Xylene, m+p-	8021B	A2LA
95-47-6	Soil	Xylene, o-	8021B	A2LA
95-47-6	Water	Xylene, o-	8021B	A2LA
1330-20-7	Soil	Xylene, Total	8021B	A2LA
1330-20-7	Water	Xylene, Total	8021B	A2LA