prepared for

U.S. Army,
Corps of Engineers,
Alaska District

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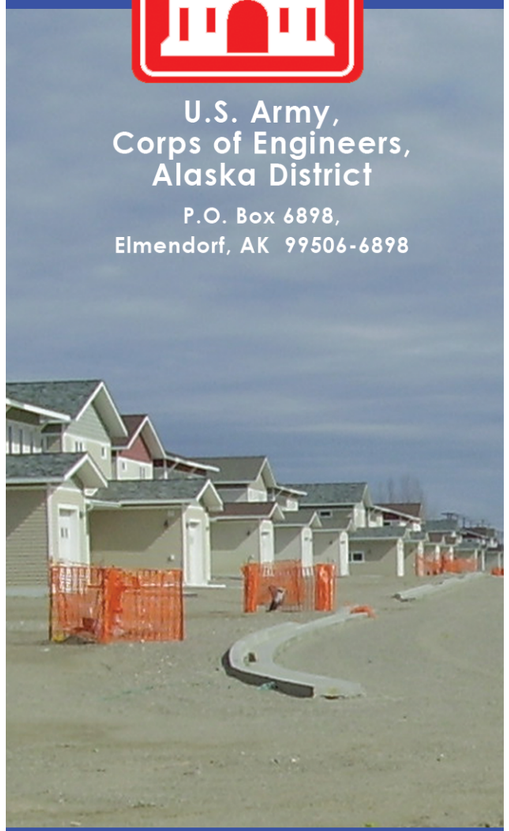

INTERIM DRAFT

357465

Remedial Investigation Management Plan

Volume 1

Contract No.
W911KB-05-D-0010
Task Order 0009

CH2MHILL
301 W. Northern Lights Blvd., Suite 601
Anchorage, AK 99503

prepared for
U.S. Army, Corps of Engineers, Alaska District
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Contents of the Interim Draft Remedial Investigation Management Plan

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Work Plan
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Responses to Comments
- Remedial Investigation Work Plan
- Field Sampling Plan
- Site Safety and Health Plan
- Community Involvement Plan
- Risk Assessment Work Plan
- Quality Assurance Project Plan

Field Sampling Plan
Site Safety and Health Plan
Community Involvement Plan

VOLUME 2

Risk Assessment Work Plan
Quality Assurance Project Plan
Geophysical Work Plan
MEC Support Work Plan
Drum and Debris Investigation Work Plan
Communications Plan
PCB Removal Action Work Plan
Long-Term Soil Stockpile Plan

Interim Draft

Remedial Investigation Work Plan

FWA 102 Former Communications Site
Fort Wainwright, Alaska

Prepared for

Department of the Army
U.S. Army Corps of Engineers,
Alaska District

P.O. Box 6898
Elmendorf AFB, Alaska 99506-6898

Contract No. W911KB-05-D-0010
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October 2007

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Abbreviations and Acronyms

°F	degrees Fahrenheit
AAC	Alaska Administrative Code
ADEC	Alaska Department of Environmental Conservation
ARAR	applicable or relevant and appropriate requirement
Army	U.S. Army
bgs	below ground surface
CAD	computer-aided design
CERCLA	Comprehensive Environmental Response, Compensation, and Liability Act
COPC	chemical of potential concern
CRREL	Cold Regions Research and Engineering Laboratory
CSM	conceptual site model
DEW	Distant Early Warning
DMM	discarded military munitions
DOD	U.S. Department of Defense
DPW	Directorate of Public Works
DQO	data quality objective
DRO	diesel range organics
ESQD	Explosive Safety Quantity Distance
ESRI	Environmental System Research Institute
EZ	Exclusion Zone
FCS	Former Communications Site
FS	Feasibility Study
ftp	file transfer protocol
GIS	geographic information system
GRO	gasoline range organics
HE	high explosive
HTRW	hazardous, toxic, and radioactive waste

LAAF	Ladd Army Airfield
LAFB	Ladd Air Force Base
MD	munitions debris
MEC	munitions and explosives of concern
mg/kg	milligrams per kilogram
MGFD	Munitions with the Greatest Fragmentation Distance
MI	multi-incremental
MRA	Munitions Response Area
MRS	Munitions Response Site
North Wind	North Wind, Inc.
Oasis	Oasis Environmental, Inc.
PCB	polychlorinated biphenyl
PID	photoionization detector
POL	petroleum, oil, and lubricants
ppm	parts per million
PSE	Preliminary Site Evaluation
PX	Post Exchange
QA	quality assurance
QAPP	Quality Assurance Project Plan
QC	quality control
RI	Remedial Investigation
RI/FS	Remedial Investigation/Feasibility Study
ROD	Record of Decision
RPM	Remedial Project Manager
RRO	residual range organics
SAS	School Age Services
SSHP	Site Safety and Health Plan
SVOC	semivolatile organic compound
TPH	total petroleum hydrocarbon

TSA	Transformer Service Area
U.S.	United States
USACE	U.S. Army Corps of Engineers
USAF	U.S. Air Force
USEPA	U.S. Environmental Protection Agency
USGS	U.S. Geological Survey
UXO	unexploded ordnance
VOC	volatile organic compound

SECTION 1

Introduction

1.1 Introduction

This Work Plan outlines the tasks to be performed for the Remedial Investigation (RI) and Feasibility Study (FS) that will occur at the Former Communications Site (FCS), also known as Taku Gardens Family Housing development, on Fort Wainwright, Alaska. This work will be conducted by CH2M HILL for the U.S. Army (Army) and is projected to be completed during 2007 and 2008.

This Work Plan and the following additional plans form the RI Management Plan for this RI/FS project:

- Field Sampling Plan
- Site Safety and Health Plan
- Quality Assurance Project Plan (QAPP)
- Community Involvement Plan
- Risk Assessment Work Plan
- Munitions and Explosives of Concern Support Work Plan
- Drum and Debris Investigation
- PCB Removal Action
- Long-Term Soil Stockpile Plan
- Communications Plan
- Geophysical Investigation Work Plan

The RI/FS is being conducted to ensure protection of human health and the environment in the FCS and adjacent affected areas. (See Figure 1-1. Figures are provided at the end of each section.) The main area of the site covers approximately 54 acres and is the location of 55 buildings containing 110 dwellings. These dwellings are finished, with the exception of major appliances, but cannot be inhabited until the concerns about potential human health risk have been addressed. The FCS has had a history of mixed uses, including, but not limited to, salvage/reclamation yard activities, debris disposal, garden plots, firefighter training, barracks and company headquarters, ammunition storage, and communication and radar systems. As a result of the mixed uses and past disposal practices that have occurred at the site, a variety of potential contaminants have been identified in the local soils and groundwater. The nature and extent of the contamination at the site has not been fully characterized. Preliminary site evaluations have documented potential contamination sources and exceedances of risk screening levels in site soils and groundwater. The RI will evaluate the risk to human health and the environment using a baseline risk assessment.

This Work Plan identifies gaps in the current data that need to be addressed to assess risks to human health and the environment and identifies the following areas of investigation (discussed in Section 4) that will be undertaken to address data gaps:

- Soil gas investigation
- Surface soil investigation

- Subsurface soil investigation
- Groundwater investigation
- Sediment investigation in swale area
- Onsite stockpile investigation
- Confirmation sampling for polychlorinated biphenyl (PCB) removal action

Some aspects of this project, such as the approach for collecting chemical data for human health risk assessment in areas of known buried metal debris and the approach for possible debris removal actions, have not been fully developed at this time. This additional site work will be defined later based on the results of ongoing geophysical and chemical investigations, and with appropriate consultation with Army, U.S. Environmental Protection Agency (USEPA), and Alaska Department of Environmental Conservation (ADEC) project managers. As these additional work tasks and approaches are defined and approved, they will be added to this work plan through addenda.

1.2 Objectives of the Remedial Investigation

The objectives of the RI are as follows:

- Collect sufficient data and use these data to quantify baseline chemical risk to expected site residents, current and future construction workers, and ecological receptors
- Collect sufficient data to determine whether Taku Gardens housing can be occupied
- Collect sufficient data to determine the nature and extent of surface and subsurface contamination
- Perform a geophysical investigation to determine locations and depths of buried debris within the Taku Gardens housing
- Conduct a drum/debris investigation to assess associated risk to human health or ecological receptors
- Determine distribution and associated risk from buried munitions and explosives of concern
- Collect sufficient data to confirm removal of PCB-contaminated soil and to characterize onsite soil piles for disposal or reuse and conduct other associated tasks as needed to facilitate occupancy of the housing development as soon as possible
- Prepare a draft RI report with results of the field investigation and recommendations for remedial actions, if required

All RI activities are planned for completion in 2007. The scope has been developed to be flexible so that expansion, if necessary, can be accommodated. If contamination is found to be more extensive than expected, field work in 2008 may be required to complete the RI.

1.3 Overview of Remedial Investigation Approach

To meet the RI objectives stated in the previous section, the following approach will be used:

- Collect soil gas samples at each building to quantify indoor air inhalation risk and across the site to locate contaminant sources and plumes
- Use existing surface soil sample data collected during previous investigations and near-surface soil sample data collected during the RI to quantify resident and visitor direct contact risk
- Collect additional subsurface soil samples to quantify trench worker direct contact risk and vadose zone source contamination
- Characterize groundwater across the site using temporary and permanent monitoring wells, to determine nature and extent of contamination and potential for migration of contaminants to the Chena River
- Collect sediment samples at the drainage swale to determine extent of offsite migration of contaminants through surface runoff
- Obtain soil borings and groundwater samples downgradient from known debris disposal areas to quantify chemical risk
- Investigate areas of debris disposal identified through geophysics by using direct excavation and confirmation sampling to characterize the nature of the buried debris and any associated chemical contamination that may cause risk to human health or ecological receptors

1.4 Project Organization and Responsibility

The overall organization of the RI/FS project, along with the interface of all key personnel, is shown in Figure 1-2. Personnel specifically identified at this time for this project are named in the organization chart.

The responsibilities of key personnel are as follows:

- **The U.S. Army Corps of Engineers (USACE) project manager –** The USACE project manager has the overall responsibility for coordination among Army, regulatory agencies, consultants, and removal contractors.
- **CH2M HILL project manager –** The CH2M HILL project manager is responsible for overseeing the work specified in the delivery order. Responsibilities include reviewing deliverables for quality, assigning resources, and monitoring budgets and schedules for compliance with project goals. The CH2M HILL project manager is also the point of contact for the USACE, Army, and regulators.
- **CH2M HILL program manager –** The CH2M HILL program manager is responsible for overall CH2M HILL performance on the USACE program. The CH2M HILL program manager is an alternative point of contact for the USACE and Army.

- **CH2M HILL risk assessor –** The CH2M HILL risk assessor is responsible for conducting the baseline human health and ecological risk assessments using appropriate regulatory guidance. The CH2M HILL risk assessor also helps plan the RI data collection so that appropriate data are collected to support the risk assessment.
- **CH2M HILL quality assurance (QA) manager –** The CH2M HILL QA manager acts independently of program management staff and is responsible for quality management, including training, surveillance, management of audits, and review and verification of corrective actions. The CH2M HILL QA manager arranges for and assists in internal QA audits of projects and assigns qualified staff to perform such audits. The QA manager assures that reviews and surveillances are documented in written form and that the generation and storage of QA records is in accordance with project procedures. If necessary, the QA manager delegates authority for QA on a particular project to designated QA staff with no other project responsibilities.
- **CH2M HILL senior reviewers –** The CH2M HILL senior reviewers are responsible for reviewing the technical quality of project deliverables and providing guidance to the project team. The senior reviewers for the FCS RI/FS have broad experience in RI techniques, remedial technologies, risk assessment, and regulatory policy in Alaska.
- **CH2M HILL health and safety manager –** The CH2M HILL health and safety manager is responsible for reviewing and approving health and safety plans, performing safety audits, and overseeing the site safety coordinators during field activities.
- **Field team leader –** A CH2M HILL field team leader will be in the field during all activities to assist in sampling activities, make field decisions, provide direction to the field team, provide progress reports and briefings to the CH2M HILL project manager, and implement the provisions of the RI Management Plan.

All personnel will have the training and experience necessary to accomplish their respective tasks. The field crews and supervisors who work on the RI/FS project will meet the training requirements for hazardous waste operations and emergency response. Any additional training given in the field or to laboratory personnel during the course of the project will be documented in field or laboratory training files.

1.5 Schedule of Activities of the FCS Remedial Investigation

A schedule for RI activities and reporting is shown in Figure 1-3.

1.6 Change Management

The Army, USEPA, and ADEC have agreed to conduct the RI at the FCS using the Triad approach. The RI Management Plan applies the Triad approach by using technically defensible methods necessary to complete site characterization activities. For this fast-paced project, changes in priorities, work plans, and actions are expected. The systematic project planning required for Triad is facilitated by an FCS Management Team representing the federal and state agencies and composed of technical experts that review and approve RI work tasks, planning documents, and specific investigation procedures. Dynamic work

strategies are incorporated by the FCS Management Team to ensure flexibility to needed changes can occur. As information is gathered, it is used to make decisions about what subsequent activities will best resolve outstanding data uncertainties, meet cleanup goals, or both. These work strategies are documented in this Work Plan for the RI Management Plan as addenda. Each addendum is prepared and submitted for Remedial Project Manager (RPM) review and approval and then appended to the RI Management Plan during the course of the RI.

As RI work plan details are finalized, it is understood that corresponding plan addenda may be required to address changes. All FCS Management Team members are kept informed of changes as they occur.

1.7 Document Management

As outlined in the RI schedule (Section 1.5), several RPM meetings are scheduled during the project to review plans and incoming data. Meeting minutes will be prepared and circulated for review and concurrence to document important decisions.

As an additional management tool, CH2M HILL has prepared an Information Request/Transmittal Log to track status of information requests from the team and transmittals to the team. The transmittal log will capture the transmittal and status of all plans, meeting minutes, and reports. This log will be updated throughout the planning and execution of the project.

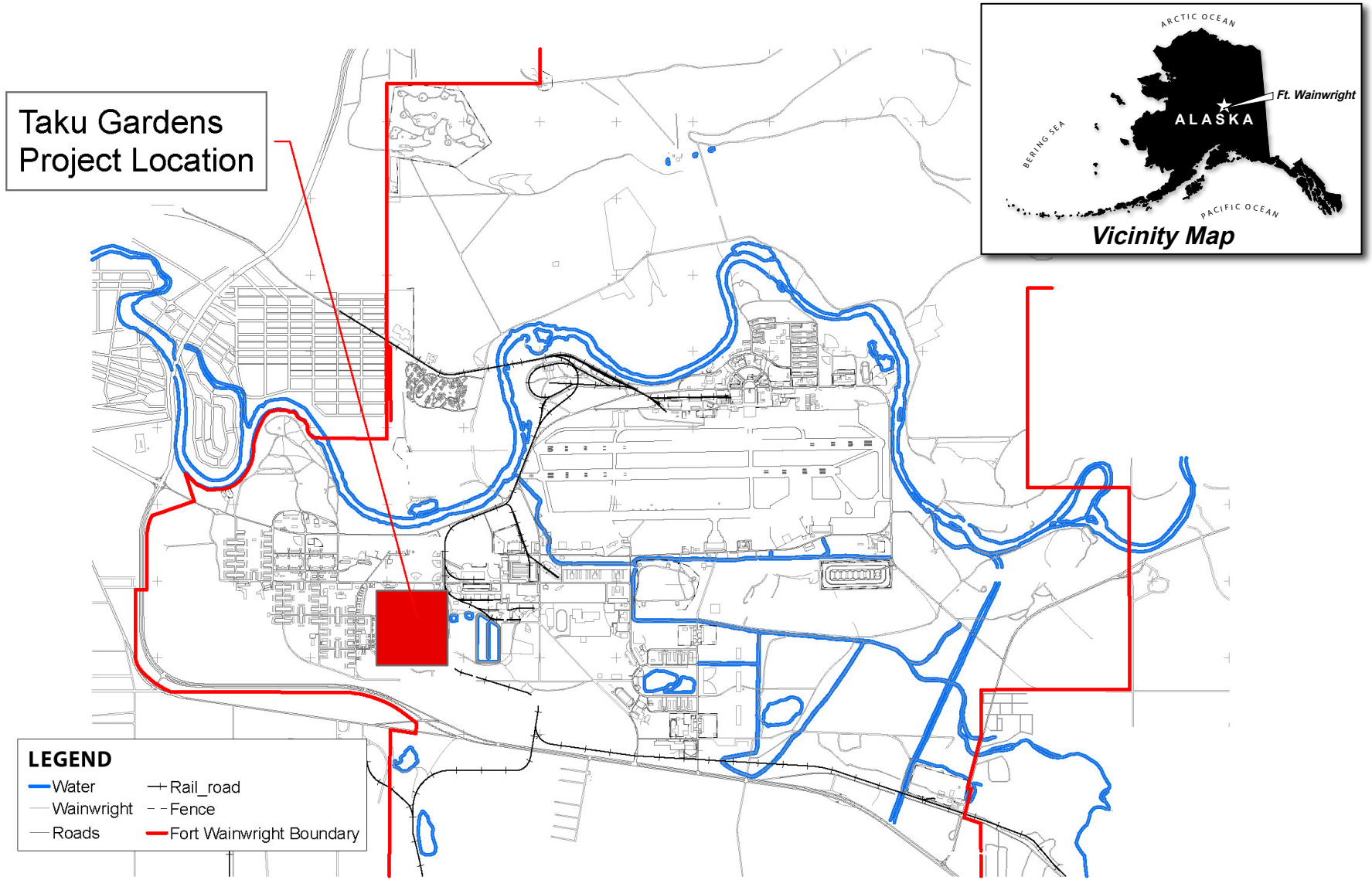
CH2M HILL will host a secure file transfer protocol (ftp) site. Current versions of all project plans, meeting minutes, and reports will be maintained at this site.

1.8 Data Management

The QAPP has been prepared to present the QA and quality control (QC) requirements designed to ensure that environmental data collected during this investigation will be of the appropriate quality to achieve project objectives. Specific details about field and laboratory quality controls, data management, validation, reporting and assessment, and QA deliverables are provided in the QAPP.

Laboratory data will be fed into a central database in biweekly data packets. Each data packet will be validated, then exported to a Microsoft Access database and posted on a secure project ftp site available to RPMs. Once in the central database, the data will be formatted for consistency to facilitate upload to a geographic information system (GIS).

CH2M HILL will create a project geodatabase in Environmental System Research Institute (ESRI) format. CH2M HILL will use the Spatial Data Standard for Facilities, Infrastructure, and Environment data model of the U.S. Department of Defense (DOD) for naming and organizing spatial data. Existing spatial data will be imported into the project geodatabase for use during the project. These data will include appropriate computer-aided design (CAD) and GIS layers. In addition to existing spatial data, final versions of all spatial data generated in support of the project will be incorporated into the project geodatabase. All spatial data will be documented with metadata, including information about source, time period, and accuracy, and will be stored in the project geodatabase.



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Approximate scale in feet

Source: North Wind, Inc., 2007.

FIGURE 1-1
Site Location Map
Remedial Investigation Work Plan
Former Communications Site, Fort Wainwright, Alaska

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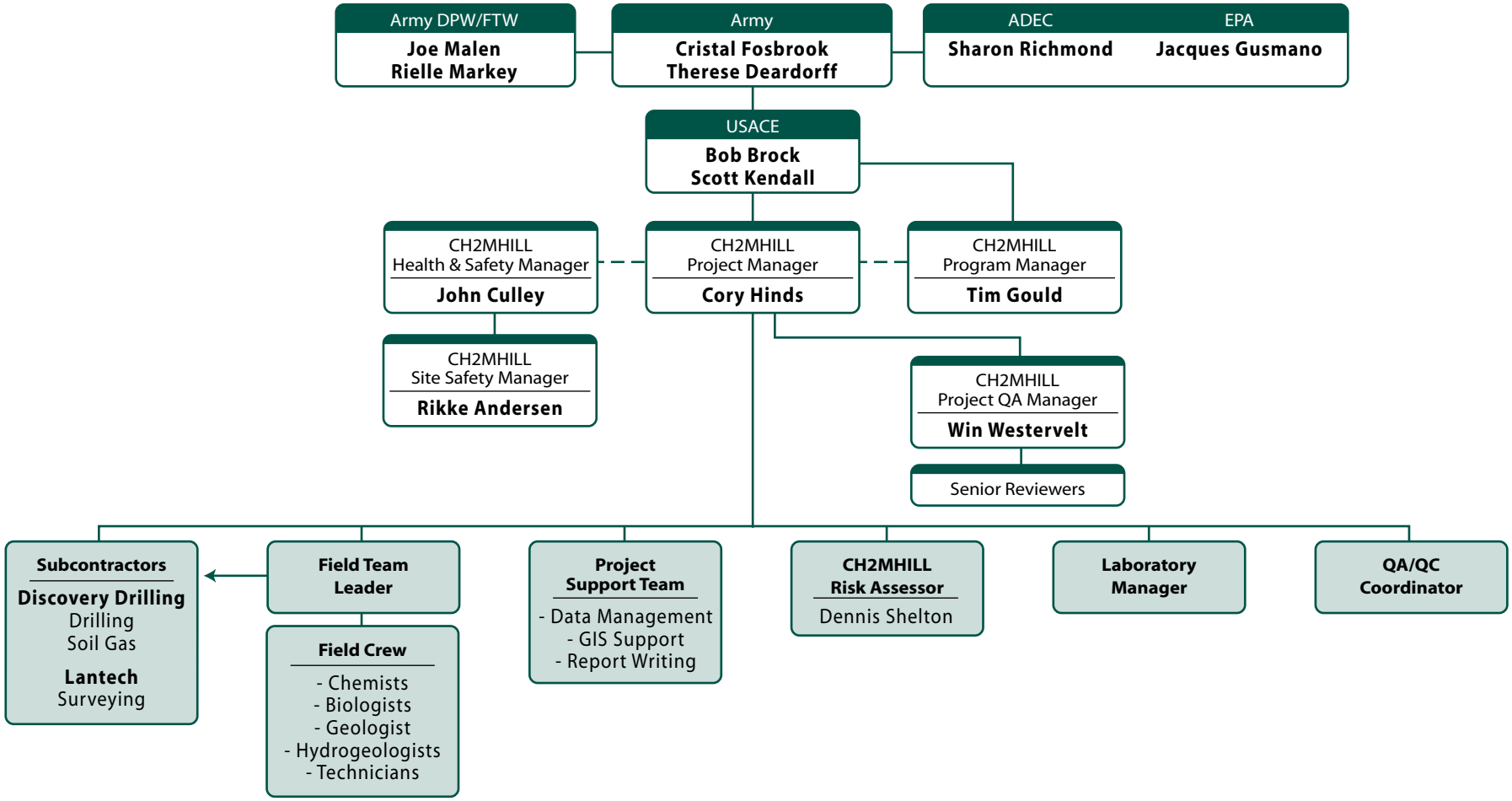
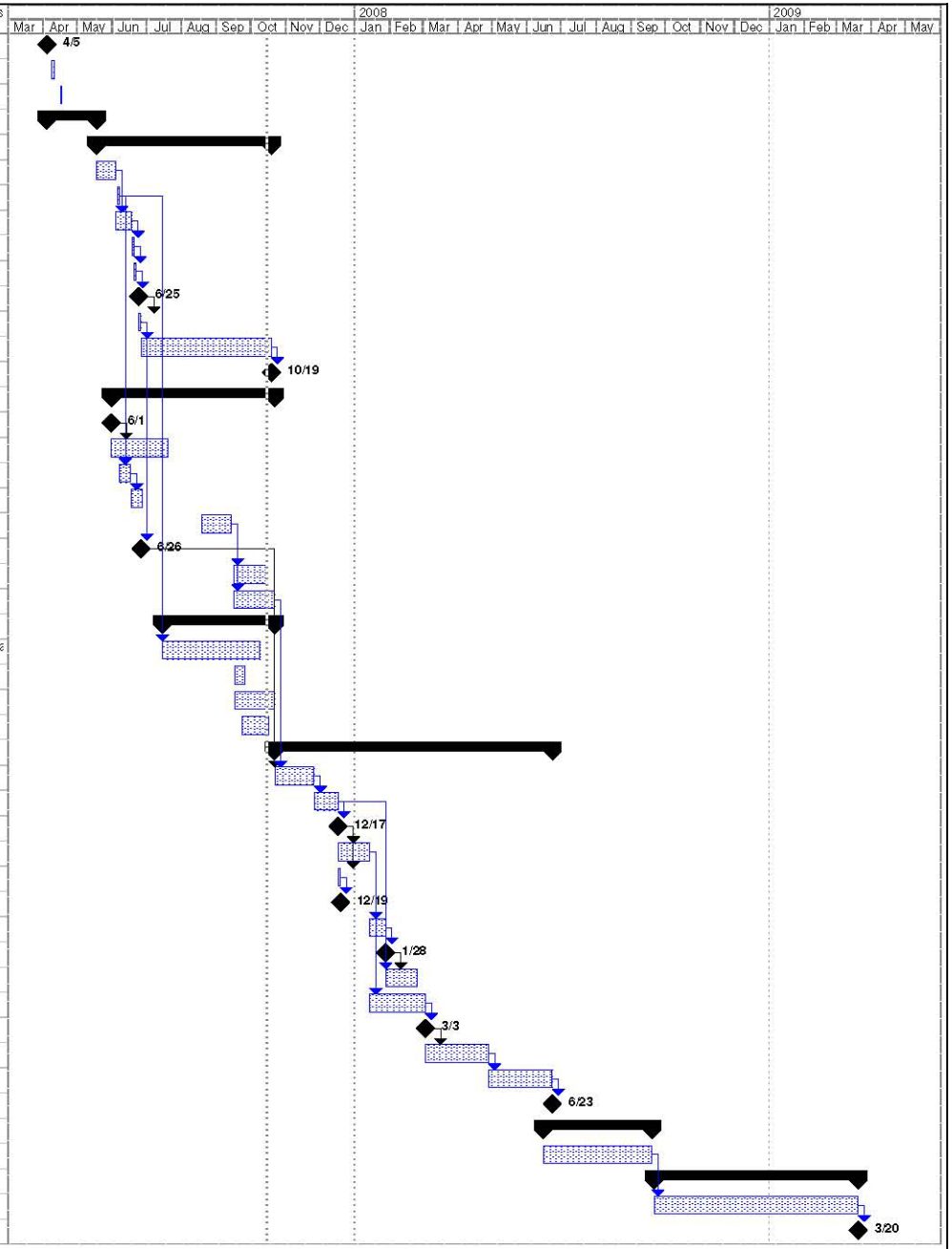


FIGURE 1-2
Project Organization Chart
Former Communications Site, Fort Wainwright, Alaska

ID	Task Name	Duration	Start	Finish	Predecess
1	Award	0 days	Thu 4/5/07	Thu 4/5/07	
2	CSM and DQO meetings	3 days	Mon 4/9/07	Wed 4/11/07	
3	RPM Scoping Meeting	1 day	Tue 4/17/07	Tue 4/17/07	
4	**Draft RI Management Plan**	**44 days**	**Thu 4/5/07**	**Fri 5/18/07**	
14	**Final RI Management Plan**	**123 days**	**Sat 5/19/07**	**Fri 10/19/07**	**13**
15	USACE and agency review of draft plan	17 days	Sat 5/19/07	Mon 6/4/07	13
16	RI Mgmt Plan review conference	2 days	Wed 6/6/07	Thu 6/7/07	
17	Prepare revised draft redline	14 days	Tue 6/5/07	Mon 6/18/07	15
18	Review and editing for revised draft	2 days	Tue 6/19/07	Wed 6/20/07	17
19	Reproduction of revised draft	2 days	Thu 6/21/07	Fri 6/22/07	18
20	Deliver revised (redline) draft	0 days	Mon 6/25/07	Mon 6/25/07	19
21	Additional USACE and agency review	2 days	Mon 6/25/07	Tue 6/26/07	20
22	Prepare final RI Mgmt Plan	84 days	Wed 6/27/07	Fri 10/19/07	21
23	Deliver final RI Mgmt Plan	0 days	Fri 10/19/07	Fri 10/19/07	22
24	**RI Field Work 2007**	**111 days**	**Fri 6/1/07**	**Mon 10/22/07**	
25	Award RI	0 days	Fri 6/1/07	Fri 6/1/07	
26	Evaluation of pre-RI data	45 days	Fri 6/1/07	Fri 7/20/07	25
27	Prepare specific work plan addenda	10 days	Fri 6/8/07	Sun 6/17/07	16
28	Mobilization	10 days	Mon 6/18/07	Wed 6/27/07	27
29	Soil gas sampling	20 days	Mon 8/20/07	Fri 9/14/07	
30	Surface soil sampling	0 days	Tue 6/26/07	Tue 6/26/07	21
31	Install borings and monitoring wells	21 days	Mon 9/17/07	Mon 10/15/07	29
32	Develop and sample monitoring wells	26 days	Mon 9/17/07	Mon 10/22/07	29
33	**Removal Actions (Jacobs Engineering)**	**71 days**	**Mon 7/16/07**	**Mon 10/22/07**	
34	Work plans	62 days	Mon 7/16/07	Tue 10/9/07	16FS+5 da
35	Drum removal	7 days	Tue 9/18/07	Wed 9/26/07	
36	Debris removal (scope TBD)	25 days	Tue 9/18/07	Mon 10/22/07	
37	PCB soil removal	18 days	Mon 9/24/07	Wed 10/17/07	
38	**Interim RI Report**	**175 days**	**Tue 10/23/07**	**Mon 6/23/08**	
39	Laboratory analysis	25 days	Tue 10/23/07	Mon 11/26/07	30,32
40	Data review and validation	15 days	Tue 11/27/07	Mon 12/17/07	39
41	Submit validated data to ADEC	0 days	Mon 12/17/07	Mon 12/17/07	40
42	Complete GIS database	20 days	Tue 12/18/07	Mon 1/14/08	41
43	Prepare graphics for RPM meeting	2 days	Tue 12/18/07	Wed 12/19/07	41
44	RPM meeting to discuss data	0 days	Wed 12/19/07	Wed 12/19/07	43
45	Prepare field data report	10 days	Tue 1/15/08	Mon 1/28/08	42
46	Submit field data report	0 days	Mon 1/28/08	Mon 1/28/08	45
47	Baseline risk assessment	20 days	Tue 1/29/08	Mon 2/25/08	40,46
48	Prepare draft interim RI report	35 days	Tue 1/15/08	Mon 3/3/08	42
49	Submit draft interim RI report	0 days	Mon 3/3/08	Mon 3/3/08	48
50	RPM review of draft interim RI report	40 days	Tue 3/4/08	Mon 4/28/08	49
51	Prepare final interim RI report	40 days	Tue 4/29/08	Mon 6/23/08	50
52	Submit final interim RI report	0 days	Mon 6/23/08	Mon 6/23/08	51
53	**RI Field Work 2008**	**70 days**	**Mon 6/16/08**	**Fri 9/19/08**	
54	Investigation activities TBD	70 days	Mon 6/16/08	Fri 9/19/08	
55	**Final RI Report**	**130 days**	**Mon 9/22/08**	**Fri 3/20/09**	
56	Reporting	130 days	Mon 9/22/08	Fri 3/20/09	54
57	Submit final RI report	0 days	Fri 3/20/09	Fri 3/20/09	56



Project: RI Schedule 082207
Date: Mon 10/15/07

Task | Progress | Summary | External Tasks | Deadline
Split | Milestone | Project Summary | External Milestone

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FIGURE 1-3

Remedial Investigation Schedule, Former Communications Site

SECTION 2

Preliminary Conceptual Site Models

The conceptual site model (CSM) describes the FCS and its environs, and presents hypotheses regarding sources of contamination, contaminant release mechanisms, nature and extent of contamination present, contaminant routes of migration, and potential impacts of contaminants on sensitive receptors. The conceptual model hypotheses are tested, refined, and modified throughout the RI. A CSM assists in the identification of data quality objectives, data needs, remedial alternatives, and general management decisions.

2.1 Background and Physical Setting

2.1.1 Post History

Fort Wainwright has been used by the DOD for military operations continuously since 1938. Originally known as LADD Army Airfield (LAAF), the post was established for cold weather experimentation. During World War II, LAAF served as a transfer point in the lend-lease program. Between 1942 and 1945, almost 8,000 combat and transport aircraft were transferred to Soviet aircrews at LAAF. In 1947, the newly formed U.S. Air Force (USAF) assumed control of LAAF, which was redesignated as LADD Air Force Base (LAFB). LAFB served as a resupply and maintenance base for the Remote Distant Early Warning (DEW) sites and experimental ice stations in the Arctic Ocean. During the Korean conflict, LAFB served as part of the defense network, and was the site of the first Nike Hercules Missile launch from a tactical missile site in December 1959.

On January 1, 1961, the Army resumed control over LAFB. The Army renamed the installation Fort Wainwright, after General Jonathan M. Wainwright, the commander of the forces defending the Bataan Peninsula in the Philippines at the beginning of World War II.

Fort Wainwright has been home to several units, including the 171st Infantry Brigade (Mechanized), a Nike-Hercules Battalion, the 172nd Infantry Brigade, and the 6th Infantry Division (Light). In July 2001, the Army announced its intent to make the 172nd Infantry Brigade, located at Forts Wainwright and Richardson, into one of the next four interim brigade combat teams as part of its transformation to a more strategic and responsive force.

The 172nd Stryker Brigade Combat Team is currently the major unit at Fort Wainwright. Subordinate commands include the 2nd Battalion, 1st Infantry Regiment; 1st Battalion, 17th Infantry Regiment; 4th Battalion, 11th Field Artillery and 123rd Aviation Regiment; 172nd Brigade Support Battalion; and 4th Squadron, 14th Cavalry Regiment. Fort Wainwright is also home to the Medical Activity-Alaska and Dental Activity-Alaska, and the Bassett Army Community Hospital. In the past decade, many new sets of family quarters have been built, as well as a Post Exchange (PX)/Commissary mall, physical fitness center, and maintenance facilities.

Fort Wainwright currently employs a large Department of the Army and DOD civilian work force and serves a daily population of more than 12,000 people, including soldiers, family

members, civilian employees, contractors, and other tenants, such as the Cold Regions Test Center of the Army and the Alaska Fire Service of the Bureau of Land Management.

2.1.2 Current Land Use

Fort Wainwright is located within the Fairbanks North Star Borough in interior Alaska and occupies 918,000 acres on the east side of Fairbanks. Fort Wainwright consists of a main post area, which is 2 miles east of Fairbanks between the Chena and Tanana rivers and has a cantonment area, a small arms range complex, and a close-in range complex. The main post was originally established as a cold-weather testing station. The Tanana Flats Training Area is across Tanana River from the main post, and the Yukon Training Area is 16 miles east-southeast of Fairbanks, adjacent to Eielson Air Force Base. Figure 1-1 provides a map of Fort Wainwright and the surrounding area.

The Fairbanks North Star Borough is lightly populated with several scattered developments. The City of Fairbanks (population 35,000) is on the western boundary of Fort Wainwright.

Primary missions at Fort Wainwright include training infantry soldiers in the arctic environment, testing equipment in arctic conditions, preparing troops for defense of the Pacific Rim, and rapid deployment of troops worldwide. Onsite industrial activities include operation, maintenance, and repair of fixed-wing aircraft, helicopters, tactical and nontactical vehicles. On-site industrial activities include drinking water production, power generation, and steam heat production.

2.1.3 Geology

Fort Wainwright and the adjacent Fairbanks area are part of the Highlands Area of the Interior Alaska and Western Alaska Physiographic Province. This province is underlain by metamorphic rocks of the Yukon-Tanana Terrain. The metamorphic rocks west of Fort Wainwright are known as the Birch Hill Sequence and are located approximately 400 feet below the floodplain of the Tanana and Chena rivers.

Overlying the Birch Hill Sequence is as much as 400 feet of fluvial deposits, which embody the unconfined aquifer known as the Chena Formation. These alluvial sediments aggraded primarily from net deposition from the Tanana River (Pewe et al., 1976; Anderson, 1970; Nelson, 1978).

Fort Wainwright is underlain by soil and unconsolidated sediment that consists of silt, sand, and gravel, ranging in thickness from 10 feet to more than 400 feet above bedrock. A 5-foot-thick surficial soil layer of fine-grained soil overlies the deeper alluvial deposits. Alluvial floodplain deposits underlay the surface soils and consist of varying proportions of sand and gravel, which are commonly layered. Where present, permafrost forms discontinuous confining layers that influence groundwater movement and distribution. The depth to permafrost, when present, ranges from 2 to 40 feet below ground surface (bgs). The greater depths are found on cleared and developed land surfaces, where thermal degradation of underlying permafrost occurs. Regionally, the thickness of the permafrost intervals varies from about 5 to 275 feet. The seasonal frost layer (or active layer) varies between 2 and 12 feet thick (Ecology & Environment, Inc., 1993).

Soil borings (Figure 2-1) drilled during the Preliminary Site Evaluation (PSE) II investigation (typically to depths of 15 feet) indicated that soil conditions at the FCS generally consist of sandy silt nearest the surface, changing to sand and sand with silt and gravel at around 8 to 10 feet.

2.1.4 Hydrogeology and Groundwater Use

The Chena River flows through Fort Wainwright and the City of Fairbanks, and eventually into the Tanana River south of the post. The Tanana River borders the south portion of Fort Wainwright. The main aquifer in the Fort Wainwright area is the Tanana Basin alluvial aquifer, a buried river valley. This aquifer ranges from a few feet thick at the base of Birch Hill to at least 300 feet thick under the main cantonment area of the post. The aquifer may reach a thickness of 700 feet in the Tanana River valley.

Groundwater movement between the Tanana and Chena rivers generally follows a northwest regional direction, similar to flow direction of the rivers. Seasonal changes in groundwater flow directions of up to 180 degrees are not uncommon adjacent to the rivers because of the effects of changing river stages in the Tanana River and the Chena River. Groundwater levels near the Chena River fluctuate greatly because of river stage and interactions with the Tanana River. Typically, groundwater levels rise during spring breakup and late summer runoff and drop during fall and winter when rainfall decreases and precipitation becomes snow.

The Tanana Basin alluvial aquifer beneath Fort Wainwright consists of deposits of the Chena Formation that vary in texture from sandy silt to coarse sandy gravel. The Chena Formation has a relatively high horizontal hydraulic conductivity in this area, estimated to be as high as 600 feet per day; whereas the vertical hydraulic conductivity has been estimated to be approximately 30 feet per day (U.S. Geological Survey [USGS], 1996). The Chena Formation deposits are extensive and thus provide a large capacity for groundwater storage.

Groundwater in the Tanana-Chena floodplain generally is considered to be unconfined in permafrost-free areas. In wells drilled through the permafrost, however, the aquifer exhibits the characteristic of a confined aquifer. Here the groundwater rises to levels above the deepest extent of the permafrost, which acts as a confining layer. The fact that these levels are similar to those of wells completed in unfrozen alluvium supports the interpretation that the basin alluvium is a single unit aquifer (USACE, 1991). Rates of movement for water and contaminants in frozen, porous soils depends on the overall temperature of the system, the thermal gradient, the occurrence of interconnected films of unfrozen water, and the general continuity of the permafrost. Previous studies indicate that the permafrost containing large, interconnected films of unfrozen water is most likely to be composed of fine-grained materials (silt and clay sizes). When encountered, permafrost should not be regarded as an impermeable material, but rather as a material of very low hydraulic conductivity (Sloan and van Everdingen, 1988).

Groundwater is the only source of potable water used at Fort Wainwright and the Fairbanks area. Approximately 95 percent of the potable water on Fort Wainwright is supplied through a single distribution system fed by two large-capacity wells in Building 3559 (see Figure 2-2). These wells are completed at a depth of approximately 80 feet bgs and provide

between 1.5 million and 2.5 million gallons of water per day to the Post Water Treatment Plant for processing and distribution. In addition to the main drinking water supply wells, five emergency standby supply wells are located around the cantonment area. These wells are completed between 80 and 120 feet bgs and are capable of pumping approximately 250,000 gallons per day per well. Physical information about the supply wells and backup wells 101 and 3565 is summarized in Table 2-1.

Golden Heart Utilities has four developed wells located 1¼ miles downgradient of the Fort Wainwright boundaries, on the banks of the Chena River. All municipal water users are currently supplied from the Golden Heart wells. At one time, College Utilities also supplied water from three water wells located along the Chena River, but these wells have not been used since 2002.

TABLE 2-1
Water Supply Wells near the FCS

Well Number	Location Relative to FCS Perimeter	Status and Period of Operation	Total Well Depth (ft)	Screen Interval (ft)	Slot Size (in.)	Pumping Rate (gpm)
3559A, B	100 ft northeast	Primary wells. Operated from 1988 to present.	100	60–80	0.110	1,040–1,740
101 (3563)	350 ft northeast	Backup well. Primary supply well from early 1950s until 1985.	109	96–109	0.125	1,200–1,400 before 1969; 750 after 1969
3565	300 ft east	Out of service. Primary supply well from 1969 to 1988. Backup well from 1988 to 1994.	208.6	180–200	0.100	1,000

Notes: gpm = gallons per minute
Source: CH2M HILL, 1996b.

The main drinking water supply wells near Buildings 3559A and 3559B are located approximately 100 feet northeast of the FCS perimeter. According to the groundwater flow modeling results from *Groundwater Modeling at Building 3564*, *Delivery Order 5*, *Fort Wainwright*, *Alaska* (CH2M HILL, 1996a), some of the capture zone of these wells overlaps with the eastern portion of the FCS. The backup supply wells are downgradient of the FCS area near Buildings 3563 and 3565, less than 400 feet from the FCS perimeter.

Groundwater at the FCS is typically encountered at 12 to 15 feet bgs (North Wind, Inc. [North Wind], 2006a) and the general flow direction is west-northwest toward the Chena River. At the FCS, the aquifer is generally highly transmissive, with areas of lower transmissivity associated with higher silt content or permafrost, which is discontinuous beneath the thaw zone across the site (Oasis Environmental, Inc. [Oasis], 2007a). General hydrogeological characteristics of the FCS are summarized in Table 2-2

TABLE 2-2
General Hydrogeological Characteristics of the FCS

Site Feature	Characteristic
Saturated soil type	Sand, silty sand, and gravelly sand. Gravel size increases with depth.
Depth to groundwater	15 feet
Estimated saturated thickness	400 feet
Hydraulic conductivity	600 feet/day (horizontal), 30 feet/day (vertical)
Groundwater flow direction	West-northwest under natural flow conditions; flow direction can be affected by nearby water supply wells
Groundwater temperature	54°F to 61°F (measured at PX Service Station during 1995)
Climate	Temperature extremes range from -62° to 96°F. Annual rainfall and snowfall are 10.4 and 65.4 inches, respectively.

Hoppe's Slough curves through the middle of the FCS creating an oxbow that enters and exits the FCS on the north side. The oxbow enters the north of the FCS and continues south, approximately 1,500 feet, where it curves around along the western edge of the FCS and exits the site at the north. The footprint of the slough and a second meander south of the slough were identified in 1948 photography and are partially visible in the late 1960s (Oasis, 2007a). Historical photographs document the filling of meanders as the area was developed. A geophysical survey performed in May 2004 indicated the material used to fill the slough included metallic objects (Oasis, 2007a). The influence on groundwater flow from the former slough channel is unknown and will be further evaluated as part of this RI.

2.1.5 Ecological Setting

The FCS is located in the Tanana-Kuskokwim Lowlands and consists of relatively flat terrain with no permanent surface water bodies. Man-made drainage swales have been installed south to north along the west side between the existing housing on White Street and the new Taku Gardens housing, and also east to west along the northwest section (North Wind, 2006a). The combined swale exits the site to the north, running west of the School Age Services (SAS). (See Figure 2-2.) After meandering through the new hospital grounds and other properties, runoff from the FCS area may join overland flow that eventually empties to the Chena River. The FCS swales are expected to contain flowing water only for a short time each year during periods of heavy spring runoff and summer storms.

The FCS is currently almost completely devoid of vegetation because of clearing activities to support construction. The area is also surrounded by an 8-foot chain link fence topped with three-strand barbed wire. Because access to the area by larger terrestrial organisms is limited by the fence and very little vegetation exists on site to provide food or cover to birds or smaller terrestrial organisms, the area is considered inadequate habitat for local species.

2.2 Former Communications Site Description and History

The FCS is currently the site of the Taku Gardens Family Housing development, a subdivision that includes 110 new duplexes (in 55 buildings. The buildings are intended to house Fort Wainwright personnel, but are presently unoccupied. An additional 10 unfinished buildings would house another 20 dwellings. Although the recent transfer of the 172nd Stryker Brigade to Fort Wainwright has created a pressing need to use this new housing, potential risk from the prior site uses to human health and the environment must be addressed first.

The Taku Gardens Family Housing development is located between Alder and Neely roads, east of White Street and west of the Fort Wainwright Power Plant. Figure 2-3 shows the layout of the Taku Gardens subdivision. The area was selected for military family housing in 2002 and 2003. Preconstruction geotechnical samples were collected in late 2003 and again in 2004. Geophysical testing was also completed during this time and indicated several large debris areas. Work began on the Taku Gardens Family Housing development in mid-2005 on foundations and underground utilities necessary for the construction of the 55 duplex buildings and two mechanical buildings.

During construction in July 2005, equipment operators uncovered PCBs and petroleum, oil, and lubricants (POL) contamination. They also unearthed an extensive array of buried debris, including crushed drums, scrapped equipment, and ordnance used for troop training in the 1940s and 1950s. The area was subsequently fenced and referred to as the "Exclusion Zone" (EZ) and divided into five distinct areas of concern (Subareas A through E). During construction, any munitions encountered were removed and properly disposed of.

The majority of the housing units have been finished, with the exception of major appliances. No additional subgrade activities are being conducted because of the potential presence of ordnance. The contractor has completed aboveground construction with the intent of winterizing the units by activating the electrical systems, steam mains, and glycol heat exchangers. Fencing of the entire site, including the EZ, was completed in the summer of 2007. The housing units will not be released for occupancy until additional investigations and risk assessment of both chemical contamination and ordnance are completed.

2.2.1 History of Investigations at the FCS

The FCS has a history of mixed uses, including, but not limited to, salvage/reclamation yard activities, debris disposal, garden plots, firefighter training, barracks and company headquarters, ammunition storage, and communication and radar systems. As a result of the mixed uses and past disposal practices, a variety of potential contaminants have been identified in the local soils and groundwater (refer to Section 2.5). The nature and extent of the contamination at the site have not been fully characterized. PSEs have documented potential contamination sources and exceedance of risk screening levels in site soils and groundwater as well as the presence of munitions and explosives of concern (MEC) in buried debris areas.

In 2005, a PSE was undertaken to summarize available information and begin to identify areas of contamination that had the potential to be a threat to human health or the

environment. PSE I, the first phase, integrated historical information with incidental findings of debris and contamination since site clearing and construction of Taku Gardens commenced in 2003.

A limited number of existing written records describing activities specifically occurring at the FCS during the course of its use are available. Much of what is known about the FCS has been inferred from examining and comparing historical photographs (dating from 1947 to the present), the 1958 Fort Wainwright "Master Plans," past geographical surveys, and concurrent military operations with similar missions conducted at other locations. In addition to the PSE findings, USACE geotechnical reports and site characterization data (such as PCB soil sample results from North Wind [2006a]) have supplemented site understanding. The results of this historical research indicate evidence of varied uses in the area, including the following:

- A salvage/reclamation yard occupying much of the FCS
- Disposal of debris/salvage material in the dry Chena River oxbow that extends through the site, in trenches in the salvage yard area, and possibly in other local depressions
- Garden plots
- Possible firefighting training activities (as evidenced by potential circular fire pits and a partially dismembered aircraft)
- Barracks and company headquarters extending into the northwest corner of the site
- Ammunition storage
- Communications and radar systems

Figure 2-4 shows an overlay of a 1956 historical photograph with site uses listed above over existing Taku Gardens housing.

Table 2-3 summarizes the activities and investigations conducted at the FCS from 2003 to present.

2.2.2 Description, History, and Contaminants of Potential Concern for FCS Subareas

During the course of evaluating historical data for the PSE I, the decision was made to divide the FCS source area into five subareas based on documented historical use and detected contaminants. These factors were subsequently used to determine the parameters and media that should be sampled during the RI to finish characterizing each subarea. Five subareas, known as Subareas A through E, are currently recognized within the FCS. These subareas are described briefly below and their locations are shown in Figure 2-3. The PSE I findings (Oasis, 2007a) include a more thorough description of the known historical information and an aerial photographic log of the FCS dating back to 1947. Chemicals of potential concern (COPCs) for each subarea were determined conservatively from examining historical information and existing data. COPCs are discussed below.

TABLE 2-3
Historical Activities/Investigations at the FCS

Date	Activity/Investigation	Responsible Party and Relevant Documents
October 2003	Limited geotechnical Investigation, including geophysical investigation and soil boring/soil sample collection	Cold Regions Research and Engineering Laboratory (CRREL) and Shannon and Wilson
November 2003-February 2004	Geotechnical Investigation, including collection of geological and chemical data from soil borings	Chemical Data Report, Foundation Studies HTRW Survey (FTW 251 and FTW 382) (USACE 2004a and 2004b)
March 2004-April 2004	Subsurface soil sampling in suspected PCB contaminated area. Results did not confirm previous detections.	North Wind
March 2004-2006	Explosive ordnance device (EOD) reports filed when suspected discarded military munitions were detected during excavation or removal actions	Military ordnance experts
May 2004	Geophysical investigation to detect buried debris and construction waste from former site activities	R&M Consultants, Inc.
2004	Site clearing activities removed some detected buried metal debris that were located in proposed housing locations	Fort Wainwright Directorate of Public Works (DPW)
April 2005	Construction of 64 military housing units known as Taku Gardens commenced. During construction, debris that affected housing foundations or roads was removed by the contractor. Shannon & Wilson collected analytical samples from trenches during installation of utilities.	Construction contractor
June 2005	Construction crews identify solvent-like odor in area of original Building 52.	Construction contractor
June-October 2005	Site Investigation activities, including investigation of soil and groundwater for fuels and PCBs in targeted areas. Surface wipe sampling also conducted for PCBs to evaluate the potential presence of contaminated dust.	North Wind Field Data Report (2006a)
2005 and 2006	Summary of information on past activities and identification of where hazardous materials impacts to soil and groundwater may exist.	Oasis PSE I Report (2007a)
2006	Field activities in support of the Preliminary Source Evaluation (PSE) II, including test pits, soil borings, soil gas, soil pile, geophysical, and debris investigations for PCBs, volatile organic compounds, semivolatile organic compounds, petroleum products, pesticides, metals, anions, explosives, perchlorate, and dioxins/dibenzofurans.	North Wind PSE II Report (2007)

2.2.2.1 Subarea A

Subarea A occupies the northeastern portion of the site. Historical records and photographs indicate that much of this subarea was used as a salvage yard and disposal area from around the 1940s to the 1960s. During this time period, aerial photographs indicate the storage and movement of large amounts of material (including scrap material and drums) around Subarea A and the use of the oxbow for burying debris. Other historical activities in the subarea included fire training exercises in the southwestern portion of the area, snow disposal in an area at the northeastern corner, and a company headquarters and barracks extending into the northwestern part of the area.

Investigations into Subarea A in preparation for the construction of the current dwellings (starting in 2002) have included geophysical surveys, soil borings (including chemical analysis), and debris excavation. These activities documented the existence of wide areas of a variety of metal debris (surface and buried), including vehicle parts and drums. In addition to metal debris, excavations also uncovered discarded military munitions (DMM) material in this area. Laboratory testing indicated the presence of low-level lead and PCB concentrations across Subarea A and a single residual-range organics (RRO) detection for a soil boring in the southeast corner of the subarea.

On the basis of information from investigations, the following COPCs have been identified for Subarea A:

- Gasoline-range organics (GRO)
- RRO
- Diesel-range organics (DRO)
- Volatile organic compounds (VOCs)
- Semivolatile organic compounds (SVOCs)
- PCBs
- Metals
- Explosives
- Herbicides
- Pesticides

2.2.2.2 Subarea B

Subarea B is located in the northern portion of the site between Subarea A and Subarea C. It was occupied by company barracks and headquarters in the 1940s to 1960s (the same set of structures that extended into the west side of Subarea A). Storage and handling of fuel and other hazardous materials in association with dwellings and operations occurring in this subarea appear to be the main source of contamination in Subarea B. In addition, salvage activities also appear to have occurred in Subarea B.

The primary contaminant for this subarea is DRO, which was encountered at high levels during construction-related excavation. Fuel contaminated soil was excavated and stockpiled until laboratory testing could be used to determine whether the stockpiles could be returned to the excavations or required offsite disposal. A total of 150 cubic yards was transported off site for disposal. Metal debris and DMM were also unearthed in this area during clearing and excavating for construction activities.

During the RI, Subarea B samples will be analyzed for fuel and other COPCs, including the following:

- GRO
- RRO
- DRO
- VOCs
- SVOCs
- Metals
- Pesticides
- Herbicides
- Explosives

2.2.2.3 Subarea C

Subarea C is located in the northwestern corner of the FCS and is bordered by Subarea B and the SAS on the east, Neely Road on the north, and existing housing areas to the west and south. The company headquarters and barracks that were located in Subareas A and B also extended into Subarea C.

Strange odors were detected during construction activities in Subarea C, including one that resembled sour milk. Samples were collected in the subarea and a single low-level PCB detection was recorded north of the current location of Building 1. Metal debris were also encountered and removed during construction.

Because the historical use of Subarea C is expected to have been very similar to that of Subarea B, COPCs for Subarea C include the same parameter groups:

- GRO
- RRO
- DRO
- VOCs
- SVOCs
- Metals
- Pesticides
- Herbicides
- Explosives

2.2.2.4 Subarea D

Subarea D is located in the southeast corner of the site. Historical information related to this subarea is derived from aerial photographs, the 1958 Master Plans, and a 1953 topographical survey. These records indicate salvage and disposal activities as well as possible ammunition storage occurred in Subarea D. The storage of transformers and presence of power poles is indicated by aerial photographs and was verified in an interview with Fire Captain Scott Hunt (Fort Wainwright Directorate of Public Works [DPW], 2006).

Recent construction activities at the FCS resulted in stockpiling and later reusing soil excavated throughout the site without full characterization. Soil samples from the berm at

the east and south perimeters of the site indicated PCBs at concentrations greater than 1 milligram per kilogram (mg/kg).

On the basis of findings from historical and recent activities, the following COPCs have been identified for Subarea D:

- GRO
- RRO
- DRO
- VOCs
- SVOCs
- PCBs
- Metals
- Explosives
- Herbicides
- Pesticides

2.2.2.5 Subarea E

Subarea E is located in the southwest corner of the FCS and includes the PCB EZ. Records indicate that this subarea was home to communication and radar systems, as well as a transformer service area starting in the late 1950s. Aerial photographs show several small structures and power poles that appear to match the 1958 Electrical Power and Lighting Facilities Master Plan. Because of the high voltage levels indicated in the plan, it can be assumed that a transformer would have been required to step down the voltage to a usable level. Garden plots and several small associated buildings were also present in the southwest portion of the subarea. The 1953 survey of LAAF indicated that ammunition may have been stored in Subarea E.

The power poles and associated transformers are suspected to be the source of the high PCB concentrations detected in Subarea E during construction work on the original Building 52. These suspicions seem at least partially confirmed by the fact that construction activities uncovered remnants of a wooden power pole and guy wire within the Building 52 excavation. Buried metal debris were also encountered during construction activities in this subarea, indicating the salvage area may also have extended into Subarea E.

On the basis of findings from historical and recent activities, the following COPCs have been identified for Subarea E:

- GRO
- RRO
- DRO
- VOCs
- SVOCs
- PCBs
- Metals
- Explosives
- Herbicides
- Pesticides

2.3 Sitewide Conceptual Site Model for Environmental Contaminants

Environmental contaminants may present a risk to human health and the environment through exposures. The degree of risk posed by contaminants is usually proportional to the toxicity of the contaminants, as well as the amount and duration of exposure. Figures 2-5 and 2-6 illustrate the sources of contamination, exposure pathways, and potential receptors.

2.3.1 Sources

Information about historical site activities has been supplemented from historical aerial photographs, records, and interviews (see PSE I report [Oasis, 2007a]). Potential sources of contamination at the FCS come from various spills and historical waste disposal practices. These sources include chemicals spilled during fire training activities, leaks from heating fuel tanks or pipelines used at headquarters and barracks, disposal of scrap metal and MEC at the former salvage yard, burial of drums of waste oil and chemicals, and discharge of transformer oil.

2.3.2 Transport Mechanisms

Contaminants have been released to soil by spills, leaks, and percolation/infiltration. Contaminants in soil may have been transported to other areas and additional media by the following actions:

- Physical soil movement (excavation and accidental and deliberate movement)
- Construction dewatering activities
- Breakdown resulting from biodegradation and mixture with other chemicals
- Fugitive dust emission
- Volatilization
- Surface runoff and overland flow (from spring thawing or flooding)
- Leaching to groundwater

2.3.3 Affected Media

Impacts to surface and subsurface soil have been confirmed at multiple areas. Some contaminants, such as POL at Subarea B, are known to have affected groundwater.

2.3.4 Identification of Preliminary Target Analytes List and Proposed Test Methods

A preliminary list of chemicals or categories of chemicals potentially stored, released, or both at the FCS was developed for each source area in the PSE I report. This list was used in the PSE I and PSE II reports to develop preliminary lists of COPCs and to select test methods to identify and quantify those analytes. The results of PSE II laboratory testing were used to refine the list of COPCs and the proposed test methods for the FCS. These COPCs are summarized by subarea in Section 2.2.2. Consistent with the dynamic planning element of the Triad Approach, a series of addenda providing additional details and information about the purpose and procedures for selected RI elements (such as for the sound berm, soil piles, soil gas, and groundwater) were prepared to supplement this Work Plan.

Specific chemicals proposed to be sampled for selected areas at FCS are listed in each addendum. The addenda were developed by incorporating comments and recommendations provided by the FCS Management Team, which includes representatives of the Army, USEPA, USACE, and ADEC.

Because of uncertainties in historical site uses and the possibility of unknown contaminant sources, the FCS Management Team has decided to run a full suite of analytical methods at most subareas.

2.3.5 Exposure Pathways

Potential exposure pathways (Figure 2-7) for human receptors include vapor intrusion to indoor air, migration to (and inhalation of) outdoor air, and inhalation/ingestion/dermal contact with contaminated soil and groundwater. Sediment samples collected from the drainage swales and groundwater samples collected from the FCS (including the former river slough) will be compared to media-specific concentrations. A screening level evaluation for birds and mammals will also be conducted. As an initial screening, these data will be directly compared to available sediment screening benchmarks (for example, National Oceanic and Atmospheric Administration Screening Quick Reference Tables [SQuiRTs]) and ambient water quality criteria. If site concentrations exceed screening levels, further evaluation of offsite areas will be considered.

2.3.6 Data Gaps

Data gaps for the FCS include the following:

1. Nature, extent, and associated risk from chemical contamination in surface soil, subsurface soil, and groundwater
2. Nature and extent of chemical contamination in soil stockpiles
3. Nature, extent, and associated risk from buried debris and MEC

The data collection activities proposed in this RI focus on addressing Data Gaps 1 and 2. Observations and characterization during test pit investigations and removal actions will be used to address Data Gap 3.

2.4 Conceptual Site Model for MEC

2.4.1 Introduction

Ordnance presents a hazard of direct physical injury resulting from the blast, heat, fragmentation, or acute chemical affects (for chemical warfare material) of munitions or munitions components. Because the FCS is a defense site known or suspected to contain ordnance, it falls under the definition of a Munitions Response Area (MRA). Subarea A, a former salvage yard, is located on the east side of the FCS and likely received DMM that was improperly disposed of while in operation as a salvage yard. Subarea A is considered a Munitions Response Site (MRS) because military munitions and related items have previously been discovered.

This component of the RI is intended to identify munitions response sources, evaluate the history of the FCS, and identify MEC found to date for use in developing the CSM for MEC and an initial risk evaluation.

2.4.2 Background

The subsections below present information on the site history, MEC located to date and potential impacts from MEC to the soil and groundwater.

2.4.2.1 Munitions Discovery

During the 2006 field season, an investigation was conducted on excavation spoils from housing subgrade preparation and test pits were installed to determine whether physical or chemical hazards were associated with the buried debris. Initial test pits were found to not contain much debris. Therefore, a high-resolution geophysical investigation was conducted to better identify sites containing debris for test pit locations. The test pits were all located in Subarea A. In addition, many stockpiles from the installation of subgrade infrastructure and general site grading were located around the perimeter of the construction site. Five stockpiles contained debris with very little soil; these were referred to as "debris piles." The stockpiles were located in the southern portion of Subarea E. In total, 30 test pits and 22 stockpiles were investigated during the 2006 field season; containing an estimated 3,600 cubic yards of material. The 2006 investigation represents sampling associated with previous construction activities over the entire site footprint as well as from test pits whose locations were biased to buried debris.

Eight ordnance items related to DMM were uncovered, including six items from the test pits and two from the debris piles. Table 2-4 identifies the items and includes a description, the location found (when available), evaluation of the item, disposition, and the associated hazard. The initial risk was determined by using the Army's field manual for risk management (Headquarters Department of the Army, 1998), and the specifics of the items were determined from explosive ordnance records. Additional items found, but not included in the table because they are related to munitions debris (MD), were 105-millimeter artillery round shipping tubes, an M10 chemical smoke tank, and rifle casings.

An uninvestigated anomaly exists in Subarea D that could contain additional scrap from facility operations with the potential for the presence of MEC. Additional items were located at the For Wainwright Gas Station, which lies just outside of the northeast corner of the FCS. Information on these items is presented in Table 2-5. The specific locations and depth of the items located were not detailed in the reports (U.S. Army Alaska, 2007a; Oasis, 2007a).

TABLE 2-4
Items Located at the Former Communications Site

Item	Description	Location Found, Date Found	Evaluation and Method of Destruction	Risk
1	AN MIAI, 20-pounds – for fragmentation	Debris Pile 2 North of Bldg 11 06/11/06	With high explosive filler and no fuze Detonation	Non-Intrusive the Risk from HE is Critical in Severity with a Seldom Encounter with overall II-D, Moderate Risk Direct Excavation without Construction Support (per USACE 75-1-2) equals II-C, High Risk Intrusive Activities without Construction Support (per USACE 75-1-2) equals II-D Moderate Risk.
2	M47 series Crushed empty, with burster tube	Debris Pile 4 North of Bldg 13 06/25/06	Shipping plug in nose, with a burster tube running full length. No HE Detonation	***No risk***
3	T-85 3.5-inch rocket	Test Pit 25 SE Unit 23, 3 to 4 inches bgs 07/21/06	Potential for mechanical detonation when subject to heat, shock, friction. Contained HE Detonation	Marginal severity and occasional encounter ***III-C = moderate risk***
4	M47 series Crushed empty with burster tube	Test Pit 27 NW Bldg 25, 3 feet bgs 07/26/06	No fuse, no filler, had HE burster charge Detonation	Same as for Item 1
5	M 106 8-inch projectile Inert filler	Test Pit 28 SW Bldg, 1 - 1.5 feet bgs 07/28/06	Ballistic training, no HE filler, inert Detonation	***No risk***
6	M 106 8-inch projectile Inert filler	Test Pit 29 SW Bldg 22, 3 to 3.5 feet bgs 07/29/06	Un-fuzed, no HE filler, inert Detonation	***No risk***
7	M47 series[a] Water filled	Test Pit 31 SW Bldg 22, 3 - 4 feet bgs 07/31/06	Determined to be water filled[a]	***No risk***
8	M47 series[a] Crushed, empty	Test Pit 31 SW Bldg 22, 3 to 4 feet bgs 07/31/06	Reported inert filler[a]	***No risk***

Notes:
[a] Explosive Ordnance Incident Report not available for review. Source: U.S. Army Alaska, 2007a. Oasis (2007a) indicated that Item 7 was destroyed by “conventional means,” which may be assumed to mean detonation.

HE = high explosive

TABLE 2-5
Items Located at the Fort Wainwright Gas Station

Item	Description	Date Found and Disposition	Evaluation	Risk
1	8-inch projectile Unarmed	04/12/04 Detonated	No HE and unarmed	***No risk***
2	8-inch projectile Unarmed	04/12/04 Detonated	No HE and unarmed	***No risk***
3	8-inch projectile Inert filler	04/08/04 Detonated	No HE and unarmed	***No risk***
4	75 mm recoilless rifle Expended/unarmed	04/08/04 Detonated	No HE and expended/unarmed	***No risk***
5	8-inch projectile Inert filler	04/09/04 Detonated	No HE	***No risk***
6	Old style bomb box	03/24/04 Scrap	No HE	***No risk***
7	37-mm recoilless projectile casing (2 items)	03/24/04 Scrap	No HE and inert	***No risk***
8	3.5-inch rocket training warhead	03/24/04 Scrap	No HE and unarmed	***No risk***
9	3.5-inch rocket	03/24/04 Scrap	No HE and expended	***No risk***
10	8-inch artillery round Unarmed	03/24/04 Detonated	Detonated	***Insufficient information for a determination***
11	8-inch artillery round Unarmed	04/20/04 Scrap	No HE	***No risk***

Notes:
HE = high explosive
mm = millimeter

Geophysical surveys indicate large areas of buried subsurface metal. Subsurface investigations of these areas identified the presence of DMM and other MD buried along with large quantities of scrap metal. Laboratory results suggest that MEC may also be present (refer to Section 2.4.2.3). From analysis of geophysical results, the main burial areas appear to be concentrated at two locations within Subarea A (Figure 2-8). The northern portion of Subarea A includes Buildings 15, 17, and 19, and the southern portion of Subarea A includes Buildings 22, 23, 24, and 25 as well as Building 48 immediately west.

2.4.2.2 Munitions Type and Risk

Historical records and aerial photograph review revealed no evidence that unexploded ordnance (UXO) were stored or disposed of on site. To date, UXO has not been discovered in Subarea A. UXO is not expected to be discovered because it represents items that have been prepared for action and fired, dropped, launched, or projected in a manner that represents a hazard and are typically located on a range.

The majority of the DMM items discovered to date have been inert, unarmed, or empty; typical of training rounds. The historical records, however, indicate that Area A has conclusive evidence that the subsurface contains items filled with high explosives (HEs) and a propellant. Additional items may remain. Therefore, Subarea A is determined to be "moderate to low risk" for non-intrusive actions, or actions that apply avoidance techniques (according to USACE Pamphlet EP 75-1-2 [2004c]). For intrusive actions that do not apply avoidance techniques, such as mechanical excavation, the risk is "high" as a result of impact. Consequently, MEC support is required during hazardous, toxic, and radioactive waste (HTRW) investigations, and construction activities by UXO-qualified persons are required during intrusive activities. For planned intrusive actions, an EZ or Explosive Safety Quantity Distance (ESQD), based on the Munitions with the Greatest Fragmentation Distance (MGFD), is required to protect non-essential personnel. To date, MEC and MD have not been discovered outside Subarea A, except for the gas station immediately northeast of the site (refer to Table 2-5).

2.4.2.3 Munitions Constituents

Explosives-related compounds were detected in 24 soil samples collected at the FCS from debris and soil piles (generated from the installation of site infrastructure) as well as from test pits installed to further characterize the site. The test pits were in the two primary metal debris burial locations as determined by the geophysical survey. All results are very low (less than 0.5 mg/kg) and flagged with a "J," meaning that the reported concentrations are estimated and below the method reporting limit. The reported concentrations are not sufficiently high to suggest a large source of explosives or degradation products in the area. The analytical results were compared to soil cleanup levels of the ADEC to gauge the possible regulatory implications for soil beyond the munitions response component of the project. None of the results was found to exceed the cleanup levels.

Explosives-related compounds were detected in groundwater samples collected at five monitoring wells. The highest concentrations of explosives-related compounds were reported in samples from MW06A, MW06B, and MW12 (in Subarea B immediately west of the eastern leg of the former river channel) where petroleum hydrocarbon concentrations were also elevated. Only trace levels of a single compound (nitrobenzene) were reported in samples from MW05 (western boundary of the FCS) and MW11 (center of the FCS), which did not contain petroleum hydrocarbons. The method used to analyze the groundwater samples for explosive-related compounds (Method SW8330) is known to experience interferences from petroleum hydrocarbons (that is, petroleum compounds may be mistaken for explosives-related compounds). In addition, most of the results are J-flagged. Given the possibility of interferences and the J flags, the actual presence of explosives-related compounds and degradation products in the groundwater at the site is uncertain. The reported concentrations, even if correct, are not sufficiently high to suggest a large

source of explosives in the area. The analytical results were compared to ADEC groundwater cleanup levels to gauge the possible regulatory implications for groundwater beyond the munitions response component of the project. Only one result (2,6-dinitrotoluene at MW06B) was found to exceed the cleanup level. This result may be biased high because of interferences from petroleum hydrocarbons.

2.4.3 Conceptual Site Model Development

The following subsections describe the development of the CSM for ordnance at the FCS, including the constraints of the CSM, data quality objectives (DQOs), site profile, and pathway analysis.

2.4.3.1 Conceptual Site Model Development

The development of this CSM generally follows *Engineering Design – Conceptual Site Models for Ordnance and Explosives (OE) and Hazardous, Toxic, and Radioactive Waste (HTRW) Projects*, Engineering Manual (EM) 1110-1-1200 (Department of the Army, 2003).

2.4.3.2 Data Quality Objectives

Table 2-6 presents a general summary of the DQOs for the MEC CSM. These objectives relate to the objective of ultimately releasing the housing units for occupancy. As previously discussed, the units have been readied for winter to protect them from the elements. They are not being released for occupancy. The current state of the knowledge is at the stage of "Inputs to Decision," as detailed in the following DQOs. Additional investigations are being conducted to further define additional inputs. The ultimate objective is to have the site released for occupancy either unrestricted or with the implementation of institutional controls in relation to subgrade intrusive activities.

TABLE 2-6
Inputs to Data Quality Objectives for the MEC CSM

Identify Decision	Inputs to Decision	Study Boundaries	Optimized Design
Can housing be occupied? How to make site safe for occupancy? Define non-MEC site areas Determine extent of removals, if any	Geophysical data pre-housing surveys boundary definition Infrastructure photos and notes Literature search Chemical data Aerial photographs and historical records Test pit observations As-builts Frost depth Practices at similar sites	Use the area to define boundaries Ensure lateral boundary using all the data	Revise reports to incorporate inputs and new data MEC hazard assessment guidance Results: how many how deep how dangerous

2.4.3.3 Site Profile Information Summary

Table 2-7 presents a summary of profile information for the FCS, specifically Subarea A. The information was summarized from historical and current site information, including PSEs I and II and associated data. Additional detail is provided in earlier sections of this Work Plan.

TABLE 2-7
Profile Information Summary for Subarea A

Profile	Description
Facility profile	Former salvage and reclamation yard. Operated from approximately 1947 through 1956, a 10- to 11-year period. Material salvaged for reuse and debris buried onsite in pits, in single events, as evidenced by historic photographs. Area has extensive buried debris piles. Area had a former river channel that meandered west of Subarea A, which was filled as the site was developed. Debris was buried in pits at the site, as evidenced by the geophysical survey. Surrounding areas used for military staging and mobilization. Groundwater is at 13 to 15 feet below ground surface flowing to the west-northwest. Site has discontinuous permafrost that can affect groundwater flow and infiltration. Historically the 4th Infantry Area was to the west, a concrete batch plant to the north, and garden plots to the southwest. The duplex housing units are constructed. Utilities generally follow the roads, except in a few cases.
Physical profile	The area is a relatively flat site cleared of vegetation with duplex housing units for living quarters. The units are currently not occupied. The area was extensively disturbed in support of site grading and the installation of surface and subsurface infrastructure. Access to potential MEC is limited to intrusive activities and frost heave. MEC discovered to date has been at or less than 4 feet below ground surface. The aerial extent of potential MEC is in areas of heavy metal debris concentration as determined by geophysical investigation. One uninvestigated anomaly located in Subarea D may or may not include MEC. Detection of potential MEC items is difficult because of the large amount of subsurface metal debris. Recovery of potential MEC items is complicated by the housing units and infrastructure.
Release profile	The source of MEC is likely DMM that were improperly disposed of at the salvage yard, either incidentally with the material to be salvaged (for example, contained in a piece of equipment) or otherwise brought to the salvage yard. Potential MEC may be present in the subsurface debris below the housing units. The location is fences and the housing units are currently unoccupied. Potential release mechanisms include intrusive site activities, upward movement from frost heaves, and items that may remain on the surface.
Land use and exposure profile	The planned use for the site is military housing. The construction is complete on the duplex housing units, but the units have not been released for occupancy. Roads and other infrastructure have been installed. Exposure to DMM would be through intrusive site activities or the presence of DMM on the surface.
Ecological profile	The site has been extensively disturbed by past salvage and reclamation activities as well as subgrade and surface activities associated with the installation of site utilities and the construction of foundations for the housing units.

2.4.3.4 Pathway Analysis and the Conceptual Site Model

The information in Table 2-8 provides details about sources, receptors, and the associated interactions for development of the MEC CSM. The information is summarized from

available site data and will be supplemented when additional investigations and archive research have been completed.

TABLE 2-8
Pathway Information Summary for Subarea A

Factor	Description
Source	Source area
	FCS, Specifically Subarea A, the former salvage yard operation
	Improperly disposed of DMM, source of material was likely incidental to the salvage and reclamation operations.
	MEC location
	DMM can be located on the surface as well as shallow and deep subsurface; has been reported as deep as 4 feet below ground surface.
	Potential for MEC to leach into soil and groundwater; although this pathway has not as yet been fully defined (refer to Section 2.4.2.3)
Interaction	Activity
	Non-intrusive activities include such activities as picking up a piece of ordnance left on the ground surface or a piece that may have reached the ground surface through frost heave
	Intrusive activities include excavation and incidental digging by occupants.
	Access
	Without institutional controls, access would be available to excavation or routine digging.
	Access restrictions would not affect items left on the surface or that have reached the surface through frost heave.
Receptors	Current receptors
	Onsite construction workers are potential receptors; however, onsite work is related to completion of structures and no subgrade work is allowed at this time.
	Future receptors
	Residents (occupants)
	Visitors (guests, recreation users, etc.)
	Maintenance/utility workers

The CSM illustrated in Figure 2-9 was developed based on the pathway analysis presented in Table 2-8. Interaction between the potential receptors and source area (salvage and reclamation yard) has two components: (1) the receptor must have access to the source and (2) the receptor must engage in some activity that results in contact with individual MEC items within the source area. For example, MEC in subsurface, including perimeter soil berms, would likely not present a hazard if left. The release of chemical constituents (including filler, HE, and degradation products) is possible and is considered in the sitewide environmental contaminants CSM (Section 2.3). In the MEC CSM, pathways are represented as complete, incomplete, and potential.

2.4.4 Data Gaps and Next Steps

The CSM is dynamic in nature and will be updated as additional investigations and literature research is completed. The planned and ongoing investigations and research are summarized below:

- Additional research (archive search/research) on the operational history of the facility
- Completion of additional sampling and test pit excavating to determine the presence of MEC concurrent with HTRW-related sampling
- Establishment of fixed boundaries around the MEC areas based on ongoing investigations
- Investigation of other metal debris-containing areas for MEC (including the former river channel)
- Frost heave calculations, an activity that may be complicated because the material is in compacted debris rather than soil

The consequences of an encounter are more difficult to evaluate and will be developed during the RI/FS process. The components of an encounter are detailed below:

- The receptor must have access to an item to come into contact with the item
- The method of the encounter, which is important from the perspective of how the item is found (by casual encounter, excavation, etc.)
- The type of item, whether inert, training, debris, HE containing, or other

2.4.5 Initial Hazard Assessment

This site hazard determination is based on previous historical information, condition of munitions encountered, the current setting with respect to access control, and security. Information reviewed to date indicates that DMM are not on the surface or widely scattered; therefore, an area of concern is consolidated within a small specific geographical subsurface location. This consolidation of DMM was confirmed through the encounter of eight munitions items located within 3,600 cubic yards of stockpiles (including debris piles) and worst-case bias trench sampling to areas of high subsurface debris content. The area is not an impact area; therefore, research supports a cause determination of munitions dumping. On the basis of currently available information, two located HE items place the initial risk assessment as “high risk.” The items were not fired, fuzed, or dropped to sustain arming. Local restrictions and controls reduced the risk from "high" to "moderate" for subsurface excavations and place the surface exposure risk as low. The high risk associated with intrusive encounters is mitigated through the local requirement that the USACE “Munitions and Explosives of Concern (MEC) Support During Hazardous, Toxic and Radioactive Waste (HTRW) and Construction Activities” (EP 75-1-2, 2004c) be required and implemented for all intrusive activities or access, thereby lowering the risk to “moderate.”

The current risk associated with MEC does not provide an overall ranking for the entire site or Subarea A necessarily. The potential hazard will be addressed as data gaps are filled by

using appropriate assessment methodology. The potential hazard will provide input for the DQOs related to future remedial actions, the application of land use controls at the site, or both, including the application for dig permits before excavation and the application of MEC avoidance principles by UXO-trained personnel. Hazard assessment guidance for MEC will be used as supplemental analysis for decisions. The FS will be used to evaluate alternatives.

2.5 Summary of Historical Data

Sources of FCS historical information are listed in Section 2.2.1. The PSE process summarized these sources, particularly in the PSE I where existing site information was evaluated to consider potential site risks.

As described above, the USACE and their consultants have collected a relatively large set of chemical data to help characterize the FCS. The existing soils and groundwater laboratory test data and sample location data have been compiled into a project database. The database contains information on more than 1,200 separate soil and groundwater samples, and each sample has been tested in a laboratory to quantify the concentrations of up to about 160 analytes. In addition, the database sample location information has been linked to a GIS to facilitate map display of the data.

2.5.1 Database and GIS Display of Existing Data

2.5.1.1 Screening Levels

To help understand the chemical data, these data have been compared to "screening levels" that are in concept related to human health risk. The soil screening levels currently used in the database are shown in Table 2-9. (The data tables, Tables 2-9 through 2-16, are provided in Appendix A, Statistical Summary of Analytical Data.) The table lists the ADEC soil ingestion, migration to outdoor air (inhalation) and migration to groundwater cleanup levels and the EPA Region 6 residential preliminary remediation goals. The ADEC concentration values are from Title 18, Chapter 75, of the *Alaska Administrative Code* (18 AAC 75), Tables B1 and B2, Technical Memorandum 01-007 (Additional Cleanup Levels Values, 2003), and Technical Memorandum 06-003 (Trichloroethylene Toxicity Values, 2006). The soil screening level was calculated as one-tenth of the lowest of the three ADEC exposure pathway values, or if the ADEC did not have a cleanup level for a compound, the EPA Region 6 preliminary remediation goal was used as the screening level.

The only exception to the above approach for determining screening levels is for arsenic. Arsenic occurs naturally at relatively high concentrations in Fairbanks area soils. Because one objective of the investigation at the FCS is to identify and quantify sources of risk in excess of background, it is appropriate to screen arsenic concentrations against naturally occurring background concentrations. The 95 percent point on the cumulative data distribution curve was used as a characterization of naturally occurring background concentration (USACE, 1994). About 1 in 20 samples would be expected to exceed this concentration if no anthropogenic contamination is present. The screening levels for all analytes and the source of the screening levels are listed on the right side of Table 2-9. Analytes are grouped based on the test method used to quantify their concentrations (for example, VOCs, SVOCs, pesticides, chlorinated herbicides, explosives, and metals). Because

some analytes are detected by more than one test method, analytes may appear more than once on the table.

Groundwater screening levels are listed in Table 2-10 and are the lower of one-tenth of the ADEC Table C groundwater cleanup levels or the EPA Region 6 tap water screening levels. Table 2-10 also lists maximum contaminant levels and Federal Drinking Water Equivalent values. Analytes are grouped in the table according to standard test methods.

As described above, these screening levels are in concept related to human health. The risk levels for most analytes are a carcinogenic risk of 10^{-6} and a hazard index of 0.1. It should be clear, however, that the screening levels presented here are not true risk-based values because of assumptions about phase partitioning, dilution and attenuation, site specific soil conditions, and exposure parameters. However, the screening levels are interpreted to be adequate to screen the existing data to help identify data gaps that need further investigation. Different screening levels may be developed in the future to identify COPCs for the risk assessment and to identify contaminant "source areas."

A "color coding" system has been developed to help characterize the existing chemical concentration results relative to the screening levels. The color coding system has five colors or levels: blue, green, yellow, orange, and red. These colors related to the screening levels as follows:

- Blue indicates concentrations less than or equal to the screening level.
- Green indicates concentrations greater than the screening level and less than or equal to 10 times the screening level.
- Yellow indicates concentrations greater than 10 times the screening level and less than or equal to 100 times the screening level.
- Orange indicates concentrations greater than 100 times the screening level and less than or equal to 1,000 times the screening level.
- Red indicates concentrations greater than 1,000 times the screening level.

Given that the screening levels are in concept related to carcinogenic risk levels of 10^{-6} or a hazard index quotient of 0.1, the yellow, orange, and red color codes may exceed the Alaska default carcinogenic risk level of 10^{-5}, a hazard quotient of 1.0. or both. Many of the results in the database indicate that the analyte was not detected. When an analytes was not detected, a value of half the detection limit was used to statistically characterize the result, and this value was assigned the appropriate color code. The color coding system is used in a statistical summary of the existing data and to map the chemical data.

2.5.1.2 Statistical Evaluation of the Existing Data

The chemical data in the database are from samples that represent the following:

- Soils that remains on site (in situ soil)
- Soils that were excavated and stockpiled or disposed of off site (ex situ soil)
- Groundwater at the site

The in situ soils and groundwater results are data that would likely be used in future site characterization and risk assessment work, and the ex situ soils data may be used to characterize excavated soil stockpiles for disposal and as an indicator of chemicals historically used or disposed of at the site. (The excavated soils data would not be used in a characterization of current site conditions or risk.) All chemical results in the database have been assigned a color code that represents the analyte concentration relative to the screening level.

Table 2-11 summarizes the distribution of the existing data in several categories, as follows:

- Columns 1 and 2 list all analytes in the database (and their CAS numbers) in alphabetical order.
- Columns 3 indicates whether the result represents soil or groundwater.
- Column 4 indicates whether the results represents in situ or ex situ soil conditions. (All groundwater results represent in situ conditions.)
- Column 5 indicates whether the analyte was detected or not detected in the analysis.
- Column 6 lists the analyte screening levels.
- Columns 7 through 12 list the number of laboratory test results in the color categories given the media—in situ versus ex situ and detect versus non-detect—conditions represented by the row.
- Column 13 lists the total number of analyte results for in situ soil, ex situ soil, and groundwater.
- Column 14 shows the percentage of the in situ soil, ex situ soil, and groundwater results that detected or did not detect an analyte.
- Columns 15 through 19 show the percentage of the results relative to the screening level using the color categories.

Each analyte on the table is listed in six rows and the information in the rows should be viewed in pairs—in situ soil detect + in situ soil non-detect; ex situ soil detect + ex situ soil non-detect; groundwater detect + groundwater non-detect. The sum of the "in situ soil detects" and "in situ soil non-detects" equals the total number of in situ soil analyses, and the sum of the in situ soil percentages equals 100 percent.

Consider the first compound listed in Table 2-11, 1,1,1,2-tetrachloroethane, as an example of data presented for the analyte. The table shows the following:

- There are 197 analytical results for this compound in in situ soil (column 13, rows 1 and 2).
- The compound was not detected in any of these analyses (column 12, row 1).
- The total number of non-detect results was 197 (column 12, row 2).
- In 196 of the analyses that did not detect the compound, the color is coded as "blue," indicating that half the detection limit was less than the screening level.

Review of Table 2-11 shows that several analytes routinely had detection limits more than 10 times greater than the screening levels (1,2-dibromoethane; 1,2-dibromo-3-chloropropane; 1,2,3-trichloropropane; bis-(2-chloroethyl)ether; 3,3'-dichlorobenzidine; 2,4-dinitrophenol; n-nitrosodimethylamine; n-nitrosodi-n-propylamine; pentachlorophenol; 2,4-dinitrotoluene; 2,6-dinitrotoluene). Of these compounds only n-nitrosodi-n-propylamine and pentachlorophenol were detected at the FCS. These compounds were excluded from the mapping and will likely be addressed qualitatively in the risk assessment. In addition, acetone and methylene chloride were excluded from the mapping because these compounds are common laboratory contaminants.

Table 2-12 is derived from Table 2-11 and shows the frequency of detections of analytes in in situ soils. Review of Table 2-12 shows the following:

- Most organic analytes in the database were not detected at the site (80 out of 150 organic compounds were not detected at the site).
- Most organic analytes that were detected were detected in only a small fraction of the analyses (only 13 out of 150 organic analytes were detected in more than 10 percent of the analyses).
- The most commonly detected analyte was total petroleum hydrocarbon (TPH) motor oil (RRO in Alaska) and the third most commonly detected analyte was TPH diesel (DRO in Alaska). Note that the low-level detection of these analytes probably represents detection of naturally occurring organic carbon and not fuel hydrocarbons, and the high concentrations of these analytes likely does indicate fuel hydrocarbons. (The AK102 and AK103 test methods do not differentiate between carbon in fuel hydrocarbons and carbon in naturally occurring organics.)
- Acetone and methylene chloride were detected relatively commonly, but these compounds are usually laboratory contaminants and likely do not represent true detections in in situ soil.
- 4,4-DDT, 4,4-DDE and 4,4-DDD where commonly detected, but these compounds were only detected in one sample at concentrations exceeding risk-based concentrations. The frequency of detection may be related to the normal use of these chemicals and not to spills, leaks or disposal of the chemicals.

Table 2-13 is derived from Table 2-11 and shows the frequency of detections of analytes in groundwater. Review of Table 2-13 shows the following:

- Most organic analytes in the database were not detected at the site (about 115 out of 150 organic compounds were not detected at the site).
- The most commonly detected organic analyte was TPH diesel (DRO in Alaska), and 15 percent of the detections exceeded ADEC criteria. The low level detection of DRO may represent detection of naturally occurring organic carbon and not fuel hydrocarbons, and the higher concentrations of DRO likely does indicate fuel hydrocarbons. (The AK102 and AK103 test methods do not differentiate between carbon in fuel hydrocarbons and carbon in naturally occurring organics.)

- Analytes on the explosives list were detected relatively commonly but they were below risk levels in most wells.

2.5.1.3 Mapping of Chemical Data

Three series of maps have been made to help display the spatial distribution of the in situ data and identify data gaps. (Ex situ soils data are not mapped.) Two of the series of maps show soils data, and the third series shows groundwater data. The three series of maps show the following single analytes or groups of analytes:

- DRO
- Total PCBs
- VOCs
- SVOCs
- Pesticides
- Chlorinated herbicides
- Explosives
- Metals

The compounds included in the groups of analytes are listed in Table 2-14 and correspond to the analytes in standard test methods. The highlighted analytes are not included on the maps because their method detection limits exceed screening levels, as described previously. The locations of the in situ samples are shown on the maps using symbols, with the color of the symbol indicating the concentration relative to the screening level, and the shape of the symbol representing the depth of the sample. The maps use the blue, green, yellow, orange and red color coding system. As described above, the color codes indicate the analyte concentrations relative to screening levels. On the maps representing a group of analytes, the color assigned to a location is the hottest (or worst case) result of all the analytes in the group.

Three symbol shapes are used to indicate the sample depth:

- Surficial samples with sample ending depths less than 2 feet are represented by small, solid dot.
- Samples collected between 2 and 10 feet are represented by open, medium-sized hexagons.
- Samples with ending depths greater than 10 feet are represented by open, large rings.

At most locations within the study area the small, solid dots and open, medium-sized hexagons are vadose zone samples, and the open, large rings are from the zone of seasonal water table fluctuation or the saturated zone. These symbol shapes allow the display of results from multiple depths within the same boring.

As mentioned above, there are two series of soils maps. The first series of soils maps shows the union of detected compounds of all “colors” and non-detect results with blue and green colors. The locations that have detections at the yellow, orange, and red levels have text boxes that list the analytes, concentrations, and depths of the yellow, orange and red detections. The blue and green detect and non-detect results are not labeled. These maps are intended to indicate areas where contaminants are identified at levels that suggest the need

for additional investigation (the yellow, orange, and red detections, which may indicate exceedances of risk criteria) and areas where existing data suggest a lesser degree of risk (the blue and green locations, whether they represent a detection or non-detect result).

The second series of soils maps shows locations where the laboratory did not detect an analyte, but the detection limit exceeded the screening level by a factor of 10 or more. (The analyte was not detected, but its color was yellow, orange, or red.) Table 2-14 was prepared to identify all non-detect yellow, orange, and red coded analytes; their depths; and detection limits. At most, the locations with non-detect yellow, orange, and red results, the detection limit was elevated because of the presence of other contaminants, such as fuel hydrocarbons, which caused interference in resolving separate analyte peaks, dilution of the sample, or both. The presence of other contaminants increased detection limits. Note that sample locations may appear in both the first and second map series if they have yellow, orange, or red detections and yellow, orange, or red non-detect results (otherwise each sample location should only appear on one map). In concept, these locations may require additional investigation, a qualitative evaluation in the risk assessment, or both. (The data to document that risks are within acceptable limits does not exist.)

The third series of maps show groundwater data. The groundwater data uses the same blue, green, yellow, orange, and red color-coding system as used for the soils data. However, because all existing groundwater samples were collected from the shallow saturated zone (about 10 to 20 feet below grade), the groundwater symbol shape is the same for all sample locations. The groundwater maps in general show that the groundwater data density is much lower than the soils data density. The groundwater data also shows that some monitoring well locations did not detect analytes, but the detection limits were above the groundwater criteria. Table 2-15 lists these yellow, orange, and red colored non-detect data.

2.5.1.4 Map Results and Discussion

DRO. The existing DRO soils data (Figure 2-10) clearly show a contiguous DRO source area in the vicinity of Buildings 7, 8, 9 and 10. (Figures 2-10 through 2-33 are provided in Appendix B, Chemical Data Mapping.) The orange symbol color indicates the concentration of the DRO detections are between 2,500 and 25,000 mg/kg (100x to 1,000x the 25-mg/kg screening level). The open hexagon and open ring symbol shapes indicate that the DRO is both in the vadose zone between 2 and 10 feet deep (the hexagons), and in the zone of seasonal water table fluctuation or saturated zone greater than 10 feet deep (the open rings).

The eastern, southern, and western extent of the source area appears to be relatively well defined, but the northern boundary of the DRO-contaminated soil is not well delineated. To further delineate the northern extent of the DRO source area, borings and monitoring wells are recommended to the north of Buildings 7 and 9. The map also shows a single, vadose zone, yellow DRO detection south of Building 49. The Building 49 location is to be excavated during the 2007 field season, and confirmation sampling will be conducted; therefore, additional soil borings are not recommended specifically for this location, although a downgradient boring and well will be placed near the northwest corner of Building 49. The second DRO soils map (Figure 2-11) shows that there were no locations with yellow, orange, or red non-detect DRO results.

The groundwater DRO map (Figure 2-12) shows that ADEC Table C criteria are exceeded at the MW06 and MW12 locations (which are associated with the DRO source area shown on the soils map). In addition, DRO groundwater criteria are exceeded at the MW02 location.

PCBs. The existing PCBs data (Figure 2-13) shows a relatively high data density across the FCS and that the existing yellow, orange and red PCB detections are limited to the southwest corner of the site near Building 52 and west of Building 50. The yellow, orange, and red symbols indicate that concentrations ranging from 1 to greater than 1,000 mg/kg (10x to 10,000x the 0.1-mg/kg screening level) have been measured, and the symbol shape shows that the detections are in surface soils and vadose zone soils less than 10 feet below grade. The absence of open rings at the detection locations indicate that samples from the zone of seasonal water table fluctuation, saturated zone, or both have not been analyzed. The PCB source area near Building 52 will be excavated in 2007, and confirmation sampling will be conducted across the floor of the excavation. In addition, soil borings and monitoring wells will be installed downgradient of the excavations. The second PCBs soils map (Figure 2-14) shows that there were no locations with yellow, orange, or red non-detect PCB results.

The groundwater PCB map (Figure 2-15) shows that groundwater criteria have not been exceeded at any existing well location. However, wells have not been installed at or immediately downgradient of the PCB source area. Monitoring wells will be installed in 2007 downgradient of the PCB excavation area.

VOCs. The existing VOCs soils data (Figure 2-16) show yellow, orange, and red VOC detections: in the vicinity of Building 52 (at the same location as high PCB detections), north of Building 48, and north of Building 23. The detections at the Building 52 location are for 1,2-dichlorobenzene, 1, 2, 4-trichlorobenzene, toluene, and ethylbenzene. As shown in the text box, 1, 2, 4-trichlorobenzene concentrations up to 6,480 mg/kg were detected near Building 52 in surface soils samples. At the Building 48 location, the text box shows that 1,1,2-trichloroethane was detected at the 8-foot depth at a concentration of 0.13 mg/kg. At the Building 23 location, the text box shows that benzene was detected at the 4-foot depth at a concentration of 0.34 mg/kg. The orange symbol color at the Building 23 location indicates this benzene concentration is between 100 and 1,000 times the screening level, which in concept is 10 to 100 times the generic risk-based level. The open hexagons symbol shape at the Building 48 and 23 locations indicates that the VOC detections are in the vadose zone between 2 and 10 feet deep. The text box provides the exact sampling ending depth.

During the 2007 investigation, soil borings and monitoring wells will be placed at or immediately downgradient of the yellow, orange, and red VOC detections. The second VOCs soils map (Figure 2-17) shows that there were several locations with yellow, orange, or red non-detect VOC results. Most of these results are associated with the known contaminants at the Building 52 location or the DRO source area near Buildings 7, 8, 9, and 10. A location identifier is shown on the map for locations with a yellow, orange, or red non-detect result and the specific compounds with detection limits exceeding criteria are listed in Table 2-15.

The groundwater VOC map (Figure 2-18) shows that groundwater concentration criteria are exceeded at the MW02 location. Non-detect results with elevated detection limits (yellow, orange, and red colors) are listed in Table 2-16.

SVOCs. The existing SVOCs soils data (Figure 2-19) shows yellow, orange, or red SVOC detections in the vicinity of Building 52 (at the same location as high PCB detections) and north of Building 1. The detections at the Building 52 location are for 1,2-dichlorobenzene and 1,2,4-trichlorobenzene. These compounds are also detected by the VOC test method and are displayed on the VOC map (Figure 2-16). As shown in the text box, 1,2,4-trichlorobenzene concentrations up to 6,480 mg/kg were detected near Building 52 in surface soils samples. At the Building 1 location, the text box shows that benzo(a)pyrene was detected at the 4-foot depth at a concentration of 0.33 mg/kg. The yellow symbol color at the Building 1 location indicates this benzene concentration is between 10 and 100 times the screening level, which in concept is 1 to 10 times the generic risk-based level. The open hexagons symbol shape at the Building 1 location indicates that the SVOC detection is in the vadose zone between 2 and 10 feet deep. The second SVOCs soils map (Figure 2-20) shows that there were several locations with yellow, orange, or red non-detect SVOC results. All of these results are associated with the known contaminants at the Building 52 location or the DRO source area near Buildings 7, 8, 9, and 10. A location identifier is shown on the map for locations with a yellow, orange, or red non-detect result, and the specific compounds with detection limits exceeding criteria are listed in Table 2-15.

The groundwater SVOC map (Figure 2-21) shows that criteria are not exceeded at the FCS. Non-detect results with elevated detection limits (yellow, orange, and red colors) are listed in Table 2-16.

Pesticides. The existing pesticides soils data (Figure 2-22) shows yellow, orange, or red pesticides detections south of Building 51, north of Building 25, and north of Building 11. The text boxes show the following:

- The detection at the Building 51 location is for dieldrin, for which the sample ending depth was 4 feet and the measured concentration was 0.018 mg/kg.
- The detection at the Building 25 location is for beta-BHC, for which the sample ending depth was 4 feet and the measured concentration was 0.037 mg/kg.
- The detection at the Building 11 location is for 4, 4-DDT, for which the sample ending depth was 2 feet and the measured concentration was 18.8 mg/kg.

During the 2007 investigation, soil borings and monitoring wells will be placed at or immediately downgradient of the yellow, orange, and red pesticide detections. The second pesticides soils map (Figure 2-23) shows that there were two locations with yellow non-detect pesticides results. The yellow non-detect pesticides results are near Buildings 49 (associated with the known DRO contamination at the Building 49 location) and Building 22. A location identifier is shown on the map for locations with a yellow non-detect result, and the specific compounds with detection limits exceeding criteria are listed in Table 2-15.

The groundwater pesticides map (Figure 2-24) shows that criteria are not exceeded at the FCS.

Chlorinated Herbicides. The existing soils data for chlorinated herbicides (Figure 2-25) shows that chlorinated herbicides have not been detected at yellow, orange, or red concentrations

at the FCS. The second chlorinated herbicides soils map (Figure 2-26) shows that there were no locations with yellow, orange, or red non-detect results for chlorinated herbicides.

The groundwater chlorinated herbicides map (Figure 2-27) indicates that groundwater criteria are not exceeded at the FCS.

Explosives. The existing explosives soils data (Figure 2-28) shows that explosives have not been detected at yellow, orange, or red levels at the FCS. The second explosives soils map (Figure 2-29) shows that there were several locations with yellow, orange, and red non-detect explosives results. All of these results are associated with the known contaminants at the Building 52 location or the DRO source area near Buildings 7, 8, 9, and 10. A location identifier is shown on the map for locations with a yellow, orange, or red non-detect result, and the specific compounds with detection limits exceeding criteria are listed in Table 2-15.

The groundwater explosives map (Figure 2-30) shows that the only analyte that exceeded groundwater criteria was RDX, which was detected at the MW02 location. However, several analytes that were not detected had detection limits above groundwater criteria (as shown in Table 2-16).

Metals. The existing metals soils data (Figure 2-31) shows yellow, orange, or red metals detections east of Building 26 and east of Building 19. The text boxes show the following:

- The detection at the Building 26 location is for lead, for which the sample ending depth was 2 feet and the measured concentration was 206,000 mg/kg. (This lead detection is likely from the analysis of metal debris and not soil.)
- The detection east of the Building 19 location is for cadmium, for which the sample ending depth was 11 feet and the measured concentration was 5.2 mg/kg.

The second metals soils map (Figure 2-32) shows that there were no locations with yellow, orange, or red non-detect metals results.

The groundwater metals map (Figure 2-33) indicates that groundwater criteria are not exceeded at the FCS.

2.5.2 Additional Analysis of Historical Data

2.5.2.1 Soil Gas Investigation

Passive soil gas (Gore Sorber™) samples were collected in the northern area of the FCS where there were indications of potential VOC contamination. Sample locations were determined by using a large grid, with one to two samples collected at each building in Subarea B, the western portion of Subarea A, and the two eastern-most buildings in Subarea C (see Work Plan Addendum 2 for passive soil gas sampling locations). Samples were analyzed by using gas chromatography. Passive soil gas samples are intended for use in identifying "hot spots" by comparing relative concentrations between sampling locations. They cannot be used for determining actual analyte concentrations in any one location.

Results of the passive soil gas analysis indicated the presence of petroleum-related constituents, chlorinated solvents, and chlorofluorocarbons. Detections of petroleum-related compounds were widespread, with the strongest detection at a sample located between

Buildings 9 and 10. Results also indicated possible hot spots for petroleum constituents between Buildings 3 and 4 and south of Building 8. Two chlorinated solvents, trichloroethene and tetrachloroethene, were detected at a total of five locations, with the strongest detections located between Buildings 3 and 4 and south of Building 14. Chlorofluorocarbons were tentatively identified at 33 of the 35 locations throughout the area and are believed to be the derived from foam used to insulate underground utilities for the new subdivision site-wide.

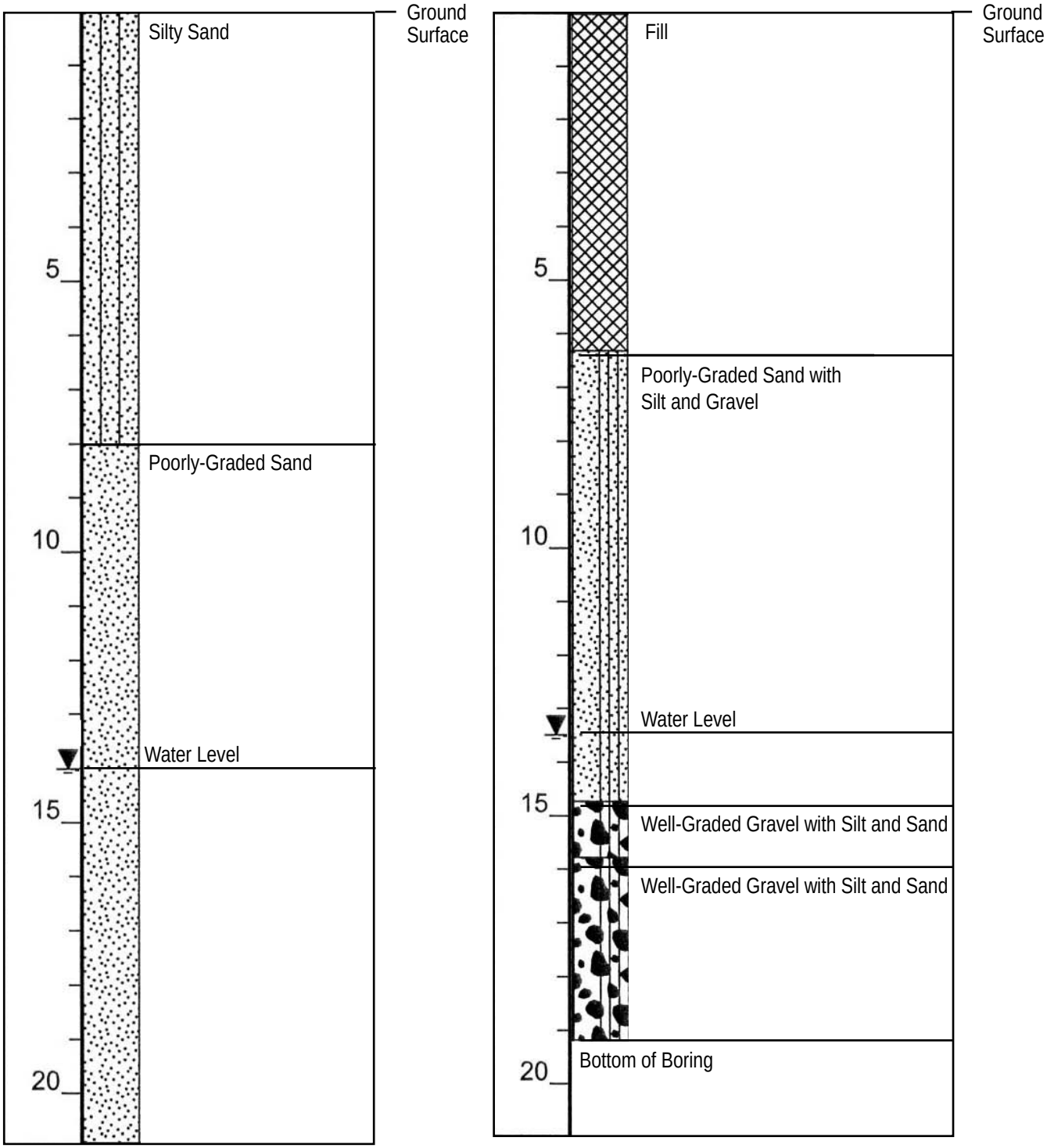

FIGURE 2-1
Typical Boring Logs
Former Communications Site, Fort Wainwright, Alaska

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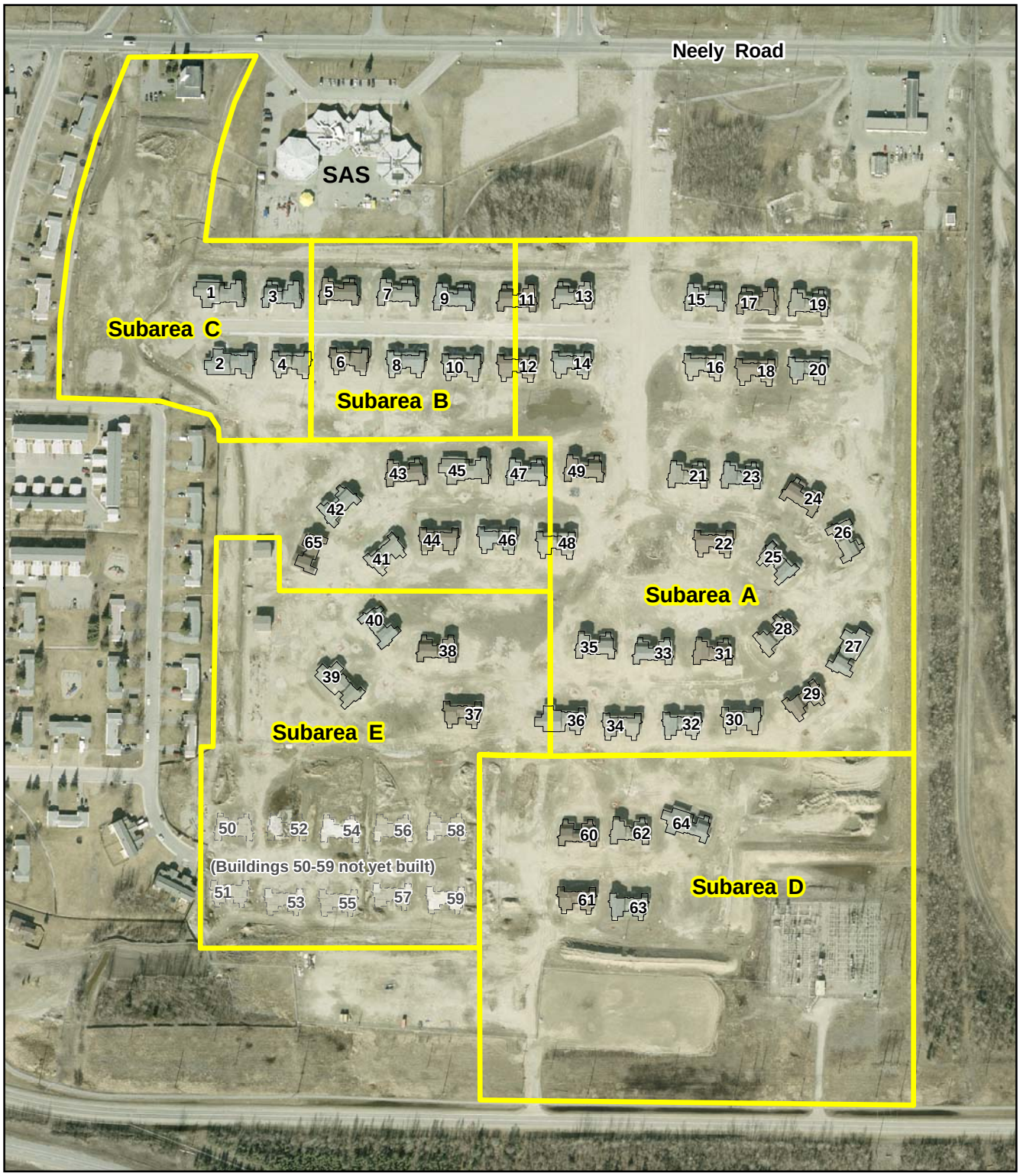
FIGURE 2-2
Swale Locations
Remedial Investigation Work Plan
Former Communications Site
Fort Wainwright, Alaska

Legend

- Former slough channel
- Capture Zone, Supply Well 3559
- Groundwater contour and flow direction
- Swale
- Swale, uncertain location
- Swale culvert

0 200 400 600 Feet



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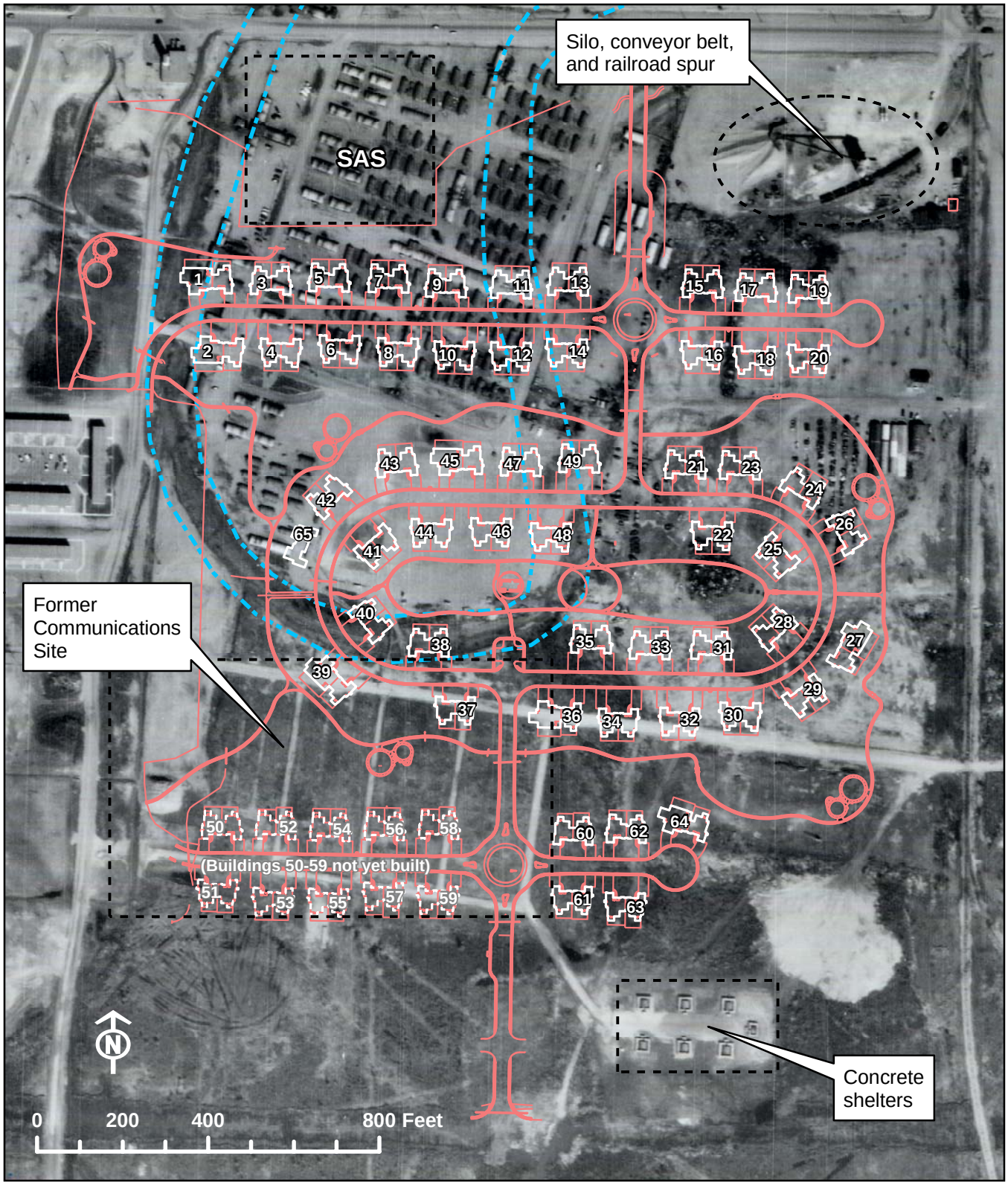
0 200 400 600 Feet

FIGURE 2-3
Location of FCS Subareas
Remedial Investigation Work Plan
Former Communications Site
Fort Wainwright, Alaska

CH2MHILL



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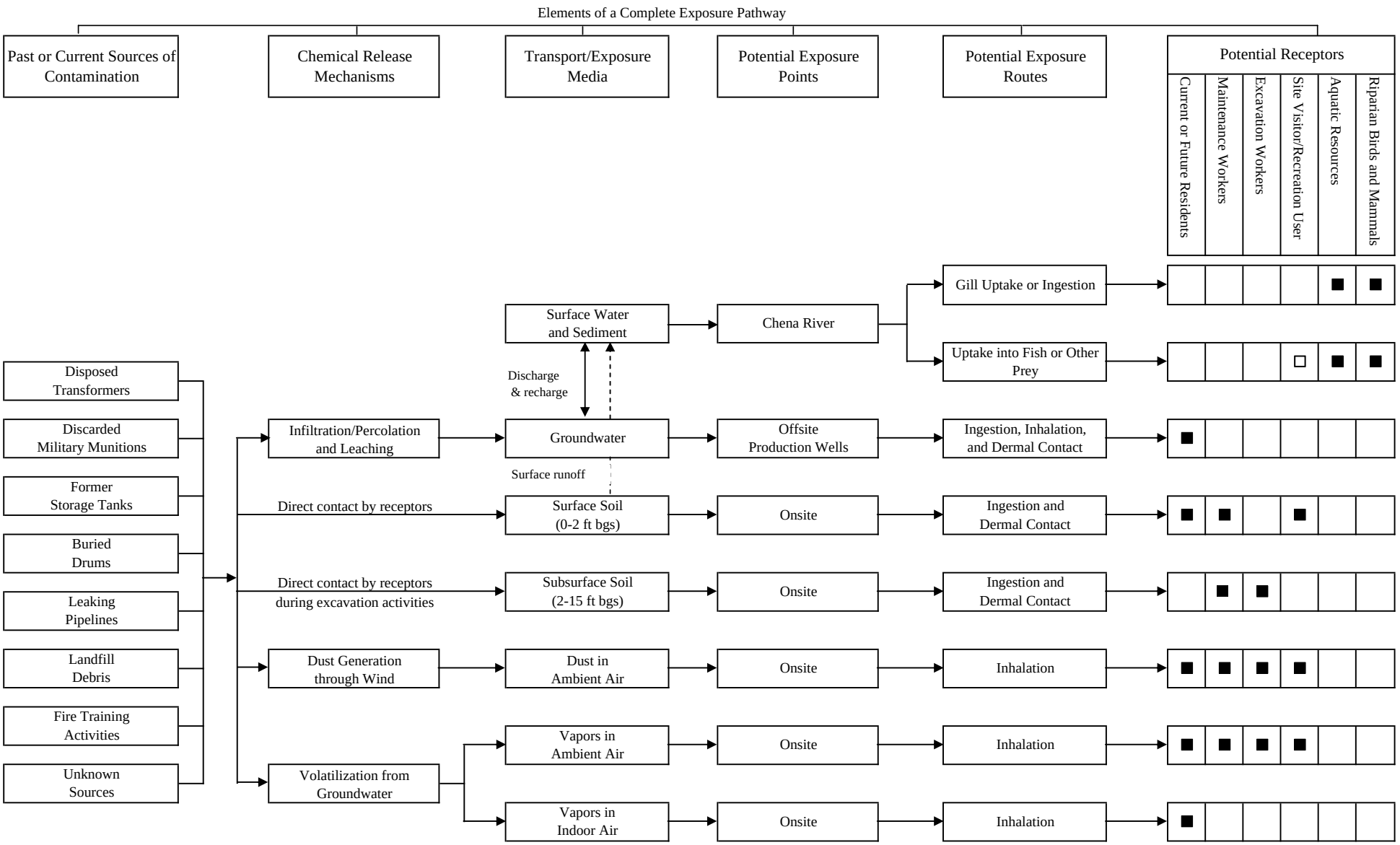
Legend

Infrastructure for Taku Gardens

Former slough channel

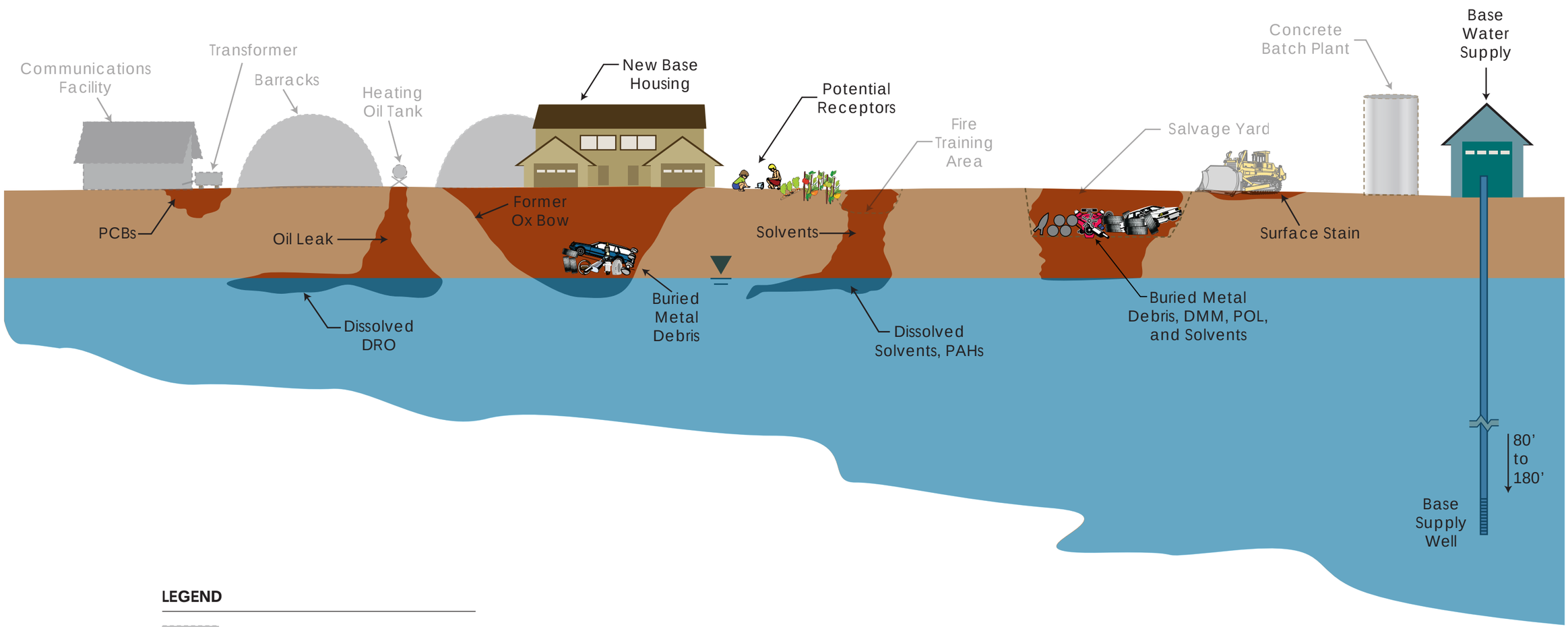
FIGURE 2-4
Photography from 1956
Remedial Investigation Work Plan
Former Communications Site
Fort Wainwright, Alaska



■ = Potentially complete pathway (to be addressed quantitatively)
□ = Pathway considered minor (to be addressed qualitatively)

Blank = Incomplete pathway

FIGURE 2-5
Conceptual Site Model for Potential Human and Ecological Exposures



LEGEND

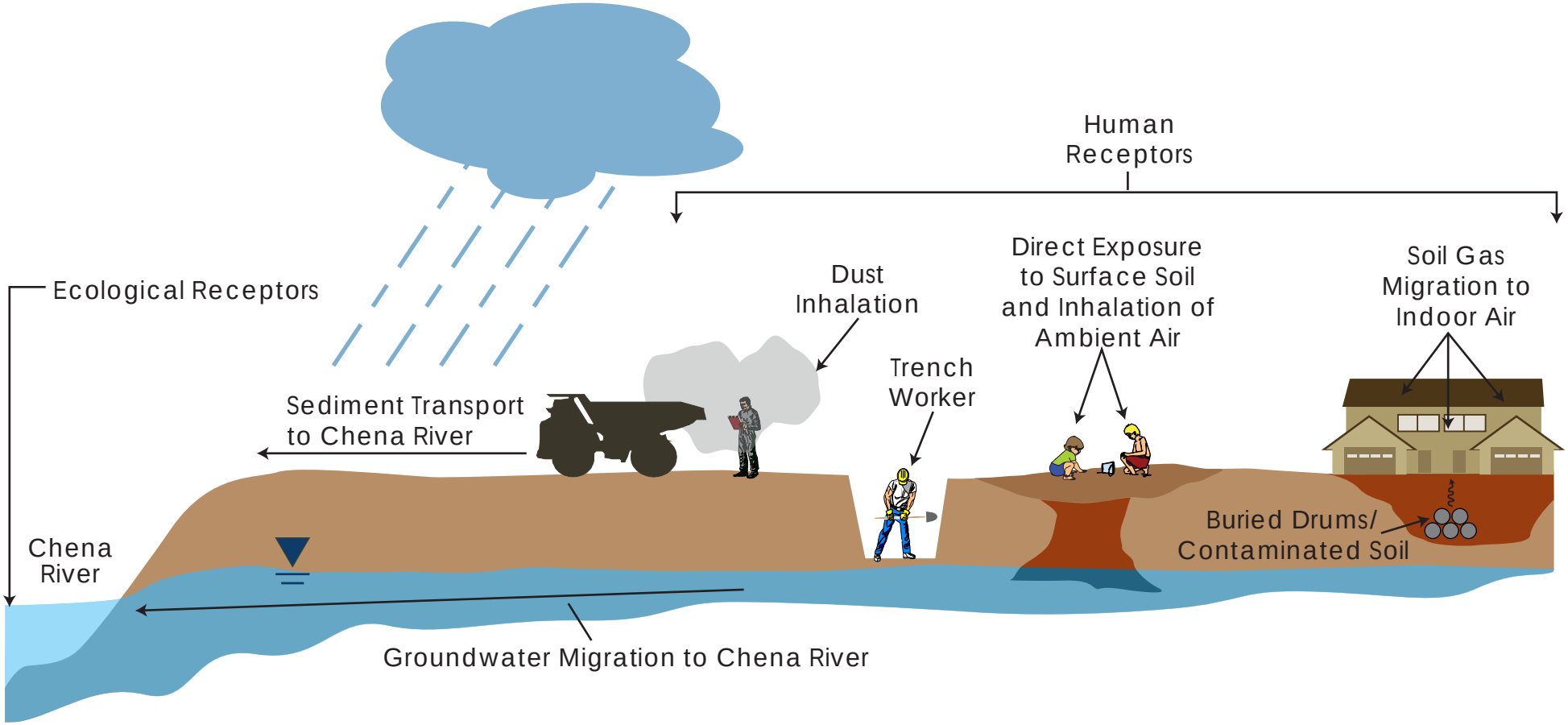
Historic Activity (grayed out)

Existing Activity (color)

Not to scale

FIGURE 2-6
Conceptual Site Model Illustration for the FCS
Remedial Investigation Work Plan
Former Communications Site, Fort Wainwright, Alaska

CH2MHILL



North

Not to Scale

FIGURE 2-7
Exposure Pathways
Remedial Investigation Work Plan
Former Communications Site, Fort Wainwright, Alaska

CH2MHILL

357465 ES042007005ANC TAKU_ExposureRoutes.ai 10/17/07 anc/cts

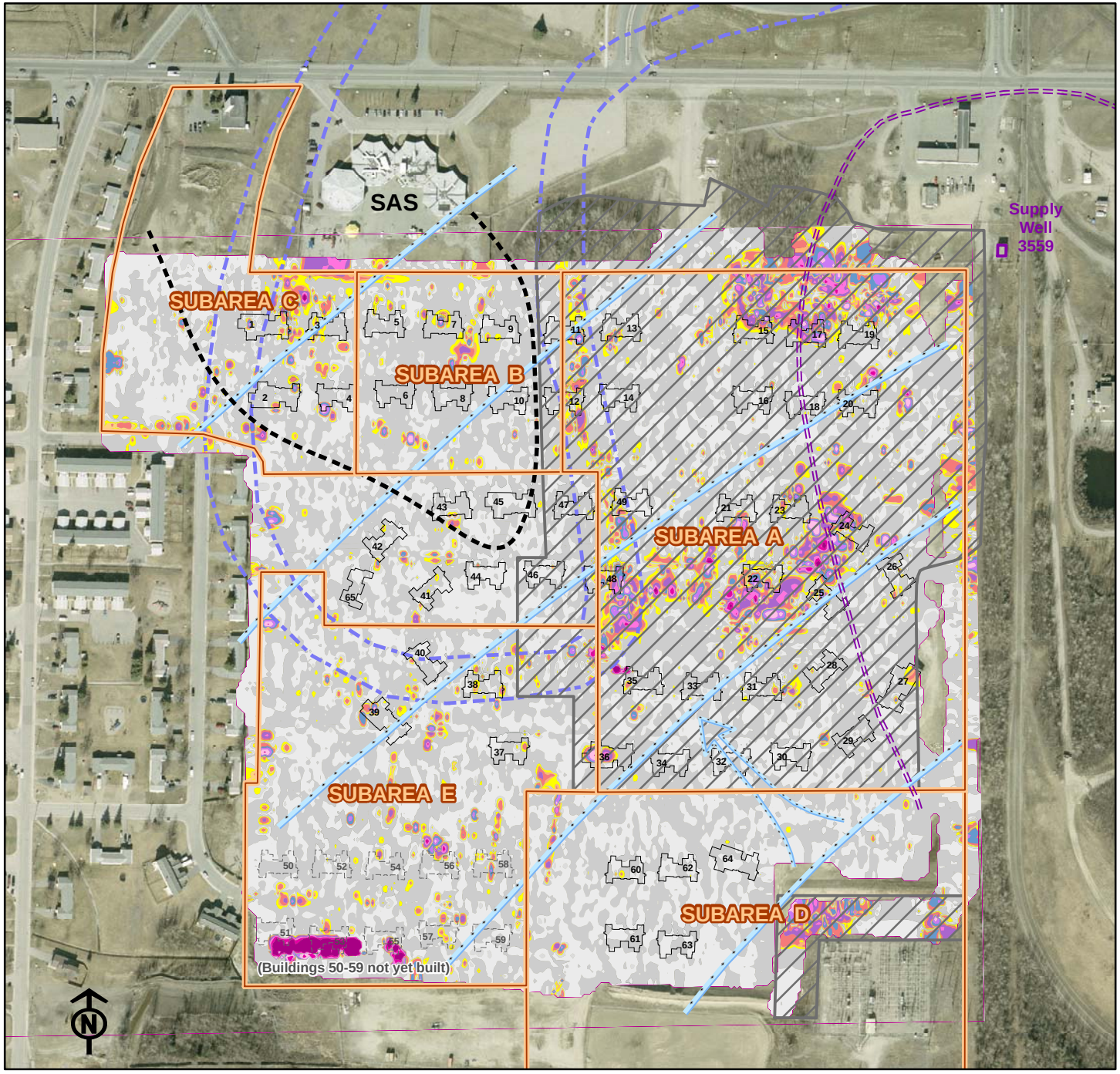


FIGURE 2-8
Geophysical Anomalies
Remedial Investigation Work Plan
Former Communications Site
Fort Wainwright, Alaska

Legend

- Moderate to High probability MEC area
- Former slough channel
- Area within elevated VOC/POL concetration
- Capture Zone, Supply Well 3559
- Groundwater contour and flow direction

2004 Magnetic Data Vertical Gradient

- -4000
- -1000
- -500
- -200
- -100
- -75
- -50
- -20
- 0
- 40
- 75
- 100
- 200
- 500
- 1000
- 2000
- 4000

0 100 200 300 Feet

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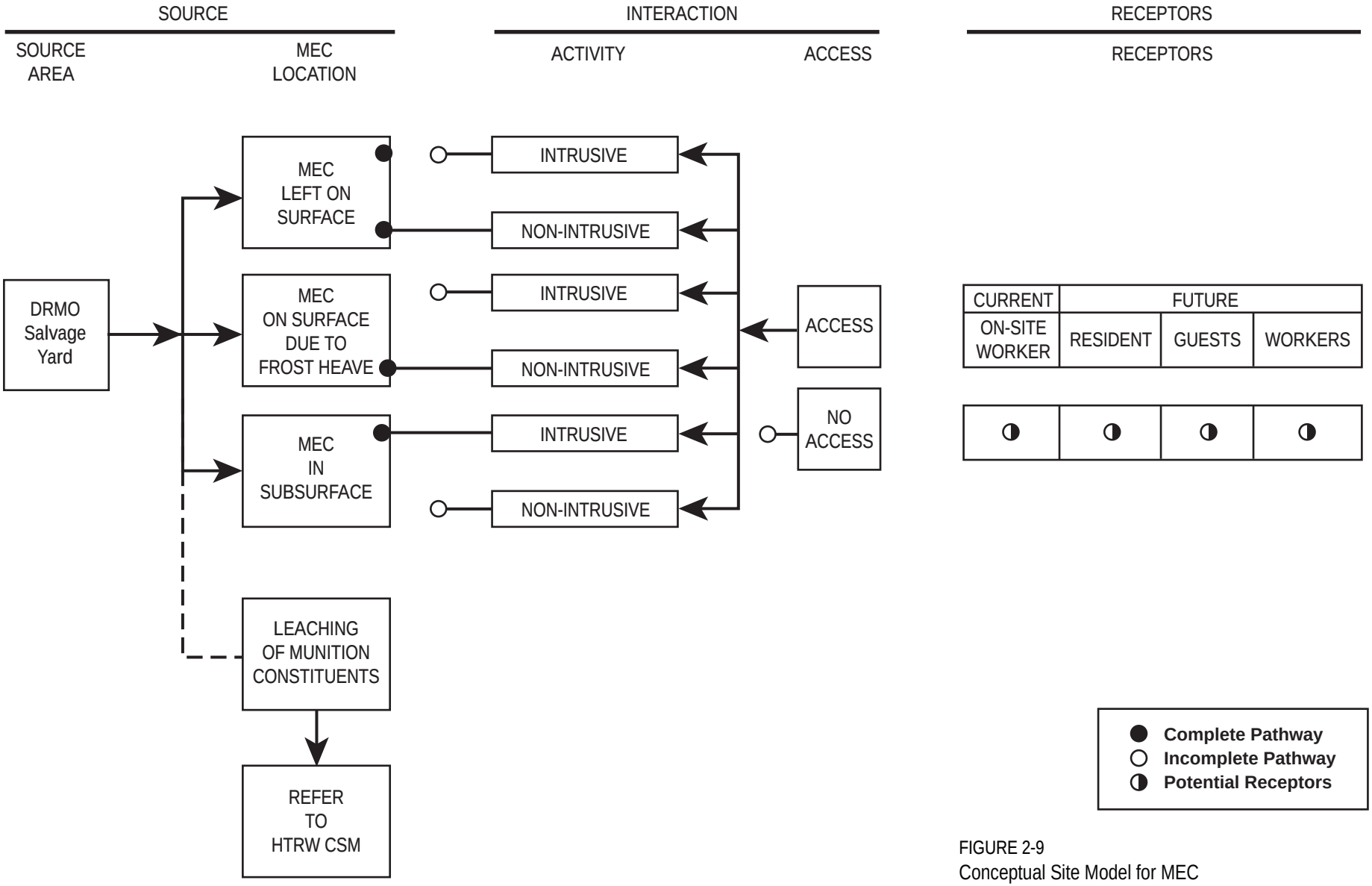

FIGURE 2-9
Conceptual Site Model for MEC
Former Communications Site, Fort Wainwright, Alaska

SECTION 3

Preliminary Identification of ARARs, Risk Screening Levels, and Remedial Technologies

The purpose of this section is to focus the remedial investigation so that data of sufficient quantity and quality are collected to conduct the baseline risk assessment. In addition, this section provides a preliminary summary of the possible applicable or relevant and appropriate requirements (ARARs) that may apply to the cleanup of the FCS. Section 121(d) of the Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA) requires that remedial actions implemented at CERCLA sites be carried out in compliance with federal or more stringent state environmental standards, laws, criteria, or limitations that are determined to be ARARs. Section 3 also broadly describes some possible remedial responses that may be appropriate for various potentially contaminated site media.

3.1 Preliminary ARARs Evaluation

ARARs are identified and considered at several steps in the remedial process, including the RI, development of remedial alternatives, detailed analysis of the remedial alternatives, and remedy selection. ARARs identified during the RI are preliminary. The final determination of ARARs is not made until the remedy is selected and documented in the Record of Decision (ROD).

A preliminary survey of possible ARARs for the FCS was developed to support site characterization information and consider plausible remedial technologies that may be needed and appropriate for site conditions. This preliminary list of ARARs will be updated when the components of the FS are developed and will be finalized when the ROD is prepared. Tables 3-1 to 3-3 present the preliminary ARARs for the FCS and include chemical-, location-, and action-specific ARARs. (These landscape tables are provided at the end of Section 3.)

3.2 Preliminary Identification of Contaminant Risk Screening Levels

Identification of risk screening levels is important to (1) help establish laboratory reporting and detection limits goals so that the laboratory data may be used to assess risk and (2) screen laboratory results to identify COPCs that are carried forward into the risk assessment. In accordance with ADEC Risk Assessment procedures (ADEC Technical Memorandum 01-007, 2003), screening values for the determination of risk are one-tenth of the most conservative ADEC cleanup levels for Method 2 ingestion, and as appropriate, of the cleanup levels for inhalation and migration to groundwater. These cleanup levels can be found in 18 AAC 75 (Tables B1 and B2) and in ADEC Technical Memorandum 01-007 (2003). USEPA Region 6 soil and tap water screening levels may also be used for assessing human

health direct contact risk for compounds not included in ADEC Tables. Detection limits consistent with ten times the USEPA Region 6 ambient air screening level will be used for soil gas.

After receipt of the project laboratory data, the data will be compared to the project and ADEC screening values. Compounds detected at concentrations exceeding the screening levels will be carried forward into the risk assessment. If a risk screening level is below the standard laboratory detection limit (or half the detection limit), the compound will be considered in the uncertainty analyses.

3.3 Preliminary Identification of Remedial Technologies

The baseline human health and ecological risk assessments will be used to determine whether any areas of the FSC will require remedial activities to reduce risk to acceptable levels. Remedial actions, if required, will be evaluated in the FS. The following subsections describe remedial alternatives that may be appropriate for various potentially contaminated media at the FCS.

3.3.1 Contaminated Surface Soil

Surface soil sample results and the human health risk assessment may indicate that direct contact with contaminated surface soil poses an unacceptable risk. The primary remedial alternative for contaminated surface soil areas would be excavation, removal, and disposal of the contaminated soil. Alternatively, contaminated areas could be capped and maintained through use of institutional controls.

3.3.2 Munitions or Explosives of Concern or Buried Drums

MEC or buried drums may be located during investigation activities. Engineered and institutional controls may be necessary for areas where MEC are encountered. Identification of certain types of MEC deemed dangerous to the safety of residents or site workers may require complete excavation, removal, and clearance of associated buried debris areas. Intact buried drums containing fluids that could pose a future risk to human health (such as through migration to indoor air) and the environment (such as through migration to groundwater and then to surface water) may require excavation, removal, and disposal.

3.3.3 Contaminated Subsurface Soil

Subsurface soil sample results and the human health risk assessment may indicate that direct contact with contaminated subsurface soil may pose unacceptable risks to trench workers. Soil gas sample results may indicate that contaminated subsurface soil poses an unacceptable risk through migration to indoor air. Remedial alternatives for contaminated subsurface soil may include excavation, removal and disposal, as well as institutional controls (such as dig restrictions).

3.3.4 Contaminated Groundwater

Groundwater sample results may indicate that migration of contaminated groundwater to offsite production wells poses an unacceptable risk for future residents or that migration of contaminated groundwater to surface water poses an unacceptable risk to ecological receptors.

Remedial alternatives for contaminated groundwater include removal of contaminated sources, groundwater treatment, and natural attenuation.

TABLE 3-1
Chemical-Specific ARARs

Media	ARAR	Prerequisites	Comments Considerations	ARAR Assessment
Surface water	Clean Water Act § 304(a)	Health-based criteria evaluated in conjunction with designated use of surface water to establish National Recommended Water Quality Criteria (WQC).	WQC can be found at: http://epa.gov/waterscience/criteria/wqcriteria.html (accessed May 2, 2007)	Relevant and appropriate, if site groundwater discharges to surface water
Surface water and groundwater	Alaska Water Quality Standards (18 AAC 70) (AS 46.03)	Alaska Water Quality Standards (18 AAC 70) apply to surface water and groundwater and establish criteria for protected classes of water use.	Alaska Water Quality Standards can be found at: http://www.dec.state.ak.us/water/wqsar/wqs/pdfs/70wqsmanual.pdf and http://www.dec.state.ak.us/water/wqsar/wqs/pdfs/18%20AAC_70%20_Amended_December_28_2006.pdf (accessed May 2, 2007)	Relevant and appropriate, if site groundwater discharges to surface water
Soil and groundwater	USEPA Region 6 Screening Values	Conservative, numeric, risk-based screening levels. USEPA Region 10 has stated that the USEPA Region 6 screening values can be used at CERCLA sites.	Screening values can be found at http://www.epa.gov/earth1r6/6pd/rcra_c/pd-n/screen.htm, (accessed May 2, 2007)	TBC
Soil, groundwater, and surface water	ADEC soil and groundwater cleanup levels 18 AAC 75.340 -.345	Promulgated numerical standards for soil and groundwater cleanup; discharges of groundwater to surface water cannot exceed state Water Quality Standards under 18 AAC 70	The ADEC Methods 1 and 2 cleanup levels for soil and groundwater can be used as screening levels until site-specific risk-based levels are developed under Methods 3 and 4 if risk-based cleanup levels are developed. The cleanup levels can be found at: http://www.dec.state.ak.us/spar/statutes_regs.htm#article03 (accessed May 4, 2007)	Applicable
Soil	PCB Spill Cleanup Policy 40 CFR 761 Subpart G	Contamination caused by spills of greater than 50 mg/kg PCBs that occurred after May 1987.	Describes requirements for self-implementing onsite cleanup of PCB contamination	Relevant and appropriate, if a spill is identified TBC if no spill is identified

TABLE 3-1
Chemical-Specific ARARs

Media	ARAR	Prerequisites	Comments Considerations	ARAR Assessment
Drinking water	40 CFR 141, as adopted by 18 AAC 80	Establishes primary maximum contaminant levels (MCLs) and non-zero maximum contaminant level goals (MCLGs) that are health-based standards for public water systems	MCLs and MCLGs can be found at: http://www.epa.gov/safewater/contaminants/index.html#mcls (accessed May 7, 2007)	Relevant and appropriate, if groundwater is a potential drinking water source
Identification and listing of hazardous waste	40 CFR 261	Generation of wastes during remediation. Wastes must be characterized to determine if they are hazardous.	Waste characterization may involve chemical analyses and comparing the results to criteria. If the analytical results are above the criteria, the waste is a hazardous waste.	Applicable to all wastes generated during investigation and remediation

Notes:
AAC = Alaska Administrative Code
ADEC = Alaska Department of Conservation
ARAR = applicable or relevant and appropriate requirement
AS = Alaska Statute
AWQC = ambient water quality criterion
CERCLA = Comprehensive, Environmental Response, Compensation, and Liability Act
CFR = Code of Federal Regulations
MCL = maximum contaminant level
MCLG = maximum contaminant level goal
mg/kg = milligrams per kilogram
PCB = polychlorinated biphenyls
TBC = to be considered
USC = United States Code
USEPA = U.S. Environmental Protection Agency
WQC = Water Quality Criteria

TABLE 3-2
Location-Specific ARARs

Location	ARAR	Prerequisite for Applicability	Comments and Considerations	ARAR Assessment
Archeological resources	43 CFR 7.4 AS 41.35; 11 AAC 16	Actions that may excavate, remove, damage or otherwise alter or deface an archeological resource are not allowed unless by permit or exception.	On non-CERCLA sites, a state permit ifs required before excavating, or altering a historical or archeological resource	Applicable, if archeological resources are present
Historic places	National Historic Preservation Act, 16 USC § 470 et seq. 36 CFR Part 800 AS 41.35 11 AAC 16	Requires federal agencies conducting or authorizing activities where significant historic or archeological data may be threatened to preserve such data before the project commences		Applicable, if historic properties are present
Presence of human remains, funerary objects, sacred objects, or objects of cultural patrimony for Native Alaskans	43 CFR 10.4(c) and (d)	Actions that disturb human remains or any of the other objects.		Applicable to intrusive activities.
Areas where migrating birds may be present	16 USC 703-712 50 CFR 10.13	If migratory birds are present, provides protection of almost all species of native birds in the U.S. from unregulated activities. Unregulated activities can include poisoning at hazardous waste sites.		Applicable, if migratory birds are present

TABLE 3-2
Location-Specific ARARs

Location	ARAR	Prerequisite for Applicability	Comments and Considerations	ARAR Assessment
Endangered Species habitat	16 USC 1531-1544 et seq. 16 USC 1361-1407 16 USC 4201-4245 50 CFR 17, 200, 222, 227, and 402 AS 16 5 AAC 95	Provides for protection and conservation of various species of fish, wildlife, and plants.		Applicable, if endangered or threatened species or habitat is present

Notes:
AAC = Alaska Administrative Code
ARAR = applicable or relevant and appropriate requirement
AS = Alaska Statute
CERCLA = Comprehensive, Environmental Response, Compensation, and Liability Act
CFR = Code of Federal Regulations
USC = United States Code

TABLE 3-3
Action-Specific ARARs

Activity	ARAR	Prerequisite for Applicability	Considerations	ARAR Assessment
Cleanup of releases to the environment	Oil and Other Hazardous Substances Pollution Control 18 ACC 75 Article 3 (18 AAC 75.300 through .396)	The site cleanup rules establish administrative processes and standards to determine the necessity for and degree of cleanup required to protect human health, safety, and welfare and the environment at a site where a hazardous substance is located.	Alaska Contaminated Sites Program addresses releases (past and present) of oil and hazardous substances.	Applicable
Discharges to state waters	40 CFR 131 Water Quality Standards for surface waters and 18 AAC 70	Any substance discharged into state waters from a point source must meet these standards. The regulations specify that turbidity standards not exceed 25 NTU above natural conditions. TDS may not exceed 1,500 mg/L, including natural conditions; increase in TDS may not exceed one-third of the concentration of the natural condition of the water body. A SWPPP will be required for the site if it is larger than 1 acre.	Current plan includes dewatering.	Applicable, if water is discharged to surface water
Point source discharges of water	National Pollutant Discharge Elimination System (NPDES) 40 CFR 122, 125, 136, and 403 AS 46.03 18 AAC 72	Discharge of pollutants from any point source into waters of the U.S. or into a sewer system that discharges to a POTW Stormwater management and an SWPPP or similar documentation will be needed if the site is larger than 1 acre	Standards for discharges from treatment plants to groundwater and surface water. Pretreatment standards for discharges to POTWs. Current plans include dewatering. Currently, USEPA has primacy for NPDES permitting in Alaska. However, Alaska has applied for primacy, and is expected to become the implementing authority for these regulations for military bases in March 2009.	Applicable, if dewatering water or surface water is discharged through a point source. Applicable, if treated water is discharged to a POTW or FOTW.

TABLE 3-3
Action-Specific ARARs

Activity	ARAR	Prerequisite for Applicability	Considerations	ARAR Assessment
Discharges to air	Clean Air Act, 42 USC §7401 et seq. 40 CFR 50, National Primary and Secondary Ambient Air Quality Standards (NAAQS) 18 AAC 50	Includes air pollution caused by visible emissions, fugitive dust, incineration, industrial processes, fuel combustion, storage of VOC, VOC water separation, and waste gas disposal.	NAAQS are the primary standards applicable to any remedial alternative that would emit regulated air pollutants	Applicable
Remediation of contaminated media	Site Remediation MACT 40 CFR 63 Subpart G	Establishes national emission standards for hazardous air pollutants from site remediation activities. The rule covers remediation of contaminated environmental media, such as soils, groundwater, or surface water. The affected sources subject to control are process vents, remediation material management units, and equipment leaks.	Projects conducted under CERCLA are exempted.	Relevant and appropriate
Underground storage tank (UST) release response	Underground storage tank regulations 18 AAC 78	Presence of USTs or contamination from USTs Corrective action requirements for petroleum releases from leaking USTs and for removal of USTs	Presence of USTs or contamination from oils	Applicable if USTs are discovered during remediation (e.g., old heating oil tanks) Relevant and appropriate, if petroleum contamination is found that is not due to USTs
Underground storage tank release response	Underground Storage Tank Procedures Manual (ADEC, November 2002)	Presence of USTs that have leaked.	Provides information on sampling procedures, analytical methods, remedial technologies, etc. The guide can be found at http://www.dec.state.ak.us/spar/guidance.htm#ust (accessed May 4, 2007)	TBC
Managing contaminated soil	Solid waste management regulations 18 AAC 60.025	Disposal of polluted soil	Polluted soil may be disposed of only in a Class 1 municipal solid waste landfill.	Applicable, if soils are disposed of offsite.

TABLE 3-3
Action-Specific ARARs

Activity	ARAR	Prerequisite for Applicability	Considerations	ARAR Assessment
Groundwater monitoring	Solid Waste Management Regulations 18 AAC 60 Article 7	Monitoring and Corrective action requirements for solid waste landfills		Relevant and appropriate if waste is left in place.
Managing wastes	Identification and listing of hazardous waste 40 CFR 261	Wastes must be characterized to determine if they are hazardous.	Applicable to any wastes (including soils) generated and sent off-site	Applicable to all wastes generated during investigation and remediation
Disposal of contaminated waste off-site	Land Disposal Restrictions Program 40 CFR 268	Hazardous wastes must be generated and managed,	Sets treatment standards for hazardous wastes based on the levels achievable by current technology; sets 2-year national variances from the statutory effective dates due to insufficient treatment capacity.	Applicable if hazardous wastes are sent off-site.
Generation of a waste stream	RCRA Hazardous Waste Determination 40 CFR 261.21-24 and Subtitle D	Activities that cause a waste to be generated	A waste is considered a RCRA hazardous waste if it exhibits any of the characteristics of ignitability, corrosivity, reactivity, or toxicity, or if it is listed as a hazardous waste. Most waste determinations will focus on whether the generated waste (e.g., treatment residuals) could be classified as toxicity characteristic waste as defined by the contaminant concentrations (e.g., a D-code hazardous waste). The toxicity characteristic is determined by running a TCLP on the waste.	Applicable
Transportation of hazardous materials	Hazardous Materials Transportation Act 49 CFR 171-177	Established standards for packaging, labeling and transportation of hazardous materials	Could apply if hazardous materials are encountered and transported offsite.	Applicable since recovered oil is transported off-base for recycling.
Used oil handling	18 AAC 75	Management, transportation, and disposal of used oil.	Standards for used oil management would apply to recovered petroleum product.	Applicable to handling of recovered petroleum.

TABLE 3-3
Action-Specific ARARs

Activity	ARAR	Prerequisite for Applicability	Considerations	ARAR Assessment
Unexploded explosive ordnance (UXO) and discarded military munitions (DMM)	DOD Ammunition and Explosives Safety Standards, DOD Directive 6055.9-STD MIL-STD 6055.9	Establishes uniform safety standards applicable to ammunition and explosives, to associated personnel and property, and to unrelated personnel and property exposed to the potential damaging effects of an accident involving ammunition and explosives during handling, transportation, storage, and disposal.		TBC
UXO and DMM management	RCRA Military Munitions Rule 40 CFR 260-265, 40 CFR 270, and 40 CFR 266 Subpart M	Presence of military munitions or contamination from military munitions	MEC has been found at the site	Applicable
UXO or DMM management	Munitions and Explosives of Concern Hazard Assessment Guidance	Presence of munitions and explosives of concern on a CERCLA site	Allows a project team to evaluate the potential explosive hazard associated with a site, given current site conditions and under various cleanup, land use activities, and land use control alternatives. The document can be found at: http://www.epa.gov/fedfac/documents/ hazard_assess_wrkgrp.htm	TBC
UXO or DMM management	Handbook on the Management of Munitions Response Actions	Potential presence of munitions and explosives of concern on a CERCLA site	Presents USEPA guidance on munitions response actions. The document can be found at: http://www.epa.gov/fedfac/pdf/ mra_hbook_5_05.pdf	TBC
Underground Injections Control Program (UIC): Criteria and Standards	40 CFR 146 AS 31.05 20 AAC 25	Underground injection of water or wastes.	USEPA enforces federal UIC requirements in Alaska. Provides for protection of underground sources of drinking water and the UIC programs.	Applicable if waters or wastes are injected into the ground

TABLE 3-3
Action-Specific ARARs

Activity	ARAR	Prerequisite for Applicability	Considerations	ARAR Assessment
Occupational safety and health standards	AS 18.60 8 AAC 61	Work conducted in Alaska	Alaska has a delegated OSH program. This program sets standards for safety in the work environment.	Applicable

Notes:
AAC = Alaska Administrative Code
ADEC = Alaska Department of Environmental Conservation
ARAR = applicable or relevant and appropriate requirement
AS = Alaska Statute
CERCLA = Comprehensive, Environmental Response, Compensation, and Liability Act
CFR = Code of Federal Regulations
DOD = Department of Defense
DMM = discarded military munitions
FOTW = federally-owned treatment works
MACT = maximum achievable control technology
mg/L = milligrams per liter
NAAQS = National Primary and Secondary Ambient Air Quality Standards
NPDES = National Pollutant Discharge Elimination System
NTU = nephelometric turbidity unit
OSH = Occupational safety and health
POTW = publicly owned treatment works
RCRA = Resource Conservation and Recovery Act
SWPPP = Stormwater pollution prevention plan
TBC = to be considered
TCLP = toxicity characteristic leaching procedure
TDS = total dissolved solids
UIC = underground injection control
USEPA = U.S. Environmental Protection Agency
UST = underground storage tank
UXO = unexploded ordnance
VOC = volatile organic compound

SECTION 4

RI Tasks

The Army, USEPA, and ADEC have agreed to conduct the RI at the FCS by using the Triad approach. The work tasks described in this section apply the Triad approach by using technically defensible methods necessary to complete site RI characterization activities. As part of the systematic project planning required in Triad, an FCS Management Team represented by technical experts from the Army, USEPA, and ADEC reviews and approves RI work tasks, including those discussed in the following sections.

During an RI Management Plan review meeting convened on June 6 and 7, 2007, the FCS Management Team recommended changes to portions of the Draft RI Management Plan. These modifications were developed and summarized in four addenda that are appended to this Interim Draft RI Management Plan. (See the tab labeled "Work Plan Addenda.") These addenda provide more detailed information about specific tasks that will ensure the data quality is consistent with data gathering and processing needed to obtain accurate site characterization. Additional addenda may be added to this RI Management Plan during the course of the RI at the FCS. This approach has been determined by the FCS Management Team to be the most effective, efficient, and appropriate method for investigating this site.

The tasks required to perform an RI at the FCS are discussed in the following sections.

4.1 Soil Gas Investigation

The objective of the soil gas investigation is to determine the risk to human health posed by potential vapor intrusion from buildings and selected areas at Taku Gardens. Soil gas sample results will also be used to identify contaminant sources and plumes to provide chemical concentration data for the baseline risk assessment. Addendum 3 addressing the characterization of soil gas on the FCS was prepared to provide more detailed information about this investigation. This addendum covers collection procedures of sub-slab soil gas samples at all buildings and subsurface soil gas samples in open areas within the low-probability MEC area[1] only. Other than the sub-slab samples, no other subsurface soil gas samples will be collected in the moderate-to-high-probability MEC area. Because of MEC concerns in the moderate-to-high-probability MEC area, each intrusive sampling location must be excavated and cleared. The excavations will be replaced with clean backfill, and sampling soil gas in clean backfill does not yield meaningful data. It was agreed by the FCS Management Team that the sub-slab soil gas results, together with groundwater and soil sampling results will be sufficient to satisfy data objectives in this area. Table 4-1 presents the DQOs for the soil gas investigation; Figure 4-1 presents the corresponding decision tree for this investigation. (The tables and figures are provided at the end of Section 4.)

[1] See Work Plan Addendum 3 for discussion of the low-probability and moderate-to-high probability MEC areas.

4.2 Surface Soil Investigation

With the exception of sampling in the sound berm, data collected in 2005 and 2006 will be used to characterize the nature and extent of surface soils at the FCS. Additional surface soil samples are not planned as part of the RI. The purpose of the sound berm investigation is to ensure that these structures do not pose a direct contact risk to human health. The FCS Management Team elected to use multi-increment (MI) soil samples as the screening tool for this effort. Addendum 1 addressing the characterization of these berms was prepared to provide more detailed instructions about this investigation. The sound berm is divided into nine decision units. Within each decision unit, the strategy will consist of 30 randomly distributed discrete samples to compose each MI sample. Samples will be collected on the top and on each side of the berm. No samples will be collected from the interior of the berm because there is no reason to believe that the composition of subsurface samples would be different from that of surface samples.

If concentrations from any sections of the berm exceed established risk screening criteria, discrete samples will be collected to calculate baseline risk for subsequent management decisions. Table 4-2 presents the DQOs for the sound berm investigation, and Figure 4-2 presents the corresponding decision tree for this investigation.

4.3 Subsurface Soil Sampling

Two objectives for the subsurface soil investigation at the FCS are to assess (1) the risk to human health for residential and "trench worker" scenario, and (2) the potential for subsurface soil contaminant migration to groundwater. Table 4-3 presents the DQOs and proposed data collection efforts for the subsurface soil investigation, and Figure 4-3 presents the corresponding decision tree for this investigation.

4.3.1 Monitoring Well Installation Soil Sampling

Subsurface soil samples will be collected at each monitoring well boring. As agreed by the FCS Management Team, a minimum of three samples will be collected at each well boring location: one in the near surface (0 to 2 feet bgs), one in the vadose zone (2 to 10 feet bgs), and one in the smear zone (10 to 14 feet bgs). The rig geologist has the authority to collect an additional soil sample at each well boring location if unusual geology or signs of contamination are encountered during drilling. Addendum 4 addresses the characterization of soil and groundwater at the FCS. Subsurface soil cores will be collected during monitoring well installation for lithologic description and will be sampled for COPC , then analyzed by a laboratory. Analytical results will be compared to screening values for determination of risk (one-tenth of the most conservative ADEC Method 2 cleanup levels for ingestion and cleanup levels for migration to groundwater). Soil samples will also be collected at areas cleared for monitoring well locations in the moderate-to-high-probability MEC area. Two samples will be collected in each excavation used to clear the well locations, and these samples will take the place of the near surface and vadose zone soil samples, which would typically be collected during installation of the monitoring well boring.

4.3.2 Confirmation Soil Sampling at Debris Investigations

Subsurface soil confirmation sampling will be conducted in excavations at Building 49, Building 48, and any other area investigated as part of the RI to evaluate concentrations of COPCs in soil following the debris investigations. The same suite of analytes proposed for soil borings and monitoring wells will be sampled during confirmation sampling (as described in Addendum 4). Samples will be collected from excavator buckets directly into sample containers.

As agreed by the FCS Management Team, the soil confirmation samples will be collected on a 50-foot grid in areas that have no signs of contamination. Where potential sources of contamination have been excavated, a finer sampling grid will be used, with size and spacing of the grid determined using best professional judgment (for example, 10 by 10 feet or 20 by 20 feet, depending on the distribution of the source).

4.4 Groundwater Investigation

Groundwater data will be collected to characterize the hydrogeology and assess (1) potential risk to post drinking supply wells, (2) potential impact to surface water, and (3) contribution to vapor intrusion risk. Groundwater samples will also be used to assess the nature and extent of contamination at the site, delineate plumes of contaminants, and locate sources of contamination. Water level data will be used to confirm water flow direction and may be useful in the assessment of potential preferential flow patterns in the former river channels. Addendum 4 was developed by the FCS Management Team to provide additional details about characterization procedures for soil (collected during installation of the monitoring wells) and groundwater to support the objectives of this groundwater investigation.

Figure 4-4 presents the location of the existing and proposed monitoring wells for this investigation. Monitoring wells were selected to provide sitewide coverage for locating sources, characterize groundwater quality downgradient of anomalies, characterize the POL plume and the former river channels, and evaluate locations where concentrations reported in historical data exceeded screening levels. Table 4-4 presents the DQOs and proposed data collection methods for the groundwater investigation, and Figure 4-5 presents the corresponding decision tree for this investigation.

The groundwater assessment will target several area types, including buildings, disposal areas, the POL plume located at the north end of the site in Subarea B (low-probability MEC area), and the former river channels. As many as 70 two-inch diameter monitoring wells will first be installed and screened from approximately 10 to 20 feet bgs. These wells will be developed and sampled for the COPCs listed in Section 2.2.2.

Monitoring well locations will be cleared for MEC as outlined in the MEC Support Work Plan. In the moderate-to-high-probability MEC area, the subsurface will physically be cleared through excavation. Excavations will be backfilled, then monitoring wells will be installed.

The purpose of/justification for each proposed monitoring well is included in Table 4-5. Figure 4-4 shows the locations for all proposed monitoring wells.

Approximately 20 permanent monitoring wells will be installed based on the results of groundwater samples obtained from 27 temporary monitoring wells and existing permanent wells. At least one permanent well will be installed to monitor the POL plume. Two other permanent wells will be deep wells: one to a depth of 30 feet bgs, and the other to a depth of 50 feet bgs. Both of these permanent wells will be located near the main post supply well. All permanent wells will be protected by protective steel casing and bollards.

4.4.1 POL Plume

The objective of the groundwater investigation for the POL plume is to determine the nature and extent of the plume. Some data will be obtained from the groundwater samples collected at Buildings 1 through 14. These data will be used to augment existing soil gas and groundwater data to characterize the source of the POL plume. Using the known groundwater gradient to predict movement of the POL plume, the first soil boring will be installed west of the SAS building, approximately 250 feet from MW-06A. This location is proposed because it is in line with the known POL plume and it outside of the SAS playground.

Field screening of subsurface soil near the groundwater table will be used as a real-time indicator of dissolved contamination in groundwater. Field screening will be conducted with a photoionization detector (PID) on head space samples using procedures outlined in the Field Sampling Plan. If PID readings greater than 10 ppm are detected, the location will be deemed to be still within the POL plume. Intermediate borings within the POL plume will then be abandoned following approved ADEC procedures. Additional borings will be installed downgradient, if needed, until no PID readings are detected. From the results of natural attenuation studies of fuels at Fort Wainwright, it is anticipated that the proposed well located approximately 250 feet from MW-06A and west of the SAS building will be clean. At the location where no PID readings are detected, a permanent monitoring well will be installed to confirm the extent of the POL plume and provide a permanent monitoring point.

4.4.2 Former River Channels

Because historical aerial photos indicate the former river channels in the FCS were used for disposal and because these areas could potentially have a different geological composition than surrounding soils (possibly more transmissive for groundwater), additional temporary wells will be installed in the former channels to assess potential contamination. Locations will be chosen to avoid existing structures, utilities, and geophysical anomalies. If geophysical anomalies cannot be avoided, monitoring wells may be installed within test pits that have been cleared of debris. See Figure 4-4 for proposed monitoring well locations with former river channel locations.

4.5 Drainage Swale Sediment Investigation

4.5.1 Objective

The objective of sampling the drainage swale sediment is to determine whether runoff exiting the FCS might present an ecological risk to surface water receptors in the Chena

River. Table 4-6 present the DQOs, and Figure 4-6 presents the corresponding decision tree for this investigation.

Drainage for the Taku Gardens Family Housing development is channeled into two main swales located along the north and west perimeters of the subdivision. The swales converge north-northwest of Building 1, and the combined swale runs in a north-northeast direction past the SAS building. This drainage swale is the primary carrier for site runoff from heavy storm events and snowmelt. To evaluate concentrations of contaminants leaving the site through sediment, three sediment samples will be taken from the swale. The first sample will be collected at a point where sediment has collected at a barrier of hay bales near the point where the swale runs under the FCS boundary fence (Figure 4-7). The second sample will be collected just upgradient of the culvert under Neely Road. The third sample will be collected between the first two. The sediment samples will be analyzed for the preliminary target analytes listed in Section 2.3. If target analytes are detected at this third sample location, additional downgradient samples will be taken. These locations would be defined in a future work plan addendum.

4.6 Onsite Soil Pile Investigation

There are 47 soil piles at the FCS. The soil piles are generally located around the perimeter of the construction (see figure in Work Plan Addendum 2). Approximately 5 acres of this area were fenced off and designated as the PCB EZ. Twenty four of the piles are located in the PCB EZ. The size of the soil piles range from approximately 10 to several hundred cubic yards.

Addendum 2 was prepared to provide more detailed information about the soil pile investigation. MI sampling was selected to characterize the soil stockpiles. This approach was determined by the FCS Management Team to be the most effective, efficient, and appropriate method for investigating this area.

The objective of the work associated with the onsite soil pile investigation is characterization of contaminant levels in the soil piles so that appropriate decisions about their disposal can be made. Soil piles are designated for offsite disposal in the Fort Wainwright Class I landfill unless they contain constituents that exceed ADEC Table B1 or Table B2 soil cleanup levels provided in 18 AAC 75. If stockpile soils exceed these concentrations, they will be processed and disposed of by the Fort Wainwright Defense Reutilization Marketing Office. If PCBs are detected in the stockpiles above the Fort Wainwright landfill acceptance criterion of 10 mg/kg, they will be disposed of as part of a separate PCB removal project and will not be part of the work described in this section. Table 4-7 presents the summary of DQOs for the soil pile investigation. Figure 4-8 presents the corresponding decision tree for this investigation.

The sample results from each soil pile will be compared to ADEC cleanup levels and chemical-specific risk screening levels to determine whether soil piles should be removed and disposed off site, or if the soil can be reused on site. If any cleanup levels or chemical-specific risk screening values are exceeded, the affected soil pile will be removed and disposed of off site. If none of the cleanup levels or chemical-specific risk screening values are exceeded, the soil piles will be reused on site.

Data for soil piles that will remain on site will be used in the baseline risk assessment once the disposition of the soil piles is understood. Data for soil piles that require disposal will be provided to disposal contractors as required for disposal.

4.7 PCB Removal Action Support

The Army DPW contracted with Jacobs Engineering Group, Inc., to conduct a removal of PCB contaminated soil. The plan for the PCB removal action is documented in the PCB Removal Action Work Plan (Jacobs, 2007). CH2M HILL will support this removal action by taking confirmation samples.

4.7.1 Objective

The objective of the sampling is to provide confirmation that all PCB-contaminated soil above regulatory levels has been removed.

4.7.2 Approach

Several areas have been proposed for removal actions near the former Building 52 location where prior sampling has indicated high levels of PCBs. Confirmation soil sampling will be conducted in the excavations after the removal actions have been completed. Test kit samples will be used to guide the excavation, and laboratory confirmation samples will be used to confirm the PCB removal. At least four confirmation samples will be taken from the excavation walls, and at least two confirmation samples will be taken from the floor of each excavation. Excavations will remain open until laboratory analysis either confirms the full extent of the PCB contamination has been excavated and the hole can be backfilled with clean soil or indicates that further excavation is needed.

TABLE 4-1
Summary of Data Quality Objectives for Soil Gas Sampling

Objective	Sample Type and Data To Be Collected	Analytes of Concern	Data Evaluation	Other Considerations
Determine whether soil gas poses potential risk to residents and for source delineation	Sub-slab soil gas samples. Samples will be collected at a depth of 3 inches below the slab in accordance with USEPA guidance.	Volatile organic compounds	Input soil gas concentrations into Johnson/Ettinger Model Run model and make decisions about potential risk (see Risk Assessment Work Plan)	Detection limits consistent with 10X the USEPA Region 6 Ambient Air Screening Level will be used (multiplier accounts for soil gas to indoor air attenuation).
Better define the location of potential contaminant source areas	Soil gas samples from borings in open areas. Soil gas probes will be installed to a depth of approximately 6 feet bgs by using a direct-push drill rig.	Volatile organic compounds	Map soil gas and sub-slab concentrations to help identify potential source areas and extent of petroleum, oil, and lubricants (POL) plume	Sample locations will be selected to avoid geophysical anomalies and utilities. Potential exposure to and risk from ambient air will be addressed as part of the Baseline Risk Assessment for surface and subsurface soil.

TABLE 4-2
Summary of Data Quality Objectives for Sound Berm Sampling

Objective	Sample Type and Data To Be Collected	Analytes of Concern	Data Evaluation	Other Considerations
Determine whether soil in sound berm decision unit contains elevated concentrations of target analytes and requires further sampling and analysis	Multi-increment soil sample composed of 30 subsamples from multiple locations in decision unit 9 multi-increment decision units; each 200 to 400 feet long Samples to come from surficial 2 feet of soil, surface assumed to be representative of all materials in berm Triplicates will be collected at one decision unit. Results for triplicates will be used to adjust results for other decision units.	VOCs SVOCS PCBs Metals DRO/RRO GRO Pesticides Herbicides Explosives	Compare adjusted decision unit results to screening level (1/10th Method 2 cleanup level or Region 6 preliminary remediation goal if no Method 2 cleanup level available). If the results do not exceed screening levels, no further investigation or remedial action is required for the decision unit. Otherwise, evaluate the need to collect discrete samples from decision unit and if necessary collect the discrete samples and evaluate to determine whether elevated concentrations pose potential risk (see next row).	If the RSD results for a triplicate sample do not meet an ADEC criterion, the usefulness of the results will be evaluated. Agency approval should be obtained before discrete samples are collected, if needed.
Determine whether elevated concentrations in decision unit poses potential risk	Discrete soil samples from decision unit.	Constituents that exceed screening level in decision unit	Assess excess risk posed by constituents in soil. If acceptable risk, no further investigation or remedial action is required for the decision unit. Otherwise determine source of excess risk and assess options to address risk	Multiple sampling events may be required to obtain sufficient data for risk assessment, delineate source of high concentrations, or obtain approval for removal and/or treatment.

Notes:
DRO = diesel-range organics
EPH = extractable petroleum hydrocarbon
GRO = gasoline-range organics
MI = multi-incremental
PCB = polychlorinated biphenyls
RRO = residual-range organics
SVOC = semivolatile organic compound
VOC = volatile organic compound

TABLE 4-3
Summary of Data Quality Objectives for Subsurface Soil Sampling

Objective	Sample Type and Data To Be Collected	Analytes of Concern	Data Evaluation	Other Considerations
Determine whether contaminants in subsurface soil pose potential worker and residential risk	Borings to be advanced in VOC plume area, former slough channel, northern boundary of the FCS, and additional locations to provide site-wide coverage (approximately one every 0.75 acre) At a minimum, three soil samples will be collected in each boring at the following depths: near the ground surface (approximately 2 to 3 feet below existing grade); in middle of the vadose zone at a location likely to contain contamination; and in the zone of seasonal water table fluctuation at depth of approximately 11 to 13 feet	VOCs and TICs SVOCS Metals DRO/RRO GRO Pesticides Herbicides Explosives EPH VPH	Use data in risk assessment (see Risk Assessment Work Plan) and for nature and extent evaluation. Residential risk will be considered in the upper 2 feet of soil. Excavation worker risk will be considered in soil from 0 to 15 ft bgs.	Additional soil samples may be collected at the field geologist's discretion.
Characterize subsurface conditions and potential soil impacts to groundwater	Same as above	Same as above	Map contaminant concentrations by depth and evaluate distribution to help identify potential source areas Compare results for deepest sample in boring to groundwater protection screening levels. If elevated concentrations extend to capillary fringe, characterize groundwater conditions in vicinity of boring	Detection limits consistent with 1/10th Method 2 groundwater protection levels will be used.

Notes:
DRO = diesel-range organics
EPH = extractable petroleum hydrocarbon
GRO = gasoline-range organics
RRO = residual-range organics
SVOC = semivolatile organic compound
TIC = = tentatively identified compound
VOC = volatile organic compound
VPH = = volatile petroleum hydrocarbon

TABLE 4-4
Summary of Data Quality Objectives for Groundwater

Objective	Sample Type and Data To Be Collected	Analytes of Concern	Data Evaluation	Other Considerations
Hydrogeologic characterization	Install wells in VOC plume area, former slough channel, northern boundary of the FCS, and additional locations to provide site-wide coverage) Well location and elevation data, water level data	Not applicable	Calculate groundwater elevations Prepare contour map Use map and water supply well capture zone information to assign each well to location-specific evaluation (see rows below)	Additional wells may be installed to complete delineation of contaminant plumes or provide additional data for modeling. Most wells will be screened in the upper 5 to 10 feet of the aquifer, but at least two wells in the vicinity of the water supply well will have longer screens matching the screened interval for the water supply well.
Assess potential risk posed to Groundwater	Groundwater samples collected from wells in water supply well capture zone	GRO DRO/RRO Metals Pesticides PCBs Herbicides VOCs SVOCS Transitional explosives Explosives VPH EPH	Compare results for samples to risk-based screening levels. If results from all wells are below criteria, no further investigation will be required. Otherwise, use results in Baseline Risk Assessment and model future concentrations in groundwater. If model predicts potential exposure via water supply well, a feasibility study for remedial actions to address risk will be required.	Detection limits consistent with 1/10th of the ADEC risk-based screening levels will be used.
Assess potential risk posed to surface water	Groundwater samples collected from wells along northern boundary (outside of water supply well capture zone)	GRO DRO/RRO Metals Pesticides PCBs Herbicides VOCs SVOCS Transitional explosives Explosives VPH EPH	Compare results for samples to surface water criteria and applicability to aquatic ecological criteria. If results from all wells are below criteria, no further investigation will be required. Otherwise, use results in Baseline Risk Assessment and model future concentrations in surface water. If model predicts potential exposure to ecological receptors in surface water, a feasibility study for remedial actions to address risk will be required.	Detection limits consistent with 1/10th of the surface water criteria will be used. Samples analyzed for metals may be filtered

TABLE 4-4
Summary of Data Quality Objectives for Groundwater

Objective	Sample Type and Data To Be Collected	Analytes of Concern	Data Evaluation	Other Considerations
Characterize contaminant levels in groundwater and delineate plumes	Groundwater samples collected from wells	GRO DRO/RRO Metals Pesticides PCBs Herbicides VOCs SVOCS Transitional explosives Explosives VPH EPH	Map distribution of detected analytes Compare results to ADEC drinking water and surface water criteria and to 18 AAC 75, Table C, groundwater cleanup levels. If results exceed criteria and extent is not determined, install additional wells to define extent. Otherwise, establish land use controls and incorporate selected wells into long-term monitoring program.	

Notes:
DRO = diesel-range organics
EPH = extractable petroleum hydrocarbon
GRO = gasoline-range organics
PCB = polychlorinated biphenyls
RRO = residual-range organics
SVOC = semivolatile organic compound
VOC = volatile organic compound
VPH = = volatile petroleum hydrocarbon

TABLE 4-5
Purpose of/Justification for RI Monitoring Wells

Well ID	Depth	Purpose/Justification
MW13	Shallow	Characterize potential contamination associated with sub station anomaly.
MW14	Shallow	Establish groundwater gradient, characterize potential sources in the area
MW15	Shallow	Establish groundwater gradient, characterize potential sources in the area
MW16	Shallow	Establish groundwater gradient, characterize potential sources in the area
MW17	Shallow	Characterize potential contamination associated with Bldg 52 PCB hotspot
MW18	Shallow	Characterize potential contamination associated with sub station anomaly.
MW19	Shallow	Evaluate extent of contamination in former river channel.
MW20	Shallow	Evaluate extent of contamination in former river channel.
MW21	Shallow	Evaluate extent of contamination in former river channel.
MW22	Shallow	Establish groundwater gradient, characterize potential sources in the area
MW23	Shallow	Characterize potential contamination associated with Bldg 48 anomaly.
MW24	Shallow	Delineate POL plume
MW25	Shallow	Delineate POL plume
MW26	Shallow	Delineate POL plume
MW27	Shallow	Delineate POL plume
MW28	Shallow	Delineate POL plume
MW29	Shallow	Delineate POL plume
MW30	Shallow	Delineate POL plume. Evaluate extent of contamination in former river channel.
MW31	Shallow	Delineate POL plume. Evaluate extent of contamination in former river channel.
MW32	Shallow	Delineate POL plume
MW33	Shallow	Delineate POL plume
MW34	Shallow	Delineate POL plume, dissolved phase. Evaluate extent of contamination in former river channel.
MW35	Shallow	Delineate POL plume, dissolved phase. Evaluate extent of contamination in former river channel.
MW36	Shallow	Delineate POL plume, dissolved phase
MW37	Shallow	Delineate POL plume, dissolved phase
MW38	Shallow	Evaluate extent of contamination in former river channel.
MW39	Deep	Evaluate contaminant concentrations at depth close to drinking water supply wells
MW40	Deep	Evaluate contaminant concentrations at depth close to drinking water supply wells
MW41	Shallow	Characterize potential contamination associated with Bldg 15 anomaly.

TABLE 4-5
Purpose of/Justification for RI Monitoring Wells

Well ID	Depth	Purpose/Justification
MW42	Shallow	Characterize potential contamination associated with Bldg 15 anomaly.
MW43	Shallow	Evaluate extent of contamination in former river channel.
MW44	Shallow	Evaluate extent of contamination in former river channel. Characterize potential contamination associated with Bldg 11 anomaly.
MW45	Shallow	Characterize potential contamination associated with Bldg 24 anomaly.
MW46	Shallow	Establish groundwater gradient, characterize potential sources in the area
MW47	Shallow	Establish groundwater gradient, characterize potential sources in the area
MW48	Shallow	Establish groundwater gradient, characterize potential sources in the area
MW49	Shallow	Establish groundwater gradient, characterize potential sources in the area
MW50	Shallow	Characterize potential contamination associated with Bldg 24 anomaly.
MW51	Shallow	Characterize potential contamination associated with Bldg 22 anomaly.
MW52	Shallow	Characterize potential contamination associated with Bldg 48 anomaly.
MW53	Shallow	Establish groundwater gradient, characterize potential sources in the area
MW54	Shallow	Evaluate extent of contamination in former river channel. Establish groundwater gradient, characterize potential sources in the area.
MW55	Shallow	Characterize potential contamination associated with Bldg 36 anomaly.
MW56	Shallow	Characterize potential contamination associated with Bldg 22/24 anomaly.
MW57	Shallow	Establish groundwater gradient, characterize potential sources in the area
MW58	Shallow	Delineate POL plume, dissolved phase
MW59	Shallow	Characterize potential contamination associated with Bldg 22 anomaly.
MW60	Shallow	Characterize potential contamination associated with Bldg 49 anomaly.
MW61	Shallow	Characterize potential contamination associated with PSE II soil gas (TCE/PCE) anomaly.
MW62	Shallow	Delineate POL plume LNAPL
MW63	Shallow	Delineate POL plume LNAPL
MW64	Shallow	Delineate POL plume LNAPL
MW65	Shallow	Delineate POL plume LNAPL
MW66	Boring only	Delineate POL plume LNAPL
MW67	Shallow	Delineate POL plume LNAPL
MW68	Shallow	Characterize potential contamination associated with historic VOC (benzene) detect
MW69	Shallow	Characterize potential contamination associated with historic pesticide detection above screening level
MW70	Shallow	Characterize potential contamination associated with former location of drums, PID hits, and chemical odors reported in PSE 1 report near Building 28 (PSE I

TABLE 4-5
Purpose of/Justification for RI Monitoring Wells

Well ID	Depth	Purpose/Justification
		report)
MW71	Shallow	Characterize potential contamination associated with former locations of drums of white powder and leaking oil near Building 31 (PSE I report)
MW72	Shallow	Characterize potential contamination associated with former location of drums and PID hit near Building 30 (PSE 1 report)
MW73	Shallow	Characterize potential contamination associated with PID hits indicating volatile contamination near Building 32 (PSE 1 report)
MW74	Shallow	Characterize potential contamination associated with Bldg 52 PCB/VOC hotspot
MW75	Shallow	Characterize potential contamination associated with Bldg 52 PCB/VOC hotspot

TABLE 4-6
Summary of Data Quality Objectives for Drainage Swale Sediment

Objective	Sample Type and Data To Be Collected	Analytes of Concern	Data Evaluation	Other Considerations
Determine whether sediment in drainage swales contains elevated concentrations of analytes	Sediment samples	VOCs SVOCS Metals DRO/RRO GRO Pesticides Herbicides Explosives EPH VPH PCBs	Compare analytical results for each sample to ecological screening benchmarks for aquatic and terrestrial wildlife If results are less than criteria, no further investigation is required. Otherwise, review appropriateness of screening criteria for the site, and as necessary, gather additional samples, and conduct ecological risk assessment (see Risk Assessment Work Plan)	None

Notes:
DRO = diesel-range organics
EPH = extractable petroleum hydrocarbon
GRO = gasoline-range organics
PCB = polychlorinated biphenyls
RRO = residual-range organics
SVOC = semivolatile organic compound
VOC = volatile organic compound
VPH = = volatile petroleum hydrocarbon

TABLE 4-7
Summary of Data Quality Objectives for Soil Piles

Objective	Sample Type and Data To Be Collected	Analytes of Concern	Data Evaluation	Other Considerations
Determine whether soil piles can be disposed of in the Fort Wainwright landfill; if not, apply disposal and/or treatment as needed through DRMO based on the waste's designation.	Multi-incremental soil sample composed of 30 subsamples from multiple locations and depths in the pile Small soil piles adjacent to each other may be combined into a single decision unit. Large soil piles may be divided into multiple decision units. Triplicates will be collected at 10% of decision units.	Soil piles in PCB exclusion zone– PCBs[a] Soil piles outside PCB exclusion zone– DRO RRO Metals SVOCs VOCs in northwest corner soil piles [b]	Compare analytical results for decision unit to Fort Wainwright landfill acceptance criteria If results are less than criteria, dispose of soil pile at landfill; otherwise evaluate disposal and/or treatment options, including disposal of soil through DRMO	Existing information and analytical results for soil pile may be used to select target analyte list for soil pile.

Notes:
[a] Soil pile 18 also will be sampled for SVOC by Method SW8270 to confirm the detection of 2,6-dinitrotoluene.
[b] Soil piles 4 though 9 in the northwest corner of the site also will be sampled for VOCs.

ADEC = Alaska Department of Environmental Conservation
DRMO = Defense Reutilization Marketing Office
DRO = diesel-range organics
PCB = polychlorinated biphenyls
RRO = residual-range organics
RSD = relative standard deviation
SVOC = semivolatile organic compound
VOC = volatile organic compound

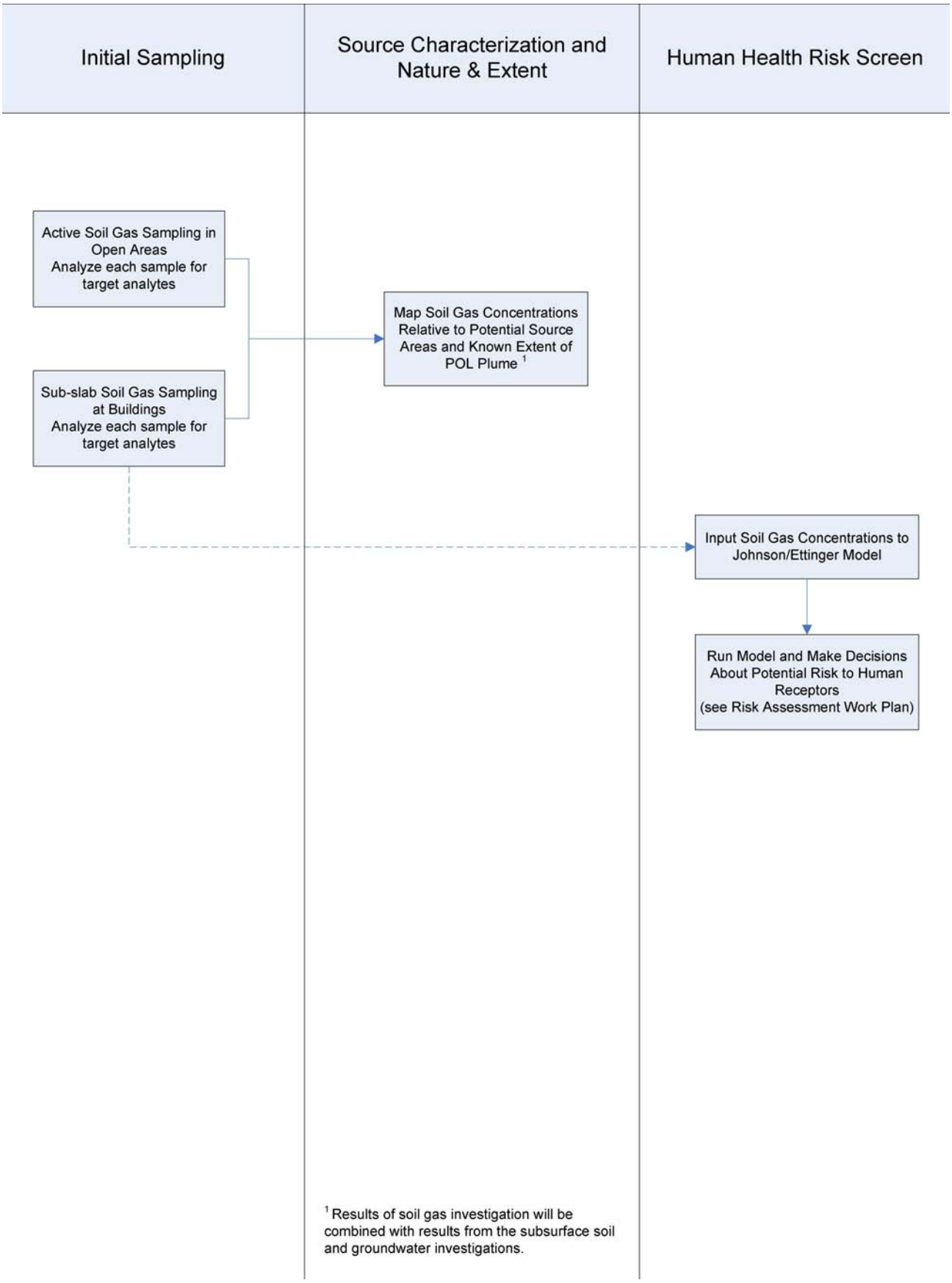

FIGURE 4-1
Sampling and Data Evaluation Process for Soil Gas
Former Communications Site, Fort Wainwright, Alaska

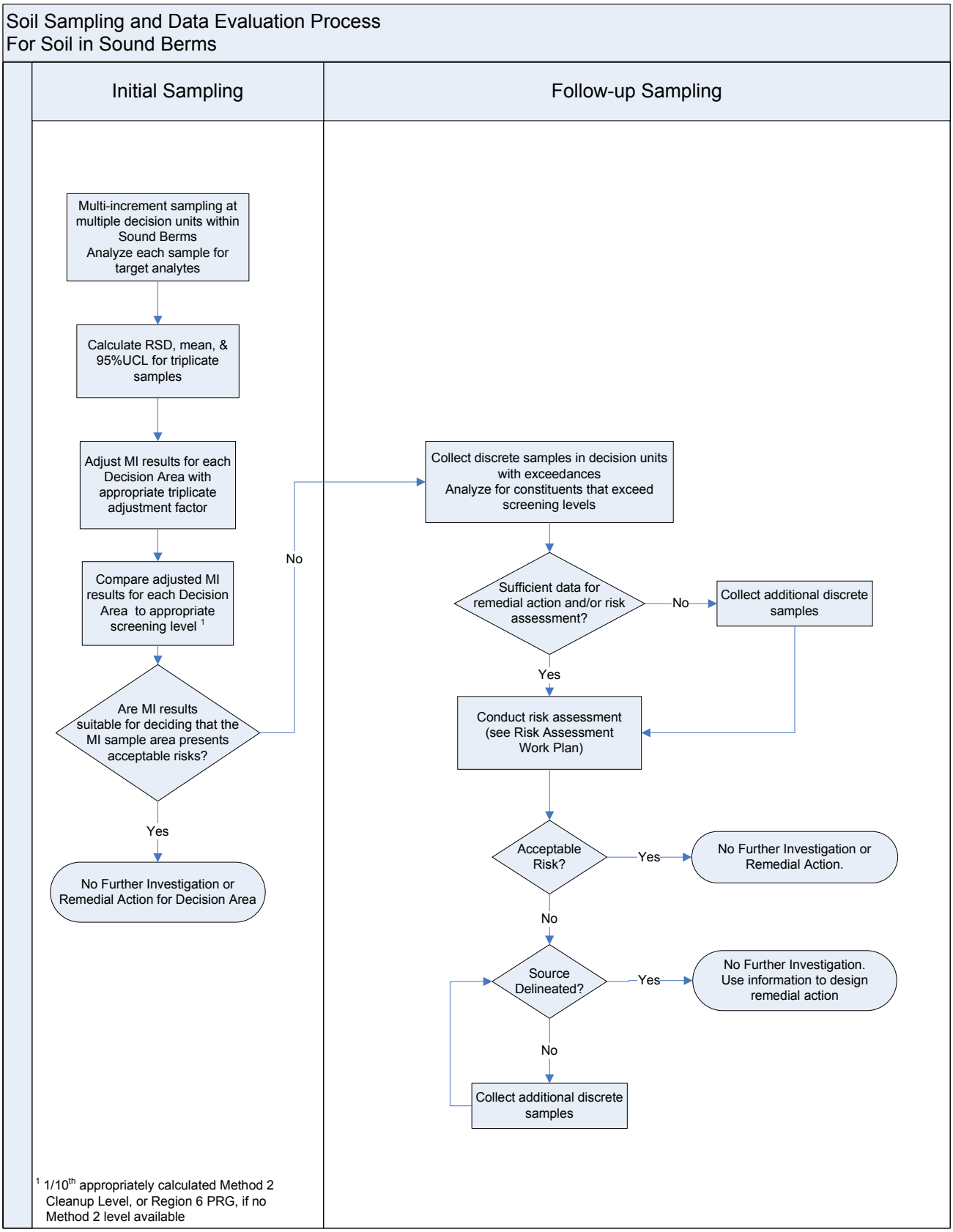

FIGURE 4-2
Soil Sampling and Data Evaluation Process for Soil in Sound Berms
Former Communications Site, Fort Wainwright, Alaska

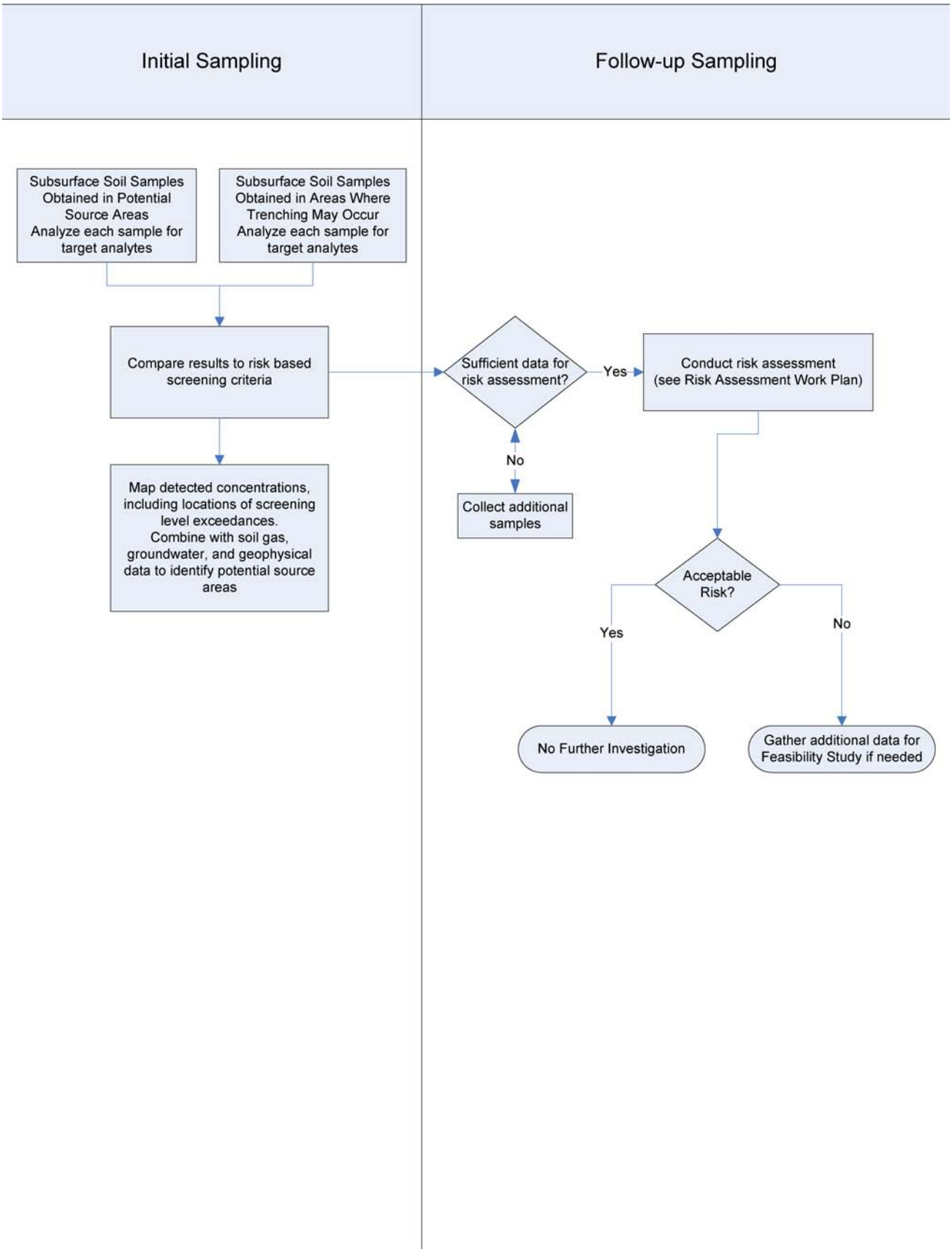

FIGURE 4-3
Sampling and Data Evaluation Process for Subsurface Soil
Project Name

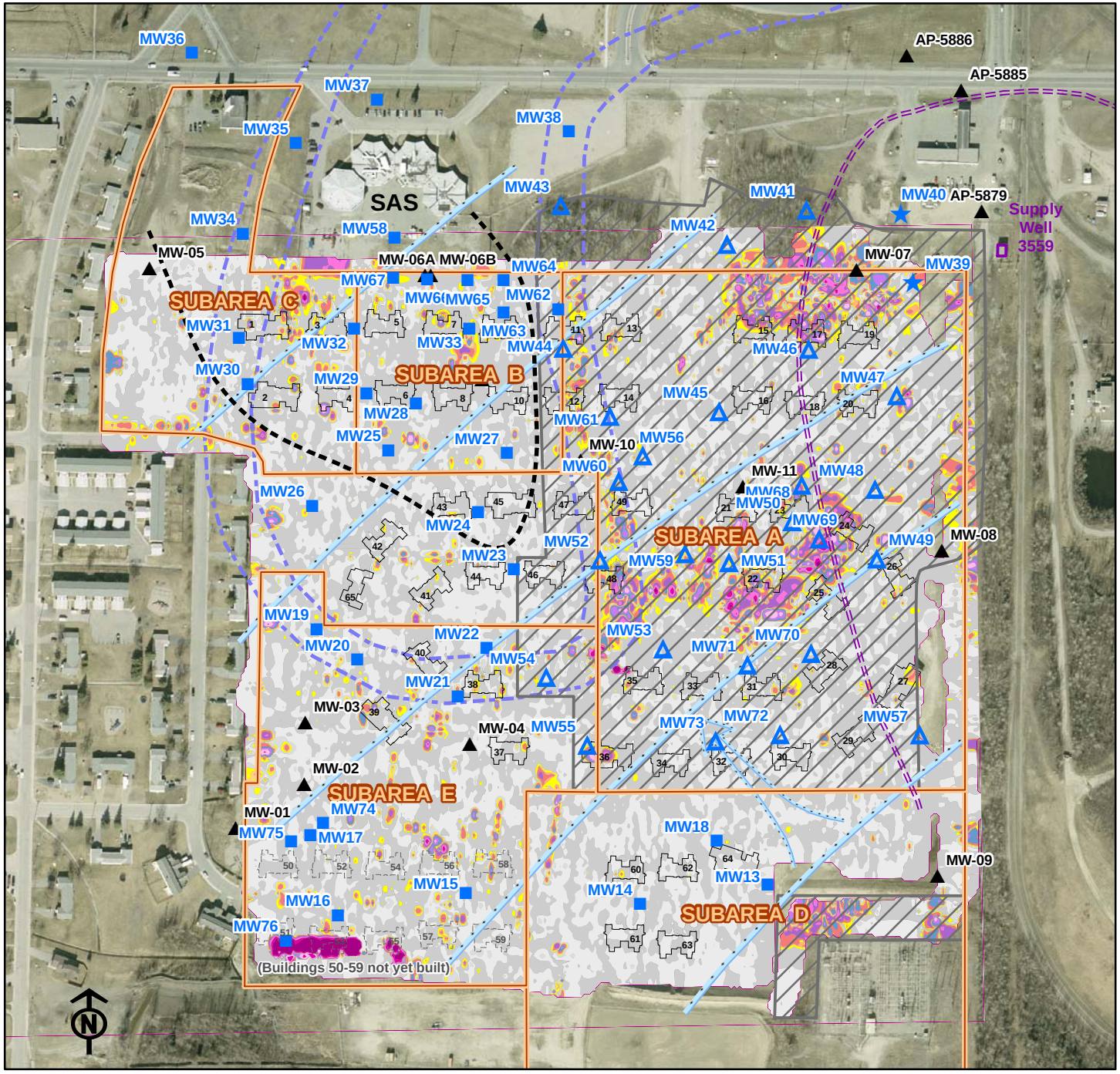

FIGURE 4-4

Final Proposed Monitoring Well Locations

Remedial Investigation Work Plan
Former Communications Site
Fort Wainwright, Alaska

Legend

- Moderate to High probability MEC area
- Former slough channel
- Area within elevated VOC/POL concetration
- Capture Zone, Supply Well 3559
- Groundwater contour and flow direction
- Existing monitoring well locations
- Proposed monitoring well locations
- Proposed well locations in Moderate to High Probability MEC Area
- Proposed deep monitoring locations

2004 Magnetic Data Vertical Gradient

- -4000
- -1000
- -500
- -200
- -100
- -75
- -50
- -20
- 0
- 40
- 75
- 100
- 200
- 500
- 1000
- 2000
- 4000

0 100 200 300 Feet

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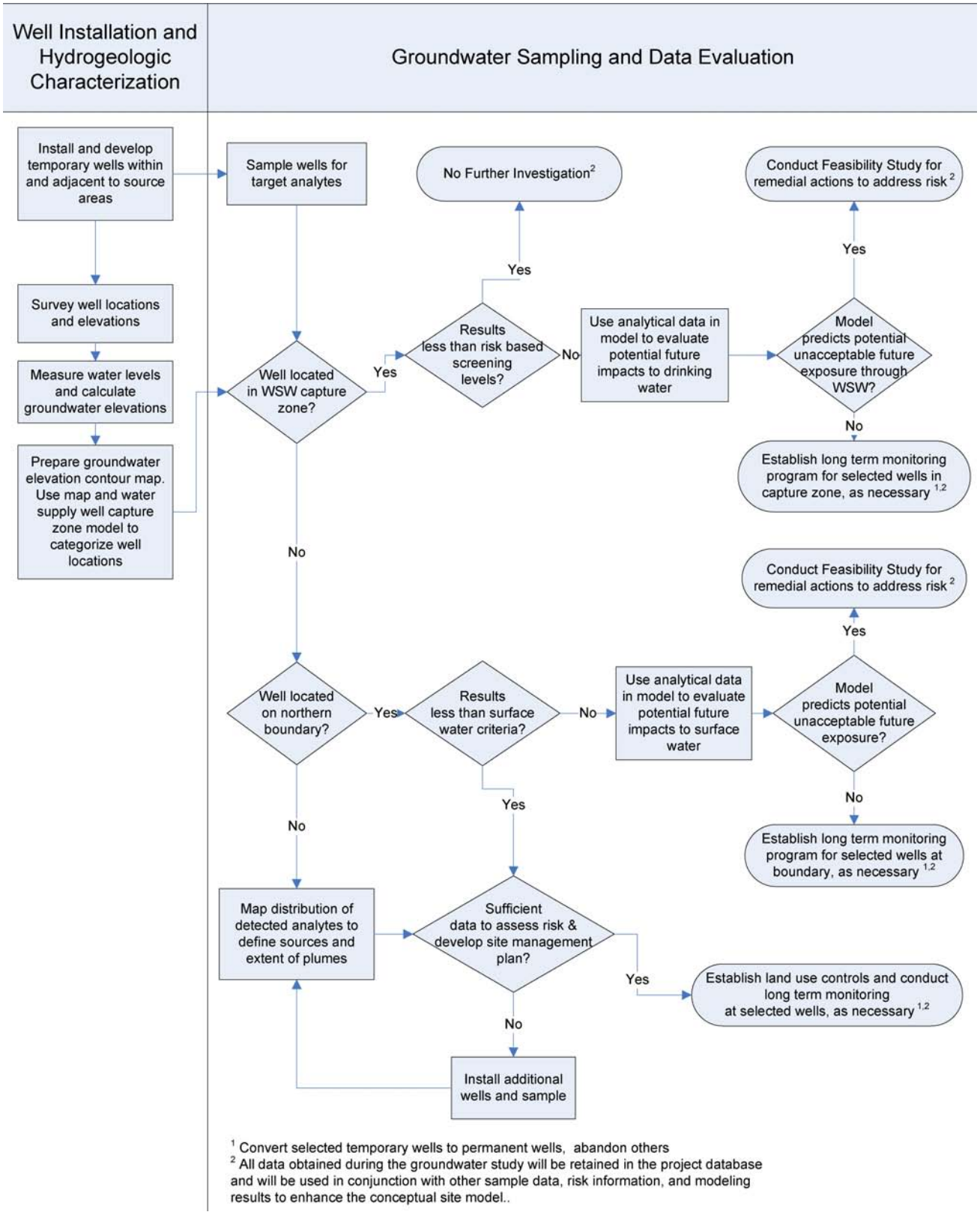
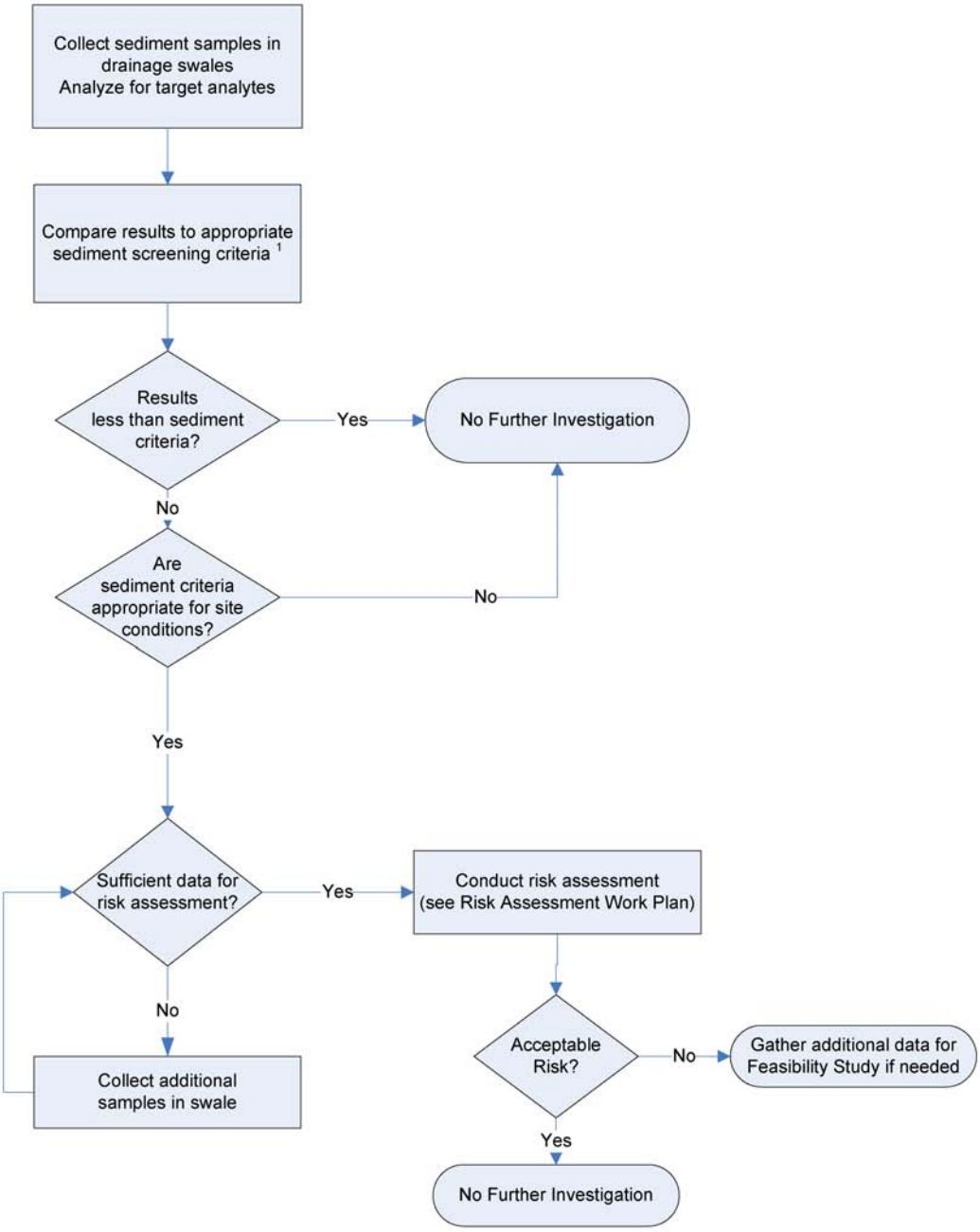


FIGURE 4-5
Sampling and Data Evaluation Process for Groundwater
Former Communications Site, Fort Wainwright, Alaska

Sampling and Data Evaluation



[1] Ecological screening benchmarks for aquatic (freshwater) and terrestrial wildlife

FIGURE 4-6
Soil Sampling and Data Evaluation Process
for Sediment in Drainage Swales
Project Name

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N

0 200 400 Feet

FIGURE 4-7
Sediment Sampling Locations
Remedial Investigation Work Plan
Former Communications Site
Fort Wainwright, Alaska

CH2MHILL

Sampling and Data Evaluation

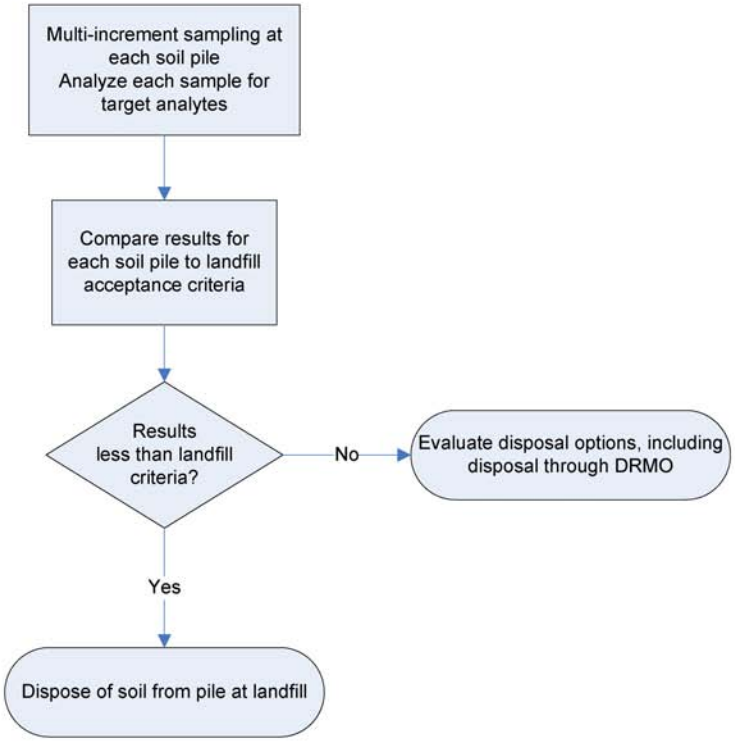

FIGURE 4-8
Soil Sampling and Data Evaluation Process for Soil Piles
Former Communications Site, Fort Wainwright, Alaska

SECTION 5

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Appendix A
Statistical Summary of Analytical Data

TABLE 2-9
ADEC and USEPA Soil Screening Levels

CAS No.	Analyte	ADEC "Under 40-inch Zone" Table B1 & B2 Levels			USEPA Region 6 Residential Soil PRG (mg/kg)	Lowest ADEC Table B1 & B2 Value (mg/kg)	1/10 Lowest ADEC Table B1 & B2 Value (mg/kg)	Screening Level (mg/kg)	Source of Screening Level (NA= no screening level, 1= ADEC, 2=USEPA)
		Ingestion (mg/kg)	Inhalation (mg/kg)	Migration to Groundwater (mg/kg)					
Volatile Organic Compounds									
71556	1,1,1-Trichloroethane	NA	460	1.0	1,400	1.0000	0.1000	1.00E-01	ADEC
630206	1,1,1,2-Tetrachloroethane	NA	NA	NA	3.0	0.0000	0.0000	3.00E+00	USEPA
79345	1,1,2,2-Tetrachloroethane	42	5.4	0.017	0.38	0.0170	0.0017	1.70E-03	ADEC
7311	1,1,2-Trichloro-1,2,2-trifluoroethane	NA	NA	NA	NA	0.0000	0.0000	NA	NA
79005	1,1,2-Trichloroethane	150	10	0.017	0.84	0.0170	0.0017	1.70E-03	ADEC
75354	1,1,-Dichloroethene	14	0.90	0.030	280	0.0300	0.0030	3.00E-03	ADEC
75343	1,1-Dichloroethane	10,000	890	12	850	12.0000	1.2000	1.20E+00	ADEC
78999	1,1-Dichloropropane	NA	NA	NA	NA	0.0000	0.0000	NA	NA
563586	1,1-Dichloropropene	NA	NA	NA	NA	0.0000	0.0000	NA	NA
120821	1,2,4-Trichlorobenzene	1,000	570	2.0	140	2.0000	0.2000	2.00E-01	ADEC
95636	1,2,4-Trimethylbenzene	5070	92.2	95.2	52	92.2000	9.2200	9.22E+00	ADEC
108678	1,3,5-Trimethylbenzene	5070	38.3	25	21	25.0000	2.5000	2.50E+00	ADEC
87616	1,2,3-Trichlorobenzene	NA	NA	NA	NA	0.0000	0.0000	NA	NA
96184	1,2,3-Trichloropropane	4.15	10.4	0.002	0.0014	0.0020	0.0002	2.00E-04	ADEC
96128	1,2-Dibromo-3-chloropropane*	NA	NA	NA	0.0026	0.0000	0.0000	2.60E-03	USEPA
106934	1,2-Dibromoethane	0.10	1.2	3.06E-05	0.028	0.0000	0.0000	3.06E-06	ADEC
95501	1,2-Dichlorobenzene	9,100	110	7.0	280	7.0000	0.7000	7.00E-01	ADEC
107062	1,2-Dichloroethane	91	5.0	0.015	0.35	0.0150	0.0015	1.50E-03	ADEC
78875	1,2-Dichloropropane	120	17	0.017	0.35	0.0170	0.0017	1.70E-03	ADEC
541731	1,3-Dichlorobenzene	3,040	NA	12	69	12.1000	1.2100	1.21E+00	ADEC
142289	1,3-Dichloropropane	NA	NA	NA	NA	0.0000	0.0000	NA	NA

TABLE 2-9
ADEC and USEPA Soil Screening Levels

CAS No.	Analyte	ADEC "Under 40-inch Zone" Table B1 & B2 Levels			USEPA Region 6 Residential Soil PRG (mg/kg)	Lowest ADEC Table B1 & B2 Value (mg/kg)	1/10 Lowest ADEC Table B1 & B2 Value (mg/kg)	Screening Level (mg/kg)	Source of Screening Level (NA= no screening level, 1= ADEC, 2=USEPA)
		Ingestion (mg/kg)	Inhalation (mg/kg)	Migration to Groundwater (mg/kg)					
106467	1,4-Dichlorobenzene	350	8,000	0.80	3.2	0.8000	0.0800	8.00E-02	ADEC
78933	2-Butanone (MEK)	60,800	28,100	60	32,000	60.0000	6.0000	6.00E+00	ADEC
591786	2-Hexanone	NA	NA	NA	NA	0.0000	0.0000	NA	NA
594207	2,2-Dichloropropane	NA	NA	NA	NA	0.0000	0.0000	NA	NA
108101	4-Methyl-2-pentanone (MIBK)	NA	NA	NA	NA	0.0000	0.0000	NA	NA
67641	Acetone	10,000	NA	10	14,000	10.0000	1.0000	1.00E+00	ADEC
71432	Benzene	150	9.0	0.020	0.66	0.0200	0.0020	2.00E-03	ADEC
108861	Bromobenzene	NA	NA	NA	73	0.0000	0.0000	7.30E+01	USEPA
74975	Bromochloromethane	NA	NA	NA	NA	0.0000	0.0000	NA	NA
75274	Bromodichloromethane	NA	NA	NA	1.0	0.0000	0.0000	1.00E+00	USEPA
75252	Bromoform	1,050	500	0.38	62	0.3800	0.0380	3.80E-02	ADEC
74839	Bromomethane (Methyl bromide)	NA	NA	NA	3.9	0.0000	0.0000	3.90E+00	USEPA
75150	Carbon Disulfide	10,000	453	17	720	17.0000	1.7000	1.70E+00	ADEC
56235	Carbon Tetrachloride	64	3.4	0.030	0.24	0.0300	0.0030	3.00E-03	ADEC
108907	Chlorobenzene	2,000	110	0.60	270	0.6000	0.0600	6.00E-02	ADEC
75003	Chloroethane	NA	NA	NA	NA	0.0000	0.0000	NA	NA
67663	Chloroform	1,000	3.4	0.34	0.25	0.3400	0.0340	3.40E-02	ADEC
74873	Chloromethane	NA	NA	NA	1.3	0.0000	0.0000	1.30E+00	USEPA
156592	cis-1,2-Dichloroethene	1,000	NA	0.20	43	0.2000	0.0200	2.00E-02	ADEC
10061015	cis-1,3-Dichloropropene*	83	14	0.020	0.70	0.0200	0.0020	2.00E-03	ADEC
110827	Cyclohexane	NA	NA	NA	NA	0.0000	0.0000	NA	NA
124481	Dibromochloromethane	NA	NA	NA	NA	0.0000	0.0000	NA	NA

TABLE 2-9
ADEC and USEPA Soil Screening Levels

CAS No.	Analyte	ADEC "Under 40-inch Zone" Table B1 & B2 Levels			USEPA Region 6 Residential Soil PRG (mg/kg)	Lowest ADEC Table B1 & B2 Value (mg/kg)	1/10 Lowest ADEC Table B1 & B2 Value (mg/kg)	Screening Level (mg/kg)	Source of Screening Level (NA= no screening level, 1= ADEC, 2=USEPA)
		Ingestion (mg/kg)	Inhalation (mg/kg)	Migration to Groundwater (mg/kg)					
74953	Dibromomethane	NA	NA	NA	NA	0.0000	0.0000	NA	NA
75718	Dichlorodifluoromethane	20,300	260	60	94	60.0000	6.0000	6.00E+00	ADEC
100414	Ethylbenzene	10,000	89	5.5	230	5.5000	0.5500	5.50E-01	ADEC
98828	Isopropylbenzene	10,100	585	227	370	227.0000	22.7000	2.27E+01	ADEC
79209	Methyl Acetate	NA	NA	NA	NA	0.0000	0.0000	NA	NA
1634044	Methyl tert-Butyl Ether	NA	NA	NA	32	0.0000	0.0000	3.20E+01	USEPA
108872	Methylcyclohexane	NA	NA	NA	NA	0.0000	0.0000	NA	NA
75092	Methylene Chloride	1,100	180	0.015	8.9	0.0150	0.0015	1.50E-03	ADEC
63072446	Methyl pentanone	NA	NA	NA	NA	0.0000	0.0000	NA	NA
100425	Styrene	20,300	280	1.3	1,700	1.3000	0.1300	1.30E-01	ADEC
127184	Tetrachloroethene	160	80	0.030	0.55	0.0300	0.0030	3.00E-03	ADEC
108883	Toluene	20,300	180	5.4	520	5.4000	0.5400	5.40E-01	ADEC
156605	trans-1,2-Dichloroethene	2,000	NA	0.40	120	0.4000	0.0400	4.00E-02	ADEC
10061026	trans-1,3-Dichloropropene*	83	14	0.020	0.70	0.0200	0.0020	2.00E-03	ADEC
79016	Trichloroethene	21	0.570	0.020	0.043	0.0200	0.0020	2.00E-03	ADEC
75694	Trichlorofluoromethane	NA	NA	NA	390	0.0000	0.0000	3.90E+02	USEPA
26523648	Trichlorotriflouroethane	1000000	4660	31800	NA	4660.0000	466.0000	4.66E+02	ADEC
75014	Vinyl Chloride	6.0	4.0	0.0090	0.043	0.0090	0.0009	9.00E-04	ADEC
1330207	Xylene (total)	203,000	81	78	280	78.0000	7.8000	7.80E+00	ADEC
136777612	m&p-Xylene	NA	NA	NA	210	0.0000	0.0000	2.10E+02	USEPA
95476	o-Xylene	NA	NA	NA	280	0.0000	0.0000	2.80E+02	USEPA
Semivolatile Organic Compounds									
92524	1,1'-Biphenyl	NA	NA	NA	NA	0.0000	0.0000	NA	NA

TABLE 2-9
ADEC and USEPA Soil Screening Levels

CAS No.	Analyte	ADEC "Under 40-inch Zone" Table B1 & B2 Levels			USEPA Region 6 Residential Soil PRG (mg/kg)	Lowest ADEC Table B1 & B2 Value (mg/kg)	1/10 Lowest ADEC Table B1 & B2 Value (mg/kg)	Screening Level (mg/kg)	Source of Screening Level (NA= no screening level, 1= ADEC, 2=USEPA)
		Ingestion (mg/kg)	Inhalation (mg/kg)	Migration to Groundwater (mg/kg)					
103651	n-Propylbenzene	NA	NA	NA	NA	0.0000	0.0000	NA	NA
108601	2,2'-oxybis(1-Chloropropane)	NA	NA	NA	NA	0.0000	0.0000	NA	NA
95954	2,4,5-Trichlorophenol	10,000	NA	90	6,100	90.0000	9.0000	9.00E+00	ADEC
88062	2,4,6-Trichlorophenol	750	1,500	0.60	44	0.6000	0.0600	6.00E-02	ADEC
94757	2,4-D	NA	NA	NA	NA	0.0000	0.0000	NA	NA
120832	2,4-Dichlorophenol	300	NA	0.45	180	0.4500	0.0450	4.50E-02	ADEC
105679	2,4-Dimethylphenol	2,000	NA	4.0	1,200	4.0000	0.4000	4.00E-01	ADEC
51285	2,4-Dinitrophenol	200	NA	0.20	120	0.2000	0.0200	2.00E-02	ADEC
121142	2,4-Dinitrotoluene	12	NA	0.0050	120	0.0050	0.0005	5.00E-04	ADEC
606202	2,6-Dinitrotoluene	12	NA	0.0044	61	0.0044	0.0004	4.40E-04	ADEC
110758	2-Chloroethylvinyl ether	NA	NA	NA	NA	0.0000	0.0000	NA	NA
91587	2-Chloronaphthalene	8,110	NA	70	3,900	70.0000	7.0000	7.00E+00	ADEC
95578	2-Chlorophenol	510	NA	1.4	64	1.4000	0.1400	1.40E-01	ADEC
95498	2-Chlorotoluene	NA	NA	NA	160	0.0000	0.0000	1.60E+02	USEPA
90120	1-Methylnaphthalene	4,100	NA	43	NA	43.0000	4.3000	4.30E+00	ADEC
110496	2-Methoxyethyl acetate	NA	NA	NA	NA	0.0000	0.0000	NA	NA
91576	2-Methylnaphthalene	2,030	NA	61	NA	60.9000	6.0900	6.09E+00	ADEC
95487	2-Methylphenol	5,100	NA	7.0	3,100	7.0000	0.7000	7.00E-01	ADEC
88744	2-Nitroaniline	NA	NA	NA	180	0.0000	0.0000	1.80E+02	USEPA
88755	2-Nitrophenol	NA	NA	NA	NA	0.0000	0.0000	NA	NA
91941	3,3'-Dichlorobenzidine	18	NA	0.020	1.1	0.0200	0.0020	2.00E-03	ADEC
34MP	3,4-Methylphenol*	NA	NA	NA	NA	0.0000	0.0000	NA	NA
108394	3-Methylphenol	NA	NA	NA	NA	0.0000	0.0000	NA	NA

TABLE 2-9
ADEC and USEPA Soil Screening Levels

CAS No.	Analyte	ADEC "Under 40-inch Zone" Table B1 & B2 Levels			USEPA Region 6 Residential Soil PRG (mg/kg)	Lowest ADEC Table B1 & B2 Value (mg/kg)	1/10 Lowest ADEC Table B1 & B2 Value (mg/kg)	Screening Level (mg/kg)	Source of Screening Level (NA= no screening level, 1= ADEC, 2=USEPA)
		Ingestion (mg/kg)	Inhalation (mg/kg)	Migration to Groundwater (mg/kg)					
99092	3-Nitroaniline	NA	NA	NA	NA	0.0000	0.0000	NA	NA
534521	4,6-Dinitro-2-methylphenol	NA	NA	NA	NA	0.0000	0.0000	NA	NA
101553	4-Bromophenyl-phenylether	NA	NA	NA	NA	0.0000	0.0000	NA	NA
59507	4-Chloro-3-methylphenol	NA	NA	NA	310	0.0000	0.0000	3.10E+02	USEPA
106478	4-Chloroaniline	410	NA	0.50	240	0.5000	0.0500	5.00E-02	ADEC
7005723	4-Chlorophenyl-phenylether	NA	NA	NA	NA	0.0000	0.0000	NA	NA
106434	4-Chlorotoluene	NA	NA	NA	NA	0.0000	0.0000	NA	NA
99876	4-Isopropyltoluene	NA	NA	NA	NA	0.0000	0.0000	NA	NA
106445	4-Methylphenol	NA	NA	NA	NA	0.0000	0.0000	NA	NA
100016	4-Nitroaniline	NA	NA	NA	NA	0.0000	0.0000	NA	NA
100027	4-Nitrophenol	NA	NA	NA	490	0.0000	0.0000	4.90E+02	USEPA
83329	Acenaphthene	6,100	NA	210	3,700	210.0000	21.0000	2.10E+01	ADEC
208968	Acenaphthylene	6,100	NA	210	NA	210.0000	21.0000	2.10E+01	ADEC
98862	Acetophenone	NA	NA	NA	NA	0.0000	0.0000	NA	NA
62533	Aniline	NA	NA	NA	NA	0.0000	0.0000	NA	NA
120127	Anthracene	30,000	NA	4,300	22,000	4300.0000	430.0000	4.30E+02	ADEC
1912249	Atrazine	NA	NA	NA	NA	0.0000	0.0000	NA	NA
100527	Benzaldehyde	NA	NA	NA	NA	0.0000	0.0000	NA	NA
56553	Benzo (a) anthracene	11	NA	6.0	0.15	6.0000	0.6000	1.50E-01	USEPA
50328	Benzo (a) pyrene	1.0	NA	3.0	0.015	1.0000	0.1000	1.50E-02	USEPA
205992	Benzo (b) fluoranthene	11	NA	20	0.15	11.0000	1.1000	1.50E-01	USEPA
191242	Benzo (g,h,i) perylene	3,000	NA	1,500	1.5	1500.0000	150.0000	1.50E+00	USEPA
207089	Benzo (k) fluoranthene	110	NA	200	NA	110.0000	11.0000	1.10E+01	ADEC

TABLE 2-9
ADEC and USEPA Soil Screening Levels

CAS No.	Analyte	ADEC "Under 40-inch Zone" Table B1 & B2 Levels			USEPA Region 6 Residential Soil PRG (mg/kg)	Lowest ADEC Table B1 & B2 Value (mg/kg)	1/10 Lowest ADEC Table B1 & B2 Value (mg/kg)	Screening Level (mg/kg)	Source of Screening Level (NA= no screening level, 1= ADEC, 2=USEPA)
		Ingestion (mg/kg)	Inhalation (mg/kg)	Migration to Groundwater (mg/kg)					
65850	Benzoic Acid	410,000	NA	390	100,000	390.0000	39.0000	3.90E+01	ADEC
100516	Benzyl alcohol	NA	NA	NA	18,000	0.0000	0.0000	1.80E+04	USEPA
117817	bis (2-Ethylhexyl) phthalate	590	NA	1,200	35	590.0000	59.0000	3.50E+01	USEPA
111911	bis(2-Chloroethoxy)methane	NA	NA	NA	NA	0.0000	0.0000	NA	NA
111444	bis(2-Chloroethyl)ether	8.0	3.0	0.0020	0.21	0.0020	0.0002	2.00E-04	ADEC
39638329	bis(2-Chloroisopropyl)ether	NA	NA	NA	2.9	0.0000	0.0000	2.90E+00	USEPA
85687	Butylbenzylphthalate	20,000	NA	5,600	240	5600.0000	560.0000	2.40E+02	USEPA
105602	Caprolactam	NA	NA	NA	NA	0.0000	0.0000	NA	NA
86748	Carbazole	420	NA	2.0	24	2.0000	0.2000	2.00E-01	ADEC
218019	Chrysene	1,100	NA	620	15	620.0000	62.0000	1.50E+01	USEPA
53703	Dibenzo (a,h) anthracene	1.0	NA	6.0	0.015	1.0000	0.1000	1.50E-02	USEPA
84662	Diethylphthalate	81,000	NA	190	49,000	190.0000	19.0000	1.90E+01	ADEC
131113	Dimethylphthalate	1.00E+06	NA	1,400	100,000	1400.0000	140.0000	1.40E+02	ADEC
84742	Di-n-butylphthalate	10,000	NA	1,700	NA	1700.0000	170.0000	1.70E+02	ADEC
117840	Di-n-octylphthalate	2,000	NA	810,000	NA	2000.0000	200.0000	2.00E+02	ADEC
206440	Fluoranthene	4,100	NA	2,100	2,300	2100.0000	210.0000	2.10E+02	ADEC
86737	Fluorene	4,100	NA	270	2,600	270.0000	27.0000	2.70E+01	ADEC
118741	Hexachlorobenzene	5.0	7.0	0.73	0.30	0.7300	0.0730	7.30E-02	ADEC
87683	Hexachlorobutadiene	20	55	8.0	6.2	8.0000	0.8000	8.00E-01	ADEC
77474	Hexachlorocyclopentadiene	710	7.0	130	NA	7.0000	0.7000	7.00E-01	ADEC
67721	Hexachloroethane	101	390	1.6	35	1.6000	0.1600	1.60E-01	ADEC
193395	Indeno (1,2,3-cd) pyrene	11	NA	54	0.15	11.0000	1.1000	1.50E-01	USEPA
78591	Isophorone	8,700	NA	3.0	510	3.0000	0.3000	3.00E-01	ADEC

TABLE 2-9
ADEC and USEPA Soil Screening Levels

CAS No.	Analyte	ADEC "Under 40-inch Zone" Table B1 & B2 Levels			USEPA Region 6 Residential Soil PRG (mg/kg)	Lowest ADEC Table B1 & B2 Value (mg/kg)	1/10 Lowest ADEC Table B1 & B2 Value (mg/kg)	Screening Level (mg/kg)	Source of Screening Level (NA= no screening level, 1= ADEC, 2=USEPA)
		Ingestion (mg/kg)	Inhalation (mg/kg)	Migration to Groundwater (mg/kg)					
104518	n-Butylbenzene	NA	NA	NA	61	0.0000	0.0000	6.10E+01	USEPA
91203	Naphthalene	2,000	120	21	120	21.0000	2.1000	2.10E+00	ADEC
98953	Nitrobenzene	51	90	0.060	20	0.0600	0.0060	6.00E-03	ADEC
62759	N-Nitrosodimethylamine	1,700	NA	3.4	0.0023	3.4000	0.3400	2.30E-03	USEPA
621647	N-Nitroso-di-n-propylamine	1.2	NA	3.60E-04	0.069	0.0004	0.0000	3.60E-05	ADEC
86306	N-Nitrosodiphenylamine	1,700	NA	3.4	99	3.4000	0.3400	3.40E-01	ADEC
87865	Pentachlorophenol	35	NA	0.010	3.0	0.0100	0.0010	1.00E-03	ADEC
85018	Phenanthrene	30,000	NA	4,300	NA	4300.0000	430.0000	4.30E+02	ADEC
108952	Phenol	60,800	NA	67	18,000	67.0000	6.7000	6.70E+00	ADEC
129000	Pyrene	3,000	NA	1,500	2,300	1500.0000	150.0000	1.50E+02	ADEC
483658	Retene	NA	NA	NA	NA	0.0000	0.0000	NA	NA
135988	sec-Butylbenzene	NA	NA	NA	61	0.0000	0.0000	6.10E+01	USEPA
98066	tert-Butylbenzene	NA	NA	NA	130	0.0000	0.0000	1.30E+02	USEPA
Petroleum Hydrocarbons									
GRO	Gasoline Range Organics (GRO)	1,400	1,400	300	NA	300.0000	30.0000	3.00E+01	ADEC
DRO	Diesel Range Organics (DRO)	10,250	12,500	250	NA	250.0000	25.0000	2.50E+01	ADEC
RRO	Residual Range Organics (RRO)	10,000	22,000	11,000	NA	10000.0000	1000.0000	1.00E+03	ADEC
VPH									
	C6-C8 Aromatics	1000	1000	150	NA	150.0000	15.0000	1.50E+01	ADEC
	C8-C10 Aromatics	1000	1000	150	NA	150.0000	15.0000	1.50E+01	ADEC
	C10-C12 Aromatics	4100	5000	100	NA	100.0000	10.0000	1.00E+01	ADEC

TABLE 2-9
ADEC and USEPA Soil Screening Levels

CAS No.	Analyte	ADEC "Under 40-inch Zone" Table B1 & B2 Levels			USEPA Region 6 Residential Soil PRG (mg/kg)	Lowest ADEC Table B1 & B2 Value (mg/kg)	1/10 Lowest ADEC Table B1 & B2 Value (mg/kg)	Screening Level (mg/kg)	Source of Screening Level (NA= no screening level, 1= ADEC, 2=USEPA)
		Ingestion (mg/kg)	Inhalation (mg/kg)	Migration to Groundwater (mg/kg)					
	C5-C6 Aliphatics	1000	1000	270	NA	270.0000	27.0000	2.70E+01	ADEC
	C6-C8 Aliphatics	1000	1000	270	NA	270.0000	27.0000	2.70E+01	ADEC
	C8-C10 Aliphatics	1000	1000	270	NA	270.0000	27.0000	2.70E+01	ADEC
	C10-C12 Aliphatics	10000	10000	7200	NA	7200.0000	720.0000	7.20E+02	ADEC
EPH									
	C10-C12 Aromatics	4100	5000	100	NA	100.0000	10.0000	1.00E+01	ADEC
	C12-C16 Aromatics	4100	5000	100	NA	100.0000	10.0000	1.00E+01	ADEC
	C16-C21 Aromatics	4100	5000	100	NA	100.0000	10.0000	1.00E+01	ADEC
	C21-C34 Aromatics	3000	10000	3300	NA	3000.0000	300.0000	3.00E+02	ADEC
	C10-C12 Aliphatics	10000	10000	7200	NA	7200.0000	720.0000	7.20E+02	ADEC
	C12-C16 Aliphatics	10000	10000	7200	NA	7200.0000	720.0000	7.20E+02	ADEC
	C16-C21 Aliphatics	10000	10000	7200	NA	7200.0000	720.0000	7.20E+02	ADEC
	C21-C34 Aliphatics	20000	20000	20000	NA	20000.0000	2000.0000	2.00E+03	ADEC
Pestcides									
309002	Aldrin	0.50	24	1.6	0.029	0.5000	0.0500	2.90E-02	USEPA
319846	alpha-BHC	1.3	5.5	0.0026	0.090	0.0026	0.0003	2.60E-04	ADEC
5103719	alpha-Chlordane	NA	NA	NA	NA	0.0000	0.0000	NA	NA
319857	beta-BHC	4.6	43	0.0090	0.32	0.0090	0.0009	9.00E-04	ADEC
12789036	Chlordane	24	510	3.0	NA	3.0000	0.3000	3.00E-01	ADEC
72548	4,4'-DDD	35	NA	47	2.4	35.0000	3.5000	2.40E+00	USEPA
72559	4,4'-DDE	24	NA	150	1.7	24.0000	2.4000	1.70E+00	USEPA
50293	4,4'-DDT	24	5,300	88	1.7	24.0000	2.4000	1.70E+00	USEPA
319868	delta-BHC	NA	NA	NA	NA	0.0000	0.0000	NA	NA

TABLE 2-9
ADEC and USEPA Soil Screening Levels

CAS No.	Analyte	ADEC "Under 40-inch Zone" Table B1 & B2 Levels			USEPA Region 6 Residential Soil PRG (mg/kg)	Lowest ADEC Table B1 & B2 Value (mg/kg)	1/10 Lowest ADEC Table B1 & B2 Value (mg/kg)	Screening Level (mg/kg)	Source of Screening Level (NA= no screening level, 1= ADEC, 2=USEPA)
		Ingestion (mg/kg)	Inhalation (mg/kg)	Migration to Groundwater (mg/kg)					
Dichloprop	Dichloropropanol	NA	NA	NA	NA	0.0000	0.0000	NA	NA
60571	Dieldrin	0.50	8.0	0.015	0.030	0.0150	0.0015	1.50E-03	ADEC
959988	Endosulfan I*	610	NA	7.0	370	7.0000	0.7000	7.00E-01	ADEC
33213659	Endosulfan II*	610	NA	7.0	NA	7.0000	0.7000	7.00E-01	ADEC
1031078	Endosulfan Sulfate	NA	NA	NA	NA	0.0000	0.0000	NA	NA
72208	Endrin	30	NA	0.30	18	0.3000	0.0300	3.00E-02	ADEC
7421934	Endrin aldehyde	NA	NA	NA	NA	0.0000	0.0000	NA	NA
53494705	Endrin ketone	NA	NA	NA	NA	0.0000	0.0000	NA	NA
57749	gamma Chlordane	NA	NA	NA	NA	0.0000	0.0000	NA	NA
58899	gamma-BHC (Lindane)	6.4	NA	0.0030	0.44	0.0030	0.0003	3.00E-04	ADEC
76448	Heptachlor	2.0	0.80	8.0	0.11	0.8000	0.0800	8.00E-02	ADEC
1024573	Heptachlor epoxide	0.90	33	0.20	0.053	0.2000	0.0200	2.00E-02	ADEC
72435	Methoxychlor	510	NA	52	310	52.0000	5.2000	5.20E+00	ADEC
8001352	Toxaphene	8.0	620	10	NA	8.0000	0.8000	8.00E-01	ADEC
Metals & Other Inorganics									
7429905	Aluminum	NA	NA	NA	NA	0.0000	0.0000	NA	NA
7664417	Ammonia (as N)	NA	NA	NA	NA	0.0000	0.0000	NA	NA
7440360	Antimony	41	NA	3.6	31	3.6000	0.3600	3.60E-01	ADEC
7440382	Arsenic	5.5	NA	2	0.39	2.0000	0.2000	1.66E+01	Site Specific
7440393	Barium	7100	NA	1100	16000	1100.0000	110.0000	1.10E+02	ADEC
7440417	Beryllium	200	NA	42	NA	42.0000	4.2000	4.20E+00	ADEC
7440439	Cadmium	100	NA	5	NA	5.0000	0.5000	5.00E-01	ADEC
7440702	Calcium	NA	NA	NA	NA	0.0000	0.0000	NA	NA

TABLE 2-9
ADEC and USEPA Soil Screening Levels

CAS No.	Analyte	ADEC "Under 40-inch Zone" Table B1 & B2 Levels			USEPA Region 6 Residential Soil PRG (mg/kg)	Lowest ADEC Table B1 & B2 Value (mg/kg)	1/10 Lowest ADEC Table B1 & B2 Value (mg/kg)	Screening Level (mg/kg)	Source of Screening Level (NA= no screening level, 1= ADEC, 2=USEPA)
		Ingestion (mg/kg)	Inhalation (mg/kg)	Migration to Groundwater (mg/kg)					
7440473	Chromium total	410	NA	300	NA	300.0000	30.0000	3.00E+01	ADEC
16065-83-1	Chromium +3	200000	NA	150000	NA	150000	15000	1.50E+04	ADEC
18540-29-9	Chromium +6	410	NA	300	NA	300.0000	30.0000	3.00E+01	ADEC
7440484	Cobalt	NA	NA	NA	90	0.0000	0.0000	9.00E+01	USEPA
7440508	Copper	4060	NA	7000	2900	4060.0000	406.0000	4.06E+02	ADEC
7439896	Iron	NA	NA	NA	NA	0.0000	0.0000	NA	NA
7439921	Lead	400	400	NA	NA	400.0000	40.0000	4.00E+01	ADEC
7439954	Magnesium	NA	NA	NA	NA	0.0000	0.0000	NA	NA
7439965	Manganese	NA	NA	NA	NA	0.0000	0.0000	NA	NA
7439976	Mercury	NA	18	1.4	23	1.4000	0.1400	1.40E-01	ADEC
7440020	Nickel	2000	NA	87	NA	87.0000	8.7000	8.70E+00	ADEC
NO3/NO2	Nitrate/Nitrite	NA	NA	NA	NA	0.0000	0.0000	NA	NA
7440097	Potassium	NA	NA	NA	NA	0.0000	0.0000	NA	NA
7782492	Selenium	510	NA	3.5	39	3.5000	0.3500	3.50E-01	ADEC
7440224	Silver	510	NA	21	NA	21.0000	2.1000	2.10E+00	ADEC
7440235	Sodium	NA	NA	NA	NA	0.0000	0.0000	NA	NA
14808798	Sulfate	NA	NA	NA	NA	0.0000	0.0000	NA	NA
7440280	Thallium	NA	NA	NA	6	0.0000	0.0000	5.50E+00	USEPA
7440622	Vanadium	710	NA	3400	NA	710.0000	71.0000	7.10E+01	ADEC
7440666	Zinc	30000	NA	9100	NA	9100.0000	910.0000	9.10E+02	ADEC
PCBs									
12674112	Aroclor 1016*	1.0	1.0	NA	3.9	1.0000	0.1000	1.00E-01	ADEC
11104282	Aroclor 1221*	1.0	1.0	NA	0.22	1.0000	0.1000	1.00E-01	ADEC

TABLE 2-9
ADEC and USEPA Soil Screening Levels

CAS No.	Analyte	ADEC "Under 40-inch Zone" Table B1 & B2 Levels			USEPA Region 6 Residential Soil PRG (mg/kg)	Lowest ADEC Table B1 & B2 Value (mg/kg)	1/10 Lowest ADEC Table B1 & B2 Value (mg/kg)	Screening Level (mg/kg)	Source of Screening Level (NA= no screening level, 1= ADEC, 2=USEPA)
		Ingestion (mg/kg)	Inhalation (mg/kg)	Migration to Groundwater (mg/kg)					
11141165	Aroclor 1232*	1.0	1.0	NA	0.22	1.0000	0.1000	1.00E-01	ADEC
53469219	Aroclor 1242*	1.0	1.0	NA	0.22	1.0000	0.1000	1.00E-01	ADEC
12672296	Aroclor 1248*	1.0	1.0	NA	0.22	1.0000	0.1000	1.00E-01	ADEC
11097691	Aroclor 1254*	1.0	1.0	NA	0.22	1.0000	0.1000	1.00E-01	ADEC
11096825	Aroclor 1260*	1.0	1.0	NA	0.22	1.0000	0.1000	1.00E-01	ADEC
1336363	PCBs, total	1.0	1.0	NA	NA	1.0000	0.1000	1.00E-01	ADEC
Herbicides									
94-75-7	2,4-D	NA	NA	NA	690	0.0000	0.0000	6.90E+02	USEPA
94-82-6	2,4-DB	NA	NA	NA	490	0.0000	0.0000	4.90E+02	USEPA
	2,4,5-T	NA	NA	NA	NA	0.0000	0.0000	NA	NA
	2,4,5-TP (Silvex)	NA	NA	NA	NA	0.0000	0.0000	NA	NA
75-99-0	Dalapon	NA	NA	NA	1800	0.0000	0.0000	1.80E+03	USEPA
1918-00-9	Dicamba	NA	NA	NA	1800	0.0000	0.0000	1.80E+03	USEPA
	Dichlorprop	NA	NA	NA	NA	0.0000	0.0000	NA	NA
88-85-7	Dinoseb	NA	NA	NA	61	0.0000	0.0000	6.10E+01	USEPA
16484-77-8	MCPA	NA	NA	NA	61	0.0000	0.0000	6.10E+01	USEPA
Dioxins									
	2,3,7,8-TCDD	NA	NA	NA	0.0000039	0.0000	0.0000	3.90E-06	USEPA
	1,2,3,7,8-PeCDD	NA	NA	NA	NA	0.0000	0.0000	NA	NA
	1,2,3,4,7,8-HxCDD	NA	NA	NA	NA	0.0000	0.0000	NA	NA
	1,2,3,6,7,8-HxCDD	NA	NA	NA	NA	0.0000	0.0000	NA	NA
	1,2,3,7,8,9-HxCDD	NA	NA	NA	NA	0.0000	0.0000	NA	NA
	1,2,3,4,6,7,8-HpCDD	NA	NA	NA	NA	0.0000	0.0000	NA	NA

TABLE 2-9
ADEC and USEPA Soil Screening Levels

CAS No.	Analyte	ADEC "Under 40-inch Zone" Table B1 & B2 Levels			USEPA Region 6 Residential Soil PRG (mg/kg)	Lowest ADEC Table B1 & B2 Value (mg/kg)	1/10 Lowest ADEC Table B1 & B2 Value (mg/kg)	Screening Level (mg/kg)	Source of Screening Level (NA= no screening level, 1= ADEC, 2=USEPA)
		Ingestion (mg/kg)	Inhalation (mg/kg)	Migration to Groundwater (mg/kg)					
	OCDD	NA	NA	NA	NA	0.0000	0.0000	NA	NA
	2,3,7,8-TCDF	NA	NA	NA	NA	0.0000	0.0000	NA	NA
	1,2,3,7,8-PeCDF	NA	NA	NA	NA	0.0000	0.0000	NA	NA
	2,3,4,7,8-PeCDF	NA	NA	NA	NA	0.0000	0.0000	NA	NA
	1,2,3,4,7,8-HxCDF	NA	NA	NA	NA	0.0000	0.0000	NA	NA
	1,2,3,6,7,8-HxCDF	NA	NA	NA	NA	0.0000	0.0000	NA	NA
	2,3,4,6,7,8-HxCDF	NA	NA	NA	NA	0.0000	0.0000	NA	NA
	1,2,3,7,8,9-HxCDF	NA	NA	NA	NA	0.0000	0.0000	NA	NA
	1,2,3,4,6,7,8-HpCDF	NA	NA	NA	NA	0.0000	0.0000	NA	NA
	1,2,3,4,7,8,9-HpCDF	NA	NA	NA	NA	0.0000	0.0000	NA	NA
	OCDF	NA	NA	NA	NA	0.0000	0.0000	NA	NA
Explosives									
99-35-4	1,3,5-Trinitrobenzene	NA	NA	NA	1800	0.0000	0.0000	1.80E+03	USEPA
99-65-0	1,3-Dinitrobenzene	NA	NA	NA	6.1	0.0000	0.0000	6.10E+00	USEPA
121142	2,4-Dinitrotoluene	NA	NA	NA	120	0.0000	0.0000	1.20E+02	USEPA
606202	2,6-Dinitrotoluene	NA	NA	NA	61	0.0000	0.0000	6.10E+01	USEPA
118-96-7	2,4,6-Trinitrotoluene (TNT)	NA	NA	NA	16	0.0000	0.0000	1.60E+01	USEPA
	2-Amino-4,6-dinitrotoluene	NA	NA	NA	NA	0.0000	0.0000	NA	NA
	2-Nitrotoluene	NA	NA	NA	2.8	0.0000	0.0000	2.80E+00	USEPA
	3-Nitrotoluene	NA	NA	NA	1600	0.0000	0.0000	1.60E+03	USEPA
	4-Amino-4,6-dinitrotoluene	NA	NA	NA	NA	0.0000	0.0000	NA	NA
	4-Nitrotoluene	NA	NA	NA	38	0.0000	0.0000	3.80E+01	USEPA
121-82-4	Hexahydro-1,3,5-trinitro-1,3,5-triazine (RDX)	NA	NA	NA	4.4	0.0000	0.0000	4.40E+00	USEPA

TABLE 2-9
ADEC and USEPA Soil Screening Levels

CAS No.	Analyte	ADEC "Under 40-inch Zone" Table B1 & B2 Levels			USEPA Region 6 Residential Soil PRG (mg/kg)	Lowest ADEC Table B1 & B2 Value (mg/kg)	1/10 Lowest ADEC Table B1 & B2 Value (mg/kg)	Screening Level (mg/kg)	Source of Screening Level (NA= no screening level, 1= ADEC, 2=USEPA)
		Ingestion (mg/kg)	Inhalation (mg/kg)	Migration to Groundwater (mg/kg)					
	Methyl-2,4,6-trinitrophenylnitramine (Tetryl)	NA	NA	NA	NA	0.0000	0.0000	NA	NA
98953	Nitrobenzene	NA	NA	NA	20	0.0000	0.0000	2.00E+01	USEPA
2691-41-0	Octahydro-1,3,5,7-tetranitro-1,3,5,7-tetrazocine (HMX)	NA	NA	NA	3100	0.0000	0.0000	3.10E+03	USEPA

Notes:
NA = not available
ADEC = Alaska Department of Environmental Conservation
mg/kg = milligrams per kilogram
µg/kg = micrograms per kilogram
USEPA = United States Environmental Protection Agency
PRG = preliminary remediation goal
* Surrogate compound was used.

References:
ADEC, 2003. 18 AAC 75 Oil and Other Hazardous Substances Pollution Control. State of Alaska Department of Environmental Conservation. Table B1 in 18 AAC 75.345(b) Method 2 Soil Cleanup Levels
USEPA, 2002. Region IX Preliminary Remediation Goals (PRGs). Available at USEPA Region IX website: www.epa.gov/region 09/waste/sfund/prg/intro.htm October, 2002.
http://www.epa.gov/earth1r6/6pd/rcra_c/pd-n/screen.htm

TABLE 2-10
ADEC and USEPA Groundwater Screening Levels

CAS No.	Analyte	Human Health Screening Levels for Groundwater: Maximum Contaminant Level[a] (µg/L)	Federal Drinking Water Equivalent[a] (µg/L)	ADEC Screening Level[b] (µg/L)	USEPA Region 9 Tap Water PRG[c] (µg/L)	USEPA Region 6 Tapwater Screening Level[d] (µg/L)	Taku Groundwater Screening Level (ug/L) Lower of 1/10th ADEC Level or USEPA Region 6 Level	Source of Screening Level (NA= no screening level, 1= ADEC, 2=USEPA)
Volatile Organic Compounds								
71556	1,1,1-Trichloroethane	2.00E+02	1.00E+03	2.00E+02	3.17E+03	8.40E+02	2.00E+01	ADEC
630206	1,1,1,2-Tetrachloroethane		1	NA	4.30E-01	4.30E-01	4.30E-01	USEPA
79345	1,1,2,2-Tetrachloroethane	NA	2.00E+00	4.00E+00	5.53E-02	5.50E-02	5.50E-02	USEPA
7311	1,1,2-Trichloro-1,2,2-trifluoroethane	NA	NA	NA	NA	NA	NA	NA
79005	1,1,2-Trichloroethane	5.00E+00	1.00E+02	5.00E+00	2.00E-01	2.00E-01	2.00E-01	USEPA
75354	1,1,-Dichloroethene	7.00E+00	3.00E+02	7.00E+00	3.39E+02	3.40E+02	7.00E-01	ADEC
75343	1,1-Dichloroethane	NA	NA	3.65E+03	8.11E+02	1.20E+03	3.65E+02	ADEC
78999	1,1-Dichloropropane	NA	NA	NA	NA	NA	NA	NA
563586	1,1-Dichloropropene	NA	NA	NA	NA	NA	NA	NA
120821	1,2,4-Trichlorobenzene	7.00E+01	4.00E+02	7.00E+01	1.94E+02	8.20E+00	7.00E+00	ADEC
95636	1,2,4-Trimethylbenzene	NA	NA	NA	1.20E+01	1.20E+01	1.20E+01	USEPA
108678	1,3,5-Trimethylbenzene	NA	NA	NA	1.20E+01	1.20E+01	1.20E+01	USEPA
87616	1,2,3-Trichlorobenzene	NA	NA	NA	NA	NA	NA	NA
96184	1,2,3-Trichloropropane	NA	0.2	NA	5.60E-03	1.60E-03	1.60E-03	USEPA
96128	1,2-Dibromo-3-chloropropane*	2.00E-01	NA	NA	4.76E-02	2.00E-04	2.00E-04	USEPA
106934	1,2-Dibromoethane	5.00E-02	NA	5.00E-02	7.57E-04	5.60E-03	5.00E-03	ADEC
95501	1,2-Dichlorobenzene	NA	3.00E+03	6.00E+02	3.70E+02	4.90E+01	4.90E+01	USEPA
107062	1,2-Dichloroethane	5.00E+00	NA	5.00E+00	1.23E-01	1.20E-01	1.20E-01	USEPA
78875	1,2-Dichloropropane	5.00E+00	NA	5.00E+00	1.65E-01	1.60E-01	1.60E-01	USEPA
541731	1,3-Dichlorobenzene	NA	3.00E+03	1.10E+03	5.48E+00	1.40E+01	1.40E+01	USEPA
142289	1,3-Dichloropropane	NA	NA	NA	NA	NA	NA	NA
106467	1,4-Dichlorobenzene	NA	NA	7.50E+01	5.00E-01	4.70E-01	4.70E-01	USEPA
78933	2-Butanone (MEK)	NA	2.00E+04	2.20E+04	1.90E+03	7.10E+03	2.20E+03	ADEC
591786	2-Hexanone	NA	NA	NA	NA	NA	NA	NA

TABLE 2-10
ADEC and USEPA Groundwater Screening Levels

		Human Health Screening Levels for Groundwater						
CAS No.	Analyte	Maximum Contaminant Level[a] (µg/L)	Federal Drinking Water Equivalent[a] (µg/L)	ADEC Screening Level[b] (µg/L)	USEPA Region 9 Tap Water PRG[c] (µg/L)	USEPA Region 6 Tapwater Screening Level[d] (µg/L)	Taku Groundwater Screening Level (ug/L) Lower of 1/10th ADEC Level or USEPA Region 6 Level	Source of Screening Level (NA= no screening level, 1= ADEC, 2=USEPA)
594207	2,2-Dichloropropane	NA	1	NA	NA	NA	NA	NA
108101	4-Methyl-2-pentanone (MIBK)	NA	NA	NA	1.58E+02	NA	NA	NA
67641	Acetone	NA	NA	3.65E+03	6.08E+02	5.50E+03	3.65E+02	ADEC
71432	Benzene	5.00E+00	NA	5.00E+00	3.36E-01	3.50E-01	3.50E-01	USEPA
108861	Bromobenzene	NA	NA	NA	2.00E+01	2.30E+01	2.30E+01	USEPA
74975	Bromochloromethane	NA	0.5	NA	NA	NA	NA	NA
75274	Bromodichloromethane	8.00E+01	7.00E+02	1.00E+02	1.81E-01	1.80E-01	1.80E-01	USEPA
75252	Bromoform	8.00E+01	7.00E+02	1.00E+02	8.51E+00	8.50E+00	8.50E+00	USEPA
74839	Bromomethane (Methyl bromide)	NA	5.00E+01	NA	8.66E+00	8.70E+00	8.70E+00	USEPA
75150	Carbon Disulfide	NA	NA	3.65E+03	1.04E+03	1.00E+03	3.65E+02	ADEC
56235	Carbon Tetrachloride	5.00E+00	3.00E+01	5.00E+00	1.71E-01	1.70E-01	1.70E-01	USEPA
108907	Chlorobenzene	1.00E+02	NA	1.00E+02	1.06E+02	9.10E+01	1.00E+01	ADEC
75003	Chloroethane	NA	NA	NA	4.64E+00	NA	NA	NA
67663	Chloroform	8.00E+01	4.00E+02	1.00E+02	6.17E+00	1.70E-01	1.70E-01	USEPA
74873	Chloromethane	NA	1.00E+02	NA	1.51E+00	2.10E+00	2.10E+00	USEPA
156592	cis-1,2-Dichloroethene	7.00E+01	4.00E+02	7.00E+01	6.08E+01	6.10E+01	7.00E+00	ADEC
10061015	cis-1,3-Dichloropropene*	NA	1.00E+03	9.00E+00	4.00E-01	4.00E-01	4.00E-01	USEPA
110827	Cyclohexane	NA	NA	NA	3.50E+04	NA	NA	NA
124481	Dibromochloromethane	8.00E+01	7.00E+02	NA	1.33E-01	NA	NA	NA
74953	Dibromomethane	NA	NA	NA	NA	NA	NA	NA
75718	Dichlorodifluoromethane	NA	5.00E+03	7.30E+03	3.95E+02	3.90E+02	3.90E+02	USEPA
100414	Ethylbenzene	7.00E+02	3.00E+03	7.00E+02	2.91E+00	1.30E+03	7.00E+01	ADEC
98828	Isopropylbenzene	NA	4.00E+03	3.65E+03	6.58E+02	6.60E+02	3.65E+02	ADEC
79209	Methyl Acetate	NA	NA	NA	6.08E+03	NA	NA	NA
1634044	Methyl tert-Butyl Ether	2.00E+01	NA	NA	1.33E+01	1.10E+01	1.10E+01	USEPA

TABLE 2-10
ADEC and USEPA Groundwater Screening Levels

CAS No.	Analyte	Human Health Screening Levels for Groundwater: Maximum Contaminant Level[a] (µg/L)	Federal Drinking Water Equivalent[a] (µg/L)	ADEC Screening Level[b] (µg/L)	USEPA Region 9 Tap Water PRG[c] (µg/L)	USEPA Region 6 Tapwater Screening Level[d] (µg/L)	Taku Groundwater Screening Level (ug/L) Lower of 1/10th ADEC Level or USEPA Region 6 Level	Source of Screening Level (NA= no screening level, 1= ADEC, 2=USEPA)
108872	Methylcyclohexane	NA	NA	NA	5.22E+03	NA	NA	NA
75092	Methylene Chloride	5.00E+00	2.00E+03	5.00E+00	4.28E+00	4.30E+00	5.00E-01	ADEC
63072446	Methyl pentanone	NA	NA	NA	NA	NA	NA	NA
100425	Styrene	1.00E+02	7.00E+03	1.00E+02	1.64E+03	1.60E+03	1.00E+01	ADEC
127184	Tetrachloroethene	5.00E+00	5.00E+02	5.00E+00	6.59E-01	1.00E-01	1.00E-01	USEPA
108883	Toluene	1.00E+03	7.00E+03	1.00E+03	7.23E+02	2.30E+03	1.00E+02	ADEC
156605	trans-1,2-Dichloroethene	1.00E+02	7.00E+02	1.00E+02	1.20E+02	1.10E+02	1.00E+01	ADEC
10061026	trans-1,3-Dichloropropene*	NA	1.00E+03	9.00E+00	4.00E-01	4.00E-01	4.00E-01	USEPA
79016	Trichloroethene	5.00E+00	2.00E+02	5.00E+00	2.80E-02	2.80E-02	2.80E-02	USEPA
75694	Trichlorofluoromethane	NA	1.00E+04	NA	1.29E+03	1.30E+03	1.30E+03	USEPA
26523648	Trichlorotriflouroethane	NA	NA	NA	NA		0.00E+00	USEPA
75014	Vinyl Chloride	2.00E+00	1.00E+02	2.00E+00	1.98E-02	1.50E-02	1.50E-02	USEPA
1330207	Xylene (total)	1.00E+04	7.00E+04	1.00E+04	2.10E+02	1.40E+03	1.00E+03	ADEC
136777612	m&p-Xylene	1.00E+04	NA	NA	NA	2.10E+02	2.10E+02	USEPA
95476	o-Xylene	1.00E+04	7.00E+01	NA	NA	1.40E+03	1.40E+03	USEPA
Semivolatile Organic Compounds								
92524	1,1'-Biphenyl	NA	NA	NA	3.04E+02	NA	NA	NA
103651	n-Propylbenzene	NA	NA	NA	2.40E+02	NA	NA	NA
108601	2,2'-oxybis(1-Chloropropane)	NA	1.00E+03	NA	2.74E-01	NA	NA	NA
95954	2,4,5-Trichlorophenol	NA	NA	3.65E+03	3.65E+03	3.65E+03	3.65E+02	ADEC
88062	2,4,6-Trichlorophenol	NA	1.00E+01	7.70E+01	3.65E+00	6.10E+00	6.10E+00	USEPA
94757	2,4-D	NA	NA	NA	3.60E+02	NA	NA	NA
120832	2,4-Dichlorophenol	NA	1.00E+02	1.00E+02	1.09E+02	1.10E+02	1.00E+01	ADEC
105679	2,4-Dimethylphenol	NA	NA	7.00E+02	7.30E+02	7.30E+02	7.00E+01	ADEC
51285	2,4-Dinitrophenol	NA	NA	7.00E+01	7.30E+01	7.30E+01	7.00E+00	ADEC

TABLE 2-10
ADEC and USEPA Groundwater Screening Levels

		Human Health Screening Levels for Groundwater						
CAS No.	Analyte	Maximum Contaminant Level[a] (µg/L)	Federal Drinking Water Equivalent[a] (µg/L)	ADEC Screening Level[b] (µg/L)	USEPA Region 9 Tap Water PRG[c] (µg/L)	USEPA Region 6 Tapwater Screening Level[d] (µg/L)	Taku Groundwater Screening Level (ug/L) Lower of 1/10th ADEC Level or USEPA Region 6 Level	Source of Screening Level (NA= no screening level, 1= ADEC, 2=USEPA)
121142	2,4-Dinitrotoluene	NA	1.00E+02	1.25E+00	7.30E+01	7.30E+01	1.25E-01	ADEC
606202	2,6-Dinitrotoluene	NA	4.00E+01	1.25E+00	3.65E+01	3.70E+01	1.25E-01	ADEC
110758	2-Chloroethylvinyl ether	NA	NA	NA	NA	NA	NA	NA
91587	2-Chloronaphthalene	NA	NA	2.90E+03	4.87E+02	4.90E+02	2.90E+02	ADEC
95578	2-Chlorophenol	NA	2.00E+02	2.00E+02	3.04E+01	3.00E+01	2.00E+01	ADEC
95498	2-Chlorotoluene	NA	NA	NA	1.20E+02	1.20E+02	1.20E+02	USEPA
90120	1-Methylnaphthalene	NA	NA	NA	NA	NA	NA	NA
110496	2-Methoxyethyl acetate	NA	NA	NA	7.30E+01	NA	NA	NA
91576	2-Methylnaphthalene	NA	NA	7.80E+02	NA	NA	7.80E+01	ADEC
95487	2-Methylphenol	NA	NA	1.80E+03	1.82E+03	1.80E+03	1.80E+02	ADEC
88744	2-Nitroaniline	NA	NA	NA	1.04E+00	1.10E+02	1.10E+02	USEPA
88755	2-Nitrophenol	NA	3.00E+02	NA	NA	NA	NA	NA
91941	3,3'-Dichlorobenzidine	NA	NA	2.00E+00	1.49E-01	1.50E-01	1.50E-01	USEPA
34MP	3,4-Methylphenol*	NA	NA	NA	NA	NA	NA	NA
108394	3-Methylphenol	NA	NA	NA	1.80E+03	NA	NA	NA
99092	3-Nitroaniline	NA	NA	NA	NA	NA	NA	NA
534521	4,6-Dinitro-2-methylphenol	NA	NA	NA	NA	NA	NA	NA
101553	4-Bromophenyl-phenylether	NA	NA	NA	NA	NA	NA	NA
59507	4-Chloro-3-methylphenol	NA	NA	NA	NA	1.80E+02	1.80E+02	USEPA
106478	4-Chloroaniline	NA	NA	1.50E+02	1.46E+02	1.50E+02	1.50E+01	ADEC
7005723	4-Chlorophenyl-phenylether	NA	NA	NA	NA	NA	NA	NA
106434	4-Chlorotoluene	NA	NA	NA	NA	NA	NA	NA
99876	4-Isopropyltoluene	NA	NA	NA	NA	NA	NA	NA
106445	4-Methylphenol	NA	NA	NA	1.82E+02	NA	NA	NA
100016	4-Nitroaniline	NA	NA	NA	NA	NA	NA	NA

TABLE 2-10
ADEC and USEPA Groundwater Screening Levels

		Human Health Screening Levels for Groundwater						
CAS No.	Analyte	Maximum Contaminant Level[a] (µg/L)	Federal Drinking Water Equivalent[a] (µg/L)	ADEC Screening Level[b] (µg/L)	USEPA Region 9 Tap Water PRG[c] (µg/L)	USEPA Region 6 Tapwater Screening Level[d] (µg/L)	Taku Groundwater Screening Level (ug/L) Lower of 1/10th ADEC Level or USEPA Region 6 Level	Source of Screening Level (NA= no screening level, 1= ADEC, 2=USEPA)
100027	4-Nitrophenol	NA	3.00E+02	NA	NA	2.90E+02	2.90E+02	USEPA
83329	Acenaphthene	NA	2.00E+03	2.20E+03	3.65E+02	3.65E+02	2.20E+02	ADEC
208968	Acenaphthylene	NA	2.00E+03	2.20E+03	NA	NA	2.20E+02	ADEC
98862	Acetophenone	NA	NA	NA	NA	NA	NA	NA
62533	Aniline	NA	NA	NA	1.20E+01	NA	NA	NA
120127	Anthracene	NA	1.00E+04	1.10E+04	1.83E+03	1.83E+03	1.10E+03	ADEC
1912249	Atrazine	3.00E+00	1.00E+03	NA	3.03E-01	NA	NA	NA
100527	Benzaldehyde	NA	NA	NA	3.65E+03	NA	NA	NA
56553	Benzo (a) anthracene	NA	NA	1.00E+00	9.21E-02	3.00E-02	3.00E-02	USEPA
50328	Benzo (a) pyrene	2.00E-01	NA	2.00E-01	9.21E-03	3.00E-03	3.00E-03	USEPA
205992	Benzo (b) fluoranthene	NA	NA	1.00E+00	9.21E-02	3.00E-02	3.00E-02	USEPA
191242	Benzo (g,h,i) perylene	NA	NA	1.10E+03	NA	3.00E-01	3.00E-01	USEPA
207089	Benzo (k) fluoranthene	NA	NA	1.00E+01	9.21E-01	NA	1.00E+00	ADEC
65850	Benzoic Acid	NA	NA	1.46E+05	1.50E+05	1.50E+05	1.46E+04	ADEC
100516	Benzyl alcohol	NA	NA	NA	1.10E+04	1.10E+04	1.10E+04	USEPA
117817	bis (2-Ethylhexyl) phthalate	NA	NA	6.00E+00	4.80E+00	4.80E+00	6.00E-01	ADEC
111911	bis(2-Chloroethoxy)methane	NA	NA	NA	NA	NA	NA	NA
111444	bis(2-Chloroethyl)ether	NA	NA	7.70E-01	9.78E-03	9.80E-03	9.80E-03	USEPA
39638329	bis(2-Chloroisopropyl)ether	NA	NA	NA	2.70E-01	2.70E-01	2.70E-01	USEPA
85687	Butylbenzylphthalate	NA	7.00E+03	7.30E+03	7.30E+03	7.30E+03	7.30E+02	ADEC
105602	Caprolactam	NA	NA	NA	1.82E+04	NA	NA	NA
86748	Carbazole	NA	NA	4.00E+01	3.36E+00	3.40E+00	3.40E+00	USEPA
218019	Chrysene	NA	NA	1.00E+02	9.21E+00	2.90E+00	2.90E+00	USEPA
53703	Dibenzo (a,h) anthracene	NA	NA	1.00E-01	9.21E-03	3.00E-03	3.00E-03	USEPA
84662	Diethylphthalate	NA	3.00E+04	2.90E+04	2.92E+04	2.90E+04	2.90E+03	ADEC

TABLE 2-10
ADEC and USEPA Groundwater Screening Levels

		Human Health Screening Levels for Groundwater						
CAS No.	Analyte	Maximum Contaminant Level[a] (µg/L)	Federal Drinking Water Equivalent[a] (µg/L)	ADEC Screening Level[b] (µg/L)	USEPA Region 9 Tap Water PRG[c] (µg/L)	USEPA Region 6 Tapwater Screening Level[d] (µg/L)	Taku Groundwater Screening Level (ug/L) Lower of 1/10th ADEC Level or USEPA Region 6 Level	Source of Screening Level (NA= no screening level, 1= ADEC, 2=USEPA)
131113	Dimethylphthalate	NA	NA	NA	3.65E+05	3.70E+05	3.70E+05	USEPA
84742	Di-n-butylphthalate	NA	4.00E+03	3.65E+03	3.65E+03	NA	3.65E+02	ADEC
117840	Di-n-octylphthalate	NA	NA	7.00E+02	1.46E+03	NA	7.00E+01	ADEC
206440	Fluoranthene	NA	NA	1.46E+03	1.46E+03	1.46E+03	1.46E+02	ADEC
86737	Fluorene	NA	1.00E+03	1.46E+03	2.43E+02	2.40E+02	1.46E+02	ADEC
118741	Hexachlorobenzene	1.00E+00	3.00E+01	1.00E+00	4.20E-02	4.20E-02	4.20E-02	USEPA
87683	Hexachlorobutadiene	NA	7.00E+00	1.00E+01	8.62E-01	8.60E-01	8.60E-01	USEPA
77474	Hexachlorocyclopentadiene	5.00E+01	2.00E+02	5.00E+01	2.19E+02	NA	5.00E+00	ADEC
67721	Hexachloroethane	NA	4.00E+01	6.00E+01	4.80E+00	4.80E+00	4.80E+00	USEPA
193395	Indeno (1,2,3-cd) pyrene	NA	NA	1.00E+00	9.21E-02	3.00E-02	3.00E-02	USEPA
78591	Isophorone	NA	7.00E+03	9.00E+02	7.08E+01	7.10E+01	7.10E+01	USEPA
104518	n-Butylbenzene	NA	NA	NA	2.40E+02	1.40E+02	1.40E+02	USEPA
91203	Naphthalene	NA	7.00E+02	7.00E+02	6.20E+00	6.20E+00	6.20E+00	USEPA
98953	Nitrobenzene	NA	NA	1.80E+01	3.40E+00	3.40E+00	1.80E+00	ADEC
62759	N-Nitrosodimethylamine	NA	NA	NA	1.40E+01	4.20E-04	4.20E-04	USEPA
621647	N-Nitroso-di-n-propylamine	NA	NA	1.00E-01	9.60E-03	9.60E-03	9.60E-03	USEPA
86306	N-Nitrosodiphenylamine	NA	NA	1.70E+02	1.37E+01	1.40E+01	1.40E+01	USEPA
87865	Pentachlorophenol	1.00E+00	1.00E+03	1.00E+00	5.60E-01	5.60E-01	1.00E-01	ADEC
85018	Phenanthrene	NA	NA	1.10E+04	NA	NA	1.10E+03	ADEC
108952	Phenol	NA	2.00E+04	2.20E+04	2.19E+04	1.10E+04	2.20E+03	ADEC
129000	Pyrene	NA	NA	1.10E+03	1.83E+02	1.80E+02	1.10E+02	ADEC
483658	Retene	NA	NA	NA	NA	NA	NA	NA
135988	sec-Butylbenzene	NA	NA	NA	2.40E+02	1.10E+02	1.10E+02	USEPA
98066	tert-Butylbenzene	NA	NA	NA	2.40E+02	6.10E+01	6.10E+01	USEPA

TABLE 2-10
ADEC and USEPA Groundwater Screening Levels

CAS No.	Analyte	Human Health Screening Levels for Groundwater: Maximum Contaminant Level[a] (µg/L)	Federal Drinking Water Equivalent[a] (µg/L)	ADEC Screening Level[b] (µg/L)	USEPA Region 9 Tap Water PRG[c] (µg/L)	USEPA Region 6 Tapwater Screening Level[d] (µg/L)	Taku Groundwater Screening Level (ug/L) Lower of 1/10th ADEC Level or USEPA Region 6 Level	Source of Screening Level (NA= no screening level, 1= ADEC, 2=USEPA)
Petroleum Hydrocarbons								
GRO	Gasoline Range Organics (GRO)	NA	NA	1.30E+03	1.82E+03	NA	1.30E+02	ADEC
DRO	Diesel Range Organics (DRO)	NA	NA	1.50E+03	1.82E+03	NA	1.50E+02	ADEC
RRO	Residual Range Organics (RRO)	NA	NA	1.10E+03	1.82E+03	NA	1.10E+02	ADEC
Pestcides								
309002	Aldrin	NA	NA	5.00E-02	4.30E-03	4.30E-03	4.30E-03	USEPA
319846	alpha-BHC	NA	NA	1.00E-01	1.10E-02	1.10E-02	1.00E-02	ADEC
5103719	alpha-Chlordane	NA	NA	NA	NA	NA	NA	NA
319857	beta-BHC	NA	NA	4.70E-01	3.70E-02	3.70E-02	3.70E-02	USEPA
12789036	Chlordane	NA	NA	2.00E+00	NA	NA	2.00E-01	ADEC
72548	4,4'-DDD	NA	NA	3.60E+00	NA	2.80E-01	2.80E-01	USEPA
72559	4,4'-DDE	NA	NA	2.50E+00	NA	2.00E-01	2.00E-01	USEPA
50293	4,4'-DDT	NA	NA	2.50E+00	NA	2.00E-01	2.00E-01	USEPA
319868	delta-BHC	NA	NA	NA	NA	NA	NA	NA
Dichloprop	Dichloropropanol	NA	NA	NA	NA	NA	NA	NA
60571	Dieldrin	NA	NA	5.00E-02	4.20E-03	4.20E-03	4.20E-03	USEPA
959988	Endosulfan I*	NA	NA	NA	NA	2.20E+02	2.20E+02	USEPA
33213659	Endosulfan II*	NA	NA	NA	NA	NA	NA	NA
1031078	Endosulfan Sulfate	NA	NA	NA	NA	NA	NA	NA
72208	Endrin	NA	NA	2.00E+00	1.10E+01	1.10E+01	2.00E-01	ADEC
7421934	Endrin aldehyde	NA	NA	NA	NA	NA	NA	NA
53494705	Endrin ketone	NA	NA	NA	NA	NA	NA	NA
57749	gamma Chlordane	NA	NA	NA	NA	NA	NA	NA
58899	gamma-BHC (Lindane)	NA	NA	2.00E-01	5.20E-02	5.20E-02	2.00E-02	ADEC

TABLE 2-10
ADEC and USEPA Groundwater Screening Levels

CAS No.	Analyte	Human Health Screening Levels for Groundwater: Maximum Contaminant Level[a] (µg/L)	Federal Drinking Water Equivalent[a] (µg/L)	ADEC Screening Level[b] (µg/L)	USEPA Region 9 Tap Water PRG[c] (µg/L)	USEPA Region 6 Tapwater Screening Level[d] (µg/L)	Taku Groundwater Screening Level (ug/L) Lower of 1/10th ADEC Level or USEPA Region 6 Level	Source of Screening Level (NA= no screening level, 1= ADEC, 2=USEPA)
76448	Heptachlor	NA	NA	4.00E-01	1.50E-02	1.50E-02	1.50E-02	USEPA
1024573	Heptachlor epoxide	NA	NA	2.00E-01	7.40E-03	7.40E-03	7.40E-03	USEPA
72435	Methoxychlor	NA	NA	4.00E+01	1.80E+02	1.80E+02	4.00E+00	ADEC
8001352	Toxaphene	NA	NA	3.00E+00	6.10E-02	NA	3.00E-01	ADEC
8082 PCBs								
12674112	Aroclor 1016*	5.00E-04	NA	5.00E-01	9.60E-01	9.60E-01	5.00E-02	ADEC
11104282	Aroclor 1221*	5.00E-04	NA	5.00E-01	3.40E-02	3.40E-02	3.40E-02	USEPA
11141165	Aroclor 1232*	5.00E-04	NA	5.00E-01	3.40E-02	3.40E-02	3.40E-02	USEPA
53469219	Aroclor 1242*	5.00E-04	NA	5.00E-01	3.40E-02	3.40E-02	3.40E-02	USEPA
12672296	Aroclor 1248*	5.00E-04	NA	5.00E-01	3.40E-02	3.40E-02	3.40E-02	USEPA
11097691	Aroclor 1254*	5.00E-04	NA	5.00E-01	3.40E-02	3.40E-02	3.40E-02	USEPA
11096825	Aroclor 1260*	5.00E-04	NA	5.00E-01	3.40E-02	3.40E-02	3.40E-02	USEPA
1336363	PCBs, total	5.00E-04	NA	5.00E-01	3.40E-02	NA	5.00E-02	ADEC
VPH								
	C6-C8 Aromatics			7.30E+03	NA	NA	7.30E+02	ADEC
	C8-C10 Aromatics			7.30E+03	NA	NA	7.30E+02	ADEC
	C10-C12 Aromatics			1.50E+03	NA	NA	1.50E+02	ADEC
	C5-C6 Aliphatics			1.30E+03	NA	NA	1.30E+02	ADEC
	C6-C8 Aliphatics			1.30E+03	NA	NA	1.30E+02	ADEC
	C8-C10 Aliphatics			1.30E+03	NA	NA	1.30E+02	ADEC
	C10-C12 Aliphatics			1.00E+02	NA	NA	1.00E+01	ADEC
EPH								
	C10-C12 Aromatics			1.50E+03	NA	NA	1.50E+02	ADEC
	C12-C16 Aromatics			1.50E+03	NA	NA	1.50E+02	ADEC

TABLE 2-10
ADEC and USEPA Groundwater Screening Levels

CAS No.	Analyte	Human Health Screening Levels for Groundwater: Maximum Contaminant Level[a] (µg/L)	Federal Drinking Water Equivalent[a] (µg/L)	ADEC Screening Level[b] (µg/L)	USEPA Region 9 Tap Water PRG[c] (µg/L)	USEPA Region 6 Tapwater Screening Level[d] (µg/L)	Taku Groundwater Screening Level (ug/L) Lower of 1/10th ADEC Level or USEPA Region 6 Level	Source of Screening Level (NA= no screening level, 1= ADEC, 2=USEPA)
	C16-C21 Aromatics			1.50E+03	NA	NA	1.50E+02	ADEC
	C21-C34 Aromatics			1.10E+00	NA	NA	1.10E-01	ADEC
	C10-C12 Aliphatics			1.00E+02	NA	NA	1.00E+01	ADEC
	C12-C16 Aliphatics			1.00E+02	NA	NA	1.00E+01	ADEC
	C16-C21 Aliphatics			1.00E+02	NA	NA	1.00E+01	ADEC
	C21-C34 Aliphatics			NA	NA	NA	NA	NA
Metals & Other Inorganics								
7429905	Aluminum			NA	3.60E+04	3.70E+04	3.70E+04	USEPA
7664417	Ammonia (as N)			NA	NA	NA	NA	NA
7440360	Antimony			6.00E+00	1.50E+01	1.50E+01	6.00E-01	ADEC
7440382	Arsenic			5.00E+01	4.50E-02	4.50E-02	7.73E+01	Site Specific
7440393	Barium			2.00E+03	2.60E+03	7.30E+03	2.00E+02	ADEC
7440417	Beryllium			4.00E+00	3.60E+00	7.30E+01	4.00E-01	ADEC
7440439	Cadmium			5.00E+00	1.80E+01	1.80E+01	5.00E-01	ADEC
7440702	Calcium				NA	NA	0.00E+00	ADEC
7440473	Chromium total			1.00E+02	NA	5.50E+04	1.00E+01	ADEC
16065-83-1	Chromium +3			5.50E+04	NA	5.50E+04	5.50E+03	ADEC
18540-29-9	Chromium +6			1.00E+02	NA	1.10E+02	1.00E+01	ADEC
7440484	Cobalt			NA	7.30E+02	7.30E+02	7.30E+02	USEPA
7440508	Copper			1.30E+03	1.50E+03	1.40E+03	1.30E+02	ADEC
7439896	Iron			NA	1.10E+04	2.60E+04	2.60E+04	USEPA
7439921	Lead	1.50E+01	NA	1.50E+01	NA	1.50E+01	1.50E+00	ADEC
7439954	Magnesium			NA	NA	NA	NA	NA
7439965	Manganese			NA	8.80E+02	1.70E+03	1.70E+03	USEPA
7439976	Mercury			2.00E+00	NA	1.10E+01	2.00E-01	ADEC

TABLE 2-10
ADEC and USEPA Groundwater Screening Levels

CAS No.	Analyte	Human Health Screening Levels for Groundwater: Maximum Contaminant Level[a] (µg/L)	Federal Drinking Water Equivalent[a] (µg/L)	ADEC Screening Level[b] (µg/L)	USEPA Region 9 Tap Water PRG[c] (µg/L)	USEPA Region 6 Tapwater Screening Level[d] (µg/L)	Taku Groundwater Screening Level (ug/L) Lower of 1/10th ADEC Level or USEPA Region 6 Level	Source of Screening Level (NA= no screening level, 1= ADEC, 2=USEPA)
7440020	Nickel			1.00E+02	7.30E+02	7.30E+02	1.00E+01	ADEC
NO3/NO2	Nitrate/Nitrite			NA	NA	NA	NA	NA
7440097	Potassium			NA	NA	NA	NA	NA
7782492	Selenium			5.00E+01	1.80E+02	1.80E+02	5.00E+00	ADEC
7440224	Silver			1.80E+02	1.80E+02	1.80E+02	1.80E+01	ADEC
7440235	Sodium			NA	NA	NA	NA	NA
14808798	Sulfate			NA	NA	NA	NA	NA
7440280	Thallium			2.00E+00	2.40E+00	2.60E+00	2.00E-01	ADEC
7440622	Vanadium			2.60E+02	2.60E+02	1.80E+02	2.60E+01	ADEC
7440666	Zinc			1.10E+04	1.10E+04	1.10E+04	1.10E+03	ADEC
Chlorinated Herbicides								
94-75-7	2,4-D			NA	NA	NA	NA	NA
94-82-6	2,4-DB			NA	NA	NA	NA	NA
	2,4,5-T			NA	NA	NA	NA	NA
	2,4,5-TP (Silvex)			NA	NA	NA	NA	NA
75-99-0	Dalapon			NA	1100	1100	1.10E+03	USEPA
1918-00-9	Dicamba			NA	1100	1100	1.10E+03	USEPA
	Dichlorprop			NA	NA	NA	NA	NA
88-85-7	Dinoseb			NA	36	37	3.70E+01	USEPA
16484-77-8	MCPA			NA	NA	NA	NA	NA
Dioxins								
	2,3,7,8-TCDD			3.00E-05		0.00000045	4.50E-07	USEPA
	1,2,3,7,8-PeCDD			NA		NA	NA	NA
	1,2,3,4,7,8-HxCDD			NA		NA	NA	NA

TABLE 2-10
ADEC and USEPA Groundwater Screening Levels

CAS No.	Analyte	Human Health Screening Levels for Groundwater: Maximum Contaminant Level[a] (µg/L)	Federal Drinking Water Equivalent[a] (µg/L)	ADEC Screening Level[b] (µg/L)	USEPA Region 9 Tap Water PRG[c] (µg/L)	USEPA Region 6 Tapwater Screening Level[d] (µg/L)	Taku Groundwater Screening Level (ug/L) Lower of 1/10th ADEC Level or USEPA Region 6 Level	Source of Screening Level (NA= no screening level, 1= ADEC, 2=USEPA)
	1,2,3,6,7,8-HxCDD			NA		NA	NA	NA
	1,2,3,7,8,9-HxCDD			NA		NA	NA	NA
	1,2,3,4,6,7,8-HpCDD			NA		NA	NA	NA
	OCDD			NA		NA	NA	NA
	2,3,7,8-TCDF			NA		NA	NA	NA
	1,2,3,7,8-PeCDF			NA		NA	NA	NA
	2,3,4,7,8-PeCDF			NA		NA	NA	NA
	1,2,3,4,7,8-HxCDF			NA		NA	NA	NA
	1,2,3,6,7,8-HxCDF			NA		NA	NA	NA
	2,3,4,6,7,8-HxCDF			NA		NA	NA	NA
	1,2,3,7,8,9-HxCDF			NA		NA	NA	NA
	1,2,3,4,6,7,8-HpCDF			NA		NA	NA	NA
	1,2,3,4,7,8,9-HpCDF			NA		NA	NA	NA
	OCDF			NA		NA	NA	NA
Explosives								
99-35-4	1,3,5-Trinitrobenzene			NA	1100	1100	1.10E+03	USEPA
99-65-0	1,3-Dinitrobenzene			NA	3.6	3.7	3.70E+00	USEPA
121142	2,4-Dinitrotoluene			NA	73	73	7.30E+01	USEPA
606202	2,6-Dinitrotoluene			NA	36	37	3.70E+01	USEPA
118-96-7	2,4,6-Trinitrotoluene (TNT)			NA	2.2	2.2	2.20E+00	USEPA
	2-Amino-4,6-dinitrotoluene			NA	7.3	NA	NA	NA
	2-Nitrotoluene			NA	0.049	0.29	2.90E-01	USEPA
	3-Nitrotoluene			NA	120	120	1.20E+02	USEPA
	4-Amino-4,6-dinitrotoluene			NA	7.3	NA	NA	NA
	4-Nitrotoluene			NA	0.66	4	4.00E+00	USEPA

TABLE 2-10
ADEC and USEPA Groundwater Screening Levels

		Human Health Screening Levels for Groundwater						
CAS No.	**Analyte**	**Maximum Contaminant Level[a] (µg/L)**	**Federal Drinking Water Equivalent[a] (µg/L)**	**ADEC Screening Level[b] (µg/L)**	**USEPA Region 9 Tap Water PRG[c] (µg/L)**	**USEPA Region 6 Tapwater Screening Level[d] (µg/L)**	**Taku Groundwater Screening Level (ug/L) Lower of 1/10th ADEC Level or USEPA Region 6 Level**	**Source of Screening Level (NA= no screening level, 1= ADEC, 2=USEPA)**
121-82-4	Hexahydro-1,3,5-trinitro-1,3,5-triazine (RDX)			NA	0.61	0.61	6.10E-01	USEPA
	Methyl-2,4,6-trinitrophenylnitramine (Tetryl)			NA	NA	NA	NA	NA
98953	Nitrobenzene			NA	3.4	3.4	3.40E+00	USEPA
2691-41-0	Octahydro-1,3,5,7-tetranitro-1,3,5,7-tetrazocine (HMX)			NA	1800	1800	1.80E+03	USEPA

Notes:
NA = not available
ADEC = Alaska Department of Environmental Conservation
µg/L = micrograms per liter
PRG = preliminary remediation goal
USEPA = United States Environmental Protection Agency
* Surrogate compound was used.

References:
[a] U.S. Environmental Protection Agency, 2002. 2002 Edition of the Drinking Water Standards and Health Advisories. MCLs and DWELs. USEPA 822R02038. Office of Water. Summer 2002.
[b] Alaska Department of Environmental Conservation, 2003. 18 AAC 75 Oil and Other Hazardous Substances Pollution Control. *Alaska Administrative Code,* Chapter18, Section 75.345(b) Method 2 Groundwater Cleanup Levels.
[c] U.S. Environmental Protection Agency, 2002. Region IX Preliminary Remediation Goals (PRGs). Available at USEPA Region IX website: www.USEPA.gov/region 09/waste/sfund/prg/intro.htm October, 2002.

TABLE 2-11
Summary of Chemical Data Relative To Screening Levels

1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19
Analyte Name	**CAS Number**	**Matrix**	**In Situ or Ex Situ?**	**Was Analyte Detected?**	**Screening Level (mg/kg or µg/L)**	**Blue Count (<=1*SL)**	**Green Count (>1*SL & <=10*SL)**	**Yellow Count (>10*SL & <=100*SL)**	**Orange Count (>100*SL & <=1000*SL)**	**Red Count (>1000*SL)**	**Total Count: Detect+ Non-detect**	**Total Count: In Situ Soil; Ex Situ Soil; Groundwater**	**Percent Detect or Non-detect in: In Situ; Ex Situ; Groundwater Groups**	**Percent Blue**	**Percent Green**	**Percent Yellow**	**Percent Orange**	**Percent Red**
1,1,1,2-Tetrachloroethane	630-20-6	SO	IN SITU	Y	3	0	0	0	0	0	0	197	0	0	0	0	0	0
1,1,1,2-Tetrachloroethane	630-20-6	SO	IN SITU	N	3	196	1	0	0	0	197	197	100	99.49	0.51	0	0	0
1,1,1,2-Tetrachloroethane	630-20-6	SO	EX SITU	Y	3	0	0	0	0	0	0	76	0	0	0	0	0	0
1,1,1,2-Tetrachloroethane	630-20-6	SO	EX SITU	N	3	74	2	0	0	0	76	76	100	97.37	2.63	0	0	0
1,1,1,2-Tetrachloroethane	630-20-6	GW	IN SITU	Y	0.43	0	0	0	0	0	0	20	0	0	0	0	0	0
1,1,1,2-Tetrachloroethane	630-20-6	GW	IN SITU	N	0.43	20	0	0	0	0	20	20	100	100	0	0	0	0
1,1,1-Trichloroethane	71-55-6	SO	IN SITU	Y	0.1	0	0	0	0	0	0	197	0	0	0	0	0	0
1,1,1-Trichloroethane	71-55-6	SO	IN SITU	N	0.1	192	4	1	0	0	197	197	100	97.46	2.03	0.51	0	0
1,1,1-Trichloroethane	71-55-6	SO	EX SITU	Y	0.1	0	0	0	0	0	0	76	0	0	0	0	0	0
1,1,1-Trichloroethane	71-55-6	SO	EX SITU	N	0.1	72	1	2	1	0	76	76	100	94.74	1.32	2.63	1.32	0
1,1,1-Trichloroethane	71-55-6	GW	IN SITU	Y	20	0	0	0	0	0	0	20	0	0	0	0	0	0
1,1,1-Trichloroethane	71-55-6	GW	IN SITU	N	20	20	0	0	0	0	20	20	100	100	0	0	0	0
1,1,2,2-Tetrachloroethane	79-34-5	SO	IN SITU	Y	0.0017	0	0	0	0	0	0	197	0	0	0	0	0	0
1,1,2,2-Tetrachloroethane	79-34-5	SO	IN SITU	N	0.0017	17	169	6	3	2	197	197	100	8.63	85.79	3.05	1.52	1.02
1,1,2,2-Tetrachloroethane	79-34-5	SO	EX SITU	Y	0.0017	0	0	0	0	0	0	76	0	0	0	0	0	0
1,1,2,2-Tetrachloroethane	79-34-5	SO	EX SITU	N	0.0017	16	56	0	1	3	76	76	100	21.05	73.68	0	1.32	3.95
1,1,2,2-Tetrachloroethane	79-34-5	GW	IN SITU	Y	0.055	0	0	1	0	0	1	20	5	0	0	5	0	0
1,1,2,2-Tetrachloroethane	79-34-5	GW	IN SITU	N	0.055	0	19	0	0	0	19	20	95	0	95	0	0	0
1,1,2-Trichloroethane	79-00-5	SO	IN SITU	Y	0.0017	0	1	1	0	0	2	197	1.02	0	0.51	0.51	0	0
1,1,2-Trichloroethane	79-00-5	SO	IN SITU	N	0.0017	12	175	3	4	1	195	197	98.98	6.09	88.83	1.52	2.03	0.51
1,1,2-Trichloroethane	79-00-5	SO	EX SITU	Y	0.0017	0	0	0	0	0	0	76	0	0	0	0	0	0
1,1,2-Trichloroethane	79-00-5	SO	EX SITU	N	0.0017	3	69	0	1	3	76	76	100	3.95	90.79	0	1.32	3.95
1,1,2-Trichloroethane	79-00-5	GW	IN SITU	Y	0.2	0	0	0	0	0	0	20	0	0	0	0	0	0
1,1,2-Trichloroethane	79-00-5	GW	IN SITU	N	0.2	20	0	0	0	0	20	20	100	100	0	0	0	0
1,1-Dichloroethane	75-34-3	SO	IN SITU	Y	1.2	0	0	0	0	0	0	197	0	0	0	0	0	0
1,1-Dichloroethane	75-34-3	SO	IN SITU	N	1.2	196	1	0	0	0	197	197	100	99.49	0.51	0	0	0
1,1-Dichloroethane	75-34-3	SO	EX SITU	Y	1.2	0	0	0	0	0	0	76	0	0	0	0	0	0
1,1-Dichloroethane	75-34-3	SO	EX SITU	N	1.2	73	2	1	0	0	76	76	100	96.05	2.63	1.32	0	0
1,1-Dichloroethane	75-34-3	GW	IN SITU	Y	365	0	0	0	0	0	0	20	0	0	0	0	0	0
1,1-Dichloroethane	75-34-3	GW	IN SITU	N	365	20	0	0	0	0	20	20	100	100	0	0	0	0
1,1-Dichloroethene	75-35-4	SO	IN SITU	Y	0.003	0	0	0	0	0	0	197	0	0	0	0	0	0
1,1-Dichloroethene	75-35-4	SO	IN SITU	N	0.003	71	119	3	3	1	197	197	100	36.04	60.41	1.52	1.52	0.51
1,1-Dichloroethene	75-35-4	SO	EX SITU	Y	0.003	0	0	0	0	0	0	76	0	0	0	0	0	0
1,1-Dichloroethene	75-35-4	SO	EX SITU	N	0.003	20	52	0	1	3	76	76	100	26.32	68.42	0	1.32	3.95
1,1-Dichloroethene	75-35-4	GW	IN SITU	Y	0.7	1	0	0	0	0	1	20	5	5	0	0	0	0
1,1-Dichloroethene	75-35-4	GW	IN SITU	N	0.7	19	0	0	0	0	19	20	95	95	0	0	0	0

TABLE 2-11
Summary of Chemical Data Relative To Screening Levels

1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19
Analyte Name	**CAS Number**	**Matrix**	**In Situ or Ex Situ?**	**Was Analyte Detected?**	**Screening Level (mg/kg or µg/L)**	**Blue Count (<=1*SL)**	**Green Count (>1*SL & <=10*SL)**	**Yellow Count (>10*SL & <=100*SL)**	**Orange Count (>100*SL & <=1000*SL)**	**Red Count (>1000*SL)**	**Total Count: Detect+ Non-detect**	**Total Count: In Situ Soil; Ex Situ Soil; Groundwater**	**Percent Detect or Non-detect in: In Situ; Ex Situ; Groundwater Groups**	**Percent Blue**	**Percent Green**	**Percent Yellow**	**Percent Orange**	**Percent Red**
1,2,3-Trichloropropane	96-18-4	SO	IN SITU	Y	0.0002	0	0	0	0	0	0	197	0	0	0	0	0	0
1,2,3-Trichloropropane	96-18-4	SO	IN SITU	N	0.0002	0	7	102	83	5	197	197	100	0	3.55	51.78	42.13	2.54
1,2,3-Trichloropropane	96-18-4	SO	EX SITU	Y	0.0002	0	0	0	0	1	1	76	1.32	0	0	0	0	1.32
1,2,3-Trichloropropane	96-18-4	SO	EX SITU	N	0.0002	0	15	16	41	3	75	76	98.68	0	19.74	21.05	53.95	3.95
1,2,3-Trichloropropane	96-18-4	GW	IN SITU	Y	0.0016	0	0	0	1	0	1	20	5	0	0	0	5	0
1,2,3-Trichloropropane	96-18-4	GW	IN SITU	N	0.0016	0	0	19	0	0	19	20	95	0	0	95	0	0
1,2,4-Trichlorobenzene	120-82-1	SO	IN SITU	Y	0.2	0	0	1	0	4	5	212	2.36	0	0	0.47	0	1.89
1,2,4-Trichlorobenzene	120-82-1	SO	IN SITU	N	0.2	202	5	0	0	0	207	212	97.64	95.28	2.36	0	0	0
1,2,4-Trichlorobenzene	120-82-1	SO	EX SITU	Y	0.2	0	0	1	0	0	1	85	1.18	0	0	1.18	0	0
1,2,4-Trichlorobenzene	120-82-1	SO	EX SITU	N	0.2	78	3	2	0	1	84	85	98.82	91.76	3.53	2.35	0	1.18
1,2,4-Trichlorobenzene	120-82-1	GW	IN SITU	Y	7	0	0	0	0	0	0	20	0	0	0	0	0	0
1,2,4-Trichlorobenzene	120-82-1	GW	IN SITU	N	7	20	0	0	0	0	20	20	100	100	0	0	0	0
1,2,4-Trimethylbenzene	95-63-6	SO	IN SITU	Y	9.22	4	0	0	0	0	4	197	2.03	2.03	0	0	0	0
1,2,4-Trimethylbenzene	95-63-6	SO	IN SITU	N	9.22	193	0	0	0	0	193	197	97.97	97.97	0	0	0	0
1,2,4-Trimethylbenzene	95-63-6	SO	EX SITU	Y	9.22	1	0	1	1	0	3	76	3.95	1.32	0	1.32	1.32	0
1,2,4-Trimethylbenzene	95-63-6	SO	EX SITU	N	9.22	73	0	0	0	0	73	76	96.05	96.05	0	0	0	0
1,2,4-Trimethylbenzene	95-63-6	GW	IN SITU	Y	12	0	0	0	0	0	0	20	0	0	0	0	0	0
1,2,4-Trimethylbenzene	95-63-6	GW	IN SITU	N	12	20	0	0	0	0	20	20	100	100	0	0	0	0
1,2-Dibromo-3-chloropropane	96-12-8	SO	IN SITU	Y	0.0026	0	0	0	0	0	0	197	0	0	0	0	0	0
1,2-Dibromo-3-chloropropane	96-12-8	SO	IN SITU	N	0.0026	0	141	51	1	4	197	197	100	0	71.57	25.89	0.51	2.03
1,2-Dibromo-3-chloropropane	96-12-8	SO	EX SITU	Y	0.0026	0	0	0	0	0	0	76	0	0	0	0	0	0
1,2-Dibromo-3-chloropropane	96-12-8	SO	EX SITU	N	0.0026	0	34	38	1	3	76	76	100	0	44.74	50	1.32	3.95
1,2-Dibromo-3-chloropropane	96-12-8	GW	IN SITU	Y	0.0002	0	0	0	0	0	0	20	0	0	0	0	0	0
1,2-Dibromo-3-chloropropane	96-12-8	GW	IN SITU	N	0.0002	0	0	0	0	20	20	20	100	0	0	0	0	100
1,2-Dibromoethane	106-93-4	SO	IN SITU	Y	0.00000306	0	0	0	0	0	0	197	0	0	0	0	0	0
1,2-Dibromoethane	106-93-4	SO	IN SITU	N	0.00000306	0	0	0	128	69	197	197	100	0	0	0	64.97	35.03
1,2-Dibromoethane	106-93-4	SO	EX SITU	Y	0.00000306	0	0	0	0	0	0	76	0	0	0	0	0	0
1,2-Dibromoethane	106-93-4	SO	EX SITU	N	0.00000306	0	0	0	28	48	76	76	100	0	0	0	36.84	63.16
1,2-Dibromoethane	106-93-4	GW	IN SITU	Y	0.005	0	0	0	0	0	0	20	0	0	0	0	0	0
1,2-Dibromoethane	106-93-4	GW	IN SITU	N	0.005	0	0	20	0	0	20	20	100	0	0	100	0	0
1,2-Dichlorobenzene	95-50-1	SO	IN SITU	Y	0.7	0	1	3	0	0	4	212	1.89	0	0.47	1.42	0	0
1,2-Dichlorobenzene	95-50-1	SO	IN SITU	N	0.7	204	4	0	0	0	208	212	98.11	96.23	1.89	0	0	0
1,2-Dichlorobenzene	95-50-1	SO	EX SITU	Y	0.7	0	0	0	0	0	0	85	0	0	0	0	0	0
1,2-Dichlorobenzene	95-50-1	SO	EX SITU	N	0.7	80	4	0	1	0	85	85	100	94.12	4.71	0	1.18	0
1,2-Dichlorobenzene	95-50-1	GW	IN SITU	Y	49	0	0	0	0	0	0	20	0	0	0	0	0	0
1,2-Dichlorobenzene	95-50-1	GW	IN SITU	N	49	20	0	0	0	0	20	20	100	100	0	0	0	0

TABLE 2-11
Summary of Chemical Data Relative To Screening Levels

1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19
Analyte Name	**CAS Number**	**Matrix**	**In Situ or Ex Situ?**	**Was Analyte Detected?**	**Screening Level (mg/kg or µg/L)**	**Blue Count (<=1*SL)**	**Green Count (>1*SL & <=10*SL)**	**Yellow Count (>10*SL & <=100*SL)**	**Orange Count (>100*SL & <=1000*SL)**	**Red Count (>1000*SL)**	**Total Count: Detect+ Non-detect**	**Total Count: In Situ Soil; Ex Situ Soil; Groundwater**	**Percent Detect or Non-detect in: In Situ; Ex Situ; Groundwater Groups**	**Percent Blue**	**Percent Green**	**Percent Yellow**	**Percent Orange**	**Percent Red**
1,2-Dichloroethane	107-06-2	SO	IN SITU	Y	0.0015	0	0	0	0	0	0	197	0	0	0	0	0	0
1,2-Dichloroethane	107-06-2	SO	IN SITU	N	0.0015	26	163	3	4	1	197	197	100	13.2	82.74	1.52	2.03	0.51
1,2-Dichloroethane	107-06-2	SO	EX SITU	Y	0.0015	0	0	0	0	0	0	76	0	0	0	0	0	0
1,2-Dichloroethane	107-06-2	SO	EX SITU	N	0.0015	15	57	0	1	3	76	76	100	19.74	75	0	1.32	3.95
1,2-Dichloroethane	107-06-2	GW	IN SITU	Y	0.12	0	0	0	0	0	0	20	0	0	0	0	0	0
1,2-Dichloroethane	107-06-2	GW	IN SITU	N	0.12	20	0	0	0	0	20	20	100	100	0	0	0	0
1,2-Dichloropropane	78-87-5	SO	IN SITU	Y	0.0017	0	0	0	0	0	0	197	0	0	0	0	0	0
1,2-Dichloropropane	78-87-5	SO	IN SITU	N	0.0017	43	146	3	4	1	197	197	100	21.83	74.11	1.52	2.03	0.51
1,2-Dichloropropane	78-87-5	SO	EX SITU	Y	0.0017	0	0	0	0	0	0	76	0	0	0	0	0	0
1,2-Dichloropropane	78-87-5	SO	EX SITU	N	0.0017	18	54	0	1	3	76	76	100	23.68	71.05	0	1.32	3.95
1,2-Dichloropropane	78-87-5	GW	IN SITU	Y	0.16	0	0	0	0	0	0	20	0	0	0	0	0	0
1,2-Dichloropropane	78-87-5	GW	IN SITU	N	0.16	20	0	0	0	0	20	20	100	100	0	0	0	0
1,3,5-Trimethylbenzene	108-67-8	SO	IN SITU	Y	2.5	6	0	0	0	0	6	197	3.05	3.05	0	0	0	0
1,3,5-Trimethylbenzene	108-67-8	SO	IN SITU	N	2.5	190	1	0	0	0	191	197	96.95	96.45	0.51	0	0	0
1,3,5-Trimethylbenzene	108-67-8	SO	EX SITU	Y	2.5	0	0	1	1	0	2	76	2.63	0	0	1.32	1.32	0
1,3,5-Trimethylbenzene	108-67-8	SO	EX SITU	N	2.5	74	0	0	0	0	74	76	97.37	97.37	0	0	0	0
1,3,5-Trimethylbenzene	108-67-8	GW	IN SITU	Y	12	1	0	0	0	0	1	20	5	5	0	0	0	0
1,3,5-Trimethylbenzene	108-67-8	GW	IN SITU	N	12	19	0	0	0	0	19	20	95	95	0	0	0	0
1,3,5-Trinitrobenzene	99-35-4	SO	IN SITU	Y	1800	12	0	0	0	0	12	91	13.19	13.19	0	0	0	0
1,3,5-Trinitrobenzene	99-35-4	SO	IN SITU	N	1800	79	0	0	0	0	79	91	86.81	86.81	0	0	0	0
1,3,5-Trinitrobenzene	99-35-4	SO	EX SITU	Y	1800	26	0	0	0	0	26	64	40.63	40.63	0	0	0	0
1,3,5-Trinitrobenzene	99-35-4	SO	EX SITU	N	1800	38	0	0	0	0	38	64	59.38	59.38	0	0	0	0
1,3,5-Trinitrobenzene	99-35-4	GW	IN SITU	Y	1100	0	0	0	0	0	0	10	0	0	0	0	0	0
1,3,5-Trinitrobenzene	99-35-4	GW	IN SITU	N	1100	10	0	0	0	0	10	10	100	100	0	0	0	0
1,3-Dichlorobenzene	541-73-1	SO	IN SITU	Y	1.21	0	0	0	0	0	0	212	0	0	0	0	0	0
1,3-Dichlorobenzene	541-73-1	SO	IN SITU	N	1.21	211	1	0	0	0	212	212	100	99.53	0.47	0	0	0
1,3-Dichlorobenzene	541-73-1	SO	EX SITU	Y	1.21	0	0	0	0	0	0	85	0	0	0	0	0	0
1,3-Dichlorobenzene	541-73-1	SO	EX SITU	N	1.21	80	4	0	1	0	85	85	100	94.12	4.71	0	1.18	0
1,3-Dichlorobenzene	541-73-1	GW	IN SITU	Y	14	0	0	0	0	0	0	20	0	0	0	0	0	0
1,3-Dichlorobenzene	541-73-1	GW	IN SITU	N	14	20	0	0	0	0	20	20	100	100	0	0	0	0
1,3-Dinitrobenzene	99-65-0	SO	IN SITU	Y	6.1	0	0	0	0	0	0	91	0	0	0	0	0	0
1,3-Dinitrobenzene	99-65-0	SO	IN SITU	N	6.1	91	0	0	0	0	91	91	100	100	0	0	0	0
1,3-Dinitrobenzene	99-65-0	SO	EX SITU	Y	6.1	0	0	0	0	0	0	64	0	0	0	0	0	0
1,3-Dinitrobenzene	99-65-0	SO	EX SITU	N	6.1	64	0	0	0	0	64	64	100	100	0	0	0	0
1,3-Dinitrobenzene	99-65-0	GW	IN SITU	Y	3.7	0	1	0	0	0	1	10	10	0	10	0	0	0
1,3-Dinitrobenzene	99-65-0	GW	IN SITU	N	3.7	9	0	0	0	0	9	10	90	90	0	0	0	0

TABLE 2-11
Summary of Chemical Data Relative To Screening Levels

1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19
Analyte Name	**CAS Number**	**Matrix**	**In Situ or Ex Situ?**	**Was Analyte Detected?**	**Screening Level (mg/kg or µg/L)**	**Blue Count (<=1*SL)**	**Green Count (>1*SL & <=10*SL)**	**Yellow Count (>10*SL & <=100*SL)**	**Orange Count (>100*SL & <=1000*SL)**	**Red Count (>1000*SL)**	**Total Count: Detect+ Non-detect**	**Total Count: In Situ Soil; Ex Situ Soil; Groundwater**	**Percent Detect or Non-detect in: In Situ; Ex Situ; Groundwater Groups**	**Percent Blue**	**Percent Green**	**Percent Yellow**	**Percent Orange**	**Percent Red**
1,4-Dichlorobenzene	106-46-7	SO	IN SITU	Y	0.08	0	0	0	0	0	0	212	0	0	0	0	0	0
1,4-Dichlorobenzene	106-46-7	SO	IN SITU	N	0.08	204	3	5	0	0	212	212	100	96.23	1.42	2.36	0	0
1,4-Dichlorobenzene	106-46-7	SO	EX SITU	Y	0.08	0	0	0	0	0	0	85	0	0	0	0	0	0
1,4-Dichlorobenzene	106-46-7	SO	EX SITU	N	0.08	78	2	4	0	1	85	85	100	91.76	2.35	4.71	0	1.18
1,4-Dichlorobenzene	106-46-7	GW	IN SITU	Y	0.47	0	0	0	0	0	0	20	0	0	0	0	0	0
1,4-Dichlorobenzene	106-46-7	GW	IN SITU	N	0.47	20	0	0	0	0	20	20	100	100	0	0	0	0
1-Methylnaphthalene	90-12-0	SO	IN SITU	Y	4.3	0	0	0	0	0	0	0	0	0	0	0	0	0
1-Methylnaphthalene	90-12-0	SO	IN SITU	N	4.3	0	0	0	0	0	0	0	0	0	0	0	0	0
1-Methylnaphthalene	90-12-0	SO	EX SITU	Y	4.3	0	1	0	0	0	1	1	100	0	100	0	0	0
1-Methylnaphthalene	90-12-0	SO	EX SITU	N	4.3	0	0	0	0	0	0	1	0	0	0	0	0	0
1-Methylnaphthalene	90-12-0	GW	IN SITU	Y		0	0	0	0	0	0	0	0	0	0	0	0	0
1-Methylnaphthalene	90-12-0	GW	IN SITU	N		0	0	0	0	0	0	0	0	0	0	0	0	0
2,4,5-Trichlorophenol	95-95-4	SO	IN SITU	Y	9	0	0	0	0	0	0	174	0	0	0	0	0	0
2,4,5-Trichlorophenol	95-95-4	SO	IN SITU	N	9	171	3	0	0	0	174	174	100	98.28	1.72	0	0	0
2,4,5-Trichlorophenol	95-95-4	SO	EX SITU	Y	9	1	0	0	0	0	1	67	1.49	1.49	0	0	0	0
2,4,5-Trichlorophenol	95-95-4	SO	EX SITU	N	9	65	0	1	0	0	66	67	98.51	97.01	0	1.49	0	0
2,4,5-Trichlorophenol	95-95-4	GW	IN SITU	Y	365	0	0	0	0	0	0	20	0	0	0	0	0	0
2,4,5-Trichlorophenol	95-95-4	GW	IN SITU	N	365	20	0	0	0	0	20	20	100	100	0	0	0	0
2,4,6-Trichlorophenol	88-06-2	SO	IN SITU	Y	0.06	0	0	0	0	0	0	174	0	0	0	0	0	0
2,4,6-Trichlorophenol	88-06-2	SO	IN SITU	N	0.06	152	14	5	2	1	174	174	100	87.36	8.05	2.87	1.15	0.57
2,4,6-Trichlorophenol	88-06-2	SO	EX SITU	Y	0.06	0	0	0	0	0	0	67	0	0	0	0	0	0
2,4,6-Trichlorophenol	88-06-2	SO	EX SITU	N	0.06	57	3	6	0	1	67	67	100	85.07	4.48	8.96	0	1.49
2,4,6-Trichlorophenol	88-06-2	GW	IN SITU	Y	6.1	0	0	0	0	0	0	20	0	0	0	0	0	0
2,4,6-Trichlorophenol	88-06-2	GW	IN SITU	N	6.1	20	0	0	0	0	20	20	100	100	0	0	0	0
2,4,6-Trinitrotoluene	118-96-7	SO	IN SITU	Y	16	0	0	0	0	0	0	91	0	0	0	0	0	0
2,4,6-Trinitrotoluene	118-96-7	SO	IN SITU	N	16	91	0	0	0	0	91	91	100	100	0	0	0	0
2,4,6-Trinitrotoluene	118-96-7	SO	EX SITU	Y	16	0	0	0	0	0	0	64	0	0	0	0	0	0
2,4,6-Trinitrotoluene	118-96-7	SO	EX SITU	N	16	64	0	0	0	0	64	64	100	100	0	0	0	0
2,4,6-Trinitrotoluene	118-96-7	GW	IN SITU	Y	2.2	0	0	0	0	0	0	10	0	0	0	0	0	0
2,4,6-Trinitrotoluene	118-96-7	GW	IN SITU	N	2.2	10	0	0	0	0	10	10	100	100	0	0	0	0
2,4-D	94-75-7	SO	IN SITU	Y	690	0	0	0	0	0	0	68	0	0	0	0	0	0
2,4-D	94-75-7	SO	IN SITU	N	690	68	0	0	0	0	68	68	100	100	0	0	0	0
2,4-D	94-75-7	SO	EX SITU	Y	690	0	0	0	0	0	0	8	0	0	0	0	0	0
2,4-D	94-75-7	SO	EX SITU	N	690	8	0	0	0	0	8	8	100	100	0	0	0	0
2,4-D	94-75-7	GW	IN SITU	Y		0	0	0	0	0	0	0	0	0	0	0	0	0
2,4-D	94-75-7	GW	IN SITU	N		0	0	0	0	0	0	0	0	0	0	0	0	0

TABLE 2-11
Summary of Chemical Data Relative To Screening Levels

1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19
Analyte Name	**CAS Number**	**Matrix**	**In Situ or Ex Situ?**	**Was Analyte Detected?**	**Screening Level (mg/kg or µg/L)**	**Blue Count (<=1*SL)**	**Green Count (>1*SL & <=10*SL)**	**Yellow Count (>10*SL & <=100*SL)**	**Orange Count (>100*SL & <=1000*SL)**	**Red Count (>1000*SL)**	**Total Count: Detect+ Non-detect**	**Total Count: In Situ Soil; Ex Situ Soil; Groundwater**	**Percent Detect or Non-detect in: In Situ; Ex Situ; Groundwater Groups**	**Percent Blue**	**Percent Green**	**Percent Yellow**	**Percent Orange**	**Percent Red**
2,4-DB	94-82-6	SO	IN SITU	Y	490	0	0	0	0	0	0	68	0	0	0	0	0	0
2,4-DB	94-82-6	SO	IN SITU	N	490	68	0	0	0	0	68	68	100	100	0	0	0	0
2,4-DB	94-82-6	SO	EX SITU	Y	490	0	0	0	0	0	0	8	0	0	0	0	0	0
2,4-DB	94-82-6	SO	EX SITU	N	490	8	0	0	0	0	8	8	100	100	0	0	0	0
2,4-DB	94-82-6	GW	IN SITU	Y		0	0	0	0	0	0	0	0	0	0	0	0	0
2,4-DB	94-82-6	GW	IN SITU	N		0	0	0	0	0	0	0	0	0	0	0	0	0
2,4-Dichlorophenol	120-83-2	SO	IN SITU	Y	0.045	0	0	0	0	0	0	174	0	0	0	0	0	0
2,4-Dichlorophenol	120-83-2	SO	IN SITU	N	0.045	145	21	5	1	2	174	174	100	83.33	12.07	2.87	0.57	1.15
2,4-Dichlorophenol	120-83-2	SO	EX SITU	Y	0.045	0	0	0	0	0	0	67	0	0	0	0	0	0
2,4-Dichlorophenol	120-83-2	SO	EX SITU	N	0.045	57	2	7	0	1	67	67	100	85.07	2.99	10.45	0	1.49
2,4-Dichlorophenol	120-83-2	GW	IN SITU	Y	10	0	0	0	0	0	0	20	0	0	0	0	0	0
2,4-Dichlorophenol	120-83-2	GW	IN SITU	N	10	20	0	0	0	0	20	20	100	100	0	0	0	0
2,4-Dimethylphenol	105-67-9	SO	IN SITU	Y	0.4	0	0	0	0	0	0	174	0	0	0	0	0	0
2,4-Dimethylphenol	105-67-9	SO	IN SITU	N	0.4	155	11	5	3	0	174	174	100	89.08	6.32	2.87	1.72	0
2,4-Dimethylphenol	105-67-9	SO	EX SITU	Y	0.4	0	0	0	0	0	0	67	0	0	0	0	0	0
2,4-Dimethylphenol	105-67-9	SO	EX SITU	N	0.4	58	2	6	1	0	67	67	100	86.57	2.99	8.96	1.49	0
2,4-Dimethylphenol	105-67-9	GW	IN SITU	Y	70	0	0	0	0	0	0	20	0	0	0	0	0	0
2,4-Dimethylphenol	105-67-9	GW	IN SITU	N	70	20	0	0	0	0	20	20	100	100	0	0	0	0
2,4-Dinitrophenol	51-28-5	SO	IN SITU	Y	0.02	0	0	0	0	0	0	173	0	0	0	0	0	0
2,4-Dinitrophenol	51-28-5	SO	IN SITU	N	0.02	0	3	148	18	4	173	173	100	0	1.73	85.55	10.4	2.31
2,4-Dinitrophenol	51-28-5	SO	EX SITU	Y	0.02	0	0	0	0	0	0	67	0	0	0	0	0	0
2,4-Dinitrophenol	51-28-5	SO	EX SITU	N	0.02	0	18	41	3	5	67	67	100	0	26.87	61.19	4.48	7.46
2,4-Dinitrophenol	51-28-5	GW	IN SITU	Y	7	0	0	0	0	0	0	20	0	0	0	0	0	0
2,4-Dinitrophenol	51-28-5	GW	IN SITU	N	7	0	20	0	0	0	20	20	100	0	100	0	0	0
2,4-Dinitrotoluene	121-14-2	SO	IN SITU	Y	0.0005	0	0	0	0	0	0	178	0	0	0	0	0	0
2,4-Dinitrotoluene	121-14-2	SO	IN SITU	N	0.0005	0	3	155	15	5	178	178	100	0	1.69	87.08	8.43	2.81
2,4-Dinitrotoluene	121-14-2	SO	EX SITU	Y	0.0005	0	0	0	0	0	0	76	0	0	0	0	0	0
2,4-Dinitrotoluene	121-14-2	SO	EX SITU	N	0.0005	0	18	49	2	7	76	76	100	0	23.68	64.47	2.63	9.21
2,4-Dinitrotoluene	121-14-2	GW	IN SITU	Y	0.125	0	1	0	0	0	1	20	5	0	5	0	0	0
2,4-Dinitrotoluene	121-14-2	GW	IN SITU	N	0.125	7	6	6	0	0	19	20	95	35	30	30	0	0
2,6-Dinitrotoluene	606-20-2	SO	IN SITU	Y	0.00044	0	0	0	0	0	0	178	0	0	0	0	0	0
2,6-Dinitrotoluene	606-20-2	SO	IN SITU	N	0.00044	0	3	150	19	6	178	178	100	0	1.69	84.27	10.67	3.37
2,6-Dinitrotoluene	606-20-2	SO	EX SITU	Y	0.00044	0	0	2	1	0	3	76	3.95	0	0	2.63	1.32	0
2,6-Dinitrotoluene	606-20-2	SO	EX SITU	N	0.00044	0	17	47	1	8	73	76	96.05	0	22.37	61.84	1.32	10.53
2,6-Dinitrotoluene	606-20-2	GW	IN SITU	Y	0.125	0	0	1	0	0	1	20	5	0	0	5	0	0
2,6-Dinitrotoluene	606-20-2	GW	IN SITU	N	0.125	7	6	6	0	0	19	20	95	35	30	30	0	0

TABLE 2-11
Summary of Chemical Data Relative To Screening Levels

1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19
Analyte Name	**CAS Number**	**Matrix**	**In Situ or Ex Situ?**	**Was Analyte Detected?**	**Screening Level (mg/kg or µg/L)**	**Blue Count (<=1*SL)**	**Green Count (>1*SL & <=10*SL)**	**Yellow Count (>10*SL & <=100*SL)**	**Orange Count (>100*SL & <=1000*SL)**	**Red Count (>1000*SL)**	**Total Count: Detect+ Non-detect**	**Total Count: In Situ Soil; Ex Situ Soil; Groundwater**	**Percent Detect or Non-detect in: In Situ; Ex Situ; Groundwater Groups**	**Percent Blue**	**Percent Green**	**Percent Yellow**	**Percent Orange**	**Percent Red**
2-Butanone	78-93-3	SO	IN SITU	Y	6	10	1	0	0	0	11	197	5.58	5.08	0.51	0	0	0
2-Butanone	78-93-3	SO	IN SITU	N	6	183	2	1	0	0	186	197	94.42	92.89	1.02	0.51	0	0
2-Butanone	78-93-3	SO	EX SITU	Y	6	5	0	1	0	0	6	76	7.89	6.58	0	1.32	0	0
2-Butanone	78-93-3	SO	EX SITU	N	6	68	2	0	0	0	70	76	92.11	89.47	2.63	0	0	0
2-Butanone	78-93-3	GW	IN SITU	Y	2200	1	0	0	0	0	1	20	5	5	0	0	0	0
2-Butanone	78-93-3	GW	IN SITU	N	2200	19	0	0	0	0	19	20	95	95	0	0	0	0
2-Chloronaphthalene	91-58-7	SO	IN SITU	Y	7	0	0	0	0	0	0	174	0	0	0	0	0	0
2-Chloronaphthalene	91-58-7	SO	IN SITU	N	7	171	2	1	0	0	174	174	100	98.28	1.15	0.57	0	0
2-Chloronaphthalene	91-58-7	SO	EX SITU	Y	7	0	0	0	0	0	0	67	0	0	0	0	0	0
2-Chloronaphthalene	91-58-7	SO	EX SITU	N	7	66	0	1	0	0	67	67	100	98.51	0	1.49	0	0
2-Chloronaphthalene	91-58-7	GW	IN SITU	Y	290	0	0	0	0	0	0	20	0	0	0	0	0	0
2-Chloronaphthalene	91-58-7	GW	IN SITU	N	290	20	0	0	0	0	20	20	100	100	0	0	0	0
2-Chlorophenol	95-57-8	SO	IN SITU	Y	0.14	0	0	0	0	0	0	174	0	0	0	0	0	0
2-Chlorophenol	95-57-8	SO	IN SITU	N	0.14	154	17	0	3	0	174	174	100	88.51	9.77	0	1.72	0
2-Chlorophenol	95-57-8	SO	EX SITU	Y	0.14	0	0	0	0	0	0	67	0	0	0	0	0	0
2-Chlorophenol	95-57-8	SO	EX SITU	N	0.14	59	5	2	0	1	67	67	100	88.06	7.46	2.99	0	1.49
2-Chlorophenol	95-57-8	GW	IN SITU	Y	20	0	0	0	0	0	0	20	0	0	0	0	0	0
2-Chlorophenol	95-57-8	GW	IN SITU	N	20	20	0	0	0	0	20	20	100	100	0	0	0	0
2-Chlorotoluene	95-49-8	SO	IN SITU	Y	160	0	0	0	0	0	0	197	0	0	0	0	0	0
2-Chlorotoluene	95-49-8	SO	IN SITU	N	160	197	0	0	0	0	197	197	100	100	0	0	0	0
2-Chlorotoluene	95-49-8	SO	EX SITU	Y	160	1	0	0	0	0	1	76	1.32	1.32	0	0	0	0
2-Chlorotoluene	95-49-8	SO	EX SITU	N	160	75	0	0	0	0	75	76	98.68	98.68	0	0	0	0
2-Chlorotoluene	95-49-8	GW	IN SITU	Y	120	0	0	0	0	0	0	20	0	0	0	0	0	0
2-Chlorotoluene	95-49-8	GW	IN SITU	N	120	20	0	0	0	0	20	20	100	100	0	0	0	0
2-Methylnaphthalene	91-57-6	SO	IN SITU	Y	6.09	2	0	0	0	0	2	174	1.15	1.15	0	0	0	0
2-Methylnaphthalene	91-57-6	SO	IN SITU	N	6.09	169	2	1	0	0	172	174	98.85	97.13	1.15	0.57	0	0
2-Methylnaphthalene	91-57-6	SO	EX SITU	Y	6.09	0	0	2	0	0	2	67	2.99	0	0	2.99	0	0
2-Methylnaphthalene	91-57-6	SO	EX SITU	N	6.09	64	0	1	0	0	65	67	97.01	95.52	0	1.49	0	0
2-Methylnaphthalene	91-57-6	GW	IN SITU	Y	78	0	0	0	0	0	0	20	0	0	0	0	0	0
2-Methylnaphthalene	91-57-6	GW	IN SITU	N	78	20	0	0	0	0	20	20	100	100	0	0	0	0
2-Methylphenol (o-Cresol)	95-48-7	SO	IN SITU	Y	0.7	0	0	0	0	0	0	174	0	0	0	0	0	0
2-Methylphenol (o-Cresol)	95-48-7	SO	IN SITU	N	0.7	166	5	2	1	0	174	174	100	95.4	2.87	1.15	0.57	0
2-Methylphenol (o-Cresol)	95-48-7	SO	EX SITU	Y	0.7	0	0	0	0	0	0	67	0	0	0	0	0	0
2-Methylphenol (o-Cresol)	95-48-7	SO	EX SITU	N	0.7	60	6	0	1	0	67	67	100	89.55	8.96	0	1.49	0
2-Methylphenol (o-Cresol)	95-48-7	GW	IN SITU	Y	180	0	0	0	0	0	0	20	0	0	0	0	0	0
2-Methylphenol (o-Cresol)	95-48-7	GW	IN SITU	N	180	20	0	0	0	0	20	20	100	100	0	0	0	0

TABLE 2-11
Summary of Chemical Data Relative To Screening Levels

1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19
Analyte Name	**CAS Number**	**Matrix**	**In Situ or Ex Situ?**	**Was Analyte Detected?**	**Screening Level (mg/kg or µg/L)**	**Blue Count (<=1*SL)**	**Green Count (>1*SL & <=10*SL)**	**Yellow Count (>10*SL & <=100*SL)**	**Orange Count (>100*SL & <=1000*SL)**	**Red Count (>1000*SL)**	**Total Count: Detect+ Non-detect**	**Total Count: In Situ Soil; Ex Situ Soil; Groundwater**	**Percent Detect or Non-detect in: In Situ; Ex Situ; Groundwater Groups**	**Percent Blue**	**Percent Green**	**Percent Yellow**	**Percent Orange**	**Percent Red**
2-Nitroaniline	88-74-4	SO	IN SITU	Y	180	0	0	0	0	0	0	174	0	0	0	0	0	0
2-Nitroaniline	88-74-4	SO	IN SITU	N	180	174	0	0	0	0	174	174	100	100	0	0	0	0
2-Nitroaniline	88-74-4	SO	EX SITU	Y	180	0	0	0	0	0	0	67	0	0	0	0	0	0
2-Nitroaniline	88-74-4	SO	EX SITU	N	180	66	1	0	0	0	67	67	100	98.51	1.49	0	0	0
2-Nitroaniline	88-74-4	GW	IN SITU	Y	110	0	0	0	0	0	0	20	0	0	0	0	0	0
2-Nitroaniline	88-74-4	GW	IN SITU	N	110	20	0	0	0	0	20	20	100	100	0	0	0	0
2-Nitrotoluene	88-72-2	SO	IN SITU	Y	2.8	0	0	0	0	0	0	91	0	0	0	0	0	0
2-Nitrotoluene	88-72-2	SO	IN SITU	N	2.8	91	0	0	0	0	91	91	100	100	0	0	0	0
2-Nitrotoluene	88-72-2	SO	EX SITU	Y	2.8	0	0	0	0	0	0	64	0	0	0	0	0	0
2-Nitrotoluene	88-72-2	SO	EX SITU	N	2.8	64	0	0	0	0	64	64	100	100	0	0	0	0
2-Nitrotoluene	88-72-2	GW	IN SITU	Y	0.29	0	0	0	0	0	0	10	0	0	0	0	0	0
2-Nitrotoluene	88-72-2	GW	IN SITU	N	0.29	7	3	0	0	0	10	10	100	70	30	0	0	0
3,3'-Dichlorobenzidine	91-94-1	SO	IN SITU	Y	0.002	0	0	0	0	0	0	174	0	0	0	0	0	0
3,3'-Dichlorobenzidine	91-94-1	SO	IN SITU	N	0.002	0	3	135	26	10	174	174	100	0	1.72	77.59	14.94	5.75
3,3'-Dichlorobenzidine	91-94-1	SO	EX SITU	Y	0.002	0	0	1	0	0	1	67	1.49	0	0	1.49	0	0
3,3'-Dichlorobenzidine	91-94-1	SO	EX SITU	N	0.002	0	17	39	2	8	66	67	98.51	0	25.37	58.21	2.99	11.94
3,3'-Dichlorobenzidine	91-94-1	GW	IN SITU	Y	0.15	0	0	0	0	0	0	20	0	0	0	0	0	0
3,3'-Dichlorobenzidine	91-94-1	GW	IN SITU	N	0.15	0	0	20	0	0	20	20	100	0	0	100	0	0
3-Nitrotoluene	99-08-1	SO	IN SITU	Y	1600	1	0	0	0	0	1	91	1.1	1.1	0	0	0	0
3-Nitrotoluene	99-08-1	SO	IN SITU	N	1600	90	0	0	0	0	90	91	98.9	98.9	0	0	0	0
3-Nitrotoluene	99-08-1	SO	EX SITU	Y	1600	2	0	0	0	0	2	64	3.13	3.13	0	0	0	0
3-Nitrotoluene	99-08-1	SO	EX SITU	N	1600	62	0	0	0	0	62	64	96.88	96.88	0	0	0	0
3-Nitrotoluene	99-08-1	GW	IN SITU	Y	120	1	0	0	0	0	1	10	10	10	0	0	0	0
3-Nitrotoluene	99-08-1	GW	IN SITU	N	120	9	0	0	0	0	9	10	90	90	0	0	0	0
4,4'-DDD	72-54-8	SO	IN SITU	Y	2.4	61	1	0	0	0	62	158	39.24	38.61	0.63	0	0	0
4,4'-DDD	72-54-8	SO	IN SITU	N	2.4	96	0	0	0	0	96	158	60.76	60.76	0	0	0	0
4,4'-DDD	72-54-8	SO	EX SITU	Y	2.4	51	1	0	0	0	52	57	91.23	89.47	1.75	0	0	0
4,4'-DDD	72-54-8	SO	EX SITU	N	2.4	5	0	0	0	0	5	57	8.77	8.77	0	0	0	0
4,4'-DDD	72-54-8	GW	IN SITU	Y	0.28	0	0	0	0	0	0	20	0	0	0	0	0	0
4,4'-DDD	72-54-8	GW	IN SITU	N	0.28	20	0	0	0	0	20	20	100	100	0	0	0	0
4,4'-DDE	72-55-9	SO	IN SITU	Y	1.7	63	1	0	0	0	64	151	42.38	41.72	0.66	0	0	0
4,4'-DDE	72-55-9	SO	IN SITU	N	1.7	87	0	0	0	0	87	151	57.62	57.62	0	0	0	0
4,4'-DDE	72-55-9	SO	EX SITU	Y	1.7	51	0	0	0	0	51	57	89.47	89.47	0	0	0	0
4,4'-DDE	72-55-9	SO	EX SITU	N	1.7	6	0	0	0	0	6	57	10.53	10.53	0	0	0	0
4,4'-DDE	72-55-9	GW	IN SITU	Y	0.2	1	0	0	0	0	1	20	5	5	0	0	0	0
4,4'-DDE	72-55-9	GW	IN SITU	N	0.2	19	0	0	0	0	19	20	95	95	0	0	0	0

TABLE 2-11
Summary of Chemical Data Relative To Screening Levels

1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19
Analyte Name	**CAS Number**	**Matrix**	**In Situ or Ex Situ?**	**Was Analyte Detected?**	**Screening Level (mg/kg or µg/L)**	**Blue Count (<=1*SL)**	**Green Count (>1*SL & <=10*SL)**	**Yellow Count (>10*SL & <=100*SL)**	**Orange Count (>100*SL & <=1000*SL)**	**Red Count (>1000*SL)**	**Total Count: Detect+ Non-detect**	**Total Count: In Situ Soil; Ex Situ Soil; Groundwater**	**Percent Detect or Non-detect in: In Situ; Ex Situ; Groundwater Groups**	**Percent Blue**	**Percent Green**	**Percent Yellow**	**Percent Orange**	**Percent Red**
4,4'-DDT	50-29-3	SO	IN SITU	Y	1.7	89	1	1	0	0	91	157	57.96	56.69	0.64	0.64	0	0
4,4'-DDT	50-29-3	SO	IN SITU	N	1.7	66	0	0	0	0	66	157	42.04	42.04	0	0	0	0
4,4'-DDT	50-29-3	SO	EX SITU	Y	1.7	52	0	1	0	0	53	57	92.98	91.23	0	1.75	0	0
4,4'-DDT	50-29-3	SO	EX SITU	N	1.7	4	0	0	0	0	4	57	7.02	7.02	0	0	0	0
4,4'-DDT	50-29-3	GW	IN SITU	Y	0.2	1	0	0	0	0	1	20	5	5	0	0	0	0
4,4'-DDT	50-29-3	GW	IN SITU	N	0.2	19	0	0	0	0	19	20	95	95	0	0	0	0
4-Chloro-3-methylphenol	59-50-7	SO	IN SITU	Y	310	0	0	0	0	0	0	148	0	0	0	0	0	0
4-Chloro-3-methylphenol	59-50-7	SO	IN SITU	N	310	148	0	0	0	0	148	148	100	100	0	0	0	0
4-Chloro-3-methylphenol	59-50-7	SO	EX SITU	Y	310	1	0	0	0	0	1	62	1.61	1.61	0	0	0	0
4-Chloro-3-methylphenol	59-50-7	SO	EX SITU	N	310	60	1	0	0	0	61	62	98.39	96.77	1.61	0	0	0
4-Chloro-3-methylphenol	59-50-7	GW	IN SITU	Y	180	0	0	0	0	0	0	20	0	0	0	0	0	0
4-Chloro-3-methylphenol	59-50-7	GW	IN SITU	N	180	20	0	0	0	0	20	20	100	100	0	0	0	0
4-Chloroaniline	106-47-8	SO	IN SITU	Y	0.05	0	0	0	0	0	0	174	0	0	0	0	0	0
4-Chloroaniline	106-47-8	SO	IN SITU	N	0.05	151	13	7	1	2	174	174	100	86.78	7.47	4.02	0.57	1.15
4-Chloroaniline	106-47-8	SO	EX SITU	Y	0.05	0	0	0	0	0	0	67	0	0	0	0	0	0
4-Chloroaniline	106-47-8	SO	EX SITU	N	0.05	57	2	5	2	1	67	67	100	85.07	2.99	7.46	2.99	1.49
4-Chloroaniline	106-47-8	GW	IN SITU	Y	15	0	0	0	0	0	0	20	0	0	0	0	0	0
4-Chloroaniline	106-47-8	GW	IN SITU	N	15	20	0	0	0	0	20	20	100	100	0	0	0	0
4-Nitrophenol	100-02-7	SO	IN SITU	Y	490	0	0	0	0	0	0	176	0	0	0	0	0	0
4-Nitrophenol	100-02-7	SO	IN SITU	N	490	176	0	0	0	0	176	176	100	100	0	0	0	0
4-Nitrophenol	100-02-7	SO	EX SITU	Y	490	1	0	0	0	0	1	67	1.49	1.49	0	0	0	0
4-Nitrophenol	100-02-7	SO	EX SITU	N	490	65	1	0	0	0	66	67	98.51	97.01	1.49	0	0	0
4-Nitrophenol	100-02-7	GW	IN SITU	Y	290	0	0	0	0	0	0	20	0	0	0	0	0	0
4-Nitrophenol	100-02-7	GW	IN SITU	N	290	20	0	0	0	0	20	20	100	100	0	0	0	0
4-Nitrotoluene	99-99-0	SO	IN SITU	Y	38	1	0	0	0	0	1	91	1.1	1.1	0	0	0	0
4-Nitrotoluene	99-99-0	SO	IN SITU	N	38	90	0	0	0	0	90	91	98.9	98.9	0	0	0	0
4-Nitrotoluene	99-99-0	SO	EX SITU	Y	38	0	0	0	0	0	0	64	0	0	0	0	0	0
4-Nitrotoluene	99-99-0	SO	EX SITU	N	38	64	0	0	0	0	64	64	100	100	0	0	0	0
4-Nitrotoluene	99-99-0	GW	IN SITU	Y	4	2	0	0	0	0	2	10	20	20	0	0	0	0
4-Nitrotoluene	99-99-0	GW	IN SITU	N	4	8	0	0	0	0	8	10	80	80	0	0	0	0
Acenaphthene	83-32-9	SO	IN SITU	Y	21	2	0	0	0	0	2	174	1.15	1.15	0	0	0	0
Acenaphthene	83-32-9	SO	IN SITU	N	21	169	3	0	0	0	172	174	98.85	97.13	1.72	0	0	0
Acenaphthene	83-32-9	SO	EX SITU	Y	21	1	0	0	0	0	1	67	1.49	1.49	0	0	0	0
Acenaphthene	83-32-9	SO	EX SITU	N	21	65	0	1	0	0	66	67	98.51	97.01	0	1.49	0	0
Acenaphthene	83-32-9	GW	IN SITU	Y	220	1	0	0	0	0	1	20	5	5	0	0	0	0
Acenaphthene	83-32-9	GW	IN SITU	N	220	19	0	0	0	0	19	20	95	95	0	0	0	0

TABLE 2-11
Summary of Chemical Data Relative To Screening Levels

1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19
Analyte Name	**CAS Number**	**Matrix**	**In Situ or Ex Situ?**	**Was Analyte Detected?**	**Screening Level (mg/kg or µg/L)**	**Blue Count (<=1*SL)**	**Green Count (>1*SL & <=10*SL)**	**Yellow Count (>10*SL & <=100*SL)**	**Orange Count (>100*SL & <=1000*SL)**	**Red Count (>1000*SL)**	**Total Count: Detect+ Non-detect**	**Total Count: In Situ Soil; Ex Situ Soil; Groundwater**	**Percent Detect or Non-detect in: In Situ; Ex Situ; Groundwater Groups**	**Percent Blue**	**Percent Green**	**Percent Yellow**	**Percent Orange**	**Percent Red**
Acenaphthylene	208-96-8	SO	IN SITU	Y	21	0	0	0	0	0	0	174	0	0	0	0	0	0
Acenaphthylene	208-96-8	SO	IN SITU	N	21	171	3	0	0	0	174	174	100	98.28	1.72	0	0	0
Acenaphthylene	208-96-8	SO	EX SITU	Y	21	0	0	0	0	0	0	67	0	0	0	0	0	0
Acenaphthylene	208-96-8	SO	EX SITU	N	21	66	0	1	0	0	67	67	100	98.51	0	1.49	0	0
Acenaphthylene	208-96-8	GW	IN SITU	Y	220	0	0	0	0	0	0	20	0	0	0	0	0	0
Acenaphthylene	208-96-8	GW	IN SITU	N	220	20	0	0	0	0	20	20	100	100	0	0	0	0
Acetone	67-64-1	SO	IN SITU	Y	1	26	7	0	0	0	33	197	16.75	13.2	3.55	0	0	0
Acetone	67-64-1	SO	IN SITU	N	1	159	4	1	0	0	164	197	83.25	80.71	2.03	0.51	0	0
Acetone	67-64-1	SO	EX SITU	Y	1	22	0	0	0	0	22	76	28.95	28.95	0	0	0	0
Acetone	67-64-1	SO	EX SITU	N	1	50	1	3	0	0	54	76	71.05	65.79	1.32	3.95	0	0
Acetone	67-64-1	GW	IN SITU	Y	365	2	0	0	0	0	2	20	10	10	0	0	0	0
Acetone	67-64-1	GW	IN SITU	N	365	18	0	0	0	0	18	20	90	90	0	0	0	0
Aldrin	309-00-2	SO	IN SITU	Y	0.029	1	0	0	0	0	1	135	0.74	0.74	0	0	0	0
Aldrin	309-00-2	SO	IN SITU	N	0.029	134	0	0	0	0	134	135	99.26	99.26	0	0	0	0
Aldrin	309-00-2	SO	EX SITU	Y	0.029	7	0	0	0	0	7	57	12.28	12.28	0	0	0	0
Aldrin	309-00-2	SO	EX SITU	N	0.029	50	0	0	0	0	50	57	87.72	87.72	0	0	0	0
Aldrin	309-00-2	GW	IN SITU	Y	0.0043	0	0	0	0	0	0	20	0	0	0	0	0	0
Aldrin	309-00-2	GW	IN SITU	N	0.0043	12	8	0	0	0	20	20	100	60	40	0	0	0
alpha-BHC	319-84-6	SO	IN SITU	Y	0.00026	0	1	0	0	0	1	142	0.7	0	0.7	0	0	0
alpha-BHC	319-84-6	SO	IN SITU	N	0.00026	97	41	3	0	0	141	142	99.3	68.31	28.87	2.11	0	0
alpha-BHC	319-84-6	SO	EX SITU	Y	0.00026	0	5	1	0	0	6	57	10.53	0	8.77	1.75	0	0
alpha-BHC	319-84-6	SO	EX SITU	N	0.00026	20	26	5	0	0	51	57	89.47	35.09	45.61	8.77	0	0
alpha-BHC	319-84-6	GW	IN SITU	Y	0.01	0	0	0	0	0	0	20	0	0	0	0	0	0
alpha-BHC	319-84-6	GW	IN SITU	N	0.01	18	2	0	0	0	20	20	100	90	10	0	0	0
Aluminum	7429-90-5	SO	IN SITU	Y		0	0	0	0	0	0	0	0	0	0	0	0	0
Aluminum	7429-90-5	SO	IN SITU	N		0	0	0	0	0	0	0	0	0	0	0	0	0
Aluminum	7429-90-5	SO	EX SITU	Y		0	0	0	0	0	0	0	0	0	0	0	0	0
Aluminum	7429-90-5	SO	EX SITU	N		0	0	0	0	0	0	0	0	0	0	0	0	0
Aluminum	7429-90-5	GW	IN SITU	Y	37000	4	0	0	0	0	4	20	20	20	0	0	0	0
Aluminum	7429-90-5	GW	IN SITU	N	37000	16	0	0	0	0	16	20	80	80	0	0	0	0
Anthracene	120-12-7	SO	IN SITU	Y	430	1	0	0	0	0	1	174	0.57	0.57	0	0	0	0
Anthracene	120-12-7	SO	IN SITU	N	430	173	0	0	0	0	173	174	99.43	99.43	0	0	0	0
Anthracene	120-12-7	SO	EX SITU	Y	430	2	0	0	0	0	2	67	2.99	2.99	0	0	0	0
Anthracene	120-12-7	SO	EX SITU	N	430	65	0	0	0	0	65	67	97.01	97.01	0	0	0	0
Anthracene	120-12-7	GW	IN SITU	Y	1100	0	0	0	0	0	0	20	0	0	0	0	0	0
Anthracene	120-12-7	GW	IN SITU	N	1100	20	0	0	0	0	20	20	100	100	0	0	0	0

TABLE 2-11
Summary of Chemical Data Relative To Screening Levels

1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19
Analyte Name	**CAS Number**	**Matrix**	**In Situ or Ex Situ?**	**Was Analyte Detected?**	**Screening Level (mg/kg or µg/L)**	**Blue Count (<=1*SL)**	**Green Count (>1*SL & <=10*SL)**	**Yellow Count (>10*SL & <=100*SL)**	**Orange Count (>100*SL & <=1000*SL)**	**Red Count (>1000*SL)**	**Total Count: Detect+ Non-detect**	**Total Count: In Situ Soil; Ex Situ Soil; Groundwater**	**Percent Detect or Non-detect in: In Situ; Ex Situ; Groundwater Groups**	**Percent Blue**	**Percent Green**	**Percent Yellow**	**Percent Orange**	**Percent Red**
Antimony	7440-36-0	SO	IN SITU	Y	0.36	55	23	1	0	0	79	129	61.24	42.64	17.83	0.78	0	0
Antimony	7440-36-0	SO	IN SITU	N	0.36	50	0	0	0	0	50	129	38.76	38.76	0	0	0	0
Antimony	7440-36-0	SO	EX SITU	Y	0.36	29	19	1	1	0	50	71	70.42	40.85	26.76	1.41	1.41	0
Antimony	7440-36-0	SO	EX SITU	N	0.36	19	2	0	0	0	21	71	29.58	26.76	2.82	0	0	0
Antimony	7440-36-0	GW	IN SITU	Y	0.6	0	0	0	0	0	0	20	0	0	0	0	0	0
Antimony	7440-36-0	GW	IN SITU	N	0.6	6	14	0	0	0	20	20	100	30	70	0	0	0
Arsenic	7440-38-2	SO	IN SITU	Y	16.63	177	4	0	0	0	181	181	100	97.79	2.21	0	0	0
Arsenic	7440-38-2	SO	IN SITU	N	16.63	0	0	0	0	0	0	181	0	0	0	0	0	0
Arsenic	7440-38-2	SO	EX SITU	Y	16.63	78	1	0	0	0	79	81	97.53	97.53	1.23	0	0	0
Arsenic	7440-38-2	SO	EX SITU	N	16.63	2	0	0	0	0	2	81	2.47	2.47	0	0	0	0
Arsenic	7440-38-2	GW	IN SITU	Y	77.3	20	0	0	0	0	20	20	100	100	0	0	0	0
Arsenic	7440-38-2	GW	IN SITU	N	77.3	0	0	0	0	0	0	20	0	0	0	0	0	0
Barium	7440-39-3	SO	IN SITU	Y	110	137	44	0	0	0	181	181	100	75.69	24.31	0	0	0
Barium	7440-39-3	SO	IN SITU	N	110	0	0	0	0	0	0	181	0	0	0	0	0	0
Barium	7440-39-3	SO	EX SITU	Y	110	62	16	1	0	0	79	81	97.53	76.54	19.75	1.23	0	0
Barium	7440-39-3	SO	EX SITU	N	110	2	0	0	0	0	2	81	2.47	2.47	0	0	0	0
Barium	7440-39-3	GW	IN SITU	Y	200	18	2	0	0	0	20	20	100	90	10	0	0	0
Barium	7440-39-3	GW	IN SITU	N	200	0	0	0	0	0	0	20	0	0	0	0	0	0
Benzene	71-43-2	SO	IN SITU	Y	0.002	2	27	0	1	0	30	241	12.45	0.83	11.2	0	0.41	0
Benzene	71-43-2	SO	IN SITU	N	0.002	162	43	2	3	1	211	241	87.55	67.22	17.84	0.83	1.24	0.41
Benzene	71-43-2	SO	EX SITU	Y	0.002	3	3	0	0	0	6	85	7.06	3.53	3.53	0	0	0
Benzene	71-43-2	SO	EX SITU	N	0.002	35	40	1	2	1	79	85	92.94	41.18	47.06	1.18	2.35	1.18
Benzene	71-43-2	GW	IN SITU	Y	0.35	0	0	0	0	0	0	20	0	0	0	0	0	0
Benzene	71-43-2	GW	IN SITU	N	0.35	20	0	0	0	0	20	20	100	100	0	0	0	0
Benzo(a)anthracene	56-55-3	SO	IN SITU	Y	0.15	4	1	0	0	0	5	174	2.87	2.3	0.57	0	0	0
Benzo(a)anthracene	56-55-3	SO	IN SITU	N	0.15	148	18	0	3	0	169	174	97.13	85.06	10.34	0	1.72	0
Benzo(a)anthracene	56-55-3	SO	EX SITU	Y	0.15	7	0	0	0	0	7	67	10.45	10.45	0	0	0	0
Benzo(a)anthracene	56-55-3	SO	EX SITU	N	0.15	52	5	2	0	1	60	67	89.55	77.61	7.46	2.99	0	1.49
Benzo(a)anthracene	56-55-3	GW	IN SITU	Y	0.03	0	0	0	0	0	0	20	0	0	0	0	0	0
Benzo(a)anthracene	56-55-3	GW	IN SITU	N	0.03	0	0	20	0	0	20	20	100	0	0	100	0	0
Benzo(a)pyrene	50-32-8	SO	IN SITU	Y	0.015	0	2	1	0	0	3	174	1.72	0	1.15	0.57	0	0
Benzo(a)pyrene	50-32-8	SO	IN SITU	N	0.015	111	38	19	0	3	171	174	98.28	63.79	21.84	10.92	0	1.72
Benzo(a)pyrene	50-32-8	SO	EX SITU	Y	0.015	3	1	0	1	0	5	67	7.46	4.48	1.49	0	1.49	0
Benzo(a)pyrene	50-32-8	SO	EX SITU	N	0.015	53	2	4	2	1	62	67	92.54	79.1	2.99	5.97	2.99	1.49
Benzo(a)pyrene	50-32-8	GW	IN SITU	Y	0.003	0	0	0	0	0	0	20	0	0	0	0	0	0
Benzo(a)pyrene	50-32-8	GW	IN SITU	N	0.003	0	0	0	20	0	20	20	100	0	0	0	100	0

TABLE 2-11
Summary of Chemical Data Relative To Screening Levels

1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19
Analyte Name	**CAS Number**	**Matrix**	**In Situ or Ex Situ?**	**Was Analyte Detected?**	**Screening Level (mg/kg or µg/L)**	**Blue Count (<=1*SL)**	**Green Count (>1*SL & <=10*SL)**	**Yellow Count (>10*SL & <=100*SL)**	**Orange Count (>100*SL & <=1000*SL)**	**Red Count (>1000*SL)**	**Total Count: Detect+ Non-detect**	**Total Count: In Situ Soil; Ex Situ Soil; Groundwater**	**Percent Detect or Non-detect in: In Situ; Ex Situ; Groundwater Groups**	**Percent Blue**	**Percent Green**	**Percent Yellow**	**Percent Orange**	**Percent Red**
Benzo(b)fluoranthene	205-99-2	SO	IN SITU	Y	0.15	0	1	0	0	0	1	174	0.57	0	0.57	0	0	0
Benzo(b)fluoranthene	205-99-2	SO	IN SITU	N	0.15	151	19	0	3	0	173	174	99.43	86.78	10.92	0	1.72	0
Benzo(b)fluoranthene	205-99-2	SO	EX SITU	Y	0.15	4	0	0	0	0	4	66	6.06	6.06	0	0	0	0
Benzo(b)fluoranthene	205-99-2	SO	EX SITU	N	0.15	55	4	2	0	1	62	66	93.94	83.33	6.06	3.03	0	1.52
Benzo(b)fluoranthene	205-99-2	GW	IN SITU	Y	0.03	0	0	0	0	0	0	20	0	0	0	0	0	0
Benzo(b)fluoranthene	205-99-2	GW	IN SITU	N	0.03	0	0	20	0	0	20	20	100	0	0	100	0	0
Benzo(g,h,i)perylene	191-24-2	SO	IN SITU	Y	1.5	1	0	0	0	0	1	174	0.57	0.57	0	0	0	0
Benzo(g,h,i)perylene	191-24-2	SO	IN SITU	N	1.5	170	0	3	0	0	173	174	99.43	97.7	0	1.72	0	0
Benzo(g,h,i)perylene	191-24-2	SO	EX SITU	Y	1.5	2	1	0	0	0	3	67	4.48	2.99	1.49	0	0	0
Benzo(g,h,i)perylene	191-24-2	SO	EX SITU	N	1.5	61	2	0	1	0	64	67	95.52	91.04	2.99	0	1.49	0
Benzo(g,h,i)perylene	191-24-2	GW	IN SITU	Y	0.3	0	2	0	0	0	2	20	10	0	10	0	0	0
Benzo(g,h,i)perylene	191-24-2	GW	IN SITU	N	0.3	12	6	0	0	0	18	20	90	60	30	0	0	0
Benzo(k)fluoranthene	207-08-9	SO	IN SITU	Y	11	3	0	0	0	0	3	174	1.72	1.72	0	0	0	0
Benzo(k)fluoranthene	207-08-9	SO	IN SITU	N	11	168	3	0	0	0	171	174	98.28	96.55	1.72	0	0	0
Benzo(k)fluoranthene	207-08-9	SO	EX SITU	Y	11	4	0	0	0	0	4	66	6.06	6.06	0	0	0	0
Benzo(k)fluoranthene	207-08-9	SO	EX SITU	N	11	61	0	1	0	0	62	66	93.94	92.42	0	1.52	0	0
Benzo(k)fluoranthene	207-08-9	GW	IN SITU	Y	1	0	0	0	0	0	0	20	0	0	0	0	0	0
Benzo(k)fluoranthene	207-08-9	GW	IN SITU	N	1	14	6	0	0	0	20	20	100	70	30	0	0	0
Benzoic acid	65-85-0	SO	IN SITU	Y	39	1	0	0	0	0	1	148	0.68	0.68	0	0	0	0
Benzoic acid	65-85-0	SO	IN SITU	N	39	144	3	0	0	0	147	148	99.32	97.3	2.03	0	0	0
Benzoic acid	65-85-0	SO	EX SITU	Y	39	4	0	0	0	0	4	62	6.45	6.45	0	0	0	0
Benzoic acid	65-85-0	SO	EX SITU	N	39	57	0	1	0	0	58	62	93.55	91.94	0	1.61	0	0
Benzoic acid	65-85-0	GW	IN SITU	Y	14600	0	0	0	0	0	0	15	0	0	0	0	0	0
Benzoic acid	65-85-0	GW	IN SITU	N	14600	15	0	0	0	0	15	15	100	100	0	0	0	0
Benzyl alcohol	100-51-6	SO	IN SITU	Y	18000	0	0	0	0	0	0	148	0	0	0	0	0	0
Benzyl alcohol	100-51-6	SO	IN SITU	N	18000	148	0	0	0	0	148	148	100	100	0	0	0	0
Benzyl alcohol	100-51-6	SO	EX SITU	Y	18000	1	0	0	0	0	1	61	1.64	1.64	0	0	0	0
Benzyl alcohol	100-51-6	SO	EX SITU	N	18000	60	0	0	0	0	60	61	98.36	98.36	0	0	0	0
Benzyl alcohol	100-51-6	GW	IN SITU	Y	11000	0	0	0	0	0	0	20	0	0	0	0	0	0
Benzyl alcohol	100-51-6	GW	IN SITU	N	11000	20	0	0	0	0	20	20	100	100	0	0	0	0
Benzyl butyl phthalate	85-68-7	SO	IN SITU	Y	240	2	0	0	0	0	2	174	1.15	1.15	0	0	0	0
Benzyl butyl phthalate	85-68-7	SO	IN SITU	N	240	172	0	0	0	0	172	174	98.85	98.85	0	0	0	0
Benzyl butyl phthalate	85-68-7	SO	EX SITU	Y	240	4	0	0	0	0	4	67	5.97	5.97	0	0	0	0
Benzyl butyl phthalate	85-68-7	SO	EX SITU	N	240	62	1	0	0	0	63	67	94.03	92.54	1.49	0	0	0
Benzyl butyl phthalate	85-68-7	GW	IN SITU	Y	730	0	0	0	0	0	0	20	0	0	0	0	0	0
Benzyl butyl phthalate	85-68-7	GW	IN SITU	N	730	20	0	0	0	0	20	20	100	100	0	0	0	0

TABLE 2-11
Summary of Chemical Data Relative To Screening Levels

1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19
Analyte Name	**CAS Number**	**Matrix**	**In Situ or Ex Situ?**	**Was Analyte Detected?**	**Screening Level (mg/kg or µg/L)**	**Blue Count (<=1*SL)**	**Green Count (>1*SL & <=10*SL)**	**Yellow Count (>10*SL & <=100*SL)**	**Orange Count (>100*SL & <=1000*SL)**	**Red Count (>1000*SL)**	**Total Count: Detect+ Non-detect**	**Total Count: In Situ Soil; Ex Situ Soil; Groundwater**	**Percent Detect or Non-detect in: In Situ; Ex Situ; Groundwater Groups**	**Percent Blue**	**Percent Green**	**Percent Yellow**	**Percent Orange**	**Percent Red**
Beryllium	7440-41-7	SO	IN SITU	Y	4.2	129	0	0	0	0	129	129	100	100	0	0	0	0
Beryllium	7440-41-7	SO	IN SITU	N	4.2	0	0	0	0	0	0	129	0	0	0	0	0	0
Beryllium	7440-41-7	SO	EX SITU	Y	4.2	69	2	0	0	0	71	71	100	97.18	2.82	0	0	0
Beryllium	7440-41-7	SO	EX SITU	N	4.2	0	0	0	0	0	0	71	0	0	0	0	0	0
Beryllium	7440-41-7	GW	IN SITU	Y	0.4	0	0	0	0	0	0	20	0	0	0	0	0	0
Beryllium	7440-41-7	GW	IN SITU	N	0.4	20	0	0	0	0	20	20	100	100	0	0	0	0
beta-BHC	319-85-7	SO	IN SITU	Y	0.0009	1	0	1	0	0	2	156	1.28	0.64	0	0.64	0	0
beta-BHC	319-85-7	SO	IN SITU	N	0.0009	139	13	2	0	0	154	156	98.72	89.1	8.33	1.28	0	0
beta-BHC	319-85-7	SO	EX SITU	Y	0.0009	1	0	1	0	0	2	57	3.51	1.75	0	1.75	0	0
beta-BHC	319-85-7	SO	EX SITU	N	0.0009	44	11	0	0	0	55	57	96.49	77.19	19.3	0	0	0
beta-BHC	319-85-7	GW	IN SITU	Y	0.037	0	0	0	0	0	0	20	0	0	0	0	0	0
beta-BHC	319-85-7	GW	IN SITU	N	0.037	20	0	0	0	0	20	20	100	100	0	0	0	0
bis-(2-Chloroethyl)ether	111-44-4	SO	IN SITU	Y	0.0002	0	0	0	0	0	0	174	0	0	0	0	0	0
bis-(2-Chloroethyl)ether	111-44-4	SO	IN SITU	N	0.0002	0	0	105	49	20	174	174	100	0	0	60.34	28.16	11.49
bis-(2-Chloroethyl)ether	111-44-4	SO	EX SITU	Y	0.0002	0	0	0	0	0	0	67	0	0	0	0	0	0
bis-(2-Chloroethyl)ether	111-44-4	SO	EX SITU	N	0.0002	0	0	57	2	8	67	67	100	0	0	85.07	2.99	11.94
bis-(2-Chloroethyl)ether	111-44-4	GW	IN SITU	Y	0.0098	0	0	0	0	0	0	20	0	0	0	0	0	0
bis-(2-Chloroethyl)ether	111-44-4	GW	IN SITU	N	0.0098	0	0	14	6	0	20	20	100	0	0	70	30	0
bis(2-Chloroisopropyl)ether	108-60-1	SO	IN SITU	Y	2.9	0	0	0	0	0	0	174	0	0	0	0	0	0
bis(2-Chloroisopropyl)ether	108-60-1	SO	IN SITU	N	2.9	171	0	3	0	0	174	174	100	98.28	0	1.72	0	0
bis(2-Chloroisopropyl)ether	108-60-1	SO	EX SITU	Y	2.9	0	0	0	0	0	0	67	0	0	0	0	0	0
bis(2-Chloroisopropyl)ether	108-60-1	SO	EX SITU	N	2.9	63	3	0	1	0	67	67	100	94.03	4.48	0	1.49	0
bis(2-Chloroisopropyl)ether	108-60-1	GW	IN SITU	Y	0.27	0	0	0	0	0	0	20	0	0	0	0	0	0
bis(2-Chloroisopropyl)ether	108-60-1	GW	IN SITU	N	0.27	0	20	0	0	0	20	20	100	0	100	0	0	0
bis-(2-Ethylhexyl)phthalate	117-81-7	SO	IN SITU	Y	35	13	0	0	0	0	13	174	7.47	7.47	0	0	0	0
bis-(2-Ethylhexyl)phthalate	117-81-7	SO	IN SITU	N	35	158	3	0	0	0	161	174	92.53	90.8	1.72	0	0	0
bis-(2-Ethylhexyl)phthalate	117-81-7	SO	EX SITU	Y	35	7	0	0	0	0	7	67	10.45	10.45	0	0	0	0
bis-(2-Ethylhexyl)phthalate	117-81-7	SO	EX SITU	N	35	59	0	1	0	0	60	67	89.55	88.06	0	1.49	0	0
bis-(2-Ethylhexyl)phthalate	117-81-7	GW	IN SITU	Y	0.6	0	0	0	0	0	0	20	0	0	0	0	0	0
bis-(2-Ethylhexyl)phthalate	117-81-7	GW	IN SITU	N	0.6	14	6	0	0	0	20	20	100	70	30	0	0	0
Bromobenzene	108-86-1	SO	IN SITU	Y	73	0	0	0	0	0	0	197	0	0	0	0	0	0
Bromobenzene	108-86-1	SO	IN SITU	N	73	197	0	0	0	0	197	197	100	100	0	0	0	0
Bromobenzene	108-86-1	SO	EX SITU	Y	73	0	0	0	0	0	0	76	0	0	0	0	0	0
Bromobenzene	108-86-1	SO	EX SITU	N	73	76	0	0	0	0	76	76	100	100	0	0	0	0
Bromobenzene	108-86-1	GW	IN SITU	Y	23	0	0	0	0	0	0	20	0	0	0	0	0	0
Bromobenzene	108-86-1	GW	IN SITU	N	23	20	0	0	0	0	20	20	100	100	0	0	0	0

TABLE 2-11
Summary of Chemical Data Relative To Screening Levels

1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19
Analyte Name	**CAS Number**	**Matrix**	**In Situ or Ex Situ?**	**Was Analyte Detected?**	**Screening Level (mg/kg or µg/L)**	**Blue Count (<=1*SL)**	**Green Count (>1*SL & <=10*SL)**	**Yellow Count (>10*SL & <=100*SL)**	**Orange Count (>100*SL & <=1000*SL)**	**Red Count (>1000*SL)**	**Total Count: Detect+ Non-detect**	**Total Count: In Situ Soil; Ex Situ Soil; Groundwater**	**Percent Detect or Non-detect in: In Situ; Ex Situ; Groundwater Groups**	**Percent Blue**	**Percent Green**	**Percent Yellow**	**Percent Orange**	**Percent Red**
Bromodichloromethane	75-27-4	SO	IN SITU	Y	1	0	0	0	0	0	0	197	0	0	0	0	0	0
Bromodichloromethane	75-27-4	SO	IN SITU	N	1	196	1	0	0	0	197	197	100	99.49	0.51	0	0	0
Bromodichloromethane	75-27-4	SO	EX SITU	Y	1	0	0	0	0	0	0	76	0	0	0	0	0	0
Bromodichloromethane	75-27-4	SO	EX SITU	N	1	73	3	0	0	0	76	76	100	96.05	3.95	0	0	0
Bromodichloromethane	75-27-4	GW	IN SITU	Y	0.18	0	0	0	0	0	0	20	0	0	0	0	0	0
Bromodichloromethane	75-27-4	GW	IN SITU	N	0.18	20	0	0	0	0	20	20	100	100	0	0	0	0
Bromoform	75-25-2	SO	IN SITU	Y	0.038	0	0	0	0	0	0	197	0	0	0	0	0	0
Bromoform	75-25-2	SO	IN SITU	N	0.038	191	2	3	1	0	197	197	100	96.95	1.02	1.52	0.51	0
Bromoform	75-25-2	SO	EX SITU	Y	0.038	0	0	0	0	0	0	76	0	0	0	0	0	0
Bromoform	75-25-2	SO	EX SITU	N	0.038	72	0	1	3	0	76	76	100	94.74	0	1.32	3.95	0
Bromoform	75-25-2	GW	IN SITU	Y	8.5	0	0	0	0	0	0	20	0	0	0	0	0	0
Bromoform	75-25-2	GW	IN SITU	N	8.5	20	0	0	0	0	20	20	100	100	0	0	0	0
Bromomethane	74-83-9	SO	IN SITU	Y	3.9	0	0	0	0	0	0	197	0	0	0	0	0	0
Bromomethane	74-83-9	SO	IN SITU	N	3.9	196	1	0	0	0	197	197	100	99.49	0.51	0	0	0
Bromomethane	74-83-9	SO	EX SITU	Y	3.9	0	0	0	0	0	0	76	0	0	0	0	0	0
Bromomethane	74-83-9	SO	EX SITU	N	3.9	73	2	1	0	0	76	76	100	96.05	2.63	1.32	0	0
Bromomethane	74-83-9	GW	IN SITU	Y	8.7	0	0	0	0	0	0	20	0	0	0	0	0	0
Bromomethane	74-83-9	GW	IN SITU	N	8.7	20	0	0	0	0	20	20	100	100	0	0	0	0
Cadmium	7440-43-9	SO	IN SITU	Y	0.5	127	7	3	0	0	137	181	75.69	70.17	3.87	1.66	0	0
Cadmium	7440-43-9	SO	IN SITU	N	0.5	44	0	0	0	0	44	181	24.31	24.31	0	0	0	0
Cadmium	7440-43-9	SO	EX SITU	Y	0.5	53	17	1	0	0	71	81	87.65	65.43	20.99	1.23	0	0
Cadmium	7440-43-9	SO	EX SITU	N	0.5	10	0	0	0	0	10	81	12.35	12.35	0	0	0	0
Cadmium	7440-43-9	GW	IN SITU	Y	0.5	0	0	0	0	0	0	20	0	0	0	0	0	0
Cadmium	7440-43-9	GW	IN SITU	N	0.5	20	0	0	0	0	20	20	100	100	0	0	0	0
Carbazole	86-74-8	SO	IN SITU	Y	0.2	1	0	0	0	0	1	96	1.04	1.04	0	0	0	0
Carbazole	86-74-8	SO	IN SITU	N	0.2	87	7	1	0	0	95	96	98.96	90.63	7.29	1.04	0	0
Carbazole	86-74-8	SO	EX SITU	Y	0.2	0	0	0	0	0	0	60	0	0	0	0	0	0
Carbazole	86-74-8	SO	EX SITU	N	0.2	55	2	3	0	0	60	60	100	91.67	3.33	5	0	0
Carbazole	86-74-8	GW	IN SITU	Y	3.4	0	0	0	0	0	0	14	0	0	0	0	0	0
Carbazole	86-74-8	GW	IN SITU	N	3.4	14	0	0	0	0	14	14	100	100	0	0	0	0
Carbon disulfide	75-15-0	SO	IN SITU	Y	1.7	0	0	0	0	0	0	185	0	0	0	0	0	0
Carbon disulfide	75-15-0	SO	IN SITU	N	1.7	181	3	1	0	0	185	185	100	97.84	1.62	0.54	0	0
Carbon disulfide	75-15-0	SO	EX SITU	Y	1.7	0	0	0	0	0	0	76	0	0	0	0	0	0
Carbon disulfide	75-15-0	SO	EX SITU	N	1.7	73	3	0	0	0	76	76	100	96.05	3.95	0	0	0
Carbon disulfide	75-15-0	GW	IN SITU	Y	365	0	0	0	0	0	0	20	0	0	0	0	0	0
Carbon disulfide	75-15-0	GW	IN SITU	N	365	20	0	0	0	0	20	20	100	100	0	0	0	0

TABLE 2-11
Summary of Chemical Data Relative To Screening Levels

1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19
Analyte Name	**CAS Number**	**Matrix**	**In Situ or Ex Situ?**	**Was Analyte Detected?**	**Screening Level (mg/kg or µg/L)**	**Blue Count (<=1*SL)**	**Green Count (>1*SL & <=10*SL)**	**Yellow Count (>10*SL & <=100*SL)**	**Orange Count (>100*SL & <=1000*SL)**	**Red Count (>1000*SL)**	**Total Count: Detect+ Non-detect**	**Total Count: In Situ Soil; Ex Situ Soil; Groundwater**	**Percent Detect or Non-detect in: In Situ; Ex Situ; Groundwater Groups**	**Percent Blue**	**Percent Green**	**Percent Yellow**	**Percent Orange**	**Percent Red**
Carbon tetrachloride	56-23-5	SO	IN SITU	Y	0.003	0	0	0	0	0	0	197	0	0	0	0	0	0
Carbon tetrachloride	56-23-5	SO	IN SITU	N	0.003	117	73	3	3	1	197	197	100	59.39	37.06	1.52	1.52	0.51
Carbon tetrachloride	56-23-5	SO	EX SITU	Y	0.003	0	0	0	0	0	0	76	0	0	0	0	0	0
Carbon tetrachloride	56-23-5	SO	EX SITU	N	0.003	27	45	1	1	2	76	76	100	35.53	59.21	1.32	1.32	2.63
Carbon tetrachloride	56-23-5	GW	IN SITU	Y	0.17	0	0	0	0	0	0	20	0	0	0	0	0	0
Carbon tetrachloride	56-23-5	GW	IN SITU	N	0.17	20	0	0	0	0	20	20	100	100	0	0	0	0
Chlorobenzene	108-90-7	SO	IN SITU	Y	0.06	0	0	0	0	0	0	197	0	0	0	0	0	0
Chlorobenzene	108-90-7	SO	IN SITU	N	0.06	192	1	3	1	0	197	197	100	97.46	0.51	1.52	0.51	0
Chlorobenzene	108-90-7	SO	EX SITU	Y	0.06	0	0	0	0	0	0	76	0	0	0	0	0	0
Chlorobenzene	108-90-7	SO	EX SITU	N	0.06	72	1	2	1	0	76	76	100	94.74	1.32	2.63	1.32	0
Chlorobenzene	108-90-7	GW	IN SITU	Y	10	0	0	0	0	0	0	20	0	0	0	0	0	0
Chlorobenzene	108-90-7	GW	IN SITU	N	10	20	0	0	0	0	20	20	100	100	0	0	0	0
Chloroform	67-66-3	SO	IN SITU	Y	0.034	0	0	0	0	0	0	197	0	0	0	0	0	0
Chloroform	67-66-3	SO	IN SITU	N	0.034	190	3	3	1	0	197	197	100	96.45	1.52	1.52	0.51	0
Chloroform	67-66-3	SO	EX SITU	Y	0.034	1	1	0	0	0	2	76	2.63	1.32	1.32	0	0	0
Chloroform	67-66-3	SO	EX SITU	N	0.034	70	1	2	1	0	74	76	97.37	92.11	1.32	2.63	1.32	0
Chloroform	67-66-3	GW	IN SITU	Y	0.17	0	0	0	0	0	0	20	0	0	0	0	0	0
Chloroform	67-66-3	GW	IN SITU	N	0.17	20	0	0	0	0	20	20	100	100	0	0	0	0
Chloromethane	74-87-3	SO	IN SITU	Y	1.3	1	0	0	0	0	1	197	0.51	0.51	0	0	0	0
Chloromethane	74-87-3	SO	IN SITU	N	1.3	195	1	0	0	0	196	197	99.49	98.98	0.51	0	0	0
Chloromethane	74-87-3	SO	EX SITU	Y	1.3	0	0	0	0	0	0	76	0	0	0	0	0	0
Chloromethane	74-87-3	SO	EX SITU	N	1.3	73	2	1	0	0	76	76	100	96.05	2.63	1.32	0	0
Chloromethane	74-87-3	GW	IN SITU	Y	2.1	0	0	0	0	0	0	20	0	0	0	0	0	0
Chloromethane	74-87-3	GW	IN SITU	N	2.1	20	0	0	0	0	20	20	100	100	0	0	0	0
Chromium	7440-47-3	SO	IN SITU	Y	30	171	10	0	0	0	181	181	100	94.48	5.52	0	0	0
Chromium	7440-47-3	SO	IN SITU	N	30	0	0	0	0	0	0	181	0	0	0	0	0	0
Chromium	7440-47-3	SO	EX SITU	Y	30	72	7	2	0	0	81	81	100	88.89	8.64	2.47	0	0
Chromium	7440-47-3	SO	EX SITU	N	30	0	0	0	0	0	0	81	0	0	0	0	0	0
Chromium	7440-47-3	GW	IN SITU	Y	10	0	6	0	0	0	6	20	30	0	30	0	0	0
Chromium	7440-47-3	GW	IN SITU	N	10	14	0	0	0	0	14	20	70	70	0	0	0	0
Chrysene	218-01-9	SO	IN SITU	Y	15	1	0	0	0	0	1	174	0.57	0.57	0	0	0	0
Chrysene	218-01-9	SO	IN SITU	N	15	170	3	0	0	0	173	174	99.43	97.7	1.72	0	0	0
Chrysene	218-01-9	SO	EX SITU	Y	15	2	0	0	0	0	2	67	2.99	2.99	0	0	0	0
Chrysene	218-01-9	SO	EX SITU	N	15	64	0	1	0	0	65	67	97.01	95.52	0	1.49	0	0
Chrysene	218-01-9	GW	IN SITU	Y	2.9	0	0	0	0	0	0	20	0	0	0	0	0	0
Chrysene	218-01-9	GW	IN SITU	N	2.9	20	0	0	0	0	20	20	100	100	0	0	0	0

TABLE 2-11
Summary of Chemical Data Relative To Screening Levels

1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19
Analyte Name	**CAS Number**	**Matrix**	**In Situ or Ex Situ?**	**Was Analyte Detected?**	**Screening Level (mg/kg or µg/L)**	**Blue Count (<=1*SL)**	**Green Count (>1*SL & <=10*SL)**	**Yellow Count (>10*SL & <=100*SL)**	**Orange Count (>100*SL & <=1000*SL)**	**Red Count (>1000*SL)**	**Total Count: Detect+ Non-detect**	**Total Count: In Situ Soil; Ex Situ Soil; Groundwater**	**Percent Detect or Non-detect in: In Situ; Ex Situ; Groundwater Groups**	**Percent Blue**	**Percent Green**	**Percent Yellow**	**Percent Orange**	**Percent Red**
cis-1,2-Dichloroethene	156-59-2	SO	IN SITU	Y	0.02	0	0	0	0	0	0	197	0	0	0	0	0	0
cis-1,2-Dichloroethene	156-59-2	SO	IN SITU	N	0.02	189	3	4	1	0	197	197	100	95.94	1.52	2.03	0.51	0
cis-1,2-Dichloroethene	156-59-2	SO	EX SITU	Y	0.02	0	0	0	0	0	0	76	0	0	0	0	0	0
cis-1,2-Dichloroethene	156-59-2	SO	EX SITU	N	0.02	72	0	1	3	0	76	76	100	94.74	0	1.32	3.95	0
cis-1,2-Dichloroethene	156-59-2	GW	IN SITU	Y	7	2	0	0	0	0	2	20	10	10	0	0	0	0
cis-1,2-Dichloroethene	156-59-2	GW	IN SITU	N	7	18	0	0	0	0	18	20	90	90	0	0	0	0
cis-1,3-Dichloropropene	10061-01-5	SO	IN SITU	Y	0.002	0	0	0	0	0	0	197	0	0	0	0	0	0
cis-1,3-Dichloropropene	10061-01-5	SO	IN SITU	N	0.002	81	108	3	4	1	197	197	100	41.12	54.82	1.52	2.03	0.51
cis-1,3-Dichloropropene	10061-01-5	SO	EX SITU	Y	0.002	0	0	0	0	0	0	76	0	0	0	0	0	0
cis-1,3-Dichloropropene	10061-01-5	SO	EX SITU	N	0.002	23	49	0	1	3	76	76	100	30.26	64.47	0	1.32	3.95
cis-1,3-Dichloropropene	10061-01-5	GW	IN SITU	Y	0.4	0	0	0	0	0	0	20	0	0	0	0	0	0
cis-1,3-Dichloropropene	10061-01-5	GW	IN SITU	N	0.4	20	0	0	0	0	20	20	100	100	0	0	0	0
Cobalt	7440-48-4	SO	IN SITU	Y	90	129	0	0	0	0	129	129	100	100	0	0	0	0
Cobalt	7440-48-4	SO	IN SITU	N	90	0	0	0	0	0	0	129	0	0	0	0	0	0
Cobalt	7440-48-4	SO	EX SITU	Y	90	69	0	0	0	0	69	71	97.18	97.18	0	0	0	0
Cobalt	7440-48-4	SO	EX SITU	N	90	2	0	0	0	0	2	71	2.82	2.82	0	0	0	0
Cobalt	7440-48-4	GW	IN SITU	Y	730	13	0	0	0	0	13	20	65	65	0	0	0	0
Cobalt	7440-48-4	GW	IN SITU	N	730	7	0	0	0	0	7	20	35	35	0	0	0	0
Copper	7440-50-8	SO	IN SITU	Y	406	127	2	0	0	0	129	129	100	98.45	1.55	0	0	0
Copper	7440-50-8	SO	IN SITU	N	406	0	0	0	0	0	0	129	0	0	0	0	0	0
Copper	7440-50-8	SO	EX SITU	Y	406	65	2	4	0	0	71	71	100	91.55	2.82	5.63	0	0
Copper	7440-50-8	SO	EX SITU	N	406	0	0	0	0	0	0	71	0	0	0	0	0	0
Copper	7440-50-8	GW	IN SITU	Y	130	5	0	0	0	0	5	20	25	25	0	0	0	0
Copper	7440-50-8	GW	IN SITU	N	130	15	0	0	0	0	15	20	75	75	0	0	0	0
Dalapon	75-99-0	SO	IN SITU	Y	1800	0	0	0	0	0	0	68	0	0	0	0	0	0
Dalapon	75-99-0	SO	IN SITU	N	1800	68	0	0	0	0	68	68	100	100	0	0	0	0
Dalapon	75-99-0	SO	EX SITU	Y	1800	0	0	0	0	0	0	8	0	0	0	0	0	0
Dalapon	75-99-0	SO	EX SITU	N	1800	8	0	0	0	0	8	8	100	100	0	0	0	0
Dalapon	75-99-0	GW	IN SITU	Y		0	0	0	0	0	0	0	0	0	0	0	0	0
Dalapon	75-99-0	GW	IN SITU	N		0	0	0	0	0	0	0	0	0	0	0	0	0
Dibenzo(a,h)anthracene	53-70-3	SO	IN SITU	Y	0.015	0	1	0	0	0	1	174	0.57	0	0.57	0	0	0
Dibenzo(a,h)anthracene	53-70-3	SO	IN SITU	N	0.015	113	38	19	0	3	173	174	99.43	64.94	21.84	10.92	0	1.72
Dibenzo(a,h)anthracene	53-70-3	SO	EX SITU	Y	0.015	0	1	0	1	0	2	67	2.99	0	1.49	0	1.49	0
Dibenzo(a,h)anthracene	53-70-3	SO	EX SITU	N	0.015	56	2	4	2	1	65	67	97.01	83.58	2.99	5.97	2.99	1.49
Dibenzo(a,h)anthracene	53-70-3	GW	IN SITU	Y	0.003	0	0	0	0	0	0	20	0	0	0	0	0	0
Dibenzo(a,h)anthracene	53-70-3	GW	IN SITU	N	0.003	0	0	0	20	0	20	20	100	0	0	0	100	0

TABLE 2-11
Summary of Chemical Data Relative To Screening Levels

1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19
Analyte Name	**CAS Number**	**Matrix**	**In Situ or Ex Situ?**	**Was Analyte Detected?**	**Screening Level (mg/kg or µg/L)**	**Blue Count (<=1*SL)**	**Green Count (>1*SL & <=10*SL)**	**Yellow Count (>10*SL & <=100*SL)**	**Orange Count (>100*SL & <=1000*SL)**	**Red Count (>1000*SL)**	**Total Count: Detect+ Non-detect**	**Total Count: In Situ Soil; Ex Situ Soil; Groundwater**	**Percent Detect or Non-detect in: In Situ; Ex Situ; Groundwater Groups**	**Percent Blue**	**Percent Green**	**Percent Yellow**	**Percent Orange**	**Percent Red**
Dicamba	1918-00-9	SO	IN SITU	Y	1800	0	0	0	0	0	0	68	0	0	0	0	0	0
Dicamba	1918-00-9	SO	IN SITU	N	1800	68	0	0	0	0	68	68	100	100	0	0	0	0
Dicamba	1918-00-9	SO	EX SITU	Y	1800	0	0	0	0	0	0	8	0	0	0	0	0	0
Dicamba	1918-00-9	SO	EX SITU	N	1800	8	0	0	0	0	8	8	100	100	0	0	0	0
Dicamba	1918-00-9	GW	IN SITU	Y		0	0	0	0	0	0	0	0	0	0	0	0	0
Dicamba	1918-00-9	GW	IN SITU	N		0	0	0	0	0	0	0	0	0	0	0	0	0
Dichlorodifluoromethane	75-71-8	SO	IN SITU	Y	6	0	0	0	0	0	0	197	0	0	0	0	0	0
Dichlorodifluoromethane	75-71-8	SO	IN SITU	N	6	196	1	0	0	0	197	197	100	99.49	0.51	0	0	0
Dichlorodifluoromethane	75-71-8	SO	EX SITU	Y	6	0	0	0	0	0	0	75	0	0	0	0	0	0
Dichlorodifluoromethane	75-71-8	SO	EX SITU	N	6	74	1	0	0	0	75	75	100	98.67	1.33	0	0	0
Dichlorodifluoromethane	75-71-8	GW	IN SITU	Y	390	5	0	0	0	0	5	20	25	25	0	0	0	0
Dichlorodifluoromethane	75-71-8	GW	IN SITU	N	390	15	0	0	0	0	15	20	75	75	0	0	0	0
Dieldrin	60-57-1	SO	IN SITU	Y	0.0015	1	8	1	0	0	10	150	6.67	0.67	5.33	0.67	0	0
Dieldrin	60-57-1	SO	IN SITU	N	0.0015	136	4	0	0	0	140	150	93.33	90.67	2.67	0	0	0
Dieldrin	60-57-1	SO	EX SITU	Y	0.0015	7	5	1	0	0	13	57	22.81	12.28	8.77	1.75	0	0
Dieldrin	60-57-1	SO	EX SITU	N	0.0015	34	10	0	0	0	44	57	77.19	59.65	17.54	0	0	0
Dieldrin	60-57-1	GW	IN SITU	Y	0.0042	0	1	0	0	0	1	20	5	0	5	0	0	0
Dieldrin	60-57-1	GW	IN SITU	N	0.0042	10	9	0	0	0	19	20	95	50	45	0	0	0
Diethyl phthalate	84-66-2	SO	IN SITU	Y	19	1	0	0	0	0	1	174	0.57	0.57	0	0	0	0
Diethyl phthalate	84-66-2	SO	IN SITU	N	19	170	3	0	0	0	173	174	99.43	97.7	1.72	0	0	0
Diethyl phthalate	84-66-2	SO	EX SITU	Y	19	2	0	0	0	0	2	67	2.99	2.99	0	0	0	0
Diethyl phthalate	84-66-2	SO	EX SITU	N	19	64	0	1	0	0	65	67	97.01	95.52	0	1.49	0	0
Diethyl phthalate	84-66-2	GW	IN SITU	Y	2900	1	0	0	0	0	1	20	5	5	0	0	0	0
Diethyl phthalate	84-66-2	GW	IN SITU	N	2900	19	0	0	0	0	19	20	95	95	0	0	0	0
Dimethyl phthalate	131-11-3	SO	IN SITU	Y	140	0	0	0	0	0	0	174	0	0	0	0	0	0
Dimethyl phthalate	131-11-3	SO	IN SITU	N	140	174	0	0	0	0	174	174	100	100	0	0	0	0
Dimethyl phthalate	131-11-3	SO	EX SITU	Y	140	1	0	0	0	0	1	67	1.49	1.49	0	0	0	0
Dimethyl phthalate	131-11-3	SO	EX SITU	N	140	65	1	0	0	0	66	67	98.51	97.01	1.49	0	0	0
Dimethyl phthalate	131-11-3	GW	IN SITU	Y	370000	0	0	0	0	0	0	20	0	0	0	0	0	0
Dimethyl phthalate	131-11-3	GW	IN SITU	N	370000	20	0	0	0	0	20	20	100	100	0	0	0	0
Di-n-butyl phthalate	84-74-2	SO	IN SITU	Y	170	15	0	0	0	0	15	174	8.62	8.62	0	0	0	0
Di-n-butyl phthalate	84-74-2	SO	IN SITU	N	170	159	0	0	0	0	159	174	91.38	91.38	0	0	0	0
Di-n-butyl phthalate	84-74-2	SO	EX SITU	Y	170	0	0	0	0	0	0	67	0	0	0	0	0	0
Di-n-butyl phthalate	84-74-2	SO	EX SITU	N	170	66	1	0	0	0	67	67	100	98.51	1.49	0	0	0
Di-n-butyl phthalate	84-74-2	GW	IN SITU	Y	365	1	0	0	0	0	1	20	5	5	0	0	0	0
Di-n-butyl phthalate	84-74-2	GW	IN SITU	N	365	19	0	0	0	0	19	20	95	95	0	0	0	0

TABLE 2-11
Summary of Chemical Data Relative To Screening Levels

1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19
Analyte Name	**CAS Number**	**Matrix**	**In Situ or Ex Situ?**	**Was Analyte Detected?**	**Screening Level (mg/kg or µg/L)**	**Blue Count (<=1*SL)**	**Green Count (>1*SL & <=10*SL)**	**Yellow Count (>10*SL & <=100*SL)**	**Orange Count (>100*SL & <=1000*SL)**	**Red Count (>1000*SL)**	**Total Count: Detect+ Non-detect**	**Total Count: In Situ Soil; Ex Situ Soil; Groundwater**	**Percent Detect or Non-detect in: In Situ; Ex Situ; Groundwater Groups**	**Percent Blue**	**Percent Green**	**Percent Yellow**	**Percent Orange**	**Percent Red**
Di-n-octyl phthalate	117-84-0	SO	IN SITU	Y	200	0	0	0	0	0	0	174	0	0	0	0	0	0
Di-n-octyl phthalate	117-84-0	SO	IN SITU	N	200	174	0	0	0	0	174	174	100	100	0	0	0	0
Di-n-octyl phthalate	117-84-0	SO	EX SITU	Y	200	4	0	0	0	0	4	67	5.97	5.97	0	0	0	0
Di-n-octyl phthalate	117-84-0	SO	EX SITU	N	200	62	1	0	0	0	63	67	94.03	92.54	1.49	0	0	0
Di-n-octyl phthalate	117-84-0	GW	IN SITU	Y	70	0	0	0	0	0	0	20	0	0	0	0	0	0
Di-n-octyl phthalate	117-84-0	GW	IN SITU	N	70	20	0	0	0	0	20	20	100	100	0	0	0	0
Dinoseb	88-85-7	SO	IN SITU	Y	61	0	0	0	0	0	0	68	0	0	0	0	0	0
Dinoseb	88-85-7	SO	IN SITU	N	61	68	0	0	0	0	68	68	100	100	0	0	0	0
Dinoseb	88-85-7	SO	EX SITU	Y	61	0	0	0	0	0	0	8	0	0	0	0	0	0
Dinoseb	88-85-7	SO	EX SITU	N	61	8	0	0	0	0	8	8	100	100	0	0	0	0
Dinoseb	88-85-7	GW	IN SITU	Y		0	0	0	0	0	0	0	0	0	0	0	0	0
Dinoseb	88-85-7	GW	IN SITU	N		0	0	0	0	0	0	0	0	0	0	0	0	0
Endosulfan I	959-98-8	SO	IN SITU	Y	0.7	1	0	0	0	0	1	141	0.71	0.71	0	0	0	0
Endosulfan I	959-98-8	SO	IN SITU	N	0.7	140	0	0	0	0	140	141	99.29	99.29	0	0	0	0
Endosulfan I	959-98-8	SO	EX SITU	Y	0.7	6	0	0	0	0	6	57	10.53	10.53	0	0	0	0
Endosulfan I	959-98-8	SO	EX SITU	N	0.7	51	0	0	0	0	51	57	89.47	89.47	0	0	0	0
Endosulfan I	959-98-8	GW	IN SITU	Y	220	0	0	0	0	0	0	20	0	0	0	0	0	0
Endosulfan I	959-98-8	GW	IN SITU	N	220	20	0	0	0	0	20	20	100	100	0	0	0	0
Endosulfan II	33213-65-9	SO	IN SITU	Y	0.7	2	0	0	0	0	2	163	1.23	1.23	0	0	0	0
Endosulfan II	33213-65-9	SO	IN SITU	N	0.7	161	0	0	0	0	161	163	98.77	98.77	0	0	0	0
Endosulfan II	33213-65-9	SO	EX SITU	Y	0.7	14	0	0	0	0	14	57	24.56	24.56	0	0	0	0
Endosulfan II	33213-65-9	SO	EX SITU	N	0.7	43	0	0	0	0	43	57	75.44	75.44	0	0	0	0
Endosulfan II	33213-65-9	GW	IN SITU	Y		0	0	0	0	0	0	0	0	0	0	0	0	0
Endosulfan II	33213-65-9	GW	IN SITU	N		0	0	0	0	0	0	0	0	0	0	0	0	0
Endrin	72-20-8	SO	IN SITU	Y	0.03	1	0	0	0	0	1	158	0.63	0.63	0	0	0	0
Endrin	72-20-8	SO	IN SITU	N	0.03	157	0	0	0	0	157	158	99.37	99.37	0	0	0	0
Endrin	72-20-8	SO	EX SITU	Y	0.03	13	0	0	0	0	13	57	22.81	22.81	0	0	0	0
Endrin	72-20-8	SO	EX SITU	N	0.03	44	0	0	0	0	44	57	77.19	77.19	0	0	0	0
Endrin	72-20-8	GW	IN SITU	Y	0.2	1	0	0	0	0	1	20	5	5	0	0	0	0
Endrin	72-20-8	GW	IN SITU	N	0.2	19	0	0	0	0	19	20	95	95	0	0	0	0
Ethylbenzene	100-41-4	SO	IN SITU	Y	0.55	27	0	1	0	0	28	241	11.62	11.2	0	0.41	0	0
Ethylbenzene	100-41-4	SO	IN SITU	N	0.55	210	2	1	0	0	213	241	88.38	87.14	0.83	0.41	0	0
Ethylbenzene	100-41-4	SO	EX SITU	Y	0.55	0	0	1	1	0	2	85	2.35	0	0	1.18	1.18	0
Ethylbenzene	100-41-4	SO	EX SITU	N	0.55	82	1	0	0	0	83	85	97.65	96.47	1.18	0	0	0
Ethylbenzene	100-41-4	GW	IN SITU	Y	70	0	0	0	0	0	0	20	0	0	0	0	0	0
Ethylbenzene	100-41-4	GW	IN SITU	N	70	20	0	0	0	0	20	20	100	100	0	0	0	0

TABLE 2-11
Summary of Chemical Data Relative To Screening Levels

1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19
Analyte Name	**CAS Number**	**Matrix**	**In Situ or Ex Situ?**	**Was Analyte Detected?**	**Screening Level (mg/kg or µg/L)**	**Blue Count (<=1*SL)**	**Green Count (>1*SL & <=10*SL)**	**Yellow Count (>10*SL & <=100*SL)**	**Orange Count (>100*SL & <=1000*SL)**	**Red Count (>1000*SL)**	**Total Count: Detect+ Non-detect**	**Total Count: In Situ Soil; Ex Situ Soil; Groundwater**	**Percent Detect or Non-detect in: In Situ; Ex Situ; Groundwater Groups**	**Percent Blue**	**Percent Green**	**Percent Yellow**	**Percent Orange**	**Percent Red**
Fluoranthene	206-44-0	SO	IN SITU	Y	210	4	0	0	0	0	4	174	2.3	2.3	0	0	0	0
Fluoranthene	206-44-0	SO	IN SITU	N	210	170	0	0	0	0	170	174	97.7	97.7	0	0	0	0
Fluoranthene	206-44-0	SO	EX SITU	Y	210	7	0	0	0	0	7	67	10.45	10.45	0	0	0	0
Fluoranthene	206-44-0	SO	EX SITU	N	210	59	1	0	0	0	60	67	89.55	88.06	1.49	0	0	0
Fluoranthene	206-44-0	GW	IN SITU	Y	146	0	0	0	0	0	0	20	0	0	0	0	0	0
Fluoranthene	206-44-0	GW	IN SITU	N	146	20	0	0	0	0	20	20	100	100	0	0	0	0
Fluorene	86-73-7	SO	IN SITU	Y	27	7	0	0	0	0	7	174	4.02	4.02	0	0	0	0
Fluorene	86-73-7	SO	IN SITU	N	27	164	3	0	0	0	167	174	95.98	94.25	1.72	0	0	0
Fluorene	86-73-7	SO	EX SITU	Y	27	2	0	0	0	0	2	67	2.99	2.99	0	0	0	0
Fluorene	86-73-7	SO	EX SITU	N	27	64	0	1	0	0	65	67	97.01	95.52	0	1.49	0	0
Fluorene	86-73-7	GW	IN SITU	Y	146	1	0	0	0	0	1	20	5	5	0	0	0	0
Fluorene	86-73-7	GW	IN SITU	N	146	19	0	0	0	0	19	20	95	95	0	0	0	0
gamma-BHC (Lindane)	58-89-9	SO	IN SITU	Y	0.0003	1	0	0	0	0	1	136	0.74	0.74	0	0	0	0
gamma-BHC (Lindane)	58-89-9	SO	IN SITU	N	0.0003	103	29	3	0	0	135	136	99.26	75.74	21.32	2.21	0	0
gamma-BHC (Lindane)	58-89-9	SO	EX SITU	Y	0.0003	0	8	5	0	0	13	57	22.81	0	14.04	8.77	0	0
gamma-BHC (Lindane)	58-89-9	SO	EX SITU	N	0.0003	21	18	5	0	0	44	57	77.19	36.84	31.58	8.77	0	0
gamma-BHC (Lindane)	58-89-9	GW	IN SITU	Y	0.02	0	0	0	0	0	0	20	0	0	0	0	0	0
gamma-BHC (Lindane)	58-89-9	GW	IN SITU	N	0.02	20	0	0	0	0	20	20	100	100	0	0	0	0
gamma-Chlordane	12789-03-6	SO	IN SITU	Y	0.3	7	0	0	0	0	7	155	4.52	4.52	0	0	0	0
gamma-Chlordane	12789-03-6	SO	IN SITU	N	0.3	148	0	0	0	0	148	155	95.48	95.48	0	0	0	0
gamma-Chlordane	12789-03-6	SO	EX SITU	Y	0.3	12	0	0	0	0	12	57	21.05	21.05	0	0	0	0
gamma-Chlordane	12789-03-6	SO	EX SITU	N	0.3	45	0	0	0	0	45	57	78.95	78.95	0	0	0	0
gamma-Chlordane	12789-03-6	GW	IN SITU	Y	0.2	0	0	0	0	0	0	20	0	0	0	0	0	0
gamma-Chlordane	12789-03-6	GW	IN SITU	N	0.2	20	0	0	0	0	20	20	100	100	0	0	0	0
Heptachlor	76-44-8	SO	IN SITU	Y	0.08	2	0	0	0	0	2	147	1.36	1.36	0	0	0	0
Heptachlor	76-44-8	SO	IN SITU	N	0.08	145	0	0	0	0	145	147	98.64	98.64	0	0	0	0
Heptachlor	76-44-8	SO	EX SITU	Y	0.08	6	0	0	0	0	6	57	10.53	10.53	0	0	0	0
Heptachlor	76-44-8	SO	EX SITU	N	0.08	51	0	0	0	0	51	57	89.47	89.47	0	0	0	0
Heptachlor	76-44-8	GW	IN SITU	Y	0.015	0	0	0	0	0	0	20	0	0	0	0	0	0
Heptachlor	76-44-8	GW	IN SITU	N	0.015	20	0	0	0	0	20	20	100	100	0	0	0	0
Heptachlor epoxide	1024-57-3	SO	IN SITU	Y	0.02	9	0	0	0	0	9	162	5.56	5.56	0	0	0	0
Heptachlor epoxide	1024-57-3	SO	IN SITU	N	0.02	153	0	0	0	0	153	162	94.44	94.44	0	0	0	0
Heptachlor epoxide	1024-57-3	SO	EX SITU	Y	0.02	3	0	0	0	0	3	57	5.26	5.26	0	0	0	0
Heptachlor epoxide	1024-57-3	SO	EX SITU	N	0.02	54	0	0	0	0	54	57	94.74	94.74	0	0	0	0
Heptachlor epoxide	1024-57-3	GW	IN SITU	Y	0.0074	1	0	0	0	0	1	20	5	5	0	0	0	0
Heptachlor epoxide	1024-57-3	GW	IN SITU	N	0.0074	19	0	0	0	0	19	20	95	95	0	0	0	0

TABLE 2-11
Summary of Chemical Data Relative To Screening Levels

1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19
Analyte Name	**CAS Number**	**Matrix**	**In Situ or Ex Situ?**	**Was Analyte Detected?**	**Screening Level (mg/kg or µg/L)**	**Blue Count (<=1*SL)**	**Green Count (>1*SL & <=10*SL)**	**Yellow Count (>10*SL & <=100*SL)**	**Orange Count (>100*SL & <=1000*SL)**	**Red Count (>1000*SL)**	**Total Count: Detect+ Non-detect**	**Total Count: In Situ Soil; Ex Situ Soil; Groundwater**	**Percent Detect or Non-detect in: In Situ; Ex Situ; Groundwater Groups**	**Percent Blue**	**Percent Green**	**Percent Yellow**	**Percent Orange**	**Percent Red**
Hexachlorobenzene	118-74-1	SO	IN SITU	Y	0.073	0	0	0	0	0	0	174	0	0	0	0	0	0
Hexachlorobenzene	118-74-1	SO	IN SITU	N	0.073	152	18	1	3	0	174	174	100	87.36	10.34	0.57	1.72	0
Hexachlorobenzene	118-74-1	SO	EX SITU	Y	0.073	0	0	0	0	0	0	67	0	0	0	0	0	0
Hexachlorobenzene	118-74-1	SO	EX SITU	N	0.073	59	4	3	0	1	67	67	100	88.06	5.97	4.48	0	1.49
Hexachlorobenzene	118-74-1	GW	IN SITU	Y	0.042	0	0	0	0	0	0	20	0	0	0	0	0	0
Hexachlorobenzene	118-74-1	GW	IN SITU	N	0.042	0	14	6	0	0	20	20	100	0	70	30	0	0
Hexachlorobutadiene	87-68-3	SO	IN SITU	Y	0.8	0	0	0	0	0	0	212	0	0	0	0	0	0
Hexachlorobutadiene	87-68-3	SO	IN SITU	N	0.8	205	6	1	0	0	212	212	100	96.7	2.83	0.47	0	0
Hexachlorobutadiene	87-68-3	SO	EX SITU	Y	0.8	0	0	0	0	0	0	85	0	0	0	0	0	0
Hexachlorobutadiene	87-68-3	SO	EX SITU	N	0.8	80	4	0	1	0	85	85	100	94.12	4.71	0	1.18	0
Hexachlorobutadiene	87-68-3	GW	IN SITU	Y	0.86	0	0	0	0	0	0	20	0	0	0	0	0	0
Hexachlorobutadiene	87-68-3	GW	IN SITU	N	0.86	20	0	0	0	0	20	20	100	100	0	0	0	0
Hexachlorocyclopentadiene	77-47-4	SO	IN SITU	Y	0.7	0	0	0	0	0	0	78	0	0	0	0	0	0
Hexachlorocyclopentadiene	77-47-4	SO	IN SITU	N	0.7	64	11	0	3	0	78	78	100	82.05	14.1	0	3.85	0
Hexachlorocyclopentadiene	77-47-4	SO	EX SITU	Y	0.7	0	0	0	0	0	0	8	0	0	0	0	0	0
Hexachlorocyclopentadiene	77-47-4	SO	EX SITU	N	0.7	5	2	0	0	1	8	8	100	62.5	25	0	0	12.5
Hexachlorocyclopentadiene	77-47-4	GW	IN SITU	Y	5	0	0	0	0	0	0	6	0	0	0	0	0	0
Hexachlorocyclopentadiene	77-47-4	GW	IN SITU	N	5	6	0	0	0	0	6	6	100	100	0	0	0	0
Hexachloroethane	67-72-1	SO	IN SITU	Y	0.16	0	0	0	0	0	0	174	0	0	0	0	0	0
Hexachloroethane	67-72-1	SO	IN SITU	N	0.16	153	17	1	3	0	174	174	100	87.93	9.77	0.57	1.72	0
Hexachloroethane	67-72-1	SO	EX SITU	Y	0.16	0	0	0	0	0	0	67	0	0	0	0	0	0
Hexachloroethane	67-72-1	SO	EX SITU	N	0.16	59	4	3	0	1	67	67	100	88.06	5.97	4.48	0	1.49
Hexachloroethane	67-72-1	GW	IN SITU	Y	4.8	0	0	0	0	0	0	20	0	0	0	0	0	0
Hexachloroethane	67-72-1	GW	IN SITU	N	4.8	20	0	0	0	0	20	20	100	100	0	0	0	0
Hexahydro-1,3,5-trinitro-1,3,5-triazine (RDX)	121-82-4	SO	IN SITU	Y	4.4	2	0	0	0	0	2	91	2.2	2.2	0	0	0	0
Hexahydro-1,3,5-trinitro-1,3,5-triazine (RDX)	121-82-4	SO	IN SITU	N	4.4	89	0	0	0	0	89	91	97.8	97.8	0	0	0	0
Hexahydro-1,3,5-trinitro-1,3,5-triazine (RDX)	121-82-4	SO	EX SITU	Y	4.4	0	0	0	0	0	0	64	0	0	0	0	0	0
Hexahydro-1,3,5-trinitro-1,3,5-triazine (RDX)	121-82-4	SO	EX SITU	N	4.4	64	0	0	0	0	64	64	100	100	0	0	0	0
Hexahydro-1,3,5-trinitro-1,3,5-triazine (RDX)	121-82-4	GW	IN SITU	Y	0.61	0	0	1	0	0	1	10	10	0	0	10	0	0
Hexahydro-1,3,5-trinitro-1,3,5-triazine (RDX)	121-82-4	GW	IN SITU	N	0.61	9	0	0	0	0	9	10	90	90	0	0	0	0
Indeno(1,2,3-cd)pyrene	193-39-5	SO	IN SITU	Y	0.15	1	1	0	0	0	2	174	1.15	0.57	0.57	0	0	0
Indeno(1,2,3-cd)pyrene	193-39-5	SO	IN SITU	N	0.15	150	19	0	3	0	172	174	98.85	86.21	10.92	0	1.72	0

TABLE 2-11
Summary of Chemical Data Relative To Screening Levels

1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19
Analyte Name	**CAS Number**	**Matrix**	**In Situ or Ex Situ?**	**Was Analyte Detected?**	**Screening Level (mg/kg or µg/L)**	**Blue Count (<=1*SL)**	**Green Count (>1*SL & <=10*SL)**	**Yellow Count (>10*SL & <=100*SL)**	**Orange Count (>100*SL & <=1000*SL)**	**Red Count (>1000*SL)**	**Total Count: Detect+ Non-detect**	**Total Count: In Situ Soil; Ex Situ Soil; Groundwater**	**Percent Detect or Non-detect in: In Situ; Ex Situ; Groundwater Groups**	**Percent Blue**	**Percent Green**	**Percent Yellow**	**Percent Orange**	**Percent Red**
Indeno(1,2,3-cd)pyrene	193-39-5	SO	EX SITU	Y	0.15	5	1	1	0	0	7	67	10.45	7.46	1.49	1.49	0	0
Indeno(1,2,3-cd)pyrene	193-39-5	SO	EX SITU	N	0.15	54	3	2	0	1	60	67	89.55	80.6	4.48	2.99	0	1.49
Indeno(1,2,3-cd)pyrene	193-39-5	GW	IN SITU	Y	0.03	0	0	0	0	0	0	20	0	0	0	0	0	0
Indeno(1,2,3-cd)pyrene	193-39-5	GW	IN SITU	N	0.03	0	0	20	0	0	20	20	100	0	0	100	0	0
Iron	7439-89-6	SO	IN SITU	Y		0	0	0	0	0	0	0	0	0	0	0	0	0
Iron	7439-89-6	SO	IN SITU	N		0	0	0	0	0	0	0	0	0	0	0	0	0
Iron	7439-89-6	SO	EX SITU	Y		0	0	0	0	0	0	0	0	0	0	0	0	0
Iron	7439-89-6	SO	EX SITU	N		0	0	0	0	0	0	0	0	0	0	0	0	0
Iron	7439-89-6	GW	IN SITU	Y		0	0	0	0	0	0	0	0	0	0	0	0	0
Iron	7439-89-6	GW	IN SITU	N		0	0	0	0	0	0	0	0	0	0	0	0	0
Isophorone	78-59-1	SO	IN SITU	Y	0.3	0	0	0	0	0	0	174	0	0	0	0	0	0
Isophorone	78-59-1	SO	IN SITU	N	0.3	156	15	0	3	0	174	174	100	89.66	8.62	0	1.72	0
Isophorone	78-59-1	SO	EX SITU	Y	0.3	0	0	0	0	0	0	67	0	0	0	0	0	0
Isophorone	78-59-1	SO	EX SITU	N	0.3	59	7	0	0	1	67	67	100	88.06	10.45	0	0	1.49
Isophorone	78-59-1	GW	IN SITU	Y	71	0	0	0	0	0	0	20	0	0	0	0	0	0
Isophorone	78-59-1	GW	IN SITU	N	71	20	0	0	0	0	20	20	100	100	0	0	0	0
Isopropylbenzene	98-82-8	SO	IN SITU	Y	22.7	2	0	0	0	0	2	197	1.02	1.02	0	0	0	0
Isopropylbenzene	98-82-8	SO	IN SITU	N	22.7	195	0	0	0	0	195	197	98.98	98.98	0	0	0	0
Isopropylbenzene	98-82-8	SO	EX SITU	Y	22.7	1	1	0	0	0	2	76	2.63	1.32	1.32	0	0	0
Isopropylbenzene	98-82-8	SO	EX SITU	N	22.7	74	0	0	0	0	74	76	97.37	97.37	0	0	0	0
Isopropylbenzene	98-82-8	GW	IN SITU	Y	365	1	0	0	0	0	1	20	5	5	0	0	0	0
Isopropylbenzene	98-82-8	GW	IN SITU	N	365	19	0	0	0	0	19	20	95	95	0	0	0	0
Lead	7439-92-1	SO	IN SITU	Y	40	170	10	0	0	1	181	181	100	93.92	5.52	0	0	0.55
Lead	7439-92-1	SO	IN SITU	N	40	0	0	0	0	0	0	181	0	0	0	0	0	0
Lead	7439-92-1	SO	EX SITU	Y	40	70	9	2	0	0	81	81	100	86.42	11.11	2.47	0	0
Lead	7439-92-1	SO	EX SITU	N	40	0	0	0	0	0	0	81	0	0	0	0	0	0
Lead	7439-92-1	GW	IN SITU	Y	1.5	0	0	0	0	0	0	20	0	0	0	0	0	0
Lead	7439-92-1	GW	IN SITU	N	1.5	20	0	0	0	0	20	20	100	100	0	0	0	0
m,p-Xylene	108-38-3/1	SO	IN SITU	Y	210	5	0	0	0	0	5	197	2.54	2.54	0	0	0	0
m,p-Xylene	108-38-3/1	SO	IN SITU	N	210	192	0	0	0	0	192	197	97.46	97.46	0	0	0	0
m,p-Xylene	108-38-3/1	SO	EX SITU	Y	210	4	1	0	0	0	5	79	6.33	5.06	1.27	0	0	0
m,p-Xylene	108-38-3/1	SO	EX SITU	N	210	74	0	0	0	0	74	79	93.67	93.67	0	0	0	0
m,p-Xylene	108-38-3/1	GW	IN SITU	Y	210	0	0	0	0	0	0	20	0	0	0	0	0	0
m,p-Xylene	108-38-3/1	GW	IN SITU	N	210	20	0	0	0	0	20	20	100	100	0	0	0	0
Manganese	7439-96-5	SO	IN SITU	Y		0	0	0	0	0	0	0	0	0	0	0	0	0
Manganese	7439-96-5	SO	IN SITU	N		0	0	0	0	0	0	0	0	0	0	0	0	0

TABLE 2-11
Summary of Chemical Data Relative To Screening Levels

1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19
Analyte Name	**CAS Number**	**Matrix**	**In Situ or Ex Situ?**	**Was Analyte Detected?**	**Screening Level (mg/kg or µg/L)**	**Blue Count (<=1*SL)**	**Green Count (>1*SL & <=10*SL)**	**Yellow Count (>10*SL & <=100*SL)**	**Orange Count (>100*SL & <=1000*SL)**	**Red Count (>1000*SL)**	**Total Count: Detect+ Non-detect**	**Total Count: In Situ Soil; Ex Situ Soil; Groundwater**	**Percent Detect or Non-detect in: In Situ; Ex Situ; Groundwater Groups**	**Percent Blue**	**Percent Green**	**Percent Yellow**	**Percent Orange**	**Percent Red**
Manganese	7439-96-5	SO	EX SITU	Y		0	0	0	0	0	0	0	0	0	0	0	0	0
Manganese	7439-96-5	SO	EX SITU	N		0	0	0	0	0	0	0	0	0	0	0	0	0
Manganese	7439-96-5	GW	IN SITU	Y	1700	20	0	0	0	0	20	20	100	100	0	0	0	0
Manganese	7439-96-5	GW	IN SITU	N	1700	0	0	0	0	0	0	20	0	0	0	0	0	0
MCPA (2-Methyl-4-chlorophenoxy acetic acid)	94-74-6	SO	IN SITU	Y	61	0	0	0	0	0	0	68	0	0	0	0	0	0
MCPA (2-Methyl-4-chlorophenoxy acetic acid)	94-74-6	SO	IN SITU	N	61	68	0	0	0	0	68	68	100	100	0	0	0	0
MCPA (2-Methyl-4-chlorophenoxy acetic acid)	94-74-6	SO	EX SITU	Y	61	0	0	0	0	0	0	8	0	0	0	0	0	0
MCPA (2-Methyl-4-chlorophenoxy acetic acid)	94-74-6	SO	EX SITU	N	61	8	0	0	0	0	8	8	100	100	0	0	0	0
MCPA (2-Methyl-4-chlorophenoxy acetic acid)	94-74-6	GW	IN SITU	Y		0	0	0	0	0	0	0	0	0	0	0	0	0
MCPA (2-Methyl-4-chlorophenoxy acetic acid)	94-74-6	GW	IN SITU	N		0	0	0	0	0	0	0	0	0	0	0	0	0
Mercury	7439-97-6	SO	IN SITU	Y	0.14	100	4	0	0	0	104	173	60.12	57.8	2.31	0	0	0
Mercury	7439-97-6	SO	IN SITU	N	0.14	69	0	0	0	0	69	173	39.88	39.88	0	0	0	0
Mercury	7439-97-6	SO	EX SITU	Y	0.14	70	0	0	0	0	70	80	87.5	87.5	0	0	0	0
Mercury	7439-97-6	SO	EX SITU	N	0.14	10	0	0	0	0	10	80	12.5	12.5	0	0	0	0
Mercury	7439-97-6	GW	IN SITU	Y	0.2	0	0	0	0	0	0	20	0	0	0	0	0	0
Mercury	7439-97-6	GW	IN SITU	N	0.2	20	0	0	0	0	20	20	100	100	0	0	0	0
Methoxychlor	72-43-5	SO	IN SITU	Y	5.2	4	0	0	0	0	4	160	2.5	2.5	0	0	0	0
Methoxychlor	72-43-5	SO	IN SITU	N	5.2	156	0	0	0	0	156	160	97.5	97.5	0	0	0	0
Methoxychlor	72-43-5	SO	EX SITU	Y	5.2	10	0	0	0	0	10	57	17.54	17.54	0	0	0	0
Methoxychlor	72-43-5	SO	EX SITU	N	5.2	47	0	0	0	0	47	57	82.46	82.46	0	0	0	0
Methoxychlor	72-43-5	GW	IN SITU	Y	4	1	0	0	0	0	1	20	5	5	0	0	0	0
Methoxychlor	72-43-5	GW	IN SITU	N	4	19	0	0	0	0	19	20	95	95	0	0	0	0
Methylene chloride	75-09-2	SO	IN SITU	Y	0.0015	0	0	10	4	1	15	197	7.61	0	0	5.08	2.03	0.51
Methylene chloride	75-09-2	SO	IN SITU	N	0.0015	20	144	13	2	3	182	197	92.39	10.15	73.1	6.6	1.02	1.52
Methylene chloride	75-09-2	SO	EX SITU	Y	0.0015	0	0	2	0	0	2	76	2.63	0	0	2.63	0	0
Methylene chloride	75-09-2	SO	EX SITU	N	0.0015	14	50	6	1	3	74	76	97.37	18.42	65.79	7.89	1.32	3.95
Methylene chloride	75-09-2	GW	IN SITU	Y	0.5	0	0	0	0	0	0	20	0	0	0	0	0	0
Methylene chloride	75-09-2	GW	IN SITU	N	0.5	20	0	0	0	0	20	20	100	100	0	0	0	0
Methyl-tert-butyl ether (MTBE)	1634-04-4	SO	IN SITU	Y	32	0	0	0	0	0	0	167	0	0	0	0	0	0
Methyl-tert-butyl ether (MTBE)	1634-04-4	SO	IN SITU	N	32	167	0	0	0	0	167	167	100	100	0	0	0	0
Methyl-tert-butyl ether (MTBE)	1634-04-4	SO	EX SITU	Y	32	0	0	0	0	0	0	70	0	0	0	0	0	0
Methyl-tert-butyl ether (MTBE)	1634-04-4	SO	EX SITU	N	32	70	0	0	0	0	70	70	100	100	0	0	0	0

TABLE 2-11
Summary of Chemical Data Relative To Screening Levels

1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19
Analyte Name	**CAS Number**	**Matrix**	**In Situ or Ex Situ?**	**Was Analyte Detected?**	**Screening Level (mg/kg or µg/L)**	**Blue Count (<=1*SL)**	**Green Count (>1*SL & <=10*SL)**	**Yellow Count (>10*SL & <=100*SL)**	**Orange Count (>100*SL & <=1000*SL)**	**Red Count (>1000*SL)**	**Total Count: Detect+ Non-detect**	**Total Count: In Situ Soil; Ex Situ Soil; Groundwater**	**Percent Detect or Non-detect in: In Situ; Ex Situ; Groundwater Groups**	**Percent Blue**	**Percent Green**	**Percent Yellow**	**Percent Orange**	**Percent Red**
Methyl-tert-butyl ether (MTBE)	1634-04-4	GW	IN SITU	Y	11	0	0	0	0	0	0	20	0	0	0	0	0	0
Methyl-tert-butyl ether (MTBE)	1634-04-4	GW	IN SITU	N	11	20	0	0	0	0	20	20	100	100	0	0	0	0
Naphthalene	91-20-3	SO	IN SITU	Y	2.1	0	1	0	0	0	1	212	0.47	0	0.47	0	0	0
Naphthalene	91-20-3	SO	IN SITU	N	2.1	210	1	0	0	0	211	212	99.53	99.06	0.47	0	0	0
Naphthalene	91-20-3	SO	EX SITU	Y	2.1	1	0	1	0	1	3	85	3.53	1.18	0	1.18	0	1.18
Naphthalene	91-20-3	SO	EX SITU	N	2.1	79	2	0	1	0	82	85	96.47	92.94	2.35	0	1.18	0
Naphthalene	91-20-3	GW	IN SITU	Y	6.2	1	0	0	0	0	1	20	5	5	0	0	0	0
Naphthalene	91-20-3	GW	IN SITU	N	6.2	19	0	0	0	0	19	20	95	95	0	0	0	0
n-Butylbenzene	104-51-8	SO	IN SITU	Y	61	3	0	0	0	0	3	197	1.52	1.52	0	0	0	0
n-Butylbenzene	104-51-8	SO	IN SITU	N	61	194	0	0	0	0	194	197	98.48	98.48	0	0	0	0
n-Butylbenzene	104-51-8	SO	EX SITU	Y	61	1	0	0	0	0	1	76	1.32	1.32	0	0	0	0
n-Butylbenzene	104-51-8	SO	EX SITU	N	61	75	0	0	0	0	75	76	98.68	98.68	0	0	0	0
n-Butylbenzene	104-51-8	GW	IN SITU	Y	140	0	0	0	0	0	0	20	0	0	0	0	0	0
n-Butylbenzene	104-51-8	GW	IN SITU	N	140	20	0	0	0	0	20	20	100	100	0	0	0	0
Nickel	7440-02-0	SO	IN SITU	Y	8.7	3	125	1	0	0	129	129	100	2.33	96.9	0.78	0	0
Nickel	7440-02-0	SO	IN SITU	N	8.7	0	0	0	0	0	0	129	0	0	0	0	0	0
Nickel	7440-02-0	SO	EX SITU	Y	8.7	1	70	0	0	0	71	71	100	1.41	98.59	0	0	0
Nickel	7440-02-0	SO	EX SITU	N	8.7	0	0	0	0	0	0	71	0	0	0	0	0	0
Nickel	7440-02-0	GW	IN SITU	Y	10	16	0	0	0	0	16	20	80	80	0	0	0	0
Nickel	7440-02-0	GW	IN SITU	N	10	4	0	0	0	0	4	20	20	20	0	0	0	0
Nitrobenzene	98-95-3	SO	IN SITU	Y	0.006	0	0	0	0	0	0	178	0	0	0	0	0	0
Nitrobenzene	98-95-3	SO	IN SITU	N	0.006	3	158	10	4	3	178	178	100	1.69	88.76	5.62	2.25	1.69
Nitrobenzene	98-95-3	SO	EX SITU	Y	0.006	0	0	1	0	0	1	76	1.32	0	0	1.32	0	0
Nitrobenzene	98-95-3	SO	EX SITU	N	0.006	17	49	1	5	3	75	76	98.68	22.37	64.47	1.32	6.58	3.95
Nitrobenzene	98-95-3	GW	IN SITU	Y	1.8	2	1	0	0	0	3	20	15	10	5	0	0	0
Nitrobenzene	98-95-3	GW	IN SITU	N	1.8	17	0	0	0	0	17	20	85	85	0	0	0	0
n-Nitrosodimethylamine	62-75-9	SO	IN SITU	Y	0.0023	0	0	0	0	0	0	148	0	0	0	0	0	0
n-Nitrosodimethylamine	62-75-9	SO	IN SITU	N	0.0023	0	73	55	17	3	148	148	100	0	49.32	37.16	11.49	2.03
n-Nitrosodimethylamine	62-75-9	SO	EX SITU	Y	0.0023	0	0	0	0	0	0	60	0	0	0	0	0	0
n-Nitrosodimethylamine	62-75-9	SO	EX SITU	N	0.0023	0	54	1	2	3	60	60	100	0	90	1.67	3.33	5
n-Nitrosodimethylamine	62-75-9	GW	IN SITU	Y	0.00042	0	0	0	0	0	0	20	0	0	0	0	0	0
n-Nitrosodimethylamine	62-75-9	GW	IN SITU	N	0.00042	0	0	0	0	20	20	20	100	0	0	0	0	100
n-Nitrosodi-n-propylamine	621-64-7	SO	IN SITU	Y	0.000036	0	0	0	0	2	2	174	1.15	0	0	0	0	1.15
n-Nitrosodi-n-propylamine	621-64-7	SO	IN SITU	N	0.000036	0	0	3	109	60	172	174	98.85	0	0	1.72	62.64	34.48
n-Nitrosodi-n-propylamine	621-64-7	SO	EX SITU	Y	0.000036	0	0	0	0	0	0	67	0	0	0	0	0	0
n-Nitrosodi-n-propylamine	621-64-7	SO	EX SITU	N	0.000036	0	0	18	40	9	67	67	100	0	0	26.87	59.7	13.43

TABLE 2-11
Summary of Chemical Data Relative To Screening Levels

1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19
Analyte Name	**CAS Number**	**Matrix**	**In Situ or Ex Situ?**	**Was Analyte Detected?**	**Screening Level (mg/kg or µg/L)**	**Blue Count (<=1*SL)**	**Green Count (>1*SL & <=10*SL)**	**Yellow Count (>10*SL & <=100*SL)**	**Orange Count (>100*SL & <=1000*SL)**	**Red Count (>1000*SL)**	**Total Count: Detect+ Non-detect**	**Total Count: In Situ Soil; Ex Situ Soil; Groundwater**	**Percent Detect or Non-detect in: In Situ; Ex Situ; Groundwater Groups**	**Percent Blue**	**Percent Green**	**Percent Yellow**	**Percent Orange**	**Percent Red**
n-Nitrosodi-n-propylamine	621-64-7	GW	IN SITU	Y	0.0096	0	0	0	0	0	0	20	0	0	0	0	0	0
n-Nitrosodi-n-propylamine	621-64-7	GW	IN SITU	N	0.0096	0	0	14	6	0	20	20	100	0	0	70	30	0
n-Nitrosodiphenylamine	86-30-6	SO	IN SITU	Y	0.34	0	0	0	0	0	0	174	0	0	0	0	0	0
n-Nitrosodiphenylamine	86-30-6	SO	IN SITU	N	0.34	155	16	0	3	0	174	174	100	89.08	9.2	0	1.72	0
n-Nitrosodiphenylamine	86-30-6	SO	EX SITU	Y	0.34	1	0	0	0	0	1	67	1.49	1.49	0	0	0	0
n-Nitrosodiphenylamine	86-30-6	SO	EX SITU	N	0.34	58	7	0	0	1	66	67	98.51	86.57	10.45	0	0	1.49
n-Nitrosodiphenylamine	86-30-6	GW	IN SITU	Y	14	0	0	0	0	0	0	20	0	0	0	0	0	0
n-Nitrosodiphenylamine	86-30-6	GW	IN SITU	N	14	20	0	0	0	0	20	20	100	100	0	0	0	0
Octahydro-1,3,5,7-tetranitro-1,3,5,7-tetrazocine (HMX)	2691-41-0	SO	IN SITU	Y	3100	0	0	0	0	0	0	91	0	0	0	0	0	0
Octahydro-1,3,5,7-tetranitro-1,3,5,7-tetrazocine (HMX)	2691-41-0	SO	IN SITU	N	3100	91	0	0	0	0	91	91	100	100	0	0	0	0
Octahydro-1,3,5,7-tetranitro-1,3,5,7-tetrazocine (HMX)	2691-41-0	SO	EX SITU	Y	3100	0	0	0	0	0	0	64	0	0	0	0	0	0
Octahydro-1,3,5,7-tetranitro-1,3,5,7-tetrazocine (HMX)	2691-41-0	SO	EX SITU	N	3100	64	0	0	0	0	64	64	100	100	0	0	0	0
Octahydro-1,3,5,7-tetranitro-1,3,5,7-tetrazocine (HMX)	2691-41-0	GW	IN SITU	Y	1800	2	0	0	0	0	2	10	20	20	0	0	0	0
Octahydro-1,3,5,7-tetranitro-1,3,5,7-tetrazocine (HMX)	2691-41-0	GW	IN SITU	N	1800	8	0	0	0	0	8	10	80	80	0	0	0	0
o-Xylene	95-47-6	SO	IN SITU	Y	280	3	0	0	0	0	3	197	1.52	1.52	0	0	0	0
o-Xylene	95-47-6	SO	IN SITU	N	280	194	0	0	0	0	194	197	98.48	98.48	0	0	0	0
o-Xylene	95-47-6	SO	EX SITU	Y	280	1	1	0	0	0	2	79	2.53	1.27	1.27	0	0	0
o-Xylene	95-47-6	SO	EX SITU	N	280	77	0	0	0	0	77	79	97.47	97.47	0	0	0	0
o-Xylene	95-47-6	GW	IN SITU	Y	1400	0	0	0	0	0	0	20	0	0	0	0	0	0
o-Xylene	95-47-6	GW	IN SITU	N	1400	20	0	0	0	0	20	20	100	100	0	0	0	0
PCB-1016 (Aroclor 1016)	12674-11-2	SO	IN SITU	Y	0.1	0	0	0	0	0	0	928	0	0	0	0	0	0
PCB-1016 (Aroclor 1016)	12674-11-2	SO	IN SITU	N	0.1	923	1	1	3	0	928	928	100	99.46	0.11	0.11	0.32	0
PCB-1016 (Aroclor 1016)	12674-11-2	SO	EX SITU	Y	0.1	0	0	0	0	0	0	276	0	0	0	0	0	0
PCB-1016 (Aroclor 1016)	12674-11-2	SO	EX SITU	N	0.1	273	2	0	0	1	276	276	100	98.91	0.72	0	0	0.36
PCB-1016 (Aroclor 1016)	12674-11-2	GW	IN SITU	Y	0.05	0	0	0	0	0	0	10	0	0	0	0	0	0
PCB-1016 (Aroclor 1016)	12674-11-2	GW	IN SITU	N	0.05	10	0	0	0	0	10	10	100	100	0	0	0	0
PCB-1221 (Aroclor 1221)	11104-28-2	SO	IN SITU	Y	0.1	0	0	0	0	0	0	928	0	0	0	0	0	0
PCB-1221 (Aroclor 1221)	11104-28-2	SO	IN SITU	N	0.1	814	110	1	3	0	928	928	100	87.72	11.85	0.11	0.32	0
PCB-1221 (Aroclor 1221)	11104-28-2	SO	EX SITU	Y	0.1	0	0	0	0	0	0	276	0	0	0	0	0	0
PCB-1221 (Aroclor 1221)	11104-28-2	SO	EX SITU	N	0.1	215	60	0	0	1	276	276	100	77.9	21.74	0	0	0.36
PCB-1221 (Aroclor 1221)	11104-28-2	GW	IN SITU	Y	0.034	0	0	0	0	0	0	10	0	0	0	0	0	0
PCB-1221 (Aroclor 1221)	11104-28-2	GW	IN SITU	N	0.034	10	0	0	0	0	10	10	100	100	0	0	0	0

TABLE 2-11
Summary of Chemical Data Relative To Screening Levels

1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19
Analyte Name	**CAS Number**	**Matrix**	**In Situ or Ex Situ?**	**Was Analyte Detected?**	**Screening Level (mg/kg or µg/L)**	**Blue Count (<=1*SL)**	**Green Count (>1*SL & <=10*SL)**	**Yellow Count (>10*SL & <=100*SL)**	**Orange Count (>100*SL & <=1000*SL)**	**Red Count (>1000*SL)**	**Total Count: Detect+ Non-detect**	**Total Count: In Situ Soil; Ex Situ Soil; Groundwater**	**Percent Detect or Non-detect in: In Situ; Ex Situ; Groundwater Groups**	**Percent Blue**	**Percent Green**	**Percent Yellow**	**Percent Orange**	**Percent Red**
PCB-1232 (Aroclor 1232)	11141-16-5	SO	IN SITU	Y	0.1	0	0	0	0	0	0	928	0	0	0	0	0	0
PCB-1232 (Aroclor 1232)	11141-16-5	SO	IN SITU	N	0.1	923	1	1	3	0	928	928	100	99.46	0.11	0.11	0.32	0
PCB-1232 (Aroclor 1232)	11141-16-5	SO	EX SITU	Y	0.1	0	0	0	0	0	0	276	0	0	0	0	0	0
PCB-1232 (Aroclor 1232)	11141-16-5	SO	EX SITU	N	0.1	273	2	0	0	1	276	276	100	98.91	0.72	0	0	0.36
PCB-1232 (Aroclor 1232)	11141-16-5	GW	IN SITU	Y	0.034	0	0	0	0	0	0	10	0	0	0	0	0	0
PCB-1232 (Aroclor 1232)	11141-16-5	GW	IN SITU	N	0.034	10	0	0	0	0	10	10	100	100	0	0	0	0
PCB-1242 (Aroclor 1242)	53469-21-9	SO	IN SITU	Y	0.1	0	0	0	0	0	0	928	0	0	0	0	0	0
PCB-1242 (Aroclor 1242)	53469-21-9	SO	IN SITU	N	0.1	923	1	1	3	0	928	928	100	99.46	0.11	0.11	0.32	0
PCB-1242 (Aroclor 1242)	53469-21-9	SO	EX SITU	Y	0.1	0	0	0	0	0	0	276	0	0	0	0	0	0
PCB-1242 (Aroclor 1242)	53469-21-9	SO	EX SITU	N	0.1	273	2	0	0	1	276	276	100	98.91	0.72	0	0	0.36
PCB-1242 (Aroclor 1242)	53469-21-9	GW	IN SITU	Y	0.034	0	0	0	0	0	0	10	0	0	0	0	0	0
PCB-1242 (Aroclor 1242)	53469-21-9	GW	IN SITU	N	0.034	10	0	0	0	0	10	10	100	100	0	0	0	0
PCB-1248 (Aroclor 1248)	12672-29-6	SO	IN SITU	Y	0.1	0	0	0	0	0	0	928	0	0	0	0	0	0
PCB-1248 (Aroclor 1248)	12672-29-6	SO	IN SITU	N	0.1	923	1	1	3	0	928	928	100	99.46	0.11	0.11	0.32	0
PCB-1248 (Aroclor 1248)	12672-29-6	SO	EX SITU	Y	0.1	0	0	0	0	0	0	276	0	0	0	0	0	0
PCB-1248 (Aroclor 1248)	12672-29-6	SO	EX SITU	N	0.1	273	2	0	0	1	276	276	100	98.91	0.72	0	0	0.36
PCB-1248 (Aroclor 1248)	12672-29-6	GW	IN SITU	Y	0.034	0	0	0	0	0	0	10	0	0	0	0	0	0
PCB-1248 (Aroclor 1248)	12672-29-6	GW	IN SITU	N	0.034	10	0	0	0	0	10	10	100	100	0	0	0	0
PCB-1254 (Aroclor 1254)	11097-69-1	SO	IN SITU	Y	0.1	0	4	0	0	0	4	928	0.43	0	0.43	0	0	0
PCB-1254 (Aroclor 1254)	11097-69-1	SO	IN SITU	N	0.1	919	1	1	3	0	924	928	99.57	99.03	0.11	0.11	0.32	0
PCB-1254 (Aroclor 1254)	11097-69-1	SO	EX SITU	Y	0.1	0	0	0	0	0	0	276	0	0	0	0	0	0
PCB-1254 (Aroclor 1254)	11097-69-1	SO	EX SITU	N	0.1	273	2	0	0	1	276	276	100	98.91	0.72	0	0	0.36
PCB-1254 (Aroclor 1254)	11097-69-1	GW	IN SITU	Y	0.034	0	0	0	0	0	0	10	0	0	0	0	0	0
PCB-1254 (Aroclor 1254)	11097-69-1	GW	IN SITU	N	0.034	10	0	0	0	0	10	10	100	100	0	0	0	0
PCB-1260 (Aroclor 1260)	11096-82-5	SO	IN SITU	Y	0.1	76	48	10	7	5	146	928	15.73	8.19	5.17	1.08	0.75	0.54
PCB-1260 (Aroclor 1260)	11096-82-5	SO	IN SITU	N	0.1	782	0	0	0	0	782	928	84.27	84.27	0	0	0	0
PCB-1260 (Aroclor 1260)	11096-82-5	SO	EX SITU	Y	0.1	11	17	5	0	1	34	276	12.32	3.99	6.16	1.81	0	0.36
PCB-1260 (Aroclor 1260)	11096-82-5	SO	EX SITU	N	0.1	241	1	0	0	0	242	276	87.68	87.32	0.36	0	0	0
PCB-1260 (Aroclor 1260)	11096-82-5	GW	IN SITU	Y	0.034	0	0	0	0	0	0	10	0	0	0	0	0	0
PCB-1260 (Aroclor 1260)	11096-82-5	GW	IN SITU	N	0.034	10	0	0	0	0	10	10	100	100	0	0	0	0
PCBs (total)	1336-36-3	SO	IN SITU	Y	0.1	48	78	12	7	5	150	933	16.08	5.14	8.36	1.29	0.75	0.54
PCBs (total)	1336-36-3	SO	IN SITU	N	0.1	676	107	0	0	0	783	933	83.92	72.45	11.47	0	0	0
PCBs (total)	1336-36-3	SO	EX SITU	Y	0.1	4	24	5	0	1	34	277	12.27	1.44	8.66	1.81	0	0.36
PCBs (total)	1336-36-3	SO	EX SITU	N	0.1	183	60	0	0	0	243	277	87.73	66.06	21.66	0	0	0
PCBs (total)	1336-36-3	GW	IN SITU	Y	0.05	0	0	0	0	0	0	10	0	0	0	0	0	0
PCBs (total)	1336-36-3	GW	IN SITU	N	0.05	0	10	0	0	0	10	10	100	0	100	0	0	0

TABLE 2-11
Summary of Chemical Data Relative To Screening Levels

1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19
Analyte Name	**CAS Number**	**Matrix**	**In Situ or Ex Situ?**	**Was Analyte Detected?**	**Screening Level (mg/kg or µg/L)**	**Blue Count (<=1*SL)**	**Green Count (>1*SL & <=10*SL)**	**Yellow Count (>10*SL & <=100*SL)**	**Orange Count (>100*SL & <=1000*SL)**	**Red Count (>1000*SL)**	**Total Count: Detect+ Non-detect**	**Total Count: In Situ Soil; Ex Situ Soil; Groundwater**	**Percent Detect or Non-detect in: In Situ; Ex Situ; Groundwater Groups**	**Percent Blue**	**Percent Green**	**Percent Yellow**	**Percent Orange**	**Percent Red**
Pentachlorophenol	87-86-5	SO	IN SITU	Y	0.001	0	0	3	1	0	4	176	2.27	0	0	1.7	0.57	0
Pentachlorophenol	87-86-5	SO	IN SITU	N	0.001	45	21	0	88	18	172	176	97.73	25.57	11.93	0	50	10.23
Pentachlorophenol	87-86-5	SO	EX SITU	Y	0.001	0	0	10	0	1	11	67	16.42	0	0	14.93	0	1.49
Pentachlorophenol	87-86-5	SO	EX SITU	N	0.001	2	13	1	32	8	56	67	83.58	2.99	19.4	1.49	47.76	11.94
Pentachlorophenol	87-86-5	GW	IN SITU	Y	0.1	0	0	0	0	0	0	20	0	0	0	0	0	0
Pentachlorophenol	87-86-5	GW	IN SITU	N	0.1	0	0	14	6	0	20	20	100	0	0	70	30	0
Phenanthrene	85-01-8	SO	IN SITU	Y	430	7	0	0	0	0	7	174	4.02	4.02	0	0	0	0
Phenanthrene	85-01-8	SO	IN SITU	N	430	167	0	0	0	0	167	174	95.98	95.98	0	0	0	0
Phenanthrene	85-01-8	SO	EX SITU	Y	430	16	0	0	0	0	16	67	23.88	23.88	0	0	0	0
Phenanthrene	85-01-8	SO	EX SITU	N	430	51	0	0	0	0	51	67	76.12	76.12	0	0	0	0
Phenanthrene	85-01-8	GW	IN SITU	Y	1100	0	0	0	0	0	0	20	0	0	0	0	0	0
Phenanthrene	85-01-8	GW	IN SITU	N	1100	20	0	0	0	0	20	20	100	100	0	0	0	0
Phenol	108-95-2	SO	IN SITU	Y	6.7	1	0	0	0	0	1	174	0.57	0.57	0	0	0	0
Phenol	108-95-2	SO	IN SITU	N	6.7	170	2	1	0	0	173	174	99.43	97.7	1.15	0.57	0	0
Phenol	108-95-2	SO	EX SITU	Y	6.7	0	0	0	0	0	0	67	0	0	0	0	0	0
Phenol	108-95-2	SO	EX SITU	N	6.7	66	0	1	0	0	67	67	100	98.51	0	1.49	0	0
Phenol	108-95-2	GW	IN SITU	Y	2200	0	0	0	0	0	0	20	0	0	0	0	0	0
Phenol	108-95-2	GW	IN SITU	N	2200	20	0	0	0	0	20	20	100	100	0	0	0	0
Pyrene	129-00-0	SO	IN SITU	Y	150	5	0	0	0	0	5	174	2.87	2.87	0	0	0	0
Pyrene	129-00-0	SO	IN SITU	N	150	169	0	0	0	0	169	174	97.13	97.13	0	0	0	0
Pyrene	129-00-0	SO	EX SITU	Y	150	14	0	0	0	0	14	67	20.9	20.9	0	0	0	0
Pyrene	129-00-0	SO	EX SITU	N	150	52	1	0	0	0	53	67	79.1	77.61	1.49	0	0	0
Pyrene	129-00-0	GW	IN SITU	Y	110	0	0	0	0	0	0	20	0	0	0	0	0	0
Pyrene	129-00-0	GW	IN SITU	N	110	20	0	0	0	0	20	20	100	100	0	0	0	0
sec-Butylbenzene	135-98-8	SO	IN SITU	Y	61	2	0	0	0	0	2	197	1.02	1.02	0	0	0	0
sec-Butylbenzene	135-98-8	SO	IN SITU	N	61	195	0	0	0	0	195	197	98.98	98.98	0	0	0	0
sec-Butylbenzene	135-98-8	SO	EX SITU	Y	61	1	1	0	0	0	2	76	2.63	1.32	1.32	0	0	0
sec-Butylbenzene	135-98-8	SO	EX SITU	N	61	74	0	0	0	0	74	76	97.37	97.37	0	0	0	0
sec-Butylbenzene	135-98-8	GW	IN SITU	Y	110	2	0	0	0	0	2	20	10	10	0	0	0	0
sec-Butylbenzene	135-98-8	GW	IN SITU	N	110	18	0	0	0	0	18	20	90	90	0	0	0	0
Selenium	7782-49-2	SO	IN SITU	Y	0.35	79	70	0	0	0	149	180	82.78	43.89	38.89	0	0	0
Selenium	7782-49-2	SO	IN SITU	N	0.35	31	0	0	0	0	31	180	17.22	17.22	0	0	0	0
Selenium	7782-49-2	SO	EX SITU	Y	0.35	29	44	1	0	0	74	81	91.36	35.8	54.32	1.23	0	0
Selenium	7782-49-2	SO	EX SITU	N	0.35	7	0	0	0	0	7	81	8.64	8.64	0	0	0	0
Selenium	7782-49-2	GW	IN SITU	Y	5	0	0	0	0	0	0	20	0	0	0	0	0	0
Selenium	7782-49-2	GW	IN SITU	N	5	20	0	0	0	0	20	20	100	100	0	0	0	0

TABLE 2-11
Summary of Chemical Data Relative To Screening Levels

1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19
Analyte Name	**CAS Number**	**Matrix**	**In Situ or Ex Situ?**	**Was Analyte Detected?**	**Screening Level (mg/kg or µg/L)**	**Blue Count (<=1*SL)**	**Green Count (>1*SL & <=10*SL)**	**Yellow Count (>10*SL & <=100*SL)**	**Orange Count (>100*SL & <=1000*SL)**	**Red Count (>1000*SL)**	**Total Count: Detect+ Non-detect**	**Total Count: In Situ Soil; Ex Situ Soil; Groundwater**	**Percent Detect or Non-detect in: In Situ; Ex Situ; Groundwater Groups**	**Percent Blue**	**Percent Green**	**Percent Yellow**	**Percent Orange**	**Percent Red**
Silver	7440-22-4	SO	IN SITU	Y	2.1	94	0	0	0	0	94	181	51.93	51.93	0	0	0	0
Silver	7440-22-4	SO	IN SITU	N	2.1	87	0	0	0	0	87	181	48.07	48.07	0	0	0	0
Silver	7440-22-4	SO	EX SITU	Y	2.1	68	0	0	0	0	68	81	83.95	83.95	0	0	0	0
Silver	7440-22-4	SO	EX SITU	N	2.1	13	0	0	0	0	13	81	16.05	16.05	0	0	0	0
Silver	7440-22-4	GW	IN SITU	Y	18	0	0	0	0	0	0	20	0	0	0	0	0	0
Silver	7440-22-4	GW	IN SITU	N	18	20	0	0	0	0	20	20	100	100	0	0	0	0
Styrene	100-42-5	SO	IN SITU	Y	0.13	0	0	0	0	0	0	197	0	0	0	0	0	0
Styrene	100-42-5	SO	IN SITU	N	0.13	192	4	1	0	0	197	197	100	97.46	2.03	0.51	0	0
Styrene	100-42-5	SO	EX SITU	Y	0.13	0	0	0	0	0	0	76	0	0	0	0	0	0
Styrene	100-42-5	SO	EX SITU	N	0.13	72	1	3	0	0	76	76	100	94.74	1.32	3.95	0	0
Styrene	100-42-5	GW	IN SITU	Y	10	0	0	0	0	0	0	20	0	0	0	0	0	0
Styrene	100-42-5	GW	IN SITU	N	10	20	0	0	0	0	20	20	100	100	0	0	0	0
tert-Butylbenzene	98-06-6	SO	IN SITU	Y	130	1	0	0	0	0	1	197	0.51	0.51	0	0	0	0
tert-Butylbenzene	98-06-6	SO	IN SITU	N	130	196	0	0	0	0	196	197	99.49	99.49	0	0	0	0
tert-Butylbenzene	98-06-6	SO	EX SITU	Y	130	0	0	0	0	0	0	76	0	0	0	0	0	0
tert-Butylbenzene	98-06-6	SO	EX SITU	N	130	76	0	0	0	0	76	76	100	100	0	0	0	0
tert-Butylbenzene	98-06-6	GW	IN SITU	Y	61	2	0	0	0	0	2	20	10	10	0	0	0	0
tert-Butylbenzene	98-06-6	GW	IN SITU	N	61	18	0	0	0	0	18	20	90	90	0	0	0	0
Tetrachloroethene (PCE)	127-18-4	SO	IN SITU	Y	0.003	0	0	0	0	0	0	197	0	0	0	0	0	0
Tetrachloroethene (PCE)	127-18-4	SO	IN SITU	N	0.003	143	47	3	3	1	197	197	100	72.59	23.86	1.52	1.52	0.51
Tetrachloroethene (PCE)	127-18-4	SO	EX SITU	Y	0.003	0	0	0	0	0	0	76	0	0	0	0	0	0
Tetrachloroethene (PCE)	127-18-4	SO	EX SITU	N	0.003	37	35	1	2	1	76	76	100	48.68	46.05	1.32	2.63	1.32
Tetrachloroethene (PCE)	127-18-4	GW	IN SITU	Y	0.1	0	0	0	0	0	0	20	0	0	0	0	0	0
Tetrachloroethene (PCE)	127-18-4	GW	IN SITU	N	0.1	0	20	0	0	0	20	20	100	0	100	0	0	0
Thallium	7440-28-0	SO	IN SITU	Y	5.5	80	0	0	0	0	80	129	62.02	62.02	0	0	0	0
Thallium	7440-28-0	SO	IN SITU	N	5.5	49	0	0	0	0	49	129	37.98	37.98	0	0	0	0
Thallium	7440-28-0	SO	EX SITU	Y	5.5	21	0	0	0	0	21	71	29.58	29.58	0	0	0	0
Thallium	7440-28-0	SO	EX SITU	N	5.5	50	0	0	0	0	50	71	70.42	70.42	0	0	0	0
Thallium	7440-28-0	GW	IN SITU	Y	0.2	0	0	0	0	0	0	20	0	0	0	0	0	0
Thallium	7440-28-0	GW	IN SITU	N	0.2	6	14	0	0	0	20	20	100	30	70	0	0	0
Toluene	108-88-3	SO	IN SITU	Y	0.54	33	1	0	1	0	35	241	14.52	13.69	0.41	0	0.41	0
Toluene	108-88-3	SO	IN SITU	N	0.54	204	1	1	0	0	206	241	85.48	84.65	0.41	0.41	0	0
Toluene	108-88-3	SO	EX SITU	Y	0.54	2	0	2	0	0	4	85	4.71	2.35	0	2.35	0	0
Toluene	108-88-3	SO	EX SITU	N	0.54	80	1	0	0	0	81	85	95.29	94.12	1.18	0	0	0
Toluene	108-88-3	GW	IN SITU	Y	100	0	0	0	0	0	0	20	0	0	0	0	0	0
Toluene	108-88-3	GW	IN SITU	N	100	20	0	0	0	0	20	20	100	100	0	0	0	0

TABLE 2-11
Summary of Chemical Data Relative To Screening Levels

1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19
Analyte Name	**CAS Number**	**Matrix**	**In Situ or Ex Situ?**	**Was Analyte Detected?**	**Screening Level (mg/kg or µg/L)**	**Blue Count (<=1*SL)**	**Green Count (>1*SL & <=10*SL)**	**Yellow Count (>10*SL & <=100*SL)**	**Orange Count (>100*SL & <=1000*SL)**	**Red Count (>1000*SL)**	**Total Count: Detect+ Non-detect**	**Total Count: In Situ Soil; Ex Situ Soil; Groundwater**	**Percent Detect or Non-detect in: In Situ; Ex Situ; Groundwater Groups**	**Percent Blue**	**Percent Green**	**Percent Yellow**	**Percent Orange**	**Percent Red**
Toxaphene	8001-35-2	SO	IN SITU	Y	0.8	0	0	0	0	0	0	166	0	0	0	0	0	0
Toxaphene	8001-35-2	SO	IN SITU	N	0.8	166	0	0	0	0	166	166	100	100	0	0	0	0
Toxaphene	8001-35-2	SO	EX SITU	Y	0.8	0	0	0	0	0	0	57	0	0	0	0	0	0
Toxaphene	8001-35-2	SO	EX SITU	N	0.8	57	0	0	0	0	57	57	100	100	0	0	0	0
Toxaphene	8001-35-2	GW	IN SITU	Y	0.3	0	0	0	0	0	0	20	0	0	0	0	0	0
Toxaphene	8001-35-2	GW	IN SITU	N	0.3	17	3	0	0	0	20	20	100	85	15	0	0	0
TPH-Diesel	PHCD	SO	IN SITU	Y	25	52	2	3	14	0	71	131	54.2	39.69	1.53	2.29	10.69	0
TPH-Diesel	PHCD	SO	IN SITU	N	25	60	0	0	0	0	60	131	45.8	45.8	0	0	0	0
TPH-Diesel	PHCD	SO	EX SITU	Y	25	23	15	22	0	1	61	67	91.04	34.33	22.39	32.84	0	1.49
TPH-Diesel	PHCD	SO	EX SITU	N	25	6	0	0	0	0	6	67	8.96	8.96	0	0	0	0
TPH-Diesel	PHCD	GW	IN SITU	Y	150	4	1	3	0	0	8	20	40	20	5	15	0	0
TPH-Diesel	PHCD	GW	IN SITU	N	150	12	0	0	0	0	12	20	60	60	0	0	0	0
TPH-Gasoline	PHCG	SO	IN SITU	Y	30	2	0	0	0	0	2	64	3.13	3.13	0	0	0	0
TPH-Gasoline	PHCG	SO	IN SITU	N	30	62	0	0	0	0	62	64	96.88	96.88	0	0	0	0
TPH-Gasoline	PHCG	SO	EX SITU	Y	30	10	1	0	1	0	12	67	17.91	14.93	1.49	0	1.49	0
TPH-Gasoline	PHCG	SO	EX SITU	N	30	55	0	0	0	0	55	67	82.09	82.09	0	0	0	0
TPH-Gasoline	PHCG	GW	IN SITU	Y	130	4	0	0	0	0	4	20	20	20	0	0	0	0
TPH-Gasoline	PHCG	GW	IN SITU	N	130	16	0	0	0	0	16	20	80	80	0	0	0	0
TPH-Motor Oil	TPH-Oil	SO	IN SITU	Y	1000	53	0	0	0	0	53	87	60.92	60.92	0	0	0	0
TPH-Motor Oil	TPH-Oil	SO	IN SITU	N	1000	34	0	0	0	0	34	87	39.08	39.08	0	0	0	0
TPH-Motor Oil	TPH-Oil	SO	EX SITU	Y	1000	35	1	0	0	0	36	60	60	58.33	1.67	0	0	0
TPH-Motor Oil	TPH-Oil	SO	EX SITU	N	1000	24	0	0	0	0	24	60	40	40	0	0	0	0
TPH-Motor Oil	TPH-Oil	GW	IN SITU	Y	110	0	1	0	0	0	1	20	5	0	5	0	0	0
TPH-Motor Oil	TPH-Oil	GW	IN SITU	N	110	16	3	0	0	0	19	20	95	80	15	0	0	0
trans-1,2-Dichloroethene	156-60-5	SO	IN SITU	Y	0.04	0	0	0	0	0	0	197	0	0	0	0	0	0
trans-1,2-Dichloroethene	156-60-5	SO	IN SITU	N	0.04	191	2	3	1	0	197	197	100	96.95	1.02	1.52	0.51	0
trans-1,2-Dichloroethene	156-60-5	SO	EX SITU	Y	0.04	0	0	0	0	0	0	76	0	0	0	0	0	0
trans-1,2-Dichloroethene	156-60-5	SO	EX SITU	N	0.04	72	1	2	1	0	76	76	100	94.74	1.32	2.63	1.32	0
trans-1,2-Dichloroethene	156-60-5	GW	IN SITU	Y	10	0	0	0	0	0	0	20	0	0	0	0	0	0
trans-1,2-Dichloroethene	156-60-5	GW	IN SITU	N	10	20	0	0	0	0	20	20	100	100	0	0	0	0
trans-1,3-Dichloropropene	10061-02-6	SO	IN SITU	Y	0.002	0	0	0	0	0	0	197	0	0	0	0	0	0
trans-1,3-Dichloropropene	10061-02-6	SO	IN SITU	N	0.002	70	119	3	4	1	197	197	100	35.53	60.41	1.52	2.03	0.51
trans-1,3-Dichloropropene	10061-02-6	SO	EX SITU	Y	0.002	0	0	0	0	0	0	76	0	0	0	0	0	0
trans-1,3-Dichloropropene	10061-02-6	SO	EX SITU	N	0.002	22	50	0	1	3	76	76	100	28.95	65.79	0	1.32	3.95
trans-1,3-Dichloropropene	10061-02-6	GW	IN SITU	Y	0.4	0	0	0	0	0	0	20	0	0	0	0	0	0
trans-1,3-Dichloropropene	10061-02-6	GW	IN SITU	N	0.4	20	0	0	0	0	20	20	100	100	0	0	0	0

TABLE 2-11
Summary of Chemical Data Relative To Screening Levels

1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19
Analyte Name	**CAS Number**	**Matrix**	**In Situ or Ex Situ?**	**Was Analyte Detected?**	**Screening Level (mg/kg or µg/L)**	**Blue Count (<=1*SL)**	**Green Count (>1*SL & <=10*SL)**	**Yellow Count (>10*SL & <=100*SL)**	**Orange Count (>100*SL & <=1000*SL)**	**Red Count (>1000*SL)**	**Total Count: Detect+ Non-detect**	**Total Count: In Situ Soil; Ex Situ Soil; Groundwater**	**Percent Detect or Non-detect in: In Situ; Ex Situ; Groundwater Groups**	**Percent Blue**	**Percent Green**	**Percent Yellow**	**Percent Orange**	**Percent Red**
Trichloroethene (TCE)	79-01-6	SO	IN SITU	Y	0.002	0	0	0	0	0	0	197	0	0	0	0	0	0
Trichloroethene (TCE)	79-01-6	SO	IN SITU	N	0.002	51	138	3	4	1	197	197	100	25.89	70.05	1.52	2.03	0.51
Trichloroethene (TCE)	79-01-6	SO	EX SITU	Y	0.002	0	0	0	0	0	0	76	0	0	0	0	0	0
Trichloroethene (TCE)	79-01-6	SO	EX SITU	N	0.002	18	54	0	1	3	76	76	100	23.68	71.05	0	1.32	3.95
Trichloroethene (TCE)	79-01-6	GW	IN SITU	Y	0.028	0	0	0	0	0	0	20	0	0	0	0	0	0
Trichloroethene (TCE)	79-01-6	GW	IN SITU	N	0.028	0	20	0	0	0	20	20	100	0	100	0	0	0
Trichlorofluoromethane	75-69-4	SO	IN SITU	Y	390	0	0	0	0	0	0	197	0	0	0	0	0	0
Trichlorofluoromethane	75-69-4	SO	IN SITU	N	390	197	0	0	0	0	197	197	100	100	0	0	0	0
Trichlorofluoromethane	75-69-4	SO	EX SITU	Y	390	0	0	0	0	0	0	76	0	0	0	0	0	0
Trichlorofluoromethane	75-69-4	SO	EX SITU	N	390	76	0	0	0	0	76	76	100	100	0	0	0	0
Trichlorofluoromethane	75-69-4	GW	IN SITU	Y	1300	0	0	0	0	0	0	20	0	0	0	0	0	0
Trichlorofluoromethane	75-69-4	GW	IN SITU	N	1300	20	0	0	0	0	20	20	100	100	0	0	0	0
Trichlorotrifluoroethane (Freon 113)	76-13-1	SO	IN SITU	Y	466	0	0	0	0	0	0	4	0	0	0	0	0	0
Trichlorotrifluoroethane (Freon 113)	76-13-1	SO	IN SITU	N	466	4	0	0	0	0	4	4	100	100	0	0	0	0
Trichlorotrifluoroethane (Freon 113)	76-13-1	SO	EX SITU	Y	466	0	0	0	0	0	0	0	0	0	0	0	0	0
Trichlorotrifluoroethane (Freon 113)	76-13-1	SO	EX SITU	N	466	0	0	0	0	0	0	0	0	0	0	0	0	0
Trichlorotrifluoroethane (Freon 113)	76-13-1	GW	IN SITU	Y		0	0	0	0	0	0	0	0	0	0	0	0	0
Trichlorotrifluoroethane (Freon 113)	76-13-1	GW	IN SITU	N		0	0	0	0	0	0	0	0	0	0	0	0	0
Vanadium	7440-62-2	SO	IN SITU	Y	71	129	0	0	0	0	129	129	100	100	0	0	0	0
Vanadium	7440-62-2	SO	IN SITU	N	71	0	0	0	0	0	0	129	0	0	0	0	0	0
Vanadium	7440-62-2	SO	EX SITU	Y	71	71	0	0	0	0	71	71	100	100	0	0	0	0
Vanadium	7440-62-2	SO	EX SITU	N	71	0	0	0	0	0	0	71	0	0	0	0	0	0
Vanadium	7440-62-2	GW	IN SITU	Y	26	0	0	0	0	0	0	20	0	0	0	0	0	0
Vanadium	7440-62-2	GW	IN SITU	N	26	20	0	0	0	0	20	20	100	100	0	0	0	0
Vinyl chloride	75-01-4	SO	IN SITU	Y	0.0009	0	0	0	0	0	0	197	0	0	0	0	0	0
Vinyl chloride	75-01-4	SO	IN SITU	N	0.0009	0	182	10	4	1	197	197	100	0	92.39	5.08	2.03	0.51
Vinyl chloride	75-01-4	SO	EX SITU	Y	0.0009	0	0	0	0	0	0	76	0	0	0	0	0	0
Vinyl chloride	75-01-4	SO	EX SITU	N	0.0009	1	63	8	1	3	76	76	100	1.32	82.89	10.53	1.32	3.95
Vinyl chloride	75-01-4	GW	IN SITU	Y	0.015	0	0	0	0	0	0	20	0	0	0	0	0	0
Vinyl chloride	75-01-4	GW	IN SITU	N	0.015	0	14	6	0	0	20	20	100	0	70	30	0	0
Xylene (calculated total)	XYLENESCALC	SO	IN SITU	Y	280	5	0	0	0	0	5	197	2.54	2.54	0	0	0	0
Xylene (calculated total)	XYLENESCALC	SO	IN SITU	N	280	192	0	0	0	0	192	197	97.46	97.46	0	0	0	0
Xylene (calculated total)	XYLENESCALC	SO	EX SITU	Y	280	4	1	0	0	0	5	79	6.33	5.06	1.27	0	0	0
Xylene (calculated total)	XYLENESCALC	SO	EX SITU	N	280	74	0	0	0	0	74	79	93.67	93.67	0	0	0	0
Xylene (calculated total)	XYLENESCALC	GW	IN SITU	Y	1400	0	0	0	0	0	0	20	0	0	0	0	0	0
Xylene (calculated total)	XYLENESCALC	GW	IN SITU	N	1400	20	0	0	0	0	20	20	100	100	0	0	0	0

TABLE 2-11
Summary of Chemical Data Relative To Screening Levels

1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19
Analyte Name	**CAS Number**	**Matrix**	**In Situ or Ex Situ?**	**Was Analyte Detected?**	**Screening Level (mg/kg or µg/L)**	**Blue Count (<=1*SL)**	**Green Count (>1*SL & <=10*SL)**	**Yellow Count (>10*SL & <=100*SL)**	**Orange Count (>100*SL & <=1000*SL)**	**Red Count (>1000*SL)**	**Total Count: Detect+ Non-detect**	**Total Count: In Situ Soil; Ex Situ Soil; Groundwater**	**Percent Detect or Non-detect in: In Situ; Ex Situ; Groundwater Groups**	**Percent Blue**	**Percent Green**	**Percent Yellow**	**Percent Orange**	**Percent Red**
Xylenes, Total	1330-20-7	SO	IN SITU	Y	7.8	27	0	0	0	0	27	71	38.03	38.03	0	0	0	0
Xylenes, Total	1330-20-7	SO	IN SITU	N	7.8	44	0	0	0	0	44	71	61.97	61.97	0	0	0	0
Xylenes, Total	1330-20-7	SO	EX SITU	Y	7.8	0	0	0	0	0	0	9	0	0	0	0	0	0
Xylenes, Total	1330-20-7	SO	EX SITU	N	7.8	9	0	0	0	0	9	9	100	100	0	0	0	0
Xylenes, Total	1330-20-7	GW	IN SITU	Y		0	0	0	0	0	0	0	0	0	0	0	0	0
Xylenes, Total	1330-20-7	GW	IN SITU	N		0	0	0	0	0	0	0	0	0	0	0	0	0
Zinc	7440-66-6	SO	IN SITU	Y	910	129	0	0	0	0	129	129	100	100	0	0	0	0
Zinc	7440-66-6	SO	IN SITU	N	910	0	0	0	0	0	0	129	0	0	0	0	0	0
Zinc	7440-66-6	SO	EX SITU	Y	910	66	1	4	0	0	71	71	100	92.96	1.41	5.63	0	0
Zinc	7440-66-6	SO	EX SITU	N	910	0	0	0	0	0	0	71	0	0	0	0	0	0
Zinc	7440-66-6	GW	IN SITU	Y	1100	17	0	0	0	0	17	20	85	85	0	0	0	0
Zinc	7440-66-6	GW	IN SITU	N	1100	3	0	0	0	0	3	20	15	15	0	0	0	0

Notes:
GW = groundwater
mg/kg = milligrams per kilogram
µg/L = micrograms per liter
SO = soil

TABLE 2-12
Analyte Frequency of Detection in In Situ Soil

1	2	3	4	5	6	7	8	9	10
Analyte Name	**CAS Number**	**Screening Level (µg/L)**	**Total Count: In Situ Soil**	**Percent Detect in In Situ Soil**	**Percent Blue**	**Percent Green**	**Percent Yellow**	**Percent Orange**	**Percent Red**
Arsenic	7440-38-2	16.63	181	100	97.79	2.21	0	0	0
Barium	7440-39-3	110	181	100	75.69	24.31	0	0	0
Beryllium	7440-41-7	4.2	129	100	100	0	0	0	0
Chromium	7440-47-3	30	181	100	94.48	5.52	0	0	0
Cobalt	7440-48-4	90	129	100	100	0	0	0	0
Copper	7440-50-8	406	129	100	98.45	1.55	0	0	0
Lead	7439-92-1	40	181	100	93.92	5.52	0	0	0.55
Nickel	7440-02-0	8.7	129	100	2.33	96.9	0.78	0	0
Vanadium	7440-62-2	71	129	100	100	0	0	0	0
Zinc	7440-66-6	910	129	100	100	0	0	0	0
Selenium	7782-49-2	0.35	180	82.78	43.89	38.89	0	0	0
Cadmium	7440-43-9	0.5	181	75.69	70.17	3.87	1.66	0	0
Thallium	7440-28-0	5.5	129	62.02	62.02	0	0	0	0
Antimony	7440-36-0	0.36	129	61.24	42.64	17.83	0.78	0	0
TPH-Motor Oil	TPH-Oil	1000	87	60.92	60.92	0	0	0	0
Mercury	7439-97-6	0.14	173	60.12	57.8	2.31	0	0	0
4,4'-DDT	50-29-3	1.7	157	57.96	56.69	0.64	0.64	0	0
TPH-Diesel	PHCD	25	131	54.2	39.69	1.53	2.29	10.69	0
Silver	7440-22-4	2.1	181	51.93	51.93	0	0	0	0
4,4'-DDE	72-55-9	1.7	151	42.38	41.72	0.66	0	0	0
4,4'-DDD	72-54-8	2.4	158	39.24	38.61	0.63	0	0	0
Xylenes, Total	1330-20-7	7.8	71	38.03	38.03	0	0	0	0
Acetone	67-64-1	1	197	16.75	13.2	3.55	0	0	0
PCBs (total)	1336-36-3	0.1	933	16.08	5.14	8.36	1.29	0.75	0.54
PCB-1260 (Aroclor 1260)	11096-82-5	0.1	928	15.73	8.19	5.17	1.08	0.75	0.54

TABLE 2-12
Analyte Frequency of Detection in In Situ Soil

1	2	3	4	5	6	7	8	9	10
Analyte Name	**CAS Number**	**Screening Level (µg/L)**	**Total Count: In Situ Soil**	**Percent Detect in In Situ Soil**	**Percent Blue**	**Percent Green**	**Percent Yellow**	**Percent Orange**	**Percent Red**
Toluene	108-88-3	0.54	241	14.52	13.69	0.41	0	0.41	0
1,3,5-Trinitrobenzene	99-35-4	1800	91	13.19	13.19	0	0	0	0
Benzene	71-43-2	0.002	241	12.45	0.83	11.2	0	0.41	0
Ethylbenzene	100-41-4	0.55	241	11.62	11.2	0	0.41	0	0
Di-n-butyl phthalate	84-74-2	170	174	8.62	8.62	0	0	0	0
Methylene chloride	75-09-2	0.0015	197	7.61	0	0	5.08	2.03	0.51
bis-(2-Ethylhexyl)phthalate	117-81-7	35	174	7.47	7.47	0	0	0	0
Dieldrin	60-57-1	0.0015	150	6.67	0.67	5.33	0.67	0	0
2-Butanone	78-93-3	6	197	5.58	5.08	0.51	0	0	0
Heptachlor epoxide	1024-57-3	0.02	162	5.56	5.56	0	0	0	0
gamma-Chlordane	12789-03-6	0.3	155	4.52	4.52	0	0	0	0
Fluorene	86-73-7	27	174	4.02	4.02	0	0	0	0
Phenanthrene	85-01-8	430	174	4.02	4.02	0	0	0	0
TPH-Gasoline	PHCG	30	64	3.13	3.13	0	0	0	0
1,3,5-Trimethylbenzene	108-67-8	2.5	197	3.05	3.05	0	0	0	0
Benzo(a)anthracene	56-55-3	0.15	174	2.87	2.3	0.57	0	0	0
Pyrene	129-00-0	150	174	2.87	2.87	0	0	0	0
m,p-Xylene	108-38-3/1	210	197	2.54	2.54	0	0	0	0
Xylene (calculated total)	XYLENESCALC	280	197	2.54	2.54	0	0	0	0
Methoxychlor	72-43-5	5.2	160	2.5	2.5	0	0	0	0
1,2,4-Trichlorobenzene	120-82-1	0.2	212	2.36	0	0	0.47	0	1.89
Fluoranthene	206-44-0	210	174	2.3	2.3	0	0	0	0
Pentachlorophenol	87-86-5	0.001	176	2.27	0	0	1.7	0.57	0
Hexahydro-1,3,5-trinitro-1,3,5-triazine (RDX)	121-82-4	4.4	91	2.2	2.2	0	0	0	0

TABLE 2-12
Analyte Frequency of Detection in In Situ Soil

1	2	3	4	5	6	7	8	9	10
Analyte Name	**CAS Number**	**Screening Level (µg/L)**	**Total Count: In Situ Soil**	**Percent Detect in In Situ Soil**	**Percent Blue**	**Percent Green**	**Percent Yellow**	**Percent Orange**	**Percent Red**
1,2,4-Trimethylbenzene	95-63-6	9.22	197	2.03	2.03	0	0	0	0
1,2-Dichlorobenzene	95-50-1	0.7	212	1.89	0	0.47	1.42	0	0
Benzo(a)pyrene	50-32-8	0.015	174	1.72	0	1.15	0.57	0	0
Benzo(k)fluoranthene	207-08-9	11	174	1.72	1.72	0	0	0	0
n-Butylbenzene	104-51-8	61	197	1.52	1.52	0	0	0	0
o-Xylene	95-47-6	280	197	1.52	1.52	0	0	0	0
Heptachlor	76-44-8	0.08	147	1.36	1.36	0	0	0	0
beta-BHC	319-85-7	0.0009	156	1.28	0.64	0	0.64	0	0
Endosulfan II	33213-65-9	0.7	163	1.23	1.23	0	0	0	0
2-Methylnaphthalene	91-57-6	6.09	174	1.15	1.15	0	0	0	0
Acenaphthene	83-32-9	21	174	1.15	1.15	0	0	0	0
Benzyl butyl phthalate	85-68-7	240	174	1.15	1.15	0	0	0	0
Indeno(1,2,3-cd)pyrene	193-39-5	0.15	174	1.15	0.57	0.57	0	0	0
n-Nitrosodi-n-propylamine	621-64-7	0.000036	174	1.15	0	0	0	0	1.15
3-Nitrotoluene	99-08-1	1600	91	1.1	1.1	0	0	0	0
4-Nitrotoluene	99-99-0	38	91	1.1	1.1	0	0	0	0
Carbazole	86-74-8	0.2	96	1.04	1.04	0	0	0	0
1,1,2-Trichloroethane	79-00-5	0.0017	197	1.02	0	0.51	0.51	0	0
Isopropylbenzene	98-82-8	22.7	197	1.02	1.02	0	0	0	0
sec-Butylbenzene	135-98-8	61	197	1.02	1.02	0	0	0	0
Aldrin	309-00-2	0.029	135	0.74	0.74	0	0	0	0
gamma-BHC (Lindane)	58-89-9	0.0003	136	0.74	0.74	0	0	0	0
Endosulfan I	959-98-8	0.7	141	0.71	0.71	0	0	0	0
alpha-BHC	319-84-6	0.00026	142	0.7	0	0.7	0	0	0
Benzoic acid	65-85-0	39	148	0.68	0.68	0	0	0	0

TABLE 2-12
Analyte Frequency of Detection in In Situ Soil

1	2	3	4	5	6	7	8	9	10
Analyte Name	**CAS Number**	**Screening Level (µg/L)**	**Total Count: In Situ Soil**	**Percent Detect in In Situ Soil**	**Percent Blue**	**Percent Green**	**Percent Yellow**	**Percent Orange**	**Percent Red**
Endrin	72-20-8	0.03	158	0.63	0.63	0	0	0	0
Anthracene	120-12-7	430	174	0.57	0.57	0	0	0	0
Benzo(b)fluoranthene	205-99-2	0.15	174	0.57	0	0.57	0	0	0
Benzo(g,h,i)perylene	191-24-2	1.5	174	0.57	0.57	0	0	0	0
Chrysene	218-01-9	15	174	0.57	0.57	0	0	0	0
Dibenzo(a,h)anthracene	53-70-3	0.015	174	0.57	0	0.57	0	0	0
Diethyl phthalate	84-66-2	19	174	0.57	0.57	0	0	0	0
Phenol	108-95-2	6.7	174	0.57	0.57	0	0	0	0
Chloromethane	74-87-3	1.3	197	0.51	0.51	0	0	0	0
tert-Butylbenzene	98-06-6	130	197	0.51	0.51	0	0	0	0
Naphthalene	91-20-3	2.1	212	0.47	0	0.47	0	0	0
PCB-1254 (Aroclor 1254)	11097-69-1	0.1	928	0.43	0	0.43	0	0	0
1,1,1,2-Tetrachloroethane	630-20-6	3	197	0	0	0	0	0	0
1,1,1-Trichloroethane	71-55-6	0.1	197	0	0	0	0	0	0
1,1,2,2-Tetrachloroethane	79-34-5	0.0017	197	0	0	0	0	0	0
1,1-Dichloroethane	75-34-3	1.2	197	0	0	0	0	0	0
1,1-Dichloroethene	75-35-4	0.003	197	0	0	0	0	0	0
1,2,3-Trichloropropane	96-18-4	0.0002	197	0	0	0	0	0	0
1,2-Dibromo-3-chloropropane	96-12-8	0.0026	197	0	0	0	0	0	0
1,2-Dibromoethane	106-93-4	0.00000306	197	0	0	0	0	0	0
1,2-Dichloroethane	107-06-2	0.0015	197	0	0	0	0	0	0
1,2-Dichloropropane	78-87-5	0.0017	197	0	0	0	0	0	0
1,3-Dichlorobenzene	541-73-1	1.21	212	0	0	0	0	0	0
1,3-Dinitrobenzene	99-65-0	6.1	91	0	0	0	0	0	0
1,4-Dichlorobenzene	106-46-7	0.08	212	0	0	0	0	0	0

TABLE 2-12
Analyte Frequency of Detection in In Situ Soil

1	2	3	4	5	6	7	8	9	10
Analyte Name	**CAS Number**	**Screening Level (µg/L)**	**Total Count: In Situ Soil**	**Percent Detect in In Situ Soil**	**Percent Blue**	**Percent Green**	**Percent Yellow**	**Percent Orange**	**Percent Red**
1-Methylnaphthalene	90-12-0	4.3	0	0	0	0	0	0	0
2,4,5-Trichlorophenol	95-95-4	9	174	0	0	0	0	0	0
2,4,6-Trichlorophenol	88-06-2	0.06	174	0	0	0	0	0	0
2,4,6-Trinitrotoluene	118-96-7	16	91	0	0	0	0	0	0
2,4-D	94-75-7	690	68	0	0	0	0	0	0
2,4-DB	94-82-6	490	68	0	0	0	0	0	0
2,4-Dichlorophenol	120-83-2	0.045	174	0	0	0	0	0	0
2,4-Dimethylphenol	105-67-9	0.4	174	0	0	0	0	0	0
2,4-Dinitrophenol	51-28-5	0.02	173	0	0	0	0	0	0
2,4-Dinitrotoluene	121-14-2	0.0005	178	0	0	0	0	0	0
2,6-Dinitrotoluene	606-20-2	0.00044	178	0	0	0	0	0	0
2-Chloronaphthalene	91-58-7	7	174	0	0	0	0	0	0
2-Chlorophenol	95-57-8	0.14	174	0	0	0	0	0	0
2-Chlorotoluene	95-49-8	160	197	0	0	0	0	0	0
2-Methylphenol (o-Cresol)	95-48-7	0.7	174	0	0	0	0	0	0
2-Nitroaniline	88-74-4	180	174	0	0	0	0	0	0
2-Nitrotoluene	88-72-2	2.8	91	0	0	0	0	0	0
3,3'-Dichlorobenzidine	91-94-1	0.002	174	0	0	0	0	0	0
4-Chloro-3-methylphenol	59-50-7	310	148	0	0	0	0	0	0
4-Chloroaniline	106-47-8	0.05	174	0	0	0	0	0	0
4-Nitrophenol	100-02-7	490	176	0	0	0	0	0	0
Acenaphthylene	208-96-8	21	174	0	0	0	0	0	0
Benzyl alcohol	100-51-6	18000	148	0	0	0	0	0	0
bis-(2-Chloroethyl)ether	111-44-4	0.0002	174	0	0	0	0	0	0
bis(2-Chloroisopropyl)ether	108-60-1	2.9	174	0	0	0	0	0	0

TABLE 2-12
Analyte Frequency of Detection in In Situ Soil

1	2	3	4	5	6	7	8	9	10
Analyte Name	**CAS Number**	**Screening Level (µg/L)**	**Total Count: In Situ Soil**	**Percent Detect in In Situ Soil**	**Percent Blue**	**Percent Green**	**Percent Yellow**	**Percent Orange**	**Percent Red**
Bromobenzene	108-86-1	73	197	0	0	0	0	0	0
Bromodichloromethane	75-27-4	1	197	0	0	0	0	0	0
Bromoform	75-25-2	0.038	197	0	0	0	0	0	0
Bromomethane	74-83-9	3.9	197	0	0	0	0	0	0
Carbon disulfide	75-15-0	1.7	185	0	0	0	0	0	0
Carbon tetrachloride	56-23-5	0.003	197	0	0	0	0	0	0
Chlorobenzene	108-90-7	0.06	197	0	0	0	0	0	0
Chloroform	67-66-3	0.034	197	0	0	0	0	0	0
cis-1,2-Dichloroethene	156-59-2	0.02	197	0	0	0	0	0	0
cis-1,3-Dichloropropene	10061-01-5	0.002	197	0	0	0	0	0	0
Dalapon	75-99-0	1800	68	0	0	0	0	0	0
Dicamba	1918-00-9	1800	68	0	0	0	0	0	0
Dichlorodifluoromethane	75-71-8	6	197	0	0	0	0	0	0
Dimethyl phthalate	131-11-3	140	174	0	0	0	0	0	0
Di-n-octyl phthalate	117-84-0	200	174	0	0	0	0	0	0
Dinoseb	88-85-7	61	68	0	0	0	0	0	0
Hexachlorobenzene	118-74-1	0.073	174	0	0	0	0	0	0
Hexachlorobutadiene	87-68-3	0.8	212	0	0	0	0	0	0
Hexachlorocyclopentadiene	77-47-4	0.7	78	0	0	0	0	0	0
Hexachloroethane	67-72-1	0.16	174	0	0	0	0	0	0
Isophorone	78-59-1	0.3	174	0	0	0	0	0	0
MCPA (2-Methyl-4-chlorophenoxy acetic acid)	94-74-6	61	68	0	0	0	0	0	0
Methyl-tert-butyl ether (MTBE)	1634-04-4	32	167	0	0	0	0	0	0
Nitrobenzene	98-95-3	0.006	178	0	0	0	0	0	0

TABLE 2-12
Analyte Frequency of Detection in In Situ Soil

1	2	3	4	5	6	7	8	9	10
Analyte Name	**CAS Number**	**Screening Level (µg/L)**	**Total Count: In Situ Soil**	**Percent Detect in In Situ Soil**	**Percent Blue**	**Percent Green**	**Percent Yellow**	**Percent Orange**	**Percent Red**
n-Nitrosodimethylamine	62-75-9	0.0023	148	0	0	0	0	0	0
n-Nitrosodiphenylamine	86-30-6	0.34	174	0	0	0	0	0	0
Octahydro-1,3,5,7-tetranitro-1,3,5,7-tetrazocine (HMX)	2691-41-0	3100	91	0	0	0	0	0	0
PCB-1016 (Aroclor 1016)	12674-11-2	0.1	928	0	0	0	0	0	0
PCB-1221 (Aroclor 1221)	11104-28-2	0.1	928	0	0	0	0	0	0
PCB-1232 (Aroclor 1232)	11141-16-5	0.1	928	0	0	0	0	0	0
PCB-1242 (Aroclor 1242)	53469-21-9	0.1	928	0	0	0	0	0	0
PCB-1248 (Aroclor 1248)	12672-29-6	0.1	928	0	0	0	0	0	0
Styrene	100-42-5	0.13	197	0	0	0	0	0	0
Tetrachloroethene (PCE)	127-18-4	0.003	197	0	0	0	0	0	0
Toxaphene	8001-35-2	0.8	166	0	0	0	0	0	0
trans-1,2-Dichloroethene	156-60-5	0.04	197	0	0	0	0	0	0
trans-1,3-Dichloropropene	10061-02-6	0.002	197	0	0	0	0	0	0
Trichloroethene (TCE)	79-01-6	0.002	197	0	0	0	0	0	0
Trichlorofluoromethane	75-69-4	390	197	0	0	0	0	0	0
Trichlorotrifluoroethane (Freon 113)	76-13-1	466	4	0	0	0	0	0	0
Vinyl chloride	75-01-4	0.0009	197	0	0	0	0	0	0

Note:
µg/L = micrograms per liter

TABLE 2-13
Analyte Frequency of Detection in Groundwater

1	2	3	4	5	6	7	8	9	10
Analyte Name	**CAS Number**	**Screening Level (mg/L)**	**Total Count: Groundwater**	**Percent Detect in Groundwater**	**Percent Blue**	**Percent Green**	**Percent Yellow**	**Percent Orange**	**Percent Red**
Arsenic	7440-38-2	77.3	20	100	100	0	0	0	0
Barium	7440-39-3	200	20	100	90	10	0	0	0
Iron	7439-89-6	26000	20	100	100	0	0	0	0
Manganese	7439-96-5	1700	20	100	100	0	0	0	0
Zinc	7440-66-6	1100	20	85	85	0	0	0	0
Nickel	7440-02-0	10	20	80	80	0	0	0	0
Cobalt	7440-48-4	730	20	65	65	0	0	0	0
TPH-Diesel	PHCD	150	20	40	20	5	15	0	0
Chromium	7440-47-3	10	20	30	0	30	0	0	0
Copper	7440-50-8	130	20	25	25	0	0	0	0
Dichlorodifluoromethane	75-71-8	390	20	25	25	0	0	0	0
4-Nitrotoluene	99-99-0	4	10	20	20	0	0	0	0
Aluminum	7429-90-5	37000	20	20	20	0	0	0	0
Octahydro-1,3,5,7-tetranitro-1,3,5,7-tetrazocine (HMX)	2691-41-0	1800	10	20	20	0	0	0	0
TPH-Gasoline	PHCG	130	20	20	20	0	0	0	0
Nitrobenzene	98-95-3	1.8	20	15	10	5	0	0	0
1,3-Dinitrobenzene	99-65-0	3.7	10	10	0	10	0	0	0
3-Nitrotoluene	99-08-1	120	10	10	10	0	0	0	0
Acetone	67-64-1	365	20	10	10	0	0	0	0
Benzo(g,h,i)perylene	191-24-2	0.3	20	10	0	10	0	0	0
cis-1,2-Dichloroethene	156-59-2	7	20	10	10	0	0	0	0
Hexahydro-1,3,5-trinitro-1,3,5-triazine (RDX)	121-82-4	0.61	10	10	0	0	10	0	0
sec-Butylbenzene	135-98-8	110	20	10	10	0	0	0	0
tert-Butylbenzene	98-06-6	61	20	10	10	0	0	0	0

TABLE 2-13
Analyte Frequency of Detection in Groundwater

1	2	3	4	5	6	7	8	9	10
Analyte Name	**CAS Number**	**Screening Level (mg/L)**	**Total Count: Groundwater**	**Percent Detect in Groundwater**	**Percent Blue**	**Percent Green**	**Percent Yellow**	**Percent Orange**	**Percent Red**
1,1,2,2-Tetrachloroethane	79-34-5	0.055	20	5	0	0	5	0	0
1,1-Dichloroethene	75-35-4	0.7	20	5	5	0	0	0	0
1,2,3-Trichloropropane	96-18-4	0.0016	20	5	0	0	0	5	0
1,3,5-Trimethylbenzene	108-67-8	12	20	5	5	0	0	0	0
2,4-Dinitrotoluene	121-14-2	0.125	20	5	0	5	0	0	0
2,6-Dinitrotoluene	606-20-2	0.125	20	5	0	0	5	0	0
2-Butanone	78-93-3	2200	20	5	5	0	0	0	0
4,4'-DDE	72-55-9	0.2	20	5	5	0	0	0	0
4,4'-DDT	50-29-3	0.2	20	5	5	0	0	0	0
Acenaphthene	83-32-9	220	20	5	5	0	0	0	0
Dieldrin	60-57-1	0.0042	20	5	0	5	0	0	0
Diethyl phthalate	84-66-2	2900	20	5	5	0	0	0	0
Di-n-butyl phthalate	84-74-2	365	20	5	5	0	0	0	0
Endrin	72-20-8	0.2	20	5	5	0	0	0	0
Fluorene	86-73-7	146	20	5	5	0	0	0	0
Heptachlor epoxide	1024-57-3	0.0074	20	5	5	0	0	0	0
Isopropylbenzene	98-82-8	365	20	5	5	0	0	0	0
Methoxychlor	72-43-5	4	20	5	5	0	0	0	0
Naphthalene	91-20-3	6.2	20	5	5	0	0	0	0
TPH-Motor Oil	TPH-Oil	110	20	5	0	5	0	0	0
1,1,1,2-Tetrachloroethane	630-20-6	0.43	20	0	0	0	0	0	0
1,1,1-Trichloroethane	71-55-6	20	20	0	0	0	0	0	0
1,1,2-Trichloroethane	79-00-5	0.2	20	0	0	0	0	0	0
1,1-Dichloroethane	75-34-3	365	20	0	0	0	0	0	0
1,2,4-Trichlorobenzene	120-82-1	7	20	0	0	0	0	0	0

TABLE 2-13
Analyte Frequency of Detection in Groundwater

1	2	3	4	5	6	7	8	9	10
Analyte Name	**CAS Number**	**Screening Level (mg/L)**	**Total Count: Groundwater**	**Percent Detect in Groundwater**	**Percent Blue**	**Percent Green**	**Percent Yellow**	**Percent Orange**	**Percent Red**
1,2,4-Trimethylbenzene	95-63-6	12	20	0	0	0	0	0	0
1,2-Dibromo-3-chloropropane	96-12-8	0.0002	20	0	0	0	0	0	0
1,2-Dibromoethane	106-93-4	0.005	20	0	0	0	0	0	0
1,2-Dichlorobenzene	95-50-1	49	20	0	0	0	0	0	0
1,2-Dichloroethane	107-06-2	0.12	20	0	0	0	0	0	0
1,2-Dichloropropane	78-87-5	0.16	20	0	0	0	0	0	0
1,3,5-Trinitrobenzene	99-35-4	1100	10	0	0	0	0	0	0
1,3-Dichlorobenzene	541-73-1	14	20	0	0	0	0	0	0
1,4-Dichlorobenzene	106-46-7	0.47	20	0	0	0	0	0	0
2,4,5-Trichlorophenol	95-95-4	365	20	0	0	0	0	0	0
2,4,6-Trichlorophenol	88-06-2	6.1	20	0	0	0	0	0	0
2,4,6-Trinitrotoluene	118-96-7	2.2	10	0	0	0	0	0	0
2,4-Dichlorophenol	120-83-2	10	20	0	0	0	0	0	0
2,4-Dimethylphenol	105-67-9	70	20	0	0	0	0	0	0
2,4-Dinitrophenol	51-28-5	7	20	0	0	0	0	0	0
2-Chloronaphthalene	91-58-7	290	20	0	0	0	0	0	0
2-Chlorophenol	95-57-8	20	20	0	0	0	0	0	0
2-Chlorotoluene	95-49-8	120	20	0	0	0	0	0	0
2-Methylnaphthalene	91-57-6	78	20	0	0	0	0	0	0
2-Methylphenol (o-Cresol)	95-48-7	180	20	0	0	0	0	0	0
2-Nitroaniline	88-74-4	110	20	0	0	0	0	0	0
2-Nitrotoluene	88-72-2	0.29	10	0	0	0	0	0	0
3,3'-Dichlorobenzidine	91-94-1	0.15	20	0	0	0	0	0	0
4,4'-DDD	72-54-8	0.28	20	0	0	0	0	0	0
4-Chloro-3-methylphenol	59-50-7	180	20	0	0	0	0	0	0

TABLE 2-13
Analyte Frequency of Detection in Groundwater

1	2	3	4	5	6	7	8	9	10
Analyte Name	**CAS Number**	**Screening Level (mg/L)**	**Total Count: Groundwater**	**Percent Detect in Groundwater**	**Percent Blue**	**Percent Green**	**Percent Yellow**	**Percent Orange**	**Percent Red**
4-Chloroaniline	106-47-8	15	20	0	0	0	0	0	0
4-Nitrophenol	100-02-7	290	20	0	0	0	0	0	0
Acenaphthylene	208-96-8	220	20	0	0	0	0	0	0
Aldrin	309-00-2	0.0043	20	0	0	0	0	0	0
alpha-BHC	319-84-6	0.01	20	0	0	0	0	0	0
Anthracene	120-12-7	1100	20	0	0	0	0	0	0
Antimony	7440-36-0	0.6	20	0	0	0	0	0	0
Benzene	71-43-2	0.35	20	0	0	0	0	0	0
Benzo(a)anthracene	56-55-3	0.03	20	0	0	0	0	0	0
Benzo(a)pyrene	50-32-8	0.003	20	0	0	0	0	0	0
Benzo(b)fluoranthene	205-99-2	0.03	20	0	0	0	0	0	0
Benzo(k)fluoranthene	207-08-9	1	20	0	0	0	0	0	0
Benzoic acid	65-85-0	14600	15	0	0	0	0	0	0
Benzyl alcohol	100-51-6	11000	20	0	0	0	0	0	0
Benzyl butyl phthalate	85-68-7	730	20	0	0	0	0	0	0
Beryllium	7440-41-7	0.4	20	0	0	0	0	0	0
beta-BHC	319-85-7	0.037	20	0	0	0	0	0	0
bis-(2-Chloroethyl)ether	111-44-4	0.0098	20	0	0	0	0	0	0
bis(2-Chloroisopropyl)ether	108-60-1	0.27	20	0	0	0	0	0	0
bis-(2-Ethylhexyl)phthalate	117-81-7	0.6	20	0	0	0	0	0	0
Bromobenzene	108-86-1	23	20	0	0	0	0	0	0
Bromodichloromethane	75-27-4	0.18	20	0	0	0	0	0	0
Bromoform	75-25-2	8.5	20	0	0	0	0	0	0
Bromomethane	74-83-9	8.7	20	0	0	0	0	0	0
Cadmium	7440-43-9	0.5	20	0	0	0	0	0	0

TABLE 2-13
Analyte Frequency of Detection in Groundwater

1	2	3	4	5	6	7	8	9	10
Analyte Name	**CAS Number**	**Screening Level (mg/L)**	**Total Count: Groundwater**	**Percent Detect in Groundwater**	**Percent Blue**	**Percent Green**	**Percent Yellow**	**Percent Orange**	**Percent Red**
Carbazole	86-74-8	3.4	14	0	0	0	0	0	0
Carbon disulfide	75-15-0	365	20	0	0	0	0	0	0
Carbon tetrachloride	56-23-5	0.17	20	0	0	0	0	0	0
Chlorobenzene	108-90-7	10	20	0	0	0	0	0	0
Chloroform	67-66-3	0.17	20	0	0	0	0	0	0
Chloromethane	74-87-3	2.1	20	0	0	0	0	0	0
Chrysene	218-01-9	2.9	20	0	0	0	0	0	0
cis-1,3-Dichloropropene	10061-01-5	0.4	20	0	0	0	0	0	0
Dibenzo(a,h)anthracene	53-70-3	0.003	20	0	0	0	0	0	0
Dimethyl phthalate	131-11-3	370000	20	0	0	0	0	0	0
Di-n-octyl phthalate	117-84-0	70	20	0	0	0	0	0	0
Endosulfan I	959-98-8	220	20	0	0	0	0	0	0
Ethylbenzene	100-41-4	70	20	0	0	0	0	0	0
Fluoranthene	206-44-0	146	20	0	0	0	0	0	0
gamma-BHC (Lindane)	58-89-9	0.02	20	0	0	0	0	0	0
gamma-Chlordane	12789-03-6	0.2	20	0	0	0	0	0	0
Heptachlor	76-44-8	0.015	20	0	0	0	0	0	0
Hexachlorobenzene	118-74-1	0.042	20	0	0	0	0	0	0
Hexachlorobutadiene	87-68-3	0.86	20	0	0	0	0	0	0
Hexachlorocyclopentadiene	77-47-4	5	6	0	0	0	0	0	0
Hexachloroethane	67-72-1	4.8	20	0	0	0	0	0	0
Indeno(1,2,3-cd)pyrene	193-39-5	0.03	20	0	0	0	0	0	0
Isophorone	78-59-1	71	20	0	0	0	0	0	0
Lead	7439-92-1	1.5	20	0	0	0	0	0	0
m,p-Xylene	108-38-3/1	210	20	0	0	0	0	0	0

TABLE 2-13
Analyte Frequency of Detection in Groundwater

1	2	3	4	5	6	7	8	9	10
Analyte Name	**CAS Number**	**Screening Level (mg/L)**	**Total Count: Groundwater**	**Percent Detect in Groundwater**	**Percent Blue**	**Percent Green**	**Percent Yellow**	**Percent Orange**	**Percent Red**
Mercury	7439-97-6	0.2	20	0	0	0	0	0	0
Methylene chloride	75-09-2	0.5	20	0	0	0	0	0	0
Methyl-tert-butyl ether (MTBE)	1634-04-4	11	20	0	0	0	0	0	0
n-Butylbenzene	104-51-8	140	20	0	0	0	0	0	0
n-Nitrosodimethylamine	62-75-9	0.00042	20	0	0	0	0	0	0
n-Nitrosodi-n-propylamine	621-64-7	0.0096	20	0	0	0	0	0	0
n-Nitrosodiphenylamine	86-30-6	14	20	0	0	0	0	0	0
o-Xylene	95-47-6	1400	20	0	0	0	0	0	0
PCB-1016 (Aroclor 1016)	12674-11-2	0.05	10	0	0	0	0	0	0
PCB-1221 (Aroclor 1221)	11104-28-2	0.034	10	0	0	0	0	0	0
PCB-1232 (Aroclor 1232)	11141-16-5	0.034	10	0	0	0	0	0	0
PCB-1242 (Aroclor 1242)	53469-21-9	0.034	10	0	0	0	0	0	0
PCB-1248 (Aroclor 1248)	12672-29-6	0.034	10	0	0	0	0	0	0
PCB-1254 (Aroclor 1254)	11097-69-1	0.034	10	0	0	0	0	0	0
PCB-1260 (Aroclor 1260)	11096-82-5	0.034	10	0	0	0	0	0	0
PCBs (total)	1336-36-3	0.05	10	0	0	0	0	0	0
Pentachlorophenol	87-86-5	0.1	20	0	0	0	0	0	0
Phenanthrene	85-01-8	1100	20	0	0	0	0	0	0
Phenol	108-95-2	2200	20	0	0	0	0	0	0
Pyrene	129-00-0	110	20	0	0	0	0	0	0
Selenium	7782-49-2	5	20	0	0	0	0	0	0
Silver	7440-22-4	18	20	0	0	0	0	0	0
Styrene	100-42-5	10	20	0	0	0	0	0	0
Tetrachloroethene (PCE)	127-18-4	0.1	20	0	0	0	0	0	0
Thallium	7440-28-0	0.2	20	0	0	0	0	0	0

TABLE 2-13
Analyte Frequency of Detection in Groundwater

1	2	3	4	5	6	7	8	9	10
Analyte Name	**CAS Number**	**Screening Level (mg/L)**	**Total Count: Groundwater**	**Percent Detect in Groundwater**	**Percent Blue**	**Percent Green**	**Percent Yellow**	**Percent Orange**	**Percent Red**
Toluene	108-88-3	100	20	0	0	0	0	0	0
Toxaphene	8001-35-2	0.3	20	0	0	0	0	0	0
trans-1,2-Dichloroethene	156-60-5	10	20	0	0	0	0	0	0
trans-1,3-Dichloropropene	10061-02-6	0.4	20	0	0	0	0	0	0
Trichloroethene (TCE)	79-01-6	0.028	20	0	0	0	0	0	0
Trichlorofluoromethane	75-69-4	1300	20	0	0	0	0	0	0
Vanadium	7440-62-2	26	20	0	0	0	0	0	0
Vinyl chloride	75-01-4	0.015	20	0	0	0	0	0	0
Xylene (calculated total)	XYLENESCALC	1400	20	0	0	0	0	0	0

TABLE 2-14
Analytes Included in Mapping Groups

Analytical Method	Included on Maps	CAS Number	Analyte Name	Analyte ERPIMS Parlabel
Volatile Organic Compounds				
SW8260	Yes	100-41-4	Ethylbenzene	EBZ
SW8260	Yes	100-42-5	Styrene	STY
SW8260	Yes	10061-01-5	cis-1,3-Dichloropropene	DCP13C
SW8260	Yes	10061-02-6	trans-1,3-Dichloropropene	DCP13T
SW8260	Yes	103-65-1	n-Propylbenzene	PBZN
SW8260	Yes	104-51-8	n-Butylbenzene	BTBZN
SW8260	Yes	106-43-4	4-Chlorotoluene	CLBZME4
SW8260	Yes	106-46-7	1,4-Dichlorobenzene	DCBZ14
SW8260	No	106-93-4	1,2-Dibromoethane	EDB
SW8260	Yes	107-06-2	1,2-Dichloroethane	DCA12
SW8260	Yes	108-10-1	4-Methyl-2-pentanone	MIBK
SW8260	Yes	108-38-3/1	m,p-Xylene	XYLMP
SW8260	Yes	108-67-8	1,3,5-Trimethylbenzene	TMB135
SW8260	Yes	108-86-1	Bromobenzene	BRBZ
SW8260	Yes	108-88-3	Toluene	BZME
SW8260	Yes	108-90-7	Chlorobenzene	CLBZ
SW8260	Yes	120-82-1	1,2,4-Trichlorobenzene	TCB124
SW8260	Yes	124-48-1	Dibromochloromethane	DBCME
SW8260	Yes	127-18-4	Tetrachloroethene (PCE)	PCE
SW8260	Yes	135-98-8	sec-Butylbenzene	BTBZS
SW8260	Yes	142-28-9	1,3-Dichloropropane	DCPA13
SW8260	Yes	156-59-2	cis-1,2-Dichloroethene	DCE12C
SW8260	Yes	156-60-5	trans-1,2-Dichloroethene	DCE12T
SW8260	Yes	1634-04-4	Methyl-tert-butyl ether (MTBE)	TBUTMEE
SW8260	Yes	541-73-1	1,3-Dichlorobenzene	DCBZ13
SW8260	Yes	56-23-5	Carbon tetrachloride	CTCL
SW8260	Yes	563-58-6	1,1-Dichloropropene	DCP11
SW8260	Yes	591-78-6	2-Hexanone	HXO2
SW8260	Yes	594-20-7	2,2-Dichloropropane	DCPA22
SW8260	Yes	630-20-6	1,1,1,2-Tetrachloroethane	TC1112
SW8260	No	67-64-1	Acetone	ACE
SW8260	Yes	67-66-3	Chloroform	TCLME
SW8260	Yes	71-43-2	Benzene	BZ
SW8260	Yes	71-55-6	1,1,1-Trichloroethane	TCA111
SW8260	Yes	74-83-9	Bromomethane	BRME
SW8260	Yes	74-87-3	Chloromethane	CLME
SW8260	Yes	74-95-3	Dibromomethane	DBMA

TABLE 2-14
Analytes Included in Mapping Groups

Analytical Method	Included on Maps	CAS Number	Analyte Name	Analyte ERPIMS Parlabel
SW8260	Yes	74-97-5	Bromochloromethane	BRCLME
SW8260	Yes	75-00-3	Chloroethane	CLEA
SW8260	Yes	75-01-4	Vinyl chloride	VC
SW8260	No	75-09-2	Methylene chloride	MTLNCL
SW8260	Yes	75-15-0	Carbon disulfide	CDS
SW8260	Yes	75-25-2	Bromoform	TBME
SW8260	Yes	75-27-4	Bromodichloromethane	BDCME
SW8260	Yes	75-34-3	1,1-Dichloroethane	DCA11
SW8260	Yes	75-35-4	1,1-Dichloroethene	DCE11
SW8260	Yes	75-69-4	Trichlorofluoromethane	FC11
SW8260	Yes	75-71-8	Dichlorodifluoromethane	FC12
SW8260	Yes	78-87-5	1,2-Dichloropropane	DCPA12
SW8260	Yes	78-93-3	2-Butanone	MEK
SW8260	Yes	79-00-5	1,1,2-Trichloroethane	TCA112
SW8260	Yes	79-01-6	Trichloroethene (TCE)	TCE
SW8260	Yes	79-34-5	1,1,2,2-Tetrachloroethane	PCA
SW8260	Yes	87-61-6	1,2,3-Trichlorobenzene	TCB123
SW8260	Yes	87-68-3	Hexachlorobutadiene	HCBU
SW8260	Yes	91-20-3	Naphthalene	NAPH
SW8260	Yes	95-47-6	o-Xylene	XYLO
SW8260	Yes	95-49-8	2-Chlorotoluene	CLBZME2
SW8260	Yes	95-50-1	1,2-Dichlorobenzene	DCBZ12
SW8260	Yes	95-63-6	1,2,4-Trimethylbenzene	TMB124
SW8260	No	96-12-8	1,2-Dibromo-3-chloropropane	DBCP
SW8260	No	96-18-4	1,2,3-Trichloropropane	TCPR123
SW8260	Yes	98-06-6	tert-Butylbenzene	BTBZT
SW8260	Yes	98-82-8	Isopropylbenzene	IPBZ
SW8260	Yes	99-87-6	4-Isopropyltoluene	CYMP
SW8260	Yes	XYLENESCALC	Xylene (calculated total)	XYLENESCALC
Semivolatile Organic Compounds				
SW8270C	Yes	83-32-9	Acenaphthene	ACNP
SW8270C	Yes	208-96-8	Acenaphthylene	ACNPY
SW8270C	Yes	120-12-7	Anthracene	ANTH
SW8270C	Yes	85-68-7	Benzyl butyl phthalate	BBP
SW8270C	Yes	111-91-1	bis-(2-Chloroethoxy)methane	BECEM
SW8270C	No	111-44-4	bis-(2-Chloroethyl)ether	BIS2CEE
SW8270C	Yes	108-60-1	bis(2-Chloroisopropyl)ether	BIS2CIE
SW8270C	Yes	117-81-7	bis-(2-Ethylhexyl)phthalate	BIS2EHP

TABLE 2-14
Analytes Included in Mapping Groups

Analytical Method	Included on Maps	CAS Number	Analyte Name	Analyte ERPIMS Parlabel
SW8270C	Yes	101-55-3	4-Bromophenyl phenyl ether	BPPE4
SW8270C	Yes	56-55-3	Benzo(a)anthracene	BZAA
SW8270C	Yes	65-85-0	Benzoic acid	BZACID
SW8270C	Yes	50-32-8	Benzo(a)pyrene	BZAP
SW8270C	Yes	205-99-2	Benzo(b)fluoranthene	BZBF
SW8270C	Yes	191-24-2	Benzo(g,h,i)perylene	BZGHIP
SW8270C	Yes	207-08-9	Benzo(k)fluoranthene	BZKF
SW8270C	Yes	100-51-6	Benzyl alcohol	BZLAL
SW8270C	Yes	59-50-7	4-Chloro-3-methylphenol	C4M3PH
SW8270C	Yes	86-74-8	Carbazole	CARBAZOLE
SW8270C	Yes	218-01-9	Chrysene	CHRYSENE
SW8270C	Yes	106-47-8	4-Chloroaniline	CLANIL4
SW8270C	Yes	95-57-8	2-Chlorophenol	CLPH2
SW8270C	Yes	91-58-7	2-Chloronaphthalene	CNPH2
SW8270C	Yes	7005-72-3	4-Chlorophenyl phenyl ether	CPPE4
SW8270C	Yes	53-70-3	Dibenzo(a,h)anthracene	DBAHA
SW8270C	Yes	132-64-9	Dibenzofuran	DBF
SW8270C	No	91-94-1	3,3'-Dichlorobenzidine	DBZD33
SW8270C	Yes	95-50-1	1,2-Dichlorobenzene	DCBZ12
SW8270C	Yes	541-73-1	1,3-Dichlorobenzene	DCBZ13
SW8270C	Yes	106-46-7	1,4-Dichlorobenzene	DCBZ14
SW8270C	Yes	120-83-2	2,4-Dichlorophenol	DCP24
SW8270C	Yes	84-66-2	Diethyl phthalate	DEPH
SW8270C	Yes	105-67-9	2,4-Dimethylphenol	DMP24
SW8270C	Yes	131-11-3	Dimethyl phthalate	DMPH
SW8270C	Yes	534-52-1	2-Methyl-4,6-dinitrophenol	DN46M
SW8270C	Yes	84-74-2	Di-n-butyl phthalate	DNBP
SW8270C	Yes	117-84-0	Di-n-octyl phthalate	DNOP
SW8270C	No	51-28-5	2,4-Dinitrophenol	DNP24
SW8270C	Yes	86-73-7	Fluorene	FL
SW8270C	Yes	206-44-0	Fluoranthene	FLA
SW8270C	Yes	87-68-3	Hexachlorobutadiene	HCBU
SW8270C	Yes	77-47-4	Hexachlorocyclopentadiene	HCCP
SW8270C	Yes	118-74-1	Hexachlorobenzene	HCLBZ
SW8270C	Yes	67-72-1	Hexachloroethane	HCLEA
SW8270C	Yes	193-39-5	Indeno(1,2,3-cd)pyrene	INP123
SW8270C	Yes	78-59-1	Isophorone	ISOP
SW8270C	Yes	1319-77-3	m,p-Cresol	MEPH1314

TABLE 2-14
Analytes Included in Mapping Groups

Analytical Method	Included on Maps	CAS Number	Analyte Name	Analyte ERPIMS Parlabel
SW8270C	Yes	95-48-7	2-Methylphenol (o-Cresol)	MEPH2
SW8270C	Yes	91-57-6	2-Methylnaphthalene	MTNPH2
SW8270C	Yes	91-20-3	Naphthalene	NAPH
SW8270C	No	62-75-9	n-Nitrosodimethylamine	NNSM
SW8270C	Yes	86-30-6	n-Nitrosodiphenylamine	NNSPH
SW8270C	No	621-64-7	n-Nitrosodi-n-propylamine	NNSPR
SW8270C	Yes	88-74-4	2-Nitroaniline	NO2ANIL2
SW8270C	Yes	99-09-2	3-Nitroaniline	NO2ANIL3
SW8270C	Yes	100-01-6	4-Nitroaniline	NO2ANIL4
SW8270C	Yes	88-75-5	2-Nitrophenol	NTPH2
SW8270C	Yes	100-02-7	4-Nitrophenol	NTPH4
SW8270C & 8151A	No	87-86-5	Pentachlorophenol	PCP
SW8270C	Yes	85-01-8	Phenanthrene	PHAN
SW8270C	Yes	108-95-2	Phenol	PHENOL
SW8270C	Yes	129-00-0	Pyrene	PYR
SW8270C	Yes	120-82-1	1,2,4-Trichlorobenzene	TCB124
SW8270C	Yes	95-95-4	2,4,5-Trichlorophenol	TCP245
SW8270C	Yes	88-06-2	2,4,6-Trichlorophenol	TCP246
SW8270C & 8330	No	121-14-2	2,4-Dinitrotoluene	DNT24
SW8270C & 8330	No	606-20-2	2,6-Dinitrotoluene	DNT26
Pesticides				
SW8081A	Yes	1024-57-3	Heptachlor epoxide	HEPT-EPOX
SW8081A	Yes	12789-03-6	gamma-Chlordane	CHLORDANEG
SW8081A	Yes	309-00-2	Aldrin	ALDRIN
SW8081A	Yes	319-84-6	alpha-BHC	BHCALPHA
SW8081A	Yes	319-85-7	beta-BHC	BHCBETA
SW8081A	Yes	319-86-8	delta-BHC	BHCDELTA
SW8081A	Yes	5103-71-9	alpha-Chlordane	CHLORDANEA
SW8081A	Yes	58-89-9	gamma-BHC (Lindane)	BHCGAMMA
SW8081A	Yes	72-43-5	Methoxychlor	MTXYCL
SW8081A	Yes	72-54-8	4,4'-DDD	DDD44
SW8081A	Yes	76-44-8	Heptachlor	HEPTACHLOR
SW8081A	Yes	959-98-8	Endosulfan I	ENDOSULFANA
SW8081A	Yes	1031-07-8	Endosulfan sulfate	ENDOSULFANS
SW8081A	Yes	33213-65-9	Endosulfan II	ENDOSULFANB
SW8081A	Yes	50-29-3	4,4'-DDT	DDT44
SW8081A	Yes	53494-70-5	Endrin ketone	ENDRINKET

TABLE 2-14
Analytes Included in Mapping Groups

Analytical Method	Included on Maps	CAS Number	Analyte Name	Analyte ERPIMS Parlabel
SW8081A	Yes	60-57-1	Dieldrin	DIELDRIN
SW8081A	Yes	72-20-8	Endrin	ENDRIN
SW8081A	Yes	72-55-9	4,4'-DDE	DDE44
SW8081A	Yes	7421-93-4	Endrin aldehyde	ENDRINALD
SW8081A	Yes	8001-35-2	Toxaphene	TOXAP
Metals				
SW6010 & SW6020	Yes	7439-92-1	Lead	PB
SW6010 & SW6020	Yes	7440-22-4	Silver	AG
SW6010 & SW6020	Yes	7440-38-2	Arsenic	AS
SW6010 & SW6020	Yes	7440-39-3	Barium	BA
SW6010 & SW6020	Yes	7440-43-9	Cadmium	CD
SW6010 & SW6020	Yes	7440-47-3	Chromium	CR
SW6010 & SW6020	Yes	7782-49-2	Selenium	SE
SW7470A	Yes	7439-97-6	Mercury	HG
Explosives				
SW8330	Yes	35572-78-2	2-Amino-4,6-dinitrotoluene	A2DNT46
SW8330	Yes	19406-51-0	4-Amino-2,6-dinitrotoluene	A4DNT26
SW8330	Yes	99-65-0	1,3-Dinitrobenzene	DNB13
SW8330 & 8270	No	121-14-2	2,4-Dinitrotoluene	DNT24
SW8330 & 8270	No	606-20-2	2,6-Dinitrotoluene	DNT26
SW8330	Yes	2691-41-0	Octahydro-1,3,5,7-tetranitro-1,3,5,7-tetrazocine (HMX)	HMX
SW8330	Yes	88-72-2	2-Nitrotoluene	NBZME2
SW8330	Yes	99-08-1	3-Nitrotoluene	NBZME3
SW8330	Yes	99-99-0	4-Nitrotoluene	NBZME4
SW8330	Yes	98-95-3	Nitrobenzene	NO2BZ
SW8330	Yes	55-63-0	Nitroglycerin	NTG
SW8330	Yes	78-11-5	Pentaerythritol tetranitrate	PETN
SW8330	Yes	121-82-4	Hexahydro-1,3,5-trinitro-1,3,5-triazine (RDX)	RDX
SW8330	Yes	479-45-8	Methyl-2,4,6-trinitrophenylnitramine (Tetryl)	TETRYL
SW8330	Yes	99-35-4	1,3,5-Trinitrobenzene	TNB135
SW8330	Yes	118-96-7	2,4,6-Trinitrotoluene	TNT

TABLE 2-14
Analytes Included in Mapping Groups

Analytical Method	Included on Maps	CAS Number	Analyte Name	Analyte ERPIMS Parlabel
Chlorinated Herbicides				
SW8151A	Yes	100-02-7	4-Nitrophenol	NTPH4
SW8151A	Yes	120-36-5	Dichlorprop	DCPROP
SW8151A	Yes	1918-00-9	Dicamba	DICAMBA
SW8151A	Yes	75-99-0	Dalapon	DALAPON
SW8151A	Yes	88-85-7	Dinoseb	DINOSEB
SW8151A	Yes	93-65-2	MCPP (2-(2-methyl-4-chlorophenoxy) propanoic acid)	MCPP
SW8151A	Yes	93-72-1	2,4,5-TP (Silvex)	SILVEX
SW8151A	Yes	93-76-5	2,4,5-T	245T
SW8151A	Yes	94-74-6	MCPA (2-Methyl-4-chlorophenoxy acetic acid)	MCPA
SW8151A	Yes	94-75-7	2,4-D	24D
SW8151A	Yes	94-82-6	2,4-DB	24DB
SW8151A	Yes	100-02-7	4-Nitrophenol	NTPH4
SW8151A	Yes	120-36-5	Dichlorprop	DCPROP
SW8151A	Yes	1918-00-9	Dicamba	DICAMBA
SW8151A	Yes	75-99-0	Dalapon	DALAPON
SW8151A & 8270	No	87-86-5	Pentachlorophenol	PCP

TABLE 2-15
Soil Non-detect Results with Detection Limits Exceeding Screening Levels

Location	Sample Date	Sample Ending Depth (ft)	Sample Name	Analytical Method	CAS Number	Analyte Name	ERPIMS Abbreviation	Result (mg/kg)	Flag	Screening Level (mg/kg)	Color
Explosives Non-detect Results with Yellow, Orange, & Red Colors											
TG-A52-04	07/22/05	0.33	05FTW-TG-A52-04-SO	SW8270C	98-95-3	Nitrobenzene	NO2BZ	287	U	0.006	Red
TG-A52-03	07/22/05	0.33	05FTW-TG-A52-03-SO	SW8270C	98-95-3	Nitrobenzene	NO2BZ	336	U	0.006	Red
TG-A52-05	07/22/05	0.33	05FTW-TG-A52-05-SO	SW8270C	98-95-3	Nitrobenzene	NO2BZ	458	U	0.006	Red
TGHP-8-BH08	07/28/05	8	05FTW-TGHP-8-BH08-SO	SW8270C	98-95-3	Nitrobenzene	NO2BZ	2.52	U	0.006	Yellow
TGHP-8-BH06	07/28/05	8	05FTW-TGHP-8-BH06-SO	SW8270C	98-95-3	Nitrobenzene	NO2BZ	2.58	U	0.006	Yellow
TGHP-8-BH05	07/28/05	8	05FTW-TGHP-8-BH05-SO	SW8270C	98-95-3	Nitrobenzene	NO2BZ	2.61	U	0.006	Yellow
TGHP-8-BH09	07/28/05	8	05FTW-TGHP-8-BH09-SO	SW8270C	98-95-3	Nitrobenzene	NO2BZ	2.61	U	0.006	Yellow
TGHP-10-BH07	07/28/05	10	05FTW-TGHP-10-BH07-SO	SW8270C	98-95-3	Nitrobenzene	NO2BZ	2.56	U	0.006	Yellow
TGHP-10-BH09	07/28/05	10	05FTW-TGHP-10-BH09-SO	SW8270C	98-95-3	Nitrobenzene	NO2BZ	2.6	U	0.006	Yellow
TGHP-10-BH04	07/27/05	10	05FTW-TGHP-10-BH04-SO	SW8270C	98-95-3	Nitrobenzene	NO2BZ	2.7	U	0.006	Yellow
TGHP-10-BH06	07/28/05	10	05FTW-TGHP-10-BH06-SO	SW8270C	98-95-3	Nitrobenzene	NO2BZ	2.7	U	0.006	Yellow
TGHP-10-BH05	07/28/05	10	05FTW-TGHP-10-BH05-SO	SW8270C	98-95-3	Nitrobenzene	NO2BZ	2.71	U	0.006	Yellow
TGHP-10-BH08	07/28/05	10	05FTW-TGHP-10-BH08-SO	SW8270C	98-95-3	Nitrobenzene	NO2BZ	2.74	U	0.006	Yellow
06SI31	09/08/06	12	06SI31S01	SW8270C	98-95-3	Nitrobenzene	NO2BZ	7	U	0.006	Orange
06SI29	09/06/06	14	06SI29S01	SW8270C	98-95-3	Nitrobenzene	NO2BZ	7	U	0.006	Orange
06SI20	08/29/06	16	06SI20S03	SW8270C	98-95-3	Nitrobenzene	NO2BZ	18	U	0.006	Orange
06SI34	09/11/06	16	06SI34S01	SW8270C	98-95-3	Nitrobenzene	NO2BZ	18	U	0.006	Orange
Semivolatile Organic Compound Non-detect Results with Yellow, Orange & Red Colors											
TG-A52-04	07/22/05	0.33	05FTW-TG-A52-04-SO	SW8270C	98-95-3	Nitrobenzene	NO2BZ	287	U	0.006	Red
TG-A52-03	07/22/05	0.33	05FTW-TG-A52-03-SO	SW8270C	98-95-3	Nitrobenzene	NO2BZ	336	U	0.006	Red
TG-A52-05	07/22/05	0.33	05FTW-TG-A52-05-SO	SW8270C	98-95-3	Nitrobenzene	NO2BZ	458	U	0.006	Red
TGHP-8-BH08	07/28/05	8	05FTW-TGHP-8-BH08-SO	SW8270C	98-95-3	Nitrobenzene	NO2BZ	2.52	U	0.006	Yellow
TGHP-8-BH06	07/28/05	8	05FTW-TGHP-8-BH06-SO	SW8270C	98-95-3	Nitrobenzene	NO2BZ	2.58	U	0.006	Yellow
TGHP-8-BH05	07/28/05	8	05FTW-TGHP-8-BH05-SO	SW8270C	98-95-3	Nitrobenzene	NO2BZ	2.61	U	0.006	Yellow
TGHP-8-BH09	07/28/05	8	05FTW-TGHP-8-BH09-SO	SW8270C	98-95-3	Nitrobenzene	NO2BZ	2.61	U	0.006	Yellow
TGHP-10-BH07	07/28/05	10	05FTW-TGHP-10-BH07-SO	SW8270C	98-95-3	Nitrobenzene	NO2BZ	2.56	U	0.006	Yellow

TABLE 2-15
Soil Non-detect Results with Detection Limits Exceeding Screening Levels

Location	Sample Date	Sample Ending Depth (ft)	Sample Name	Analytical Method	CAS Number	Analyte Name	ERPIMS Abbreviation	Result (mg/kg)	Flag	Screening Level (mg/kg)	Color
TGHP-10-BH09	07/28/05	10	05FTW-TGHP-10-BH09-SO	SW8270C	98-95-3	Nitrobenzene	NO2BZ	2.6	U	0.006	Yellow
TGHP-10-BH04	07/27/05	10	05FTW-TGHP-10-BH04-SO	SW8270C	98-95-3	Nitrobenzene	NO2BZ	2.7	U	0.006	Yellow
TGHP-10-BH06	07/28/05	10	05FTW-TGHP-10-BH06-SO	SW8270C	98-95-3	Nitrobenzene	NO2BZ	2.7	U	0.006	Yellow
TGHP-10-BH05	07/28/05	10	05FTW-TGHP-10-BH05-SO	SW8270C	98-95-3	Nitrobenzene	NO2BZ	2.71	U	0.006	Yellow
TGHP-10-BH08	07/28/05	10	05FTW-TGHP-10-BH08-SO	SW8270C	98-95-3	Nitrobenzene	NO2BZ	2.74	U	0.006	Yellow
06SI31	09/08/06	12	06SI31S01	SW8270C	98-95-3	Nitrobenzene	NO2BZ	7	U	0.006	Orange
06SI29	09/06/06	14	06SI29S01	SW8270C	98-95-3	Nitrobenzene	NO2BZ	7	U	0.006	Orange
06SI20	08/29/06	16	06SI20S03	SW8270C	98-95-3	Nitrobenzene	NO2BZ	18	U	0.006	Orange
06SI34	09/11/06	16	06SI34S01	SW8270C	98-95-3	Nitrobenzene	NO2BZ	18	U	0.006	Orange
Pesticides Non-detect Results with Yellow, Orange, & Red Colors											
DB09-01	08/01/07	0.3	07FW-DB09-01-080107	SW8081A	319-84-6	alpha-BHC	BHCALPHA	0.09	U	0.00026	Yellow
AP-8960	02/05/04	6	04FHFW26SL	SW8081A	319-84-6	alpha-BHC	BHCALPHA	0.1	U	0.00026	Yellow
06TP14	06/13/06	10	06TP14S03	SW8081A	58-89-9	gamma-BHC (Lindane)	BHCGAMMA	0.1	U	0.0003	Yellow
06TP14	06/13/06	10	06TP14S03	SW8081A	319-84-6	alpha-BHC	BHCALPHA	0.1	U	0.00026	Yellow
DB09-01	08/01/07	0.3	07FW-DB09-01-080107	SW8081A	319-85-7	beta-BHC	BHCBETA	0.09	U	0.0009	Yellow
AP-8960	02/05/04	6	04FHFW26SL	SW8081A	319-85-7	beta-BHC	BHCBETA	0.2	U	0.0009	Yellow
DB09-01	08/01/07	0.3	07FW-DB09-01-080107	SW8081A	58-89-9	gamma-BHC (Lindane)	BHCGAMMA	0.09	U	0.0003	Yellow
AP-8960	02/05/04	6	04FHFW26SL	SW8081A	58-89-9	gamma-BHC (Lindane)	BHCGAMMA	0.1	U	0.0003	Yellow
Volatile Organic Compound Non-detect Results with Yellow, Orange, & Red Colors											
TG-A52-03	07/22/05	0.33	05FTW-TG-A52-03-SO	SW8260B	71-43-2	Benzene	BZ	2.46	U	0.002	Orange
TG-A52-05	07/22/05	0.33	05FTW-TG-A52-05-SO	SW8260B	71-43-2	Benzene	BZ	2.67	U	0.002	Orange
TG-A52-02	07/22/05	0.33	05FTW-TG-A52-02-SO	SW8260B	71-43-2	Benzene	BZ	2.95	U	0.002	Orange
TG-A52-04	07/22/05	0.33	05FTW-TG-A52-04-SO	SW8260B	71-43-2	Benzene	BZ	21.7	U	0.002	Red
TGHP-10-BH05	07/28/05	10	05FTW-TGHP-10-BH05-SO	SW8260B	71-43-2	Benzene	BZ	0.138	U	0.002	Yellow
TGHP-10-BH06	07/28/05	10	05FTW-TGHP-10-BH06-SO	SW8260B	71-43-2	Benzene	BZ	0.934	U	0.002	Yellow

TABLE 2-15
Soil Non-detect Results with Detection Limits Exceeding Screening Levels

Location	Sample Date	Sample Ending Depth (ft)	Sample Name	Analytical Method	CAS Number	Analyte Name	ERPIMS Abbreviation	Result (mg/kg)	Flag	Screening Level (mg/kg)	Color
TG-A52-04	07/22/05	0.33	05FTW-TG-A52-04-SO	SW8260B	108-88-3	Toluene	BZME	83.4	U	0.54	Yellow
TG-A52-04	07/22/05	0.33	05FTW-TG-A52-04-SO	SW8260B	75-15-0	Carbon disulfide	CDS	167	U	1.7	Yellow
TG-A52-03	07/22/05	0.33	05FTW-TG-A52-03-SO	SW8260B	108-90-7	Chlorobenzene	CLBZ	4.73	U	0.06	Yellow
TG-A52-05	07/22/05	0.33	05FTW-TG-A52-05-SO	SW8260B	108-90-7	Chlorobenzene	CLBZ	5.13	U	0.06	Yellow
TG-A52-02	07/22/05	0.33	05FTW-TG-A52-02-SO	SW8260B	108-90-7	Chlorobenzene	CLBZ	5.68	U	0.06	Yellow
TG-A52-04	07/22/05	0.33	05FTW-TG-A52-04-SO	SW8260B	108-90-7	Chlorobenzene	CLBZ	41.7	U	0.06	Orange
TG-A52-03	07/22/05	0.33	05FTW-TG-A52-03-SO	SW8260B	56-23-5	Carbon tetrachloride	CTCL	4.73	U	0.003	Orange
TG-A52-05	07/22/05	0.33	05FTW-TG-A52-05-SO	SW8260B	56-23-5	Carbon tetrachloride	CTCL	5.13	U	0.003	Orange
TG-A52-02	07/22/05	0.33	05FTW-TG-A52-02-SO	SW8260B	56-23-5	Carbon tetrachloride	CTCL	5.68	U	0.003	Orange
TG-A52-04	07/22/05	0.33	05FTW-TG-A52-04-SO	SW8260B	56-23-5	Carbon tetrachloride	CTCL	41.7	U	0.003	Red
TGHP-8-BH05	07/28/05	8	05FTW-TGHP-8-BH05-SO	SW8260B	56-23-5	Carbon tetrachloride	CTCL	0.232	U	0.003	Yellow
TGHP-10-BH05	07/28/05	10	05FTW-TGHP-10-BH05-SO	SW8260B	56-23-5	Carbon tetrachloride	CTCL	0.266	U	0.003	Yellow
TGHP-10-BH06	07/28/05	10	05FTW-TGHP-10-BH06-SO	SW8260B	56-23-5	Carbon tetrachloride	CTCL	1.8	U	0.003	Yellow
TG-A52-03	07/22/05	0.33	05FTW-TG-A52-03-SO	SW8260B	107-06-2	1,2-Dichloroethane	DCA12	4.73	U	0.0015	Orange
TG-A52-05	07/22/05	0.33	05FTW-TG-A52-05-SO	SW8260B	107-06-2	1,2-Dichloroethane	DCA12	5.13	U	0.0015	Orange
TG-A52-02	07/22/05	0.33	05FTW-TG-A52-02-SO	SW8260B	107-06-2	1,2-Dichloroethane	DCA12	5.68	U	0.0015	Orange
TG-A52-04	07/22/05	0.33	05FTW-TG-A52-04-SO	SW8260B	107-06-2	1,2-Dichloroethane	DCA12	41.7	U	0.0015	Red
TGHP-8-BH10	07/28/05	8	05FTW-TGHP-8-BH10-SO	SW8260B	107-06-2	1,2-Dichloroethane	DCA12	0.188	U	0.0015	Yellow

TABLE 2-15
Soil Non-detect Results with Detection Limits Exceeding Screening Levels

Location	Sample Date	Sample Ending Depth (ft)	Sample Name	Analytical Method	CAS Number	Analyte Name	ERPIMS Abbreviation	Result (mg/kg)	Flag	Screening Level (mg/kg)	Color
TGHP-8-BH05	07/28/05	8	05FTW-TGHP-8-BH05-SO	SW8260B	107-06-2	1,2-Dichloroethane	DCA12	0.232	U	0.0015	Yellow
TGHP-10-BH05	07/28/05	10	05FTW-TGHP-10-BH05-SO	SW8260B	107-06-2	1,2-Dichloroethane	DCA12	0.266	U	0.0015	Yellow
TGHP-10-BH06	07/28/05	10	05FTW-TGHP-10-BH06-SO	SW8260B	107-06-2	1,2-Dichloroethane	DCA12	1.8	U	0.0015	Orange
TG-A52-04	07/22/05	0.33	05FTW-TG-A52-04-SO	SW8260B	106-46-7	1,4-Dichlorobenzene	DCBZ14	41.7	U	0.08	Yellow
06SI21	08/29/06	12	06SI21S01	SW8270C	106-46-7	1,4-Dichlorobenzene	DCBZ14	17	U	0.08	Yellow
06SI21	08/29/06	16	06SI21S02	SW8270C	106-46-7	1,4-Dichlorobenzene	DCBZ14	17	U	0.08	Yellow
06SI20	08/29/06	16	06SI20S03	SW8270C	106-46-7	1,4-Dichlorobenzene	DCBZ14	18	U	0.08	Yellow
06SI34	09/11/06	16	06SI34S01	SW8270C	106-46-7	1,4-Dichlorobenzene	DCBZ14	18	U	0.08	Yellow
TG-A52-03	07/22/05	0.33	05FTW-TG-A52-03-SO	SW8260B	75-35-4	1,1-Dichloroethene	DCE11	4.73	U	0.003	Orange
TG-A52-05	07/22/05	0.33	05FTW-TG-A52-05-SO	SW8260B	75-35-4	1,1-Dichloroethene	DCE11	5.13	U	0.003	Orange
TG-A52-02	07/22/05	0.33	05FTW-TG-A52-02-SO	SW8260B	75-35-4	1,1-Dichloroethene	DCE11	5.68	U	0.003	Orange
TG-A52-04	07/22/05	0.33	05FTW-TG-A52-04-SO	SW8260B	75-35-4	1,1-Dichloroethene	DCE11	41.7	U	0.003	Red
TGHP-8-BH05	07/28/05	8	05FTW-TGHP-8-BH05-SO	SW8260B	75-35-4	1,1-Dichloroethene	DCE11	0.232	U	0.003	Yellow
TGHP-10-BH05	07/28/05	10	05FTW-TGHP-10-BH05-SO	SW8260B	75-35-4	1,1-Dichloroethene	DCE11	0.266	U	0.003	Yellow
TGHP-10-BH06	07/28/05	10	05FTW-TGHP-10-BH06-SO	SW8260B	75-35-4	1,1-Dichloroethene	DCE11	1.8	U	0.003	Yellow
TG-A52-03	07/22/05	0.33	05FTW-TG-A52-03-SO	SW8260B	156-59-2	cis-1,2-Dichloroethene	DCE12C	4.73	U	0.02	Yellow

TABLE 2-15
Soil Non-detect Results with Detection Limits Exceeding Screening Levels

Location	Sample Date	Sample Ending Depth (ft)	Sample Name	Analytical Method	CAS Number	Analyte Name	ERPIMS Abbreviation	Result (mg/kg)	Flag	Screening Level (mg/kg)	Color
TG-A52-05	07/22/05	0.33	05FTW-TG-A52-05-SO	SW8260B	156-59-2	cis-1,2-Dichloroethene	DCE12C	5.13	U	0.02	Yellow
TG-A52-02	07/22/05	0.33	05FTW-TG-A52-02-SO	SW8260B	156-59-2	cis-1,2-Dichloroethene	DCE12C	5.68	U	0.02	Yellow
TG-A52-04	07/22/05	0.33	05FTW-TG-A52-04-SO	SW8260B	156-59-2	cis-1,2-Dichloroethene	DCE12C	41.7	U	0.02	Orange
TGHP-10-BH06	07/28/05	10	05FTW-TGHP-10-BH06-SO	SW8260B	156-59-2	cis-1,2-Dichloroethene	DCE12C	1.8	U	0.02	Yellow
TG-A52-03	07/22/05	0.33	05FTW-TG-A52-03-SO	SW8260B	156-60-5	trans-1,2-Dichloroethene	DCE12T	4.73	U	0.04	Yellow
TG-A52-05	07/22/05	0.33	05FTW-TG-A52-05-SO	SW8260B	156-60-5	trans-1,2-Dichloroethene	DCE12T	5.13	U	0.04	Yellow
TG-A52-02	07/22/05	0.33	05FTW-TG-A52-02-SO	SW8260B	156-60-5	trans-1,2-Dichloroethene	DCE12T	5.68	U	0.04	Yellow
TG-A52-04	07/22/05	0.33	05FTW-TG-A52-04-SO	SW8260B	156-60-5	trans-1,2-Dichloroethene	DCE12T	41.7	U	0.04	Orange
TG-A52-03	07/22/05	0.33	05FTW-TG-A52-03-SO	SW8260B	10061-01-5	cis-1,3-Dichloropropene	DCP13C	4.73	U	0.002	Orange
TG-A52-05	07/22/05	0.33	05FTW-TG-A52-05-SO	SW8260B	10061-01-5	cis-1,3-Dichloropropene	DCP13C	5.13	U	0.002	Orange
TG-A52-02	07/22/05	0.33	05FTW-TG-A52-02-SO	SW8260B	10061-01-5	cis-1,3-Dichloropropene	DCP13C	5.68	U	0.002	Orange
TG-A52-04	07/22/05	0.33	05FTW-TG-A52-04-SO	SW8260B	10061-01-5	cis-1,3-Dichloropropene	DCP13C	41.7	U	0.002	Red
TGHP-8-BH10	07/28/05	8	05FTW-TGHP-8-BH10-SO	SW8260B	10061-01-5	cis-1,3-Dichloropropene	DCP13C	0.188	U	0.002	Yellow
TGHP-8-BH05	07/28/05	8	05FTW-TGHP-8-BH05-SO	SW8260B	10061-01-5	cis-1,3-Dichloropropene	DCP13C	0.232	U	0.002	Yellow
TGHP-10-BH05	07/28/05	10	05FTW-TGHP-10-BH05-SO	SW8260B	10061-01-5	cis-1,3-Dichloropropene	DCP13C	0.266	U	0.002	Yellow
TGHP-10-BH06	07/28/05	10	05FTW-TGHP-10-BH06-SO	SW8260B	10061-01-5	cis-1,3-Dichloropropene	DCP13C	1.8	U	0.002	Orange

TABLE 2-15
Soil Non-detect Results with Detection Limits Exceeding Screening Levels

Location	Sample Date	Sample Ending Depth (ft)	Sample Name	Analytical Method	CAS Number	Analyte Name	ERPIMS Abbreviation	Result (mg/kg)	Flag	Screening Level (mg/kg)	Color
TG-A52-03	07/22/05	0.33	05FTW-TG-A52-03-SO	SW8260B	10061-02-6	trans-1,3-Dichloropropene	DCP13T	4.73	U	0.002	Orange
TG-A52-05	07/22/05	0.33	05FTW-TG-A52-05-SO	SW8260B	10061-02-6	trans-1,3-Dichloropropene	DCP13T	5.13	U	0.002	Orange
TG-A52-02	07/22/05	0.33	05FTW-TG-A52-02-SO	SW8260B	10061-02-6	trans-1,3-Dichloropropene	DCP13T	5.68	U	0.002	Orange
TG-A52-04	07/22/05	0.33	05FTW-TG-A52-04-SO	SW8260B	10061-02-6	trans-1,3-Dichloropropene	DCP13T	41.7	U	0.002	Red
TGHP-8-BH10	07/28/05	8	05FTW-TGHP-8-BH10-SO	SW8260B	10061-02-6	trans-1,3-Dichloropropene	DCP13T	0.188	U	0.002	Yellow
TGHP-8-BH05	07/28/05	8	05FTW-TGHP-8-BH05-SO	SW8260B	10061-02-6	trans-1,3-Dichloropropene	DCP13T	0.232	U	0.002	Yellow
TGHP-10-BH05	07/28/05	10	05FTW-TGHP-10-BH05-SO	SW8260B	10061-02-6	trans-1,3-Dichloropropene	DCP13T	0.266	U	0.002	Yellow
TGHP-10-BH06	07/28/05	10	05FTW-TGHP-10-BH06-SO	SW8260B	10061-02-6	trans-1,3-Dichloropropene	DCP13T	1.8	U	0.002	Orange
TG-A52-03	07/22/05	0.33	05FTW-TG-A52-03-SO	SW8260B	78-87-5	1,2-Dichloropropane	DCPA12	4.73	U	0.0017	Orange
TG-A52-05	07/22/05	0.33	05FTW-TG-A52-05-SO	SW8260B	78-87-5	1,2-Dichloropropane	DCPA12	5.13	U	0.0017	Orange
TG-A52-02	07/22/05	0.33	05FTW-TG-A52-02-SO	SW8260B	78-87-5	1,2-Dichloropropane	DCPA12	5.68	U	0.0017	Orange
TG-A52-04	07/22/05	0.33	05FTW-TG-A52-04-SO	SW8260B	78-87-5	1,2-Dichloropropane	DCPA12	41.7	U	0.0017	Red
TGHP-8-BH10	07/28/05	8	05FTW-TGHP-8-BH10-SO	SW8260B	78-87-5	1,2-Dichloropropane	DCPA12	0.188	U	0.0017	Yellow
TGHP-8-BH05	07/28/05	8	05FTW-TGHP-8-BH05-SO	SW8260B	78-87-5	1,2-Dichloropropane	DCPA12	0.232	U	0.0017	Yellow
TGHP-10-BH05	07/28/05	10	05FTW-TGHP-10-BH05-SO	SW8260B	78-87-5	1,2-Dichloropropane	DCPA12	0.266	U	0.0017	Yellow
TGHP-10-BH06	07/28/05	10	05FTW-TGHP-10-BH06-SO	SW8260B	78-87-5	1,2-Dichloropropane	DCPA12	1.8	U	0.0017	Orange

TABLE 2-15
Soil Non-detect Results with Detection Limits Exceeding Screening Levels

Location	Sample Date	Sample Ending Depth (ft)	Sample Name	Analytical Method	CAS Number	Analyte Name	ERPIMS Abbreviation	Result (mg/kg)	Flag	Screening Level (mg/kg)	Color
TG-A52-04	07/22/05	0.33	05FTW-TG-A52-04-SO	SW8260B	100-41-4	Ethylbenzene	EBZ	41.7	U	0.55	Yellow
TG-A52-04	07/22/05	0.33	05FTW-TG-A52-04-SO	SW8260B	87-68-3	Hexachlorobutadiene	HCBU	83.4	U	0.8	Yellow
TG-A52-04	07/22/05	0.33	05FTW-TG-A52-04-SO	SW8260B	78-93-3	2-Butanone	MEK	417	U	6	Yellow
TSW-64-4	09/15/05	3	05FTW-TSW-64-4-SO	SW8260B	79-34-5	1,1,2,2-Tetrachloroethane	PCA	0.133	U	0.0017	Yellow
TG-A52-03	07/22/05	0.33	05FTW-TG-A52-03-SO	SW8260B	79-34-5	1,1,2,2-Tetrachloroethane	PCA	9.46	U	0.0017	Orange
TG-A52-05	07/22/05	0.33	05FTW-TG-A52-05-SO	SW8260B	79-34-5	1,1,2,2-Tetrachloroethane	PCA	10.3	U	0.0017	Orange
TG-A52-02	07/22/05	0.33	05FTW-TG-A52-02-SO	SW8260B	79-34-5	1,1,2,2-Tetrachloroethane	PCA	11.4	U	0.0017	Red
TG-A52-04	07/22/05	0.33	05FTW-TG-A52-04-SO	SW8260B	79-34-5	1,1,2,2-Tetrachloroethane	PCA	83.4	U	0.0017	Red
MW02	09/17/05	9	05FTW-MW-2-1-SO	SW8260B	79-34-5	1,1,2,2-Tetrachloroethane	PCA	0.121	U	0.0017	Yellow
TGHP-8-BH10	07/28/05	8	05FTW-TGHP-8-BH10-SO	SW8260B	79-34-5	1,1,2,2-Tetrachloroethane	PCA	0.376	U	0.0017	Yellow
TGHP-8-BH05	07/28/05	8	05FTW-TGHP-8-BH05-SO	SW8260B	79-34-5	1,1,2,2-Tetrachloroethane	PCA	0.464	U	0.0017	Yellow
MW02	09/17/05	12	05FTW-MW-2-2-SO	SW8260B	79-34-5	1,1,2,2-Tetrachloroethane	PCA	0.137	U	0.0017	Yellow
TGHP-10-BH05	07/28/05	10	05FTW-TGHP-10-BH05-SO	SW8260B	79-34-5	1,1,2,2-Tetrachloroethane	PCA	0.531	U	0.0017	Yellow
TGHP-10-BH06	07/28/05	10	05FTW-TGHP-10-BH06-SO	SW8260B	79-34-5	1,1,2,2-Tetrachloroethane	PCA	3.59	U	0.0017	Orange
TG-A52-03	07/22/05	0.33	05FTW-TG-A52-03-SO	SW8260B	127-18-4	Tetrachloroethene (PCE)	PCE	4.73	U	0.003	Orange
TG-A52-05	07/22/05	0.33	05FTW-TG-A52-05-SO	SW8260B	127-18-4	Tetrachloroethene (PCE)	PCE	5.13	U	0.003	Orange
TG-A52-02	07/22/05	0.33	05FTW-TG-A52-02-SO	SW8260B	127-18-4	Tetrachloroethene (PCE)	PCE	5.68	U	0.003	Orange

TABLE 2-15
Soil Non-detect Results with Detection Limits Exceeding Screening Levels

Location	Sample Date	Sample Ending Depth (ft)	Sample Name	Analytical Method	CAS Number	Analyte Name	ERPIMS Abbreviation	Result (mg/kg)	Flag	Screening Level (mg/kg)	Color
TG-A52-04	07/22/05	0.33	05FTW-TG-A52-04-SO	SW8260B	127-18-4	Tetrachloroethene (PCE)	PCE	41.7	U	0.003	Red
TGHP-8-BH05	07/28/05	8	05FTW-TGHP-8-BH05-SO	SW8260B	127-18-4	Tetrachloroethene (PCE)	PCE	0.232	U	0.003	Yellow
TGHP-10-BH05	07/28/05	10	05FTW-TGHP-10-BH05-SO	SW8260B	127-18-4	Tetrachloroethene (PCE)	PCE	0.266	U	0.003	Yellow
TGHP-10-BH06	07/28/05	10	05FTW-TGHP-10-BH06-SO	SW8260B	127-18-4	Tetrachloroethene (PCE)	PCE	1.8	U	0.003	Yellow
TG-A52-04	07/22/05	0.33	05FTW-TG-A52-04-SO	SW8260B	100-42-5	Styrene	STY	41.7	U	0.13	Yellow
TG-A52-03	07/22/05	0.33	05FTW-TG-A52-03-SO	SW8260B	75-25-2	Bromoform	TBME	4.73	U	0.038	Yellow
TG-A52-05	07/22/05	0.33	05FTW-TG-A52-05-SO	SW8260B	75-25-2	Bromoform	TBME	5.13	U	0.038	Yellow
TG-A52-02	07/22/05	0.33	05FTW-TG-A52-02-SO	SW8260B	75-25-2	Bromoform	TBME	5.68	U	0.038	Yellow
TG-A52-04	07/22/05	0.33	05FTW-TG-A52-04-SO	SW8260B	75-25-2	Bromoform	TBME	41.7	U	0.038	Orange
TG-A52-04	07/22/05	0.33	05FTW-TG-A52-04-SO	SW8260B	71-55-6	1,1,1-Trichloroethane	TCA111	41.7	U	0.1	Yellow
TG-A52-03	07/22/05	0.33	05FTW-TG-A52-03-SO	SW8260B	79-00-5	1,1,2-Trichloroethane	TCA112	4.73	U	0.0017	Orange
TG-A52-05	07/22/05	0.33	05FTW-TG-A52-05-SO	SW8260B	79-00-5	1,1,2-Trichloroethane	TCA112	5.13	U	0.0017	Orange
TG-A52-02	07/22/05	0.33	05FTW-TG-A52-02-SO	SW8260B	79-00-5	1,1,2-Trichloroethane	TCA112	5.68	U	0.0017	Orange
TG-A52-04	07/22/05	0.33	05FTW-TG-A52-04-SO	SW8260B	79-00-5	1,1,2-Trichloroethane	TCA112	41.7	U	0.0017	Red
TGHP-8-BH10	07/28/05	8	05FTW-TGHP-8-BH10-SO	SW8260B	79-00-5	1,1,2-Trichloroethane	TCA112	0.188	U	0.0017	Yellow
TGHP-8-BH05	07/28/05	8	05FTW-TGHP-8-BH05-SO	SW8260B	79-00-5	1,1,2-Trichloroethane	TCA112	0.232	U	0.0017	Yellow
TGHP-10-BH05	07/28/05	10	05FTW-TGHP-10-BH05-SO	SW8260B	79-00-5	1,1,2-Trichloroethane	TCA112	0.266	U	0.0017	Yellow
TGHP-10-BH06	07/28/05	10	05FTW-TGHP-10-BH06-SO	SW8260B	79-00-5	1,1,2-Trichloroethane	TCA112	1.8	U	0.0017	Orange

TABLE 2-15
Soil Non-detect Results with Detection Limits Exceeding Screening Levels

Location	Sample Date	Sample Ending Depth (ft)	Sample Name	Analytical Method	CAS Number	Analyte Name	ERPIMS Abbreviation	Result (mg/kg)	Flag	Screening Level (mg/kg)	Color
TG-A52-03	07/22/05	0.33	05FTW-TG-A52-03-SO	SW8260B	79-01-6	Trichloroethene (TCE)	TCE	4.73	U	0.002	Orange
TG-A52-05	07/22/05	0.33	05FTW-TG-A52-05-SO	SW8260B	79-01-6	Trichloroethene (TCE)	TCE	5.13	U	0.002	Orange
TG-A52-02	07/22/05	0.33	05FTW-TG-A52-02-SO	SW8260B	79-01-6	Trichloroethene (TCE)	TCE	5.68	U	0.002	Orange
TG-A52-04	07/22/05	0.33	05FTW-TG-A52-04-SO	SW8260B	79-01-6	Trichloroethene (TCE)	TCE	41.7	U	0.002	Red
TGHP-8-BH10	07/28/05	8	05FTW-TGHP-8-BH10-SO	SW8260B	79-01-6	Trichloroethene (TCE)	TCE	0.188	U	0.002	Yellow
TGHP-8-BH05	07/28/05	8	05FTW-TGHP-8-BH05-SO	SW8260B	79-01-6	Trichloroethene (TCE)	TCE	0.232	U	0.002	Yellow
TGHP-10-BH05	07/28/05	10	05FTW-TGHP-10-BH05-SO	SW8260B	79-01-6	Trichloroethene (TCE)	TCE	0.266	U	0.002	Yellow
TGHP-10-BH06	07/28/05	10	05FTW-TGHP-10-BH06-SO	SW8260B	79-01-6	Trichloroethene (TCE)	TCE	1.8	U	0.002	Orange
TG-A52-03	07/22/05	0.33	05FTW-TG-A52-03-SO	SW8260B	67-66-3	Chloroform	TCLME	4.73	U	0.034	Yellow
TG-A52-05	07/22/05	0.33	05FTW-TG-A52-05-SO	SW8260B	67-66-3	Chloroform	TCLME	5.13	U	0.034	Yellow
TG-A52-02	07/22/05	0.33	05FTW-TG-A52-02-SO	SW8260B	67-66-3	Chloroform	TCLME	5.68	U	0.034	Yellow
TG-A52-04	07/22/05	0.33	05FTW-TG-A52-04-SO	SW8260B	67-66-3	Chloroform	TCLME	41.7	U	0.034	Orange
TSW-64-4	09/15/05	3	05FTW-TSW-64-4-SO	SW8260B	75-01-4	Vinyl chloride	VC	0.0665	U	0.0009	Yellow
AP-8933	12/13/03	1	03FHFW19SL	SW8260B	75-01-4	Vinyl chloride	VC	0.076	U	0.0009	Yellow
AP-8958	01/25/04	0.5	04FHFW04SL	SW8260B	75-01-4	Vinyl chloride	VC	0.1	U	0.0009	Yellow
TG-A52-03	07/22/05	0.33	05FTW-TG-A52-03-SO	SW8260B	75-01-4	Vinyl chloride	VC	4.73	U	0.0009	Orange
TG-A52-05	07/22/05	0.33	05FTW-TG-A52-05-SO	SW8260B	75-01-4	Vinyl chloride	VC	5.13	U	0.0009	Orange
TG-A52-02	07/22/05	0.33	05FTW-TG-A52-02-SO	SW8260B	75-01-4	Vinyl chloride	VC	5.68	U	0.0009	Orange
TG-A52-04	07/22/05	0.33	05FTW-TG-A52-04-SO	SW8260B	75-01-4	Vinyl chloride	VC	41.7	U	0.0009	Red
06SI37	09/14/06	3	06SI37S01	SW8260B	75-01-4	Vinyl chloride	VC	0.23	UJ	0.0009	Yellow
06SI46	09/15/06	4	06SI46S01	SW8260B	75-01-4	Vinyl chloride	VC	0.22	UJ	0.0009	Yellow
MW02	09/17/05	9	05FTW-MW-2-1-SO	SW8260B	75-01-4	Vinyl chloride	VC	0.0607	U	0.0009	Yellow

TABLE 2-15
Soil Non-detect Results with Detection Limits Exceeding Screening Levels

Location	Sample Date	Sample Ending Depth (ft)	Sample Name	Analytical Method	CAS Number	Analyte Name	ERPIMS Abbreviation	Result (mg/kg)	Flag	Screening Level (mg/kg)	Color
TGHP-8-BH10	07/28/05	8	05FTW-TGHP-8-BH10-SO	SW8260B	75-01-4	Vinyl chloride	VC	0.188	U	0.0009	Yellow
TGHP-8-BH05	07/28/05	8	05FTW-TGHP-8-BH05-SO	SW8260B	75-01-4	Vinyl chloride	VC	0.232	U	0.0009	Yellow
MW02	09/17/05	12	05FTW-MW-2-2-SO	SW8260B	75-01-4	Vinyl chloride	VC	0.0684	U	0.0009	Yellow
TGHP-10-BH05	07/28/05	10	05FTW-TGHP-10-BH05-SO	SW8260B	75-01-4	Vinyl chloride	VC	0.266	U	0.0009	Yellow
TGHP-10-BH06	07/28/05	10	05FTW-TGHP-10-BH06-SO	SW8260B	75-01-4	Vinyl chloride	VC	1.8	U	0.0009	Orange

Note:
mg/kg = milligrams per kilogram

TABLE 2-16
Groundwater Non-detect Results with Detection Limits Exceeding Screening Levels

Location	Sample Date	Sample Name	Analytical Method	CAS Number	Analyte Name	ERPIMS Abbreviation	Result (ug/L)	Flag	Screening Level (mg/kg)	Color
Volatile Organic Compound Non-detect Results with Yellow, Orange, & Red Colors										
MW01	9/21/05	05FTW-TK-MW-1-W	SW8260B	75-01-4	Vinyl chloride	VC	1	U	0.015	Yellow
MW02	9/22/05	05FTW-TK-MW-2-W	SW8260B	75-01-4	Vinyl chloride	VC	1	U	0.015	Yellow
MW03	9/22/05	05FTW-TK-MW-3-W	SW8260B	75-01-4	Vinyl chloride	VC	1	U	0.015	Yellow
MW04	9/22/05	05FTW-TK-MW-04-W	SW8260B	75-01-4	Vinyl chloride	VC	1	U	0.015	Yellow
TW-6	9/21/05	05FTW-TK-TW-6-W	SW8260B	75-01-4	Vinyl chloride	VC	1	U	0.015	Yellow
TW-8	9/21/05	05FTW-TK-TW-8-W	SW8260B	75-01-4	Vinyl chloride	VC	1	U	0.015	Yellow
Pesticide Non-detect Results with Yellow, Orange, & Red Colors										
MW06B	5/17/07	07MW06BS01	SW8081A	60-57-1	Dieldrin	DIELDRIN	2	U	0.0042	Yellow
MW12	5/17/07	07MW12S01	SW8081A	60-57-1	Dieldrin	DIELDRIN	2	U	0.0042	Yellow
MW06A	5/17/07	07MW06AS01	SW8081A	60-57-1	Dieldrin	DIELDRIN	2.1	U	0.0042	Yellow
MW06B	5/17/07	07MW06BS01	SW8081A	8001-35-2	Toxaphene	TOXAP	39	U	0.3	Yellow
MW12	5/17/07	07MW12S01	SW8081A	8001-35-2	Toxaphene	TOXAP	40	U	0.3	Yellow
MW06A	5/17/07	07MW06AS01	SW8081A	8001-35-2	Toxaphene	TOXAP	42	U	0.3	Yellow
Polychlorinated Biphenyl (PCB) Non-detect Results with Yellow, Orange, & Red Colors										
MW02	7/12/06	06MW02S01	SW8082	1336-36-3	PCBs (total)	PCBCALC	0.1064	U	0.05	Green
MW01	9/21/05	05FTW-TK-MW-1-W	SW8082	1336-36-3	PCBs (total)	PCBCALC	0.1085	U	0.05	Green
MW01	7/11/06	06MW01S01	SW8082	1336-36-3	PCBs (total)	PCBCALC	0.1085	U	0.05	Green
MW03	9/22/05	05FTW-TK-MW-3-W	SW8082	1336-36-3	PCBs (total)	PCBCALC	0.1085	U	0.05	Green
MW03	7/12/06	06MW03S02	SW8082	1336-36-3	PCBs (total)	PCBCALC	0.1085	U	0.05	Green
MW04	9/22/05	05FTW-TK-MW-04-W	SW8082	1336-36-3	PCBs (total)	PCBCALC	0.1085	U	0.05	Green
TW-6	9/21/05	05FTW-TK-TW-6-W	SW8082	1336-36-3	PCBs (total)	PCBCALC	0.1085	U	0.05	Green
TW-8	9/21/05	05FTW-TK-TW-8-W	SW8082	1336-36-3	PCBs (total)	PCBCALC	0.1085	U	0.05	Green
MW02	9/22/05	05FTW-TK-MW-2-W	SW8082	1336-36-3	PCBs (total)	PCBCALC	0.1106	U	0.05	Green
MW03	7/12/06	06MW03S01	SW8082	1336-36-3	PCBs (total)	PCBCALC	0.1106	U	0.05	Green
MW06B	5/17/07	07MW06BS01	SW8082	1336-36-3	PCBs (total)	PCBCALC	0.8	U	0.05	Yellow
MW02	5/15/07	07MW02S01	SW8082	1336-36-3	PCBs (total)	PCBCALC	0.815	U	0.05	Yellow

TABLE 2-16
Groundwater Non-detect Results with Detection Limits Exceeding Screening Levels

Location	Sample Date	Sample Name	Analytical Method	CAS Number	Analyte Name	ERPIMS Abbreviation	Result (ug/L)	Flag	Screening Level (mg/kg)	Color
MW05	5/14/07	07MW05S01	SW8082	1336-36-3	PCBs (total)	PCBCALC	0.815	U	0.05	Yellow
MW01	5/15/07	07MW01S01	SW8082	1336-36-3	PCBs (total)	PCBCALC	0.82	U	0.05	Yellow
MW08	5/14/07	07MW08S01	SW8082	1336-36-3	PCBs (total)	PCBCALC	0.82	U	0.05	Yellow
MW08	5/14/07	07MW08S02	SW8082	1336-36-3	PCBs (total)	PCBCALC	0.82	U	0.05	Yellow
MW09	5/15/07	07MW09S01	SW8082	1336-36-3	PCBs (total)	PCBCALC	0.82	U	0.05	Yellow
MW10	5/16/07	07MW10S01	SW8082	1336-36-3	PCBs (total)	PCBCALC	0.82	U	0.05	Yellow
MW11	5/16/07	07MW11S01	SW8082	1336-36-3	PCBs (total)	PCBCALC	0.82	U	0.05	Yellow
MW12	5/17/07	07MW12S01	SW8082	1336-36-3	PCBs (total)	PCBCALC	0.82	U	0.05	Yellow
MW03	5/11/07	07MW03S01	SW8082	1336-36-3	PCBs (total)	PCBCALC	0.835	U	0.05	Yellow
MW04	5/11/07	07MW04S01	SW8082	1336-36-3	PCBs (total)	PCBCALC	0.835	U	0.05	Yellow
MW06A	5/17/07	07MW06AS01	SW8082	1336-36-3	PCBs (total)	PCBCALC	0.85	U	0.05	Yellow
MW07	5/14/07	07MW07S01	SW8082	1336-36-3	PCBs (total)	PCBCALC	0.85	U	0.05	Yellow
Semivolatile Organic Compounds Non-detect Results with Yellow, Orange, & Red Colors										
MW10	5/16/07	07MW10S01	SW8270C	56-55-3	Benzo(a)anthracene	BZAA	9.6	U	0.03	Yellow
MW07	9/20/06	06MW07S01	SW8270C	56-55-3	Benzo(a)anthracene	BZAA	9.7	U	0.03	Yellow
MW07	5/14/07	07MW07S01	SW8270C	56-55-3	Benzo(a)anthracene	BZAA	9.7	U	0.03	Yellow
MW11	9/19/06	06MW11S01	SW8270C	56-55-3	Benzo(a)anthracene	BZAA	9.7	U	0.03	Yellow
MW01	5/15/07	07MW01S01	SW8270C	56-55-3	Benzo(a)anthracene	BZAA	9.8	U	0.03	Yellow
MW04	5/11/07	07MW04S01	SW8270C	56-55-3	Benzo(a)anthracene	BZAA	9.8	U	0.03	Yellow
MW12	5/17/07	07MW12S01	SW8270C	56-55-3	Benzo(a)anthracene	BZAA	9.8	U	0.03	Yellow
MW02	9/21/06	06MW12S01	SW8270C	56-55-3	Benzo(a)anthracene	BZAA	9.9	U	0.03	Yellow
MW02	5/15/07	07MW02S01	SW8270C	56-55-3	Benzo(a)anthracene	BZAA	9.9	U	0.03	Yellow
MW05	5/14/07	07MW05S01	SW8270C	56-55-3	Benzo(a)anthracene	BZAA	9.9	U	0.03	Yellow
MW06A	9/20/06	06MW06AS01	SW8270C	56-55-3	Benzo(a)anthracene	BZAA	9.9	U	0.03	Yellow
MW08	5/14/07	07MW08S01	SW8270C	56-55-3	Benzo(a)anthracene	BZAA	9.9	U	0.03	Yellow
MW01	9/21/05	05FTW-TK-MW-1-W	SW8270C	56-55-3	Benzo(a)anthracene	BZAA	10	U	0.03	Yellow
MW01	7/11/06	06MW01S01	SW8270C	56-55-3	Benzo(a)anthracene	BZAA	10	U	0.03	Yellow
MW02	9/22/05	05FTW-TK-MW-2-W	SW8270C	56-55-3	Benzo(a)anthracene	BZAA	10	U	0.03	Yellow

TABLE 2-16
Groundwater Non-detect Results with Detection Limits Exceeding Screening Levels

Location	Sample Date	Sample Name	Analytical Method	CAS Number	Analyte Name	ERPIMS Abbreviation	Result (ug/L)	Flag	Screening Level (mg/kg)	Color
MW02	7/12/06	06MW02S01	SW8270C	56-55-3	Benzo(a)anthracene	BZAA	10	U	0.03	Yellow
MW03	9/22/05	05FTW-TK-MW-3-W	SW8270C	56-55-3	Benzo(a)anthracene	BZAA	10	U	0.03	Yellow
MW03	7/12/06	06MW03S02	SW8270C	56-55-3	Benzo(a)anthracene	BZAA	10	U	0.03	Yellow
MW03	5/11/07	07MW03S01	SW8270C	56-55-3	Benzo(a)anthracene	BZAA	10	U	0.03	Yellow
MW04	9/22/05	05FTW-TK-MW-04-W	SW8270C	56-55-3	Benzo(a)anthracene	BZAA	10	U	0.03	Yellow
MW04	9/18/06	06MW04S01	SW8270C	56-55-3	Benzo(a)anthracene	BZAA	10	U	0.03	Yellow
MW05	9/18/06	06MW05S01	SW8270C	56-55-3	Benzo(a)anthracene	BZAA	10	U	0.03	Yellow
MW06A	5/17/07	07MW06AS01	SW8270C	56-55-3	Benzo(a)anthracene	BZAA	10	U	0.03	Yellow
MW06B	9/13/06	06MW06BS01	SW8270C	56-55-3	Benzo(a)anthracene	BZAA	10	U	0.03	Yellow
MW06B	5/17/07	07MW06BS01	SW8270C	56-55-3	Benzo(a)anthracene	BZAA	10	U	0.03	Yellow
MW08	5/14/07	07MW08S02	SW8270C	56-55-3	Benzo(a)anthracene	BZAA	10	U	0.03	Yellow
MW09	9/26/06	06MW09S01	SW8270C	56-55-3	Benzo(a)anthracene	BZAA	10	U	0.03	Yellow
MW09	5/15/07	07MW09S01	SW8270C	56-55-3	Benzo(a)anthracene	BZAA	10	U	0.03	Yellow
MW10	9/19/06	06MW10S01	SW8270C	56-55-3	Benzo(a)anthracene	BZAA	10	U	0.03	Yellow
MW11	5/16/07	07MW11S01	SW8270C	56-55-3	Benzo(a)anthracene	BZAA	10	U	0.03	Yellow
MW11	5/16/07	07MW11S02	SW8270C	56-55-3	Benzo(a)anthracene	BZAA	10	U	0.03	Yellow
TW-6	9/21/05	05FTW-TK-TW-6-W	SW8270C	56-55-3	Benzo(a)anthracene	BZAA	10	U	0.03	Yellow
TW-8	9/21/05	05FTW-TK-TW-8-W	SW8270C	56-55-3	Benzo(a)anthracene	BZAA	10	U	0.03	Yellow
MW03	7/12/06	06MW03S01	SW8270C	56-55-3	Benzo(a)anthracene	BZAA	11	U	0.03	Yellow
MW08	9/21/06	06MW08S01	SW8270C	56-55-3	Benzo(a)anthracene	BZAA	11	U	0.03	Yellow
MW10	5/16/07	07MW10S01	SW8270C	50-32-8	Benzo(a)pyrene	BZAP	9.6	U	0.003	Orange
MW07	9/20/06	06MW07S01	SW8270C	50-32-8	Benzo(a)pyrene	BZAP	9.7	U	0.003	Orange
MW07	5/14/07	07MW07S01	SW8270C	50-32-8	Benzo(a)pyrene	BZAP	9.7	U	0.003	Orange
MW11	9/19/06	06MW11S01	SW8270C	50-32-8	Benzo(a)pyrene	BZAP	9.7	U	0.003	Orange
MW01	5/15/07	07MW01S01	SW8270C	50-32-8	Benzo(a)pyrene	BZAP	9.8	U	0.003	Orange
MW04	5/11/07	07MW04S01	SW8270C	50-32-8	Benzo(a)pyrene	BZAP	9.8	U	0.003	Orange
MW12	5/17/07	07MW12S01	SW8270C	50-32-8	Benzo(a)pyrene	BZAP	9.8	U	0.003	Orange
MW02	9/21/06	06MW12S01	SW8270C	50-32-8	Benzo(a)pyrene	BZAP	9.9	U	0.003	Orange

TABLE 2-16
Groundwater Non-detect Results with Detection Limits Exceeding Screening Levels

Location	Sample Date	Sample Name	Analytical Method	CAS Number	Analyte Name	ERPIMS Abbreviation	Result (ug/L)	Flag	Screening Level (mg/kg)	Color
MW02	5/15/07	07MW02S01	SW8270C	50-32-8	Benzo(a)pyrene	BZAP	9.9	U	0.003	Orange
MW05	5/14/07	07MW05S01	SW8270C	50-32-8	Benzo(a)pyrene	BZAP	9.9	U	0.003	Orange
MW06A	9/20/06	06MW06AS01	SW8270C	50-32-8	Benzo(a)pyrene	BZAP	9.9	U	0.003	Orange
MW08	5/14/07	07MW08S01	SW8270C	50-32-8	Benzo(a)pyrene	BZAP	9.9	U	0.003	Orange
MW01	9/21/05	05FTW-TK-MW-1-W	SW8270C	50-32-8	Benzo(a)pyrene	BZAP	10	U	0.003	Orange
MW01	7/11/06	06MW01S01	SW8270C	50-32-8	Benzo(a)pyrene	BZAP	10	U	0.003	Orange
MW02	9/22/05	05FTW-TK-MW-2-W	SW8270C	50-32-8	Benzo(a)pyrene	BZAP	10	U	0.003	Orange
MW02	7/12/06	06MW02S01	SW8270C	50-32-8	Benzo(a)pyrene	BZAP	10	U	0.003	Orange
MW03	9/22/05	05FTW-TK-MW-3-W	SW8270C	50-32-8	Benzo(a)pyrene	BZAP	10	U	0.003	Orange
MW03	7/12/06	06MW03S02	SW8270C	50-32-8	Benzo(a)pyrene	BZAP	10	U	0.003	Orange
MW03	5/11/07	07MW03S01	SW8270C	50-32-8	Benzo(a)pyrene	BZAP	10	U	0.003	Orange
MW04	9/22/05	05FTW-TK-MW-04-W	SW8270C	50-32-8	Benzo(a)pyrene	BZAP	10	U	0.003	Orange
MW04	9/18/06	06MW04S01	SW8270C	50-32-8	Benzo(a)pyrene	BZAP	10	U	0.003	Orange
MW05	9/18/06	06MW05S01	SW8270C	50-32-8	Benzo(a)pyrene	BZAP	10	U	0.003	Orange
MW06A	5/17/07	07MW06AS01	SW8270C	50-32-8	Benzo(a)pyrene	BZAP	10	U	0.003	Orange
MW06B	9/13/06	06MW06BS01	SW8270C	50-32-8	Benzo(a)pyrene	BZAP	10	U	0.003	Orange
MW06B	5/17/07	07MW06BS01	SW8270C	50-32-8	Benzo(a)pyrene	BZAP	10	U	0.003	Orange
MW08	5/14/07	07MW08S02	SW8270C	50-32-8	Benzo(a)pyrene	BZAP	10	U	0.003	Orange
MW09	9/26/06	06MW09S01	SW8270C	50-32-8	Benzo(a)pyrene	BZAP	10	U	0.003	Orange
MW09	5/15/07	07MW09S01	SW8270C	50-32-8	Benzo(a)pyrene	BZAP	10	U	0.003	Orange
MW10	9/19/06	06MW10S01	SW8270C	50-32-8	Benzo(a)pyrene	BZAP	10	U	0.003	Orange
MW11	5/16/07	07MW11S01	SW8270C	50-32-8	Benzo(a)pyrene	BZAP	10	U	0.003	Orange
MW11	5/16/07	07MW11S02	SW8270C	50-32-8	Benzo(a)pyrene	BZAP	10	U	0.003	Orange
TW-6	9/21/05	05FTW-TK-TW-6-W	SW8270C	50-32-8	Benzo(a)pyrene	BZAP	10	U	0.003	Orange
TW-8	9/21/05	05FTW-TK-TW-8-W	SW8270C	50-32-8	Benzo(a)pyrene	BZAP	10	U	0.003	Orange
MW03	7/12/06	06MW03S01	SW8270C	50-32-8	Benzo(a)pyrene	BZAP	11	U	0.003	Orange
MW08	9/21/06	06MW08S01	SW8270C	50-32-8	Benzo(a)pyrene	BZAP	11	U	0.003	Orange
MW10	5/16/07	07MW10S01	SW8270C	205-99-2	Benzo(b)fluoranthene	BZBF	9.6	U	0.03	Yellow

TABLE 2-16
Groundwater Non-detect Results with Detection Limits Exceeding Screening Levels

Location	Sample Date	Sample Name	Analytical Method	CAS Number	Analyte Name	ERPIMS Abbreviation	Result (ug/L)	Flag	Screening Level (mg/kg)	Color
MW07	9/20/06	06MW07S01	SW8270C	205-99-2	Benzo(b)fluoranthene	BZBF	9.7	U	0.03	Yellow
MW07	5/14/07	07MW07S01	SW8270C	205-99-2	Benzo(b)fluoranthene	BZBF	9.7	U	0.03	Yellow
MW11	9/19/06	06MW11S01	SW8270C	205-99-2	Benzo(b)fluoranthene	BZBF	9.7	U	0.03	Yellow
MW01	5/15/07	07MW01S01	SW8270C	205-99-2	Benzo(b)fluoranthene	BZBF	9.8	U	0.03	Yellow
MW04	5/11/07	07MW04S01	SW8270C	205-99-2	Benzo(b)fluoranthene	BZBF	9.8	U	0.03	Yellow
MW12	5/17/07	07MW12S01	SW8270C	205-99-2	Benzo(b)fluoranthene	BZBF	9.8	U	0.03	Yellow
MW02	9/21/06	06MW12S01	SW8270C	205-99-2	Benzo(b)fluoranthene	BZBF	9.9	U	0.03	Yellow
MW02	5/15/07	07MW02S01	SW8270C	205-99-2	Benzo(b)fluoranthene	BZBF	9.9	U	0.03	Yellow
MW05	5/14/07	07MW05S01	SW8270C	205-99-2	Benzo(b)fluoranthene	BZBF	9.9	U	0.03	Yellow
MW06A	9/20/06	06MW06AS01	SW8270C	205-99-2	Benzo(b)fluoranthene	BZBF	9.9	U	0.03	Yellow
MW08	5/14/07	07MW08S01	SW8270C	205-99-2	Benzo(b)fluoranthene	BZBF	9.9	U	0.03	Yellow
MW01	9/21/05	05FTW-TK-MW-1-W	SW8270C	205-99-2	Benzo(b)fluoranthene	BZBF	10	U	0.03	Yellow
MW01	7/11/06	06MW01S01	SW8270C	205-99-2	Benzo(b)fluoranthene	BZBF	10	U	0.03	Yellow
MW02	9/22/05	05FTW-TK-MW-2-W	SW8270C	205-99-2	Benzo(b)fluoranthene	BZBF	10	U	0.03	Yellow
MW02	7/12/06	06MW02S01	SW8270C	205-99-2	Benzo(b)fluoranthene	BZBF	10	U	0.03	Yellow
MW03	9/22/05	05FTW-TK-MW-3-W	SW8270C	205-99-2	Benzo(b)fluoranthene	BZBF	10	U	0.03	Yellow
MW03	7/12/06	06MW03S02	SW8270C	205-99-2	Benzo(b)fluoranthene	BZBF	10	U	0.03	Yellow
MW03	5/11/07	07MW03S01	SW8270C	205-99-2	Benzo(b)fluoranthene	BZBF	10	U	0.03	Yellow
MW04	9/22/05	05FTW-TK-MW-04-W	SW8270C	205-99-2	Benzo(b)fluoranthene	BZBF	10	U	0.03	Yellow
MW04	9/18/06	06MW04S01	SW8270C	205-99-2	Benzo(b)fluoranthene	BZBF	10	U	0.03	Yellow
MW05	9/18/06	06MW05S01	SW8270C	205-99-2	Benzo(b)fluoranthene	BZBF	10	U	0.03	Yellow
MW06A	5/17/07	07MW06AS01	SW8270C	205-99-2	Benzo(b)fluoranthene	BZBF	10	U	0.03	Yellow
MW06B	9/13/06	06MW06BS01	SW8270C	205-99-2	Benzo(b)fluoranthene	BZBF	10	U	0.03	Yellow
MW06B	5/17/07	07MW06BS01	SW8270C	205-99-2	Benzo(b)fluoranthene	BZBF	10	U	0.03	Yellow
MW08	5/14/07	07MW08S02	SW8270C	205-99-2	Benzo(b)fluoranthene	BZBF	10	U	0.03	Yellow
MW09	9/26/06	06MW09S01	SW8270C	205-99-2	Benzo(b)fluoranthene	BZBF	10	U	0.03	Yellow
MW09	5/15/07	07MW09S01	SW8270C	205-99-2	Benzo(b)fluoranthene	BZBF	10	U	0.03	Yellow
MW10	9/19/06	06MW10S01	SW8270C	205-99-2	Benzo(b)fluoranthene	BZBF	10	U	0.03	Yellow

TABLE 2-16
Groundwater Non-detect Results with Detection Limits Exceeding Screening Levels

Location	Sample Date	Sample Name	Analytical Method	CAS Number	Analyte Name	ERPIMS Abbreviation	Result (ug/L)	Flag	Screening Level (mg/kg)	Color
MW11	5/16/07	07MW11S01	SW8270C	205-99-2	Benzo(b)fluoranthene	BZBF	10	U	0.03	Yellow
MW11	5/16/07	07MW11S02	SW8270C	205-99-2	Benzo(b)fluoranthene	BZBF	10	U	0.03	Yellow
TW-6	9/21/05	05FTW-TK-TW-6-W	SW8270C	205-99-2	Benzo(b)fluoranthene	BZBF	10	U	0.03	Yellow
TW-8	9/21/05	05FTW-TK-TW-8-W	SW8270C	205-99-2	Benzo(b)fluoranthene	BZBF	10	U	0.03	Yellow
MW03	7/12/06	06MW03S01	SW8270C	205-99-2	Benzo(b)fluoranthene	BZBF	11	U	0.03	Yellow
MW08	9/21/06	06MW08S01	SW8270C	205-99-2	Benzo(b)fluoranthene	BZBF	11	U	0.03	Yellow
MW10	5/16/07	07MW10S01	SW8270C	53-70-3	Dibenzo(a,h)anthracene	DBAHA	9.6	U	0.003	Orange
MW07	9/20/06	06MW07S01	SW8270C	53-70-3	Dibenzo(a,h)anthracene	DBAHA	9.7	U	0.003	Orange
MW07	5/14/07	07MW07S01	SW8270C	53-70-3	Dibenzo(a,h)anthracene	DBAHA	9.7	U	0.003	Orange
MW11	9/19/06	06MW11S01	SW8270C	53-70-3	Dibenzo(a,h)anthracene	DBAHA	9.7	U	0.003	Orange
MW01	5/15/07	07MW01S01	SW8270C	53-70-3	Dibenzo(a,h)anthracene	DBAHA	9.8	U	0.003	Orange
MW04	5/11/07	07MW04S01	SW8270C	53-70-3	Dibenzo(a,h)anthracene	DBAHA	9.8	U	0.003	Orange
MW12	5/17/07	07MW12S01	SW8270C	53-70-3	Dibenzo(a,h)anthracene	DBAHA	9.8	U	0.003	Orange
MW02	9/21/06	06MW12S01	SW8270C	53-70-3	Dibenzo(a,h)anthracene	DBAHA	9.9	U	0.003	Orange
MW02	5/15/07	07MW02S01	SW8270C	53-70-3	Dibenzo(a,h)anthracene	DBAHA	9.9	U	0.003	Orange
MW05	5/14/07	07MW05S01	SW8270C	53-70-3	Dibenzo(a,h)anthracene	DBAHA	9.9	U	0.003	Orange
MW06A	9/20/06	06MW06AS01	SW8270C	53-70-3	Dibenzo(a,h)anthracene	DBAHA	9.9	U	0.003	Orange
MW08	5/14/07	07MW08S01	SW8270C	53-70-3	Dibenzo(a,h)anthracene	DBAHA	9.9	U	0.003	Orange
MW01	9/21/05	05FTW-TK-MW-1-W	SW8270C	53-70-3	Dibenzo(a,h)anthracene	DBAHA	10	U	0.003	Orange
MW01	7/11/06	06MW01S01	SW8270C	53-70-3	Dibenzo(a,h)anthracene	DBAHA	10	U	0.003	Orange
MW02	9/22/05	05FTW-TK-MW-2-W	SW8270C	53-70-3	Dibenzo(a,h)anthracene	DBAHA	10	U	0.003	Orange
MW02	7/12/06	06MW02S01	SW8270C	53-70-3	Dibenzo(a,h)anthracene	DBAHA	10	U	0.003	Orange
MW03	9/22/05	05FTW-TK-MW-3-W	SW8270C	53-70-3	Dibenzo(a,h)anthracene	DBAHA	10	U	0.003	Orange
MW03	7/12/06	06MW03S02	SW8270C	53-70-3	Dibenzo(a,h)anthracene	DBAHA	10	U	0.003	Orange
MW03	5/11/07	07MW03S01	SW8270C	53-70-3	Dibenzo(a,h)anthracene	DBAHA	10	U	0.003	Orange
MW04	9/22/05	05FTW-TK-MW-04-W	SW8270C	53-70-3	Dibenzo(a,h)anthracene	DBAHA	10	U	0.003	Orange
MW04	9/18/06	06MW04S01	SW8270C	53-70-3	Dibenzo(a,h)anthracene	DBAHA	10	U	0.003	Orange
MW05	9/18/06	06MW05S01	SW8270C	53-70-3	Dibenzo(a,h)anthracene	DBAHA	10	U	0.003	Orange

TABLE 2-16
Groundwater Non-detect Results with Detection Limits Exceeding Screening Levels

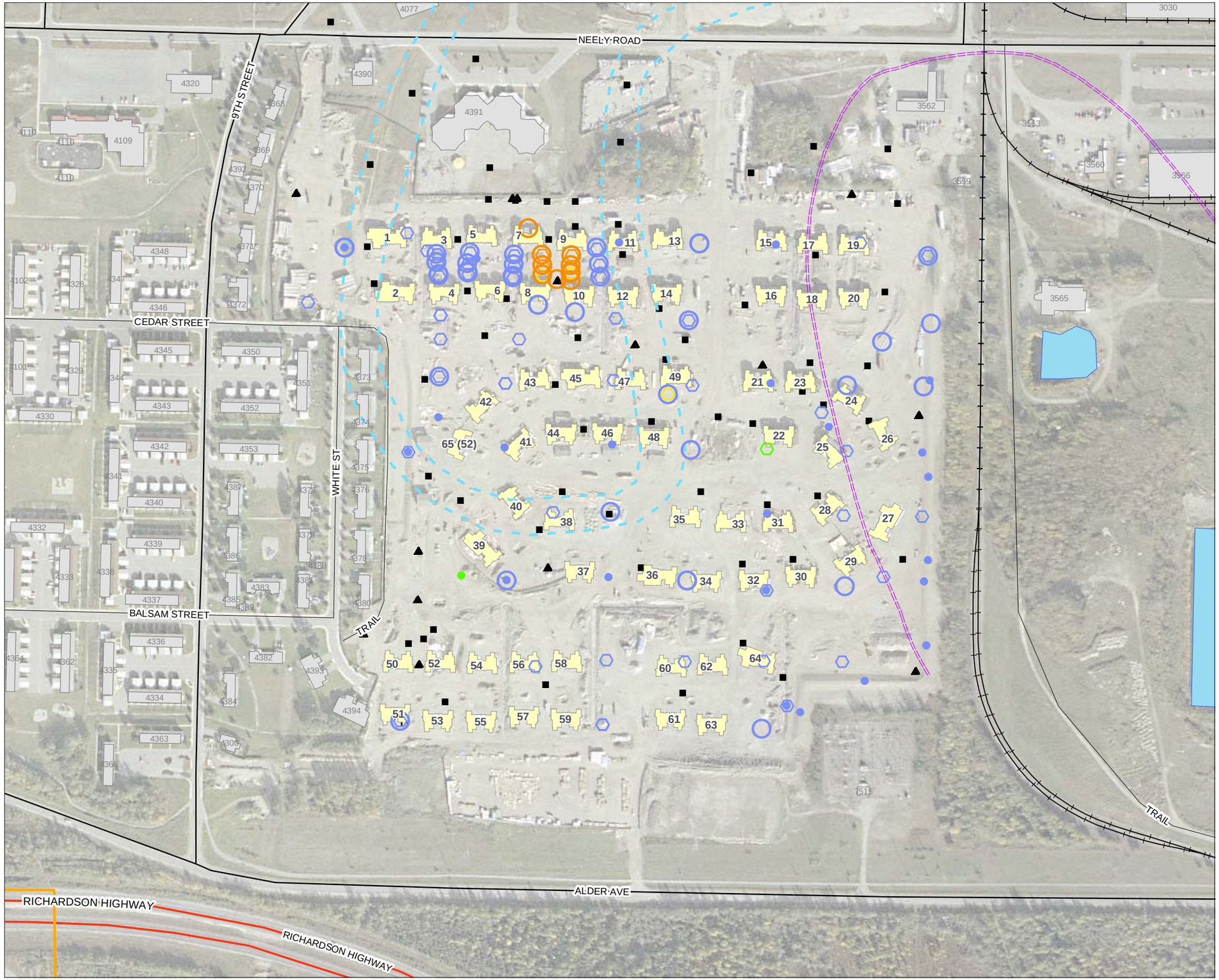
Location	Sample Date	Sample Name	Analytical Method	CAS Number	Analyte Name	ERPIMS Abbreviation	Result (ug/L)	Flag	Screening Level (mg/kg)	Color
MW06A	5/17/07	07MW06AS01	SW8270C	53-70-3	Dibenzo(a,h)anthracene	DBAHA	10	U	0.003	Orange
MW06B	9/13/06	06MW06BS01	SW8270C	53-70-3	Dibenzo(a,h)anthracene	DBAHA	10	U	0.003	Orange
MW06B	5/17/07	07MW06BS01	SW8270C	53-70-3	Dibenzo(a,h)anthracene	DBAHA	10	U	0.003	Orange
MW08	5/14/07	07MW08S02	SW8270C	53-70-3	Dibenzo(a,h)anthracene	DBAHA	10	U	0.003	Orange
MW09	9/26/06	06MW09S01	SW8270C	53-70-3	Dibenzo(a,h)anthracene	DBAHA	10	U	0.003	Orange
MW09	5/15/07	07MW09S01	SW8270C	53-70-3	Dibenzo(a,h)anthracene	DBAHA	10	U	0.003	Orange
MW10	9/19/06	06MW10S01	SW8270C	53-70-3	Dibenzo(a,h)anthracene	DBAHA	10	U	0.003	Orange
MW11	5/16/07	07MW11S01	SW8270C	53-70-3	Dibenzo(a,h)anthracene	DBAHA	10	U	0.003	Orange
MW11	5/16/07	07MW11S02	SW8270C	53-70-3	Dibenzo(a,h)anthracene	DBAHA	10	U	0.003	Orange
TW-6	9/21/05	05FTW-TK-TW-6-W	SW8270C	53-70-3	Dibenzo(a,h)anthracene	DBAHA	10	U	0.003	Orange
TW-8	9/21/05	05FTW-TK-TW-8-W	SW8270C	53-70-3	Dibenzo(a,h)anthracene	DBAHA	10	U	0.003	Orange
MW03	7/12/06	06MW03S01	SW8270C	53-70-3	Dibenzo(a,h)anthracene	DBAHA	11	U	0.003	Orange
MW08	9/21/06	06MW08S01	SW8270C	53-70-3	Dibenzo(a,h)anthracene	DBAHA	11	U	0.003	Orange
MW01	9/21/05	05FTW-TK-MW-1-W	SW8270C	118-74-1	Hexachlorobenzene	HCLBZ	10	U	0.042	Yellow
MW02	9/22/05	05FTW-TK-MW-2-W	SW8270C	118-74-1	Hexachlorobenzene	HCLBZ	10	U	0.042	Yellow
MW03	9/22/05	05FTW-TK-MW-3-W	SW8270C	118-74-1	Hexachlorobenzene	HCLBZ	10	U	0.042	Yellow
MW04	9/22/05	05FTW-TK-MW-04-W	SW8270C	118-74-1	Hexachlorobenzene	HCLBZ	10	U	0.042	Yellow
TW-6	9/21/05	05FTW-TK-TW-6-W	SW8270C	118-74-1	Hexachlorobenzene	HCLBZ	10	U	0.042	Yellow
TW-8	9/21/05	05FTW-TK-TW-8-W	SW8270C	118-74-1	Hexachlorobenzene	HCLBZ	10	U	0.042	Yellow
MW01	9/21/05	05FTW-TK-MW-1-W	SW8270C	193-39-5	Indeno(1,2,3-cd)pyrene	INP123	10	U	0.03	Yellow
MW02	9/22/05	05FTW-TK-MW-2-W	SW8270C	193-39-5	Indeno(1,2,3-cd)pyrene	INP123	10	U	0.03	Yellow
MW03	9/22/05	05FTW-TK-MW-3-W	SW8270C	193-39-5	Indeno(1,2,3-cd)pyrene	INP123	10	U	0.03	Yellow
MW04	9/22/05	05FTW-TK-MW-04-W	SW8270C	193-39-5	Indeno(1,2,3-cd)pyrene	INP123	10	U	0.03	Yellow
TW-6	9/21/05	05FTW-TK-TW-6-W	SW8270C	193-39-5	Indeno(1,2,3-cd)pyrene	INP123	10	U	0.03	Yellow
TW-8	9/21/05	05FTW-TK-TW-8-W	SW8270C	193-39-5	Indeno(1,2,3-cd)pyrene	INP123	10	U	0.03	Yellow
MW10	5/16/07	07MW10S01	SW8270C	193-39-5	Indeno(1,2,3-cd)pyrene	INP123	14	U	0.03	Yellow
MW01	5/15/07	07MW01S01	SW8270C	193-39-5	Indeno(1,2,3-cd)pyrene	INP123	15	U	0.03	Yellow
MW02	7/12/06	06MW02S01	SW8270C	193-39-5	Indeno(1,2,3-cd)pyrene	INP123	15	U	0.03	Yellow

TABLE 2-16
Groundwater Non-detect Results with Detection Limits Exceeding Screening Levels

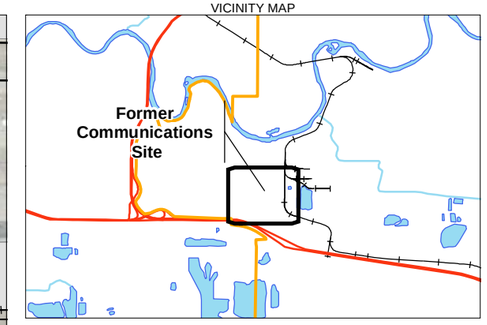
Location	Sample Date	Sample Name	Analytical Method	CAS Number	Analyte Name	ERPIMS Abbreviation	Result (ug/L)	Flag	Screening Level (mg/kg)	Color
MW02	9/21/06	06MW12S01	SW8270C	193-39-5	Indeno(1,2,3-cd)pyrene	INP123	15	U	0.03	Yellow
MW02	5/15/07	07MW02S01	SW8270C	193-39-5	Indeno(1,2,3-cd)pyrene	INP123	15	U	0.03	Yellow
MW03	5/11/07	07MW03S01	SW8270C	193-39-5	Indeno(1,2,3-cd)pyrene	INP123	15	U	0.03	Yellow
MW04	9/18/06	06MW04S01	SW8270C	193-39-5	Indeno(1,2,3-cd)pyrene	INP123	15	U	0.03	Yellow
MW04	5/11/07	07MW04S01	SW8270C	193-39-5	Indeno(1,2,3-cd)pyrene	INP123	15	U	0.03	Yellow
MW05	9/18/06	06MW05S01	SW8270C	193-39-5	Indeno(1,2,3-cd)pyrene	INP123	15	U	0.03	Yellow
MW05	5/14/07	07MW05S01	SW8270C	193-39-5	Indeno(1,2,3-cd)pyrene	INP123	15	U	0.03	Yellow
MW06A	9/20/06	06MW06AS01	SW8270C	193-39-5	Indeno(1,2,3-cd)pyrene	INP123	15	U	0.03	Yellow
MW06A	5/17/07	07MW06AS01	SW8270C	193-39-5	Indeno(1,2,3-cd)pyrene	INP123	15	U	0.03	Yellow
MW06B	9/13/06	06MW06BS01	SW8270C	193-39-5	Indeno(1,2,3-cd)pyrene	INP123	15	U	0.03	Yellow
MW06B	5/17/07	07MW06BS01	SW8270C	193-39-5	Indeno(1,2,3-cd)pyrene	INP123	15	U	0.03	Yellow
MW07	9/20/06	06MW07S01	SW8270C	193-39-5	Indeno(1,2,3-cd)pyrene	INP123	15	U	0.03	Yellow
MW07	5/14/07	07MW07S01	SW8270C	193-39-5	Indeno(1,2,3-cd)pyrene	INP123	15	U	0.03	Yellow
MW08	5/14/07	07MW08S01	SW8270C	193-39-5	Indeno(1,2,3-cd)pyrene	INP123	15	U	0.03	Yellow
MW08	5/14/07	07MW08S02	SW8270C	193-39-5	Indeno(1,2,3-cd)pyrene	INP123	15	U	0.03	Yellow
MW09	9/26/06	06MW09S01	SW8270C	193-39-5	Indeno(1,2,3-cd)pyrene	INP123	15	U	0.03	Yellow
MW09	5/15/07	07MW09S01	SW8270C	193-39-5	Indeno(1,2,3-cd)pyrene	INP123	15	U	0.03	Yellow
MW11	9/19/06	06MW11S01	SW8270C	193-39-5	Indeno(1,2,3-cd)pyrene	INP123	15	U	0.03	Yellow
MW11	5/16/07	07MW11S01	SW8270C	193-39-5	Indeno(1,2,3-cd)pyrene	INP123	15	U	0.03	Yellow
MW11	5/16/07	07MW11S02	SW8270C	193-39-5	Indeno(1,2,3-cd)pyrene	INP123	15	U	0.03	Yellow
MW12	5/17/07	07MW12S01	SW8270C	193-39-5	Indeno(1,2,3-cd)pyrene	INP123	15	U	0.03	Yellow
MW01	7/11/06	06MW01S01	SW8270C	193-39-5	Indeno(1,2,3-cd)pyrene	INP123	16	U	0.03	Yellow
MW03	7/12/06	06MW03S01	SW8270C	193-39-5	Indeno(1,2,3-cd)pyrene	INP123	16	U	0.03	Yellow
MW03	7/12/06	06MW03S02	SW8270C	193-39-5	Indeno(1,2,3-cd)pyrene	INP123	16	U	0.03	Yellow
MW08	9/21/06	06MW08S01	SW8270C	193-39-5	Indeno(1,2,3-cd)pyrene	INP123	16	U	0.03	Yellow
MW10	9/19/06	06MW10S01	SW8270C	193-39-5	Indeno(1,2,3-cd)pyrene	INP123	16	U	0.03	Yellow

Note:
ug/L = micrograms per liter

Appendix B
Chemical Data Mapping



VICINITY MAP



LEGEND

- Permanent monitoring well locations
- Proposed monitoring well locations
- Capture Zone, Supply Well 3559
- Former slough channel

Concentration Relative to Screening Level

- Blue indicates concentrations <= screening level
- Green indicates concentrations > screening level and <= 10x screening level
- Yellow indicates concentrations > 10x screening level and <= 100x screening level
- Orange indicates concentrations > 100x screening level and <= 1,000x screening level
- Red indicates concentrations > 1,000x screening level

Sample Depth

- Small Circle = 0 to 2 ft depth soil samples
- Medium Hexagon = 2 to 10 ft depth soil samples
- Large Circle = Greater than 10 ft depth soil samples

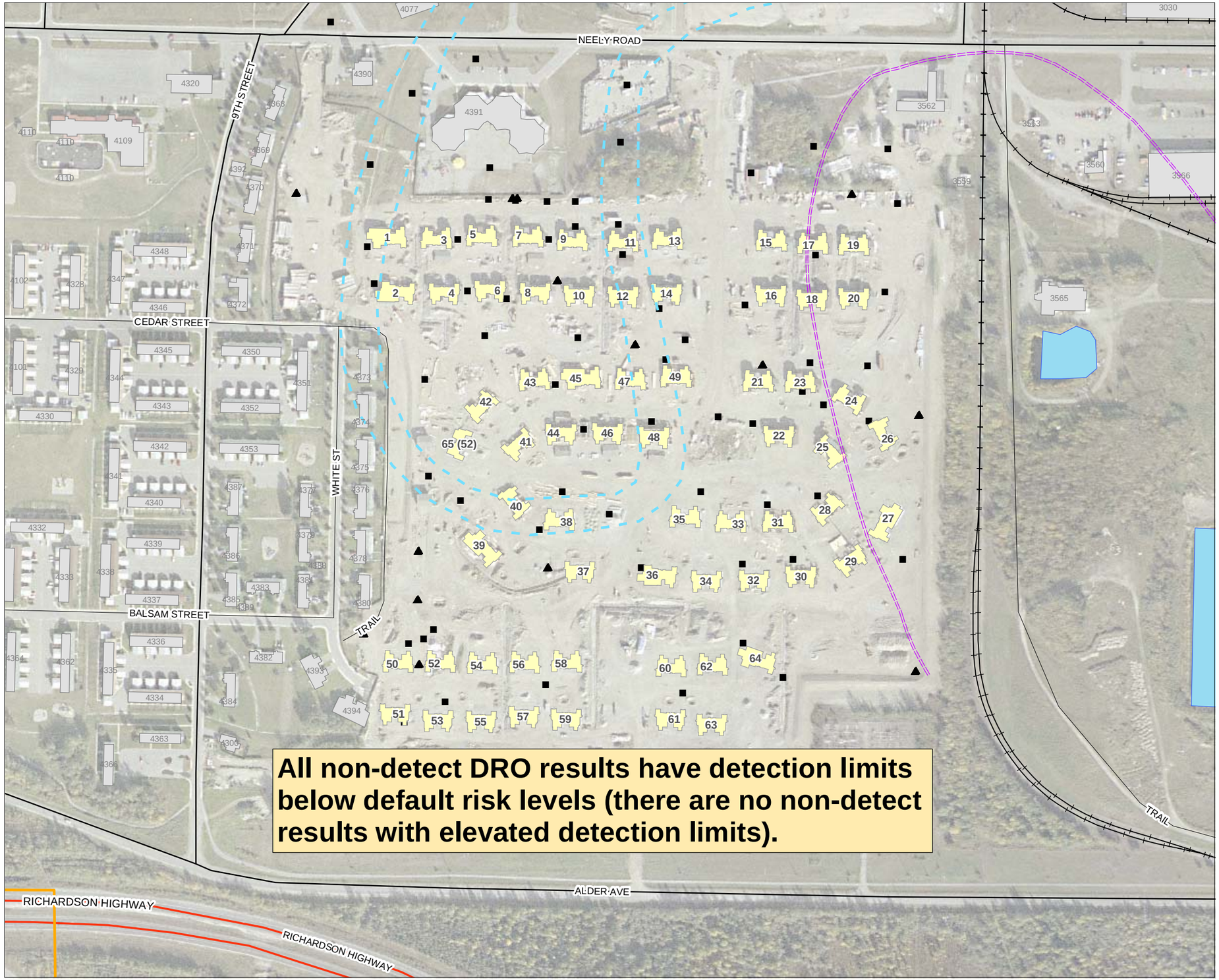
NOTES:
1. Screening Levels are 1/10th of ADEC Cleanup Levels or EPA Region 6 PRGs
2. Projection: WGS84 UTM Zone 6N

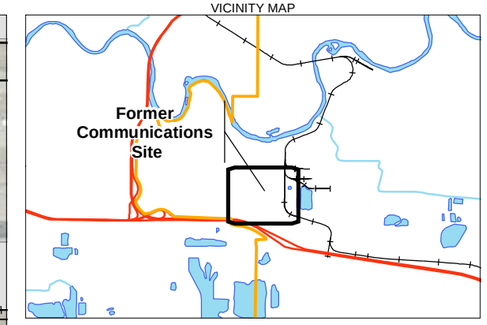
N

0 150 300
Feet

FIGURE 2-10
DRO IN SOILS
Yellow, Orange & Red Detects
Blue & Green Detects and Non-detects
Former Communications Site
Fort Wainwright, Alaska

DRAFT





LEGEND

- ▲ Permanent monitoring well locations
- ■ Proposed monitoring well locations
- Capture Zone, Supply Well 3559
- Former slough channel

Concentration Relative to Screening Level

- Blue indicates concentrations <= screening level
- Green indicates concentrations > screening level and <= 10x screening level
- Yellow indicates concentrations > 10x screening level and <= 100x screening level
- Orange indicates concentrations > 100x screening level and <= 1,000x screening level
- Red indicates concentrations > 1,000x screening level

Sample Depth

- Small Circle = 0 to 2 ft depth soil samples
- Medium Hexagon = 2 to 10 ft depth soil samples
- Large Circle = Greater than 10 ft depth soil samples

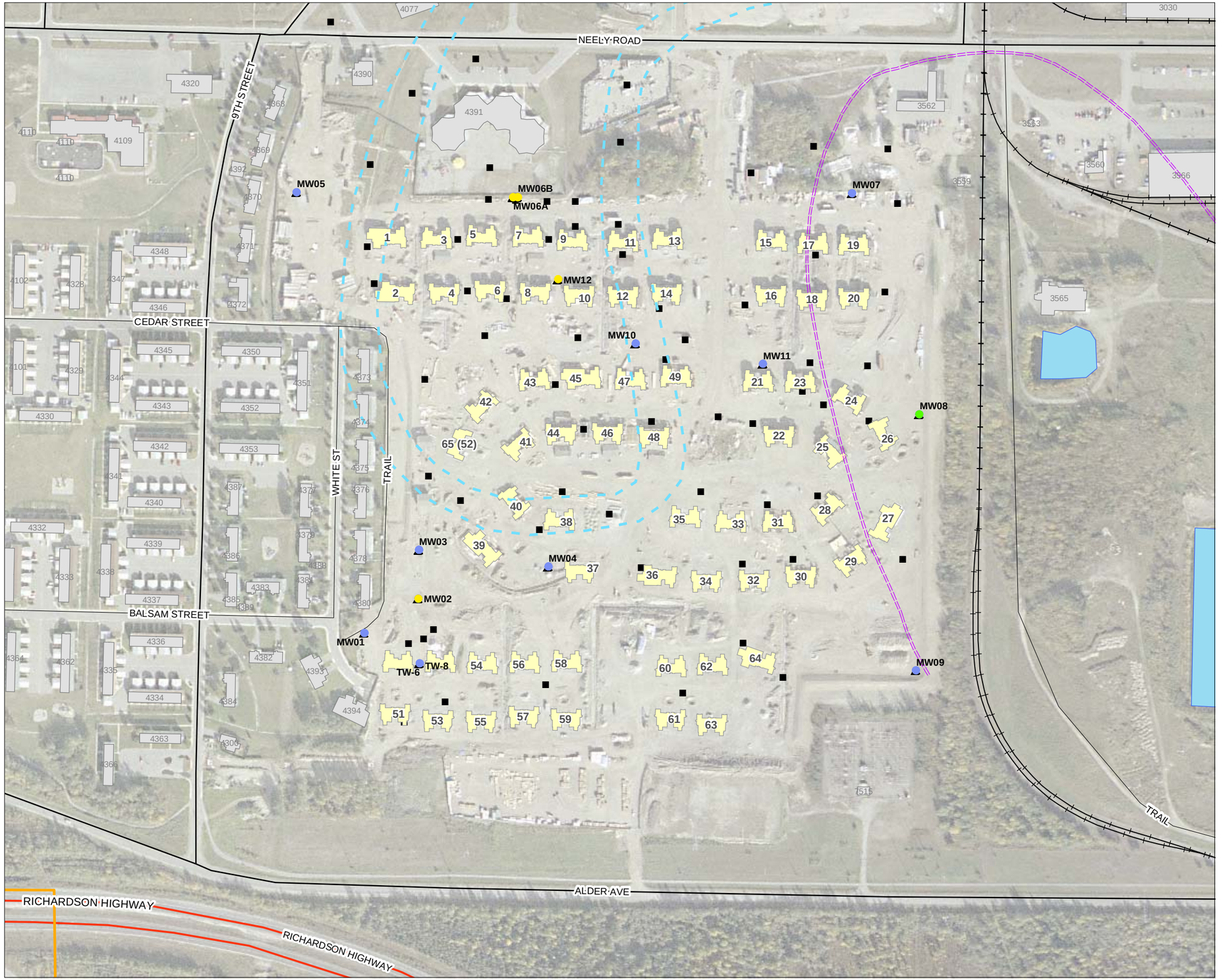
NOTES:
1. Screening Levels are 1/10th of ADEC Cleanup Levels or EPA Region 6 PRGs
2. Projection: WGS84 UTM Zone 6N

N

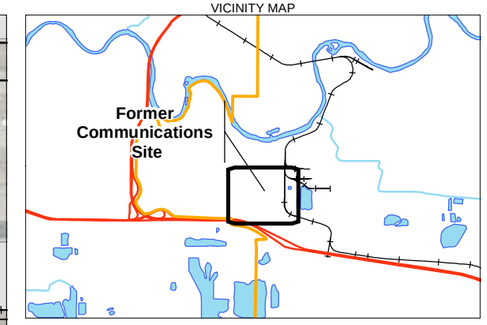
0 150 300
Feet

FIGURE 2-11
DRO SOIL NON-DETECT RESULTS WITH ELEVATED DETECTION LIMITS
Yellow, Orange & Red Non-detects
Former Communications Site
Fort Wainwright, Alaska

DRAFT



VICINITY MAP



LEGEND

- ▲ Permanent monitoring well locations
- ■ Proposed monitoring well locations
- Capture Zone, Supply Well 3559
- Former slough channel

Concentration Relative to Screening Level

- Blue indicates concentrations <= screening level
- Green indicates concentrations > screening level and <= 10x screening level
- Yellow indicates concentrations > 10x screening level and <= 100x screening level
- Orange indicates concentrations > 100x screening level and <= 1,000x screening level
- Red indicates concentrations > 1,000x screening level

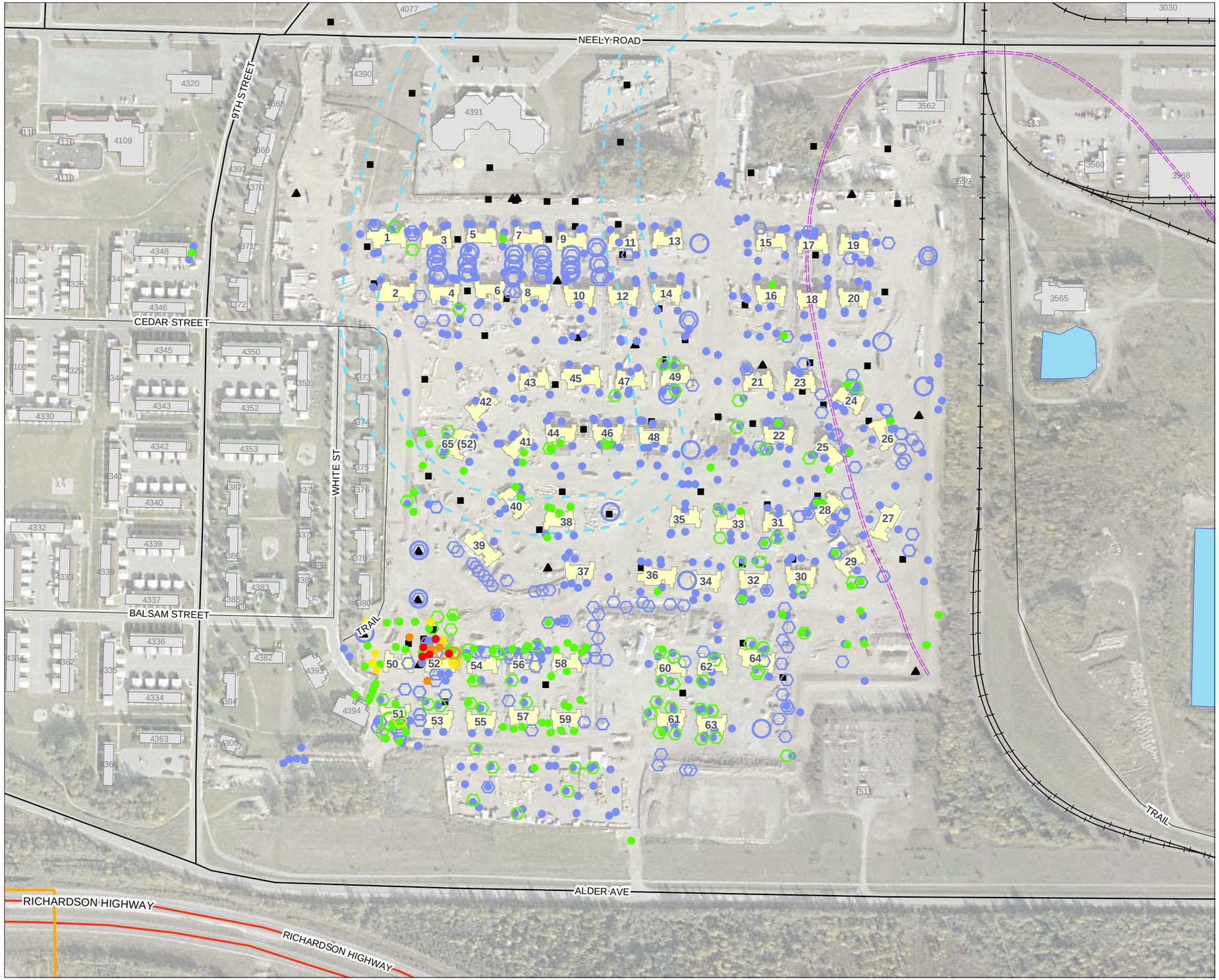
NOTES:
1. Screening Levels are 1/10th of ADEC Cleanup Levels or EPA Region 6 PRGs
2. Projection: WGS84 UTM Zone 6N

N

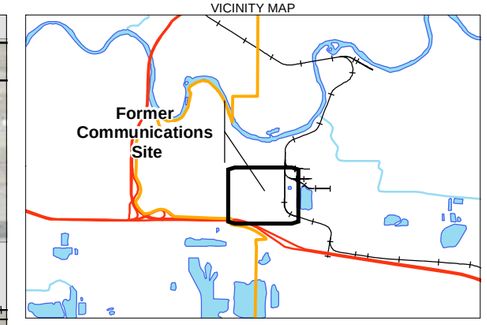
0 150 300
Feet

FIGURE 2-12
DRO IN GROUNDWATER
Yellow, Orange & Red Detects
Blue & Green Detects and Non-detects
Former Communications Site
Fort Wainwright, Alaska

DRAFT



VICINITY MAP



LEGEND

- ▲ Permanent monitoring well locations
- ■ Proposed monitoring well locations
- Capture Zone, Supply Well 3559
- Former slough channel

Concentration Relative to Screening Level

- Blue indicates concentrations <= screening level
- Green indicates concentrations > screening level and <= 10x screening level
- Yellow indicates concentrations > 10x screening level and <= 100x screening level
- Orange indicates concentrations > 100x screening level and <= 1,000x screening level
- Red indicates concentrations > 1,000x screening level

Sample Depth

- Small Circle = 0 to 2 ft depth soil samples
- Medium Hexagon = 2 to 10 ft depth soil samples
- Large Circle = Greater than 10 ft depth soil samples

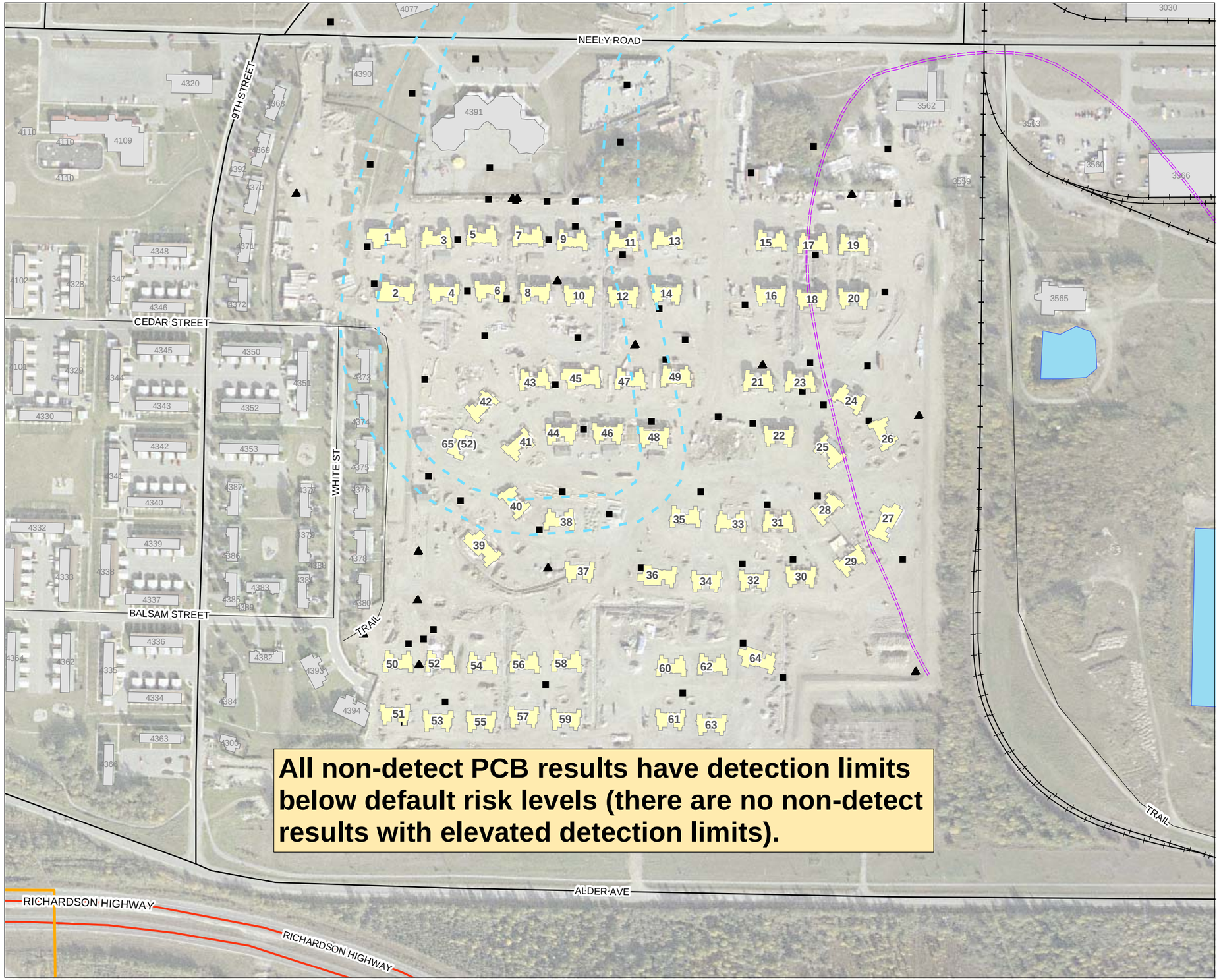
NOTES:
1. Screening Levels are 1/10th of ADEC Cleanup Levels or EPA Region 6 PRGs
2. Projection: WGS84 UTM Zone 6N

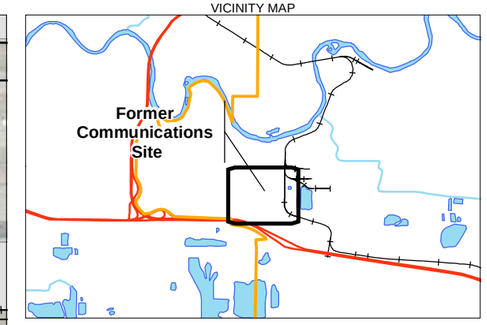
N

0 150 300
Feet

FIGURE 2-13
PCBs IN SOILS
Yellow, Orange & Red Detects
Blue & Green Detects and Non-detects
Former Communications Site
Fort Wainwright, Alaska

DRAFT





LEGEND

- ▲ Permanent monitoring well locations
- ■ Proposed monitoring well locations
- Capture Zone, Supply Well 3559
- Former slough channel

Concentration Relative to Screening Level

- Blue indicates concentrations <= screening level
- Green indicates concentrations > screening level and <= 10x screening level
- Yellow indicates concentrations > 10x screening level and <= 100x screening level
- Orange indicates concentrations > 100x screening level and <= 1,000x screening level
- Red indicates concentrations > 1,000x screening level

Sample Depth

- Small Circle = 0 to 2 ft depth soil samples
- Medium Hexagon = 2 to 10 ft depth soil samples
- Large Circle = Greater than 10 ft depth soil samples

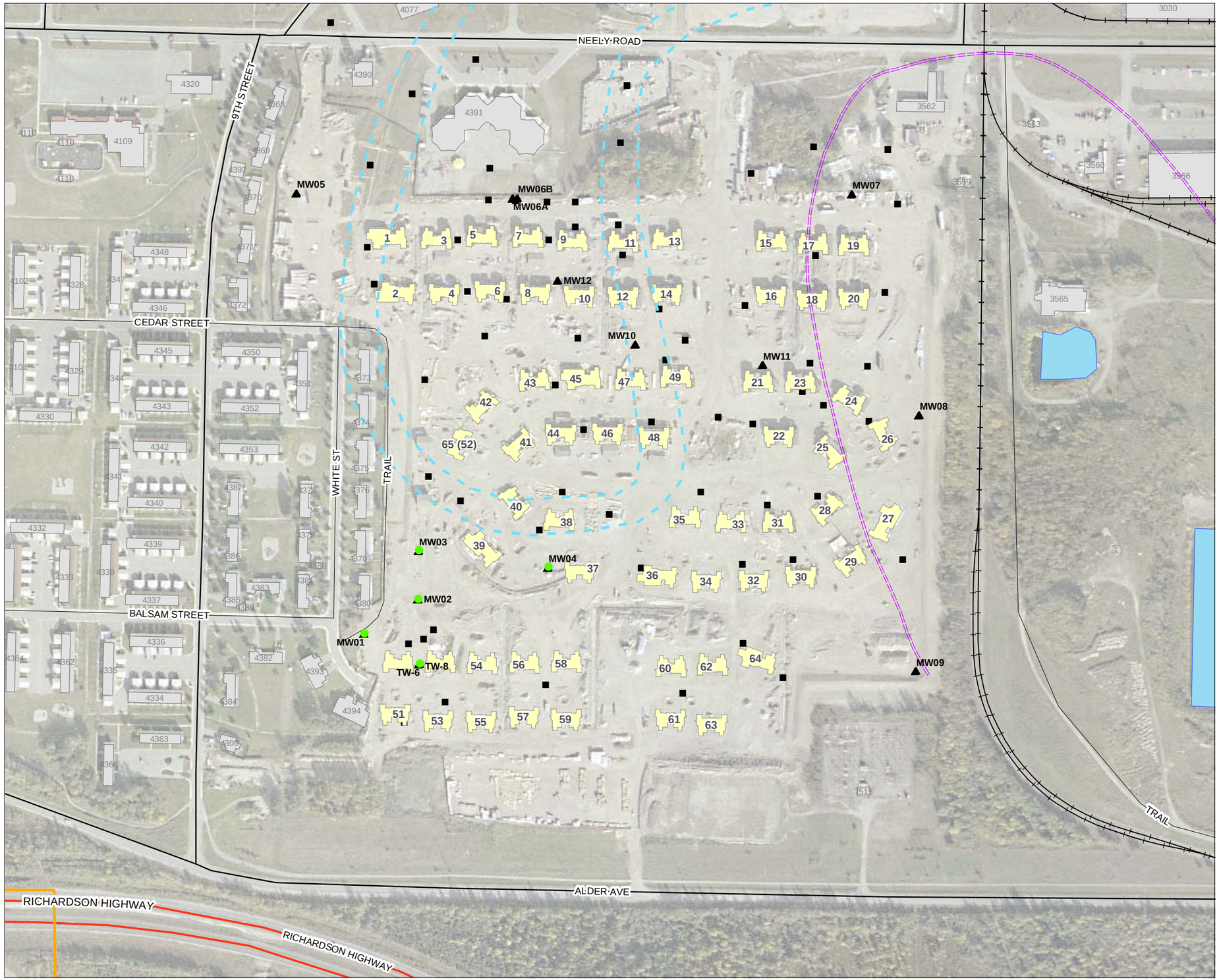
NOTES:
1. Screening Levels are 1/10th of ADEC Cleanup Levels or EPA Region 6 PRGs
2. Projection: WGS84 UTM Zone 6N

N

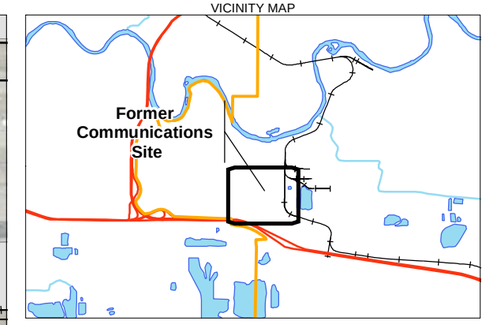
0 150 300
Feet

FIGURE 2-14
PCB SOIL NON-DETECT RESULTS WITH ELEVATED DETECTION LIMITS
Yellow, Orange & Red Non-detects
Former Communications Site
Fort Wainwright, Alaska

DRAFT



VICINITY MAP



LEGEND

- ▲ Permanent monitoring well locations
- ■ Proposed monitoring well locations
- Capture Zone, Supply Well 3559
- Former slough channel

Concentration Relative to Screening Level

- Blue indicates concentrations <= screening level
- Green indicates concentrations > screening level and <= 10x screening level
- Yellow indicates concentrations > 10x screening level and <= 100x screening level
- Orange indicates concentrations > 100x screening level and <= 1,000x screening level
- Red indicates concentrations > 1,000x screening level

NOTES:
1. Screening Levels are 1/10th of ADEC Cleanup Levels or EPA Region 6 PRGs
2. Projection: WGS84 UTM Zone 6N

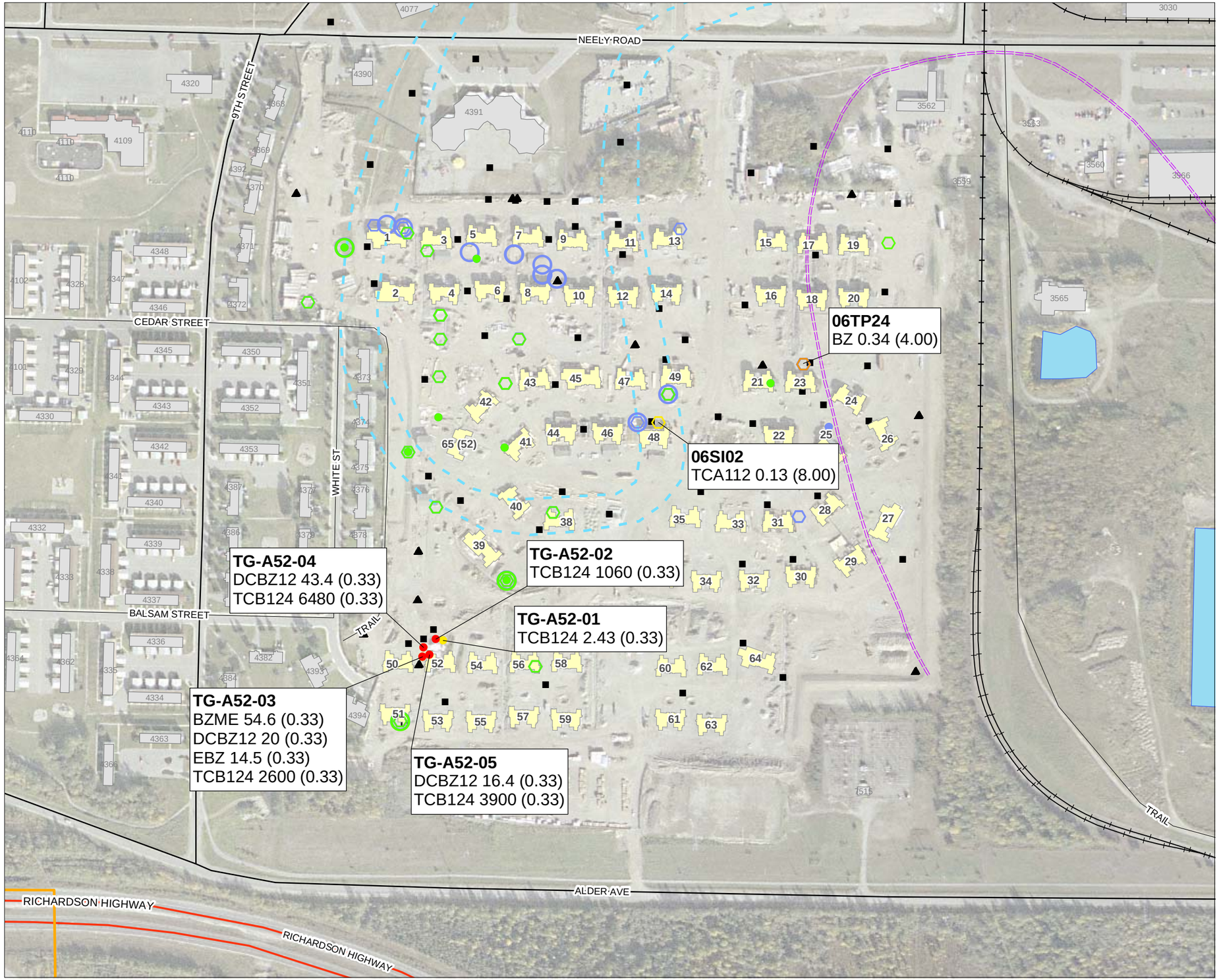
N

0 150 300
Feet

FIGURE 2-15
PCBs IN GROUNDWATER
Yellow, Orange & Red Detects
Blue & Green Detects and Non-detects
Former Communications Site
Fort Wainwright, Alaska

DRAFT

CH2MHILL



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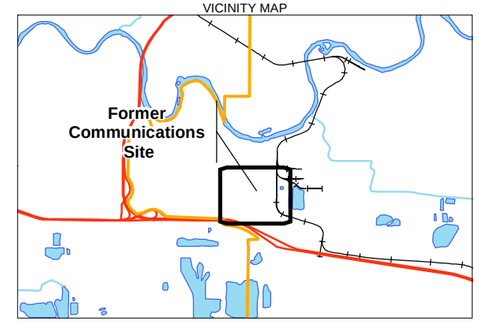


LEGEND

- ▲ Permanent monitoring well locations
- ■ Proposed monitoring well locations
- Capture Zone, Supply Well 3559
- Former slough channel

Concentration Relative to Screening Level

- Blue indicates concentrations <= screening level
- Green indicates concentrations > screening level and <= 10x screening level
- Yellow indicates concentrations > 10x screening level and <= 100x screening level
- Orange indicates concentrations > 100x screening level and <= 1,000x screening level
- Red indicates concentrations > 1,000x screening level

Sample Depth

- Small Circle = 0 to 2 ft depth soil samples
- Medium Hexagon = 2 to 10 ft depth soil samples
- Large Circle = Greater than 10 ft depth soil samples

SAMPLE LOCATION — TSW-64-1
ANALYTE ABBREVIATION — BZ 2.1 (4.0)
CONCENTRATION (mg/kg)
SAMPLE ENDING DEPTH (feet)

NOTES:
1. 999 = Unknown Sampling Depth
2. All sampling units are in mg/kg
3. Screening Levels are 1/10th of ADEC Cleanup Levels or EPA Region 6 PRGs
4. Projection: WGS84 UTM Zone 6N

ANALYTE ABBREVIATION	ANALYTE NAME
BZ	Benzene
BZME	Toluene
DCBZ12	1,2-Dichlorobenzene
EBZ	Ethylbenzene
TCA112	1,1,2-Trichloroethane
TCB124	1,2,4-Trichlorobenzene

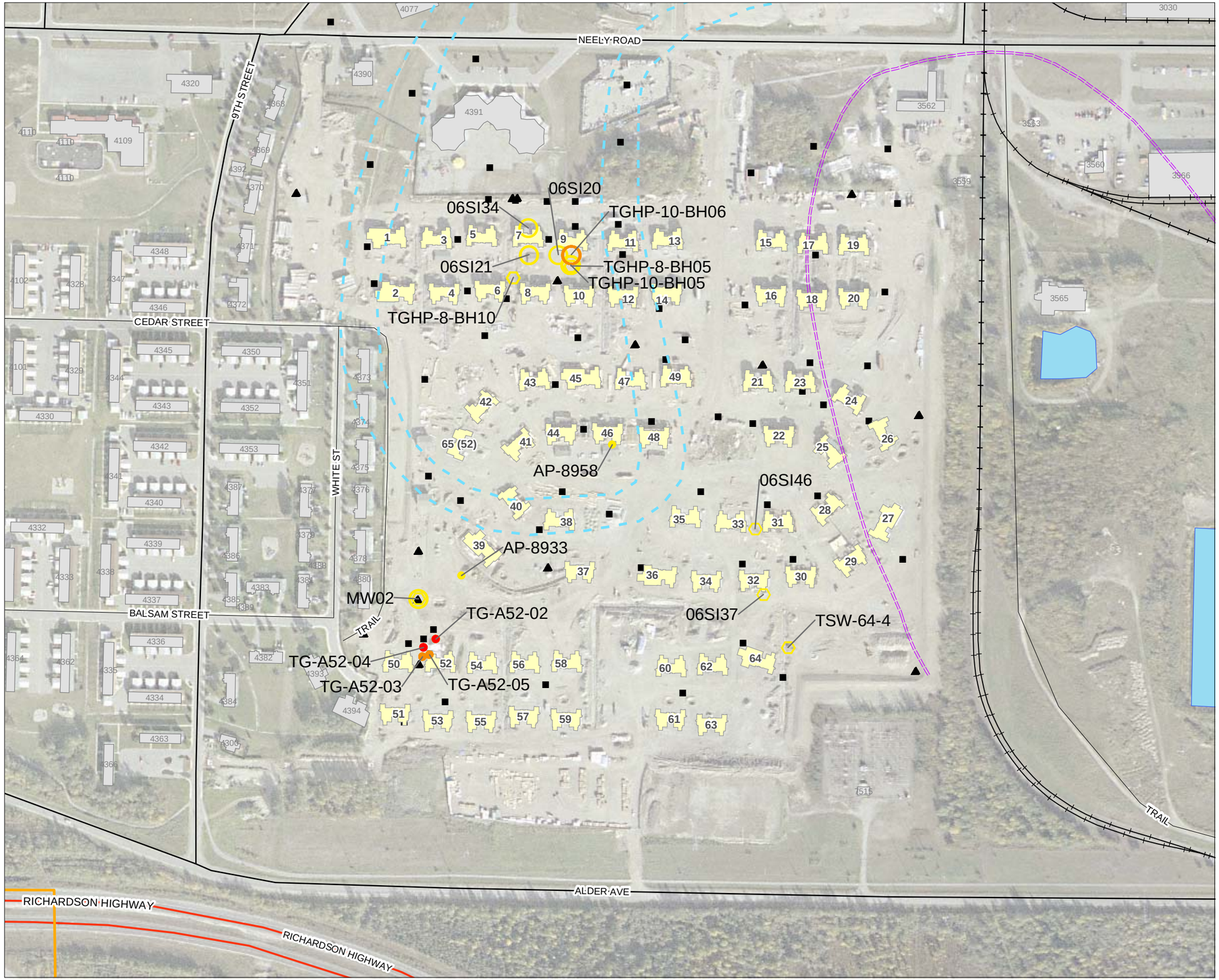
N

0 150 300
Feet

FIGURE 2-16
VOCs IN SOILS
Yellow, Orange & Red Detects
Blue & Green Detects and Non-detects
Former Communications Site
Fort Wainwright, Alaska

DRAFT

CH2MHILL



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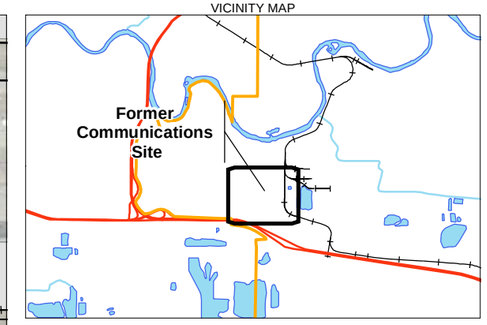

LEGEND

- ▲ Permanent monitoring well locations
- ■ Proposed monitoring well locations
- Capture Zone, Supply Well 3559
- Former slough channel

Concentration Relative to Screening Level

- Blue indicates concentrations <= less screening level
- Green indicates concentrations > screening level and <= 10x screening level
- Yellow indicates concentrations > 10x screening level and <= 100x screening level
- Orange indicates concentrations > 100x screening level and <= 1,000x screening level
- Red indicates concentrations > 1,000x screening level

Sample Depth

- Small Circle = 0 to 2 ft depth soil samples
- Medium Hexagon = 2 to 10 ft depth soil samples
- Large Circle = Greater than 10 ft depth soil samples

NOTES:
1. Projection: WGS84 UTM Zone 6N
2. Screening Levels are 1/10th of ADEC Cleanup Levels or EPA Region 6 PRGs

N

0 150 300
Feet

FIGURE 2-17
VOC SOIL NON-DETECT RESULTS WITH ELEVATED DETECTION LIMITS
Yellow, Orange & Red Non-detects
Former Communications Site
Fort Wainwright, Alaska

DRAFT

CH2MHILL

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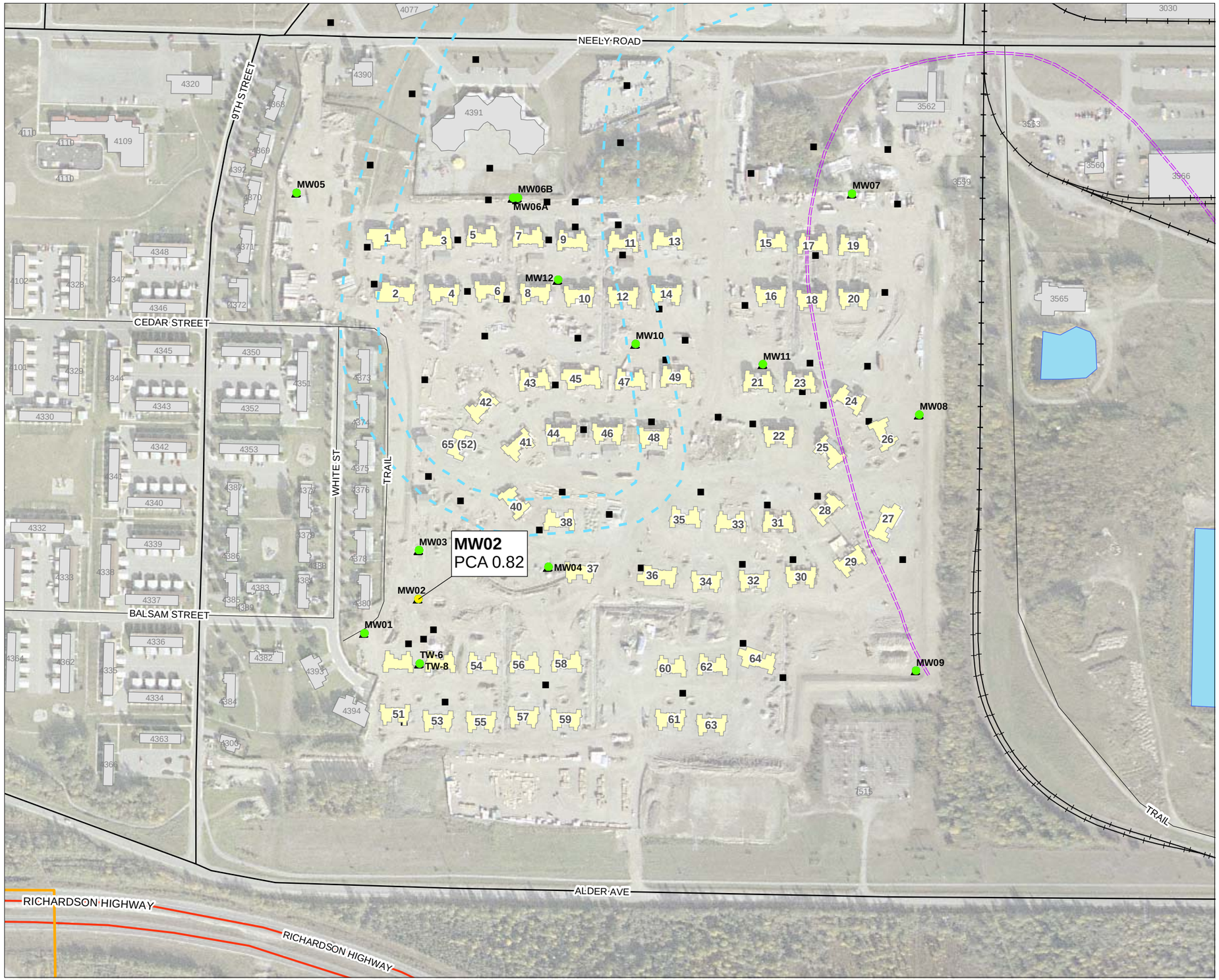

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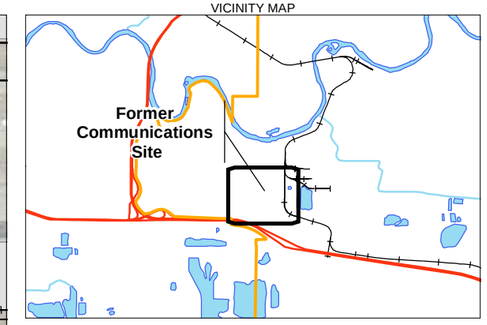


LEGEND

- ▲ Permanent monitoring well locations
- ■ Proposed monitoring well locations
- Capture Zone, Supply Well 3559
- Former slough channel

Concentration Relative to Screening Level

- Blue indicates concentrations <= screening level
- Green indicates concentrations > screening level and <= 10x screening level
- Yellow indicates concentrations > 10x screening level and <= 100x screening level
- Orange indicates concentrations > 100x screening level and <= 1,000x screening level
- Red indicates concentrations > 1,000x screening level

SAMPLE LOCATION — **MW02**
ANALYTE ABBREVIATION — PCA 0.82
CONCENTRATION (µg/L)

NOTES:
1. All sampling units are in µg/L
2. Screening Levels are 1/10th of ADEC Cleanup Levels or EPA Region 6 PRGs
3. Projection: WGS84 UTM Zone 6N
4. All Non-detect Results with Elevated Detection Limits are listed on Table 2.8

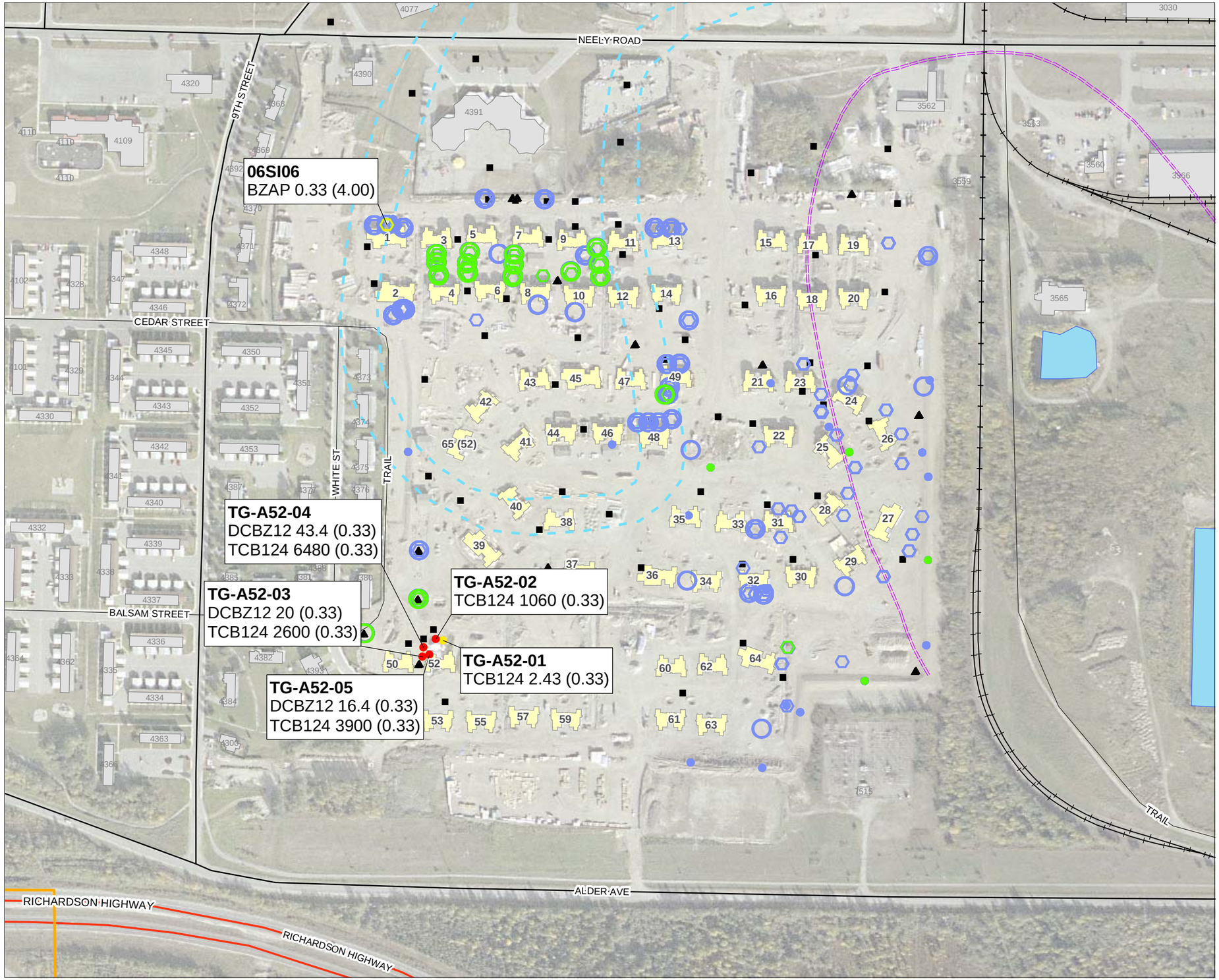
ANALYTE ABBREVIATION	ANALYTE NAME
PCA	1,1,2,2-Tetrachloroethane

N

0 150 300
Feet

FIGURE 2-18
VOCs IN GROUNDWATER
Yellow, Orange & Red Detects
Blue & Green Detects and Non-detects
Former Communications Site
Fort Wainwright, Alaska

DRAFT



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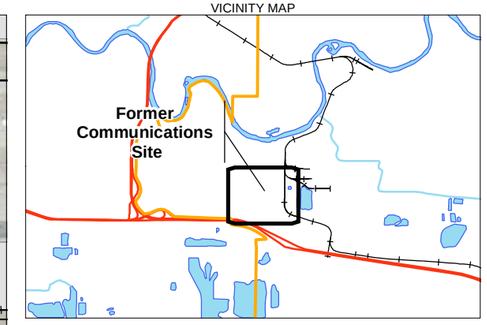

LEGEND

- ▲ Permanent monitoring well locations
- ■ Proposed monitoring well locations
- Capture Zone, Supply Well 3559
- Former slough channel

Concentration Relative to Screening Level

- Blue indicates concentrations <= screening level
- Green indicates concentrations > screening level and <= 10x screening level
- Yellow indicates concentrations > 10x screening level and <= 100x screening level
- Orange indicates concentrations > 100x screening level and <= 1,000x screening level
- Red indicates concentrations > 1,000x screening level

Sample Depth

- Small Circle = 0 to 2 ft depth soil samples
- Medium Hexagon = 2 to 10 ft depth soil samples
- Large Circle = Greater than 10 ft depth soil samples

SAMPLE LOCATION — **TSW-64-1**
ANALYTE ABBREVIATION — BZ 2.1 (4.0)
CONCENTRATION (mg/kg)
SAMPLE ENDING DEPTH (feet)

NOTES:
1. 999 = Unknown Sampling Depth
2. All sampling units are in mg/kg
3. Screening Levels are 1/10th of ADEC Cleanup Levels or EPA Region 6 PRGs
4. Projection: WGS84 UTM Zone 6N

ANALYTE ABBREVIATION	ANALYTE NAME
BZAP	Benzo(a)pyrene
DCBZ12	1,2-Dichlorobenzene
TCB124	1,2,4-Trichlorobenzene

N

0 150 300
Feet

FIGURE 2-19
SVOCs IN SOILS
Yellow, Orange & Red Detects
Blue & Green Detects and Non-detects
Former Communications Site
Fort Wainwright, Alaska

DRAFT

CH2MHILL

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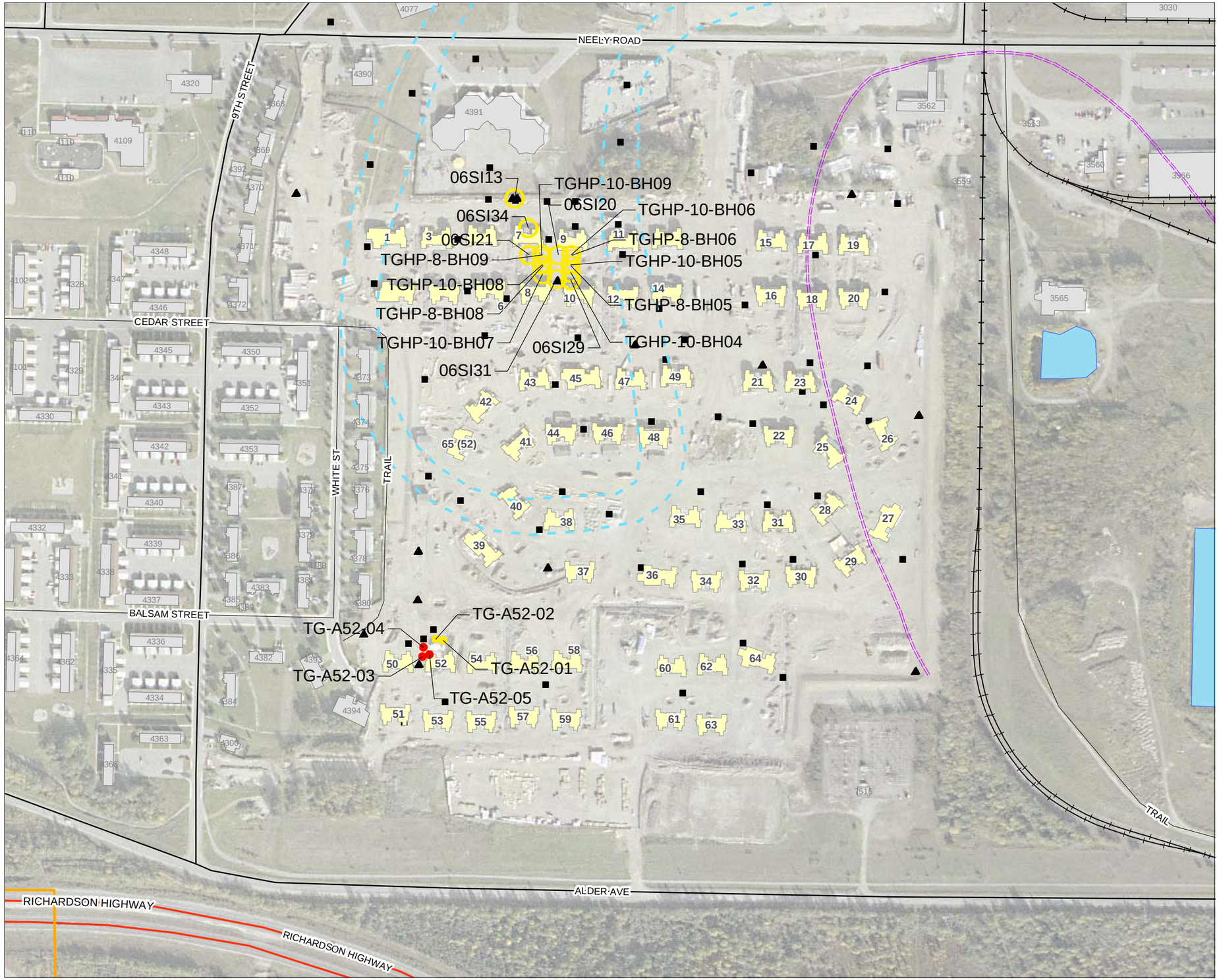
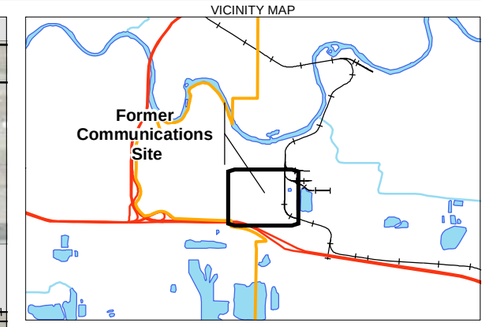




LEGEND

- ▲ Permanent monitoring well locations
- ■ Proposed monitoring well locations
- Capture Zone, Supply Well 3559
- Former slough channel

Concentration Relative to Screening Level

- Blue indicates concentrations <= screening level
- Green indicates concentrations > screening level and <= 10x screening level
- Yellow indicates concentrations > 10x screening level and <= 100x screening level
- Orange indicates concentrations > 100x screening level and <= 1,000x screening level
- Red indicates concentrations > 1,000x screening level

Sample Depth

- Small Circle = 0 to 2 ft depth soil samples
- Medium Hexagon = 2 to 10 ft depth soil samples
- Large Circle = Greater than 10 ft depth soil samples

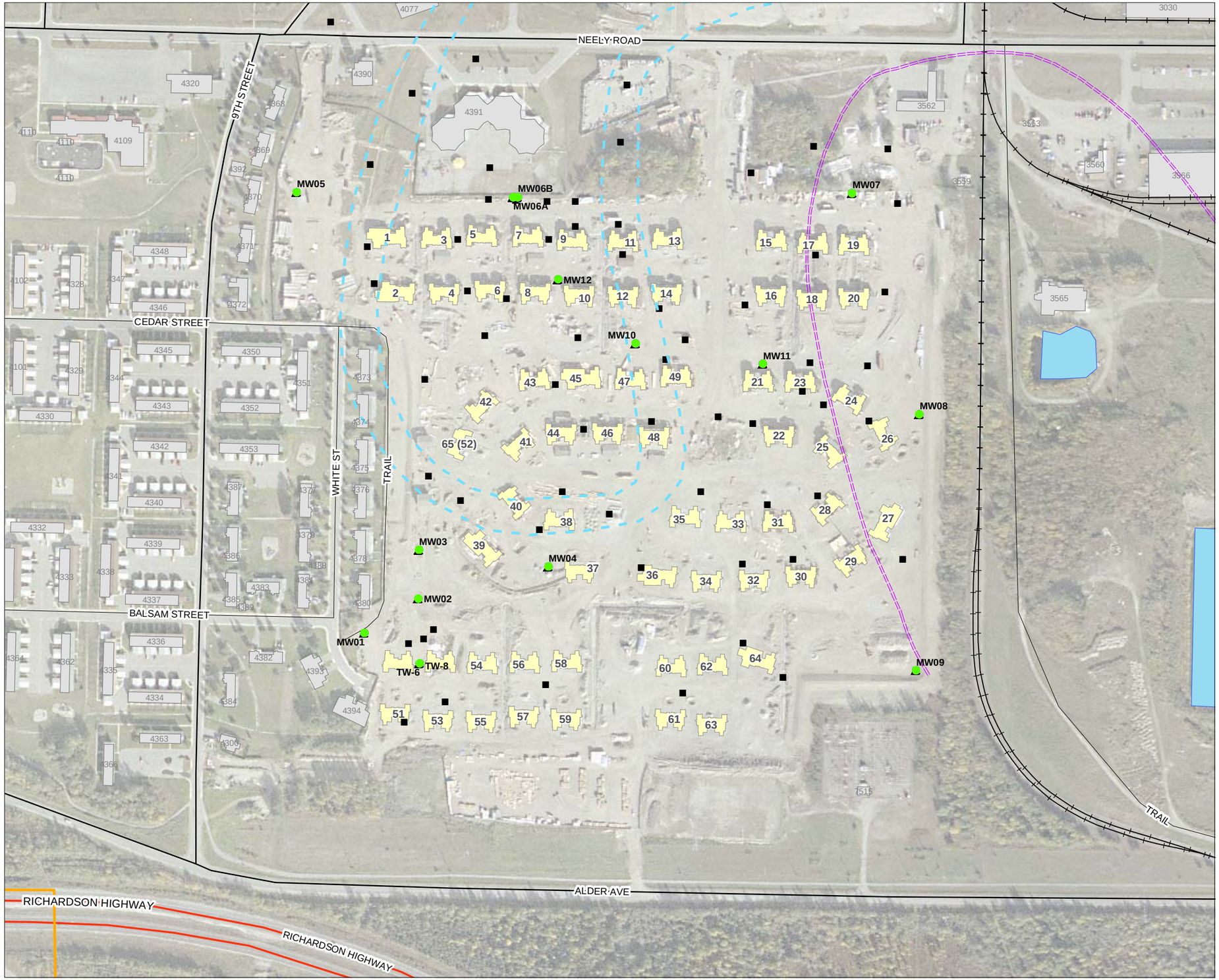
NOTES:
1. Screening Levels are 1/10th of ADEC Cleanup Levels or EPA Region 6 PRGs
2. Projection: WGS84 UTM Zone 6N

N

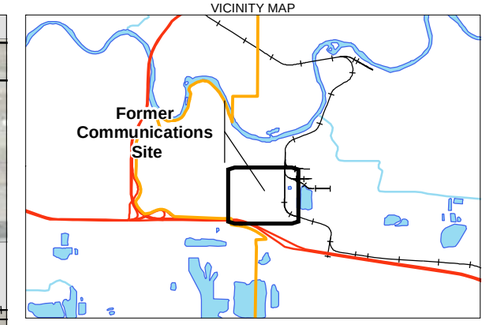
0 150 300
Feet

FIGURE 2-20
SVOC SOIL NON-DETECT RESULTS WITH ELEVATED DETECTION LIMITS
Yellow, Orange & Red Non-detects
Former Communications Site
Fort Wainwright, Alaska

DRAFT



VICINITY MAP



LEGEND

- ▲ Permanent monitoring well locations
- ■ Proposed monitoring well locations
- Capture Zone, Supply Well 3559
- Former slough channel

Concentration Relative to Screening Level

- Blue indicates concentrations <= screening level
- Green indicates concentrations > screening level and <= 10x screening level
- Yellow indicates concentrations > 10x screening level and <= 100x screening level
- Orange indicates concentrations > 100x screening level and <= 1,000x screening level
- Red indicates concentrations > 1,000x screening level

SAMPLE LOCATION — **MW02**
ANALYTE ABBREVIATION — PCA 0.82
CONCENTRATION (µg/L)

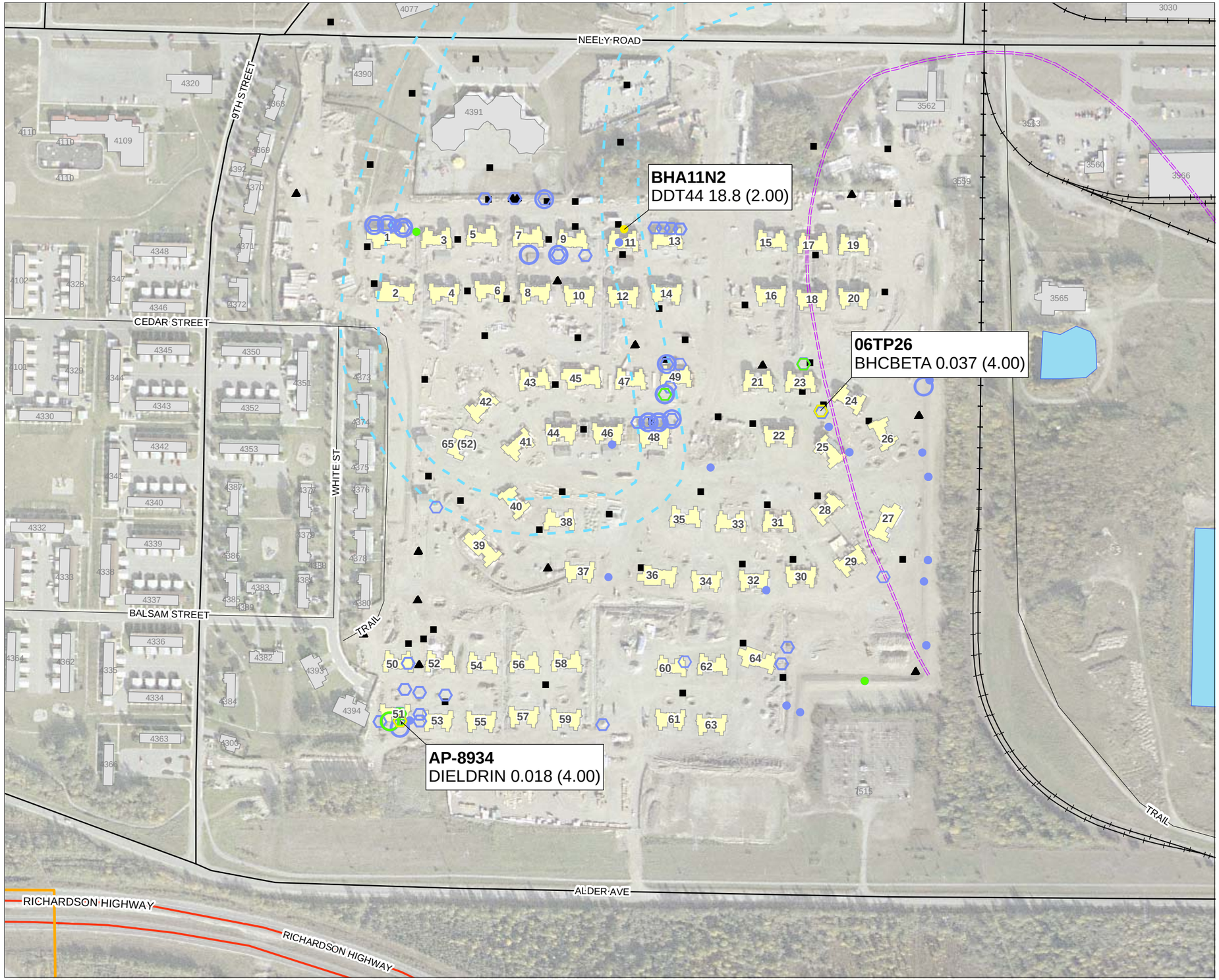
NOTES:
1. All sampling units are in µg/L
2. Screening Levels are 1/10th of ADEC Cleanup Levels or EPA Region 6 PRGs
3. Projection: WGS84 UTM Zone 6N
4. All Non-detect Results with Elevated Detection Limits are listed on Table 2.8

N

0 150 300
Feet

FIGURE 2-21
SVOCs IN GROUNDWATER
Yellow, Orange & Red Detects
Blue & Green Detects and Non-detects
Former Communications Site
Fort Wainwright, Alaska

DRAFT



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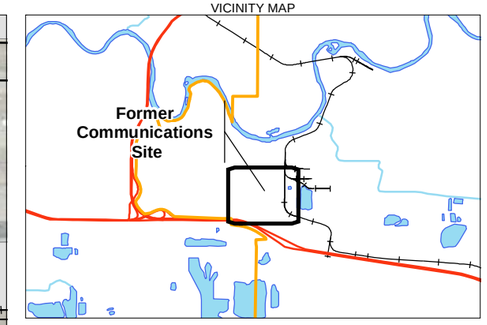

LEGEND

- ▲ Permanent monitoring well locations
- ■ Proposed monitoring well locations
- Capture Zone, Supply Well 3559
- Former slough channel

Concentration Relative to Screening Level

- Blue indicates concentrations <= screening level
- Green indicates concentrations > screening level and <= 10x screening level
- Yellow indicates concentrations > 10x screening level and <= 100x screening level
- Orange indicates concentrations > 100x screening level and <= 1,000x screening level
- Red indicates concentrations > 1,000x screening level

Sample Depth

- Small Circle = 0 to 2 ft depth soil samples
- Medium Hexagon = 2 to 10 ft depth soil samples
- Large Circle = Greater than 10 ft depth soil samples

SAMPLE LOCATION — TSW-64-1
ANALYTE ABBREVIATION — BZ 2.1 (4.0)
CONCENTRATION (mg/kg)
SAMPLE ENDING DEPTH (feet)

NOTES:
1. 999 = Unknown Sampling Depth
2. All sampling units are in mg/kg
3. Screening Levels are 1/10th of ADEC Cleanup Levels or EPA Region 6 PRGs
4. Projection: WGS84 UTM Zone 6N

ANALYTE ABBREVIATION	ANALYTE NAME
BHCBETA	beta-BHC
DDT44	4,4'-DDT
DIELDRIN	Dieldrin

N

0 150 300
Feet

FIGURE 2-22
PESTICIDES IN SOILS
Yellow, Orange & Red Detects
Blue & Green Detects and Non-detects
Former Communications Site
Fort Wainwright, Alaska

DRAFT

CH2MHILL

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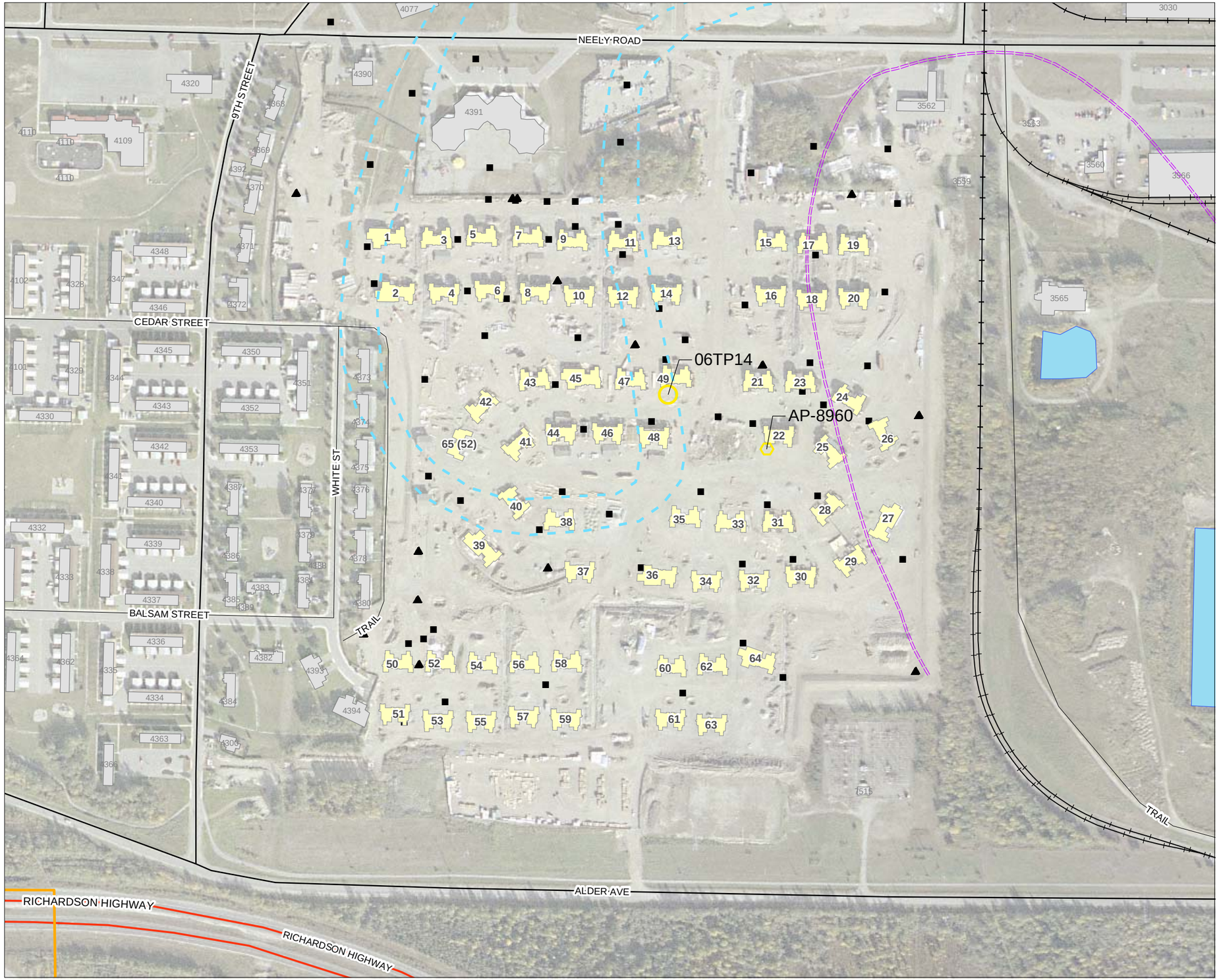

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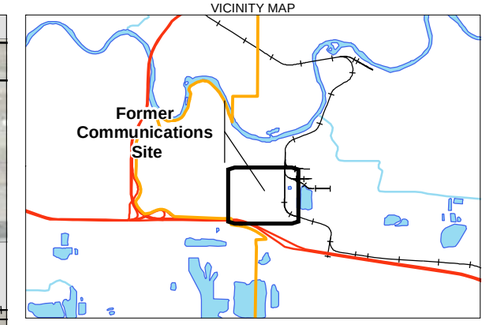


LEGEND

- ▲ Permanent monitoring well locations
- ■ Proposed monitoring well locations
- Capture Zone, Supply Well 3559
- Former slough channel

Concentration Relative to Screening Level

- Blue indicates concentrations <= screening level
- Green indicates concentrations > screening level and <= 10x screening level
- Yellow indicates concentrations > 10x screening level and <= 100x screening level
- Orange indicates concentrations > 100x screening level and <= 1,000x screening level
- Red indicates concentrations > 1,000x screening level

Sample Depth

- Small Circle = 0 to 2 ft depth soil samples
- Medium Hexagon = 2 to 10 ft depth soil samples
- Large Circle = Greater than 10 ft depth soil samples

NOTES:
1. Screening Levels are 1/10th of ADEC Cleanup Levels or EPA Region 6 PRGs
2. Projection: WGS84 UTM Zone 6N

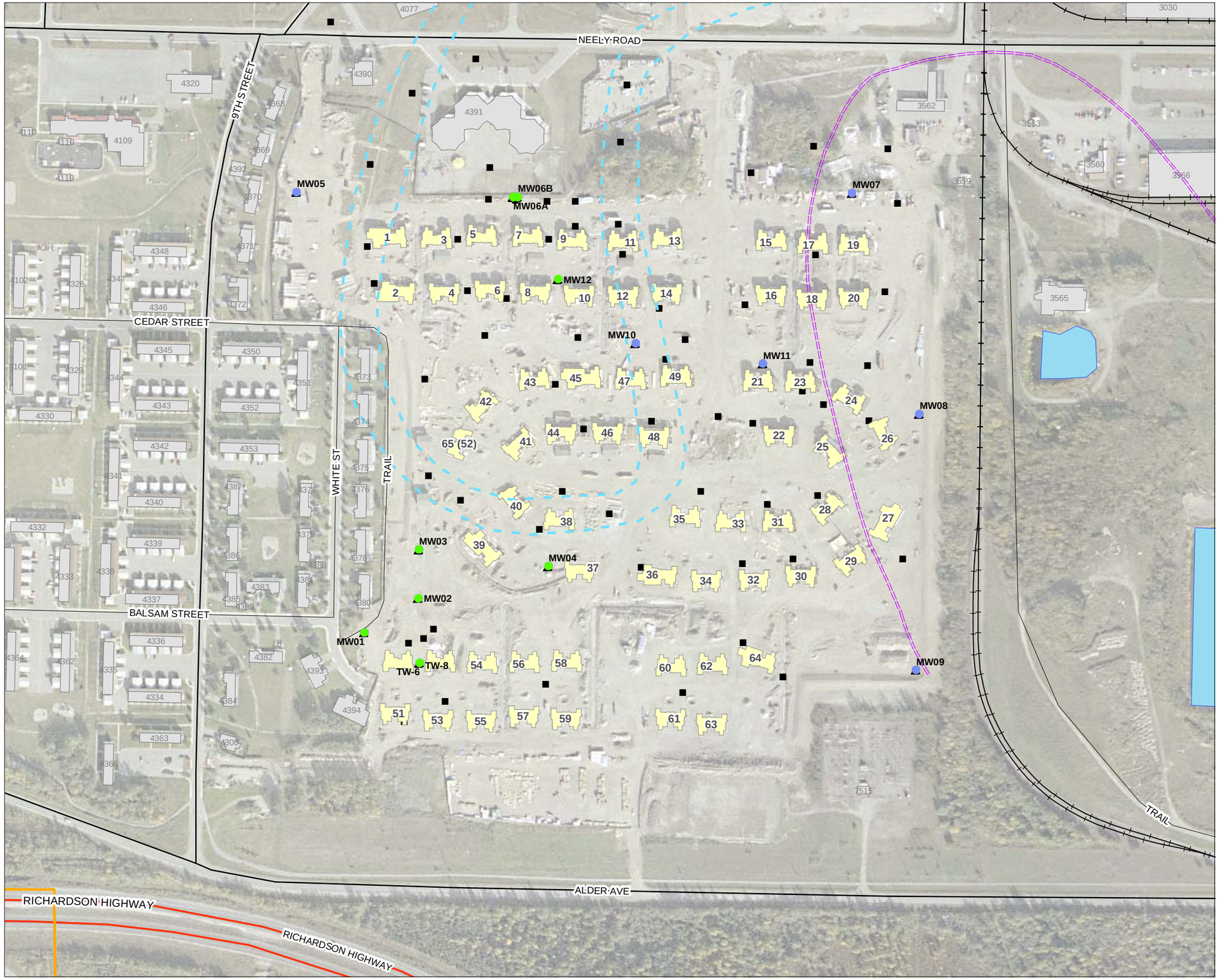
N

0 150 300
Feet

FIGURE 2-23
PESTICIDE SOIL NON-DETECT RESULTS WITH ELEVATED DETECTION LIMITS
Yellow, Orange & Red Non-detects
Former Communications Site
Fort Wainwright, Alaska

DRAFT

CH2MHILL



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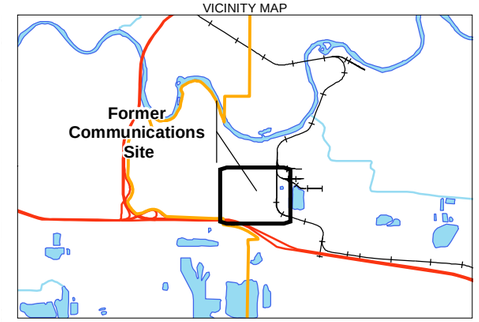

LEGEND

- ▲ Permanent monitoring well locations
- ■ Proposed monitoring well locations
- Capture Zone, Supply Well 3559
- Former slough channel

Concentration Relative to Screening Level

- Blue indicates concentrations <= screening level
- Green indicates concentrations > screening level and <= 10x screening level
- Yellow indicates concentrations > 10x screening level and <= 100x screening level
- Orange indicates concentrations > 100x screening level and <= 1,000x screening level
- Red indicates concentrations > 1,000x screening level

SAMPLE LOCATION — **MW02**
ANALYTE ABBREVIATION — PCA 0.82
CONCENTRATION (µg/L)

NOTES:
1. All sampling units are in µg/L
2. Screening Levels are 1/10th of ADEC Cleanup Levels or EPA Region 6 PRGs
3. Projection: WGS84 UTM Zone 6N
4. All Non-detect Results with Elevated Detection Limits are listed on Table 2.8

N

0 150 300
Feet

FIGURE 2-24
PESTICIDES IN GROUNDWATER
Yellow, Orange & Red Detects
Blue & Green Detects and Non-detects
Former Communications Site
Fort Wainwright, Alaska

DRAFT

CH2MHILL

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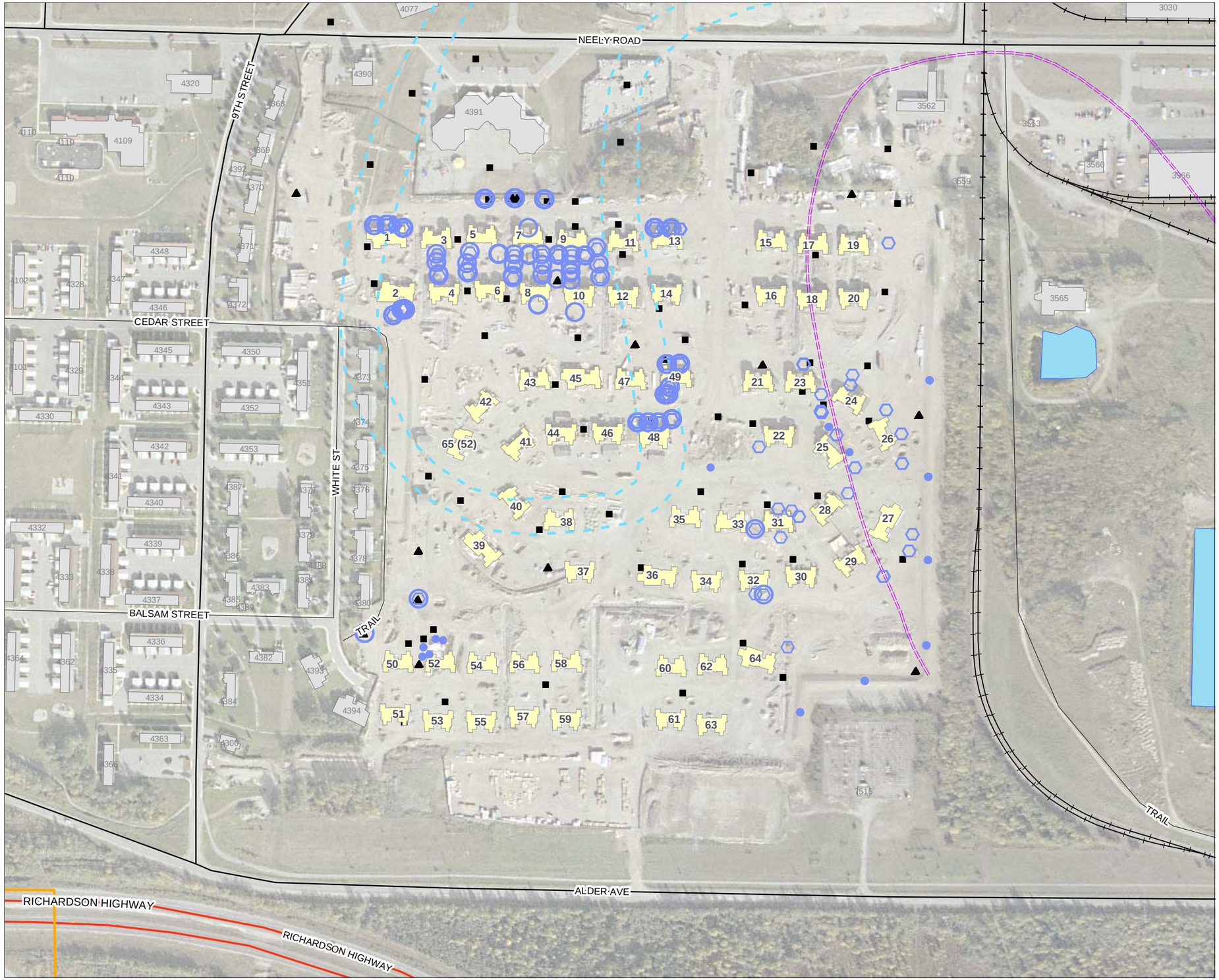

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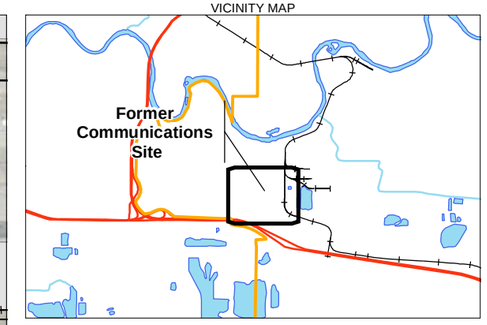


LEGEND

- ▲ Permanent monitoring well locations
- ■ Proposed monitoring well locations
- Capture Zone, Supply Well 3559
- Former slough channel

Concentration Relative to Screening Level

- Blue indicates concentrations <= screening level
- Green indicates concentrations > screening level and <= 10x screening level
- Yellow indicates concentrations > 10x screening level and <= 100x screening level
- Orange indicates concentrations > 100x screening level and <= 1,000x screening level
- Red indicates concentrations > 1,000x screening level

Sample Depth

- Small Circle = 0 to 2 ft depth soil samples
- Medium Hexagon = 2 to 10 ft depth soil samples
- Large Circle = Greater than 10 ft depth soil samples

SAMPLE LOCATION — TSW-64-1
ANALYTE ABBREVIATION — BZ 2.1 (4.0)
CONCENTRATION (mg/kg)
SAMPLE ENDING DEPTH (feet)

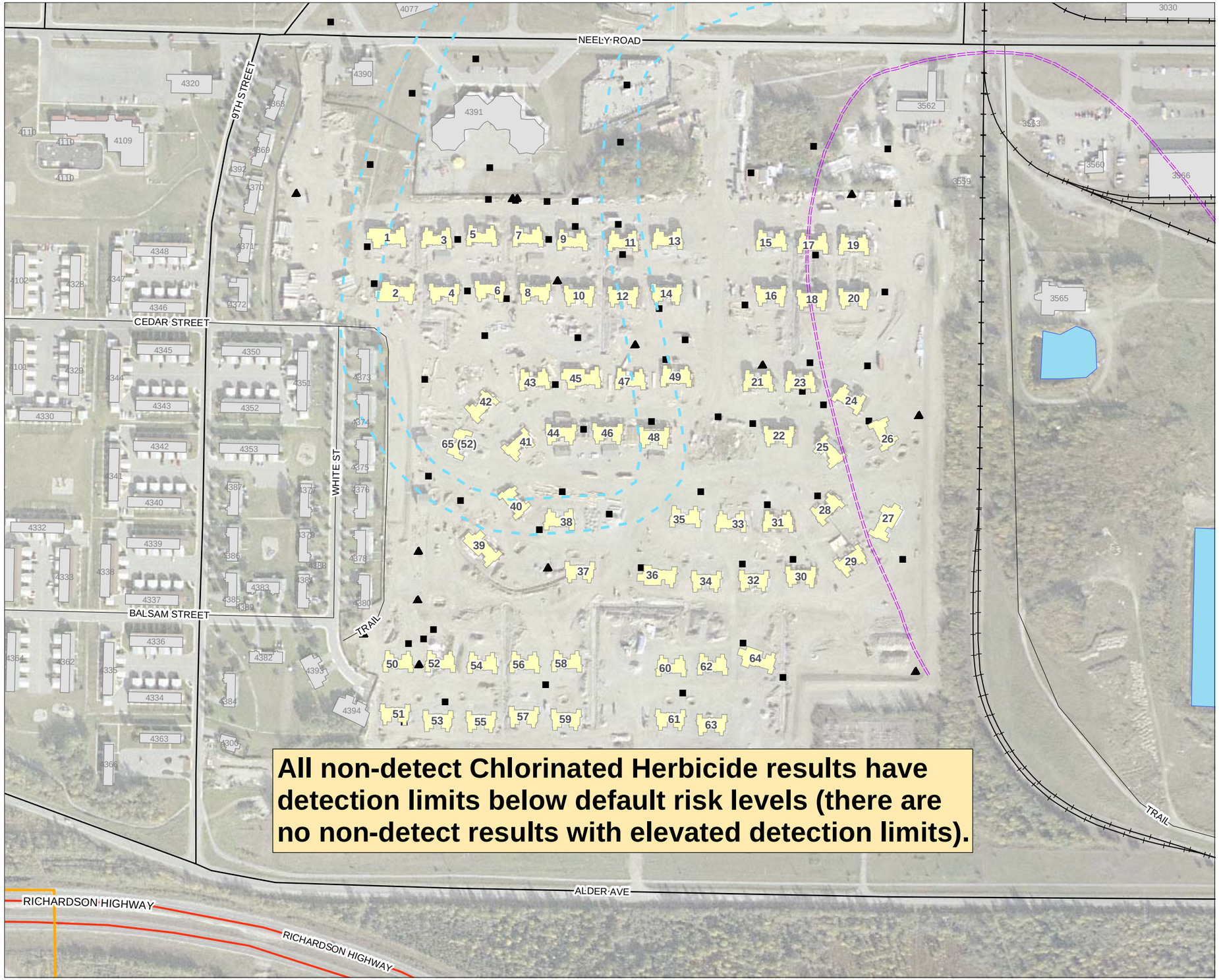
NOTES:
1. 999 = Unknown Sampling Depth
2. All sampling units are in mg/kg
3. Screening Levels are 1/10th of ADEC Cleanup Levels or EPA Region 6 PRGs
4. Projection: WGS84 UTM Zone 6N

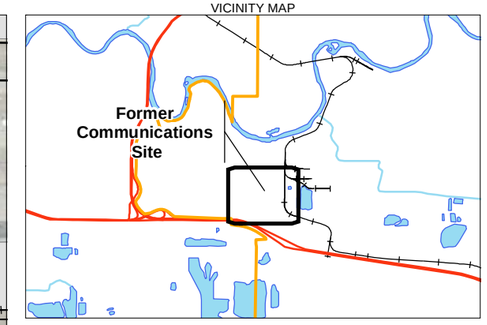
N

0 150 300
Feet

FIGURE 2-25
CHLORINATED HERBICIDES IN SOILS
Yellow, Orange & Red Detects
Blue & Green Detects and Non-detects
Former Communications Site
Fort Wainwright, Alaska

DRAFT





LEGEND

- ▲ Permanent monitoring well locations
- ■ Proposed monitoring well locations
- Capture Zone, Supply Well 3559
- Former slough channel

Concentration Relative to Screening Level

- Blue indicates concentrations <= screening level
- Green indicates concentrations > screening level and <= 10x screening level
- Yellow indicates concentrations > 10x screening level and <= 100x screening level
- Orange indicates concentrations > 100x screening level and <= 1,000x screening level
- Red indicates concentrations > 1,000x screening level

Sample Depth

- Small Circle = 0 to 2 ft depth soil samples
- Medium Hexagon = 2 to 10 ft depth soil samples
- Large Circle = Greater than 10 ft depth soil samples

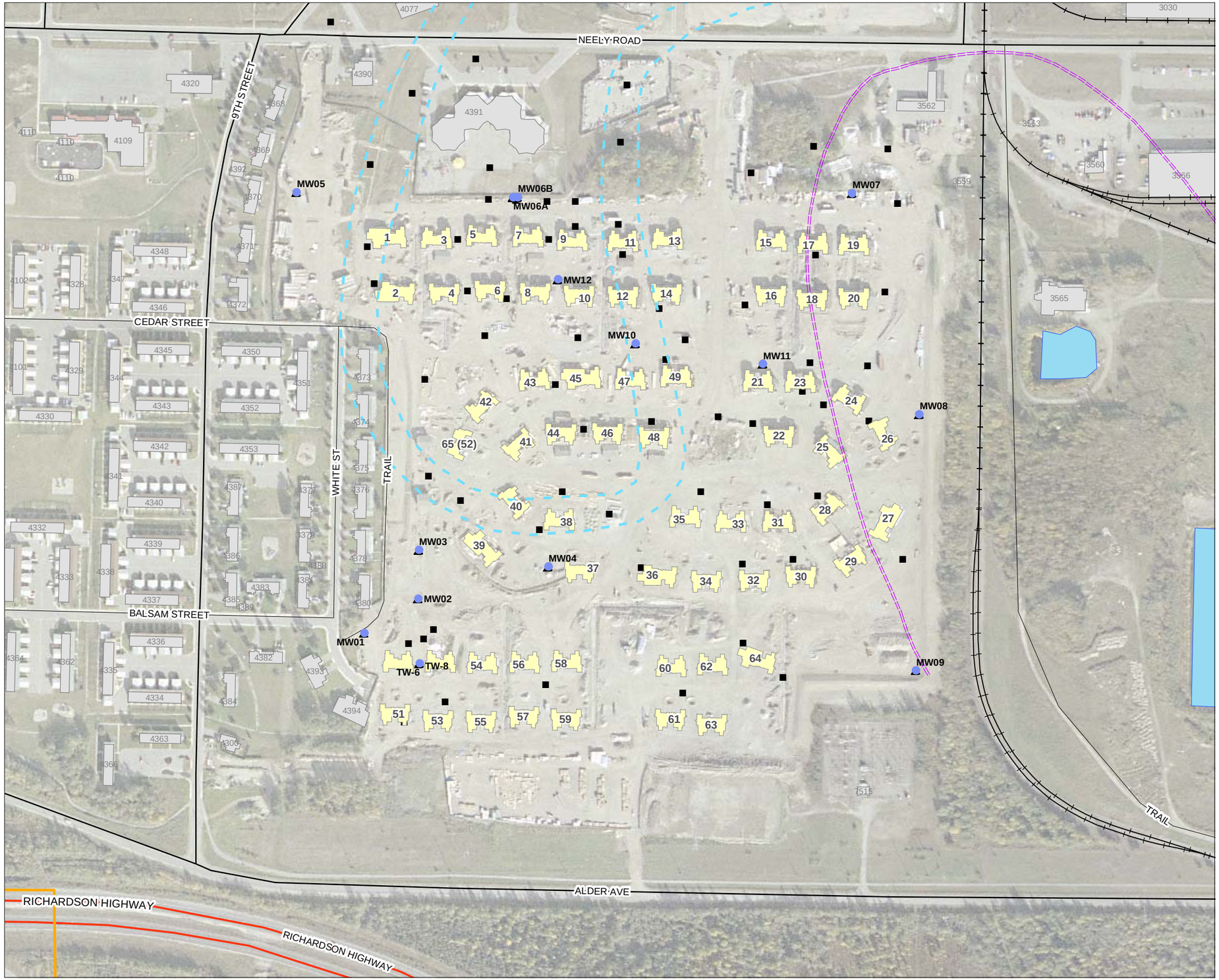
NOTES:
1. Screening Levels are 1/10th of ADEC Cleanup Levels or EPA Region 6 PRGs
2. Projection: WGS84 UTM Zone 6N

N

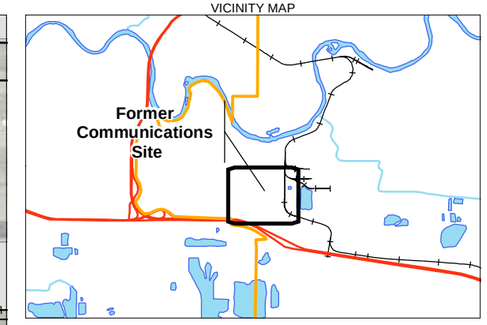
0 150 300
Feet

FIGURE 2-26
CHLORINATED HERBICIDE SOIL NON-DETECT RESULTS WITH ELEVATED DETECTION LIMITS
Yellow, Orange & Red Non-detects
Former Communications Site
Fort Wainwright, Alaska

DRAFT



VICINITY MAP



LEGEND

- ▲ Permanent monitoring well locations
- ■ Proposed monitoring well locations
- Capture Zone, Supply Well 3559
- Former slough channel

Concentration Relative to Screening Level

- Blue indicates concentrations <= screening level
- Green indicates concentrations > screening level and <= 10x screening level
- Yellow indicates concentrations > 10x screening level and <= 100x screening level
- Orange indicates concentrations > 100x screening level and <= 1,000x screening level
- Red indicates concentrations > 1,000x screening level

SAMPLE LOCATION — **MW02**
ANALYTE ABBREVIATION — PCA 0.82
CONCENTRATION (µg/L)

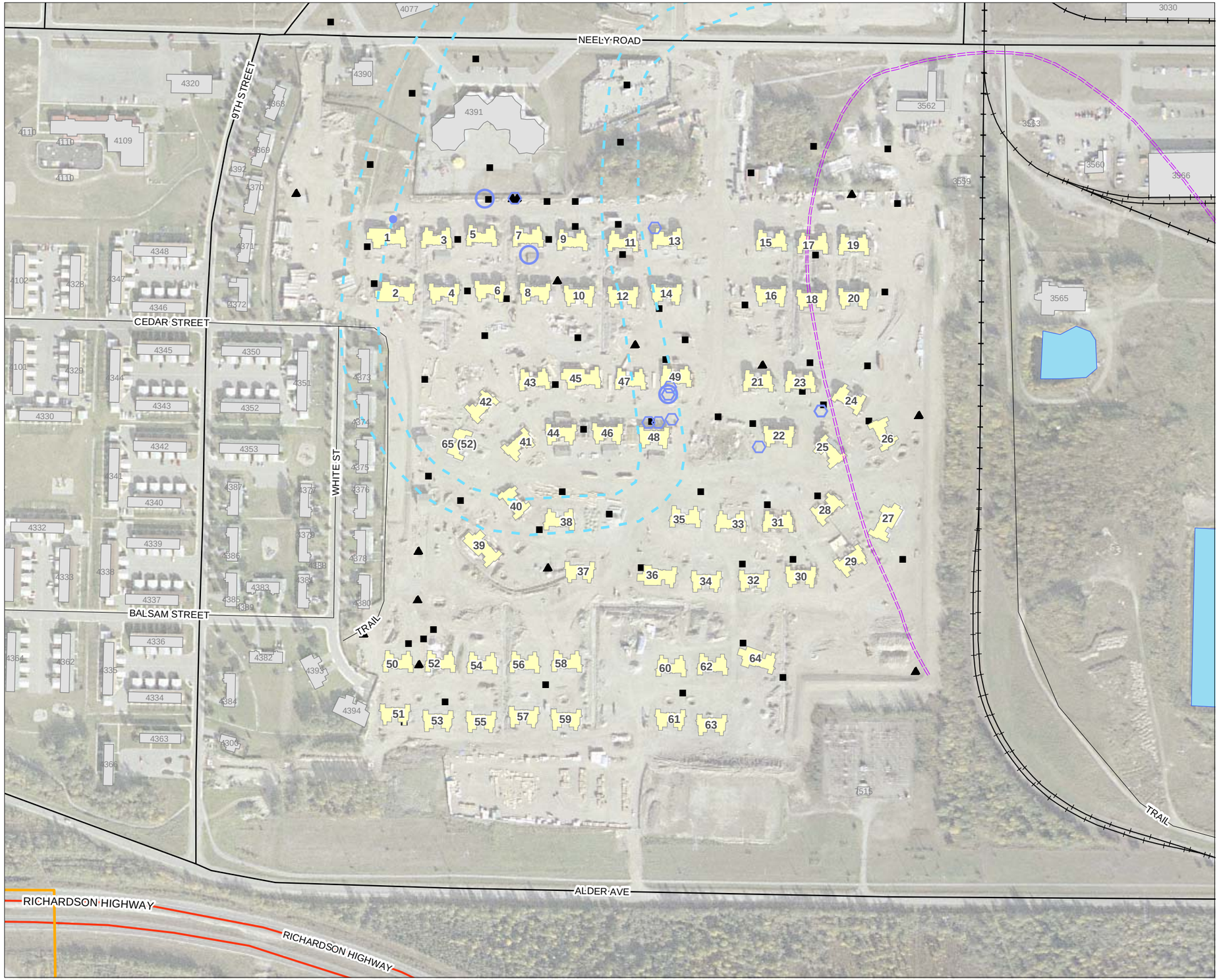
NOTES:
1. All sampling units are in µg/L
2. Screening Levels are 1/10th of ADEC Cleanup Levels or EPA Region 6 PRGs
3. Projection: WGS84 UTM Zone 6N
4. All Non-detect Results with Elevated Detection Limits are listed on Table 2.8

N

0 150 300
Feet

FIGURE 2-27
CHLORINATED HERBICIDES IN GROUNDWATER
Yellow, Orange & Red Detects
Blue & Green Detects and Non-detects
Former Communications Site
Fort Wainwright, Alaska

DRAFT



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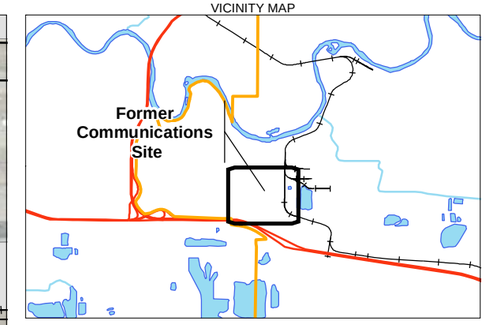

LEGEND

- ▲ Permanent monitoring well locations
- ■ Proposed monitoring well locations
- Capture Zone, Supply Well 3559
- Former slough channel

Concentration Relative to Screening Level

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- Yellow indicates concentrations > 10x screening level and <= 100x screening level
- Orange indicates concentrations > 100x screening level and <= 1,000x screening level
- Red indicates concentrations > 1,000x screening level

Sample Depth

- Small Circle = 0 to 2 ft depth soil samples
- Medium Hexagon = 2 to 10 ft depth soil samples
- Large Circle = Greater than 10 ft depth soil samples

SAMPLE LOCATION — **TSW-64-1**
ANALYTE ABBREVIATION — BZ 2.1 (4.0)
CONCENTRATION (mg/kg)
SAMPLE ENDING DEPTH (feet)

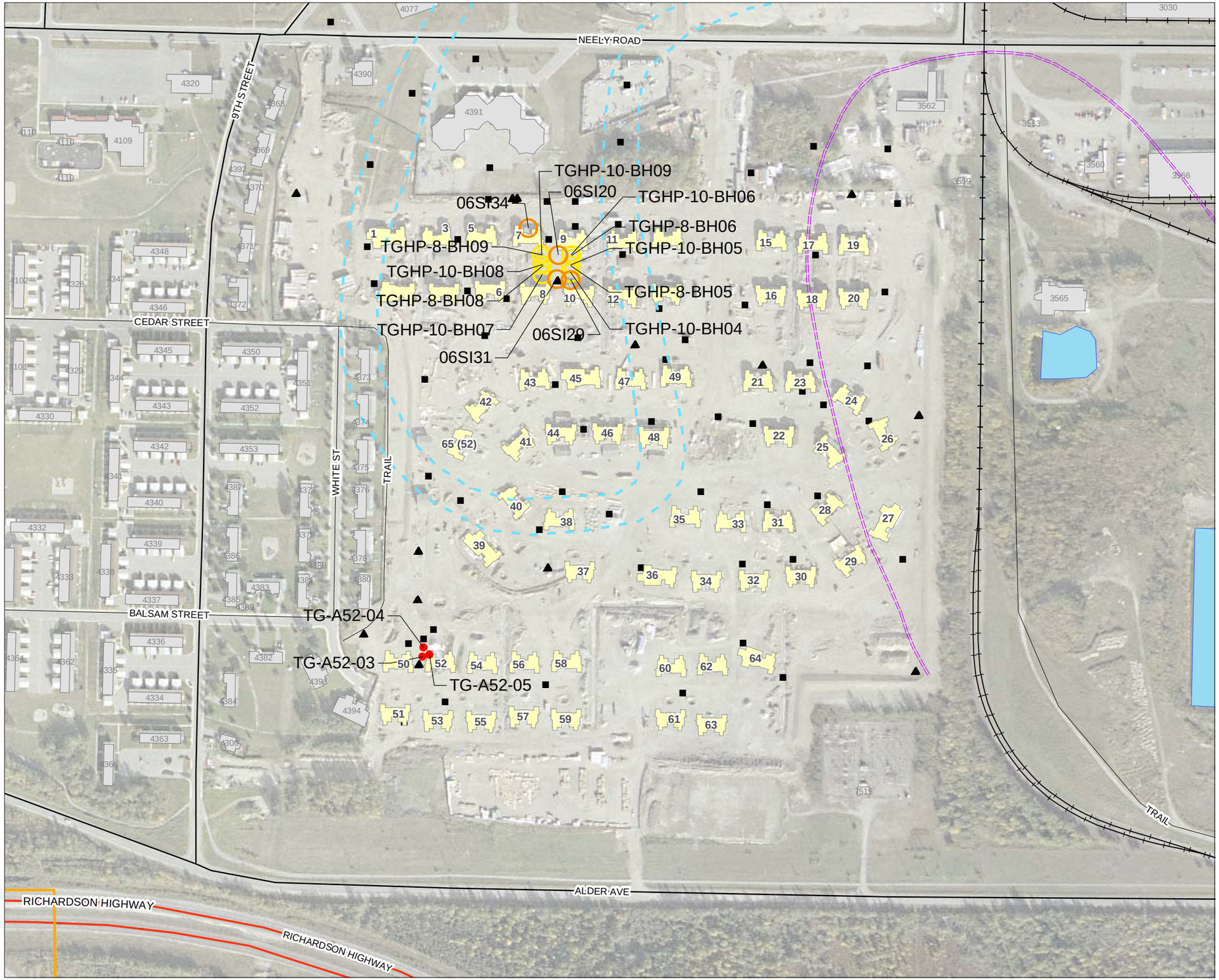
NOTES:
1. 999 = Unknown Sampling Depth
2. All sampling units are in mg/kg
3. Screening Levels are 1/10th of ADEC Cleanup Levels or EPA Region 6 PRGs
4. Projection: WGS84 UTM Zone 6N

N

0 150 300
Feet

FIGURE 2-28
EXPLOSIVES IN SOILS
Yellow, Orange & Red Detects
Blue & Green Detects and Non-detects
Former Communications Site
Fort Wainwright, Alaska

DRAFT



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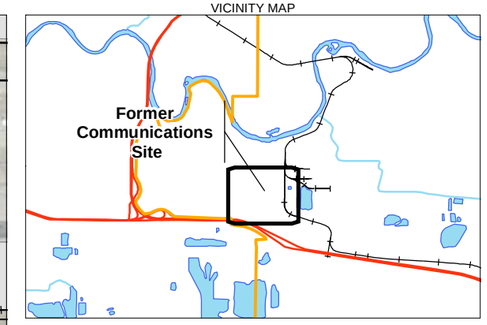

LEGEND

- ▲ Permanent monitoring well locations
- ■ Proposed monitoring well locations
- Capture Zone, Supply Well 3559
- Former slough channel

Concentration Relative to Screening Level

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- Yellow indicates concentrations > 10x screening level and <= 100x screening level
- Orange indicates concentrations > 100x screening level and <= 1,000x screening level
- Red indicates concentrations > 1,000x screening level

Sample Depth

- Small Circle = 0 to 2 ft depth soil samples
- Medium Hexagon = 2 to 10 ft depth soil samples
- Large Circle = Greater than 10 ft depth soil samples

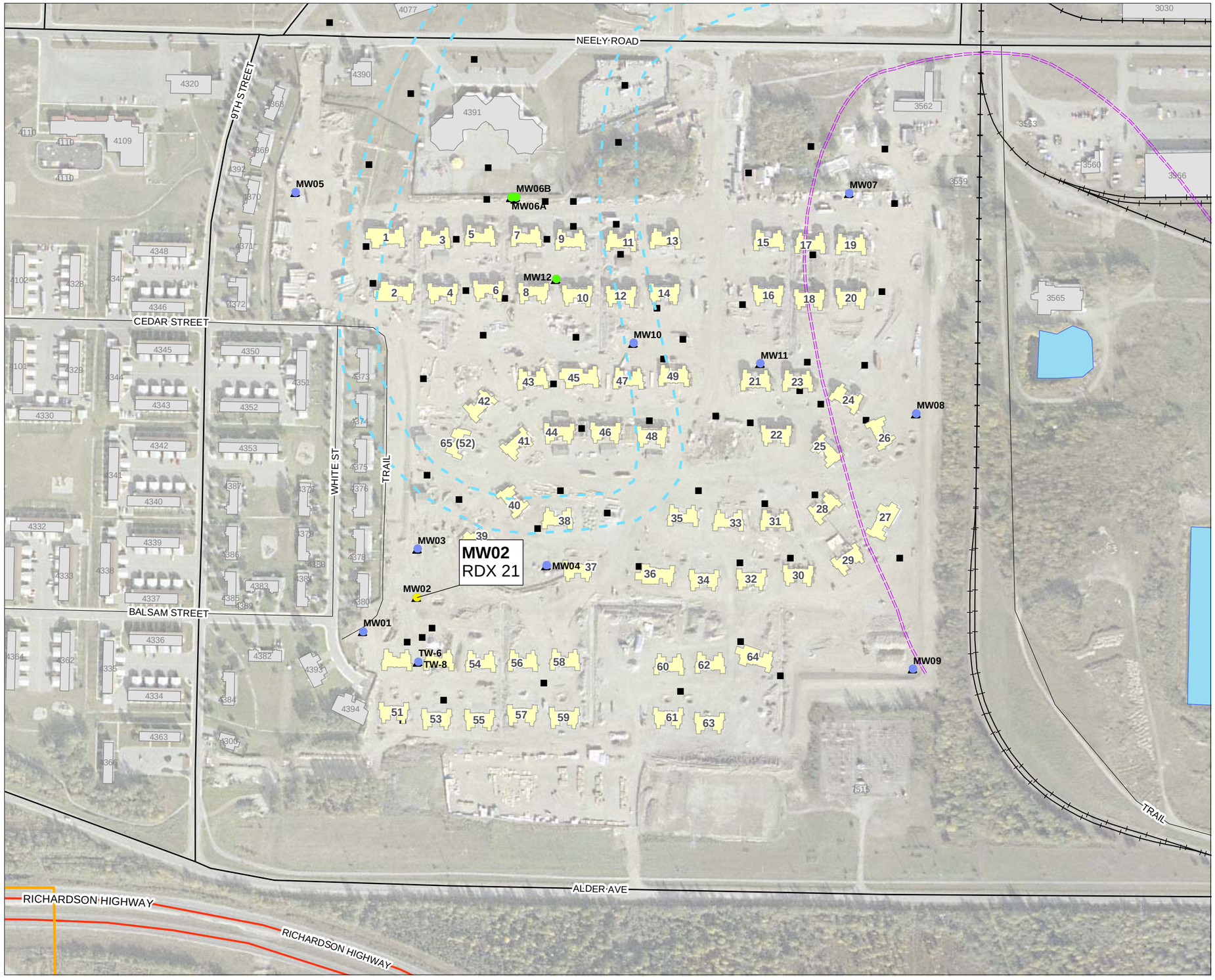
NOTES:
1. Screening Levels are 1/10th of ADEC Cleanup Levels or EPA Region 6 PRGs
2. Projection: WGS84 UTM Zone 6N

N

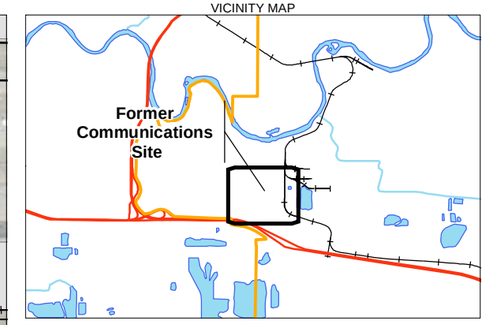
0 150 300
Feet

FIGURE 2-29
EXPLOSIVE SOIL NON-DETECT RESULTS WITH ELEVATED DETECTION LIMITS
Yellow, Orange & Red Non-detects
Former Communications Site
Fort Wainwright, Alaska

DRAFT



VICINITY MAP



LEGEND

- ▲ Permanent monitoring well locations
- ■ Proposed monitoring well locations
- Capture Zone, Supply Well 3559
- Former slough channel

Concentration Relative to Screening Level

- Blue indicates concentrations <= screening level
- Green indicates concentrations > screening level and <= 10x screening level
- Yellow indicates concentrations > 10x screening level and <= 100x screening level
- Orange indicates concentrations > 100x screening level and <= 1,000x screening level
- Red indicates concentrations > 1,000x screening level

SAMPLE LOCATION — **MW02**
ANALYTE ABBREVIATION — PCA 0.82
CONCENTRATION (µg/L)

NOTES:
1. All sampling units are in µg/L
2. Screening Levels are 1/10th of ADEC Cleanup Levels or EPA Region 6 PRGs
3. Projection: WGS84 UTM Zone 6N
4. All Non-detect Results with Elevated Detection Limits are listed on Table 2.8

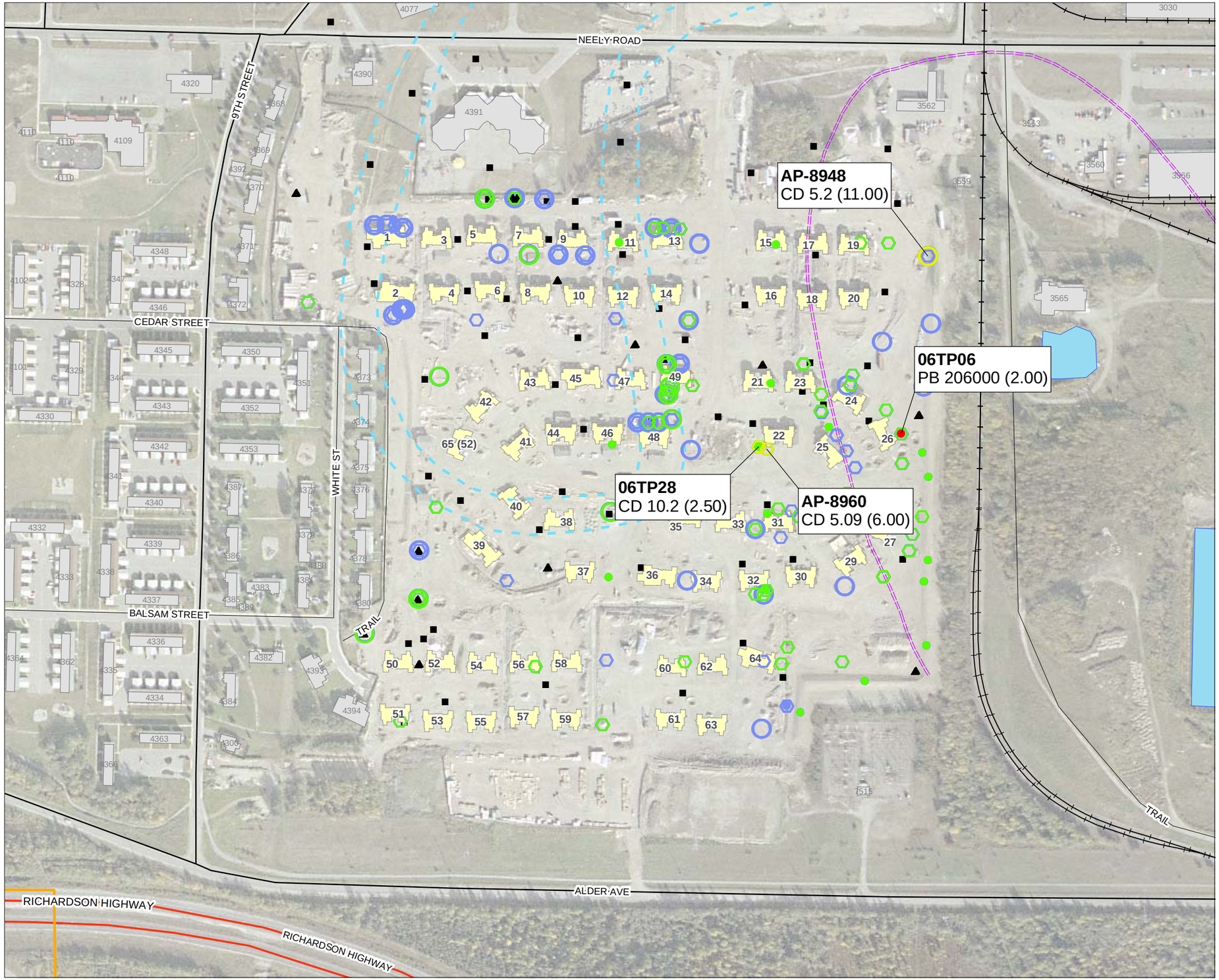
ANALYTE ABBREVIATION	ANALYTE NAME
RDX	Hexahydro-1,3,5-trinitro-1,3,5-triazine (RDX)

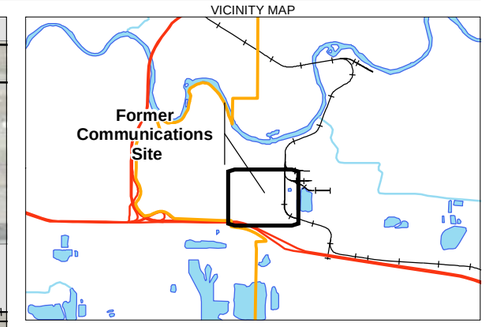
N

0 150 300
Feet

FIGURE 2-30
EXPLOSIVES IN GROUNDWATER
Yellow, Orange & Red Detects
Blue & Green Detects and Non-detects
Former Communications Site
Fort Wainwright, Alaska

DRAFT





LEGEND

- ▲ Permanent monitoring well locations
- ■ Proposed monitoring well locations
- Capture Zone, Supply Well 3559
- Former slough channel

Concentration Relative to Screening Level

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- Green indicates concentrations > screening level and <= 10x screening level
- Yellow indicates concentrations > 10x screening level and <= 100x screening level
- Orange indicates concentrations > 100x screening level and <= 1,000x screening level
- Red indicates concentrations > 1,000x screening level

Sample Depth

- Small Circle = 0 to 2 ft depth soil samples
- Medium Hexagon = 2 to 10 ft depth soil samples
- Large Circle = Greater than 10 ft depth soil samples

SAMPLE LOCATION — TSW-64-1
ANALYTE ABBREVIATION — BZ 2.1 (4.0)
CONCENTRATION (mg/kg)
SAMPLE ENDING DEPTH (feet)

NOTES:
1. 999 = Unknown Sampling Depth
2. All sampling units are in mg/kg
3. Screening Levels are 1/10th of ADEC Cleanup Levels or EPA Region 6 PRGs
4. Projection: WGS84 UTM Zone 6N

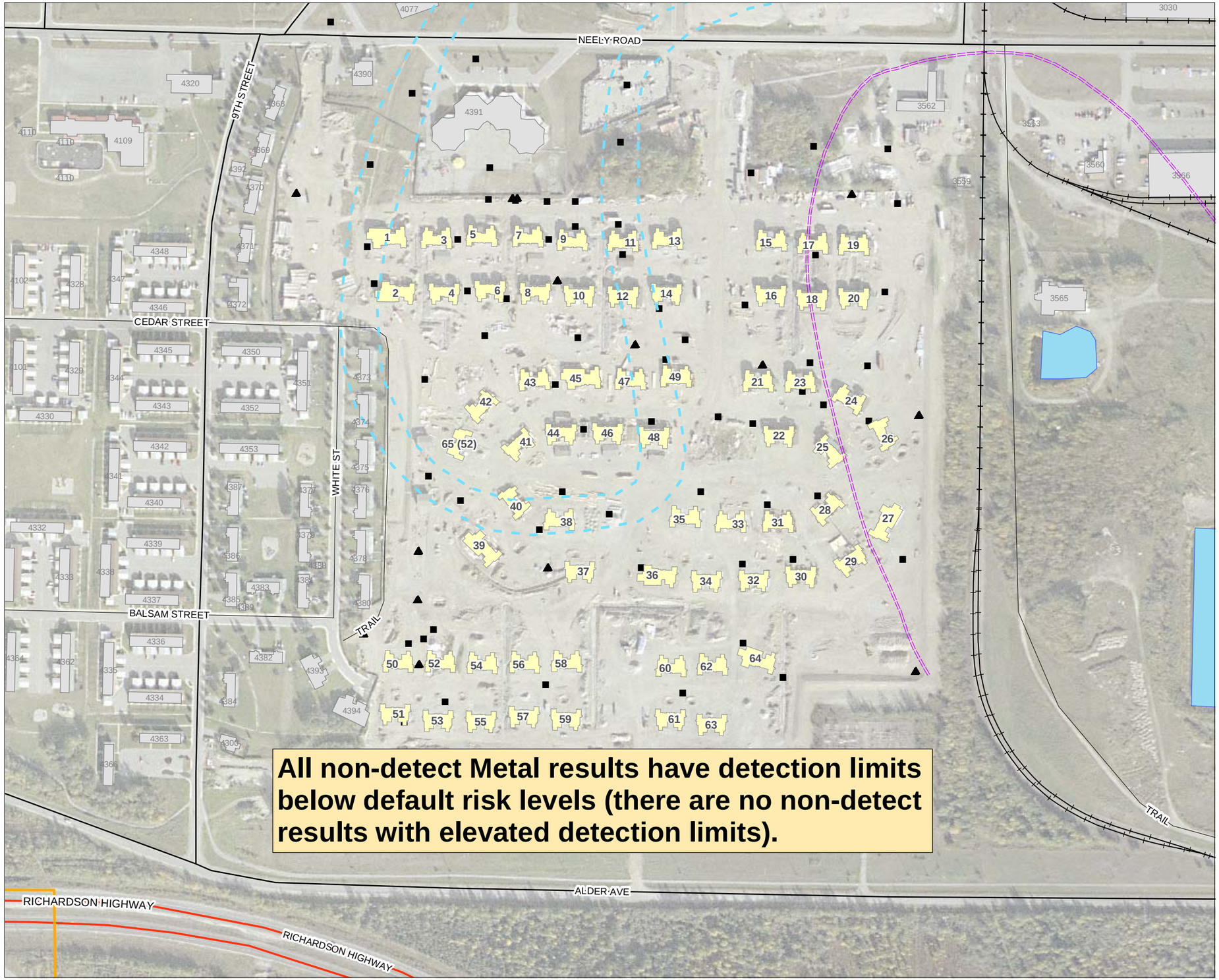
ANALYTE ABBREVIATION	ANALYTE NAME
BH	Cadmium
TP	Lead

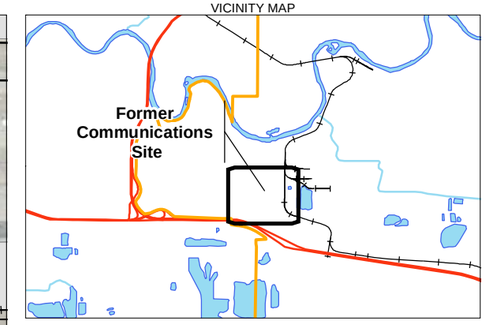
N

0 150 300
Feet

FIGURE 2-31
METALS IN SOILS
Yellow, Orange & Red Detects
Blue & Green Detects and Non-detects
Former Communications Site
Fort Wainwright, Alaska

DRAFT





LEGEND

- ▲ Permanent monitoring well locations
- ■ Proposed monitoring well locations
- Capture Zone, Supply Well 3559
- Former slough channel

Concentration Relative to Screening Level

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- Yellow indicates concentrations > 10x screening level and <= 100x screening level
- Orange indicates concentrations > 100x screening level and <= 1,000x screening level
- Red indicates concentrations > 1,000x screening level

Sample Depth

- Small Circle = 0 to 2 ft depth soil samples
- Medium Hexagon = 2 to 10 ft depth soil samples
- Large Circle = Greater than 10 ft depth soil samples

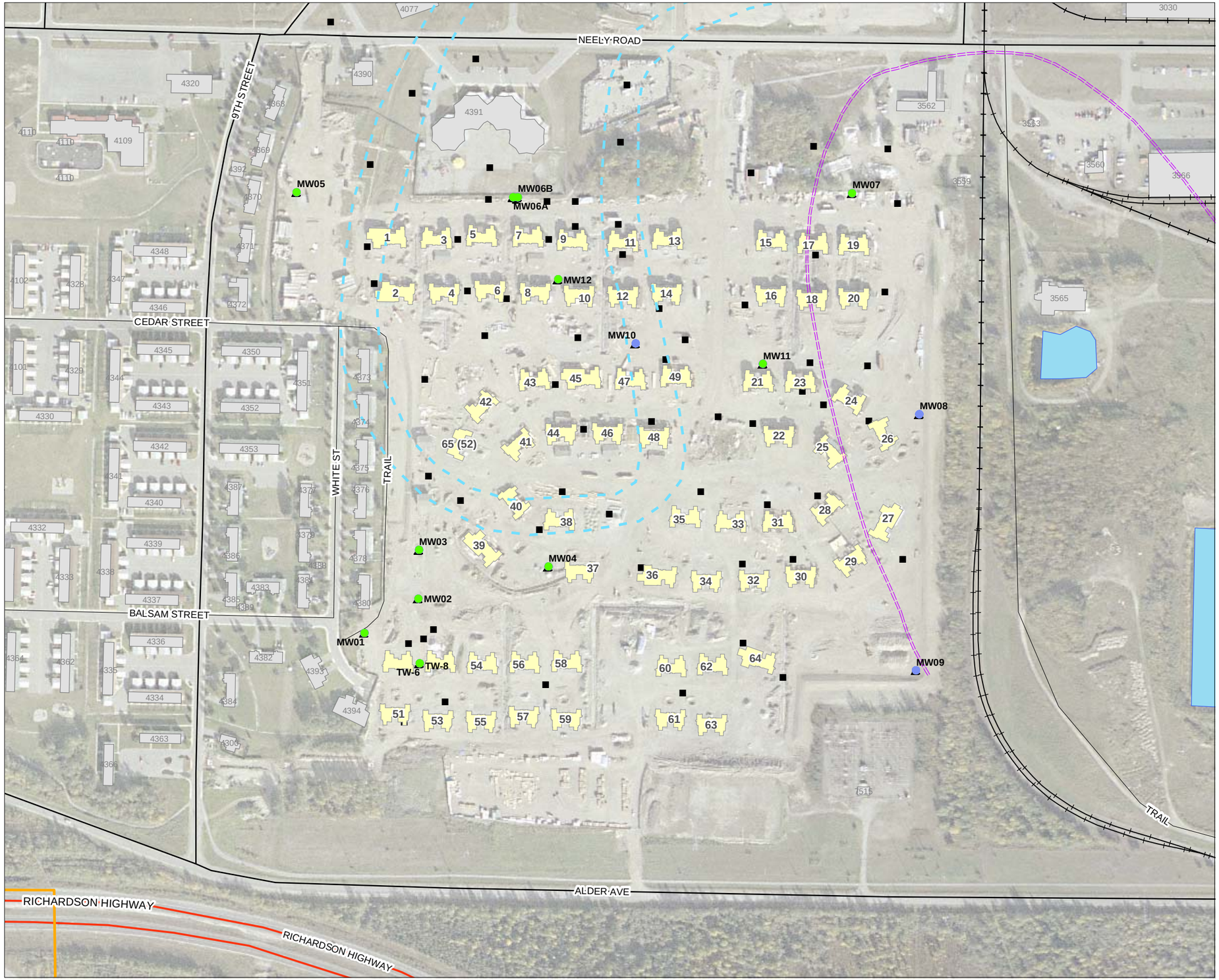
NOTES:
1. Screening Levels are 1/10th of ADEC Cleanup Levels or EPA Region 6 PRGs
2. Projection: WGS84 UTM Zone 6N

N

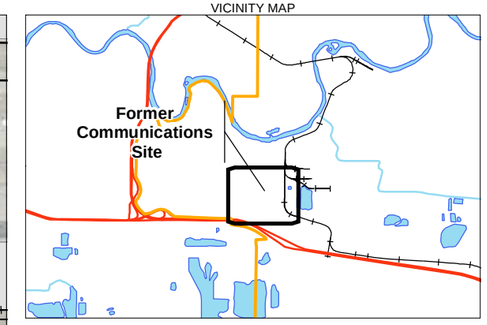
0 150 300
Feet

FIGURE 2-32
METAL SOIL NON-DETECT RESULTS WITH ELEVATED DETECTION LIMITS
Yellow, Orange & Red Non-detects
Former Communications Site
Fort Wainwright, Alaska

DRAFT



VICINITY MAP



LEGEND

- ▲ Permanent monitoring well locations
- ■ Proposed monitoring well locations
- Capture Zone, Supply Well 3559
- Former slough channel

Concentration Relative to Screening Level

- Blue indicates concentrations <= screening level
- Green indicates concentrations > screening level and <= 10x screening level
- Yellow indicates concentrations > 10x screening level and <= 100x screening level
- Orange indicates concentrations > 100x screening level and <= 1,000x screening level
- Red indicates concentrations > 1,000x screening level

SAMPLE LOCATION — **MW02**
ANALYTE ABBREVIATION — PCA 0.82
CONCENTRATION (µg/L)

NOTES:
1. All sampling units are in µg/L
2. Screening Levels are 1/10th of ADEC Cleanup Levels or EPA Region 6 PRGs
3. Projection: WGS84 UTM Zone 6N
4. All Non-detect Results with Elevated Detection Limits are listed on Table 2.8

N

0 150 300
Feet

FIGURE 2-33
METALS IN GROUNDWATER
Yellow, Orange & Red Detects
Blue & Green Detects and Non-detects
Former Communications Site
Fort Wainwright, Alaska

DRAFT

Addendum 1

Revised Draft

Addendum 1–to the Remedial Investigation Work Plan

Sound Berm Investigation

FWA 102 Former Communications Site
Fort Wainwright, Alaska

Prepared for

Department of the Army
U.S. Army Corps of Engineers,
Alaska District

P.O. Box 6898
Elmendorf AFB, Alaska 99506-6898

Contract No. W911KB-05-D-0010
Task Order 0009

Revision 1, 25 July 2007

CH2MHILL
301 W. Northern Lights Boulevard, Suite 601
Anchorage, AK 99503

ADDENDUM 1

Sound Berm Investigation

Purpose

This document serves as an addendum to the May 2007 *Remedial Investigation/Feasibility Study Management Plan, FWA 102, Former Communications Site, Fort Wainwright, Alaska* (RI Management Plan). It addresses the characterization of the Sound Berm at the Former Communication Site (FCS). The purpose of this addendum is to ensure that the Sound Berm does not pose a direct contact risk to human health. Consistent with the June 6 and 7 meeting to review the Draft RI Management Plan, the FCS Management Team's decision was to use multi-increment (MI) soil samples as a screening tool to eliminate sections of the Sound Berm that are not a risk. If any sections of the Sound Berm exceed established risk screening criteria, then discrete samples will be collected to calculate baseline risk and characterize for subsequent management decisions.

Background Information

The Sound Berm is a 6-foot (ft)- to 10-ft-high earthen structure designed to be a sound barrier separating the railroad tracks and the housing units on the FCS. It extends from the northeast corner of the site running approximately 1,200 ft along the east boundary toward the south perimeter where it extends approximately 1,000 feet to the west. The Sound Berm was generated from near surface soil and organic matter (such as tree stumps) obtained during site clearing in the FCS and imported soil from other Fort Wainwright construction sites. Consequently, contaminants found in other areas of the site could also be in the Sound Berm and may or may not correlate with FCS soil samples collected elsewhere.

Previous Sampling Results

Two relatively short sections of the Sound Berm have been partially characterized for polychlorinated biphenyls (PCBs). One of the sections is located in the southwest portion of the Sound Berm. Twenty samples were collected from the berm and analyzed using a field screening method (Hach PCB Test Kit). Four of the 20 samples indicated the presence of PCBs above 1 part per million (ppm). These four samples were submitted for lab analyses and PCBs were not detected. Because the results from the field screening appear to be inconclusive and because the sample locations appear to be limited to the perimeter of the berm, it is recommended that this portion of the Sound Berm be re-sampled for PCBs and for other chemical constituents during this field investigation effort.

The other partially characterized section is that portion of the Sound Berm situated over the former Transformer Service Area (TSA). Twenty-five samples were collected from this section and tested with the Hach Field Screening Kit. Five of the 25 field-screened samples exceeded the 1 ppm cleanup level for PCBs. Two of the five field samples were analyzed in the laboratory and only one of these exceeded criteria. This soil below this portion of the

Sound Berm will be re-sampled for PCBs in conformance with MEC clearance procedures. As discussed above, the Sound Berm soil will be characterized using MI sampling procedures. Sample collection and processing will follow the procedures described in the State of Alaska Department of Environmental Conservation's (ADEC) Draft Guidance on Multi-Incremental Sampling (March 2007).

Data Quality Objectives (DQOs)

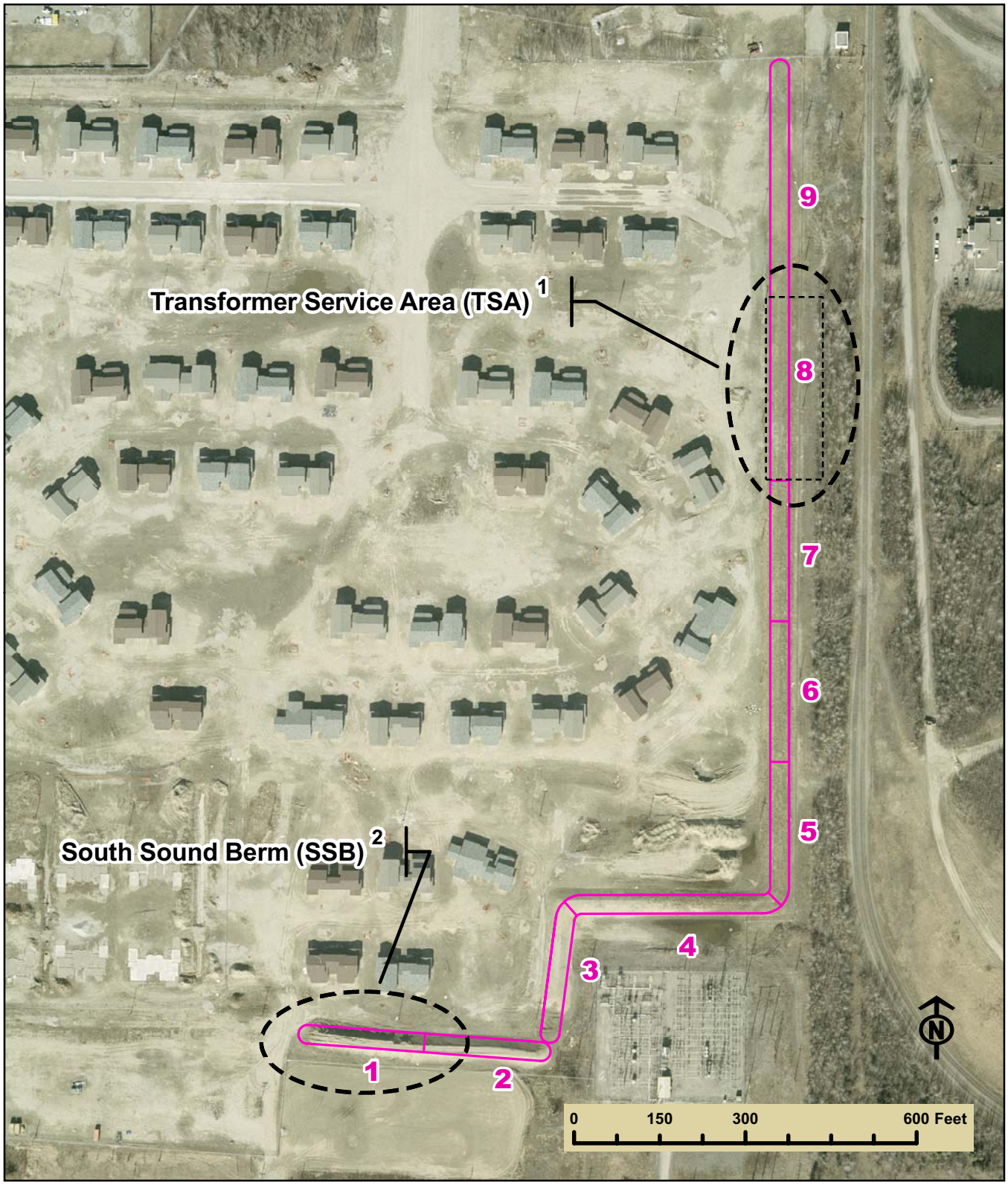
A DQO process was used to document the purpose of data to be collected for the RI. The objective of this addendum is to assess the nature and extent of chemicals in the Sound Berm soil that present unacceptable risk to human health.

Sample results will be validated following Level III protocols. Ten percent of the results will be validated following Level IV protocols. Screening values for the determination of risk are 1/10th of ADEC's most conservative Method 2 ingestion cleanup levels, and as appropriate, inhalation and migration to groundwater cleanup levels. These cleanup levels can be found in 18 AAC 75 (Tables B1 and B2) and in ADEC Technical Memorandum 01-007, *Additional Cleanup Levels*. U.S. Environmental Protection Agency (EPA) Region 6 Soil Screening Levels may also be used for assessing human health direct contact risk for any compounds not included in ADEC Tables. If soil results do not exceed risk based criteria, no additional action is needed. In accordance with ADEC's *Draft Guidance on Multi-Incremental Soil Sampling* (March 2007) the calculated 95% UCL will be compared to risk-based screening criteria. If the MI soil sample results exceed risk-based screening criteria (e.g., 1/10th of ADEC soil cleanup levels), then discrete samples for compounds of concern shall be collected within the affected Decision Unit. All of the discrete sample data will be used in the baseline risk assessment. If discrete sample results show an unacceptable risk, then the data will be used in the Feasibility Study for the FCS. Agency approval will be obtained before any follow-on discrete sampling is performed.

Sampling Approach

All MI field and laboratory sampling and quality assurance and control procedures will follow ADEC guidance ADEC's *Draft Guidance on Multi-Incremental Soil Sampling* (March 2007). The following bullets highlight the key elements of the Sound Berm investigation:

- Soil samples will be randomly collected from a systematic grid established over nine Decision Units (see Figure 1-1).
- Each Decision Unit is an approximately 200- to 400-ft-long section of the Sound Berm.
- Sound Berm will be sampled from all sides from 0 to 2 ft depths.
- The top 24 inches of underlying mineral soil will be collected; organic material will be excluded.
- One MI soil sample will be collected from 8 of the 9 Decision Units; a duplicate and triplicate MI sample will be randomly collected from the 9th Decision Unit.
- UCLs will be calculated for the triplicate and the regular samples per the guidance



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Legend

MI Sampling Decision Unit

Transformer Service Area (TSA)

Historical Sampling Results

[1] TSA: 2 PCB lab samples, one exceeding cleanup criteria

[2] SSB: 4 PCB lab samples, all non-detect

Figure 1-1
Former Communications Site
Fort Wainwright, Alaska
Sound Berm

- Each MI soil sample will be composed of 30 incremental samples consistent with ADEC guidance that requires a minimum of 30 to 50 increments. The duplicate and triplicate sample quadrants, within each increment, will be determined randomly by dice roll, but samples may not be from the same quadrant.
- For volatiles, samples will be field preserved directly in methanol. Volatile samples will not be sieved.
- For non-volatiles, a bulk soil sample of the entire 3'' column (e.g. the 3'' hand auger from 0-24 inches, or approximately 60 grams of soil per sample increment) will be coarse screened with a 6-mm (0.25-inch) sieve and sent to the laboratory. The laboratory will sieve (#10 sieve to 2-mm size), subsample, and distribute through the lab for analysis. For MI sampling of metals the laboratory will digest 10 grams of sample to achieve a fundamental error requirement of less than 15%.
- Laboratory procedures have been submitted to the ADEC for review.
- Additional information about MI sampling protocols and quality assurance (QA)/quality control (QC) requirements for the Sound Berm investigation can be found in the FCS Field Sampling Plan (FSP) and Quality Assurance Project Plan (QAPP), respectively.

Sample Collection and Analyses

Sample collection procedures are provided in the FSP and QAPP. Field quality control samples including equipment blank, trip blank, and matrix spike/matrix spike duplicate samples will be collected. Details will be specified in the FSP and QAPP. Table 1-1 presents the summary of analytical methods that will be followed in this Addendum.

TABLE 1-1
Analytical Methods for Sound Berm Soil

Analysis	Method Number	Container	Preservative	Maximum Holding Time	Number of Soil Samples
VOCs	EPA SW8260B	1, 4-oz amber glass jar with septa lid	Methanol 4°C	14 days to analysis	11 MI samples (one from each Decision Unit plus 2 QC) (Duplicate/Triplicate from Decision Unit 9)
SVOCs	EPA SW8270C	2, 1-liter widemouth glass jars (these same containers are used to hold soil for all non-volatile sample analyses)	4°C	14 days to extraction, 40 days to analysis	11 MI samples (one from each Decision Unit plus 2 QC) (Duplicate/Triplicate from Decision Unit 9)
PCBs	EPA SW8082	2, 1-liter widemouth glass jars (these same containers are used to hold soil for all non-volatile sample analyses)	4°C	14 days to extraction, 40 days to analysis	11 MI samples (one from each Decision Unit plus 2 QC) (Duplicate/Triplicate from Decision Unit 9)
Metals/Mercury	EPA SW6010/6020/ SW7471A	2, 1-liter widemouth glass jars (these same containers are used to hold soil for all non-volatile sample analyses)	4°C	28 days for mercury, 6 months for all others	11 MI samples (one from each Decision Unit plus 2 QC) (Duplicate/Triplicate from Decision Unit 9)
GRO	AK 101	1 4-oz amber glass, septa lid	Methanol 4°C	28 days to analysis	11 MI samples (one from each Decision Unit plus 2 QC) (Duplicate/Triplicate from Decision Unit 9)
DRO/RRO	AK 102/103	2, 1-liter widemouth glass jars (these same containers are used to hold soil for all non-volatile sample analyses)	4°C	14 days to extraction, 40 days to analysis	11 MI samples (one from each Decision Unit plus 2 QC) (Duplicate/Triplicate from Decision Unit 9)

TABLE 1-1
Analytical Methods for Sound Berm Soil

Analysis	Method Number	Container	Preservative	Maximum Holding Time	Number of Soil Samples
Chlorinated Pesticides	EPA SW8081A	2, 1-liter widemouth glass jars (these same containers are used to hold soil for all non-volatile sample analyses)jars	4°C	14 days to extraction, 40 days to analysis	11 MI samples (one from each Decision Unit plus 2 QC) (Duplicate/Triplicate from Decision Unit 9)
Chlorinated Herbicides	EPA SW8151A	2, 1-liter widemouth glass jars (these same containers are used to hold soil for all non-volatile sample analyses)	4°C	14 days to extraction, 40 days to analysis	11 MI samples (one from each Decision Unit plus 2 QC) (Duplicate/Triplicate from Decision Unit 9)
Explosives	EPA SW8330	2, 1-liter widemouth glass jars (these same containers are used to hold soil for all non-volatile sample analyses)	4°C	14 days to extraction, 40 days to analysis	11 MI samples (one from each Decision Unit plus 2 QC) (Duplicate/Triplicate from Decision Unit 9)

AK = Alaska
C = centigrade
DRO = diesel-range organics
EPA = U.S. Environmental Protection Agency
GRO = gasoline-range organics
MI = multi-increment
PCB = polychlorinated biphenyl
RRO = residual-range organics
SVOC = semivolatile organic compound
QC = quality control
VOC = volatile organic compound

Responses to Comments

REVIEW COMMENTS	PROJECT: RI Former Communication Site, Ft. Wainwright DOCUMENT: WP Addendum #1, Sound Berm Investigation	
U.S. ARMY CORPS OF ENGINEERS	DATE: 6/30/07 REVIEWER: Robert D. Brock, POA PHONE:	Action taken on comment by: CH2M HILL

Item No.	Page, Section.	COMMENTS	A - comment accepted W - comment withdrawn	RESPONSE (Response to backcheck comments underlined)	USACE BACKCHECK
Addendum 1 Sound Berm					
1	Purpose	Delete all but the first two sentences of this section.	A	This section was revised to incorporate comments from all reviewers.	
2	Area of Investiga-tion	Explain how MEC was determined and that a conservative approach was used (see email from Beth Astley, CRREL). Consider squaring off the area for ease of locating in the field. Add that if site conditions change (i.e. debris is encountered in other areas) that the plan will be revisited and changed as needed. Add that UXO technicians (two reams) will be onsite to support Building 48/49 investigations and test pit installations and will be available to provide support as warranted by changed site conditions. Work below EXISTING grade in MEC area will require UXO support	A	Information about how the MEC was conservatively determined is included in this response to comments and will be included in Addenda and Plans if MEC may be encountered. As the Sound Berm is located above grade and MEC clearance procedures do not apply to above grade structures, this section was revised accordingly.	
3	DQOs	Validated using Level III or IV protocols? Explain.	A	Typically, there are four types of data reduction, validation, and reporting deliverables that depend upon the DQOs of the individual project. The specific data	

U.S. ARMY CORPS OF ENGINEERS	DATE: 6/30/07 REVIEWER: Robert D. Brock, POA PHONE:	Action taken on comment by: CH2M HILL

Item No.	Page, Section.	COMMENTS	A - comment accepted W - comment withdrawn	RESPONSE (Response to backcheck comments underlined)	USACE BACKCHECK
				deliverable level must be defined in the project-specific SAP. See also response to Sharon Richmond's Comment No. 6 below.	
4	Table 1-1	Reference for Extractable VOC method? Purpose of this sample?	A	Extractable VOC samples have been eliminated from the FSP and this Addendum.	

U.S. ARMY CORPS OF ENGINEERS	DATE: REVIEWER: Sharon Richmond PHONE:	Action taken on comment by: CH2M HILL

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1.		The first paragraph indicates that multi-increment (MI) sampling data will be used for a baseline risk assessment. As agreed upon in our planning meeting, MI data can not be used for risk assessment because it does not address acute exposure.	A	The Sound Berm Sampling Addendum will be revised in Section 1-1 to state that the purpose is to ensure that the Sound Berm does not pose a direct contact risk to human health. Consistent with the June 6 and 7 meeting to review the Draft RI Management Plan, the FCS Management Team's decision was to use multi-increment (MI) soil samples as a screening tool to eliminate sections of the Sound Berm that are not a risk. If any sections of the Sound Berm exceed established risk screening criteria, then discrete samples will be collected to calculate baseline risk and characterize for disposal	
2.		I recognize that this will be a dynamic work plan and agree that this is the best approach but we need a decision "tree" to document how decisions will be made. This is critical for approval of this work plan.		The decision tree included as Figure 4-2 of the draft Work Plan applies to the MI soil sampling for the Sound Berm. If the MI soil sample results are below risk screening levels, then it is considered clean. If the MI soil sample results are above risk screening levels, then discrete sampling (grid pattern) will be used to locate the source, calculate baseline risk, and characterize the area for appropriate management decisions. Other decision trees will be developed for other parts of the RI.	

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3.	Second par.	The management team has not yet agreed upon the boundaries of the MEC area and the non-MEC area. I think we should have a meeting about this on Monday as suggested in Julie's email on 6/25/07. Approval of this and other addenda hinges upon this decision.		The development of the area where MEC clearance is potentially required was presented in the email sent to RPMs from Bob Brock on 6/25/07, and discussed on the conference call on the same date. The area was based on a geophysical survey of magnetic anomalies, backed up by locations of recovered MEC, historical photographs, and the former river channel. The purpose of Figure 1-1 was to delineate the area where MEC clearance is not required so that intrusive RI fieldwork can begin. Note that MEC clearance is not required for aboveground berms and soil piles anywhere at the site, so Figure 1-1 has been revised in Addendum 1 to depict the Sound Berm features only.	
4.	Page 2. First full par.	Please use 1 mg/kg cleanup level instead of criteria.	A	Will revise the Addendum and the FSP to say cleanup level instead of criteria.	
5.		I understand that the former transformer storage area will be sampled differently from the other portions of the sound berm, which will be sampled using MI techniques, but I don't understand what "at a later date in accordance with MEC clearance procedures" means. If this area will be sampled using soil	A	The Transformer Service Area (TSA) will be sampled using soil borings and discrete sampling with UXO support.	

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		borings and discrete sampling with UXO support, please state this.			
6.	Page 3.	Please briefly explain Level 4 protocols. (Sorry, I'm not familiar with data validation procedures.)	A	Typically, there are four types of data reduction, validation, and reporting deliverables that depend upon the DQOs of the individual project. The specific data deliverable level must be defined in the project-specific SAP. Level 4 is appropriate for investigative, confirmatory, or closure results. Critical decisions may be made using these data and should be used for projects that require a high degree of confidence in the accuracy of the data. A Level 4 report will include all elements required for the Level 1-3 report formats and all of the associated raw data. In the Level 4 report, the relative scale used for all chromatographic and other instrument data must be supplied in a scale that facilitates review from hard copy. Sufficient "blow ups" of complex areas of sample chromatograms are provided in the Level 4 report. The following information is also supplied in a Level 4 report:	

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				• Sample preparation logs. • Example calculation for obtaining numerical results from at least one sample for each matrix analyzed; provide algorithm. • Ion Ratio information for dioxin/furan methods Additional information about the Level 4 report for the FCS RI is included in the QAPP.	
7.	Sampling Approach.	The systematic grid is not presented. Suggest using the phrase “30 to 50 samples” instead of approximately 33 samples. It isn’t clear why “approximately 33 samples” was chosen.	A	A figure depicting the systematic grid is provided in the FSP. The Sound Berm is systematically divided into 9 Decision Units, each measuring approximately 200 to 400 feet in length. Each Decision Unit along the Sound Berm will be sampled from the top and sides from 11 cells lengthwise and three cells widthwise. One sample will be collected from each cell in a random fashion. This yields 33 samples per Decision Unit.	
8.		Approval of this document hinges upon approval of the field sampling plan and QAPP.	A	Comment noted. The revised FSP and QAPP will be posted for agency review on the FTP site.	

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9.	Table 1.1.	Please add a note explaining why VOC samples will be preserved with sodium bisulfate instead of methanol. I know that we won't be closing the site with these data so I'm not terribly concerned about this but we should document why we're using an unapproved method.	A	VOC samples will be preserved with methanol per the instructions of the *Draft Guidance on Multi-Incremental Soil Sampling* (March 2007). This will be reflected in the FSP and the QAPP.	
10.	Table 1.1.	Please discuss using MI sampling for metals with Earl.	A	Comment noted; CH2M HILL will contact Earl. <u>Earl was contacted for discussion of MI sampling for metals.</u>	Not contacted.
11.	Figure 1.	Our team needs to agree upon the MEC vs. non-MEC areas. See Comment 3.	A	Agreed. See response to Comment No. 3.	
12.	General Comment	Addenda should be replaced with addendum throughout document.	A	Comment noted; replacement made.	

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1.	1-1 Purpose	If the purpose of this sampling activity is to collect data for use in a risk assessment, then why will multi-increment sampling occur? Why not collect 33 discrete samples?	A	The Sound Berm Sampling Addendum will be revised in Section 1-1 to state that the purpose is to ensure that the Sound Berm does not pose a direct contact risk to human health. Consistent with the June 6 and 7 meeting to review the Draft RI Management Plan, the FCS Management Team's decision was to use MI soil samples as a screening tool to eliminate sections of the Sound Berm that are not a risk. If any sections of the Sound Berm exceed established risk screening criteria, then discrete samples will be collected to calculate baseline risk and characterize for disposal.	Accepted
2.	Figures	Please provide figures with available site data plotted for reference.	A	Figure 1-1 has been revised to delineate the Sound Berm and available site data.	Accepted
3.	1-1 Previous Sampling Results	At what depth were previous samples collected? Is sampling 2 ft as proposed appropriate based on previous results? The initial management plan had incremental samples being collected only in the top 6 inches. Please provide consistency and justification for MI sampling in the top 2 feet.	A A	The depths of the previous Sound Berm samples are not known. Consistent with the June 6 and 7 meeting to review the Draft RI Management Plan, the FCS Management Team decided to sample at 0 to 2 feet depths. The justification was that there was existing knowledge about how the berm was constructed and no reason to think that surface soil is different than subsurface soil.	Accepted. However, the assumption regarding subsurface soil should be evaluated as an uncertainty. Additionally,

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				Institutional controls will be considered in the Feasibility Study.	appropriate institutional controls (no dig) will be required for regulatory compliance for soil 0-15 feet.
4.	1-2 DQOs	Approach not acceptable as presented. If MI results exceed ADEC cleanup levels, there is no need for additional discrete sampling. *Marty, I don't get this comment. If the results are above cleanup levels, then they do need to get more samples.* If MI results exceed risk based screening levels (1/10 ADEC cleanup levels), discrete sampling of all nodes should be conducted to calculate risk. If discrete samples indicate unacceptable risk, then management decisions should follow.	A	At the June 12 and 13 review meeting, the FCS Management Team indicated if an MI soil sample is greater than risk screening criteria (ADEC cleanup levels), then collect discrete samples to locate the source, calculate baseline risk, and characterize for management decisions such as removal of that section of the berm. Comment noted on approval needed for follow-on discrete sampling if required.	Accepted. Discrete sampling of the sound berm decision unit(s) for risk assessment purposes (if required) will require separate addendum and approval as necessary.
5.	1-2 Sampling Approach	Please clarify that MI samples taken at 2 ft depths shall be collected from all sides of the berm in the recommended systematic random	A	MI soil samples shall be collected at 0 to 2 feet depths and from all sides of the berm in a systematic random manner. Additional	Accepted

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		manner. MI sample should be collected in a systematic random approach over the decision unit. In systematic or systematic random sampling, the first location should be randomly determined; each location within the initial grid/square should have an equal chance of being sampled (randomness). The sampling location in subsequent grid squares is then the same as the randomly determined first grid location. Provide additional details, including an example grid figure, as to how systematic random sampling locations will be determined for the decision unit.		details, including a figure depicting the Decision Unit grid and sample increment locations, will be provided in the Field Sampling Plan (FSP).	
6.	1-2 Sampling Approach	*Approximately* 33 increments? Recommend revising text to read "*a minimum of 30-50 increments, per ADEC guidance…*".	A	Text will be revised as suggested. The FSP will provide detail on how the 30 increments were selected. <u>The FSP has been changed to 30 increments.</u>	Accepted. Note that the FSP specifies thirty (30) increments per decision unit (not 33).
7.	1-3 Sampling Approach	The QAPP provides very little additional information on MI sampling and the FSP has not been reviewed. Neither the QAPP nor the FSP have been approved at this time. All comments and/or approvals are contingent upon approval of a final FSP and QAPP.	A	Comment noted. The revised FSP and QAPP will provide additional detail on MI sampling methods. These work plans are subject to the approval of the FCS Management Team.	
8.	1-3	How will the increments be collected? Will	A	The soil will be collected using a	See

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	Sampling Approach	hand augers or a coring device be used? Will the entire 2' core be used as the increments or will it be subsampled, scraped, etc., to attain the increment?		decontaminated hand auger. The surficial soil and any organic matter will be stripped from the incremental sample location. The top 24 inches of underlying mineral soil will be collected and placed into an "MI mixing bucket." The bucket will be used to churn all the incremental samples so that the contents are uniformly distributed. Oversize material will screened out, then the entire bulk soil sample (approximately 60g per sample increment) will be shipped to the lab for additional screening (#10 sieve to yield a minus 2 mm soil) and sub-sampling. Field and laboratory methods will follow ADEC's *Draft Guidance on Multi-Incremental Soil Sampling* (March 2007). The final FSP will provide additional detail on MI sampling procedures.	comments below on volatile and non-volatile MI sample collection.
9.	1.3 Sampling Approach	MI non-volatiles. The MI guidance recommends 30-60 grams per increment be collected and additional mass if oversized material is encountered (page 9). Approximately 500-1000 g of material following sieving should be available (page 10). Recommend adding this clarification to ensure adequate, representative mass is collected.	A	CH2M HILL has been in close contact with the project laboratory to confirm the sample mass required for MI non-volatile extraction and analyses. <u>We will ship the entire 3'' column from 0 to 2 feet to the lab.</u> -. (Oversize material will be removed before sieving is completed.) <u>This is expected to meet the recommended mass requirements.</u> The additional material sent	Not accepted. The 30-60 gram requirement is per MI increment (30), the 500-100 gram mass is the

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				to the project laboratory will ensure adequate mass is collected and will allow for additional analyses if necessary. Sub-sampling procedures will follow ADEC's *Draft Guidance on Multi-Incremental Soil Sampling* (March 2007).	post sieving (<2mm) requirement. If the entire 3" diameter column will be collected and sieved, please state that this is expected to meet the recommened mass requirements.

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10.	1.3 Sampling Approach	MI non-volatiles. Please specify that a single MI sample jar containing 30-50 grams will be collected and submitted per analysis (DRO/RRO, SVOC, etc.). The jars should not be filled as stated in the initial management plan. Coordination with the laboratory to ensure the minimum extraction mass, 30 grams, from the appropriate sample jar is required. Sub-sampling of the <2mm fraction should be performed per ADEC guidance, clarification required. Additionally, recommend specifying that a minimum of one additional sample jar be collected and submitted per MI sample in the event of breakage or if laboratory re-analysis is required.	A	The entire <6mm fraction from each increment will be submitted to the laboratory. As stated above for MI non-volatiles, the project laboratory shall sub-sample the bulk soil sample (appoximately 1.8 kg) in accordance with . sub-sampling procedures in ADEC's *Draft Guidance on Multi-Incremental Soil Sampling* (March 2007). The laboratory SOP for the sieving and subsampling procedure for non-volatiles has been submitted for ADEC review.	Not accepted. The FSP states the MI sample will be sieved to <6mm and ~2 kg submitted to the laboratory for further sieving (<2mm), subsampling and analysis. Unless, subsampling per ADEC guidance is performed in the field, the entire <6mm fraction should be submitted to the laboratory. Additionally,

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					please provide the laboratory SOP for the sieving and subsampling procedure for non-volatiles for ADEC review.
11.	1.3 Sampling Approach	The MI sample should not be air dried for 12-24 hours prior to sieving, as this may not be appropriate for all analytes. Provide additional details on incremental sampling, sieving and sub-sampling procedures.	A	The MI soil sample will not be air-dried for 12 to 24 hours prior to sieving. Additional details on incremental sampling, sieving, and sub-sampling procedures are provided in the FSP and QAPP. <u>The laboratory SOP for the sieving and subsampling procedure for non-volatiles has been submitted for ADEC review.</u>	Not accepted. See above comment. Additional details on field and laboratory subsampling are required.
12.	1.3	Include 95% UCL calculation. Add that the triplicate results will be used for the 95%	A	A 95% UCL calculation will be used to compare MI soil sample results from each	Accepted. However,

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	Sampling Approach	UCL calculation and that the 95% UCL only will be used to assess contaminant concentrations.		Decision Unit to the risk screening criteria. The calculated 95% UCL MI results will be compared to risk levels (1/10th Method 2 ingestion/ inhalation). The 95% UCL for all Decision Units and triplicate sample results shall be calculated as described in Section VI, Quality Assurance and Control of ADEC's *Draft Guidance on Multi-Incremental Soil Sampling* (March 2007). Per the guidance, triplicate samples will be collected at a frequency of 10%, which means one triplicate sample for the 9 sections of Sound Berm.	please revise the DQO section to state that the calculated 95% UCL MI results will be compared to risk levels (1/10th Method 2 ingestion/ inhalation)
13.	1.3 Sampling Approach	Duplicate/triplicate samples must be collected from different random locations. Recommend adding clarification as to how this will be determined. Specify a minimum distance and directions for duplicate/triplicate locations. Recommend a minimum of one-half (1/2) the grid size. Refer to MI guidance for guidance on marking/flagging the initial (random) location and specify an adequate direction and spacing distance for duplicate/triplicate sample locations.	A	A triplicate sample will be randomly collected from Decision Unit 9. Dice will be rolled for quadrant selection for duplicate and triplicate MI samples; they may not be from the same quadrant. The details of how the triplicate sample will be collected are provided in the revised FSP.	Not accepted. The duplicate/ triplicate MI samples should be collected from alternate quadrants, not 5' north and east as specified in the FSP.

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					Revise FSP to state dice will be rolled for alternate quadrant selection for duplicate and triplicate MI samples.
14	1.3 Sampling Approach	MI sampling for metals is not recommended at this time. Sieving to <2mm may not be appropriate for metals determinations, since larger metal particles would be screened out and theoretically bias the sample results (low). Grinding may introduce metals, specifically chromium, into the samples. Fundamental error requirement cannot be achieved with the normal 1 gram digestion mass. Additional information addressing metals MI sampling and analysis is required prior to approval.		Per discussion with Mr. Earl Crapps, ADEC, the laboratory will digest 10 grams of sample to achieve the fundamental error requirement.	Not accepted. This comment was omitted and not addressed at all. Earl was not contacted.
15.	1-3 Table 1-1	Please provide extraction methods for all analyses.	A	Extraction methods for all analyses are provided in the QAPP.	Accepted
16.	1-3 Table 1-1	Volatiles preservatives are incorrect.	A	Volatile preservatives have been corrected. Volatile sample increments will be collected from the 2' depth. The entire initial aliquot of methanol must be in the	See comment below on volatile MI collection

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				sampling jar prior to addition of the MI soil increments.	and methanol field preservation.
17.	1-3 Table 1-1	EPH and VPH analyses should be deleted.		Comment noted; EPH and VPH analyses have been deleted.	Accepted
18.	1-3 Table 1-1	Volatiles should be included in the suite of analyses for surface soils collected at 0-2ft bgs. Methanol preserved MI sampling procedure for volatiles should be followed. Per QAPP and ADEC, the methanol field preserved VOCs should be collected in 4-oz amber glass jars with septa lids. VOCs may be collected and analyzed 1-3 from the same container as the AK101, dependent on lab requirements.	A	Volatile analyses are included in the suite of analytical methods for soil samples collected from the Sound Berm and will be preserved with methanol. The MI soil samples for volatiles will be collected in the field from the 2' depth without any sieving. For the 30 incremental samples, 1 to 2 grams will be collected from each incremental sample location and placed into the same 4-oz jar. A 3-ml syringe will be used at each Decision Unit. The syringe will have a wide mouth and will be used to collect 1 gram of soil from each of the sub-sampling locations. The entire initial aliquot of methanol will be in the sampling jar prior to addition of the MI soil increments. The methanol, cannot be spilled and no splashing can occur as each gram of soil is added. In the end, 30 grams of soil and ~30 mls of the pre-spiked methanol will be in the 4-oz amber jar with a septa lid.	Not accepted. Specify in the FSP that the volatile sample increments will be collected from the 2' depth. Per guidance, the entire, initial aliquot of methanol should be in the sampling jar prior to addition of the MI soil increments. Please revise FSP

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				Specific field procedures for collecting MI soil samples for volatile analyses are provided in the FSP and are consistent with the instructions provided in ADEC's *Draft Guidance on Multi-Incremental Soil Sampling* (March 2007).	accordingly. Again, the FSP specifies 30 increments per MI sample.
19.	1-3 Table 1-1	Specific volumes should be specified for MI samples.	A	CH2M HILL has been in close contact with the project laboratory to confirm the sample mass required for MI non-volatile and volatile samples. For non-volatile samples, approximately 1.8 kg of <6mm soil will be provided to the laboratory. For volatile samples, 30 grams of soil and ~30 mls of the pre-spiked methanol will be in the 4-oz amber jar with a septa lid. These volumes are provided in the FSP.	See above comments. FSP states 2 kg of <6mm will be submitted to lab and 30 increments (~30 grams) for volatiles.
20.	Figure 1-1	Please identify the berm on figure 1-1 in relation to the where MEC clearance is required. The area outlined in green is noted as where samples will be collected under this Addenda, but this area encompasses clearly more than the berm area being addressed in this addenda. Please revise figure legend as appropriate.	A	The location of the Sound Berm is depicted on Figure 1-1 and is referenced in the legend. MEC clearance is not required for sampling areas above grade like the Sound Berm, therefore MEC clearance zones are not depicted on this Figure.	

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1.	General Field Health and Safety Concerns	EPA feels that it is premature to reduce the level of onsite MEC-related safety precautions at this time. EPA considers MEC location, delineation and characterization at the FCS to be of the utmost concern and considers the MEC areas, as yet, undefined. Please see Specific Comment No. 1 for more detail.	D	Geophysical surveys, historical photographs, and several years' worth of construction and investigation all indicate that the MEC precautions can be reduced in the area indicated on Figure 1-1.	EPA feels that there is merit in the Army's response to this comment, but continues to have some reservations on the path forward. Furthermore, EPA recognizes that the MEC issues would be more appropriately addressed as part of planning for subsurface intrusive

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					work such as the soil gas and groundwater investigation activities. EPA therefore agrees to defer further discussion of the MEC issue and supports the Army's decision to remove the MEC discussion from this Addendum.
2.	General Clarification on needed for scope	The order of information presented in this addendum invites questions as to whether the samples will be analyzed consistently and with a broad enough analytical scope that	A	See responses to specific comments below.	This resolution is acceptable to EPA.

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	of analyses for defining COPCs	COPCs will be confidently identified. EPA has made a number of suggestions that may help to bring the overall robustness of the sampling design into focus. Please refer to Specific Comments Nos. 5, 9, 15 and others.			
3.	Specific Comment No. 1 p 1-1, par 2, Sentence 1	MEC has been definitively found and removed from this site. Thus, the potential for additional MEC items being unearthed is clearly more likely than that estimated by the Huntsville MMCX. EPA reiterates its utmost concern on this issue, both as it applies to the immediate safety of onsite workers and for the long term safety of residents and site visitors, not to mention the potential of harm to the environment by the release of hazardous filler constituents. EPA feels that it is premature to reduce the level of onsite MEC-related safety precautions until the RI investigation has generated convincing evidence that the MEC affected areas have been fully delineated, and characterized. This addendum does not present a basis for the MEC-clearance subdivision; thus EPA surmises that it is based upon the distribution	D	Geophysical surveys, historical photographs, and several years' worth of construction and investigation all indicate that the MEC precautions can be reduced in affected areas. Per agreement at the June 6 and 7 meeting, CH2M HILL will include a chapter in the Interim Draft RI Management Plan that pulls together all available information in support of MEC risk level at the site. We will develop a conceptual site model for MEC, which will be used to produce the hazard assessment.	See back-check response to EPA General Comment 1. (Army Item ID 3).

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		of geophysical anomalies and an expectation that no false negatives (i.e. undetected MEC) exist in the geophysical data. To EPA's knowledge, the geophysical data has not yet been fully analyzed or interpreted and the results have not been formally reported to the team for its review. Additionally, EPA notes that the documents and records reviewed during the PSE1 provide insufficient information to adequately document historical site activity. This lack of background information additionally undermines the proposal to reduce MEC related safety protocols in any area of the FCS. EPA maintains its position that MEC clearance continues to be necessary in all portions of the FCS. Recommendation: Reinstitute MEC clearance FCS-wide. Additionally, replace the text in the "Area of Investigation" section with text that describes the Sound Berm and adjacent areas to be investigated pursuant to this addendum.	A	As MEC clearance is not required for aboveground berms, the current text under "Area of Investigation" has been replaced with text describing the Sound Berm.	

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4.	Specific Comment No. 2 p 1-1, par 4, Sentence 2	A figure should be cited here showing the sound berm boundary. Recommendation: Add the sound berm to Figure 1-1 rather than citing Figure 1-2, which is better used later when discussing the proposed investigative activities.	A	The Sound Berm has been delineated on Figure 1-1 as suggested.	The Army's revisions resolve the issue; however EPA suggests citing Figure 1-1 on Page 1-1 in paragraph 2 sentence 1 so that the reader can visually follow the site description text.
5.	Specific Comment No. 3 p 1-1, par 4,	Please also mention the presence of organic matter, such as tree stumps, and voids in the berm.	A	Have added this information.	Thank you.

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6.	Specific Comment No. 4 p 1-1, par 4, Last sentence	If it is known that the soils brought in from other areas of Fort Wainwright were sampled prior to incorporation into the sound berm and no hazardous substances were detected, then EPA recommends stating that information here. If it is not known whether the soils were sampled, then the last sentence should clarify that the contaminants potentially existing in the sound berm may or may not correlate with those found previously in FCS samples.	A	Other than the PCB samples collected from a portion of the Sound Berm, it is unknown if the soil used to construct the Sound Berm has been previously sampled. The Addendum will be edited to clarify that the contaminants potentially existing in the Sound Berm may or may not correlate with those found previously in FCS soil samples collected elsewhere. However, if the soil came from off site, it likely passed the required construction specifications for clean fill.	EPA agrees with the revision however, it suggests that part of the function of the work plan is to document the current understandin g of the site. Thus the substance of the Army's last sentence in its response should be spelled out in the text. Is the soil known to have been

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					determined to be clean fill or is that an assumption? Part of the rationale for broad spectrum sampling would be to answer this question if documentation on the soil disposition does not exist or is not available.
7.	Specific Comment No. 5 p 1-2, par 1, Last	EPA agrees with the proposal that the previously sampled areas of the sound berm be re-sampled for PCBs and for additional analytes. EPA Recommends specifically identifying the proposed additional analytes		Other than the PCB samples described in this Addendum, it is unknown if the soil used to construct the Sound Berm has been previously sampled. The analytical methods proposed for the Sound Berm	This response is acceptable.

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	sentence	in the text here and also developing and including a "Proposed Sample Summary Table", where all proposed samples (and QA samples) to be collected are identified and described. EPA additionally suggests including in the table each anticipated sample location, location IDs, types of sample (e.g. discrete, multi-increment, etc), intended depth or depths of MI incremental samples, plus a sample specific list of all analytical methods to be completed. Also, EPA recommends including a column in the table that identifies any field features of interest or decision parameters (if any are known from previous work) that might guide field decisions regarding sample location selection. Also include a number of contingency samples, to allow flexibility in the field. [A similar table could also be developed that presented details for all previously collected samples. This would provide a useful mechanism for comparing the data sets and for effective design review and decision making].		soil samples are listed in Table 1-1. Specific analytes for each method are listed in the FSP and the QAPP. All soil samples will be MI collected from 0 to 2 feet depths as agreed by the FCS Management Team. Sample locations correspond to the MI Sampling Grid described above and are specified in the FSP. With the exception of the TSA, there are no known field features of interest.	
8.	Specific	As discussed in Specific Comment No. 1,	D	See response to specific Comment No. 1.	See back-

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	Comment No. 6 p 1-2, par 1, Last sentence	MEC clearance procedures should be used at all sampling locations. EPA recommends adding an additional sentence stating that MEC clearance and safety procedures will be conducted during the re-sampling.			check response to EPA General Comment 1. (Army Item ID 3).
9.	Specific Comment No. 7 p 1-2, par 2, First sentence	EPA suggests citing a figure showing the location of the TSA. EPA recommends adding the TSA to Figure 1-1.		Figure 1-1 has been revised to delineate the Sound Berm, the location of the TSA, and the Decision Units within the Sound Berm.	Excellent revision to the Figure. Thank you.
10.	Specific Comment No. 8 p 1-2, par 2, last sentence	As discussed in Specific Comment No. 1, MEC clearance procedures should be used at all sampling locations. EPA recommends removing from this sentence the phrase “but at a later date”.	D	See response to Specific Comment No. 1; also deleted the term, ‘later date.”	See back-check response to EPA General Comment 1. (Army Item ID 3).
11.	Specific Comment No. 9 p 1-2, par 2, Last	EPA agrees with the proposal that the previously sampled areas of the sound berm be re-sampled for PCBs but suggests that the same substances analyzed for in the southwestern berm samples be analyzed for	A	See response to Comment No. 5. Samples collected from the TSA portion of the south Sound Berm will also be analyzed for all of the methods listed in Table 1-1.	Acknowledged. This response is acceptable to EPA.

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	sentence	the TSA Berm samples as well. Recommendation: Revise the text to add additional proposed analyses (be specific) along with the PCB analysis. Also, include these samples on the additional "Proposed Sample Summary Table" described in EPA Specific Comment No. 5.			
12.	Specific Comment No. 10 p 1-2, par 4, Sentence 5	Multi-increment sampling should be introduced earlier than it is. There it should be described briefly with an explanation as to why MI sampling is appropriate for sampling the sound berm. EPA suggests adding the MI introduction and description in a new paragraph immediately preceding the DQO section.	A	A sentence has been inserted in the section preceding the DQO section stating that consistent with the June 6 and 7 meeting to review the Draft RI Management Plan, the FCS Management Team's decision was to use to use MI soil samples as a screening tool to eliminate sections of the Sound Berm that are not a risk. If any sections of the Sound Berm exceed established risk screening criteria, then discrete samples will be collected to calculate the baseline risk and characterize areas of concern for disposal.	Good. Nice resolution.
13.	Specific Comment No. 11 p 1-2, par	This portion of text is confusing. Sentence 4 begins "If soil results do not exceed risk…." But Sentence 5 begins "If the Multi-increment (MI) soil sample results….." It is	A	The text has been revised to say "MI soil results" for all sections of the text. See also response to Comment No. 5 above.	This is acceptable.

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	4, Sentences 4, 5, etc	unclear from previous content that different sampling techniques would be applied, thus it is unclear how "soil results" differ from "MI results". EPA suggests that the addition of the "Proposed Sample Summary Table", described above, would help clarify this. Please revise the text as necessary.			
14.	Specific Comment No. 12 p 1-2, par 5, Whole section]:	EPA recommends moving this section ahead of the DQOs. This move would solve some of the issues identified in previous Specific Comments, such as introducing MI sampling.	A	A sentence has been inserted in the section preceding the DQO section stating that consistent with the June 12 and 13 meeting to review the Draft RI Management Plan, the FCS Management Team's decision was to use MI soil samples for the Sound Berm.	Good.
15.	Specific Comment No. 13 p 1-2, par 5, bullet 4	Please clarify whether the MI triplicate sample will be collected from Decision Unit number 9, as depicted on Figure 1-2, or whether the ninth decision unit will be selected at random. Also, EPA recommends citing Figure 1-2 here.	A	The MI triplicate sample will be collected from Decision Unit No. 9, as depicted on Figure 1-2. Figure 1-2 has been eliminated.	Good.
16.	Specific Comment No. 14	Why approximately 33 incremental samples? What will determine the exact number of increments? Please clarify.	A	The word "approximately" will be removed. As described above, each Decision Unit along the Sound Berm will	This response resolves

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	p 1-2, par 5, bullet 4			sampled from the top and sides from 11 cells lengthwise and three cells widthwise. One sample will be collected from each cell in a random fashion. This yields 33 samples per Decision Unit.	EPA's concerns, however, the text in this response is slightly more detailed than that provided in the revised Addendum. EPA suggests blending the response into the revised text as appropriate.
17.	Specific Comment No. 15 p 1-3, Table 1-1	This table is good, but would be better if paired against a "Proposed Sample Summary Table", as suggested above.	A	A column was added to Table 1-1 to indicate the proposed number of samples (regular and QC).	This revision is acceptable. Note, however, that EPA prefers the

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					form of the sample table provided in Addendum 2 to summarize the Soil Pile sampling.
18.	Specific Comment No. 16 Figure 1-1	The scale is obscured somewhat by the underlying aerial photographic detail, particularly the nearby road. Suggestion: Move or otherwise highlight the scale.	A	Figure 1-1 has been revised including the scale	Excellent. Thank you.
19.	Specific Comment No. 17 Figure 1-1	EPA recommends adding the following field features to Figure 1-1: The Sound Berm The TSA and the area bounding the previous TSA sample locations, and The southwestern area of the berm where previous samples were collected	A	These additions were made to Figure 1-1. The MEC/non-MEC clearance areas were removed as such clearance is not required for the Sound Berm.	Agreed. This resolution is acceptable to EPA.
20.	Specific Comment No. 18 Figure 1-	As discussed in Specific Comment No. 1, EPA recommends removing the colored boundary polygons indicating the two areas with different MEC safety protocols. If it is	D	MEC clearance is not required for sampling surface soil on the Sound Berm. The MEC clearance areas have been removed from Figure 1-1.	See back-check response to EPA General

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	1]	anticipated that samples will be collected adjacent to, but not directly from the sound berm materials, then one additional new polygon should be added (in addition to the Sound Berm polygon suggested above) encapsulating the entire area potentially impacted by the work proposed in this addendum.			Comment 1. (Army Item ID 3).
21.	Specific Comment No. 19 Cover Page and p 1-1 Title	Is this addendum addressing a sound berm or a soil berm? These two pages say two different things. EPA recommends exchanging “sound” for “soil” in the title on page 1-1.	A	Text in the title has been revised within this Addendum to consistently refer to this area as the Sound Berm.	Good.
22.	EPA Specific Comment No. 20 p 1-1, par 1, Sentences 1 & 2	These two sentences feel out of order. EPA recommends rewording slightly and changing the order.	A	Sentences modified.	Good.
23.	Specific Comment No. 21	These three sentences are not really necessary. EPA recommends removing these sentences.	A	Comment noted. However, the text was left as-is to respond to other commenters and for additional clarification of the	This response is acceptable to

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	p 1-1, par 1, Sentences 3 to end of par			purpose for this Addendum.	EPA.
24.	Specific Comment No. 22 p 1-1, par 5, Sentence 2	EPA suggests spelling out all acronyms at their first occurrence, e.g. HACH PCB test.	A	HACH should be spelled Hach and has been corrected in this text. It is not an acronym, but rather, the last name of the husband and wife who founded the Hach Company. Other acronyms have been spelled out.	Thank you.

Addendum 2

Final

Addendum 2 to the Remedial Investigation Work Plan

Soil Pile Investigation

FWA 102 Former Communications Site
Fort Wainwright, Alaska

Prepared for

Department of the Army
U.S. Army Corps of Engineers,
Alaska District

P.O. Box 6898
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Task Order 0009

Final, 18 September 2007

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ADDENDUM 2

Soil Pile Investigation

Purpose

This document serves as an addendum to the May 2007 *Remedial Investigation/Feasibility Study Management Plan FWA 102 Former Communications Site Fort Wainwright Alaska* (*RI Management Plan*). It is being submitted to the FCS Team for review and approval. It addresses the chemical characterization of numerous soil stockpiles (soil piles) located at the Former Communication Site (FCS) for the soil disposal purposes. Multi-incremental sampling will be conducted to characterize the soil stockpiles. This approach was determined to be the most effective, efficient, and appropriate method for investigating this site.

All soil piles will be disposed of offsite in the Fort Wainwright Class I landfill unless they contain constituents that exceed Alaska Department of Environmental Conservation (ADEC) Table B1 or Table B2 soil cleanup levels provided in 18 AAC 75. If stockpile soils exceed these concentrations, they will be disposed of by the Defense Reutilization Management Office (DRMO) Fort Wainwright. If polychlorinated biphenyls (PCBs) are detected in the stockpiles located in the Exclusion Zone above the Fort Wainwright landfill acceptance criterion of 10 mg/kg, they will be disposed of as part of a separate polychlorinated biphenyl (PCB) removal project and will not be part of the work described in this addendum.

The U.S. Army, U.S. Environmental Protection Agency (EPA), and ADEC have agreed to conduct the remedial investigation/feasibility study (RI/FS) for the FCS using the Triad approach. An RI Management Plan addresses this approach and overall site management and includes the Quality Assurance Project Plan (QAPP), and Field Sampling Plan. The RI Management Plan should be used to find additional information on specific RI/FS tasks.

Area of Investigation

There are 47 soil piles at the FCS. The soil piles are generally located around the perimeter of the construction area as depicted in Figure 2-1 (Attachment 1). Table 2-1 (Attachment 1) lists the general location and estimated volume of each soil pile relative to subdivisions of the FCS site. As indicated in Table 2-1, the size of the soil piles range from approximately 10 to several hundred cubic yards. Table 2-1 also summarizes the proposed sampling program of these soil piles using the MI sampling approach.

Background Information

During housing construction activities, high levels of PCBs were encountered in soil in the southwestern corner of the site. Approximately 5 acres of this area were fenced off and designated as the PCB Exclusion Zone. There are 24 soil piles within the PCB exclusion

zone. The remaining 23 soil piles[1] were also generated during housing development from activities such as utility installation and building foundations. During the PSE Phase II Investigation, it was concluded that the stockpiles represented the same material as that found in the test pits excavated to investigate buried debris. The test pits and soil piles were determined to contain soil and debris consisting of scrap metal, concrete, asphalt, wood, and other inert waste materials. Since the final disposition of the soil piles is offsite disposal, they will need to be characterized to meet acceptance requirements.

Available Chemistry Data and Relationship to Soil Pile Characterization

Table 2-2 (Attachment 1) presents analytical results on soil pile sampling that was completed during the Preliminary Source Evaluation (PSE) Phase II Investigation (North Wind, 2007). It identifies any detected chemicals that exceed the Fort Wainwright Class 1 landfill acceptance criteria (i.e., ADEC Table B1 or Table B2 values for soil protective of groundwater, or in the case of PCBs, 10 parts per million [ppm]). Detected sample results that exceed landfill acceptance criteria are indicated in Table 2-2 by the use of bolding and gray shading.

In general, the existing analytical results for the soil samples show no detects or low levels of tested constituents. The data do not show any significant petroleum contamination (including both gasoline-range organic [GRO] and diesel-range organic [DRO] compounds). Similarly, volatile organic compounds (VOCs) and semi-volatile organic compounds (SVOCs) were generally not detected above their respective laboratory reporting level, or if they were detected in the case of SVOCs, the reported concentrations were significantly below the landfill acceptance criteria. DDT and its breakdown products were detected in some samples but all pesticide results, are below the landfill acceptance criteria. Similarly, polycyclic aromatic hydrocarbons (PAHs) were detected at low concentrations below the landfill acceptance criteria.

Pentachlorophenol (PCP) was detected above the landfill acceptance criteria in 4 samples (out of 15). In most cases, the reported concentration is J-qualified, meaning that the concentration is estimated. In all cases, the reported concentration was only slightly above the landfill acceptance criteria (0.010 milligrams per kilogram [mg/kg]). Consequently, soil piles outside the Exclusion Zone will be retested for PCP.

Arsenic was detected above landfill acceptance criteria levels (8 mg/kg) in a number of samples. Arsenic is, however, a naturally occurring metal, and the average background concentration calculated for Fort Wainwright was between 8 and 11 ± 6 mg/kg (USACE, 1994). In most instances, the detected concentration of arsenic was only slightly (2 to 5 mg/kg) above the landfill acceptance criteria and within the reasonable range of background. However, the arsenic concentration in one sample collected from Soil Pile 11 was considerably higher (31 mg/kg) than in other samples. Several other metals (antimony, cadmium, chromium, and zinc) also detected in this sample were above the landfill acceptance criteria. The PSE II Report indicated the presence of crushed drums and other metal debris in Soil Pile 11, which accounts for these results. Because of the size of this soil pile (less than 200 cubic yards), the existing analytical results, and the presence of metal

[1] There is no pile 16 shown in Figure 2-1, this pile was clean fill.

debris, Soil Pile 11 will not be sent to the to the Fort Wainwright landfill, but will be disposed of by the DRMO. [1]

Soil pile samples were also analyzed for chemicals associated with explosives. None were detected in the samples or, if detected, the levels were below the landfill acceptance criteria. However, one sample from Soil Pile 18 had a single J-qualified concentration of 2,6-dinitrotoluene at 0.017 mg/kg, which exceeds the landfill acceptance criteria of 0.0044 mg/kg. Since the existing result was flagged, this soil pile will be retested using Method SW8270 to confirm the presence of this chemical.

Data Quality Objectives

The objective of the work associated with this addendum is characterization of contaminant levels in the soil piles so that appropriate decisions about their disposal can be made. An abbreviated data quality objective (DQO) process was used to establish the type and quality of data needed to make the following decision:

> *Can soil from this soil pile (or group of soil piles) be disposed of in the Fort Wainwright municipal landfill, or does it need to be processed by DRMO for treatment and/or disposal?*

Key inputs to the decision are described in the following subsections.

Target Analytes

The soil samples used to characterize the soil for disposal need to be analyzed for all contaminants that are likely to be present based on what is known about the site. Nine piles have already been tested. The remaining 36 soil piles have not been sampled. With a few exceptions, the previous sample results provide a reasonable understanding of the types of contaminants that are not likely to be present in the soil piles, including VOCs, pesticides, explosives, most SVOCs, and most metals. Based on site history, PCBs may be present in soil piles within the PCB Exclusion Zone, but PCBs are not expected in soil piles outside of it.[2] Although SVOC compounds were not significantly represented in the tested soil piles, SVOC analyses (EPA Method SW8270) is recommended because it covers a wide range of organic compounds and is appropriate for chromatographic confirmation of compounds that may have been identified by another technique. Similarly, DRO and RRO constituents were not encountered in the tested soil piles, but due to the ubiquitous nature of these petroleum contaminants, testing for them is proposed in this investigation. Metals testing, particularly to confirm arsenic concentrations in soil piles, is also recommended. The following general list of target analyte groups has been established for the different soil pile areas:

- 24 soil piles in PCB exclusion zone (Soil piles 17 through 39 and soil piles SPF and SPD) **– PCBs**[3]
- 22 soil piles outside PCB exclusion zone (Soil piles 01 through 07; combined soil piles 08 and 09, 14, 15, combined soil piles 40 and 41, and soil piles SPA, SPG, SPB, SPC) **– DRO, RRO, Metals, and SVOCs**[4]

---

[1] Soil pile 11 and soil pile 12 are indistinguishable, so both piles will be sent to DRMO for offsite disposal.

[2] Based on 2005 PCB surface soil results (*Field Data Report*, Northwind, Inc., February 2006).

[3] Soil pile 18 also will be sampled for SVOC by Method SW8270 to confirm the detection of 2,6-dinitrotoluene.

4 Soil piles 4 though 9 in the northwest corner of the site also will be sampled for VOCs.

- Soil pile SPE will be sampled for PCBs as shown on Table 2-1.
- Soil piles 11 and 12 – No sampling; this combined soil pile will be processed by DRMO.

Detection Limits

The Fort Wainwright Class I landfill is the expected destination for the soil. According to their permit [Solid Waste Disposal Permit 0131-BA003], the landfill will not accept soil that contains hazardous substances in a concentration exceeding an "over 40-inch zone" migration to groundwater level set in 18 AAC 75.341, Table B1 or Table B2; the landfill will also not accept soil that contains PCBs in concentrations greater than 10 ppm.

The landfill acceptance criteria and the previous sampling results are listed in Table 2-2. The analytical methods used to characterize the soil piles for disposal should be capable of determining whether the target analytes are present in the soil at these levels or correspond to the requirements of the respective analytical methodology.

Representativeness

The soil samples submitted for analysis must be representative of the soil that will be disposed of, both in terms of the mean contaminant concentration and potential contaminant type.

Sampling Approach

A multi-increment (MI) sampling approach will be used to characterize the soil for disposal purposes. The MI sampling approach provides for better representation of the mean concentration within a defined decision unit as compared to a typical discrete sampling program. MI sampling is also advantageous because it reduces the number of analyses and costs compared to a typical discrete sampling program.

All MI field and laboratory sampling and quality assurance and quality control (QA/QC) procedures will follow ADEC guidance (*Draft Guidance on Multi-Increment Soil Sampling*, March 2007). The key elements of the soil pile MI sampling program include the following:

- Grouping small soil piles into single MI Decision Units of approximately 100 cubic yards. [1] Figure 2-1 and Table 2-1 depict the layout of the soil piles and summarize their volumes, respectively.
- Dividing large soil piles in multiple MI Decision Units (one Decision Unit per 500 cubic yards).
- The MI sample for each Decision Unit will be made up of approximately 30 randomly collected subsamples. Both surface and subsurface soil will be sampled. One-third of the subsamples will be obtained from the surface (0 to 2 feet); the remaining subsamples will come from random 2-foot-thick subsurface intervals collected from below half-height within the pile(s).[2] In this investigation, subsurface refers to soil below the surface of the soil pile, not soil below ground surface.

1 It was agreed during 8/6/07 conference call (ADEC, USACE, CH2M HILL) that piles within the same general area are similar in nature and therefore soil piles can be combined into the same decision unit.

2 In the absence of specific guidance, the split between surface and subsurface samples is based on professional judgment.

  - For smaller piles combined into one decision unit, the number of incremental samples per pile is based on the ratio of the pile volume to the total volume of the group of piles (Table 2-1). Each pile is divided into the appropriate number of increments and samples are collected from a random quadrant, A, B, C, or D, by rolling dice.
  - Larger piles are divided into multiple decision units. A grid of 30 increments is overlaid on each decision unit. Samples are collected from a random quadrant within each increment by rolling dice.

- For VOC analysis, samples will be field preserved directly in methanol. VOC samples will not be stored.
- For DRO, RRO, and SVOC analysis, 30 to 60 grams of soil will be collected at each subsample location/interval. The soil will be sieved in the field with a 6-mm (0.25-inch) screen to remove large particles, and the soil will be placed in 1 liter jars for transfer to the laboratory. The laboratory will sieve (#10 sieve to 2 mm size), subsample, and distribute through the lab for analysis.
- For metals analysis, unsieved MI samples will be collected and analyzed for TCLP. Unsieved samples will be collected from each of the 30 incremental sample locations. The entire volume (approximately 1 liter) will be homogenized and sent to the laboratory. The laboratory will subsample and obtain the required 100 g for analysis.
- Hand tools (trowels, shovels, and/or hand augers) will be used to collect the surface samples and subsurface samples.
- Triplicate samples will be collected at 10 percent of the Decision Units. Table 2-3 (Attachment 1) shows locations for the triplicate sampling and associated piles applied to each triplicate section. The relative standard deviation (RSD) results for each triplicate will be evaluated to ensure they are within 30 percent. ADEC MI sampling guidance will be followed to calculate the 95 percent upper confidence limit (UCL) for triplicate and regular samples. If the RSD results for a triplicate do not meet the ADEC criterion, the Decision Unit may need to be sampled discretely to determine the source of the variability.

Table 2-1 summarizes the MI sampling program for the soil piles. Additional information about sampling protocols and QA/QC requirements can be found in the FSC *Field Sampling Plan* and QAPP, respectively.

Analytical Methods

Table 2-4 lists the analytical methods to be used for soil pile characterization.

Evaluation of Results

All analytical results will be compared to the landfill criteria shown in Table 2-2, with the exception of the TCLP analysis for metals. TCLP metals results will be compared to the limits in Table 2-5. If any analytical results exceed the landfill criteria or TCLP results, the soil pile will be disposed offsite via DRMO, or in the case of PCBs, disposed as part of the PCB removal action.

References

ADEC. 2007. *Draft Guidance on Multi-Increment Soil Sampling*. Alaska Department of Environmental Conservation. March.

Code of Federal Regulations 261.24.

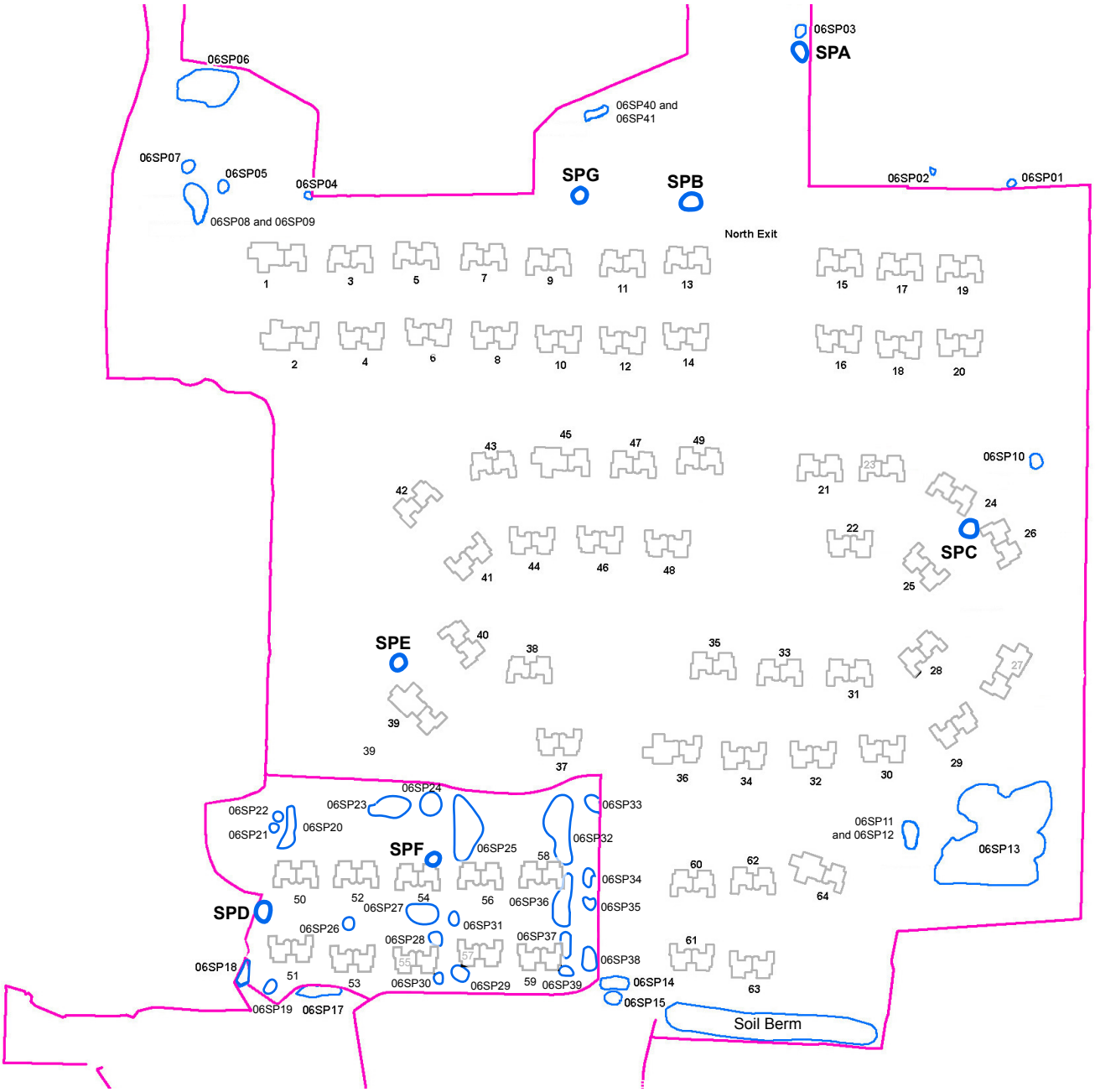
North Wind, Inc. February 2006. *FWA-102 Former Communication Site (Taku Gardens) Field Data Report, Fort Wainwright, Alaska.* Prepared for Department of the Army.

North Wind, Inc. May 2007. *Preliminary Source Evaluation II Report.* Taku Gardens Fort Wainwright, Alaska (Final).

USACE. 1994. *Background Data Analysis for Arsenic, Barium, Cadmium, and Lead on Fort Wainwright, Alaska.* U.S. Army Corps of Engineers, Alaska District. March.

ATTACHMENT 1

Figure and Tables



LEGEND

Buildings

Fence

Soil Piles

Additional Soil Piles SPA – SPG

Adapted from North Wind, Inc., PSEII Report, 2007

North

0 300 600

Approximate scale in feet

FIGURE 2-1
Location of Soil Piles
Remedial Investigation Work Plan, Addendum 2
Former Communications Site, Fort Wainwright, Alaska

TABLE 2-1
Soil Pile Sampling and Analysis Program
Taku Gardens, Fort Wainwright, Alaska

Group	Soil Pile	Volume (cy)	Number of Incremental Samples Per Soil Pile	MI Decision Units	Target Analyte Suites
Group 1 (north/north east corner)	06SP01	7	1	1	DRO, RRO, SVOCs, Metals
	06SP02	3	1		
	06SP03	36	7		
	06SP40[a]	0	0		
	06SP41[a]	28	6		
	SPA	35	7		
	SPB	32	6		
	SPG	8	2		
	Total Volume in Group	**149**			
	Total Number of Incremental Samples		**30**		
Group 2 (north/north west)	06SP04	2	1	1	DRO, RRO, SVOCs, Metals, VOCs
	06SP05	31	10		
	06SP07	58	19		
	Total Volume in Group	**92**			
	Total Number of Incremental Samples		30		
SP06 (northwest corner)	06SP06	1,111	120	4	DRO, RRO, SVOCs, Metals, VOCs
	Total Volume in Group	**1,111**			
	Total Number of Incremental Samples		120		
Group 3 (northwest)	06SP08[a]	296	30	1	DRO, RRO, SVOCs, Metals, VOCs
	06SP09[a]	0			
	Total Volume in Group	**296**			
	Total Number of Incremental Samples		30		
Group 4 (north/north east)	06SP10	78	14	1	DRO, RRO, SVOCs, Metals
	SPC	93	16		
	Total Volume in Group	**171**			
	Total Number of Incremental Samples		30		
Group 5 (southeast corner)	06SP11[a]	0	0	No MI Samples DRMO Disposal	DRO, RRO, SVOCs, Metals
	06SP12[a]	192	0		
	Total Volume in Group	**192**			
	Total Number of Incremental Samples		0		
SP13 (southeast corner)	06SP13 Base	2,111	131	10	DRO, RRO, SVOCs, Metals
	06SP13 Mound 1	510	32		
	06SP13 Mound 2	1,067	66		
	06SP13 Mound 3	1,133	71		
	Total Volume in Group	**4,821**			
	Total Number of Incremental Samples		300		
Group 6 (south)	06SP14	126	25	1	DRO, RRO, SVOCs, Metals
	06SP15	27	5		
	06SP16	0	0		
	Total Volume in Group	**153**			
	Total Number of Incremental Samples		30		
SP17 (southwest corner)	06SP17 Base	25	10	1	DRO, RRO, SVOCs, Metals
	06SP17 Mound	48	20		
	Total Volume in Group	**73**			
	Total Number of Incremental Samples		30		
SP18 (PCB Area)	06SP18	142	30	1	PCBs
	Total Volume in Group	**142**			
	Total Number of Incremental Samples		30		
SP20 (PCB Area)	06SP20	195	30	1	PCBs
	Total Volume in Group	**195**			
	Total Number of Incremental Samples		30		
Group 7 (PCB Area)	06SP19	28	9	1	PCBs
	06SP21	8	2		

TABLE 2-1
Soil Pile Sampling and Analysis Program
Taku Gardens, Fort Wainwright, Alaska

Group	Soil Pile	Volume (cy)	Number of Incremental Samples Per Soil Pile	MI Decision Units	Target Analyte Suites
	06SP22	11	4		
	06SP26	46	15		
	Total Volume in Group	**94**			
	Total Number of Incremental Samples		30		
Group 8 (PCB Area)	06SP23	333	21	2	PCBs
	06SP24	119	9		
	06SP25	600	30		
	Total Volume in Group	**1,052**			
	Total Number of Incremental Samples		60		
SP27 (PCB Area)	06SP27	398	30	1	PCBs
	Total Volume in Group	**398**			
	Total Number of Incremental Samples				
SP29 (PCB Area)	06SP29	107	30	1	PCBs
	Total Volume in Group	**107**			
	Total Number of Incremental Samples		30		
Group 9 (PCB Area)	06SP28	44	16	1	PCBs
	06SP30	17	6		
	06SP31	20	8		
	Total Volume in Group	**82**			
	Total Number of Incremental Samples		30		
Group 10 (PCB Area)	06SP32 Base	275	20	2	PCBs
	06SP32 Mound 1	407	29		
	06SP32 Mound 2	164	11		
	Total Volume in Group	**846**			
	Total Number of Incremental Samples		60		
Group 11 (PCB Area)	06SP33	52	18	1	PCBs
	06SP34	26	9		
	06SP35	9	3		
	Total Volume in Group	**87**			
	Total Number of Incremental Samples				
Group 12 (PCB Area)	06SP36 Mound 1	361	26	1	PCBs
	06SP36 Mound 2	48	4		
	Total Volume in Group	**409**			
	Total Number of Incremental Samples		30		
Group 13 (PCB Area)	06SP37	72	20	1	PCBs
	06SP39	36	10		
	Total Volume in Group	**108**			
	Total Number of Incremental Samples		30		
SP38	06SP38	95	30	1	PCBs
	Total Volume in Group	**95**			
	Total Number of Incremental Samples		30		
Group 14 (PCB Area)	SPD	8	4	1	PCBs
	SPE	19	11		
	SPF	28	15		
	Total Volume in Group	**54**			
	Total Number of Incremental Samples		30		
	Total Estimated Volume to Landfill		**10532**		
	Total Estimate Volume to DRMO		**192**		
			Total MI Samples (Triplicates not listed)	35	

[a]These piles are combined, not separate

TABLE 2-2
Soil Pile Analytical Results Compared to Landfill Criteria
Taku Gardens, Fort Wainwright, Alaska

Sample ID				**06SP01S01**	**06SP03S01**	**06SP03S02**	**06SP10S01**	**06SP11S01**	**06SP11S02**	**06SP11S03**	**06SP11S04**	**06SP14S01**	**06SP15S01**	**06SP16S01**	**06SP16S02**	**06SP16S03**	**06SP17S01**	**06SP17S02**	**06SP18S01**	**06SP18S02**	**06SP18S03**	**06SP40S01**
Location ID				06SP01	06SP03	06SP03	06SP10	06SP11	06SP11	06SP11	06SP11	06SP14	06SP15	06SP16	06SP16	06SP16	06SP17	06SP17	06SP18	06SP18	06SP18	06SP40
Sample Date				6/23/2006	6/27/2006	6/27/2006	6/22/2006	6/19/2006	6/19/2006	6/21/2006	6/21/2006	6/26/2006	6/27/2006	7/25/2006	7/25/2006	7/25/2006	8/19/2006	8/19/2006	8/19/2006	8/19/2006	8/19/2006	6/27/2006
Chemical Group	**Chemical Name**	**Units**	**Landfill Criteria**																			
VOC	1,1,1,2-Tetrachloroethane	mg/kg	--	0.0080 U	0.011 U	0.012 U	0.0096 U	0.0061 U	0.0063 U	--	--	0.0060 U	0.020 U	0.13 U	--	0.067 U	0.092 UJ	0.055 UJ	0.091 UJ	0.063 UJ	--	0.0055 U
VOC	1,1,1-Trichloroethane	mg/kg	1.0	0.0080 U	0.011 U	0.012 U	0.0096 U	0.0061 U	0.0063 U	--	--	0.0060 U	0.020 U	0.13 U	--	0.067 U	0.092 UJ	0.055 UJ	0.091 UJ	0.063 UJ	--	0.0055 U
VOC	1,1,2,2-Tetrachloroethane	mg/kg	0.017	0.0080 U	0.011 U	0.012 U	0.0096 U	0.0061 U	0.0063 U	--	--	0.0060 U	0.020 U	0.13 U	--	0.067 U	0.092 UJ	0.055 UJ	0.091 UJ	0.063 UJ	--	0.0055 U
VOC	1,1,2-Trichloroethane	mg/kg	0.017	0.0080 U	0.011 U	0.012 U	0.0096 U	0.0061 U	0.0063 U	--	--	0.0060 U	0.020 U	0.13 U	--	0.067 U	0.092 UJ	0.055 UJ	0.091 UJ	0.063 UJ	--	0.0055 U
VOC	1,1-Dichloroethane	mg/kg	12	0.0080 U	0.011 U	0.012 U	0.0096 U	0.0061 U	0.0063 U	--	--	0.0060 U	0.020 U	0.13 U	--	0.067 U	0.092 UJ	0.055 UJ	0.091 UJ	0.063 UJ	--	0.0055 U
VOC	1,1-Dichloroethene	mg/kg	0.030	0.0080 U	0.011 U	0.012 U	0.0096 U	0.0061 U	0.0063 U	--	--	0.0060 U	0.020 U	0.13 U	--	0.067 U	0.092 UJ	0.055 UJ	0.091 UJ	0.063 UJ	--	0.0055 U
VOC	1,1-Dichloropropene	mg/kg	--	0.0080 U	0.011 U	0.012 U	0.0096 U	0.0061 U	0.0063 U	--	--	0.0060 U	0.020 U	0.13 U	--	0.067 U	0.092 UJ	0.055 UJ	0.091 UJ	0.063 UJ	--	0.0055 U
VOC	1,2,3-Trichlorobenzene	mg/kg	--	0.0080 U	0.011 U	0.012 U	0.0096 U	0.0061 U	0.0063 U	--	--	0.0060 U	0.020 UJ	0.13 U	--	0.067 U	0.092 UJ	0.055 UJ	0.091 UJ	0.063 UJ	--	0.0055 U
VOC	1,2,3-Trichloropropane	mg/kg	0.002	0.0080 U	0.011 U	0.012 U	0.0096 U	0.0061 U	0.0063 U	--	--	0.0060 U	0.020 U	0.40 U	--	0.20 U	0.28 UJ	0.16 UJ	0.27 UJ	0.19 UJ	--	0.0055 U
VOC	1,2,4-Trichlorobenzene	mg/kg	2.0	0.0080 U	0.011 U	0.012 U	0.0096 U	0.0061 U	0.0063 U	--	--	0.0060 U	--	0.13 U	--	0.067 U	--	--	--	--	--	0.0055 U
VOC	1,2,4-Trimethylbenzene	mg/kg	95.2	0.0080 U	0.011 U	0.012 U	0.0096 U	0.0061 U	0.0063 U	--	--	0.0060 U	0.020 U	0.13 U	--	0.067 U	0.092 UJ	0.055 UJ	0.091 UJ	0.063 UJ	--	0.0055 U
VOC	1,2-Dibromo-3-chloropropane	mg/kg	--	0.016 U	0.021 U	0.023 U	0.019 U	0.012 U	0.013 U	--	--	0.012 U	0.040 U	0.40 U	--	0.20 U	0.28 UJ	0.16 UJ	0.27 UJ	0.19 UJ	--	0.011 U
VOC	1,2-Dibromoethane	mg/kg	3.06E-05	0.016 U	0.021 U	0.023 U	0.019 U	0.012 U	0.013 U	--	--	0.012 U	0.040 U	0.13 U	--	0.067 U	0.092 UJ	0.055 UJ	0.091 UJ	0.063 UJ	--	0.011 U
VOC	1,2-Dichlorobenzene	mg/kg	7.0	0.0080 U	0.011 U	0.012 U	0.0096 U	0.0061 U	0.0063 U	--	--	0.0060 U	--	0.13 U	--	0.067 U	--	--	--	--	--	0.0055 U
VOC	1,2-Dichloroethane	mg/kg	0.015	0.0080 U	0.011 U	0.012 U	0.0096 U	0.0061 U	0.0063 U	--	--	0.0060 U	0.020 U	0.13 U	--	0.067 U	0.092 UJ	0.055 UJ	0.091 UJ	0.063 UJ	--	0.0055 U
VOC	1,2-Dichloropropane	mg/kg	0.017	0.0080 U	0.011 U	0.012 U	0.0096 U	0.0061 U	0.0063 U	--	--	0.0060 U	0.020 U	0.13 U	--	0.067 U	0.092 UJ	0.055 UJ	0.091 UJ	0.063 UJ	--	0.0055 U
VOC	1,3,5-Trimethylbenzene	mg/kg	25	0.0080 U	0.011 U	0.012 U	0.0096 U	0.0061 U	0.0063 U	--	--	0.0060 U	0.020 U	0.13 U	--	0.067 U	0.092 UJ	0.055 UJ	0.091 UJ	0.063 UJ	--	0.0055 U
VOC	1,3-Dichlorobenzene	mg/kg	12	0.0080 U	0.011 U	0.012 U	0.0096 U	0.0061 U	0.0063 U	--	--	0.0060 U	--	0.13 U	--	0.067 U	--	--	--	--	--	0.0055 U
VOC	1,3-Dichloropropane	mg/kg	--	0.0080 U	0.011 U	0.012 U	0.0096 U	0.0061 U	0.0063 U	--	--	0.0060 U	0.020 U	0.13 U	--	0.067 U	0.092 UJ	0.055 UJ	0.091 UJ	0.063 UJ	--	0.0055 U
VOC	1,4-Dichlorobenzene	mg/kg	0.80	0.0080 U	0.011 U	0.012 U	0.0096 U	0.0061 U	0.0063 U	--	--	0.0060 U	--	0.13 U	--	0.067 U	--	--	--	--	--	0.0055 U
VOC	2,2-Dichloropropane	mg/kg	--	0.0080 U	0.011 U	0.012 U	0.0096 U	0.0061 U	0.0063 U	--	--	0.0060 U	0.020 U	0.13 U	--	0.067 U	0.092 UJ	0.055 UJ	0.091 UJ	0.063 UJ	--	0.0055 U
VOC	2-Butanone	mg/kg	60	0.010 J	0.021 U	0.023 U	0.019 U	0.012 U	0.0062 J	--	--	0.012 U	0.029 J	0.26 U	--	0.13 U	0.18 UJ	0.11 UJ	0.18 UJ	0.13 UJ	--	0.011
VOC	2-Chlorotoluene	mg/kg	--	0.0080 U	0.011 U	0.012 U	0.0096 U	0.0061 U	0.0063 U	--	--	0.0060 U	0.020 U	0.13 U	--	0.067 U	0.092 UJ	0.055 UJ	0.091 UJ	0.063 UJ	--	0.0055 U
VOC	2-Hexanone	mg/kg	--	0.016 U	0.021 U	0.023 U	0.019 U	0.012 U	0.013 U	--	--	0.012 U	0.040 U	0.26 U	--	0.13 U	0.18 UJ	0.11 UJ	0.18 UJ	0.13 UJ	--	0.011 U
VOC	4-Chlorotoluene	mg/kg	--	0.0080 U	0.011 U	0.012 U	0.0096 U	0.0061 U	0.0063 U	--	--	0.0060 U	0.020 U	0.13 U	--	0.067 U	0.092 UJ	0.055 UJ	0.091 UJ	0.063 UJ	--	0.0055 U
VOC	4-Isopropyltoluene	mg/kg	--	0.0080 U	0.011 U	0.012 U	0.0096 U	0.0061 U	0.0063 U	--	--	0.0060 U	0.020 U	0.13 U	--	0.067 U	0.092 UJ	0.055 UJ	0.091 UJ	0.063 UJ	--	0.0055 U
VOC	4-Methyl-2-pentanone	mg/kg	--	0.016 U	0.021 U	0.023 U	0.019 U	0.012 U	0.013 U	--	--	0.012 U	0.040 U	0.26 U	--	0.13 U	0.18 UJ	0.11 UJ	0.18 UJ	0.13 UJ	--	0.0063 J
VOC	Acetone	mg/kg	10	0.090	0.070	0.068	0.090	0.080	0.085 J	--	--	0.092	0.41	1.3 U	--	0.67 U	0.53 J	0.30 J	0.91 UJ	0.63 UJ	--	0.12
VOC	Benzene	mg/kg	0.020	0.0080 U	0.011 U	0.012 U	0.0096 U	0.0061 U	0.0063 U	--	--	0.0012 J	0.0033 J	0.13 U	--	0.067 U	0.092 UJ	0.055 UJ	0.091 UJ	0.063 UJ	--	0.0055 U
VOC	Bromobenzene	mg/kg	--	0.0080 U	0.011 U	0.012 U	0.0096 U	0.0061 U	0.0063 U	--	--	0.0060 U	0.020 U	0.13 U	--	0.067 U	0.092 UJ	0.055 UJ	0.091 UJ	0.063 UJ	--	0.0055 U
VOC	Bromochloromethane	mg/kg	--	0.0080 U	0.011 U	0.012 U	0.0096 U	0.0061 U	0.0063 U	--	--	0.0060 U	0.020 U	0.13 U	--	0.067 U	0.092 UJ	0.055 UJ	0.091 UJ	0.063 UJ	--	0.0055 U
VOC	Bromodichloromethane	mg/kg	--	0.0080 U	0.011 U	0.012 U	0.0096 U	0.0061 U	0.0063 U	--	--	0.0060 U	0.020 U	0.13 U	--	0.067 U	0.092 UJ	0.055 UJ	0.091 UJ	0.063 UJ	--	0.0055 U
VOC	Bromoform	mg/kg	0.38	0.0080 U	0.011 U	0.012 U	0.0096 U	0.0061 U	0.0063 U	--	--	0.0060 U	0.020 U	0.13 U	--	0.067 U	0.092 UJ	0.055 UJ	0.091 UJ	0.063 UJ	--	0.0055 U
VOC	Bromomethane	mg/kg	--	0.0080 U	0.011 U	0.012 U	0.0096 U	0.0061 U	0.0063 U	--	--	0.0060 U	0.020 U	0.26 U	--	0.13 U	0.18 UJ	0.11 UJ	0.18 UJ	0.13 UJ	--	0.0055 U
VOC	Carbon disulfide	mg/kg	17	0.016 U	0.021 U	0.023 U	0.019 U	0.012 U	0.013 U	--	--	0.012 U	0.040 U	0.26 U	--	0.13 U	0.18 UJ	0.11 UJ	0.18 UJ	0.13 UJ	--	0.011 U
VOC	Carbon tetrachloride	mg/kg	0.030	0.0080 U	0.011 U	0.012 U	0.0096 U	0.0061 U	0.0063 U	--	--	0.0060 U	0.020 U	0.13 U	--	0.067 U	0.092 UJ	0.055 UJ	0.091 UJ	0.063 UJ	--	0.0055 U
VOC	Chlorobenzene	mg/kg	0.60	0.0080 U	0.011 U	0.012 U	0.0096 U	0.0061 U	0.0063 U	--	--	0.0060 U	0.020 U	0.13 U	--	0.067 U	0.092 UJ	0.055 UJ	0.091 UJ	0.063 UJ	--	0.0055 U
VOC	Chloroethane	mg/kg	--	0.0080 U	0.011 U	0.012 U	0.0096 U	0.0061 U	0.0063 U	--	--	0.0060 U	0.020 U	0.13 U	--	0.067 U	0.092 UJ	0.055 UJ	0.091 UJ	0.063 UJ	--	0.0055 U
VOC	Chloroform	mg/kg	0.34	0.0080 U	0.011 U	0.012 U	0.0096 U	0.0061 U	0.0063 U	--	--	0.0060 U	0.020 U	0.13 U	--	0.067 U	0.092 UJ	0.055 UJ	0.091 UJ	0.063 UJ	--	0.0055 U
VOC	Chloromethane	mg/kg	--	0.0080 U	0.011 U	0.012 U	0.0096 U	0.0061 U	0.0063 U	--	--	0.0060 U	0.020 U	0.13 U	--	0.067 U	0.092 UJ	0.055 UJ	0.091 UJ	0.063 UJ	--	0.0055 U
VOC	cis-1,2-Dichloroethene	mg/kg	0.20	0.0080 U	0.011 U	0.012 U	0.0096 U	0.0061 U	0.0063 U	--	--	0.0060 U	0.020 U	0.13 U	--	0.067 U	0.092 UJ	0.055 UJ	0.091 UJ	0.063 UJ	--	0.0055 U
VOC	cis-1,3-Dichloropropene	mg/kg	0.020	0.0080 U	0.011 U	0.012 U	0.0096 U	0.0061 U	0.0063 U	--	--	0.0060 U	0.020 U	0.13 U	--	0.067 U	0.092 UJ	0.055 UJ	0.091 UJ	0.063 UJ	--	0.0055 U
VOC	Dibromochloromethane	mg/kg	--	0.0080 U	0.011 U	0.012 U	0.0096 U	0.0061 U	0.0063 U	--	--	0.0060 U	0.020 U	0.13 U	--	0.067 U	0.092 UJ	0.055 UJ	0.091 UJ	0.063 UJ	--	0.0055 U
VOC	Dibromomethane	mg/kg	--	0.0080 U	0.011 U	0.012 U	0.0096 U	0.0061 U	0.0063 U	--	--	0.0060 U	0.020 U	0.13 U	--	0.067 U	0.092 UJ	0.055 UJ	0.091 UJ	0.063 UJ	--	0.0055 U
VOC	Dichlorodifluoromethane	mg/kg	60	0.0080 U	0.011 U	0.012 U	0.0096 U	0.0061 U	0.0063 U	--	--	0.0060 U	0.020 U	0.13 U	--	0.067 U	0.092 UJ	0.055 UJ	0.091 UJ	0.063 UJ	--	0.0055 U
VOC	Ethylbenzene	mg/kg	5.5	0.0080 U	0.011 U	0.012 U	0.0096 U	0.0061 U	0.0063 U	--	--	0.0060 U	0.020 U	0.13 U	--	0.067 U	0.092 UJ	0.055 UJ	0.091 UJ	0.063 UJ	--	0.0055 U
VOC	Hexachlorobutadiene	mg/kg	8.0	0.0080 U	0.011 U	0.012 U	0.0096 U	0.0061 U	0.0063 U	--	--	0.0060 U	--	0.13 U	--	0.067 U	--	--	--	--	--	0.0055 U
VOC	Isopropylbenzene	mg/kg	227	0.0080 U	0.011 U	0.012 U	0.0096 U	0.0061 U	0.0063 U	--	--	0.0060 U	0.020 U	0.13 U	--	0.067 U	0.092 UJ	0.055 UJ	0.091 UJ	0.063 UJ	--	0.0055 U
VOC	Methylene chloride	mg/kg	0.015	0.016 U	0.021 U	0.023 U	0.019 U	0.012 U	0.013 U	--	--	0.012 U	0.040 U	0.13 U	--	0.067 U	0.092 UJ	0.055 UJ	0.091 UJ	0.063 UJ	--	0.011 U
VOC	Methyl-tert-butyl ether (MTBE)	mg/kg	--	0.016 U	0.021 U	0.023 U	0.019 U	0.012 U	0.013 U	--	--	0.012 U	0.040 U	0.26 U	--	0.13 U	0.18 UJ	0.11 UJ	0.18 UJ	0.13 UJ	--	0.011 U
VOC	Naphthalene	mg/kg	21	0.0080 U	0.011 U	0.012 U	0.0096 U	0.0061 U	0.0063 U	--	--	0.0060 U	--	0.13 U	--	0.067 U	--	--	--	--	--	0.0055 U
VOC	n-Butylbenzene	mg/kg	--	0.0080 U	0.011 U	0.012 U	0.0096 U	0.0061 U	0.0063 U	--	--	0.0060 U	0.020 U	0.13 U	--	0.067 U	0.092 UJ	0.055 UJ	0.091 UJ	0.063 UJ	--	0.0055 U
VOC	n-Propylbenzene	mg/kg	--	0.0080 U	0.011 U	0.012 U	0.0096 U	0.0061 U	0.0063 U	--	--	0.0060 U	0.020 U	0.13 U	--	0.067 U	0.092 UJ	0.055 UJ	0.091 UJ	0.063 UJ	--	0.0055 U
VOC	o-Xylene	mg/kg	78	0.0080 U	0.011 U	0.012 U	0.0096 U	0.0061 U	0.0063 U	--	--	0.0060 U	0.020 U	0.13 U	--	0.067 U	0.092 UJ	0.055 UJ	0.091 UJ	0.063 UJ	--	0.0055 U
VOC	sec-Butylbenzene	mg/kg	--	0.0080 U	0.011 U	0.012 U	0.0096 U	0.0061 U	0.0063 U	--	--	0.0060 U	0.020 U	0.13 U	--	0.067 U	0.092 UJ	0.055 UJ	0.091 UJ	0.063 UJ	--	0.0055 U
VOC	Styrene	mg/kg	1.3	0.0080 U	0.011 U	0.012 U	0.0096 U	0.0061 U	0.0063 U	--	--	0.0060 U	0.020 UJ	0.13 U	--	0.067 U	0.092 UJ	0.055 UJ	0.091 UJ	0.063 UJ	--	0.0055 U
VOC	tert-Butylbenzene	mg/kg	--	0.0080 U	0.011 U	0.012 U	0.0096 U	0.0061 U	0.0063 U	--	--	0.0060 U	0.020 U	0.13 U	--	0.067 U	0.092 UJ	0.055 UJ	0.091 UJ	0.063 UJ	--	0.0055 U
VOC	Tetrachloroethene (PCE)	mg/kg	0.030	0.0080 U	0.011 U	0.012 U	0.0096 U	0.0061 U	0.0063 U	--	--	0.0060 U	0.020 U	0.13 U	--	0.067 U	0.092 UJ	0.055 UJ	0.091 UJ	0.063 UJ	--	0.0055 U
VOC	Toluene	mg/kg	5.4	0.0080 U	0.011 U	0.012 U	0.0096 U	0.0061 U	0.0063 U	--	--	0.0060 U	0.0031 J	0.13 U	--	0.067 U	0.092 UJ	0.055 UJ	0.091 UJ	0.063 UJ	--	0.0055 U
VOC	trans-1,2-Dichloroethene	mg/kg	0.40	0.0080 U	0.011 U	0.012 U	0.0096 U	0.0061 U	0.0063 U	--	--	0.0060 U	0.020 U	0.13 U	--	0.067 U	0.092 UJ	0.055 UJ	0.091 UJ	0.063 UJ	--	0.0055 U
VOC	trans-1,3-Dichloropropene	mg/kg	0.020	0.0080 U	0.011 U	0.012 U	0.0096 U	0.0061 U	0.0063 U	--	--	0.0060 U	0.020 U	0.13 U	--	0.067 U	0.092 UJ	0.055 UJ	0.091 UJ	0.063 UJ	--	0.0055 U
VOC	Trichloroethene (TCE)	mg/kg	0.020	0.0080 U	0.011 U	0.012 U	0.0096 U	0.0061 U	0.0063 U	--	--	0.0060 U	0.020 U	0.13 U	--	0.067 U	0.092 UJ	0.055 UJ	0.091 UJ	0.063 UJ	--	0.0055 U
VOC	Trichlorofluoromethane	mg/kg	--	0.0080 U	0.011 U	0.012 U	0.0096 U	0.0061 U	0.0063 U	--	--	0.0060 U	0.020 U	0.13 U	--	0.067 U	0.092 UJ	0.055 UJ	0.091 UJ	0.063 UJ	--	0.0055 U
VOC	Vinyl chloride	mg/kg	0.0090	0.0080 U	0.011 U	0.012 U	0.0096 U	0.0061 U	0.0063 U	--	--	0.0060 U	0.020 U	0.13 U	--	0.067 U	0.092 UJ	0.055 UJ	0.091 UJ	0.063 UJ	--	0.0055 U
VOC	Xylene, Isomers m & p	mg/kg	78	0.0080 U	0.011 U	0.012 U	0.0096 U	0.0061 U	0.0063 U	--	--	0.0060 U	0.020 U	0.26 U	--	0.13 U	0.18 UJ	0.11 UJ	0.18 UJ	0.13 UJ	--	0.0055 U
TPH	Diesel Range Organics	mg/kg	250	13	--	--	3.5	6.6	9.3	--	--	0.90 J	7.5 J	1.8	3.1 J	--	6.2 J	5.0	2.3	3.1	--	--
TPH	Gasoline Range Organics (C6-C10)	mg/kg	300	0.80 J	--	--	0.45 J	0.58 U	0.62 U	--	--	2.5 U	0.89 U	1.1 U	--	0.68 U	4.8 U	4.2 U	4.6 U	4.1 U	--	--
TPH	Residual Range Organics	mg/kg	11,000	50	--	--	15	32 J	30	--	--	6.7 J	79 J	9.6 J	18 J	--	33 J	23 J	8.0 J	16 J	--	--
SVOC	1,2,4-Trichlorobenzene	mg/kg	2.0	--	--	--	--	--	--	--	--	--	0.36 U	--	--	--	0.029 U	0.030 U	0.027 U	--	0.029 U	--

TABLE 2-2
Soil Pile Analytical Results Compared to Landfill Criteria
Taku Gardens, Fort Wainwright, Alaska

Sample ID				**06SP01S01**	**06SP03S01**	**06SP03S02**	**06SP10S01**	**06SP11S01**	**06SP11S02**	**06SP11S03**	**06SP11S04**	**06SP14S01**	**06SP15S01**	**06SP16S01**	**06SP16S02**	**06SP16S03**	**06SP17S01**	**06SP17S02**	**06SP18S01**	**06SP18S02**	**06SP18S03**	**06SP40S01**
Location ID				06SP01	06SP03	06SP03	06SP10	06SP11	06SP11	06SP11	06SP11	06SP14	06SP15	06SP16	06SP16	06SP16	06SP17	06SP17	06SP18	06SP18	06SP18	06SP40
Sample Date				6/23/2006	6/27/2006	6/27/2006	6/22/2006	6/19/2006	6/19/2006	6/21/2006	6/21/2006	6/26/2006	6/27/2006	7/25/2006	7/25/2006	7/25/2006	8/19/2006	8/19/2006	8/19/2006	8/19/2006	8/19/2006	6/27/2006
Chemical Group	**Chemical Name**	**Units**	**Landfill Criteria**																			
SVOC	1,2-Dichlorobenzene	mg/kg	7.0	--	--	--	--	--	--	--	--	--	0.36 U	--	--	--	0.029 U	0.030 U	0.027 U	--	0.029 U	--
SVOC	1,3-Dichlorobenzene	mg/kg	12	--	--	--	--	--	--	--	--	--	0.36 U	--	--	--	0.029 U	0.030 U	0.027 U	--	0.029 U	--
SVOC	1,4-Dichlorobenzene	mg/kg	0.80	--	--	--	--	--	--	--	--	--	0.36 U	--	--	--	0.029 U	0.030 U	0.027 U	--	0.029 U	--
SVOC	2,4,5-Trichlorophenol	mg/kg	90	0.36 U	17 U	0.35 U	0.35 U	0.37 U	0.38 U	--	--	0.36 U	0.36 U	0.41 U	0.37 U	--	0.029 U	0.030 U	0.027 U	--	0.029 U	18 U
SVOC	2,4,6-Trichlorophenol	mg/kg	0.60	0.36 U	17 U	0.35 U	0.35 U	0.37 U	0.38 U	--	--	0.36 U	0.36 U	0.41 U	0.37 U	--	0.029 U	0.030 U	0.027 U	--	0.029 U	18 U
SVOC	2,4-Dichlorophenol	mg/kg	0.45	0.36 U	17 U	0.35 U	0.35 U	0.37 U	0.38 U	--	--	0.36 U	0.36 U	0.41 U	0.37 U	--	0.029 U	0.030 U	0.027 U	--	0.029 U	18 U
SVOC	2,4-Dimethylphenol	mg/kg	4.0	0.55 U	26 U	0.52 U	0.53 U	0.57 U	0.57 U	--	--	0.55 U	0.55 U	0.63 U	0.56 U	--	0.012 U	0.012 U	0.011 U	--	0.011 U	28 U
SVOC	2,4-Dinitrophenol	mg/kg	0.20	2.2 U	100 U	2.1 U	2.1 U	2.3 U	2.3 U	--	--	2.2 U	2.2 U	2.5 U	--	2.2 U	0.29 U	0.30 U	0.27 U	--	0.29 U	110 U
SVOC	2,4-Dinitrotoluene	mg/kg	0.0050	--	17 U	0.35 U	--	--	--	--	--	--	--	--	--	--	0.058 U	0.060 U	0.053 U	--	0.057 U	18 U
SVOC	2,6-Dinitrotoluene	mg/kg	0.0044	--	17 U	0.35 U	--	--	--	--	--	--	--	--	--	--	0.058 U	0.060 U	**0.017 J**	--	0.057 U	18 U
SVOC	2-Chloronaphthalene	mg/kg	70	0.36 U	17 U	0.35 U	0.35 U	0.37 U	0.38 U	--	--	0.36 U	0.36 U	0.41 U	0.37 U	--	0.012 U	0.012 U	0.011 U	--	0.011 U	18 U
SVOC	2-Chlorophenol	mg/kg	1.4	0.36 U	17 U	0.35 U	0.35 U	0.37 U	0.38 U	--	--	0.36 U	0.36 U	0.41 U	0.37 U	--	0.029 U	0.030 U	0.027 U	--	0.029 U	18 U
SVOC	2-Methyl-4,6-dinitrophenol	mg/kg	--	2.2 U	100 U	2.1 U	2.1 U	2.3 U	2.3 U	--	--	2.2 U	2.2 U	2.5 U	--	2.2 U	0.29 U	0.30 U	0.27 U	--	0.29 U	110 U
SVOC	2-Methylnaphthalene	mg/kg	61	0.36 U	17 U	0.35 U	0.35 U	0.37 U	0.38 U	--	--	0.36 U	0.36 U	0.41 U	0.37 U	--	0.012 U	0.012 U	0.011 U	--	0.011 U	18 U
SVOC	2-Methylphenol (o-Cresol)	mg/kg	7.0	0.36 U	17 U	0.35 U	0.35 U	0.37 U	0.38 U	--	--	0.36 U	0.36 U	0.41 U	0.37 U	--	0.029 U	0.030 U	0.027 U	--	0.029 U	18 U
SVOC	2-Nitroaniline	mg/kg	--	1.8 U	84 U	1.7 U	1.7 U	1.8 U	1.8 U	--	--	1.8 U	1.8 U	2.0 U	1.8 U	--	0.029 U	0.030 U	0.027 U	--	0.029 U	88 U
SVOC	2-Nitrophenol	mg/kg	--	0.36 U	17 U	0.35 U	0.35 U	0.37 U	0.38 U	--	--	0.36 U	0.36 U	0.41 U	0.37 U	--	0.029 U	0.030 U	0.027 U	--	0.029 U	18 U
SVOC	3,3'-Dichlorobenzidine	mg/kg	0.020	1.8 U	84 U	1.7 U	1.7 U	1.8 U	1.8 U	--	--	1.8 U	1.8 U	2.0 U	1.8 U	--	0.12 U	0.12 U	0.11 U	--	0.11 U	88 U
SVOC	3-Nitroaniline	mg/kg	--	1.8 U	84 U	1.7 U	1.7 U	1.8 U	1.8 U	--	--	1.8 U	1.8 U	2.0 U	1.8 U	--	0.058 U	0.060 U	0.053 U	--	0.057 U	88 U
SVOC	4-Bromophenyl phenyl ether	mg/kg	--	0.36 U	17 U	0.35 U	0.35 U	0.37 U	0.38 U	--	--	0.36 U	0.36 U	0.41 U	0.37 U	--	0.058 U	0.060 U	0.053 U	--	0.057 U	18 U
SVOC	4-Chloro-3-methylphenol	mg/kg	--	0.36 U	17 U	0.35 U	0.35 U	0.37 U	0.38 U	--	--	0.36 U	0.36 U	0.41 U	0.37 U	--	0.029 U	0.030 U	0.027 U	--	0.029 U	18 U
SVOC	4-Chloroaniline	mg/kg	0.50	0.36 U	17 U	0.35 U	0.35 U	0.37 U	0.38 U	--	--	0.36 U	0.36 U	0.41 U	0.37 U	--	0.058 U	0.060 U	0.053 U	--	0.057 U	18 U
SVOC	4-Chlorophenyl phenyl ether	mg/kg	--	0.36 U	17 U	0.35 U	0.35 U	0.37 U	0.38 U	--	--	0.36 U	0.36 U	0.41 U	0.37 U	--	0.058 U	0.060 U	0.053 U	--	0.057 U	18 U
SVOC	4-Nitroaniline	mg/kg	--	1.8 U	84 U	1.7 U	1.7 U	1.8 U	1.8 U	--	--	1.8 U	1.8 U	2.0 U	1.8 U	--	0.058 U	0.060 U	0.053 U	--	0.057 U	88 U
SVOC	4-Nitrophenol	mg/kg	--	--	100 U	2.1 U	2.1 U	--	--	--	--	--	--	2.5 U	--	2.2 U	0.29 U	0.30 U	0.27 U	--	0.29 U	110 U
SVOC	Acenaphthene	mg/kg	210	0.36 U	17 U	0.35 U	0.35 U	0.37 U	0.38 U	--	--	0.36 U	0.36 U	0.41 U	--	0.022 J	0.012 U	0.012 U	0.011 U	--	0.011 U	18 U
SVOC	Acenaphthylene	mg/kg	210	0.36 U	17 U	0.35 U	0.35 U	0.37 U	0.38 U	--	--	0.36 U	0.36 U	0.41 U	0.37 U	--	0.012 U	0.012 U	0.011 U	--	0.011 U	18 U
SVOC	Anthracene	mg/kg	4,300	0.36 U	17 U	0.35 U	0.35 U	0.37 U	0.38 U	--	--	0.36 U	0.36 U	0.41 U	--	0.047 J	0.012 U	0.012 U	0.011 U	--	0.011 U	18 U
SVOC	Azobenzene	mg/kg	--	0.36 U	17 U	0.35 U	0.35 U	0.37 U	0.38 U	--	--	0.36 U	0.36 U	0.41 U	0.37 U	--	0.058 U	0.060 U	0.053 U	--	0.057 U	18 U
SVOC	Benzo(a)anthracene	mg/kg	6.0	0.36 U	17 U	0.35 U	0.057 J	0.37 U	0.38 U	--	--	0.36 U	0.36 U	0.41 U	0.073 J	--	0.012 U	0.012 U	0.011 U	--	0.011 U	18 U
SVOC	Benzo(a)pyrene	mg/kg	3.0	0.36 U	17 U	0.35 U	0.065 U	0.37 U	0.38 U	--	--	0.36 U	0.36 U	0.41 U	0.070 J	--	0.012 U	0.012 U	0.011 U	--	0.011 U	18 U
SVOC	Benzo(b)fluoranthene	mg/kg	20	0.36 U	17 U	0.027 J	0.11 UJ	0.37 U	0.38 U	--	--	0.36 U	0.36 U	0.41 U	0.37 U	--	0.012 U	0.012 U	0.011 U	--	0.011 U	18 U
SVOC	Benzo(g,h,i)perylene	mg/kg	1,500	0.12 J	3.9 J	0.079 J	0.095 U	0.37 U	0.38 U	--	--	0.36 U	0.36 U	0.41 U	0.37 U	--	0.012 U	0.012 U	0.011 U	--	0.011 U	18 U
SVOC	Benzo(k)fluoranthene	mg/kg	200	0.36 U	17 U	0.35 U	0.053 U	0.37 U	0.38 U	--	--	0.36 U	0.36 U	0.41 U	0.066 J	--	0.012 U	0.012 U	0.011 U	--	0.011 U	18 U
SVOC	Benzoic acid	mg/kg	390	1.8 U	84 U	1.7 U	1.7 U	1.8 U	1.8 U	--	--	1.8 U	1.8 U	2.0 U	1.8 U	--	0.33 J	0.32 J	0.28 J	0.31 J	--	88 U
SVOC	Benzyl alcohol	mg/kg	--	0.56 U	27 U	0.53 U	0.54 U	0.58 U	0.58 U	--	--	0.56 U	0.56 U	0.64 U	0.57 U	--	0.029 U	0.030 U	0.027 U	--	0.029 U	28 U
SVOC	Benzyl butyl phthalate	mg/kg	--	0.36 U	17 U	0.35 U	0.35 U	0.37 U	0.38 U	--	--	0.36 U	0.36 U	0.41 U	0.37 U	--	0.12 U	0.013 J	0.012 J	--	0.020 J	18 U
SVOC	bis-(2-Chloroethoxy)methane	mg/kg	--	0.36 U	17 U	0.35 U	0.35 U	0.37 U	0.38 U	--	--	0.36 U	0.36 U	0.41 U	0.37 U	--	0.058 U	0.060 U	0.053 U	--	0.057 U	18 U
SVOC	bis-(2-Chloroethyl)ether	mg/kg	0.0020	0.36 U	17 U	0.35 U	0.35 U	0.37 U	0.38 U	--	--	0.36 U	0.36 U	0.41 U	0.37 U	--	0.058 U	0.060 U	0.053 U	--	0.057 U	18 U
SVOC	bis(2-Chloroisopropyl)ether	mg/kg	--	0.36 U	17 U	0.35 U	0.35 U	0.37 U	0.38 U	--	--	0.36 U	0.36 U	0.41 U	0.37 U	--	0.14 U	0.15 U	0.13 U	--	0.14 U	18 U
SVOC	bis-(2-Ethylhexyl)phthalate	mg/kg	1,200	0.36 U	17 U	0.025 J	0.034 J	0.37 U	0.38 U	--	--	0.36 U	0.36 U	0.41 U	0.37 U	--	0.084 UJ	0.23 U	0.041 U	0.036 U	--	18 U
SVOC	Carbazole	mg/kg	2.0	0.36 U	17 U	0.35 U	0.35 U	0.37 U	0.38 U	--	--	0.36 U	0.36 U	0.41 U	0.37 U	--	0.058 U	0.060 U	0.053 U	--	0.057 U	18 U
SVOC	Chrysene	mg/kg	620	0.36 U	17 U	0.35 U	0.35 U	0.37 U	0.38 U	--	--	0.36 U	0.36 U	0.41 U	0.37 U	--	0.012 U	0.012 U	0.011 U	--	0.011 U	18 U
SVOC	Dibenzo(a,h)anthracene	mg/kg	6.0	0.36 U	3.5 J	0.061 J	0.069 U	0.37 U	0.38 U	--	--	0.36 U	0.36 U	0.41 U	0.37 U	--	0.012 U	0.012 U	0.011 U	--	0.011 U	18 U
SVOC	Dibenzofuran	mg/kg	7.8	0.36 U	17 U	0.35 U	0.35 U	0.37 U	0.38 U	--	--	0.36 U	0.36 U	0.41 U	0.37 U	--	0.029 U	0.030 U	0.027 U	--	0.029 U	18 U
SVOC	Diethyl phthalate	mg/kg	190	0.36 U	17 U	0.35 U	0.35 U	0.37 U	0.38 U	--	--	0.36 U	0.36 U	0.41 U	0.37 U	--	0.12 U	0.12 U	0.11 U	--	0.11 U	18 U
SVOC	Dimethyl phthalate	mg/kg	1,400	0.36 U	17 U	0.35 U	0.35 U	0.37 U	0.38 U	--	--	0.36 U	0.36 U	0.41 U	0.37 U	--	0.058 U	0.060 U	0.053 U	--	0.057 U	18 U
SVOC	Di-n-butyl phthalate	mg/kg	1,700	0.36 U	17 U	0.35 U	0.35 U	0.37 U	0.38 U	--	--	0.36 U	0.36 U	0.41 U	0.37 U	--	0.046 U	0.045 U	0.039 U	0.039 U	--	18 U
SVOC	Di-n-octyl phthalate	mg/kg	810,000	0.36 U	17 U	0.35 U	0.35 U	0.37 U	0.38 U	--	--	0.36 U	0.36 U	0.41 U	0.37 U	--	0.12 U	0.12 U	0.11 U	--	0.11 U	18 U
SVOC	Fluoranthene	mg/kg	2,100	0.36 U	17 U	0.35 U	0.095 J	0.37 U	0.38 U	--	--	0.36 U	0.36 U	0.41 U	0.15 J	--	0.012 U	0.012 U	0.011 U	--	0.011 U	18 U
SVOC	Fluorene	mg/kg	270	0.36 U	17 U	0.35 U	0.35 U	0.37 U	0.38 U	--	--	0.36 U	0.36 U	0.41 U	0.37 U	--	0.012 U	0.012 U	0.011 U	--	0.011 U	18 U
SVOC	Hexachlorobenzene	mg/kg	0.73	0.36 U	17 U	0.35 U	0.35 U	0.37 U	0.38 U	--	--	0.36 U	0.36 U	0.41 U	0.37 U	--	0.012 U	0.012 U	0.011 U	--	0.011 U	18 U
SVOC	Hexachlorobutadiene	mg/kg	8.0	--	--	--	--	--	--	--	--	--	0.36 U	--	--	--	0.029 U	0.030 U	0.027 U	--	0.029 U	--
SVOC	Hexachloroethane	mg/kg	1.6	0.36 U	17 U	0.35 U	0.35 U	0.37 U	0.38 U	--	--	0.36 U	0.36 U	0.41 U	0.37 U	--	0.029 U	0.030 U	0.027 U	--	0.029 U	18 U
SVOC	Indeno(1,2,3-cd)pyrene	mg/kg	54	0.11 J	2.9 J	0.063 J	0.14 J	0.37 U	0.38 U	--	--	0.36 U	0.36 U	0.41 U	0.37 U	--	0.012 U	0.012 U	0.011 U	--	0.011 U	1.3 J
SVOC	Isophorone	mg/kg	3.0	0.36 U	17 U	0.35 U	0.35 U	0.37 U	0.38 U	--	--	0.36 U	0.36 U	0.41 U	0.37 U	--	0.029 U	0.030 U	0.027 U	--	0.029 U	18 U
SVOC	m,p-Cresol	mg/kg	--	1.1 U	100 U	2.1 U	1.1 U	1.1 U	1.1 U	--	--	1.1 U	2.2 U	1.3 U	1.1 U	--	0.029 U	0.030 U	0.027 U	--	0.029 U	110 U
SVOC	Naphthalene	mg/kg	21	--	--	--	--	--	--	--	--	--	0.36 U	--	--	--	0.012 U	0.012 U	0.011 U	--	0.011 U	--
SVOC	Nitrobenzene	mg/kg	0.060	--	17 U	0.35 U	--	--	--	--	--	--	--	--	--	--	0.058 U	0.060 U	0.053 U	--	0.057 U	18 U
SVOC	n-Nitrosodimethylamine	mg/kg	3.4	0.36 U	17 U	0.35 U	0.35 U	0.37 U	0.38 U	--	--	0.36 U	0.36 U	0.41 U	0.37 U	--	0.29 U	0.30 U	0.27 U	--	0.29 U	18 U
SVOC	n-Nitrosodi-n-propylamine	mg/kg	3.60E-04	0.36 U	17 U	0.35 U	0.35 U	0.37 U	0.38 U	--	--	0.36 U	0.39 U	0.41 U	0.37 U	--	0.029 U	0.030 U	0.027 U	--	0.029 U	18 U
SVOC	n-Nitrosodiphenylamine	mg/kg	3.4	0.36 U	17 U	0.35 U	0.35 U	0.37 U	0.38 U	--	--	0.36 U	0.36 U	0.41 U	0.37 U	--	0.029 U	0.030 U	0.027 U	--	0.029 U	18 U
SVOC	Pentachlorophenol	mg/kg	0.010	--	100 U	2.1 U	2.1 U	--	--	--	--	--	--	2.5 U	--	2.2 U	0.12 U	**0.038 J**	0.11 U	**0.034 J**	--	110 U
SVOC	Phenanthrene	mg/kg	4,300	0.36 U	17 U	0.024 J	0.018 J	0.37 U	0.38 U	--	--	0.36 U	0.36 U	0.41 U	--	0.13 J	0.0014 J	0.012 U	0.011 U	--	0.0017 J	18 U
SVOC	Phenol	mg/kg	67	0.36 U	17 U	0.35 U	0.35 U	0.37 U	0.38 U	--	--	0.36 U	0.36 U	0.41 U	0.37 U	--	0.029 U	0.030 U	0.027 U	--	0.029 U	18 U
SVOC	Pyrene	mg/kg	1,500	0.36 U	17 U	0.025 J	0.079 J	0.37 U	0.38 U	--	--	0.36 U	0.36 U	0.41 U	--	0.13 J	0.012 U	0.012 U	0.011 U	--	0.011 U	18 U
PEST	4,4'-DDD	mg/kg	47	0.043	--	--	--	0.011 J	0.014 J	--	--	5.00E-04 J	0.011 J	4.20E-04 J	0.0025 J	--	0.10 J	0.014 J	0.013 J	0.071 J	--	--
PEST	4,4'-DDE	mg/kg	150	0.022 J	--	--	--	0.073	0.061	--	--	0.0028 J	0.23	3.60E-04 J	--	0.0065	0.0032 J	2.90E-04 J	8.10E-04 J	0.0024 J	--	--
PEST	4,4'-DDT	mg/kg	88	0.40	--	--	--	0.33	0.34	--	--	0.010	0.98	0.0013 J	--	0.023 J	0.19	0.021 J	0.022 J	0.13	--	--

TABLE 2-2
Soil Pile Analytical Results Compared to Landfill Criteria
Taku Gardens, Fort Wainwright, Alaska

Sample ID				**06SP01S01**	**06SP03S01**	**06SP03S02**	**06SP10S01**	**06SP11S01**	**06SP11S02**	**06SP11S03**	**06SP11S04**	**06SP14S01**	**06SP15S01**	**06SP16S01**	**06SP16S02**	**06SP16S03**	**06SP17S01**	**06SP17S02**	**06SP18S01**	**06SP18S02**	**06SP18S03**	**06SP40S01**
Location ID				06SP01	06SP03	06SP03	06SP10	06SP11	06SP11	06SP11	06SP11	06SP14	06SP15	06SP16	06SP16	06SP16	06SP17	06SP17	06SP18	06SP18	06SP18	06SP40
Sample Date				6/23/2006	6/27/2006	6/27/2006	6/22/2006	6/19/2006	6/19/2006	6/21/2006	6/21/2006	6/26/2006	6/27/2006	7/25/2006	7/25/2006	7/25/2006	8/19/2006	8/19/2006	8/19/2006	8/19/2006	8/19/2006	6/27/2006
Chemical Group	**Chemical Name**	**Units**	**Landfill Criteria**																			
PEST	Aldrin	mg/kg	1.6	0.019 U	--	--	--	0.0096 U	0.0097 U	--	--	0.0019 U	0.0094 U	0.0021 U	0.0019 U	--	6.00E-04 UJ	5.90E-04 UJ	2.70E-04 J	5.80E-04 U	--	--
PEST	alpha-BHC	mg/kg	0.0026	0.019 U	--	--	--	0.0096 U	0.0097 U	--	--	0.0019 U	0.0094 U	0.0021 U	0.0019 U	--	6.00E-04 UJ	5.90E-04 UJ	5.30E-04 UJ	5.80E-04 U	--	--
PEST	alpha-Chlordane	mg/kg	--	0.019 U	--	--	--	0.0096 U	0.0097 U	--	--	0.0028	0.0094 U	0.0021 U	0.0019 U	--	6.00E-04 UJ	5.90E-04 UJ	5.30E-04 UJ	5.80E-04 U	--	--
PEST	beta-BHC	mg/kg	0.0090	0.019 U	--	--	--	0.0096 U	0.0097 U	--	--	0.0019 U	0.0094 U	0.0021 U	0.0019 U	--	6.00E-04 UJ	5.90E-04 UJ	4.40E-04 J	5.80E-04 U	--	--
PEST	delta-BHC	mg/kg	--	0.019 U	--	--	--	0.0096 U	0.0097 U	--	--	0.0019 U	0.0094 U	0.0021 U	0.0019 U	--	6.00E-04 UJ	5.90E-04 UJ	5.30E-04 UJ	5.80E-04 U	--	--
PEST	Dieldrin	mg/kg	0.015	0.037 U	--	--	--	0.019 U	0.019 U	--	--	0.0037 U	0.019 U	0.0043 U	0.0038 U	--	0.0054 J	7.80E-04 J	7.00E-04 J	0.0039 J	--	--
PEST	Endosulfan I	mg/kg	7.0	0.019 U	--	--	--	0.0096 U	0.0097 U	--	--	0.0019 U	0.0094 U	0.0021 U	0.0019 U	--	4.80E-04 J	5.90E-04 UJ	2.70E-04 J	3.50E-04 J	--	--
PEST	Endosulfan II	mg/kg	7.0	0.037 U	--	--	--	0.019 U	0.019 U	--	--	0.0037 U	0.019 U	0.0043 U	0.0038 U	--	0.045 J	0.0069 J	0.0054 J	0.013 J	--	--
PEST	Endosulfan sulfate	mg/kg	--	0.037 U	--	--	--	0.019 U	0.019 U	--	--	0.0037 U	0.019 U	0.0043 U	0.0038 U	--	0.047 J	0.0061 J	0.0058 J	0.032 J	--	--
PEST	Endrin	mg/kg	0.30	0.037 U	--	--	--	0.019 U	0.019 U	--	--	0.0037 U	0.019 U	0.0043 U	0.0038 U	--	0.019 J	0.0025 J	0.0023 J	0.013 J	--	--
PEST	Endrin aldehyde	mg/kg	--	0.037 U	--	--	--	0.019 U	0.019 U	--	--	0.0037 U	0.019 U	0.0043 U	0.0038 U	--	0.16 J	0.019 J	0.017 J	0.094 J	--	--
PEST	Endrin ketone	mg/kg	--	0.037 U	--	--	--	0.019 U	0.019 U	--	--	0.0037 U	0.019 U	0.0043 U	0.0038 U	--	0.019 J	0.0024 J	0.0018 J	0.013 J	--	--
PEST	gamma-BHC (Lindane)	mg/kg	0.0030	0.019 U	--	--	--	0.0096 U	0.0097 U	--	--	0.0019 U	0.0094 U	0.0021 U	0.0019 U	--	6.00E-04 UJ	5.90E-04 UJ	5.30E-04 UJ	5.80E-04 U	--	--
PEST	gamma-Chlordane	mg/kg	--	0.019 U	--	--	--	0.0096 U	0.0097 U	--	--	0.0063	0.0094 U	0.0021 U	0.0019 U	--	0.0095 J	0.0014 J	0.0011 J	0.0069 J	--	--
PEST	Heptachlor	mg/kg	8.0	0.019 U	--	--	--	0.0096 U	0.0097 U	--	--	7.30E-04 J	0.0094 U	0.0021 U	0.0019 U	--	6.00E-04 UJ	5.90E-04 UJ	0.0015 J	5.80E-04 U	--	--
PEST	Heptachlor epoxide	mg/kg	0.20	0.019 U	--	--	--	0.0096 U	0.0097 U	--	--	0.0019 U	0.0094 U	0.0021 U	0.0019 U	--	1.20E-04 J	5.90E-04 UJ	5.30E-04 UJ	5.80E-04 U	--	--
PEST	Methoxychlor	mg/kg	52	0.19 U	--	--	--	0.096 U	0.097 U	--	--	0.019 U	0.094 U	0.021 U	0.019 U	--	0.069 J	0.0093 J	0.0076 J	0.047 J	--	--
PEST	Toxaphene	mg/kg	10	0.74 U	--	--	--	0.38 U	0.38 U	--	--	0.073 U	0.37 U	0.084 U	0.075 U	--	0.060 UJ	0.059 UJ	0.053 UJ	0.058 U	--	--
PCB	PCB-1016 (Aroclor 1016)	mg/kg	10	0.055 U	0.053 U	0.053 U	0.055 U	0.055 U	0.052 U	0.052 U	--	0.055 U	0.061 U	0.056 U	0.058 U	--	0.060 U	0.30 U	0.059 U	0.058 U	--	0.055 U
PCB	PCB-1221 (Aroclor 1221)	mg/kg	10	0.055 U	0.053 U	0.053 U	0.055 U	0.055 U	0.052 U	0.052 U	--	0.055 U	0.061 U	0.056 U	0.058 U	--	0.060 U	0.30 U	0.059 U	0.058 U	--	0.055 U
PCB	PCB-1232 (Aroclor 1232)	mg/kg	10	0.055 U	0.053 U	0.053 U	0.055 U	0.055 U	0.052 U	0.052 U	--	0.055 U	0.061 U	0.056 U	0.058 U	--	0.060 U	0.30 U	0.059 U	0.058 U	--	0.055 U
PCB	PCB-1242 (Aroclor 1242)	mg/kg	10	0.055 U	0.053 U	0.053 U	0.055 U	0.055 U	0.052 U	0.052 U	--	0.055 U	0.061 U	0.056 U	0.058 U	--	0.060 U	0.30 U	0.059 U	0.058 U	--	0.055 U
PCB	PCB-1248 (Aroclor 1248)	mg/kg	10	0.055 U	0.053 U	0.053 U	0.055 U	0.055 U	0.052 U	0.052 U	--	0.055 U	0.061 U	0.056 U	0.058 U	--	0.060 U	0.30 U	0.059 U	0.058 U	--	0.055 U
PCB	PCB-1254 (Aroclor 1254)	mg/kg	10	0.055 U	0.053 U	0.053 U	0.055 U	0.055 U	0.052 U	0.052 U	--	0.055 U	0.061 U	0.056 U	0.058 U	--	0.060 U	0.30 U	0.059 U	0.058 U	--	0.055 U
PCB	PCB-1260 (Aroclor 1260)	mg/kg	10	0.055 U	0.053 U	0.053 U	0.055 U	0.055 U	0.052 U	0.052 U	--	0.055 U	0.061 U	0.056 U	0.058 U	--	0.51	1.2	0.18 J	--	0.50 J	0.11
NNC	1,3,5-Trinitrobenzene	mg/kg	--	0.027 J	--	--	0.032 J	0.28 U	0.28 U	--	0.068 J	0.27 U	0.041 J	0.25 U	0.25 U	--	0.045 J	0.25 U	0.024 J	0.035 J	--	--
NNC	1,3-Dinitrobenzene	mg/kg	--	0.27 U	--	--	0.26 U	0.28 U	0.28 U	--	0.25 U	0.27 U	0.28 U	0.25 U	0.25 U	--	0.25 U	0.25 U	0.25 U	0.25 U	--	--
NNC	2,4,6-Trinitrotoluene	mg/kg	--	0.27 U	--	--	0.26 U	0.28 U	0.28 U	--	0.25 U	0.27 U	0.28 U	0.25 U	0.25 U	--	0.25 U	0.25 U	0.25 U	0.25 U	--	--
NNC	2,4-Dinitrotoluene	mg/kg	0.0050	0.27 U	--	--	0.26 U	0.28 U	0.28 U	--	0.25 U	0.27 U	0.28 U	0.25 U	0.25 U	--	--	--	--	--	--	--
NNC	2,6-Dinitrotoluene	mg/kg	0.0044	0.27 U	--	--	0.26 U	0.28 U	0.28 U	--	0.25 U	0.27 U	0.28 U	0.25 U	0.25 U	--	--	--	--	--	--	--
NNC	2-Amino-4,6-dinitrotoluene	mg/kg	--	0.33 U	--	--	0.32 U	0.34 U	0.34 U	--	0.30 U	0.33 U	0.33 U	0.30 U	0.30 U	--	0.30 U	0.30 U	0.30 U	0.30 U	--	--
NNC	2-Nitrotoluene	mg/kg	--	0.27 U	--	--	0.26 U	0.28 U	0.28 U	--	0.25 U	0.27 U	0.28 U	0.25 U	0.25 U	--	0.25 U	0.25 U	0.25 U	0.25 U	--	--
NNC	3-Nitrotoluene	mg/kg	--	0.27 U	--	--	0.26 U	0.28 U	0.28 U	--	0.25 U	0.27 U	0.28 U	0.25 U	0.25 U	--	0.25 U	0.25 U	0.25 U	0.25 U	--	--
NNC	4-Amino-2,6-dinitrotoluene	mg/kg	--	0.27 U	--	--	0.26 U	0.28 U	0.28 U	--	0.25 U	0.27 U	0.28 U	0.25 U	0.25 U	--	0.25 U	0.25 U	0.25 U	0.25 U	--	--
NNC	4-Nitrotoluene	mg/kg	--	0.27 U	--	--	0.26 U	0.28 U	0.28 U	--	0.25 U	0.27 U	0.28 U	0.25 U	0.25 U	--	0.25 U	0.25 U	0.25 U	0.25 U	--	--
NNC	Hexahydro-1,3,5-trinitro-1,3,5-triazine	mg/kg	--	0.27 U	--	--	0.26 U	0.28 U	0.28 U	--	0.25 U	0.27 U	0.28 U	0.25 U	0.25 U	--	0.25 U	0.25 U	0.25 U	0.25 U	--	--
NNC	Methyl-2,4,6-trinitrophenylnitramine	mg/kg	--	0.27 U	--	--	0.26 U	0.28 U	0.28 U	--	0.25 U	0.27 U	0.28 UJ	0.25 U	0.25 U	--	0.25 U	0.25 U	0.25 U	0.25 U	--	--
NNC	Nitrobenzene	mg/kg	0.060	0.27 U	--	--	0.26 U	0.28 U	0.28 U	--	0.25 U	0.27 U	0.28 U	0.25 U	0.25 U	--	--	--	--	--	--	--
NNC	Nitroglycerin	mg/kg	--	0.55 U	--	--	0.53 U	0.57 U	0.57 U	--	0.50 U	0.55 U	0.55 U	0.50 U	0.50 U	--	0.50 U	0.50 U	0.50 U	--	0.26 J	--
NNC	Octahydro-1,3,5,7-tetranitro-1,3,5,7-tetrazocine	mg/kg	--	0.27 U	--	--	0.26 U	0.28 U	0.28 U	--	0.25 U	0.27 U	0.28 U	0.25 U	0.25 U	--	0.25 U	0.25 U	0.25 U	0.25 U	--	--
NNC	Pentaerythritol tetranitrate	mg/kg	--	0.37 J	--	--	0.23 J	0.57 U	0.57 U	--	0.28 J	0.55 U	0.55 U	0.50 U	0.50 U	--	0.50 U	0.50 U	0.50 U	0.50 U	--	--
METAL	Aluminum	mg/kg	--	10,000	7,180	7,360	--	10,800	10,700	18,100	4,000	10,200	10,300	8,610	--	8,870	11,400	10,800	12,100	--	10,800	7,800
METAL	Antimony	mg/kg	3.6	0.25 J	0.25 J	0.28 J	--	0.51 J	3.0 J	0.33 J	**118 J**	0.66 UJ	0.30 J	0.75 U	--	0.22 J	0.40 J	0.40 J	0.34 J	--	0.33 J	0.25 J
METAL	Arsenic	mg/kg	8.0	**9.0**	4.9	5.5	--	**10 J**	**9.3 J**	**9.4 J**	**31 J**	**9.9**	**8.9**	6.9	--	**8.6**	**11**	**10**	**8.9**	**11**	--	6.4
METAL	Barium	mg/kg	1,100	119	78 J	78 J	--	131	128	111	170	104	166 J	90	--	112	116	115	102	--	107	91 J
METAL	Beryllium	mg/kg	42	0.18	0.12	0.13	--	0.19	0.19	0.16	0.11	0.18	0.21	0.17	--	0.19	0.21	0.21	0.21	--	0.21	0.15
METAL	Bismuth	mg/kg	--	0.11 J	0.52 U	0.52 U	--	0.12 J	0.14 J	0.12 J	1.0	0.11 J	0.15 J	0.63 U	0.56 U	--	0.17 J	0.16 J	0.18 J	0.15 J	--	0.55 U
METAL	Boron	mg/kg	--	5.5 U	5.2 U	5.2 U	--	1.8 J	2.2 J	6.0 U	3.8 J	5.5 U	2.9 J	6.3 U	5.6 U	--	6.3 UJ	6.0 UJ	6.1 UJ	5.8 UJ	--	1.7 J
METAL	Cadmium	mg/kg	5.0	0.39	0.19	0.26	--	0.80	0.67	0.96	**23**	0.31	0.45	0.29	0.31	--	0.33	0.33	0.36	0.32	--	0.24
METAL	Calcium	mg/kg	--	6,820	4,250	4,420	--	7,310	7,370	6,750	2,630	7,080	8,450	4,500	--	5,200	5,820	6,080	4,150	--	5,410	5,090
METAL	Chromium	mg/kg	26	20 J	12	14	--	21 J	21 J	21 J	**94 J**	20 J	20	17	--	18	22	21	23	--	21	15
METAL	Cobalt	mg/kg	--	8.7	5.8	6.3	--	9.9	8.9	8.6	20	9.7	9.3	7.6	--	8.1	10 J	10 J	9.9 J	10 J	--	6.5
METAL	Copper	mg/kg	7,000	25	15	16	--	30 J	28 J	425 J	323 J	27	24	20	--	23	28	30	33	28	--	18
METAL	Iron	mg/kg	--	21,100	13,500	14,400	--	23,400	22,200	21,000	226,000	23,200	20,100	18,200	--	18,300	22,200	21,200	21,200	21,600	--	15,300
METAL	Lead	mg/kg	--	15 J	14 J	20 J	--	22 J	18 J	37 J	1,540	7.1 J	16 J	5.4	--	6.4	12	11	11	--	11	12 J
METAL	Magnesium	mg/kg	--	5,690	3,730	3,970	--	6,110	5,870	5,710	2,070	6,200	5,130	4,740	--	4,640	5,850	5,700	5,980	--	5,610	3,990
METAL	Manganese	mg/kg	--	367	227	276	--	416	372	421	546	407	486	336	--	424	305	299	261	--	289	261
METAL	Mercury	mg/kg	1.4	0.021 J	0.018 J	0.019 J	--	0.025 J	0.026 J	0.024 J	--	0.028 J	0.031 J	0.021 J	0.024 J	--	0.040 J	0.038 J	0.036 J	--	0.031 J	0.021 J
METAL	Molybdenum	mg/kg	--	0.54	0.34	0.38	--	0.68	0.61	0.66	14	0.60	0.77	0.50	--	0.67	0.98	0.85	0.64	--	0.71	0.49
METAL	Nickel	mg/kg	87	22	15	16	--	25 J	23 J	23 J	79 J	24	22	20	--	21	23	24	24	23	--	18
METAL	Phosphorus, Total (as P)	mg/kg	--	540	371 J	390 J	--	570	535	528	242	697	526 J	497	443	--	579	510	576	--	575	418 J
METAL	Potassium	mg/kg	--	943	1,090	788	--	1,060	1,020	1,000	402	893	1,160	700	--	824	1,000	953	976	--	1,030	963
METAL	Selenium	mg/kg	3.5	0.48	0.24 J	0.25 J	--	0.51	0.48	0.46	1.2 J	0.49	0.49	0.37 J	--	0.54	0.63	0.76	0.66	0.59	--	0.29 J
METAL	Silver	mg/kg	21	0.050 J	0.049 J	0.069 J	--	0.068 J	0.068 J	0.078 J	0.96	0.050 J	0.087 J	0.059 J	--	0.096 J	0.075 J	0.082 J	0.089 J	0.074 J	--	0.069 J
METAL	Sodium	mg/kg	--	401 J	275 J	294 J	--	395 J	406 J	368 J	157 J	468 J	340 J	348	--	317	447 J	431 J	401 J	--	458 J	285 J
METAL	Strontium	mg/kg	--	34 J	23 J	23 J	--	35 J	36 J	36 J	19 J	36 J	46 J	29	--	31	40 J	42 J	30 J	--	38 J	25 J
METAL	Thallium	mg/kg	--	0.064 J	0.16 U	0.16 U	--	0.079 J	0.072 J	0.069 J	0.22	0.056 J	0.055 J	0.19 U	0.17 U	--	0.11 J	0.18 U	0.18 U	0.18 U	--	0.17 U
METAL	Vanadium	mg/kg	3,400	37 J	28 J	28 J	--	41	40	37	14	44 J	37 J	35	--	34	38	38	38	--	36	31 J
METAL	Zinc	mg/kg	9,100	68 J	34 J	37 J	--	70	66	68	**12,200**	49 J	60 J	42	--	44	55	51	59	53	--	42 J

TABLE 2-2
Soil Pile Analytical Results Compared to Landfill Criteria
Taku Gardens, Fort Wainwright, Alaska

Sample ID				**06SP01S01**	**06SP03S01**	**06SP03S02**	**06SP10S01**	**06SP11S01**	**06SP11S02**	**06SP11S03**	**06SP11S04**	**06SP14S01**	**06SP15S01**	**06SP16S01**	**06SP16S02**	**06SP16S03**	**06SP17S01**	**06SP17S02**	**06SP18S01**	**06SP18S02**	**06SP18S03**	**06SP40S01**
Location ID				06SP01	06SP03	06SP03	06SP10	06SP11	06SP11	06SP11	06SP11	06SP14	06SP15	06SP16	06SP16	06SP16	06SP17	06SP17	06SP18	06SP18	06SP18	06SP40
Sample Date				6/23/2006	6/27/2006	6/27/2006	6/22/2006	6/19/2006	6/19/2006	6/21/2006	6/21/2006	6/26/2006	6/27/2006	7/25/2006	7/25/2006	7/25/2006	8/19/2006	8/19/2006	8/19/2006	8/19/2006	8/19/2006	6/27/2006
Chemical Group	**Chemical Name**	**Units**	**Landfill Criteria**																			
HERB	2,4,5-T	mg/kg	--	0.0073 U	--	--	--	0.0074 U	0.0074 U	--	--	0.0073 U	0.0078 U	--	--	--	--	--	--	--	--	--
HERB	2,4,5-TP (Silvex)	mg/kg	--	0.0073 U	--	--	--	0.0074 U	0.0074 U	--	--	0.0073 U	0.0078 U	--	--	--	--	--	--	--	--	--
HERB	2,4-D	mg/kg	--	0.0073 U	--	--	--	0.0074 U	0.0074 U	--	--	0.0073 U	0.0078 U	--	--	--	--	--	--	--	--	--
HERB	2,4-DB	mg/kg	--	0.0073 U	--	--	--	0.0074 U	0.0074 U	--	--	0.0073 U	0.0078 U	--	--	--	--	--	--	--	--	--
HERB	4-Nitrophenol	mg/kg	--	0.0073 U	--	--	--	0.0074 U	0.0074 U	--	--	0.0073 U	0.0078 U	--	--	--	--	--	--	--	--	--
HERB	Dalapon	mg/kg	--	0.018 U	--	--	--	0.019 U	0.019 U	--	--	0.018 U	0.020 U	--	--	--	--	--	--	--	--	--
HERB	Dicamba	mg/kg	--	0.0073 U	--	--	--	0.0074 U	0.0074 U	--	--	0.0073 U	0.0078 U	--	--	--	--	--	--	--	--	--
HERB	Dichlorprop	mg/kg	--	0.0073 U	--	--	--	0.0074 U	0.0074 U	--	--	0.0073 U	0.0078 U	--	--	--	--	--	--	--	--	--
HERB	Dinoseb	mg/kg	--	0.018 U	--	--	--	0.019 U	0.019 U	--	--	0.018 U	0.020 U	--	--	--	--	--	--	--	--	--
HERB	MCPA	mg/kg	--	0.0073 U	--	--	--	0.0074 U	0.0074 U	--	--	0.0073 U	0.0078 U	--	--	--	--	--	--	--	--	--
HERB	MCPP	mg/kg	--	0.0073 U	--	--	--	0.0074 U	0.0074 U	--	--	0.0073 U	0.0078 U	--	--	--	--	--	--	--	--	--
HERB	Pentachlorophenol	mg/kg	0.010	**0.020**	--	--	--	0.0074 U	**0.024**	--	--	0.0073 U	0.0078 U	--	--	--	--	--	--	--	--	--
CONV	Bromide	mg/kg	--	2.7 U	--	--	2.6 U	2.8 U	2.8 U	3.0 U	--	2.7 U	2.8 U	--	--	--	--	--	--	--	--	--
CONV	Chloride	mg/kg	--	6.4	--	--	6.0	4.6 J	4.7 J	4.6 J	--	2.7 J	6.0	--	--	--	--	--	--	--	--	--
CONV	Fluoride	mg/kg	--	1.6 J	--	--	1.8 J	1.9 J	1.6 J	3.0 UJ	--	1.6 J	2.0 J	--	--	--	--	--	--	--	--	--
CONV	Nitrogen, Nitrate (as N)	mg/kg	--	3.6	--	--	8.1	--	--	--	--	1.2	43	--	--	--	--	--	--	--	--	--
CONV	Nitrogen, Nitrate-Nitrite	mg/kg	--	--	--	--	--	10	10	--	--	--	--	--	--	--	--	--	--	--	--	--
CONV	Nitrogen, Nitrite	mg/kg	--	0.27 U	--	--	0.26 U	--	--	--	--	0.27 U	0.28 U	--	--	--	--	--	--	--	--	--
CONV	Percent Moisture	percent	--	9.0	4.4	4.4	5.3	12	12	16	0.10 U	8.6	9.4	20	11	--	21	20	18	--	17	9.4
CONV	pH	units	--	8.1	8.6	8.2	8.2	8.0	8.0	7.8	--	8.2	7.4	--	--	--	--	--	--	--	--	7.6
CONV	Phosphorus, Total Orthophosphate (as P)	mg/kg	--	1.1 U	--	--	1.1 U	1.1 U	1.1 U	1.2 U	--	1.1 U	1.1 U	--	--	--	--	--	--	--	--	--
CONV	Solids, Percent	percent	--	--	--	--	--	--	--	--	--	--	--	--	--	--	82	80	86	84	--	--
CONV	Sulfate	mg/kg	--	62	--	--	42	69	55	36	--	24	33	--	--	--	--	--	--	--	--	--
CONV	Total Solids	percent	--	90	93	94	91	91	95	95	--	91	81	89	84	--	83	84	85	86	--	89

TABLE 2-3
MI Triplicate Sample Locations

Triplicate Sample Location	Geographic Area of Site	Piles that this Triplicate Result is Applied To
SP06	Northwest	SP04, SP05, SP06, SP07, SP08, SP09
SP03	Northeast	SP01, SP02, SP03, SP40, SP41, SPB, SPG
SP13	Southeast	SP13
SP27	Southwest	SP14, SP115, SP17-SP19, SPD, SPF, SPE

TABLE 2-4
Analytical Methods

Analysis	Method Number	Maximum Holding Time
PCBs	EPA SW8082	None
Metals	EPA SW6010/6020	TCLP Leaching 28 days for mercury, (180 days for other metals)
DRO/RRO	AK 102/103	14 days to extraction, 40 days to analysis
Pesticides	EPA 8081A	14 days to extraction, 40 days to analysis
VOCs	EPA SW8260	14 days to analysis
SVOCs	EPA SW8270	14 days to extraction, 40 days to analysis

TABLE 2-5
TCLP Limits for Metals

Method	Analyte	TCLP Limit (mg/L)[1]
SW6010B	Arsenic	5
SW6010B	Barium	100
SW6010B	Cadmium	1
SW6010B	Chromium	5
SW6010B	Lead	5
SW6010B	Mercury	0.2
SW6010B	Selenium	1
SW6010B	Silver	5

[1]Code of Federal Regulations 261.24

Responses to Comments

REVIEW COMMENTS

PROJECT: Former Communications Site
DOCUMENT: Draft WP Addenda 1-4
LOCATION: Fort Wainwright, Alaska

U.S. ARMY CORPS OF ENGINEERS CEPOA-PM-C	DATE: 3 Aug 07 REVIEWER: ADEC, Sharon and Earl, received by email PHONE:	Action taken on comment by:_____

Page No., Spec. Paragraph	Item No.	COMMENTS	REVIEW CONFERENCE A - comment accepted W - comment withdrawn		Back check by: (Initials)
	1	Combining Stockpiles: Earl called Chuck Ramsey to discuss combining small stockpiles into one decision unit. Chuck said it was acceptable with a couple of conditions: 1)That all the stockpiles came from the same source and are (or can be assumed to be) similar in nature. This would need to be documented and agreed upon by the group. Sharon: Suggest discussing this and finalizing in a meeting minutes or similar to be included in the final overall work plan instead of holding up work further. I told Rielle today that I would be able to do a site visit next Tuesday and we can discuss this during the site visit if you think it would expedite things. 2)That the number of increments collected from each stockpile must be based on the cubic yards of each stockpile. So, if one stockpile was twice as big as another, twice as many correctly located increments need to be taken from the larger stockpile than the smaller one. Sharon: Agree. This makes sense.	1) During an 8/6 conference call it was agreed that piles within the same general area are similar in nature and therefore soil piles can be combined into the same decision unit. 2) The text will be amended to state large piles will be divided into multiple decisions units (one decision unit per 500 cubic yards). For small piles combined to one decision unit the number of incremental samples per pile will be based on the ratio of pile volume to total volume of group of piles. Large piles with multiple decisions units will have 30 increments per decisions unit.		
	2	Sharon: Page 2-1. Area of Investigation. States there are 44 stock piles. Background information section states there are 25 in the PCB EZ and 15 outside the EZ. Target Analytes states there are 25 soil piles in the EZ and 19 outside of the EZ. Figure 2-1 shows 06SP01-06SP41 (06SP16 is missing) plus the 7 soil piles represented by SPA-SPG. This should be reconciled in the final document. Also, were the SPA-SPG soil piles not accounted for in the PSEII or were they created during site investigtion?	Text will be reconciled. 06SP16 was clean fill and this will be noted in the addendum.		

REVIEW COMMENTS

PROJECT: Former Communications Site
DOCUMENT: Draft WP Addenda 1-4
LOCATION: Fort Wainwright, Alaska

U.S. ARMY CORPS OF ENGINEERS CEPOA-PM-C	DATE: 3 Aug 07 REVIEWER: ADEC, Sharon and Earl, received by email PHONE:	Action taken on comment by:_____

Page No., Spec. Paragraph	Item No.	COMMENTS	REVIEW CONFERENCE A - comment accepted W - comment withdrawn		Back check by: (Initials)
	3	Earl: Page 2-3, Target Analytes. States that PCBs are not expected in soil piles outside of the exclusion zone. Do you agree, especially for the stockpiles located adjacent to the exclusion zone? If there is any question, I would recommend PCBs be analyzed for all stockpiles. Sharon: I don't think it's prudent to use sampling data from the nine piles that were tested last year to determine what might be in other soil piles because different areas were used for different purposes and Watterson mixed a lot of dirt around. Also, PCBs were detected outside of the Exclusion Zone (soil pile 17--I realize this soil came from the EZ, just need to correct text) and in the sound berm near the former transformer service area. Low levels (<1 mg/kg) of PCBs were detected at numerous locations across the site. The problem with using last year's data to eliminate COCs is that there weren't enough samples collected to adequately characterize all of the stock piles. Also, why are no soil piles being sampled for dioxin/furans?	PCBs are not expected in the soil piles outside of the exclusion zone, based on results of extensive surface soil sampling conducted in 2005. Soil pile 17 will be analyzed for PCBs. Piles outside of the exclusion zone will be tested for DRO/RRO, SVOCs and TCLP metals. VOCs will be analyzed for soil piles in the northwest corner near the known POL plume. Pesticides will be run for Group 6 piles to confirm earlier hits.		
	4	Earl: Page 2-3, Target Analytes. It is unclear from the text and the second bullet whether/where the full list SVOCs by 8270 will be reported and/or just PCP. Again, as a safeguard, I would recommend that the full list be reported. Since DRO is being analyzed, I recommend that RRO be run also. It is the same extraction/analyses and the additional cost minimal. Also, please be sure you agree with them dropping VOCs from the COC list. Sharon: Agreed. There's a VOC soil plume around the POL area that hasn't been fully delineated. Why is this being dropped?	Test will be corrected to clarify that the full list of SW8270 compounds will be analyzed. RRO will be run every where DRO is being run and VOC will be analyzed in piles 4-9 in the vicinity of the known POL plume.		
	5	Sharon: Page 2-4. Detection Limits. I think it's premature to state that all soil is expected to go to the landfill.	Comment noted. Soil piles 11 and 12 will be sent to DRMO. The text will be amended to annotate this.		
	6	Earl: Page 2-4, Sampling Approach. Grouping the smaller piles into single, ~100 cy decision units, seems appropriate, although some of them are pretty widely spaced. However, splitting the larger stockpiles into (arbitrary) 500 cy decision units, seems a bit large (?). Since it is all going off-site, I guess as long as solid waste accepts it we are OK. Just confirm that you are comfortable with their decision unit determination. Sharon: I spoke with Ken Spiers in Solid Waste and he said MI sampling was OK. Not sure if he's provided you with approval yet. He said he was expecting a written request. 500 CY does seem large but if Solid Waste is OK with it, then I'm not going to disagree.	It was agreed that decision units up to 500 cy were OK. To be conservative, SP06 in the northwest corner was broken up into 4 decision units (~ 275 cy/decision unit) since this pile is near a known contaminant plume.		

REVIEW COMMENTS

PROJECT: Former Communications Site
DOCUMENT: Draft WP Addenda 1-4
LOCATION: Fort Wainwright, Alaska

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Page No., Spec. Paragraph	Item No.	COMMENTS	REVIEW CONFERENCE A - comment accepted W - comment withdrawn		Back check by: (Initials)
	7	Recommend that for metals any visual evidence of metal pieces during sample collection and sieving, be documented. Sieving and analysis of the <2mm fraction may bias the metals results low. Is this a concern for solid waste disposal? Sharon: Agreed. One of the samples last year had 197,000 mg/kg lead. I expect this was due to a metal fragment	It was agreed that we would analyze metals for TCLP. Soil will not be sieved before being sent to the laboratory.		
	8	Earl: Page 2-4, Sampling Approach. Third Bullet. Insufficient details are provided for the MI sampling. Additional information is needed in the addendum and/or FSP section. What is the basis for the 1/3 surface – 2/3 subsurface split? How will the systematic MI locations be determined – for combined stockpiles and for single stockpiles with multiple decision units? How will depths be determined? Etc. Sufficient details and/or examples, as provided for the sound berm MI sampling, are required for review and field implementation. Sharon: Also, wouldn't the larger decision units require more samples?	It was agreed that we would document that professional judgement was used for the surface/subsurface split. For smaller piles combined into one decision unit, the number of incremental samples per pile is based on the ratio of the pile volume to the total volume of the group of piles. Each pile is divided into the appropriate number of increments and samples are collected from a random quadrant, A, B, C, or D, by rolling dice. Larger piles are divided into multiple decision units. A grid of 30 increments is overlaid on each decision unit. Samples are collected from a random quadrant within each increment by rolling dice. The text will be amended to include more details on the MI sampling.		

	9	Page 2-4, Sampling Approach. Fourth Bullet. If the Sound Berm MI protocol will be followed, e.g. 3" core sieved to <6mm and submitted to the lab, please document. If not provide details on how the increment will be collected and how the minimum mass per increment will be determined.	See response to comment #8. For non-metal, non-volatile samples, a minimum of 60 gram of sample will be collected at each of 30 increments, as specified in the FSP (identical to the Sound Berm sampling). For VOC analysis, samples at each increment will be added to methanol-preserved sample containers. For metals analysis, unsieved MI samples will be collected and analyzed for TCLP. Unsieved samples will be collected from each of the 30 incremental sample locations. the entire volume (approximately 1 liter) will be homogenized and sent to the laboratory. The laboratory will subsample and obtain the required 100 g for analysis.		
	10	Specify the decision units that triplicate samples will be collected at, 4 total, and which decision units the triplicates will be applied to for 95% UCL determination.	Agreed. This will be clarified in the text. A table was added to show locations for the triplicate sampling and associated piles applied to each triplicate sample.		
	11	Sharon: Table 2-1. Earlier in the document, it states that pesticides can be detected using 8270 but this table distinguishes between SVOCs and pesticides and gives the impression different methods will be used.	Pesticides will be analyzed by 8081, but 8270 can be used for chromatographic confirmation.		
	12	Table 2-3 DRO/RRO are listed as an analytical method. Recommend stating that RRO will be included as an analyte earlier in the document. (See comment 3)	RRO will be added. Text will be modified accordingly.		

Addendum 3

Final

Addendum 3 to the Remedial Investigation Work Plan

Soil Gas Investigation

FWA 102 Former Communications Site
Fort Wainwright, Alaska

Prepared for

Department of the Army
U.S. Army Corps of Engineers,
Alaska District

P.O. Box 6898
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Final, 18 August 2007

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ADDENDUM 3

Soil Gas Investigation

Purpose

This document serves as an addendum to the May 2007 *Remedial Investigation/Feasibility Study Management Plan FWA 102 Former Communications Site Fort Wainwright Alaska* (RI Management Plan). This addendum addresses the characterization of soil gas located at the Former Communication Site (FCS) to provide chemical concentration data for the baseline risk assessment. The FCS site has been divided into two primary areas that affect how the fieldwork for the remedial investigation (RI) is conducted: the low probability of encountering Munitions and Explosives of Concern (MEC) Area and moderate to high probability of encountering MEC Area. Figure 3-1 depicts the location of these two areas. This addendum covers collection of sub-slab soil gas samples at all the buildings and subsurface soil gas samples in open areas within the low-probability MEC area only. This addendum does not address plans for collection of soil gas samples within the moderate-to-high MEC area. Plans for collection of soil gas within the moderate to high MEC area will be included in the Interim Draft RI Management Plan.

The U.S. Army, U.S. Environmental Protection Agency (EPA), and Alaska Department of Environmental Conservation (ADEC) have agreed to conduct the remedial investigation/feasibility study (RI/FS) for the FCS using the Triad approach. The RI Management Plan addresses this approach and overall site management and includes the Quality Assurance Project Plan (QAPP) and Field Sampling Plan (FSP). This document is one of many addenda that provide detailed information about specific tasks of the RI/FS. This approach was determined to be the most effective, efficient, and appropriate method for investigating this site.

Background Information

The migration of volatile organic compounds (VOCs) from underlying contaminated soil is described as vapor intrusion and is the risk exposure pathway that will be investigated in this Work Plan Addendum. The historical activities at FCS include chemical spills from maintenance practices; fire training; leaks from tanks, pipelines, and transformers; and burial of drums and other wastes debris. Therefore, it is necessary to assess whether contaminant exposure through vapor intrusion poses potentially unacceptable risks to human health. Ambient outdoor air risk estimates and additional information on exposure pathways are included in the Risk Assessment Work Plan, Section 3.4.3.

Delineation of the MEC boundary lines, as shown on Figure 3-2, was accomplished by overlaying 2003, 2004, and 2007 geophysical data with 1949, 1956, 1982, and 2005 aerial photographs and digitizing polygons around areas that either had geophysical anomalies or surface debris. Historical photographs were used to identify areas where MEC disposal was most likely to have occurred. All of MEC uncovered to date has been within these areas. The boundary lines were conservatively expanded to the north of the tree line area and adjusted

to the west to easily distinguish housing units in each area. The geophysical data shown on Figure 3-2 is from 2004, prior to construction of the housing. The 2004 data are not clouded by anomalies from new construction.

Previous Sampling Results

A passive soil gas investigation was conducted at FCS in 2006 as part of the Preliminary Source Evaluation (PSE) Phase II Investigation. The 2006 soil gas investigation was conducted in the northwest potion of the site and near Building 49. It consisted of passive soil gas samples collected in 35 locations with a Gore™ Sorber. The sample locations selected in the PSE II Investigation were generally widespread within the northwest portion of the site to confirm the presence or absence of VOCs and not to define nature and extent. Previous passive soil gas sample points and area of elevated VOCs are shown on Figure 3-2.

Petroleum-derived constituents (total petroleum hydrocarbons [TPH]; C-11, C-13, and C-15 hydrocarbons; naphthalenes; and trimethylbenzenes) were detected in almost all sample locations (33 of 35), suggesting these compounds were ubiquitous throughout the area of investigation. Benzene, toluene, ethylbenzene, and xylene (BTEX) compounds were detected less frequently (6 of 35 locations) along the northern border of the FCS. Of the chlorinated solvents, only trichloroethene (TCE) and tetrachloroethane (PCE) were detected, and they appeared in fewer locations than petroleum constituents (5 out of 35 locations). The source of the PCE and TCE was assumed to be solvent use from the former motor pool. Tentatively identified compounds (TICs) detected appeared to be limited to chlorofluorocarbons (CFCs). The CFC source is unknown and is believed to be unrelated to the petroleum source. It is possible these constituents are associated with foam insulation covering underground utilities. The sample results from the PSE II Investigation are qualitative and cannot be used to determine actual concentrations of VOCs in a given location. Consequently, active soil gas sampling will be conducted to evaluate the nature and extent of VOCs in soil in this investigation.

Data Quality Objectives (DQOs)

A DQO process was used to determine the accuracy and quality specification that the collected data must meet to fill existing data gaps for the RI/FS. The purpose of the data is to decide whether future indoor residents may be exposed to VOC concentrations in soil gas that pose a potential for unacceptable risks through a vapor intrusion pathway. The soil gas test method should be capable of detecting VOCs at EPA Region VI values for Ambient Air Screening Levels multiplied by a factor of 10 (to adjust for soil gas to indoor air attenuation). Table 3-1 (at the end of this addendum) includes these values. The soil gas results will be evaluated by using the advanced Johnson and Ettinger (1991) *Model for Subsurface Vapor Intrusion into Buildings, Updated 2003* (SG-ADV Version 3.1; 02/04) (EPA, 2003) to estimate potential exposure from vapor intrusion. To the greatest extent possible, the site-specific building dimensions, foundation thicknesses, design values for air exchange rates, and other information will be used for the modeling. Additional site-specific factors (temperature, soil type, etc.) will be adjusted from the default values to provide site-specific estimates of exposure to vapors at FCS. Data obtained from this investigation will supplement soil and groundwater investigation results to refine the contaminant source evaluation for the FCS

site. In addition, sub-slab samples will be collected at the School Age Services (SAS) building, located adjacent to the northwest boundary of the FCS, to address the indoor air risk at that facility.

Sampling Locations

Figure 3-1 depicts the boundary of the low probability of encountering MEC area and the moderate to high probability of encountering MEC area. The sampling locations covered in the addendum are restricted to sub-slab locations and to the Low Probability MEC Area. Plans for collection of soil gas within the Moderate to High MEC Area will be included in the Interim Draft RI Management Plan.

Figure 3-2 shows the proposed 75 soil gas sample points in the Low Probability MEC Area and 30 sample locations at each building in the Moderate to High MEC Area for sub-slab samples (MEC area procedures addressed in RI Management Plan) for a total of 105 sample point shown. Sample location rationale is as follows:

1. One soil gas sample at each building for estimating risk of vapor intrusion to indoor air (25 samples from existing buildings in Low Probability MEC Area, 10 samples from potential future construction building footprints in Low Probability MEC Area, and 30 samples for existing buildings in Moderate to High MEC Area)
2. In areas of known VOC contamination, such as the northwest area of FCS, additional sample points to assess the extent of contaminations (22 samples)
3. In areas with no detected VOCs or no data (because of incomplete historical data), samples to identify potential sources (11 samples)
4. Targeting of the former slough channel to evaluate potential preferential pathways[1] (6 samples)
5. Sub-slab samples at the SAS building to address indoor air quality at that facility (1 sample shown, more possible)

Geophysical Anomaly and Utility Avoidance

Soil gas sample locations will be selected to avoid geophysical anomalies and existing utilities. Fifty-five of the proposed soil gas sampling points will be collected at a depth of 3 inches below the slab in the garage of each building. This sampling is considered safe from MEC hazard because sample equipment will not penetrate below the engineered backfill under each building. Careful review of as-built drawings, discussions with the construction contractor, and observations of utilities at the exposed slabs within the exclusion zone were conducted to reduce the chances for affecting buried utilities.

For soil gas samples in open areas GPS coordinates for sample locations, shown on Figure 3-2, will be used to mark sample locations in the field. The sample locations were selected to avoid geophysical anomalies and utilities. Additional anomaly avoidance and

[1] Note that soil type (identified through logging of soil borings) will also be used to evaluate potential for preferential pathways in the former slough channel.

location clearance with a magnetometer and current induction methods will be used if applicable.

Sample Collection Methods and Analyses

At each building, the slab will be cored in the garage area and a soil gas sample will be collected at a depth of 3 inches below the slab in accordance with EPA guidance (Attachment 1). In open areas, soil gas probes will be installed to a depth of approximately 6 feet below ground surface by using a direct-push drill rig. Soil gas samples will be collected directly into a Summa canister with Teflon tubing following the procedures outlined in the *Field Sampling Plan* (CH2M HILL, 2007). All soil gas results will be analyzed following EPA Method TO- 15. A list of the analytes and corresponding reporting limits for this method are summarized in Table 3-1.

TABLE 3-1
Reporting Limit Objectives for Method TO-15

Analyte	Reporting Limit (ug/m^3)	USEPA Region VI Ambient Air Screening Level (ug/m^3)	Target Sub-slab Vapor Intrusion Screening Level (ug/m^3)[1]
1,1,1,2-Tetrachloroethane	1	0.26	2.6
1,1,1-Trichloroethane	1	2300	23,000
1,1,2,2-Tetrachloroethane	1	0.033	0.33
1,1,2-Trichloroethane	1	0.12	1.2
1,1-Dichloroethane	1	730	7,300
1,1-Dichloroethene	1	210	2,100
1,1-Dichloropropene	1	NA	NA
1,2,3-Trichlorobenzene	1	NA	NA
1,2,3-Trichloropropane	1	0.00096	0.0096
1,2,4-Trichlorobenzene	1	4.2	42
1,2,4-Trimethylbenzene	1	6.3	63
1,2-Dibromo-3-chloropropane	1	0.0001	0.001
1,2-Dibromoethane (EDB)	1	0.0034	0.034
1,2-Dichlorobenzene	1	0.25	2.5
1,2-Dichloroethane	1	0.074	0.74
1,2-Dichloropropane	1	0.099	0.99
1,3,5-Trimethylbenzene	1	6.2	62
1,3-Dichlorobenzene	1	8.3	83
1,3-Dichloropropane	1	NA	NA
1,4-Dichlorobenzene	1	0.28	2.8
2,2-Dichloropropane	1	NA	NA
2-Butanone	1	5200	52,000
2-Chlorotoluene	1	73	730
2-Hexanone	1	NA	NA
4-Chlorotoluene	1	NA	NA
4-Methyl-2-pentanone	1	3100	31,000

TABLE 3-1
Reporting Limit Objectives for Method TO-15

Analyte	Reporting Limit (ug/m^3)	USEPA Region VI Ambient Air Screening Level (ug/m^3)	Target Sub-slab Vapor Intrusion Screening Level (ug/m^3)[1]
Acetone	5	3300	33,000
Benzene	1	0.25	2.5
Bromobenzene	1	12	120
Bromochloromethane	1	NA	NA
Bromodichloromethane	1	0.11	01.1
Bromoform	1	1.7	17
Bromomethane	1	5.2	52
Carbon disulfide	1	730	7,300
Carbon tetrachloride	1	0.13	1.3
Chlorobenzene	1	52	520
Chlorodibromomethane	1	0.08	0.8
Chloroethane	1	NA	NA
Chloroform	1	0.084	0.84
Chloromethane	1	1.1	11
cis-1,2-Dichloroethene	1	37	370
cis-1,3-Dichloropropene	1	NA	NA
Dibromomethane	1	NA	NA
Dichlorodifluoromethane	1	210	2,100
Ethylbenzene	1	1100	11,000
Hexachlorobutadiene	1	0.087	0.87
Isopropylbenzene	1	400	4,000
m,p-Xylenes	1	100	1,000
Methyl tert-butyl ether (MTBE)	1	7.4	74
Methylene chloride	1	4.1	41
Naphthalene	1	3.1	31
n-Butylbenzene	1	37	370
n-Propylbenzene	1	37	370
o-Xylene	1	730	7,300
p-Isopropyltoluene	1	NA	NA
sec-Butylbenzene	1	37	370
Styrene	1	1100	11,000
tert-Butylbenzene	1	37	370
Tetrachloroethene	1	0.33	3.3
Toluene	1	5200	52,000
Total Xylenes	1	100	1,000
trans-1,2-Dichloroethene	1	63	630
trans-1,3-Dichloropropene	1	NA	NA
Trichloroethene	1	0.017	0.17
Trichlorofluoromethane	1	730	7,300
Vinyl chloride	1	0.16	1.6

ug/m^3 = micrograms per cubic meter

[1] EPA Region VI values for Ambient Air Screening Levels are multiplied by an attenuation factor of 10 to adjust for soil gas to indoor air attenuation.

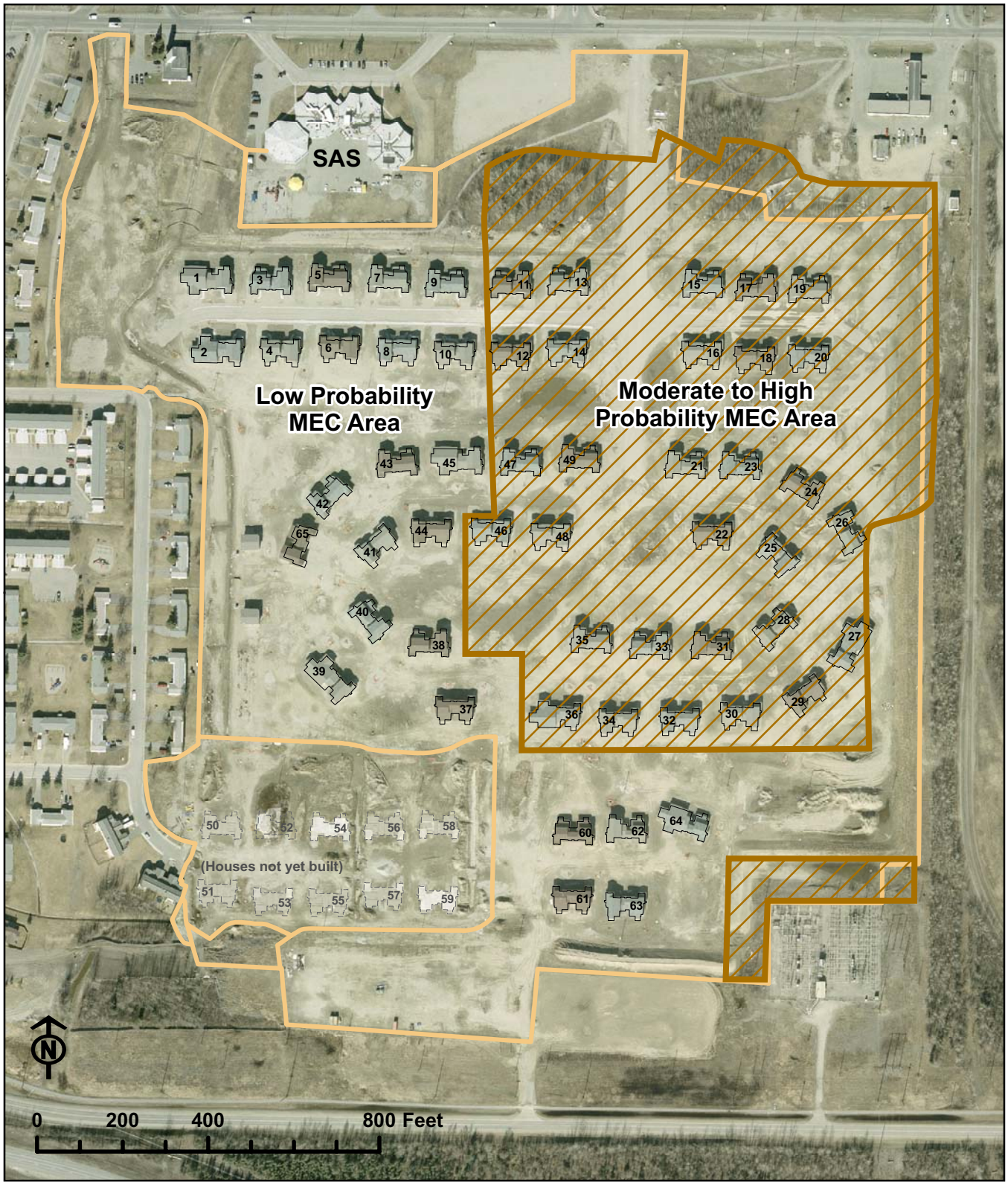

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Figure 3-1
MEC Areas and Security Fences
Former Communications Site
Fort Wainwright, Alaska

Figure 3-2
Former Communications Site
Fort Wainwright, Alaska
Soil Gas Sample Locations

Legend

- Moderate to high probability MEC area
- Former slough channel
- Area within elevated VOC/POL concentrations
- 2006 passive gas sample locations
- Proposed soil gas locations

2004 Magnetic Data Vertical Gradient

- -4000
- -1000
- -500
- -200
- -100
- -75
- -50
- -20
- 0
- 40
- 75
- 100
- 200
- 500
- 1000
- 2000
- 4000

0 100 200 300 400 Feet

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Attachment 1

Standard Operating Procedure for the Collection of Sub-Slab Vapor Samples Using Summa™ Canisters

This procedure describes the approach for the collection of sub slab soil vapor samples in Summa canisters. It includes instruction on probe installation, leak checking, gas sampling, and probe abandonment. This SOP should be used in conjunction with project data quality objectives. Only persons trained in the collection of soil gas samples should attempt this procedure

1.0 Materials

1.1 Probe Installation
- Hammer drill and 7/8″ or 1″ and 5/16″ or 3/8″ bits
- Vacuum cleaner ('shop vac' type or hand held)
- Probe (1/4″ stainless steel tube with Swagelock or equivalent nut and ferrule)
- Probe seal (1/8″ NPT internal wrenching plug)
- Probe union (1/4″ male Swagelock or equivalent to 1/8″ female NPT)
- Nuts and ferrules (1/4″ stainless steel Swagelock or equivalent)
- Hack saw
- Mortar consisting of Portland Cement mix, Fix-it-All, or similar
- Large Q-tips or paper towels and water
- Tongue depressor, putty knife, or similar tool
- Tape measure

1.2 Leak check
- Leak check enclosure
- Compressed helium tank (balloon grade), helium regulator, flow meter (0-500 ml/min)
- Helium detector, or equal
- (alternative) Isopropyl alcohol and paper towels

1.3 Sampling
- Sampling union (1/4″ male Swagelock or equivalent to 1/4″ male NPT)
- Vacuum pump, sampling manifold
- ¼″ Teflon tubing, rubber tubing
- Flow controller
- Summa canister (sized appropriately for sampling requirements)
- Miscellaneous fitting to connect tubing to sampling union and Summa canister)

1.4 Probe Abandonment
- Probe removal fitting
- Crowbar

1.5 Miscellaneous
- Teflon tape
- 9/16″, ½″, crescent wrench, screw driver
- Extension cord
- Timer/watch
- Tools required to cut carpet, and/or tools needed for removal of other floor coverings

2.0 Probe Installation

2.1 Locate the sampling locations in accordance with the work plan. Check with local utility companies to identify utilities coming into the building from outside. If possible, look for known or suspected utility conduits and note their location on a map or in the field log. Be sure to confirm that the sample locations will not interfere with the known

underground utilities. Also note the location of the probe, locations of significant features (walls, cracks, sumps, drains, etc), and conditions of the slab and soil.

2.2 If needed, expose the concrete by cutting the carpet or other loose floor coverings (Note: Carpet need not be removed, but rather a 'L' shape cut to expose the concrete for drilling and the leak check enclosure). Drill a 7/8" or 1" diameter hole to a depth of 1-3/4" (measured to the center of the hole) to allow room for the installation of the probe nut and probe union (See Figure 2). Remove the cuttings using a vacuum cleaner. Be careful to not compromise the integrity of the slab during drilling (i.e., cracking it), although note if this occurs. It is important that the slab and the probe hole remain air tight for sampling and that cracks are noted.

2.3 Drill a 5/16" or 3/8" diameter hole through the remainder of the slab and approx. 3" down into the sub-slab material (See Figure 3). Drilling into the sub slab material creates a void that is free of obstructions that might plug the probe during sampling. Record the total depth of the slab and the depth drilled into the sub slab material.

2.4 Once the total depth of the slab is known, be sure that the probe (1/4" stainless steel tube with Swagelock or equivalent nut and ferrule) is cut with a hacksaw so that it does not extend beyond the bottom of the slab. Attach the probe union (1/4" male Swagelock to 1/8" female NPT) to the probe and tighten. Wrap the probe seal with Teflon tape and tighten into the union. See Figure 8 for an expanded view of the probe parts.

2.5 Wet the walls of the hole using the Q-tip or moistened paper towel. This helps the mortar bond to the drilled concrete. Prepare the mortar in accordance with manufacturer's directions to a stiff consistency. Make sure that the consistency is such that the mixture will not run down the sides of the hole and potentially clog the probe or hole. Place sample probe and sample union part way into the hole as shown in Figure 4. The probe tip should be at least one inch into the smaller diameter hole, but not so far that mortar can not be easily placed in the large diameter hole around the probe fittings. It is critical that the mortar mixture does not get into either end of the probe and cause a plug. Using the tongue depressor or similar tool, apply mortar around the base of the sampling probe and sampling union such that it will be sealed once it is in place.

2.6 Fill the hole with mortar, and press the probe further into the hole until its top is flush with the floor. In doing so, slightly wiggle the probe to create good 'wetting' contact between the probe and the mortar as well as the mortar and the drilled concrete. Scrape off excess and make sure there is clear access to the probe. See Figure 5.

2.7 Let dry for 24 hours

2.8 Be sure to never leave the probe hole open to atmosphere for extended periods to minimize the effects of surface infiltration.

3.0 Manifold Assembly and leak check

3.1 Make sure the sampling system is assembled (as shown in Figure 1 or 10) by connecting the sampling manifold to the soil gas probe and the purge system. <u>Do not connect the flow controller or canister at this time</u>.

3.2 Make sure the gas probe valve (valve #1) is closed.

3.3 Open the sample valve (valve #2) and the purge valve (valve #3) and turn the vacuum pump on. Make sure that the flow meter on the vacuum pump exhaust is reading 200 ml/min. Let the pump run for 1 minute to allow purging of potential contaminants from the manifold

3.4 Now close valve #2 to achieve a vacuum gauge reading of 10 inches of mercury or to a vacuum that will be encountered during sampling, which ever is greater. Close the purge valve #3 and shut the vacuum pump off.

3.5 If the pressure in the manifold has not changed after a minute, then the manifold is considered leak free. If not, repair any leaks prior to use and re-check the manifold.

3.6 Record the leak check date and time on the field sampling log.

4.0 Probe Leak Check and Probe Purging

4.1 The sampling system needs to be leak-checked and purged before sampling. Two different methods supported by the available literature/guidance are presented. One method uses helium gas as a tracer and allows for the assessment of potential probe leak prior to sample collection. The other method uses isopropyl alcohol as a tracer and allows for the assessment of potential probe leak after sample collection and analysis. Both these methods are acceptable and are detailed below.

4.1.1 Helium leak checking technique and purge

4.1.1.1 Remove the probe seal insert, wrap the sampling union fitting threads (1/8″ male NPT to ¼″ male Swagelock or equivalent) with Teflon tape (wrap the NPT threads only), and tighten into the exposed probe fitting. Thread the Teflon sample tubing through the rubber grommet in the leak check enclosure from the outside, and attach the tube to the sampling union using a nut and ferrule. Slide the enclosure down so it seals on the concrete slab. Attach the other end of the sample tube to the sampling manifold. See Figure 6 and 7.

4.1.1.2 Attach tubing to the flow meter on the helium tank regulator and the other end to the enclosure. Attach the exhaust tube to the enclosure and position the other end as far away as possible to avoid detection by the helium leak detector. See figure 9.

4.1.1.3 Put the helium detector on the exhaust line from the sample pump. Make sure valve 1 is closed. Open valves 2 and 3. Turn on the sample pump and helium detector.

4.1.1.4 Open the helium tank and set the flow meter for approximately 200 ml/min. Allow it to flow for 1 minute to fill the leak check enclosure before starting the purge. Make sure that the detector is not reading any helium before starting the purge.

4.1.1.5 Two liters of sub slab gas need to be purged before sampling. The purge time is 10 minutes at a flow rate of 200 ml/min. Close valve #2 and open valve #1 simultaneously and start timing for the purge volume. During the purge, observe the helium detector for indication of probe leakage (e.g. infiltration of room air into the probe). If a reading of >5% is observed, then the probe leak check has failed, and corrective action is required. This includes first checking the fittings and trying another purge and leak check. But may result in removing the probe and re-cementing it.

4.1.1.6 At the end of the purge time, close valves #1 and #3 and turn the pump off. If at any time during the purge the detector read < 5%, then the system is leak free and ready for sampling. If >5% was observed, then check the fittings and try again. If <5% cannot be achieved, then this probe must be abandoned and a new hole drilled. Be sure to record the helium leak check value on the field sheet.

4.1.1.7 Close the helium tank valve.

4.1.2 Isopropyl alcohol leak checking technique and purge

4.1.2.1 Moisten a paper towel with isopropyl alcohol. Wrap the isopropyl alcohol moistened paper towel around probe fittings at the slab surface. Note: It is important to keep the isopropyl alcohol completely away from the sample equipment and SUMMA Canister during the set up phase. The sampler must also change nitrile gloves between setting up the sample equipment and conducting the leak detection test. It is also important to instruct the laboratory to analyze for isopropyl alcohol. If isopropyl alcohol is detected by the laboratory at a concentration greater than 5% (50,000 ppmv) then the sample is deemed to be invalid due to a leak.

4.1.2.2 Two liters of sub slab gas need to be purged before sampling. The purge time is 10 minutes at a flow rate of 200 ml/min. Close valve #2 and open valve #1 simultaneously and start timing for the purge volume.

4.1.2.3 At the end of the purge time, close valves #1 and #3 and turn the pump off.

5.0 Sampling

5.1 The Summa canister has been evacuated to near absolute zero pressure. Care should be used at all times to prevent inadvertent loss of canister vacuum. Never open the valve affixed to the canister unless the intent is to collect sample or check the pressure. Use only a canister that has been certified to be clean.

5.2 Remove the canister valve cap, attach the vacuum gauge to the canister, and open the canister valve. Record the pressure reading and close and remove the valve. The pressure in the canister should be between 28″ and 30″ of mercury. If not, then the canister has leaked and should not be used for sampling.

5.3 Connect the flow controller to the manifold (at valve #2) and the Summa canister to the flow controller. The port on the flow controller that reads 'HP' or 'In' should be attached to the manifold. The port that reads 'LP' or 'Out' should be attached to the canister. Use only a flow controller that has been cleaned and properly adjusted.

5.4 To take the sample, confirm valve #3 is closed, and open valves #1 and #2. Slowly open the canister valve approximately one (1) full turn, and start timing. Record the start time on the field sampling log. During the sampling period, record the lowest pressure from the manifold gauge on the field log.

5.5 There are different sample time and flow rate protocols. These are subject to project requirements.

5.5.1 5 minute sample period, 850 ml canister: The flow controller is set for 150 ml/min. For an 850 cc Summa canister, it will take 5 minutes to collect a sample.

5.5.2 24 hour sample period, 6 liter canister: The flow controller is set for 3.75 ml/min. For a 6 liter Summa canister, it will take 24 hours to collect a sample.

5.6 At the end of the time, close the sample valve (valve #2) and the valve affixed to the canister. Remove the canister from the apparatus.

5.7 Re-attach the vacuum gauge and record the final pressure. The canister should only have 750 mls of sample in it based on a 150 ml/min sampling rate for 5 minutes. This should equate to between 2″ and 5″ final pressure in the canister. Record the sampling date, time, canister ID, flow controller ID, and any other observation pertinent to the sampling event on the field sampling log.

5.8 Remove the gauge from the can and tighten the cap back on with a wrench. Verify that canister valve is closed.

5.9 Fill out all appropriate documentation (sampling forms, sample labels, chain of custody, sample tags, etc.).

5.10 Disconnect the sample tubing from the probe, and remove the sampling union.

6.0 Probe Abandonment

6.1 After sampling, it is critical that the probe either be removed or plugged to prevent the creation of a new pathway for vapor intrusion.

6.2 If the probe is to be used again in the future, wrap the probe seal insert with Teflon tape, and tighten it into the probe opening using a hex key until it is tight and flush with the concrete floor.

6.3 If the probe is to be removed, insert the removal fitting into the probe. Using a crow bar, remove the entire probe assembly. If the probe can not be removed in this manner, then over drill the probe with the drill and 1″ bit. Fill the hole with cement mix.

Figure 1 – Sub slab
Sampling

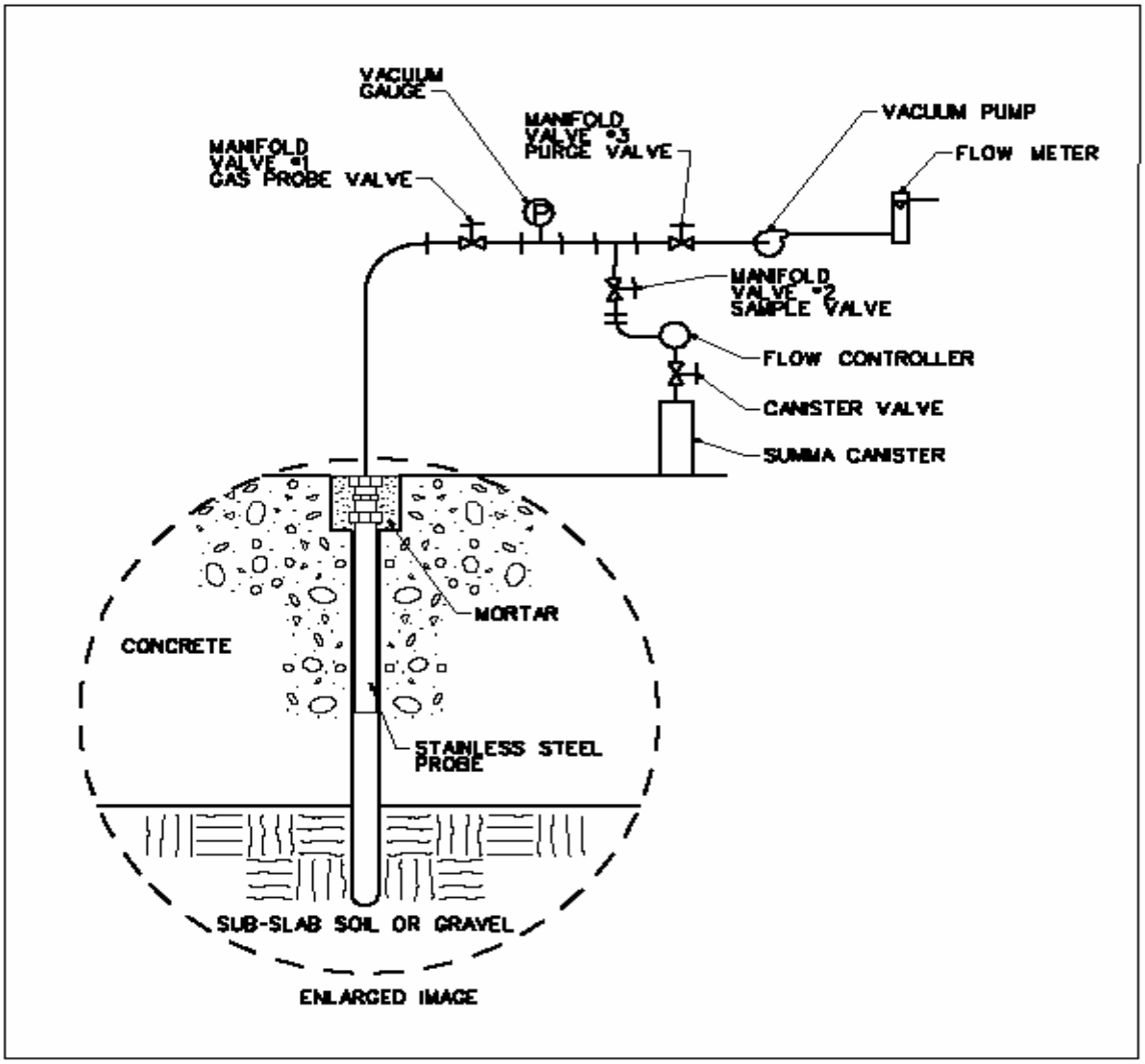


Figure 2 – Drilling 1” mortar hole to a depth of 1 ¾”

Figure 3 – Drilling 3/8” probe hole

Figure 4 – Installing Probe with mortar

Figure 5 – Installed probe, flush with slab

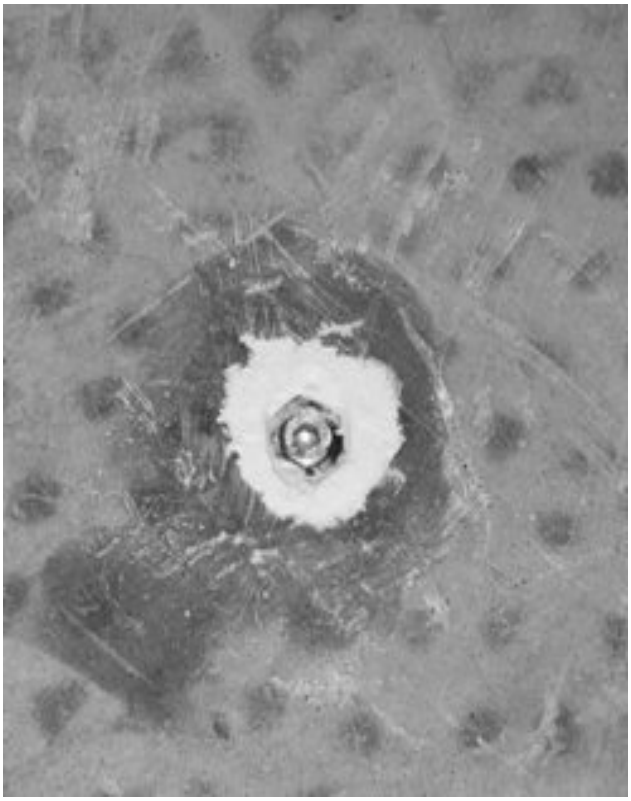


Figure 6 – Installed probe with sample tube

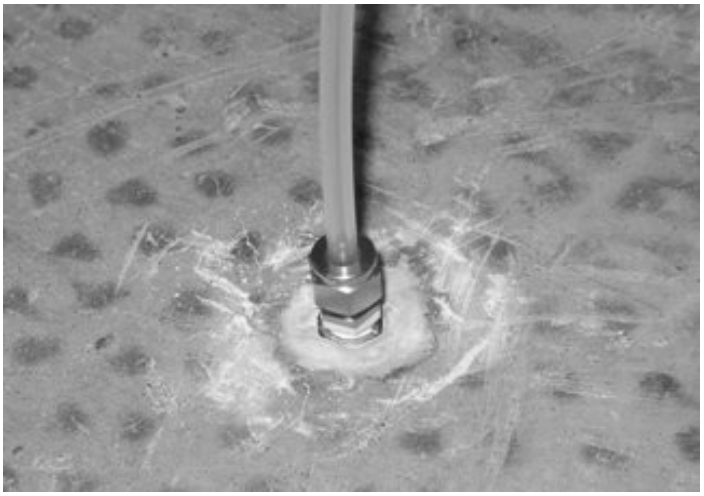
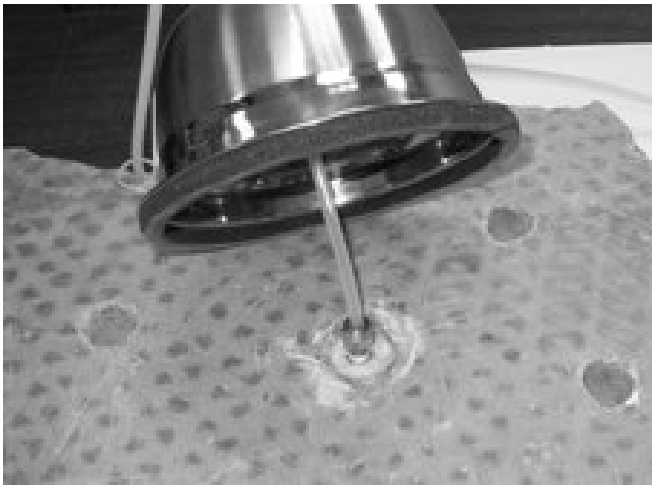


Figure 7 - Installing the helium leak check assembly



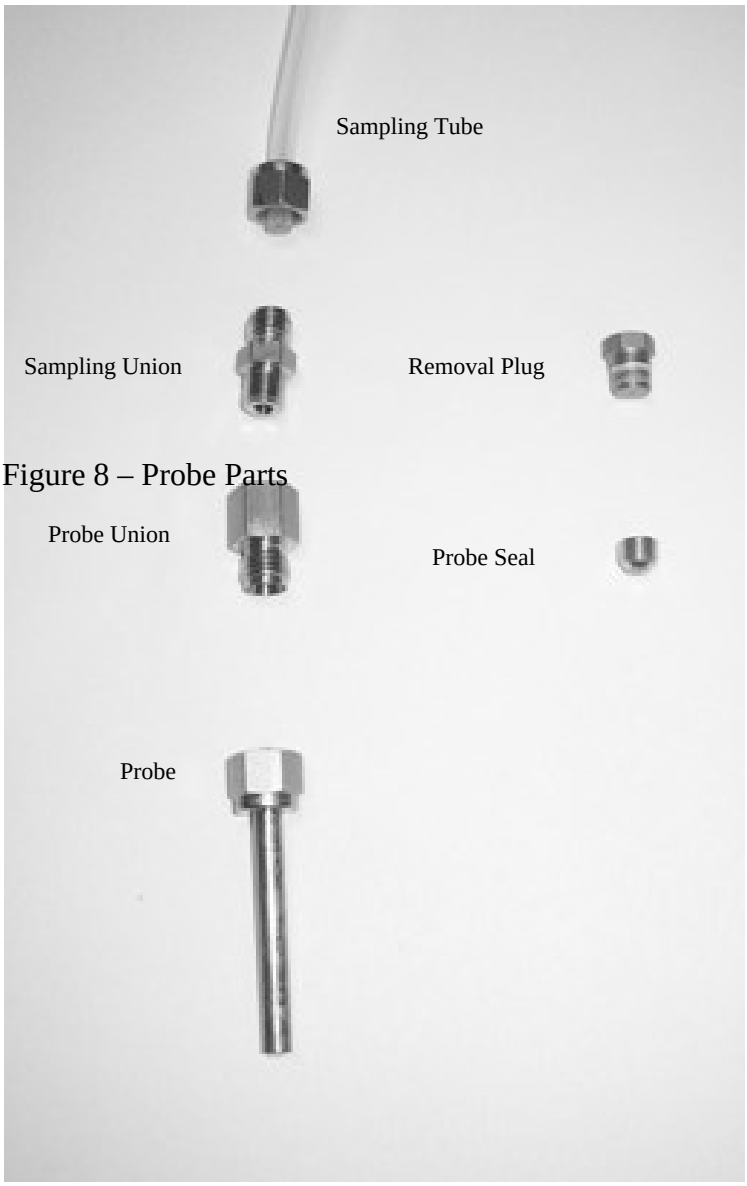


Figure 8 – Probe Parts

Figure 9 –Helium Leak Check Assembly

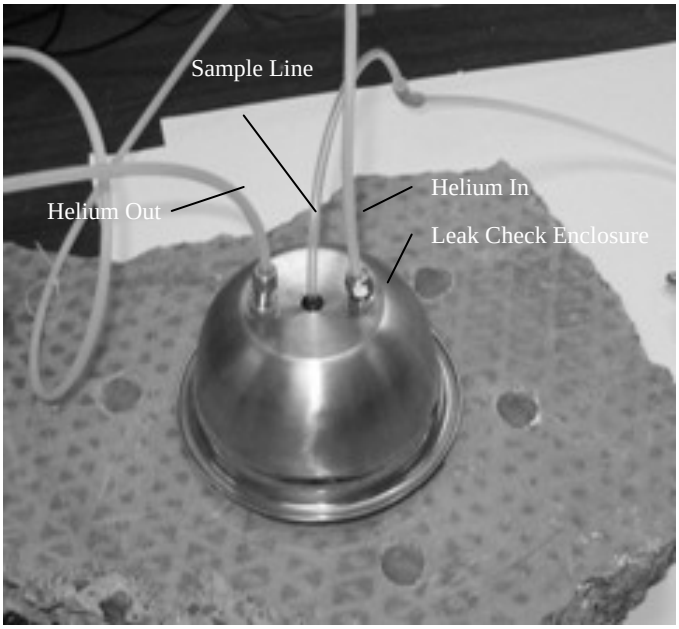
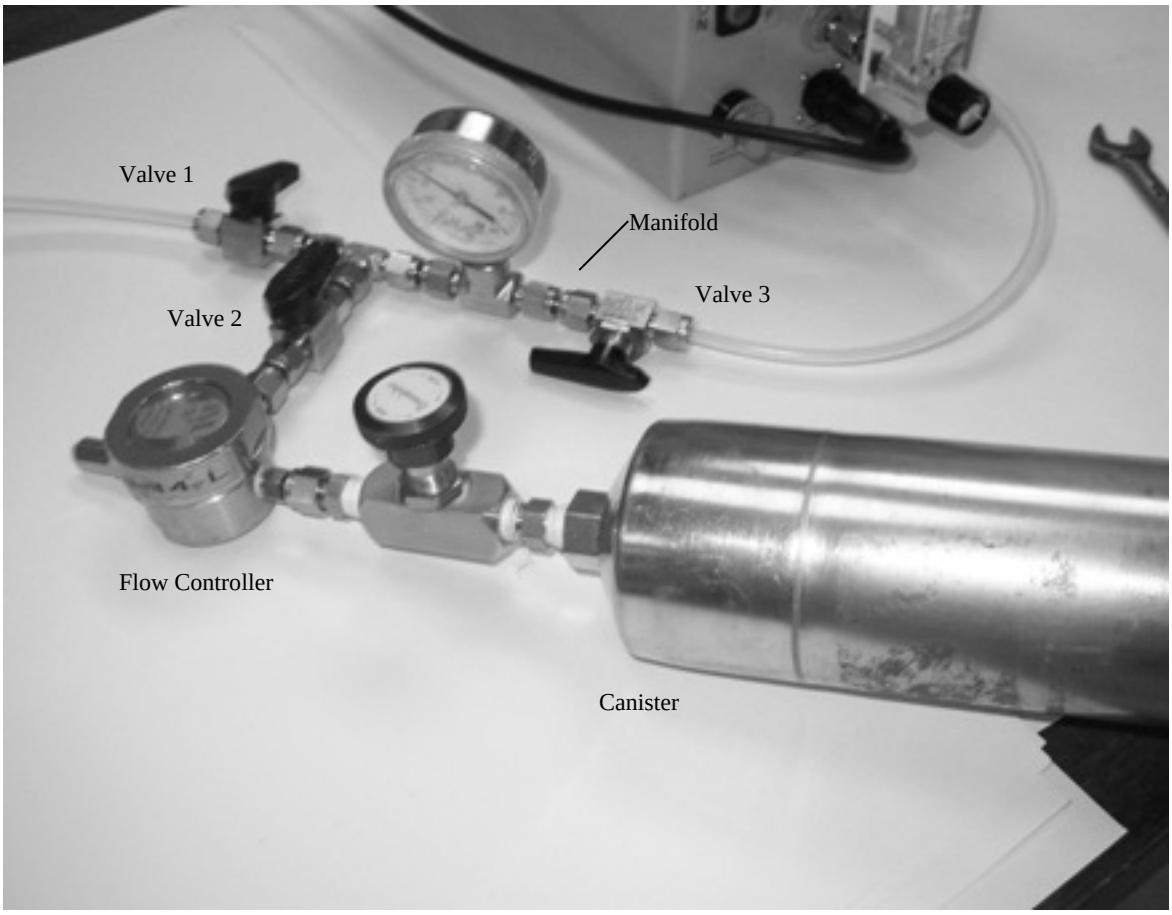


Figure 10 – Sampling Manifold



Responses to Comments

REVIEW COMMENTS

PROJECT: Former Communications Site
DOCUMENT: Draft WP Addendum 3; Soil Gas Investigation
LOCATION: Fort Wainwright, Alaska

	DATE: 7/14/2007 **REVIEWER: C. Fosbrook** **PHONE: 384-2713**	**Action taken on comment by:**_____

Page No., Spec. Paragraph	Item No.	COMMENTS	REVIEW CONFERENCE A - comment accepted W - comment withdrawn		Back check by: (Initials)
Previous Sampling Results	**1**	Indicate on Figure 3-2 previous soil gas probes.	Locations of passive gas samplers were added to Figure 3-2. Area of elevated VOCs from previous passive soil gas samples is shown on Figure 3-2.		
DQOs	**2**	Screening values should be listed as Region 6 Risk Based Tables or 1/10 of ADEC Table C. In addition, the specific section in the RI Management Plan should be listed for a quick reference.	EPA Region 6 Risk Based Table for Ambient Air Concentrations multiplied by 10 will be used as Target Sub-Slab Vapor Intrusion Screening Level. The factor of 10 will account for attenuation from the slab to indoor air.		
Sample Approach	**3**	Clarify that this plan is only for installation of wells in areas on non-MEC as discussed in the "Area of Investigation". Note that a revised or second plan will be provided for work inside the MEC area. A brief discussion on the rational for the selection of each well by sub-area should be provided along with the PCOC that was discussed in the May meeting. This could easily be a short table by sub-area. Specific reference to the FSP section or RI Management plan would explain quickly to a reader the well installation protocols and sampling techniques.	The text will clarify that this plan is only for soil gas investigation with the "non-MEC" area. Soil gas procedures for the MEC area will be included in the RI Management Plan. We do not plan to discuss the rationale for soil gas samples by sub area. We will use the existing passive sampling data to focus the sampling in areas of known POL and chlorinated solvent contamination (e.g., north west corner POL area). Per discussion at the 6/6-7 meeting, the decision was to increase the density of soil gas sampling points in areas of known VOC contamination. In the areas with no VOCs detected or no data, 11 samples will be taken. We propose VOC analysis (TO15) at all locations - no changes by sub area. This is the analysis we need for calculation of migration to indoor air. The text will refer to FSP Section 2.2.		

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		DATE: 7/14/2007 **REVIEWER: C. Fosbrook** **PHONE: 384-2713**	**Action taken on comment by:**_____

Page No., Spec. Paragraph	Item No.	COMMENTS	REVIEW CONFERENCE A - comment accepted W - comment withdrawn		Back check by: (Initials)
General	**4**	Comments and changes in WP #1 regarding MEC areas the MEC area and Non-MEC area should be carried to this plan	Text will be added to explain the conservative approach used to determine the MEC area. The text will also refer to the MEC Support Work Plan.		
General	**5**	Without completion of the RI Management Plan from May, it appears there is not a rational for so many soil probes. The rational discussed in the May meeting should be shortly summarized in this plan as well as referenced to the FSP section on installation, sampling and analytical.	The following rationale, developed at the 6/6-7 meeting will be added to the text: 1) One soil gas sample per building to satisfy our objective of qualifying risk of vapor intrusion to indoor air. 2) In areas of known VOC contamination, increase the density of sample points to assess the extent of contamination. **3)** In areas with no detected VOCs or no data, 11 samples are proposed to identify point sources since historical data is not complete.		
Purpose	6	It should be clearly that this specifically outlines the Soil Gas Analysis work. The Army, EPA and ADEC agreed to conduct the RI/FS for FCS utilizing the tri-ad approach. A Management Plan addressing the methods of the overall site management, QAPP and sampling techniques has been prepared. This document is one of many workplans that provide detailed information to the specific task of the RII/FS. This approach was determined to be the most effective, efficient and appropriate method for investigating this site. (Something like this should be stated at the beginning of each Addendum) >>>same comment from workplan #2	The addendum will clearly state that this outlines the soil gas work. This paragraph will be added to the Purpose section of the addenda.		

REVIEW COMMENTS

PROJECT: Former Communications Site
DOCUMENT: Draft WP Addendum 3; Soil Gas
LOCATION: Fort Wainwright, Alaska

U.S. ARMY CORPS OF ENGINEERS CEPOA-EN-EE	DATE: 7/6/07 REVIEWER: Julie Sharp-Dahl PHONE: 753-5689	Action taken on comment by:_____

Page No., Spec. Paragraph	Item No.	COMMENTS	REVIEW CONFERENCE A - comment accepted W - comment withdrawn		Back check by: (Initials)
Previous Sampling Results	**1**	3rd sentence: soil gas sampling was not "widespread" but rather targeted the Northern POL area and the buried drum area near B49, because these were the only known areas (at the time) of potential contamination by VOCs.	This summary of the 2006 passive sampling approach will be added to this section.		
Figure 3-2	**2**	Please add to the Legend the soil gas points that NWI installed in 2006, so reader's unfamiliar with last years efforts can see exactly what area we have *passive* soil gas data for. The addition of this information will help support the text, as well as (hopefully) show that we plan to have adequate coverage over the POL area. Suggest moving one of the points at B64 to the eastern side of B64 (instead of 2 on the west side). What is faint line running through B64 and NW to swale area? May need to remove this faint path-looking line.	Locations of passive gas samplers were added to Figure 3-2. Area of elevated VOCs from previous passive soil gas samples is shown on Figure 3-2. Relocation of B64 point may not be feasible due to utilities along the east side of the building. The new approach is to locate many of the points within the footprint of the building, through the garage slab. The faint line is the former river channel/drainage swale. This will be more clearly marked on Figure 3-2.		
	3	end			

REVIEW COMMENTS

PROJECT: Former Communications Site
DOCUMENT: Draft WP Addendum 3; Soil Gas
LOCATION: Fort Wainwright, Alaska

U.S. ARMY CORPS OF ENGINEERS CEPOA-EN-EE	DATE: 7/6/07 REVIEWER: Sharon Richmond, ADEC PHONE:	Action taken on comment by:_____

Page No., Spec. Paragraph	Item No.	COMMENTS	REVIEW CONFERENCE A - comment accepted W - comment withdrawn		Back check by: (Initials)
3-1	1	Area of Investigation. I recognize that the boundaries of the Munitions and Explosives of Concern (MEC) vs. non-MEC area have yet to be resolved and that work in the munitions disposal area is not discussed in this document	Text will be added to explain the conservative approach used to determine the MEC area. The text will also refer to the MEC Support Work Plan.		
3-1	2	Background Information. Last sentence. Please reference the potential for contaminant exposure via inhalation of outdoor air. This is important because strong odors have been documented in outdoor air during site visits and during construction activities. Based upon the soil vapor data collected in 2006, it also seems likely that vapors are present near and/or under the School Age Services (SAS) Building. It is appropriate to include an evaluation of risks from exposure to indoor and outdoor air for residents, users of the SAS, and previous and future site workers.	The inhalation of outdoor air will be included in the risk assessment. Risk Assessment Work Plan, Section 3.4.3, addresses inhalation of ambient air and other exposure pathways.		
3-2	3	Data Quality Objectives. I believe that indoor air risk at the SAS and outdoor air inhalation risks should also be included in this section. See Comment 2	Text will be revised to add collection of one sub-slab sample at the SAS Building to address the indoor air risk. Risk Assessment Work Plan, Section 3.4.3, addresses inhalation of ambient air and other exposure pathways.		
3-2	4	Sampling Approach. 1st sentence. The number of sampling probes proposed in this document has not been agreed upon. At our April 2007 planning meeting, we agreed to place more probes around houses where volatile organic compounds (VOCs) are known to be present. My recollection is that houses in the northwestern area would have six probes while other houses would have four.	One soil gas probe at each building will be sufficient for estimating risk to indoor air. Additional sample points have been included in the NW area.		
3-2	5	Sampling Approach. 2nd paragraph. It is also possible that geophysical data collected this year will be required before soil boring locations are finalized. See Comment 1.	Text will be modified to add that the latest geophysics will be used in the selection of sampling locations.		
3-3	6	Sample Collection and Analyses. General Comment. Please provide detail regarding how sample locations were chosen. The Johnson & Ettinger model is most useful with vapor concentrations collected directly beneath a building. I understand that the radiant floor heating in these buildings prevents collection of sub-slab samples. I am also concerned that positioning vapor probes equidistant between buildings is not the most conservative approach. It is preferable to place them as close to each building as possible and as close as possible to a potential or known source. Depth of sampling would then be dependent on the depth of fill present beneath each building. Data collected in this manner will allow us to be most conservative.	We have confirmed that there is no radiant floor heating in the buildings. Therefore, the approach will be changed to core the slab in the garage at each house. An addendum to the FSP will be issued to cover the procedures for collecting the sub-slab soil gas sample.		

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U.S. ARMY CORPS OF ENGINEERS CEPOA-EN-EE	DATE: 7/6/07 REVIEWER: Sharon Richmond, ADEC PHONE:	Action taken on comment by:_____

Page No., Spec. Paragraph	Item No.	COMMENTS	REVIEW CONFERENCE A - comment accepted W - comment withdrawn		Back check by: (Initials)
3-3	7	Sample Collection and Analyses. General Comment. Although it is getting late in the season, I suggest considering the use of a field gas chromatograph and Tedlar bags for sample collection and analysis. This could allow for multi-depth sampling and more samples.	Multi-depth samples are not required for sub-slab samples. Multi-depth samples are not recommended for other areas. The field GC results would not be valid for risk assessment purposes and the detection level of the field GC may not be sensitive enough to give an affirmative "non-detect" for any areas. For this investigation we do not recommend using the field GC to ensure all data can be used in risk assessment. The locations shown on Figure 3-2 are the minimum sample locations; depending on results for all sampling efforts (groundwater, soil, etc) and assessment of risk, additional point may be added at a later date.		
3-3	8	Sample Collection and Analyses. General Comment. The Field Sampling Plan (FSP) describing how the samples will be collected has not been approved. I strongly encourage the Army to consider all comments that might have been submitted and incorporate them into the FSP before starting field work.	A revised FSP, addressing all outstanding comments has been submitted. Procedures for sub-slab soil gas sampling will be attached to the Addendum. These procedures will be added to the FSP.		
General	9	General Comment. The header for this document is incorrect. Please change "Addendum 2: Soil Pile Investigation" to "Addendum 3: Soil Gas Investigation".	The header will be corrected.		
General	10	General Comment. In addition to utility locates, as-builts, and contract drawings, it would be preferable to also consider preferential pathways such as utilidors, the former slough channel, and buried debris when deciding where probes will be placed. I suggest adding a section describing how final probe locations will be chosen if it is determined in the field that they need to be moved from the proposed locations. I think this is critical to ensuring that the final placement is agreed upon by all project managers.	Some of the soil gas sample points will be targeted in the former slough channel. We cannot target utilities. However, sub-slab samples account for migration via preferential pathways from utilidors, etc.		

REVIEW COMMENTS

PROJECT: Former Communications Site
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LOCATION: Fort Wainwright, Alaska

	DATE: 19 Jul 07 **REVIEWER: Jacques Gusmano, EPA** **PHONE:**	**Action taken on comment by:**_____

Page No., Spec. Paragraph	Item No.	COMMENTS	REVIEW CONFERENCE A - comment accepted W - comment withdrawn		Back check by: (Initials)
General	**1**	EPA recommends the development of a geophysical anomaly/debris avoidance plan for use site-wide. Please see Specific Comment No. 1 for more detail.	Many of the samples have been moved to within the building footprint, and will be collected at a safe depth of 3 inches below the slab. For soil gas samples in open areas, CH2M HILL will use available geophysics, as-built drawings, and anomaly avoidance/ location clearance using a magnetometer. Additional MEC support procedures are included in the MEC Support Work Plan.		
3-1, par 2, Sent 1	**2**	The proposed subdivision of the FCS into “MEC” and “non-MEC” areas is based on a “preponderance of evidence” argument that incorporates four separate data sets 1) geophysical data, 2) historical/archival records, 3) 5 aerial photographs from a 60+ year period, and 4) observations made during recent construction activities. Because each data set differs in its quality and completeness, e.g. the geophysical data uncertainties are quantifiable and bounded whereas the aerial photos are “sparse” representing only five “samples”, the subdivision relies on a qualitative weighing of the four data sets. EPA feels that the geophysical data quality far exceeds that of the other sets and therefore should receive the highest weight in the integrated evaluation. Each of the data sets used are insufficient on their own to discriminate MEC from non-MEC debris, including the most quantifiable data from the geophysical surveys. Thus, adding sparse or otherwise lower quality data to the geophysics does not increase the amount of information that can be extracted by interpretation. More concisely, the discrimination capability of the combined data does not exceed the discrimination capability of its component parts. The geophysics has provided a high resolution image of potential buried metal site wide which should be interpreted within the context provided by the other three a priori data sets, but not constrained by them. EPA feels that the anomalies currently proposed as “not requiring MEC clearance” also deserve to be considered potentially hazardous, regardless of the presence or absence of MEC. *Continued on next page*	Figure 3-2 will be amended to include geophysical data. Anomalies in the non-MEC area will be avoided using the available geophysical data, and anomaly avoidance/ location clearance using a magnetometer. Additional MEC support procedures are included in the MEC Support Work Plan. Many of the samples have been moved to within the building footprint, and will be collected at a safe depth of 3 inches below the slab.		

REVIEW COMMENTS

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	DATE: 19 Jul 07 **REVIEWER: Jacques Gusmano, EPA** **PHONE:**	**Action taken on comment by:**_____	

Page No., Spec. Paragraph	Item No.	COMMENTS	REVIEW CONFERENCE A - comment accepted W - comment withdrawn		Back check by: (Initials)
		Continued from previous page **EPA recommends** that the Army develop an anomaly/debris avoidance plan for use site-wide during all intrusive activities. EPA further recommends that this avoidance plan consider the full range of potential hazards and develop contingency plans for their proper response. Some of the issues the debris avoidance plan might include are: a) details regarding how the location of the geophysical anomaly edges (laterally and with depth) will be made readily and immediately available to the field personnel who will be conducting, directing and/or overseeing the intrusive activities. For instance, will the anomaly edges be flagged, or will they be re-acquired prior to breaking ground? How will anomalies at depth be avoided? How will the technical lead decide how to determine step-out distances when intrusive activities are proposed immediately adjacent to a geophysical anomaly? Even non-MEC metallic debris presents immediate safety hazards to onsite workers and potential additional releases of contaminants to the environment if buried drums or small containers were to be inadvertently ruptured. b) The avoidance plan might also provide detailed methods that will be used to compare the field observations with the predictions made from the geophysical data. For example, the plan should identify who will be responsible for cross-checking the field observations with the geophysical results and what that person's responsibilities will include. c) The avoidance plan might additionally include contingency plans if observables deviate from the expectations (as noted in bullet b). The contingency details should include decision trees and action plans for circumstances such as, what will be the plan of action is a geophysical anomaly can not be re-acquired (a geophysical false positive) or, conversely, what should be done if debris is found where no geophysical anomaly was recorded (a geophysical false negative). If the "preponderance of evidence" approach were to fail at this site, the results may not only compromise the safety of workers in the vicinity, but could potentially release additional contaminants to the environment, as well as heighten public concerns beyond current levels. These factors should be considered important enough to warrant assigning the geophysical results considerably more weight in the evaluation than the photos, archives, or even construction field notes. The order in which soil gas probes and well installation occur could be important. EPA suggests that the information obtained by the well borings could give information useful to the driving of soil gas probes, such as truth testing geophysical data.			

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	DATE: 19 Jul 07 **REVIEWER: Jacques Gusmano, EPA** **PHONE:**	**Action taken on comment by:**_____

Page No., Spec. Paragraph	Item No.	COMMENTS	REVIEW CONFERENCE A - comment accepted W - comment withdrawn		Back check by: (Initials)
3-1, par 3 , Sent 1	**3**	A portion of this sentence reads "… work may require clearance and oversight measures." What criteria will be used to determine which circumstances that may require clearance? **Recommendation:** Clarify the "may require" aspect, either by adding a section in this addendum and citing that section here, or by developing a separate document (i.e. an avoidance plan) and citing that document instead.	Procedures for MEC support at the site will be presented in a separate document, the MEC Support Work Plan. The addendum will reference the MEC Support Work Plan.		
3-1, par 5	**4**	An overview figure would be helpful here. **EPA recommends** developing a figure that indicates the locations of existing site features (including key historical structures, existing wells, etc) on a detailed base map of the site, preferably using a high-resolution aerial photograph as the base layer with key site features labeled as necessary (i.e. building numbers, TSA location, etc.) This figure could then be used to indicate the locations of all proposed soil gas points, current plume boundaries or other soil gas relevant information.	Figure 3-2 will include the location of geophysical anomaly data (2004), MEC/non-MEC areas, previous passive soil gas sample locations, proposed soil gas sample locations, location of the river channel/drainage swale, and building numbers. Figure 3-1 will include aerial photograph, MEC/non-MEC area, and building numbers.		
3-2, DQOs	**5**	The first sentence states that "A DQO process was used to document the purpose of data to be collected…" The "purpose" is the Data Objective. The DQO process determines the accuracy and quality specifications that the data needs to meet in order to fill existing data gaps. **EPA recommends** expanding this discussion to identify both the purpose of the data as well as the quality requirements. EPA further suggests that this task may be easier if the section were moved "down", so that it follows the discussion of the specific tasks and activities proposed. Incidentally, "VOC" in sentence 1 should read "VOCs	The discussion will be expanded to identify the purpose of the data [(1) to decide whether future indoor residents may be exposed to VOC concentrations in soil gas that pose a potential for unacceptable risks via a vapor intrusion pathway. The quality requirements of the data will also be included in Table 3-1.		

REVIEW COMMENTS

PROJECT: Former Communications Site
DOCUMENT: Draft WP Addendum 3; Soil Gas Investigation
LOCATION: Fort Wainwright, Alaska

	DATE: 19 Jul 07 **REVIEWER: Jacques Gusmano, EPA** **PHONE:**	**Action taken on comment by:**_____

Page No., Spec. Paragraph	Item No.	COMMENTS	REVIEW CONFERENCE A - comment accepted W - comment withdrawn		Back check by: (Initials)
3-2, para 2 in DQO, sentence 2		Enough information should be currently available to briefly indicate a few details on how much the default modeling parameters will need to be changed. **EPA suggests** listing each user-definable modeling parameters in either the text (as bullets?), or in a small table. EPA suggests that each variable be followed by a parenthetical statement of the default, minimum, mean, maximum values to be used. Also, because this is discussed in the DQO section, it is appropriate to discuss the soil gas quality requirements and how variances in them are expected to impact the modeling. This is also true for uncertainties in vadose zone structural heterogeneities such as clay or silt lenses or porosity and permeability changes that may not be fully realizable using the chosen modeling application. Are there any data gaps that currently exist that might confound the results of the soil gas data acquisition or the modeling effort?	The RI will collect the data needed to do the J&E calculation and the listing the default& mean input values and ranges at this time is premature. A sensitivity analysis will be conducted, as necessary, during the risk assessment. The revised approach of collecting soil gas beneath the building slab will decrease the impacts of variances and uncertainties in vadose zone structural heterogeneities such as clay or silt lenses or porosity and permeability changes, and will provide much more defensible results. To the greatest extent possible, site-specific building dimensions and design values for air exchange rates will be used.		
3-2, 3rd para, sent 1		This sentence states that "approximately 76 direct-push soil gas points will be completed…" **EPA recommends** adding a brief statement of exactly how many points are proposed plus the number of contingency/optional points that may be anticipated.	The text will be amended to include the total number of proposed soil gas points and a number of optional points that may be anticipated.		
3-2, 3rd para, sent 2		There appears to be a missing word ("the"?) between "within" and "northwestern portion". **EPA recommends** a minor correction here.	The text will be corrected		
3-2, 4th para, sent 1		This sentence states that "the boring locations were demarcated after reviewing …" First, the soil gas points are not really borings, but drive-points" Secondly, in what way were the soil gas points demarcated? On a map? On the ground? **EPA suggests** clarifying the use of the term "demarcated".	The text will be amended to state "drive point" instead of "boring" when referencing soil gas points. The text will remove "demarcated" and replace with " proposed locations identified on Figure 3-2."		
3-2, 4th para		EPA agrees with the objective to minimize potential disturbances of, or damage to, buried utilities or other underground structures, but suggests that the sentence should be expanded to include avoidance of geophysical anomalies as well**. EPA recommends** revising the text and adding figures indicating the proposed soil gas points relative to the geophysical data so that all known potential underground objects are clearly represented in this addendum	Agreed. The plan is to avoid utilities AND geophysical anomalies. Figure 3-2 and text will be amended to show proposed soil gas drive points and geophysical data		

REVIEW COMMENTS

PROJECT: Former Communications Site
DOCUMENT: Draft WP Addendum 3; Soil Gas Investigation
LOCATION: Fort Wainwright, Alaska

	DATE: 19 Jul 07 **REVIEWER: Jacques Gusmano, EPA** **PHONE:**	**Action taken on comment by:**_____

Page No., Spec. Paragraph	Item No.	COMMENTS	REVIEW CONFERENCE A - comment accepted W - comment withdrawn		Back check by: (Initials)
Figure 3-1		As discussed in EPA Specific Comment No. 1, this figure under-values the information provided by the geophysical surveys. **EPA recommends** removing the MEC delineation boundaries and making Figure 3-1 a base map showing the location of existing features and proposed soil gas drive points (See EPA Specific Comment No. 3).	Figure 3-1 shows the MEC and non-MEC areas. These boundaries are based on geophysical surveys. Since Addendum 3 references a "MEC "and "non-MEC" it is important to show that delineation.		
Figure 3-2		This Figure is too small and the font too light for easy reading. It is unclear why this format was selected for drive point illustrations rather than the Figure 3-1 style map. **EPA recommends** an alternative approach to this figure wherein the locations for points would be added to the geophysical survey results (separate maps for each methodology) so that the field personnel can make informed decisions regarding proximity to geophysical anomalies and the need for step-out locations and avoidance.	Figure 3-2 will be revised to include a site photo with geophysical data, previous passive soil gas sample locations, proposed soil gas drive points, buildings, and location of the river channel/drainage swale.		
Figure 3-2, Legend		**EPA recommends** including avoidance of geophysical anomalies in this note.	Geophysical anomalies will be added to the Figure 3-2 and identified in the legend.		
3-1, par 1, sent 1 &2		These two sentences feel out of order. **EPA recommends** rewording slightly and changing the order.	The text will be amended.		

REVIEW COMMENTS

PROJECT: Former Communications Site
DOCUMENT: Draft WP Addenda 1-4
LOCATION: Fort Wainwright, Alaska

U.S. ARMY CORPS OF ENGINEERS CEPOA-PM-C	DATE: 6/30/07 REVIEWER: Bob Brock PHONE: 753-5612	Action taken on comment by:_____

Page No., Spec. Paragraph	Item No.	COMMENTS	REVIEW CONFERENCE A - comment accepted W - comment withdrawn		Back check by: (Initials)
Area of Investigation	**10**	See Item 2 above [Explain how MEC was determined and that a conservative approach was used (see email from Beth Astley, CRREL). Consider squaring off the area for ease of locating in the field. Add that if site conditions change (i.e. debris is encountered in other areas) that the plan will be revisited and changed as needed. Add that UXO technicians (two reams) will be onsite to support Building 48/49 investigations and test pit installations and will be available to provide support as warranted by changed site conditions. Work below EXISTING grade in MEC area will require UXO support]	Explanation of how the low-probability MEC area was determined will be included. The area was squared off for ease of locating in the field. The text will also reference the MEC Support Work Plan.		
Previous Sampling	**11**	Capitalize Benzene in fifth sentence.	Text will be amended		
DQOs	**12**	Will the soil gas data be validated?	Yes, the soil gas data will be validated.		

Addendum 4

Final

Addendum 4 to the Remedial Investigation Work Plan

Groundwater Investigation

FWA 102 Former Communications Site
Fort Wainwright, Alaska

Prepared for

Department of the Army
U.S. Army Corps of Engineers,
Alaska District

P.O. Box 6898
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Contract No. W911KB-05-D-0010
Task Order 0009

18 September 2007

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ADDENDUM 4

Groundwater Investigation

Purpose

This document serves as an addendum to the May 2007 *Remedial Investigation/Feasibility Study Management Plan FWA 102 Former Communications Site Fort Wainwright Alaska* (remedial investigation [RI] Management Plan). This addendum addresses the characterization of soil and groundwater at the Former Communication Site (FCS) for source identification and to support the baseline risk assessment. The groundwater investigation includes characterization of soils because soil samples will be collected during installation of the monitoring wells. Proposed monitoring well locations and analytical methods for groundwater and soil are presented in this addendum.

The U.S. Army, U.S. Environmental Protection Agency (EPA), and Alaska Department of Environmental Conservation (ADEC) have agreed to conduct the RI/feasibility study (FS) for the FCS using the Triad approach. The RI Management Plan addresses this approach and overall site management and includes the Quality Assurance Project Plan (QAPP) and Field Sampling Plan (FSP). This document is one of many addenda that provide detailed information about specific tasks of the RI/FS. This approach was determined to be the most effective, efficient, and appropriate method for investigating this site.

Area of Investigation

The FCS site has been divided into two primary areas that affect how the fieldwork for the RI is conducted: the Low Probability of Encountering Munitions and Explosives of Concern (MEC) Area and the Moderate to High Probability of Encountering MEC Area. Figure 4-1 depicts the location of these two areas. This addendum covers collection of groundwater samples in areas within the Low Probability MEC Area only. This addendum does not address plans for collection of groundwater samples within the Moderate-to-High MEC area. Additional wells will be installed in the Moderate-to-High MEC area upon completion of test pit activities that will clear the areas where wells will be installed. Plans for collection of groundwater samples within the Moderate-to-High MEC area will be included in the Interim Draft RI Management Plan.

Delineation of the Low and Moderate-to-High probability MEC areas, as shown on Figure 4-1, was accomplished by overlaying 2003, 2004, and 2007 geophysical data with 1949, 1956, 1982, and 2005 aerial photographs and digitizing polygons around areas that either had geophysical anomalies or surface debris. Historical photographs were used to identify areas where MEC disposal was most likely to have occurred. All of MEC uncovered to date has been within these areas. The boundary lines were conservatively expanded to the north of the tree line area and adjusted to the west to easily distinguish housing units in each area. The geophysical data shown on Figure 4-2 is from 2004, prior to construction of the housing. The 2004 data does not include anomalies generated during new construction. Figure 4-3 shows the geophysical data from 2007.

Previous Sampling Results

During the Preliminary Source Evaluation (PSE) II Investigation (Northwind, 2006), groundwater was sampled in 13 monitoring wells and analyzed for a wide range of organic and inorganic compounds. Ten of the wells sampled in 2006 were installed in 2006 and sampled only once, while three of the wells sampled in 2006 were installed during the 2005 field season and sampled in both the spring and fall of 2006. The three wells which were installed in 2005 and sampled twice in 2006 are located near the Building 52 polychlorinated biphenyl (PCB) hot spot.

Subsurface soil was sampled in 2005 and 2006 for polychlorinated biphenyls (PCBs), pesticides, metals, gasoline-range organic (GRO), diesel-range organic (DRO)/residual-range organic (RRO), volatile organic compound (VOC), semi-volatile organic compound (SVOC), and explosives. Petroleum, oil, and lubricant (POL)-contamination was identified in the northwest portion of the FCS site (Figure 4-2). Chlorinated solvents, pesticides, and explosives were also detected at the site. The coverage of previous subsurface soil and groundwater is not adequate to delineate the nature and extent of contamination for the RI. This addendum addresses collection of additional data required for source identification and for the baseline risk assessment.

Data Quality Objectives (DQOs)

A DQO process was used to determine the accuracy and quality specification that the collected data must meet to fill existing data gaps for the RI/FS. The objective of the groundwater sampling is to determine whether constituents present in site groundwater could migrate offsite at concentrations that pose a potential for unacceptable risks to base drinking supply wells, or impact offsite surface water, or cause an offsite vapor intrusion concern. The objective for soil sampling is to determine whether future site residents or excavation workers may be exposed to chemical concentrations in soil that pose a potential for unacceptable risk by direct contact.

Screening values used to assess which compounds are carried forward into the risk assessment are EPA Region 6 Risk Based Tables or 1/10th of the most conservative Alaska Department of Environmental Conservation (ADEC) soil and groundwater cleanup levels found in Title 18 Chapter 75 of the *Alaska Administrative Code* (AAC) (Tables B1, B2, and C) or in ADEC Technical Memorandum 01-007, (*Additional Cleanup Levels*.) Analytical methods have been selected with reporting limits low enough to meet these risk-based screening levels (see QAPP Section 5 Tables).

This investigation will generate soil and groundwater chemical results and water level data. Chemical data obtained from this investigation will be used with the results obtained from soil borings and soil gas investigations to determine the nature and extent of contamination on the FCS site. If constituents are detected in the soil and or groundwater at concentrations exceeding risk screening criteria these conditions will be evaluated in the baseline risk assessment and will be addressed in the Feasibility Study for the site as necessary. Groundwater quality parameters, including dissolved oxygen will be recorded for possible use in the Feasibility Study.

Groundwater Monitoring Well Locations

Figure 4-1 depicts the boundary of the "Low Probability of Encountering MEC Area" and the "Moderate to High Probability of Encountering MEC Area". The sampling locations covered in this addendum are restricted to the Low-Probability MEC Area. Additional wells will be installed in the "Moderate the High Probability of Encountering MEC Area" upon completion of test pit activities that will clear the areas where the wells will be installed. Plans for installation of wells within the Moderate-to-High MEC area will be included in the Interim Draft RI Management Plan.

Figure 4-2 shows the proposed location of 27 temporary monitoring wells in the Low Probability MEC Area. The proposed location of the 2 deep well locations are included on this figure, but since these wells are located in the Moderate to High MEC Area, the installation of these wells is not included in this addendum. Overall sample location rationale is as follows:

1. Site-wide coverage with approximately one monitoring every 0.75 acre
2. Additional monitoring wells in areas of known contamination (northwest portion of FCS) to delineate extent of contamination.
3. Monitoring wells located in former slough channel to identify potential preferential pathways.
4. Additional monitoring wells north of the FCS in the vicinity of the School Age Services (SAS) Facility.

Table 4-1 describes the number of proposed wells, and analyte groups by sub area. Sub areas are defined in the PSE 1 report (Oasis, 2007).

Well drilling, construction and development and soil and groundwater sampling procedures are provided in the *Field Sampling Plan* appendix of the *Draft RI Management Plan* (CH2M HILL, 2007). Installation of wells within the PCB exclusion zone will be scheduled to follow the PCB removal action.

Geophysical Anomaly and Utility Avoidance

Groundwater monitoring well locations will be selected to avoid geophysical anomalies and existing utilities. Careful review of as-built drawings, discussions with the construction contractor, and observations of utilities at the exposed slabs within the exclusion zone will be conducted to reduce the chances for affecting buried utilities during drilling.

GPS coordinates for monitoring well locations, shown on Figure 4-2, will be used to mark well locations in the field. Additional anomaly avoidance and location clearance with a magnetometer and current induction methods will be used if applicable. Personnel will follow *Health and Safety Plan* appendix of *Draft RI Management Plan* (CH2M HILL, 2007) and the *MEC Support Work Plan* (Jacobs Engineering Group, Inc.[JE], 2007) and use all required personal protective equipment when drilling.

TABLE 4-1

Proposed Wells and Analyte Groups by Sub Area

Sub Area	Proposed Number of Wells	Well Selection Rationale	PCOC for Soil and Groundwater	PCOC Selection Rationale
A	N/A	Area A is in the Moderate to High Probability for MEC Area and is not addressed in this Addendum	N/A (Area not sampled under this addendum)	N/A (Area not sampled under this addendum)
B[a]	12	Increased density of wells due to known POL plume in Area	GRO, DRO/RRO, Metals, Pesticides, Herbicides, VOC, SVOC, EPH, VPH, explosives	Known POL and chlorinated solvent contamination, possible pesticide and herbicide contamination, downgradient from known MEC disposal areas and past detections of explosive compounds
C	4	Increased density of wells due to known POL plume in Area	GRO, DRO/RRO, Metals, Pesticides, Herbicides, VOC, SVOC with TIC, EPH, VPH, Explosives	Known POL and chlorinated solvent contamination, possible pesticide and herbicide contamination, downgradient from known MEC disposal areas and past detections of explosive compounds
D	3	Target suspected source in northwest corner of electrical substation	GRO, DRO/RRO, Metals, Pesticides, Herbicides, VOC, SVOC with TIC, EPH, VPH, PCBs[b]	Potential POL, pesticide, herbicide, and VOC/SVOC contamination; uncharacterized anomaly recently identified[c]
E	8	Wells within and down gradient of known PCB contamination Includes wells installed in former slough channel area to identify potential preferential pathway.	GRO, DRO/RRO, Metals, Pesticides, Herbicides, VOC, SVOC, EPH, VPH, PCBs	Known PCB contamination, potential POL, pesticide, herbicide, and VOC/SVOC contamination

[a]Assume Area B extends to the south to meet the boundary of Area E and includes School Age Services (SAS) building and surrounding area.

[b]PCBs in water only at the proposed monitoring well downgradient from the recently identified anomaly at northwest corner of electrical substation.

[c]Recently identified anomaly at northwest corner of electrical substation

EPH = extractable petroleum hydrocarbons
DRO = diesel-range organic
GRO = gasoline-range organic
MEC = Munitions and explosives of concern
NA = Not applicable
PCB = polychlorinated biphenyl
PCOC = Potential contaminants of concern
POL = Petroleum, oil, and lubricant
RRO = residual-range organic
SVOC = semi-volatile organic compound
VOC = volatile organic compound
VPH = volatile petroleum hydrocarbons

Soil and Groundwater Sample Collection and Analyses

Monitoring wells will be installed using a truck- or an all terrain vehicle-mounted drill rig with a hollow stem auger drill. Installation methods will comply with *Recommended Practices for Monitoring Well Design, Installation, and Decommissioning* (ADEC, 1992).

The hollow-stem auger rig will be used to access the subsurface and collect soil cores for lithologic description and laboratory analysis. The water table at the FCS is expected to range from approximately 12 feet to 16 feet below ground surface (Northwind, 2007). For shallow wells, the screen will be placed such that approximately 5 feet is below water and 5 feet is above water table, or approximately 10 feet to 20 feet below ground surface.

Soil cores will be obtained continuously using decontaminated, 18–inch long, 3.4 inch outside diameter split barrel samplers. At a minimum, three soil samples will be collected in each monitoring well boring at the following depths: near the ground surface (approximately 2 to 3 feet below existing grade), in middle of the vadose zone at a location likely to contain contamination (e.g. clay lens, between approximately 4 and 10 feet below existing grade), and in the smear zone at depth of approximately 11 to 13 feet. A fourth sample may be collected, at the rig geologist's discretion where visual, photoionization detector (PID), or olfactory evidence of contamination is encountered. The field geologist or engineer will be responsible for directing activities, logging the lithology, and selecting the appropriate intervals for sampling. Proposed analyte groups are shown in Table 4-1.

Screening and collection of soil samples for laboratory analysis will be processed as follows:

- PID screening immediately upon opening the split-barrel sampler, followed by heated head space PID screening using procedures outlined in the *Field Sampling Plan* appendix of the *Draft RI Management Plan* (CH2M HILL, 2007).
- Samples to be analyzed for VOCs and GRO will be collected first, and quickly placed into prepared 4-ounce containers, followed by preservation with methanol.
- Samples to be analyzed for all other analytes will be homogenized prior to placing in the appropriate containers. These sample containers will be filled to the top, taking care to prevent soil from remaining in the lid threads prior to being sealed to prevent potential contaminant migration from or to the sample.

Pertinent observations made during sampling, such as the presence of odor or staining, or presence of debris or non-native fill soil will be recorded in the field logbook and on sample record forms.

Groundwater samples will be collected from each monitoring well using low-flow sampling methods. Field parameters will be monitored during well purging and samples will be collected when parameters stabilize. Well drilling, construction and development and soil and groundwater sampling procedures are provided in the *Field Sampling Plan* appendix of the *Draft RI Management Plan* (CH2M HILL, 2007).

Tables 4-2 and 4-3 present the sample collection summary for soil and groundwater samples to be collected from FCS during the groundwater investigation.

References

Alaska Department of Environmental Conservation (ADEC). 1992. *Recommended Practices: Recommended Practices for Monitoring Well Design, Installation, and Decommissioning*. April.

Alaska Department of Environmental Conservation (ADEC). 2001. *Clean-Up Levels: Calculated Cleanup Levels for Compounds without Tabular Values in Site Cleanup Rule,* Technical Memorandum 01-007.

CH2M HILL. 1996. *Groundwater Modeling at Building 3564, Delivery Order 5, Fort Wainwright, Alaska*.

CH2M HILL. 2007. *Remedial Investigation Management Plan (Draft).* May.

CH2M HILL. 2007 *Field Sampling Plan (Draft).* July.

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Northwind, Inc. (Northwind). 2007. *Preliminary Source Evaluation II Report. Taku Gardens Fort Wainwright, Alaska (Final)*. May.

U.S. Environmental Protection Agency (EPA). 2005. U.S. EPA Region 6 Human Health Medium-Specific Screening Levels.

TABLE 4-2
Sample Collection Summary–Soil/sediment

Parameter	Analytical Method[a]	Container[b,c]	Preservative	Maximum Holding Times
GRO	AK101	1 x 4-oz wide-mouth amber glass	Add 25 grams sample to 4-oz jar. Add 25 mls methanol that is prespiked with surrogate, 4°C (VOC – SW8260 analyzed from same container)	28 days to analysis
DRO/RRO	AK102/AK103	1 x 4-oz. wide-mouth amber glass	4°C	14 days to extraction 40 days to analysis
Metals	SW6010/SW6020/SW7000	1 x 8-oz. glass	4°C	28 days for mercury; 6 months for all others
Organochlorine Pesticides	SW8081A	1 x 4-oz. glass	4°C	14 days to extraction 40 days to analysis
Chlorinated Herbicides	SW8151	1 x 4-oz. glass	4°C	14 days to extraction 40 days to analysis
VOCs and TICs	SW8260B	1 x 4-oz wide-mouth amber glass	Add 25 grams sample to 4-oz jar. Add 25 mls methanol that is prespiked with surrogate, 4°C (GRO – AK101 analyzed from same container)	14 days to analysis
Low-level VOCs	SW8260B	2 x 40 mL VOA vials	Add 5 grams sample to 40-mL VOA vial pre-preserved with 1 gram sodium bisulfate/5 mL water, 4°C	14 days to analysis
Semivolatile Organic Compounds	SW8270C SW8270C-SIM	1 x 4-oz. glass	4°C	14 days to extraction 40 days to analysis
Extractable Hydrocarbon Speciation	NW EPH	1 x 4-oz. wide-mouth amber glass	4°C	14 days to extraction 40 days to analysis
Volatile Hydrocarbon Speciation	NW VPH	2 x 40-mL VOA vial, septa lid	Add 5 grams sample to 40-mL VOA vial with methanol	14 days to analysis
Explosives	SW8321	1 x 4-oz. glass	4°C	14 days to extraction 40 days to analysis

[a]Unless otherwise specified, method numbers refer to U.S. Environmental Protection Agency *Test Methods for Evaluation of Solid Waste, Physical and Chemical Methods*, SW-846, 3rd edition, Revision 4, 1996.
[b]All glass containers have polytetrafluoroethylene-lined lids.
[c]Triple the amount per laboratory for samples designated for matrix spike/matrix spike duplicate.

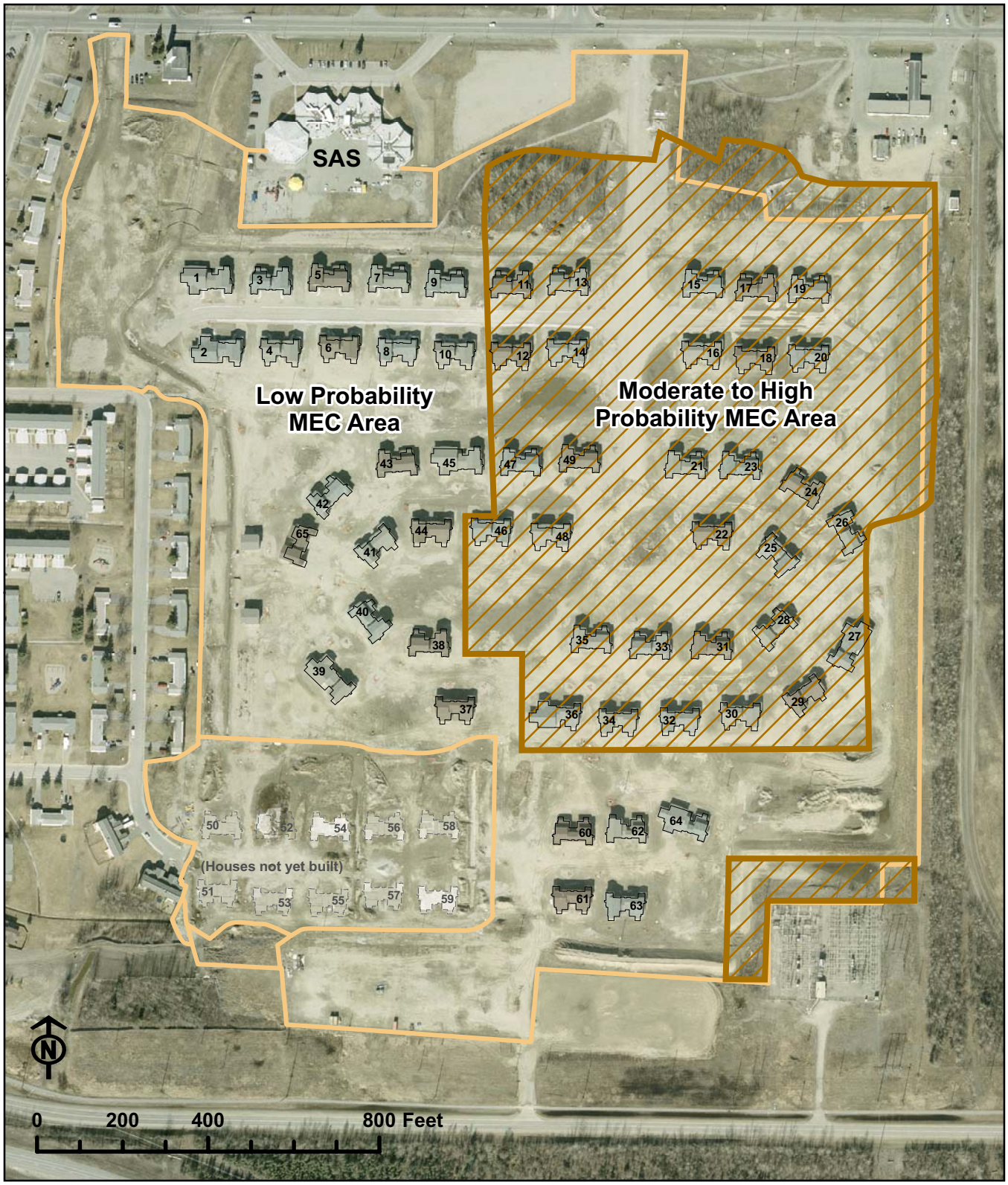
°C = degrees Celsius
EPH = extractable petroleum hydrocarbons
DRO = diesel-range organic
GRO = gasoline-range organic
mL = milliliter
RRO = residual-range organic
TICs = Tentatively Identified Compounds
VOA = volatile organic analysis
VOC = volatile organic compound
VPH = volatile petroleum hydrocarbons

TABLE 4-3
Sample Collection Summary–Aqueous/Liquid

Parameter	Analytical Method[a]	Container[b,c]	Preservative	Maximum Holding Times
Gasoline-Range Organics	AK101	3 x 40-mL amber glass, septa lid	No headspace HCl to pH<2 4°C	14 days to analysis
Diesel Range Organics/Residual Range Organics	AK102/AK103	1 x 1-liter amber glass	HCl to pH<2 4°C	14 days to extraction 40 days to analysis
Metals[d] (except Chromium VI)	SW6010/SW6020/ SW7000	1 x 500-mL HDPE	HNO_3 to pH<2 4°C	28 days for mercury 6 months for all others
Organochlorine Pesticides	SW8081A	1 x 1-liter amber glass	4°C	7 days to extraction 40 days to analysis
Polychlorinated Biphenyls[e]	SW8082	1 x 1-liter amber glass	4°C	7 days to extraction 40 days to analysis
Chlorinated Herbicides	SW8151	1 x 1-liter amber glass	4°C	7 days to extraction 40 days to analysis
Volatile Organic Compounds	SW8260B	3 x 40-mL amber glass, septa lid	HCl to pH<2, 4°C; no headspace	14 days to analysis
Semivolatile Organic Compounds	SW8270C/ SW8270C-SIM	1 x 1-liter amber glass	4°C	7 days to extraction 40 days to analysis
Transitional Explosives	SW8321	1 x 1-liter amber glass	4°C	7 days to extraction 40 days to analysis
Explosives	SW8330	1 x 1-liter amber glass	4°C	7 days to extraction 40 days to analysis

[a]Unless otherwise specified, method numbers refer to U.S. Environmental Protection Agency *Test Methods for Evaluation of Solid Waste, Physical and Chemical Methods*, SW-846, 3rd edition, Revision 4. 1996.
[b]All glass containers have polytetrafluoroethylene-lined lids.
[c]Triple the amount per laboratory for samples designated for matrix spike/matrix spike duplicate.
[d]Water samples will be analyzed for total metals (unfiltered samples). With low-flow sampling, filtering is not necessary.
[e]Only from wells within or down gradient of the PCB exclusion zone.

°C = degrees Celsius
HCl = hydrochloric acid
HDPE = high-density polyethylene
HNO_3 = nitric acid
H_2SO_4 = sulfuric acid
mL = milliliter



\\miner\proj\USACE\357465TakuGardens\GIS\MapFiles\Fig_3-1_TakuChemRisk.mxd 9/19/2007 21:00:50PM

Figure 4-1
MEC Areas and Security Fences
Former Communications Site
Fort Wainwright, Alaska

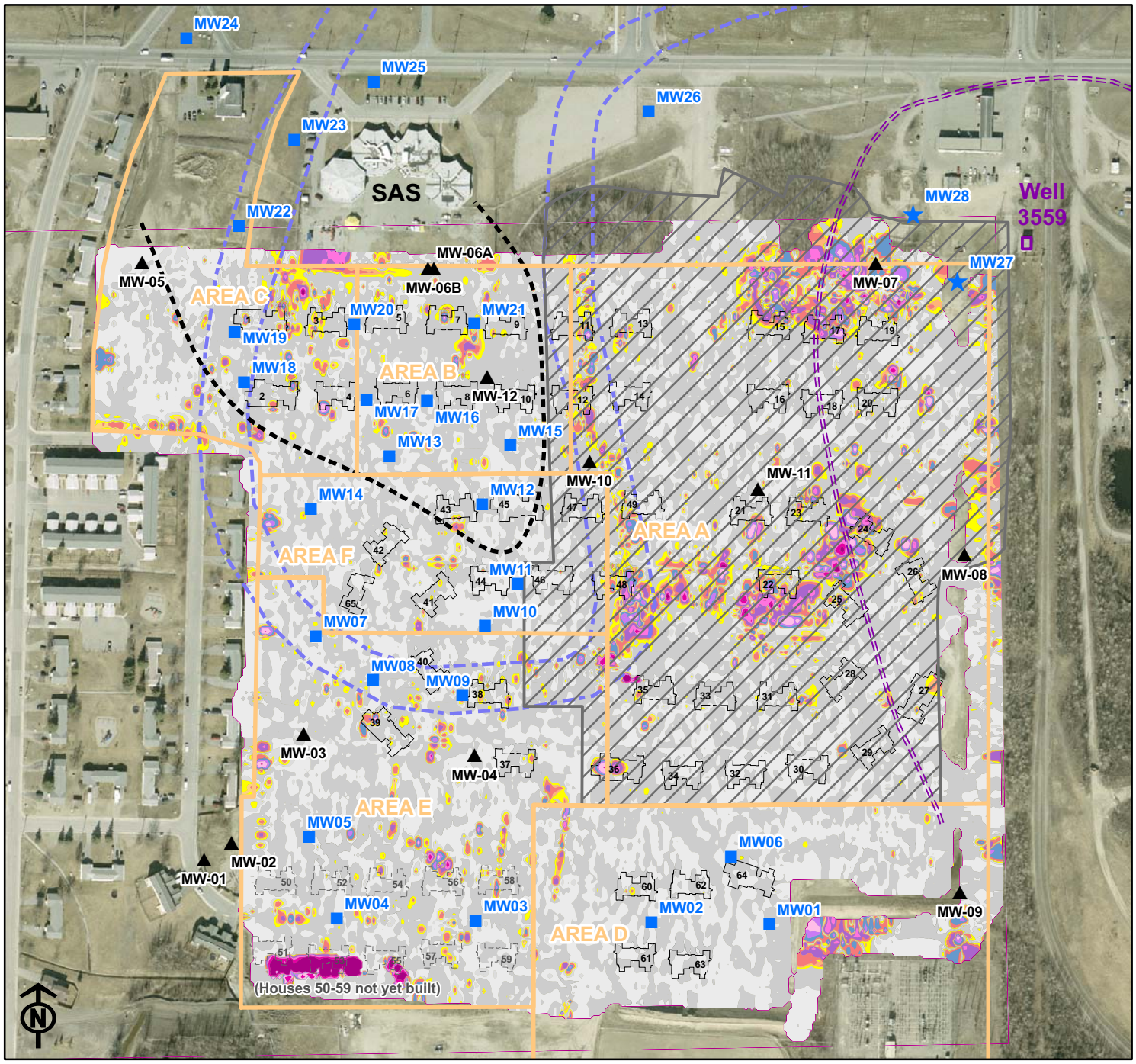


Figure 4-2
Former Communications Site
Fort Wainwright, Alaska
Monitoring Well Locations

Legend

- Moderate to High probability MEC area
- Former slough channel
- Area within elevated VOC/POL concentrations
- Capture Zone, Well 3559
- Existing monitoring well locations
- Proposed monitoring well locations
- Proposed deep monitoring locations Not addressed in Addendum 4

2004 Magnetic Data Vertical Gradient

- -4000
- -1000
- -500
- -200
- -100
- -75
- -50
- -20
- 0
- 40
- 75
- 100
- 200
- 500
- 1000
- 2000
- 4000

0 100 200 300 400 Feet

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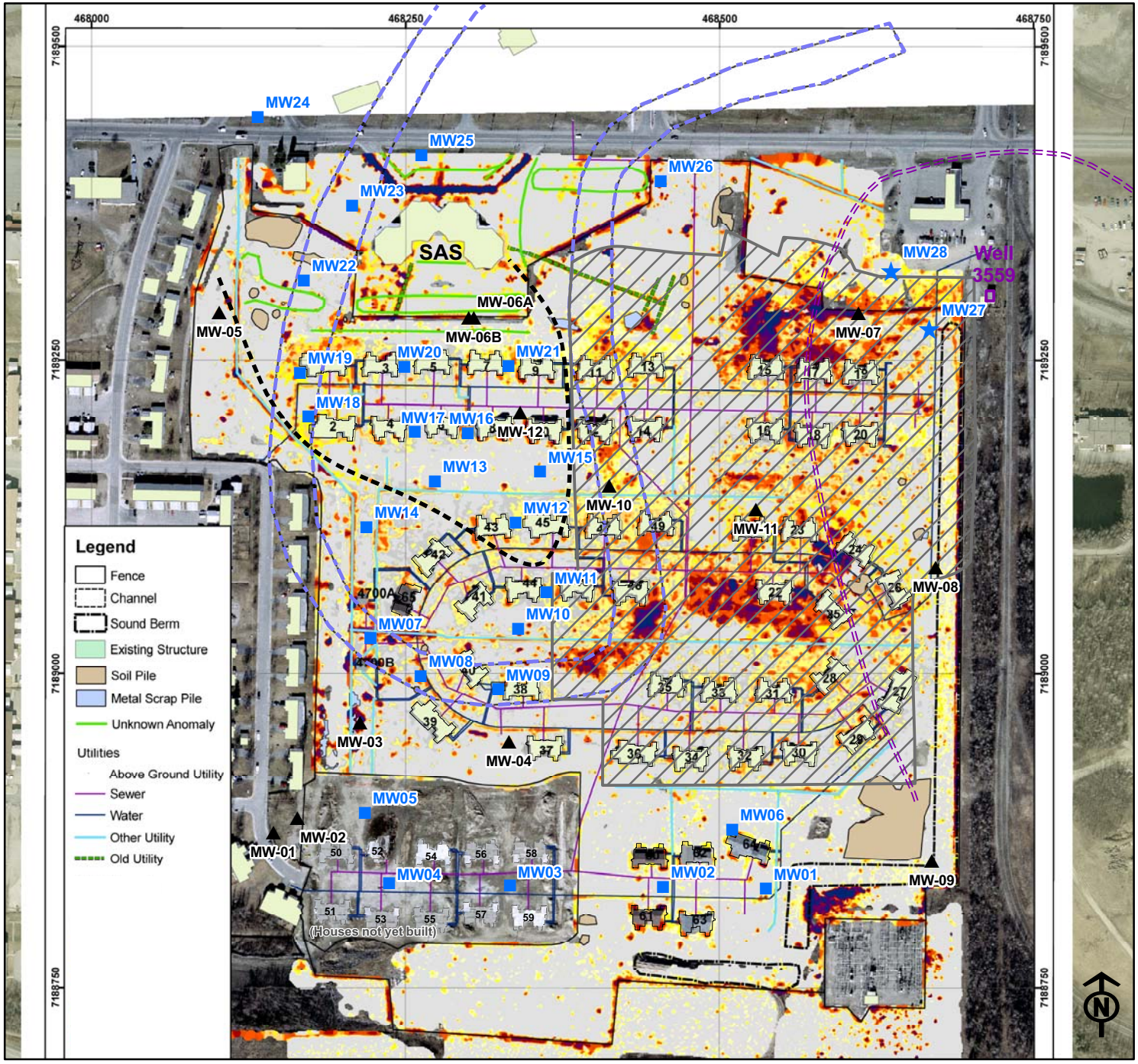

Figure 4-3

Former Communications Site
Fort Wainwright, Alaska
Monitoring Well Locations

Legend

- Moderate to High probability MEC area
- Former slough channel
- Area within elevated VOC/POL concentrations
- Capture Zone, Well 3559
- Existing monitoring well locations
- Proposed monitoring well locations
- Proposed deep monitoring locations Not addressed in Addendum 4

March 2007
Magnetic Data
EM61 Results (mV)

- No Data
- -1500
- -20
- 20
- 30
- 50
- 75
- 100
- 200
- 300
- 500
- 1000
- 2000

0 100 200 300 400 Feet

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Responses to Comments

REVIEW COMMENTS		PROJECT: Former Communications Site DOCUMENT: Draft WP Addendum 4; Ground Water Investigation LOCATION: Fort Wainwright, Alaska			
		DATE: 7/14/2007 REVIEWER: C. Fosbrook PHONE: 384-2713	Action taken on comment by: CH2M HILL		
Page No., Spec. Paragraph	**Item No.**	**Comments**	**REVIEW CONFERENCE A - comment accepted W - comment withdrawn**		**Back check by: _____ (Initials)**
Previous Sampling Results	1	Indicate on figure 4-2 previous soil gas probes.	Existing monitoring well locations will be included on Figure 4-2.		
DQOs	2	Screening values should be listed as Region 6 Risk Based Tables or 1/10 of ADEC Table C. In addition, the specific section in the RI Management Plan should be listed for a quick reference.	Agreed. Text will be modified to include these screening values. The DQO text will also be modified to include the specific objective listed in the RI Management Plan: "Collect groundwater samples to determine whether constituents present in site groundwater could migrate offsite at concentrations that pose a potential for unacceptable risks to the base drinking supply wells, or impact offsite surface water, or cause an offsite vapor intrusion concern."		
Sample Approach	3	Clarify that this plan is only for installation of wells in areas on non-mec as discussed in the "Area of Investigation". Note that a revised or second plan will be provided for work inside the MEC area. A brief discussion on the rational for the selection of each well by sub-area should be provided along with the PCOC that was discussed in the May meeting. This could easily be a short table by sub-area. Specific reference to the FSP section or RI Management plan would explain quickly to a reader the well installation protocols and sampling techniques.	The text will clarify that this addendum is only for groundwater investigation within the low probability of MEC area. Plans for installation of wells in the moderate to high MEC area will be included in the RI Management Plan. Rationale for selection of wells in each sub-area will be provided in Table 4-1with potential contaminants of concern. The decision at the 6/6-7 meeting was to go with the sitewide "grid" approach, with additional wells to characterize the POL area, and several deep wells to confirm protectiveness of the drinking water supply. Potential contaminants of concern will be the same for all sub-areas (fuels, metals, pesticides herbicides, VOCs and SVOCs) with the following exceptions: (1) PCBs will be sampled in water only at wells within the exclusion zone, (2) TICs will be collected only in areas not previously characterized (sub-areas A, C, and D). Justification will be provided. The text will refer to FSP Section 2.5 for installation protocols and sampling techniques.		

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Page No., Spec. Paragraph	**Item No.**	**Comments**	**REVIEW CONFERENCE A - comment accepted W - comment withdrawn**		**Back check by: _____ (Initials)**
General		Comments and changes in WP #1 regarding MEC areas the MEC area and Non-MEC area should be carried to this plan	The following text will be added: "Delineation of the MEC boundary lines was accomplished by overlaying 2003, 2004, and 2007 geophysical data with 1949, 1956, 1982, and 2005 aerial photographs and digitizing polygons around areas that either had geophysical anomalies or surface debris. Locations of MEC found to date were from areas where historical photographs identify areas that were most likely to be where MEC disposal would occur. The boundary lines were conservatively expanded to the north of the tree line area and adjusted to the west to easily distinguish housing units in the MEC area and those in the non-MEC area."		
General		Without completion of the RI Management Plan from May, it appears there is not a rational for so many groundwater wells and analytical samples. The rational discussed in the May meeting should be shortly summarized in this plan as well as referenced to the FSP section. Details on the field techniques, drilling, logging, installation, sampling and analytical requirements need to be complete and agreed to by all parties before work begins.	The following rationale, as discussed at the 6/6-7 meeting, will be added to the text: 1. Sitewide coverage with approximately one monitoring well per .75 acre. 2. Monitoring wells in open areas to identify sources. 3. Additional monitoring wells in areas of known contamination to delineate extent of contamination. Table 4-1 with rational for well locations in each sub area has been added. The FSP will be referenced for installation and sampling details.		
Purpose		It should be stated better that this specifically outlines the Soil Gas Analysis work. The Army, EPA and ADEC agreed to conduct the RI/FS for FCS utilizing the tri-ad approach. A Management Plan addressing the methods of the overall site management, QAPP and sampling techniques has been prepared. This document is one of many workplans that provide detailed information to the specific task of the RII/FS. This approach was determined to be the most effective, efficient and appropriate method for investigating this site. (Something like this should be stated at the beginning of each Addendum)	The text will be amended to read: The U.S. Army, U.S. Environmental Protection Agency (EPA), and Alaska Department of Environmental Conservation (ADEC) have agreed to conduct the remedial investigation/feasibility study (RI/FS) for the FCS using the Triad approach. The RI Management Plan addresses this approach and overall site management and includes the Quality Assurance Project Plan (QAPP) and Field Sampling Plan (FSP). This document is one of many addenda that provide detailed information about specific tasks of the RI/FS. This approach was determined to be the most effective, efficient, and appropriate method for investigating this site.		
Sample Location		Will the wells in the exclusion zone be installed prior to the removal action?	Installation of wells within the exclusion zone will be scheduled to follow the removal action. The text will be clarified.		

REVIEW COMMENTS	PROJECT: Former Communications Site DOCUMENT: Draft WP Addendum 4; Groundwater Investigation LOCATION: Fort Wainwright, Alaska	
U.S. ARMY CORPS OF ENGINEERS CEPOA-EN-EE	DATE: 7/6/07 REVIEWER: Julie Sharp-Dahl PHONE: 753-5689	Action taken on comment by: _____

Page No., Spec. Paragraph	Item No.	COMMENTS	REVIEW CONFERENCE A - comment accepted W - comment withdrawn		Back check by: ____ (Initials)
Previous Sampling Results	1	Thirteen (13) wells were sampled in 2006 during the PSE II: 10 were newly installed and sampled once, 3 were already on site near the B52 PCB hot spot, and were sampled both spring and fall 2006. Please revise text.	The text will be revised accordingly.		
DQOs	2	Not sure if this is something you want to add, but the GW stability parameters (dO, redox, conductivity, etc.) may be a useful set of information for future decisions- such as the possibility of monitored natural attenuation of groundwater in the Northern POL impacted area.	Agree that groundwater stability parameters are important and may be used to assess natural attenuation in the POL area. The DQO, "Collect groundwater samples to determine whether constituents present in site groundwater could migrate offsite at concentrations that pose a potential for unacceptable risks to the base drinking supply wells, or impact offsite surface water, or cause an offsite vapor intrusion concern" covers this. The groundwater stability parameters will be added to the Sample Collection and Analyses section, and reference to the FSP will be included.		
Sample Collection and Analysis	3	I thought we discussed and concurred that a minimum of 3, max. of 4 samples will be collected from each boring: one from near surface (2-3'? below present grade), 1 from the vadose zone, and one from the interval most likely to contain contamination, plus the option for one to be collected at the discretion of the geotechnical engineer/geologist to capture information about changes in site geology (clay lens, peat layer, etc). State that the soil sample will be homogenized prior to placing in the jar (post VOC-type sample collection). Add "PID response" to the last bullet detailing what will be recorded in the field log. Sentence immediately above Table 4-1: rephrase to read "….the sample collection summary for soil and groundwater samples to be collected from FCS during the groundwater investigation."	Correct, after careful review of the 6/6-7 meeting notes, I see that the additional (3rd) sample was added. At a minimum, three soil samples will be collected in each monitoring well boring at the following depths: near the ground surface (approximately 2-3' below existing grade), in middle of the vadose zone at a location likely to contain contamination (e.g. clay lens, between approximately 4 and 10 feet below existing grade), and in the smear zone at depth of approximately 11 to 13 feet. A fourth sample may be collected, at the rig geologist's discretion where visual, PID, or olfactory evidence of contamination is encountered. The field geologist or engineer will be responsible for directing activities, logging the lithology, and selecting the appropriate intervals for sampling. The text will be updated accordingly. Text will be changed to state that soil sample will be homogenized prior to placing in the jar, after sampling for VOCs. PID response will be added to the last bullet. The sentence immediately above Table 4-1 will be modified as suggested.		

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U.S. ARMY CORPS OF ENGINEERS CEPOA-EN-EE	DATE: 7/6/07 REVIEWER: Julie Sharp-Dahl PHONE: 753-5689	Action taken on comment by: _____

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Table 4-1	4	AK 102/103 method- change parameter "Motor Oil Range Organics" to "Residual Range Organics" – to Table 4-2 also. Will lab run BOTH 8270 & 8270SIM for all samples (to achieve the lower R.L.s for some of the more toxic PAHs?) or is this an "either or"? Add detail regarding when med/high level VOC (MeOH preserved) will be analyzed and when low level (bisulfate preserved) will be analyzed, or will you do both every time (concern is R.L.s once again). Add the 20 "TICs" for the 8260 and 8270 analyses for the appropriate samples 9those collected in areas previously uncharacterized).	This change will be made. Yes - both 8270 and 8270SIM will be analyzed on all samples to achieve lower RLs for the PAHs. Both low level and med/high level VOC will be analyzed every time in order to meet reporting limits. Tentatively Identified Compounds (TICs) will be added for 8260 and 8270 analyses in areas previously uncharacterized.		
Table 4-2	5	Please provide a bit of detail why both 8321 & 8330 will be used (POL interference with 8330?). Delete 2nd sentence of footnote d.	We will analyze for 8321 because it has less interference than 8330. The 2nd sentence of footnote d will be deleted.		
Figure 4-2	6	Please add the wells that are presently on site (to Legend also). Text at dark delineation around soil pile 13 (SE bottom corner of site near GVEA substation) is incorrect- no temporary wells are located here. Please clarify what you're trying to say. My recommendation, which will need team discussion and concurrence, is to add at least one more well closer to, but downgradient of the B52 PCB hot spot; unsure if pre-removal or post-removal is a better time to do so. Recommend adding a well at the NW corner of the GVEA substation.	Existing wells will be added to the figure and legend. The subject text will be deleted. Additional wells will be located as proposed.		

REVIEW COMMENTS	PROJECT: Former Communications Site DOCUMENT: Draft WP Addendum 4 Groundwater LOCATION: Fort Wainwright, Alaska	
U.S. ARMY CORPS OF ENGINEERS CEPOA-PM-C	DATE: 6/30/07 REVIEWER: Bob Brock PHONE: 753-5612	Action taken on comment by:_____

Page No., Spec. Paragraph	Item No.	COMMENTS	REVIEW CONFERENCE A - comment accepted W - comment withdrawn		Back check by: ____ (Initials)
Area of Investigation	13	See Item 2 above (Explain how MEC was determined and that a conservative approach was used (see email from Beth Astley, CRREL). Consider squaring off the area for ease of locating in the field. Add that if site conditions change (i.e. debris is encountered in other areas) that the plan will be revisited and changed as needed. Add that UXO technicians (two reams) will be onsite to support Building 48/49 investigations and test pit installations and will be available to provide support as warranted by changed site conditions. Work below EXISTING grade in MEC area will require UXO support)	Explanation of the conservative approach used to delineate the MEC area will be included. The area was squared off for ease of locating in the field. Assume that details about the number of UXO technicians, etc. will be covered in the MEC Support Work Plan.		
DQOs	14	Validated using Level III or IV protocols? Explain	Data validation procedures are addressed in the QAPP. The subject text was removed from the addendum.		
Sampling Approach	15	Additional wells will be installed in the MEC area upon completion of test pit activities that will clear the areas where the wells will be installed.	This will be clarified in the text.		
Sample Collection	16	I thought three samples were to be collected from each boring with an option for a fourth based on discussions we had at the 6/7-June meeting in Fairbanks. Confirm or deny.	Confirmed, after careful review of the 6/6-7 meeting notes, I see that the additional (3rd) sample was added. At a minimum, three soil samples will be collected in each monitoring well boring at the following depths: near the ground surface (approximately 2-3' below existing grade), in middle of the vadose zone at a location likely to contain contamination (e.g. clay lens, between approximately 4 and 10 feet below existing grade), and in the smear zone at depth of approximately 11 to 13 feet. A fourth sample may be collected, at the rig geologist's discretion where visual, PID, or olfactory evidence of contamination is encountered. The field geologist or engineer will be responsible for directing activities, logging the lithology, and selecting the appropriate intervals for sampling. . The text will be updated accordingly.		

REVIEW COMMENTS	PROJECT: Former Communications Site DOCUMENT: Draft WP Addendum 4 Groundwater LOCATION: Fort Wainwright, Alaska	
U.S. ARMY CORPS OF ENGINEERS CEPOA-PM-C	DATE: 6/30/07 REVIEWER: Bob Brock PHONE: 753-5612	Action taken on comment by:_____

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Table 4-1, 4-2	17	I didn't think perchlorate was required fourth based on discussions we had at the 6/7-June meeting in Fairbanks. Confirm or deny. At the 6/7-June meeting in Fairbanks, I thought we decided that we did not need additional PCB data from soils and that PCBs in water would only be collected from wells down gradient of the PCB Exclusion Zone. Confirm or deny.	Confirmed. It was decided not to continue this analysis since perchlorate was not detected in earlier analysis of site wells. Confirmed. The 2005 soil data coverage appears to be sufficient to characterize the extent of PCB contamination. We are proposing to sample PCBs in water only from wells within or down gradient of the PCB Exclusion zone.		

REV COMMENTS	PROJECT: Former Communications Site DOCUMENT: Draft WP Addenda 1-4 LOCATION: Fort Wainwright, Alaska	
U.S. ARMY CORPS OF ENGINEERS CEPOA-PM-C	DATE: 6/30/07 REVIEWER: EPA PHONE:	Action taken on comment by:_____

Page No., Spec. Paragraph	Item No.	COMMENTS	REVIEW CONFERENCE A - comment accepted W - comment withdrawn		Back check by: ____ (Initials)
General– Field Health and Safety Concerns		EPA recommends the development of a geophysical anomaly/debris avoidance plan for use site-wide. Please see Specific Comment No. 1 for more detail.	Locations for proposed monitoring wells will be selected using available geophysics, as-built drawings, and anomaly avoidance/ location clearance using a magnetometer. Additional MEC support procedures are included in the MEC Support Work Plan.		
4-1, par 2, Sentence 1	1	The proposed subdivision of the FCS into “MEC” and “non-MEC” areas is based on a “preponderance of evidence” argument that incorporates four separate data sets 1) geophysical data, 2) historical/archival records, 3) 5 aerial photographs from a 60+ year period, and 4) observations made during recent construction activities. Because each data set differs in its quality and completeness, e.g. the geophysical data uncertainties are quantifiable and bounded whereas the aerial photos are “sparse” representing only five “samples”, the subdivision relies on a qualitative weighing of the four data sets. EPA feels that the geophysical data quality far exceeds that of the other sets and therefore should receive the highest weight in the integrated evaluation. Each of the data sets used are insufficient on their own to discriminate MEC from non-MEC debris, including the most quantifiable data from the geophysical surveys. Thus, adding sparse or otherwise lower quality data to the geophysics does not increase the amount of information that can be extracted by interpretation. More concisely, the discrimination capability of the combined data does not exceed the discrimination capability of its component parts. The geophysics has provided a high resolution image of potential buried metal site wide which should be interpreted within the context provided by the other three *a priori* data sets, but not constrained by them. EPA feels that the anomalies currently proposed as “not requiring MEC clearance” also deserve to be considered potentially hazardous, regardless of the presence or absence of MEC.	Figure 4-2 (2004) and 4-3 (2007) will be amended to include geophysical data. Anomalies in the Low Probability MEC Area will be avoided using the available geophysical data, and anomaly avoidance/ location clearance using a magnetometer. Additional MEC support procedures are included in the MEC Support Work Plan.		

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		EPA recommends that the Army develop an anomaly/debris avoidance plan for use site-wide during all intrusive activities. EPA further recommends that this avoidance plan consider the full range of potential hazards and develop contingency plans for their proper response. Some of the issues the debris avoidance plan might include are: details regarding how the location of the geophysical anomaly edges (laterally and with depth) will be made readily and immediately available to the field personnel who will be conducting, directing and/or overseeing the intrusive activities. For instance, will the anomaly edges be flagged, or will they be re-acquired prior to breaking ground? How will anomalies at depth be avoided? How will the technical lead decide how to determine step-out distances when intrusive activities are proposed immediately adjacent to a geophysical anomaly? Even non-MEC metallic debris presents immediate safety hazards to onsite workers and potential additional releases of contaminants to the environment if buried drums or small containers were to be inadvertently ruptured. The avoidance plan might also provide detailed methods that will be used to compare the field observations with the predictions made from the geophysical data. For example, the plan should identify who will be responsible for cross-checking the field observations with the geophysical results and what that person's responsibilities will include. The avoidance plan might additionally include contingency plans if observables deviate from the expectations (as noted in bullet b). The contingency details should include decision trees and action plans for circumstances such as, what will be the plan of action is a geophysical anomaly can not be re-acquired (a geophysical false positive) or, conversely, what should be done if debris is found where no geophysical anomaly was recorded (a geophysical false negative). If the "preponderance of evidence" approach were to fail at this site, the results may not only compromise the safety of workers in the vicinity, but could potentially release additional contaminants to the environment, as well as heighten public concerns beyond current levels. These factors should be considered important enough to warrant assigning the geophysical results considerably more weight in the evaluation than the photos, archives, or even construction field notes.			

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4-1, par 3, Sentence 1	2	A portion of this sentence reads "… work may require clearance and oversight measures." What criteria will be used to determine which circumstances that may require clearance? **Recommendation:** Clarify the "may require" aspect, either by adding a section in this addendum and citing that section here, or by developing a separate document (i.e. an avoidance plan) and citing that document instead.	Procedures for MEC support at the site will be presented in a separate document, the MEC Support Work Plan. The addendum will reference the MEC Support Work Plan		
4-1, par 4	3	An overview figure would be helpful here. **EPA recommends** developing a figure that indicates the locations of the existing wells on a detailed base map of the site, preferably using a high-resolution aerial photograph as the base layer with key site features labeled as necessary (i.e. building numbers, TSA location, etc.) This figure could then be used to indicate the locations of all proposed wells, current plume boundaries (e.g. POL plume), any groundwater level data available, etc.	A high-resolution figure showing locations of existing wells is provided: Figure 4-2 (2004) and 4-3 (2007).		
4-1, par 5	4	The first sentence states that "A DQO process was used to document the purpose of data to be collected…" The "purpose" is the Data Objective. The DQO process determines the accuracy and quality specifications that the data needs to meet in order to fill existing data gaps. **EPA recommends** expanding this discussion to identify both the purpose of the data as well as the quality requirements. EPA further suggests that this task may be easier if the section were moved "down", so that it follows the discussion of the specific tasks and activities proposed.	Text will be updated to clarify the DQO for groundwater: "Collect groundwater samples to determine whether constituents present in site groundwater could migrate offsite at concentrations that pose a potential for unacceptable risks to the base drinking supply wells, or impact offsite surface water, or cause an offsite vapor intrusion concern". Data quality requirements will be added.		
4-2, par 1, sentence 2	5	This sentence should be broadened in scope so that it is clear to the lay-reader that all drinking water wells (not just base drinking water wells) are being considered. **EPA recommends** slightly rewording this sentence to include the broader concerns	This sentence will be reworded to include the broader concerns.		
4-2, par 1, sentence 1	6	This sentence states that "approximately 46 temporary monitoring wells will be completed". **EPA recommends** adding a brief statement of exactly how many are proposed plus the number of contingency/optional wells that may be expected.	The text will be updated to include the proposed number of wells.		
4-2, par 2, sentence 1	7	This sentence appears to be missing a word of two just before the "(Figure 4-2)". **EPA recommends** a minor correction here.	This change will be made.		
4-2, par 2, sentence 2	8	This sentence includes the first occurrence of the acronym POL. **EPA recommends** spelling out the acronym on the first occurrence. Also, consider where an acronym list and a reference list will exist for these Addenda. Will there be a single acronym list in the MWP? What about a reference list?	Acronyms will be spelled out at their first occurrence. A full acronym list will be included with the RI Management Plan. A list of references will be added to the addendum.		

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U.S. ARMY CORPS OF ENGINEERS CEPOA-PM-C	DATE: 6/30/07 REVIEWER: EPA PHONE:	Action taken on comment by:_____

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4-2, par 2, sentence 3	9	**EPA suggests** replacing "school yard" with "School Age Services Facility".	This change will be made.		
4-2, par 2, sentence 4	10	This sentence states that "the well locations were demarcated after reviewing …" In what way were the wells demarcated? On a map? On the ground? **EPA suggests** clarifying the use of the term "demarcated".	The text was revised; see section titled "Geophysical Anomaly and Utility Avoidance". .		
4-2, par 2, sentence 5	11	EPA agrees with the objective to minimize potential disturbances of, or damage to, buried utilities or other underground structures, but suggests that the sentence should be expanded to include avoidance of geophysical anomalies as well. **EPA recommends** revising the text and adding figures indicating the proposed well locations relative to the geophysical data so that all known potential underground objects are clearly represented in this addendum.	Agreed. The plan is to avoid utilities AND geophysical anomalies. Figure 4-2 and Figure 4-3 will be amended to show proposed groundwater well locations in relation to, and staying away from, geophysical anomalies. The text will also be updated accordingly.		
4-2, par 3, sentence 2	12	Given the uncertain nature of the buried metallic debris and the existence of buried drums on site, will any extended contingency safety protocols be instituted? For instance, because any container contents could conceivably contain a range of military substances, will the drilling team be monitoring the breathing zone, and if so, how? Will PIDs with a range of lamp ratings be available for use? What level of PPE will be used? **EPA recommends** either briefly citing the HASP here (making sure that the HASP includes contingencies for a full range of anticipated contaminants near any geophysical anomaly site-wide) or including the special safety requirements directly in this Addendum.	The Health and Safety Plan and person protective equipment will be referenced in this section.		
4-2, par 4, sentence 2	13	**EPA recommends** briefly stating how the boring end-depth of 18 feet bgs was decided upon?	The text will discuss depth to groundwater, depth of screened interval, and total boring depth.		
4-2, par 4, sentence 4	14	EPA notes that if only one "mid depth" core sample is available for the logging geologist to select, then it would be necessary to evaluate all core samples simultaneously in order to select the best location for the one available sample. **EPA recommends** clarifying whether all cores will be pulled before selecting the mid-depth sample location or whether the geologist will have the option to select more than one mid-depth sample if the observations warrant it.	This text will be updated to state At a minimum, three soil samples will be collected in each monitoring well boring at the following depths: near the ground surface (approximately 2-3' below existing grade), in middle of the vadose zone at a location likely to contain contamination (e.g. clay lens, between approximately 4 and 10 feet below existing grade), and in the smear zone at depth of approximately 11 to 13 feet. A fourth sample may be collected, at the rig geologist's discretion where visual, PID, or olfactory evidence of contamination is encountered. The field geologist or engineer will be responsible for directing activities, logging the lithology, and selecting the appropriate intervals for sampling.		

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4-2, par 4, sentence 4	15	Given the uncertainty of what items may be the source of the geophysical anomalies, **EPA recommends** including here a statement that part of the geologists responsibilities will be to evaluate the core samples for evidence that supports or conflicts with the geophysical results, including noting whether the core materials are considered native or fill.	Good idea. This will be added to responsibilities of the geologist.		
4-2, par 5, bullet 1	16	**EPA recommends** repeating, as a new bullet, the use of a PID immediately upon opening the barrel sampler for the first time.	This will be added to the first bullet, as the first step when opening the split barrel sampler.		
4-2, par 5, bullet 2	17	**EPA suggests** revising the very end of the last sentence in this bullet to read "…to prevent potential contaminant migration from or to the sample"	This edit will be made.		
4-3, par 1, sentence 1	18	**EPA suggests** changing "2-foot of screen" to "2-feet of screen"	Discussion of screening depth was moved to an earlier section.		
4-3, par 1, sentence 1	19	This is the first occurrence of the acronym LNAPL**. EPA recommends** spell this out on the first occurrence and then use the acronym thereafter.	This sentence was deleted. Discussion of screening depth was moved to an earlier section.		
Table 4-1, Row 1, Column 4	20	Shouldn't the preservative for GRO be Methanol and 4°C, rather than just Methanol? **EPA suggests** revising as appropriate.	This will be corrected.		
Table 4-1, Row 3, Column 1	21	EPA notes that the method SW7000 (Atomic Absorption) specified for analysis of metals in the boring soils/sediments is different than the method specific in Addedum-2 for analysis of Soils from the Piles (there, the Method 7471A is referenced, which is a Mercury specific, cold-vapor method). EPA agrees that the soils from the core samples should be analyzed for a full range of metals, including Mercury; however, it would be helpful to know why the two Addenda analyze the soils differently. No text revisions are necessary to this Addendum-4 unless a specific error is identified here. However, if Addendum-2 is in error, corrections should be made there, as appropriate.	The soils will not be analyzed differently. The way the metals are listed in the QAPP is SW6010B/SW6020/SW7000. This gives the lab some flexibility to analyze samples for metals by a variety of methods. We don't care if they analyze Cu by 6010 or 6020 as long as they meet the screening level. SW7000 covers mercury and graphite furnace methods. When the methods are listed all together (metals + mercury) they are listed as SW6010B/SW6020/SW7000, otherwise you list out 15 different methods for the SW7000 methods because each analyte has its own method number under the SW7000 methods. If mercury is listed alone, it is listed as its discrete method number SW7470A for water and SW7471A for soil. SW7000 refers to a group of methods, which contains SW7471A…the only soil mercury method that exists in that forum.		
Table 4-1	22	EPA notes the absence of analysis of soils for explosives and EPH/VPH. **EPA recommends** analyzing soils for both explosives and EPH/VPH. Otherwise, include in the text why these two analyses are being excluded from the core soils but not from the soil samples collected from the soil piles	EPH/VPH and explosives will be included in the list of analytes.		

REV COMMENTS	PROJECT: Former Communications Site DOCUMENT: Draft WP Addenda 1-4 LOCATION: Fort Wainwright, Alaska	
U.S. ARMY CORPS OF ENGINEERS CEPOA-PM-C	DATE: 6/30/07 REVIEWER: EPA PHONE:	Action taken on comment by:_____

Page No., Spec. Paragraph	Item No.	COMMENTS	REVIEW CONFERENCE A - comment accepted W - comment withdrawn		Back check by: ____ (Initials)
Table 4-1, Row 1, Column 8	23	Shouldn't the preservative for VOCs be Methanol and 4°C, rather than just Methanol? **EPA suggests** revising as appropriate.	The text will be corrected.		
Table 4-2, Footnote "d"	24	What will determine whether filtered samples will be collected? Dissolved metals are of interest at this site due to the existence of a drinking water supply wells down gradient. **EPA recommends** providing a more detailed description of what will determine whether filtered samples will be collected and/or why the Army does not consider them a priority for the FCS wells.	This footnote will be modified to reflect the decision NOT to filter metals samples. With low-flow sampling, filtering should not be necessary.		
Table 4-2, Acronym key	25	The numeral 3 in the formula for Nitric Acid should be subscripted.	This edit will be made.		
Figure 4-1	26	As discussed in EPA Specific Comment No. 1, this Figure under-values the information provided by the geophysical surveys. **EPA recommends** removing the MEC delineation boundaries and making Figure 4-1 a base map showing the location of existing and proposed wells (See EPA Specific Comment No. 3).	The figures will be updated. Geophysical anomalies and existing and proposed wells will be shown clearly on the figures.		
Figure 4-2	27	**:** This Figure is too small and the font too light for easy reading. It is unclear why this format was selected for well location illustrations rather than the Figure 4-1 style map. **EPA recommends** an alternative approach to this figure wherein the locations for proposed wells would be added to the geophysical survey results (separate maps for each methodology) so that the field personnel can make informed decisions regarding proximity to geophysical anomalies and the need for step-out locations and avoidance.	The figures will be updated. Geophysical anomalies and existing and proposed wells will be shown clearly on the figures.		
Figure 4-2, Legend Note 1	28	**EPA recommends** including avoidance of geophysical anomalies in this note.	Geophysical anomalies will be clearly added to figure legends.		
1-1, par 1, Sentences 1 & 2	29	These two sentences feel out of order. **EPA recommends** rewording slightly and changing the order.	The text will be edited for ordering and clarity.		

REVIEW COMMENTS	PROJECT: Former Communications Site DOCUMENT: Draft WP Addenda 1-4 LOCATION: Fort Wainwright, Alaska	
U.S. ARMY CORPS OF ENGINEERS CEPOA-PM-C	DATE: 6/30/07 REVIEWER: ADEC Sharon Richmond PHONE:	Action taken on comment by:_____

Page No., Spec. Paragraph	Item No.	COMMENTS	REVIEW CONFERENCE A - comment accepted W - comment withdrawn		Back check by: (Initials)
4-1	1	Area of Investigation. I recognize that the boundaries between areas with a low probability of encountering Munitions and Explosives of Concern (MEC) and a moderate to high probability of encountering MEC have yet to be resolved and that work in the munitions disposal area is not discussed in this document. Figure 1 is missing	Text will be added to explain the conservative approach used to determine the MEC area. The text will also refer to the MEC Support Work Plan. The figures will be updated.		
4-1	2	Previous Sampling Results. Monitoring well MW-12 is referenced but not shown on a figure. Not sure if MW-12 is on Figure 1.	Existing monitoring wells will be shown on a figure.		
4-1	3	Previous Sampling Results. Where were explosive compounds located? My understanding is that explosive compounds were mistakenly identified in MW-12. Please identify the volatile organic compound identified and the location where it was found.	The Final PSE II Report, page 2-49, includes a discussion on the explosive compounds reported in the groundwater. Explosive compounds were reported from MW-06A, MW-06B, and MW-12; nitrobenzene was reporting in MW-05. USACE review of raw analytical data determined that the elevated petroleum compounds present in MW-06A and B, and MW12 have the potential in interfere with analytical method used: EPA SW-846 Method 8330. Additional groundwater samples and different analytical method s are required to discern explosive s in the presence of petroleum compounds. In this addendum we proposed to use method SW8321 because this method is less susceptible to interferences.		
4-1, DQO, 1st sentence	4	Revise sentence to reflect that the nature and extent of contamination might or could possibly present unacceptable risk.	The DQO will be restated as follows “The objective of the groundwater sampling is to determine whether constituents present in site groundwater could migrate offsite at concentrations that pose a potential for unacceptable risks to base drinking supply wells, or impact offsite surface water, or cause an offsite vapor intrusion concern “		
4-2, Fig 2	5	Fig 2 is missing. We can’t agree or disagree on the proposed placement of wells without a figure to reference	The figures are being updated and will be included in the PDF version of the Addendum. [It is likely that you reviewed the Word version which did not contain the figures. The PDF version, also posted on the FTP site, did contain the figures.]		
4-3, Table 4-1	6	Methods SW8321 and SW8330 are not included in the Soil/Sediment Sample Collection Summary.	SW8321 will be added to the list of soil/sediment analyses. This method will be used for analysis of explosives, since it is less susceptible to interferences.		

Responses to Comments
Remedial Investigation Work Plan

Responses to Comments
FWA102 Former Communications Site
Work Plan, May 2007
Fort Wainwright, Fairbanks, Alaska

Reviewer: Bob Brock, US Army Corps of Engineers, CEPOA-PM-C

Item No.	Section/ Page/ Para	Comments	Response
1.	General	These comments are in addition to ones discussed at 6/7-June meeting	Comment noted
2.	Section 1.1	Add drum/debris investigation, PCB removal, and geophysical work to list of work to be performed to address data gaps	These tasks were added.
3.	Section 1.2	Purpose of quantifying baseline risk is to determine if housing can be occupied	This text has been modified.
4.	Section 1.2	Add objectives associated with drum/debris investigation and geophysical work	These additional objectives have been added.
5.	Section 1.3	Delete last bulleted item	The last bullet has been deleted.
6.	Section 1.4	Delete USACE project manager name from the first bulleted item (no other key personnel are identified in this section but instead are identified in Figure 1-2).	This change has been made.
7.	Figure 1.2	Jacobs Engineering will be providing UXO standby support	This change has been made.
8.	Figure 1.3	Revise based on 6/7-June meeting	The schedule has been updated.
9.	Table 1-1	Revise based on Corps-provide mark-ups	Table 1-1 has been deleted. Because Jacobs Engineering (JE) was scoped with providing the Communications Plan, we have included the JE Communications Plan as a separate tab.
10.	Section 1.6.2	Contractors need to be included in this process	Table 1-1 has been deleted.. Since Jacobs Engineering (JE) was scoped with providing the Communications Plan, we have included the JE Communications Plan as a separate tab.
11.	Section 1.7	Triad approach will be used	This section has been updated to refer to the use of the Triad approach.
12.	Section 2.2.1	Data also is included in Corps geotechnical reports, North Wind PCB Sample Data Report, and PSE1	This text has been revised.
13.	Figure 2-1	Perhaps an actual representative boring log might be more useful here.	Typical boring logs have been provided instead of the cross section.
14.	Table 2-1	Delete all references to Watterson Construction and replace with Construction contractor	This change has been made.
15.	Section 2.3.1.1	Aerial photos were used to assist in the determination of site activities but cannot document site activities by themselves. See Section 2.2.1	This text has been revised.
16.	Table 2.3	Revise as a result of May groundwater sampling event.	The May 2007 groundwater data will be incorporated into our database as soon as possible. Through the work plan addenda process, the FCS Management Team has focused the target analyte list. Tables 2-3 and 2-4 have been eliminated.
17.	Table 2-4	Remove dioxins from sampling approach. Perchlorate may also need to be removed.	Through the work plan addenda process, the FCS Management Team has focused the target analyte list. Table 2-4 has been eliminated. Dioxins will not be sampled unless high levels of PCBs are detected in water, which is not expected based on the results of past groundwater monitoring (e.g., May 2007). Perchlorate will also be deleted since it has not been detected in past groundwater monitoring.
18.	Section 2.4.2	Revise first sentence of the first paragraph. PSE2 work included test pits, soil borings, soil gas, and soil pile sampling.	This section has been revised. Table 2-3 describes the PSE 2 work.
19.	Section 2.4.3	Revise as a result of May groundwater sampling event.	Results of the May 2007 groundwater monitoring event will be incorporated into the RI as they are available and will be plotted with other data on maps.

Reviewer: Bob Brock, US Army Corps of Engineers, CEPOA-PM-C			
Item No.	**Section/ Page/ Para**	**Comments**	**Response**
20.	Section 2.3	Revise first two sentences of the first paragraph (grammatical).	This text has been revised.
21.	Section 4.2.2	Approach – Should ICs be anticipated as part of the RI? Playgrounds – These areas should be considered open areas as their exact location is flexible based on the results of the RI. Other open areas – Assumptions about the final design for recreational areas are not appropriate since their exact location is flexible based on the results of the RI	We agree that it is premature to assume that institutional controls are required or desired. The current approach is to use 2005 surface soil data and additional near-surface soil results from borings to characterize surface soil at the site.
22.	Section 4.7	Revise approach to include field laboratory. Work will be performed in accordance with JE's work plan which will be incorporated into the RI Management Plan	The decision was made not to use a field laboratory. JE's PCB removal work plan will be referenced.
23.	Section 4.8	See Comment 14	Section 4.8, which addressed Watterson activities, has been removed.

Reviewer: Mike Utley, US Army Corps of Engineers, CEPOA-EN-ES-M			
Item No.	**Section/ Page/ Para**	**Comments**	**Response**
1.	Acronyms	Please define RPM	Acronym added to list. and defined.
2.	Section 1.3	"quantify" is misspelled in 2nd to last sentence; please correct.	Text has been corrected.
3.	Figure 1-3	Line 41 - are there no plans to submit data to USACE for review first? (not according to schedule, anyway)	Data will be submitted to USACE and ADEC concurrently. This will be noted on the schedule.
4.	Table 1-1	Points of contact need to be updated. For instance, Teresa King no longer works for the Alaska District USACE and Amanda Stark is no longer with ADEC. Also, no chemist on your list?	Table 1-1 has been eliminated. Because Jacobs Engineering (JE) was scoped with providing the Communications Plan, we have included the JE Communications Plan as a separate tab.
5.	Table 2-3, 2-4	Propylene glycol was spilled on the site in early 2006 during construction. Suggest adding this compound to the suite, and utilizing method 8015 for glycol analysis Table 2-4 - please explain question marks?	Through the work plan addenda process, we have been able to further refine the target analyte list. Tables 2-3 and 2-4 have been eliminated.
6.	Section 3.2	There are a number of compounds where 1/10th of the ADEC levels cannot be reliable detected by routine laboratory methods; how will these be dealt with? What about those compounds not included in ADEC list - what criteria will be used to determine if they should be carried forward into the baseline risk assessment?	This text has been revised to state that if a risk screening level is below the standard laboratory detection limit (or ½ the detection limit), then the compound will be considered in the uncertainty analyses.
7.	Section 3.3.4	Please reference what studies indicate that contaminated groundwater will not impact the Chena River as is stated here.	This section has been revised to discuss and reference these studies.
8.	Table 3-4	DQO 7 - Step 5 - what is "remedial completion criteria"?	The DQO Tables have been revised to address agency comments; this language has been removed.
9.	Section 4	Note - PDF file is missing pages 4-1 => 4-9.	The Interim Draft has been carefully reviewed and all pages are in place.
10.	Section 4.5.2	Number of samples not consistent with DQO 3, Step 7	DQO Tables have been corrected for consistency with text.

Reviewer: Lisa Geist, US Army Corps of Engineers, Environmental Engineering			
Item No.	**Section/ Page/ Para**	**Comments**	**Response**
1.	Overall Work Plan, Section 1.3, Page 1-2	Field work approach is summarized as: • Soil gas samples at each building to quantify indoor air inhalation risk, and across the site to locate containment services and plumes • Surface soil samples across the entire site to quantify resident and visitor dermal contact risk What is meant by locating containment services and plumes? According to the RAWP, residents, maintenance workers, and site visitor/recreation users may be exposed to surface soil via the ingestion and dermal contact pathways, as well as inhalation of ambient dust. Future excavation workers may also be exposed to dust, as well as subsurface soil contamination. • Subsurface soil samples at each building to quantify trench worker dermal contact risk and vadose zone source contamination RAWP states ingestion and dermal contact as exposure routes for excavation workers. Groundwater data may also be used to characterize inhalation risks from volatiles in ambient air (outdoor/indoor).	Comment Noted. "Containment services" has been changed to read "contaminant sources."
2.	Page 1-13 Figure 1-2	John Beier is affiliated with USACE NAO, not DPW. Teresa King is no longer the QAR	Table 1-1 has been eliminated. Because Jacobs Engineering (JE) was scoped with providing the Communications Plan, we have included the JE Communications Plan as a separate tab.
3.	Page 2-8, Section 2.2.2	Use of the term COCs is inaccurate. Should use term COPCs until after the risk assessment is completed.	COCs have been changed to COPCs.
4.	Page 2-19, Section 2.3.1.5	Text states: "Potential exposure pathways (Figure 2-5) for human receptors include; vapor intrusion, migration to outdoor air, soil ingestion, dust inhalation, dermal contact with soil, and inhalation/ingestion/dermal contact. Potential ecological exposure pathways include uptake or ingestion of surface water by aquatic receptors in the Chena River. Ingestion, inhalation, and dermal contact with groundwater may occur at offsite production wells that are not receiving treatment." This is not consistent with that presented in the Risk Assessment Work Plan. Text is repetitive. Does not include riparian birds/mammals, contact with surface sediment in offsite areas.	This text has been modified. Potential exposure pathways (formerly Figure 2-5 and Figure 2-7 in the Interim Draft) for human receptors include vapor intrusion to indoor air, migration to (and inhalation of) outdoor air and inhalation/ingestion/dermal contact with contaminated soil and groundwater. Sediment samples collected from the drainage swale and groundwater samples collected from the site (including the former river slough) will be compared to media-specific concentrations. A screening level evaluation to birds and mammals will also be conducted. As an initial screening, these data will be directly compared against available sediment screening benchmarks (e.g., NOAA Screening Quick Reference Tables [SQuiRTs]) and ambient water quality criteria. If site concentrations exceed screening levels, further evaluation of offsite areas will be considered.
5.	Page 3-2, Section 3.3.1	Contaminated surface soils may also pose ingestion and/or inhalation risks, not just dermal.	This text has been changed to say "direct contact," which includes dermal, ingestion and inhalation.
6.	Page 3-2, Section 3.3.3	Contaminated subsurface soils may also pose ingestion and/or inhalation risks.	This text has been changed to say "direct contact," which includes dermal, ingestion and inhalation.

Reviewer: Lisa Geist, US Army Corps of Engineers, Environmental Engineering			
Item No.	**Section/ Page/ Para**	**Comments**	**Response**
7.	Page 4-1, Section 4.2.1	What do you mean by compute aggregate chemical risk? Is this the same as cumulative risk calculations? Regulatory aggregate risk threshold – again is this cumulative risk?	Yes the meaning is the same; these terms are interchangeable. However, approach for the surface soil investigation has changed. MI sampling for surface soil across the site has been dropped. The revised approach agreed by the management team is to use 2005 surface soil data and additional near-surface soil results from borings to characterize surface soil at the site.
8.	Page 4-1, Section 4.2.2	Use of Multi-Increment sampling for any type of chemical? MI sampling is not recommended for volatiles. How will the laboratory handle the samples once prepared in the field – typically need to analyze larger volume of soil to get representative result. What QA procedures will be followed? One sample per building/decision unit only?	MI sampling for surface soil across the site has been dropped. The revised approach agreed by the management team is to use 2005 surface soil data and additional near-surface soil results from borings to characterize surface soil at the site.
9.	Page 4-9, Section 4.3.1	Use consistent terminology between the WP and the RAWP. In the Risk Assessment WP, refers to Future Excavation Worker Scenario, and Future Maintenance Worker Scenario.	Terminology has been standardized.
10.	Figure 2-8	Legend needs improvement. What is being depicted? Delete decimal points.	This figure and legend have been updated.
11.	Figure 4-3	No legend. What are blue hatched areas? Red outlines?	MI sampling for surface soil across the site has been dropped.
12.	Section 4.3.1	Consistency of terms – Future Excavation Workers.	Terminology has been standardized.
13.	Section 4.7	What will the soil confirmation samples be analyzed for? PCBs only? Not specified here or in the Field Sampling Plan. Will the test kits be used to guide the excavations or soil confirmation sampling only? Unclear.	Yes, the confirmation samples will be analyzed for PCBs only. The test kits will be used to guide the excavations. Laboratory confirmation samples will be used to confirm removal of the PCBs.

Reviewer: Marlena Brewer, ADEC Contaminated Sites Program			
Item No.	**Section/ Page/ Para**	**Comments**	**Response**
1.	3-1, 3-1	Consider moving the ARARS tables to a more prominent location such as at the beginning of this section. The direction to Table 3-1 as *(included at the end of this report)* is confusing in the text and Table of Contents. Please provide a page number as appropriate.	All landscape tables are being placed at the ends of sections to make them easier for the reader to find.
2.	Table 3-1	What are the chemical specific ARARs for soil, groundwater, and surface water? ADEC Methods 1, 2, 3, and 4 are mentioned. Simply referencing ADEC soil and groundwater cleanup levels 18 AAC 75.340 and -.345 and 18 AAC 70 by web link is not adequate. Moreover, there is no reference to the ADEC Additional Compounds Cleanup Tech Memo (2003) or the TCE Cleanup Level Memo (2006) which includes compounds not included in the regs cited. No sediment DQOs are provided. Please refer to ADEC Sediment Screening Guidance for appropriate screening values and include them in the table. No soil vapor DQOs are provided in the table. Please include. Please provide a comprehensive table of specific screening and/or cleanup values for each contaminant and for each matrix referencing the appropriate regulatory standards or guidance.	Preliminary chemical specific ARARs are provided as Table 3-1. The RI Management Plan has been written to state that screening values for the determination of risk are 1/10 of ADEC's most conservative Method 2 ingestion cleanup levels, and as appropriate, inhalation and migration to groundwater cleanup levels. These cleanup levels can be found in 18 AC 75 (Tables B1 and B2) and in ADEC Technical Memorandum 01-007, Additional Cleanup Levels. US EPA Region VI soil and tap water screening levels may also be used for assessing human health direct contact risk for compounds not available in the ADEC Tables. As an initial screening sediment analytical data will be directly compared against available sediment screening benchmarks (e.g., NOAA Screening Quick Reference Tables [SQuiRTs] and ambient water quality criteria. If site concentrations exceed screening levels, further evaluation of offsite areas will be considered. Detection limits consistent with 10X the USEPA Region VI Ambient Air Screening Level will be used for soil gas. These screening levels are preliminary ARARs; final ARARs will be determined in the FS and documented in the final ROD. A comprehensive table of specific values will be provided in the RI report along with comparison conclusions.
3.	Table 3-1	Please note that the PCB cleanup level in soil is 1 mg/kg regardless of the spilled concentration and date.	Comment noted.
4.	Table 3-1	Please provide specific numeric criteria for hazardous waste determination.	Constituents detected at the site on the TCLP list include pesticides/herbicides and metals. Maximum TCLP limits for these compounds have been added to Table 3-1. A table of TCLP values will be provided in the RI report along with comparison conclusions.
5.	1.2, 1-2	Suggest reorganizing the bulleted items in order of priority in which case identifying the nature and extent of contamination appears to be the primary goal.	The priority is the quantification of baseline risk to site residents and other humans.. Nature and extent of contamination will be characterized in the process.
6.	1.3, 1-2	Text states that surface soil sampling will be conducted to quantify dermal risk. What about the ingestion pathway? Suggest revising text to read "*Surface soil samples across the entire site to quantify resident and visitor* ***direct*** *contact risk*."	Text has been changed.
7.	1.3, 1-4 – 1-5	Text states that sampling down gradient of known buried debris disposal areas will be done to quantify risks. However, it is not prudent to estimate risks when a known source has not been removed. Therefore, it is suggested that this sampling only identifies a current impact and cannot be used to quantify any future risk.	The RI Management Work Plan has evolved since the original language was written. Groundwater and soil gas samples will be collected in areas with known buried debris. Samples will also be collected during removal investigations. In this way, proposed sampling can be used to quantify future risk.
8.	1.3, 1-5	Text states that the extent of planned burial debris removal is unclear. However, it is deemed a crucial factor for this project that warrants some decision logic be identified prior to fieldwork.	The extent of the planned debris removal has been clarified and has been included in the Drum and Debris Investigation Work Plan included in this RI Management Plan.
9.	1.4, 1-9	Suggest providing documentation of qualifications for all project personnel for the tasks that they will be conducting in support of the project.	Qualifications can be provided directly to ADEC if requested, but are not appropriate for inclusion in the RI Management Plan.

Reviewer: Marlena Brewer, ADEC Contaminated Sites Program			
Item No.	**Section/ Page/ Para**	**Comments**	**Response**
10.	1.9, 1-17	The term validation should be clearly defined as to the level of review data will undergo. Who will perform the data packet validation and what will this entail (back calculations of results or just a simple usability review?)	Text has been added to refer to the QAPP for additional data validation details.
11.	Figure 2-3, 2-9	Suggest presenting separate human and ecological CSMs for clarity. Moreover, a CSM for each sub-area may be warranted as well as each is being evaluated individually.	Human health and ecological risk CSMs are shown on the same figure. Please provide specific questions or comments and they will be clarified.
12.	Figure 2-3, 2-10	Surface soil is defined as 0-2 ft bgs and subsurface is defined as 2-15 ft bgs not 0-6' and 0-10' as described in the figure.	The text in the figure has been changed.
13.	Table 2.3, 2-15	Define TICs as tentatively identified compounds. TICs should be reported for all analytical methods where applicable.	Through the work plan addenda process, the FCS Management Team has been able to further refine the target analyte list. Tables 2-3 and 2-4 have been eliminated. A list of 20 TICs for SVOCs will be analyzed where past analysis is not available.
14.	Table 2-4, 2-16	Please provide footnotes defining all acronyms used or refer the reader to the acronyms list at the beginning of the document.	Tables 2-3 and 2-4 have been eliminated. A list of acronyms has been included..
15.	Table 2-4, 2-16	Soil depths (see comment 13)	Tables 2-3 and 2-4 have been eliminated.. .
16.	Table 2-4 2-16	Why is perchlorate in groundwater only being analyzed at Areas A & D? Does previous sampling support not sampling it at other areas?	Through the work plan addenda process, the FCS Management Team has have been able to further refine the target analyte list. Tables 2-3 and 2-4 have been eliminated. Perchlorate was sampled in groundwater in 2006 and 2007 and was not detected. The FCS Management Team has agreed that no further sampling for perchlorate is warranted..
17.	Figure 2-5, 2-21	Inhalation of volatiles contaminants in outdoor air should be included as a potential exposure pathway as well.	This potential exposure pathway has been added to this figure.
18.	3.2, 3-1	Why were Region 6 soil screening levels used to assess the project lab detection and reporting limits? Why not use 1/10 ADEC cleanup levels as would be suggested for contaminant screening for cumulative risk consideration as described in ADEC's Risk Assessment Procedures Manual (RAPM)? Please refer to the RAPM for details on COPC screening.	1/10 of ADEC cleanup levels were used for contaminant screening and ADEC Risk Assessment procedures, (ADEC Technical Memorandum 01-003) were referenced. US EPA Region VI soil and tap water screening levels were used for assessing human health direct contact risk for compounds not available in the ADEC Tables. .
19.	Table 3-4	Suggest replacing "*ambient*" with "*anthropogenic*" to describe concentrations of organics such as DDT. Is background data available for DDT?	The text has been changed. Background data for DDT have not been identified.
20.	Table 3-4	A single sample seems inadequate to characterize subsurface conditions. What is the basis of only taking one sample and rationale of the sample location?	We propose to collect three sediment samples. The samples will be collected from the drainage swale which is the primary carrier of contaminants for site runoff from heavy storm events and snowmelt. See the Drainage Swale Sediment Investigation approach section for further discussion. Table 3-4 has been removed from the document (this table was split into smaller tables included in Section 4). Figure 4-6 has been updated to reflect three samples, not one sample.
21.	Figure 4-3	Please provide a figure legend and identify key features on the map such as the playgrounds, sound berms, and open recreational areas.	Per agreement at the 6/6 review meeting, multi-incremental soil sampling will not be used for surface soil. Historical discrete samples will be evaluated and additional near-surface soil samples will be collected in 2007 during installation of soil borings for monitoring wells. This figure will not longer be included in the RI Management Plan.

Reviewer: Marlena Brewer, ADEC Contaminated Sites Program			
Item No.	**Section/ Page/ Para**	**Comments**	**Response**
22.	4.2.2, 4-2	Why is surface soil for the open recreational area being sampled differently than other surface soils?	Per agreement at the 6/6 review meeting, multi-incremental soil sampling will not be used for surface soil. Historical discrete samples will be evaluated and near-surface soil samples will be collected in 2007 during installation of soil borings for monitoring wells.
23.	4.7.1, 4-21	Please specify what PCB contaminated soil will be removed.	The PCB-contaminated soil removal action is planned at the former Building 52 location, within the PCB Exclusion Zone, and at the former Transformer Service Area.
24.	4.8.2, 4-22	If fuel is the primary COPC, then BTEX and PAH should be collected in conjunction with DRO. BTEX and PAH data will be needed to calculate risks.	If contamination extends to groundwater, then DRO, BTEX, and PAH data will be collected.
25.	4	A figure presenting the dry oxbow and the former river channel is suggested.	Location of the former river channel is included in a figure in Work Plan Addendum #4. It is assumed that the dry oxbow is the same feature as the former river channel.

Reviewer: Jacques Gusmano, EPA Region X

Item No.	Section/ Page/ Para	Comments	Response
1.	Abbreviations and Acronyms	EOD: Device" should be "Disposal). Recommend: Word swap	This change has been made.
2.	Abbreviations and Acronyms	{Acronym- EPA} This usage is inconsistent with USACE. Recommendation: Pick one form or the other.	Agree, USEPA has been used.
3.		if the COE is the USCOE, than the EPA should be the USEPA	This change has been made.
4.	1.1 para 3	consider using single family dwellings, "residences" implies people living in the houses	This text has been modified.
5.	1.1 last para	We need a bullet for records review/ literature search so that any evidence of uxo use and disposal can be summarized and risk evaluations can be made.	A conceptual site model for MEC has been included in Section 2. Records review and literature search is included in this section.
6.	1.2, 4th bullet	Here again a major objective is to attempt to determine uxo distribution and associated risk by chemical, geophysical, field observations and literature review	A conceptual site model for MEC has been included in Section 2. Relevant data on distribution, type, chemical contamination, field observations, and literature review have been assembled in this section.
7.	1.3, last bullet	"Speed the investigation in areas of the site where MEC is not a concern," This statement is unclear, need to clarify	This bullet has been deleted based on other comments.
8.	Fig 1-3	Monitoring well (MW) installation and MW development/sampling have same end dates. A MW completed on 8/26 cannot be developed and sampled on 8/27	The project schedule has been updated.
9.	1.6.1, Table 1-1	Are there protocol, procedures and contact information, in the event non-HE weapon components are found.	Table 1-1 has been eliminated. Because Jacobs Engineering (JE) was scoped with providing the Communications Plan, we have included the JE Communications Plan as a separate tab.
10.	Table 1-3	Define HW, not in acronym list	The abbreviation is no longer used in the document.
11.	Table 1-3	Define MC, not in acronym list, assume to mean MEC	MEC is the correct acronym, and is in acronym list
12.	Table 1-3, last entry	See comment above [about protocols]	Table 1-3 has been eliminated. Because Jacobs Engineering (JE) was scoped with providing the Communications Plan, we have included the JE Communications Plan as a separate tab.
13.	2.1.1, para 1, sent 1	"Geology" and "soils" are not synonymous. Discussion of the surficial geology and permafrost conditions down to a depth of the drinking water (DW) well screens (potable aquifer) must be included as "15 feet" is completely inadequate	This section has been revised.
14.	2.1.2, para 1, sent 5	Groundwater (GW) is at 12-15 feet and flow is to the west-northwest. That is all we know about site GW from this section. Where is discussion of the bottom of the saturated zone, hydraulic conductivity, gradient, depth of the DW supply wells, aquicludes, buried channels (oxbow), etc.? All of these impact GW flow, contaminant migration, plume extent, and potential for contamination of the DW wells.	This section has been revised.
15.	2.1.2	Add description on historic oxbow	This information has been added
16.	2.1.2	Give depth of drinking water supply wells	This information has been added
17.	2.2	Appears to be a significant data gap, Wasn't the contractor that built the house required to have an environmental consultant on hand? Where is the review of their detailed notes of the findings during construction? The review of that data will help focus this investigation and remediation.	Review of construction field notes was used in siting some of the monitoring wells. Data generated during construction is being tracked down and incorporated into other historical data for use in the RI.
18.	Figure 2-1	This is not a cross section; it is a cartoon. A detailed cross section must be included to show interbedded gravels, sands, silts, clays, borehole locations, MW well screen depths, etc.	This figure has been replaced by a representative boring log. Detailed cross sections will be prepared for the RI report..

Reviewer: Jacques Gusmano, EPA Region X

Item No.	Section/ Page/ Para	Comments	Response
19.	Figure 2-1	There is no legend to explain this figure. What do the numbers represent?	The figure has been updated. A legend has been added.
20.	Figure 2-3	To the "Future Residents" column add Current Residents- area surrounding this site has potential receptors. I would also change the solid box for inhalation to site visitors to an open box, since we have not found an even moderate volatile source especially for visitors. This is a well done version of a usually required but often useless graphic. Your presentation helps the reviewer focus on high priority receptors and transport mechanisms. Good job.	These changes have been made.
21.	Figure 2-4	Excellent CSM. A child pulling a carrot out of a garden is the only missing element. Very well done!!!	Comment noted.
22.	2.3.1.4, para 2 line 4	Explosive degradation products cannot be eliminated from GW monitoring	Explosives are included in groundwater monitoring in Areas B (includes Area J) and C. See Addendum 4 Groundwater Investigation.
23.	2.3.1.4	The PSE-2 investigation had hits of UXO constituents in the GW at well mw12 and mw06A, in areas B and J. Include these areas for UXO sampling	Explosives are included in groundwater monitoring in Areas B (includes Area J) and C. See Addendum 4 Groundwater Investigation.
24.	Table 2-3	Under Chemical Warfare components you suggest to delete further sampling. We agreed to sample for thiodiglycol and other mustard breakdown product. ,I believe these should be added	Chemical warfare components were sampled in groundwater in May 2007 and there were no detections. It was agreed by the FCS Management Team that no further chemical warfare sampling would be conducted.
25.	Table 2-4	If explosives were found in the "small plume" area, why are explosives dropped as an analyte in Table 2-4 in any "sub-areas" upgradient or downgradient from this plume?	Through the work plan addenda process, we have been able to further refine the target analyte list. As described in Addendum 4, Groundwater Investigation, explosives are included in groundwater monitoring in Areas B & C. Tables 2-3 and 2-4 have been eliminated
26.	Table 2-4	Add explosive constituents to area B and J.	Explosives are included in groundwater monitoring in Areas B (includes Area J) and C. See Addendum 4 Groundwater Investigation.
27.	2.3.1.5, para 1 line 5	GW ingestion "may occur at off-site production wells" is wrong! Ingestion may occur anywhere in the public water supply system that the contaminated GW is used.	This text has been modified.
28.	2.4, para 1 line 10	The "Conceptual Site Model" section is Section 2.3, not 2.4.	This text has been corrected.
29.	Figure 2-5	Another excellent figure; not only entertaining but clearly depicts pathways for all audiences.	Comment noted.
30.	2.4.1, last sentence	Important observation; also add the high sensitivity of gore sorbers to any halogenated sources based on field experience.	Comment is noted but it not clear what revision is needed in this text.
31.	2.4.2	Searching the document this is the first mention of COPC: it is in the acronym list, but not defined in the text Probably should be introduced earlier in the section. Note found the call-out two sections below,	Text has been corrected.
32.	2.4.2	Perhaps a table of COPC with suspected source, will help when it comes time to narrow the field of COPCs	Consistent with the dynamic planning element of the Triad Approach, a series of Addenda providing additional details and information about the purpose and procedures for selected RI investigation elements (e.g., Sound Berm, Soil Piles, Soil Gas, and Groundwater) were prepared to supplement the RI Management Work Plan. Specific COPCs proposed to be sampled are listed in each Addendum.
33.		{2.4.3/2/2-3} The small plume must be shown on Figure 2.6 or on a new figure as Areas B and J are not shown so the reader has no idea where the plume is located	The plume has been shown on other figures. Subareas are shown on Figure 2-3.
34.	Figure 2-6	The small plume must be shown on Figure 2.6 or on a new figure.	The plume has been shown on other figures.

Reviewer: Jacques Gusmano, EPA Region X			
Item No.	**Section/ Page/ Para**	**Comments**	**Response**
35.	3.1.3	We need a section on establishing Background levels for metals. Since I do not see background sampling as part of the Work Plan, I assume you will use existing background data; this must be clearly explained and defended and accepted by the RPMs. We could also use this section to detail a rationale for screening ubiquitous chemicals like DDT, and expected surface construction debris like nails, paint, bonding material, and heavy equipment POLs. This must be dealt with here or in the decision tree for MI Sampling- see that section for more comments.	Comment Noted. An investigation of background soil metals will be used for comparison in the RI (*USACE.1994. Background Data Analysis for Arsenic, Barium, Cadmium, and Lead on Fort Wainwright Alaska*.). Background information is not known to be available for chemicals like DDT.
36.	3.2	We need more discussion, this is a very important section for the Risk Assessment, so that potential COCs are not screened out to early. We need language on dealing with Non Detects as compared to ½ the MDL (ADEC 2005a)." If ½ the MDL is greater than the screening level for a N.D. that constituent will not be a COPC but will be considered in the uncertainty analysis."	When evaluating non-detect lab results, the results will be compared to ½ the value of the ADEC MDL. Constituents that are encountered that are not COPCs will be considered in the uncertainty analysis.
37.	3.3.2	You should add engineering and institutional controls here also.	Text has been revised to include these controls.
38.	3.3.2, para 1 line 5-6	POL and solvent plumes may attenuate before the Chena River, but where is the data to support this statement. And what about these contaminants attenuating before the DW wells? Finally, do the metal and explosives that have been found in GW attenuate before the river or DW wells? Explosive degradation products have traveled miles downgradient to DW wells at another Army facility—Pueblo Chemical Depot.	This section has been revised with data to support these statements
39.	Table 3-4	DQO 5: The Step 7 "Assumption" does not fit the schedule in Figure 1-3. When will GW sampling occur if removal actions extend throughout the field seasons of 2007 and 2008 and still be evaluated for the Final RI if the samples are collected "after the removals"?	Based on comments from the FSC team the DQO Tables and Data Evaluation Flow Charts have been revised. The project schedule has also been revised. GW sampling is scheduled to occur on October 2007 and April 2008.
40.	4.2.2	I believe the use of MI Sampling, except in stockpiles and berms, is could be problematic at this site and goes against ADEC Guidance that states to use it only at petroleum sites. I also am concerned that the results of any composite sampling effort will not meet the Risk Assessment need to understand Point Source Concentrations. If this is indeed acceptable to Risk Assessors, then we must have a decision tree that clearly defines what is truly screened out and when discrete resampling will take place. You also must make it more clear, than the work plan does currently, that VOCs and SVOCs will not be included in the MI sampling. And it is not just because they may be absent in the first 6", it's also because of the sample collection, drying and mixture process.	This section has been supplemented by Addendum 1 to the RI management Plan – Sound Berm Investigation. Additional details on MI sampling procedures and requirements have been included in this Addendum. For other surface soil conditions, MI Sampling will not be used. As agreed to by the FCS Management Team, existing soil data will be reviewed and used to assess surface soil conditions.
41.	4.2.2	This sampling technique may not yield the desired data. This technique is if founded in the agricultural industry and is designed to characterize large homogenous areas. The required data quality may be missing to make risk based decisions and nature and extent remediation decisions. Expect extensive re-sampling to fill inherent data gaps.	This section has been supplemented by Addendum 1 to the RI management Plan – Sound Berm Investigation. Additional details on MI sampling procedures and requirements have been included in this Addendum. For other surface soil conditions, MI Sampling will not be used. As agreed to by the FCS Management Team, existing soil data will be reviewed and used to assess surface soil conditions.
42.	Figure 4-3	Figure 4-3 is unclear, are there 97 units? What do the blue hashmarked areas designate.	The approach depicted in this Figure has been revised based on comments by the FCS Management Team. Existing soil data will be reviewed and used to assess surface soil conditions. Near-surface soil data collected in this RI will also be included in the evaluation.

Reviewer: Jacques Gusmano, EPA Region X			
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43.	4.2.2 para 2	The site is a site of historical subsurface burial, the surface soil would be cover material which would be inherently clean. Historical burial technique was to 1) fill in existing low spots (drainages or gravel pit operations) or 2) using heavy equipment move surface soil out, making a pit, place burial material, and putting the cover back onto the pile, and packing with the heavy equipment. Sampling this surface soil will only document the amount of disturbance caused by the subsurface construction activity.	This approach has been changed based on comments from the FCS Management Team. MI Sampling will not be used for surface soil sitewide. Instead, existing soil data will be reviewed and used to assess surface soil conditions.
44.	4.2.2 para 2	ICs to prevent digging would be difficult to implement, or to track and maintain compliance.	Comment noted; because of text revisions, Section 4.2.2 has been eliminated.
45.	4.2.2	This is an appropriate statement and could have an effect on risk decisions later, however, we will investigate this site in its current condition, since we can't be sure of final grade yet.	Comment noted; because of text revisions, Section 4.2.2 has been eliminated.
46.	4.2.2 playground areas	Perhaps a sampling grid with discreet samples to augment the inherent Public Relations problems of having to explain the MI sampling to a less informed (already jaded) receptor population.	This approach has been changed based on comments from the FCS Management Team. MI Sampling will not be used for surface soil sitewide. Instead, soil existing data will be reviewed and used to assess surface soil conditions.
47.	4.2.2 other open areas	In case I missed this in any other area….we will sample this site as is, not based on any future plans. The only cap or cover acceptable is one that is described in a signed ROD, not a theoretical future plan. We will sample this area.	This approach has been changed based on comments from the FCS Management Team. MI Sampling will not be used for surface soil sitewide. Instead, soil existing data will be reviewed and used to assess surface soil conditions.
48.	4.3.2, para 2	Please clarify, there will not be interval samples collected during the soil boring. If not, provide rationale for only collecting the bottom sample. This text isn't clear as to that rationale	It was agreed by the FCS Management Team to collect a minimum of three discrete samples in each boring with the option to collect an additional discrete sample at the discretion of the field geologist.
49.	4.3.2 para 2	This is probably a good approach at this site, however I would like to see a contingency built in for a geologist interpretation on-site that would add another sample at a confining layer in addition to the smear zone sample, if he/she makes that determination.	It was agreed by the FCS Management Team to collect a minimum of three discrete samples in each boring with the option to collect an additional discrete sample at the discretion of the field geologist.
50.	4.3.2.1	See comment above, the homes foundations will not be to the depth sampled above, the foundations or slabs on grade will be in the upper levels which appear to be un-sampled.	It was agreed by the FCS Management Team to collect a minimum of three discrete samples in each boring with the option to collect an additional discrete sample at the discretion of the field geologist.
51.	Figure 404	Where are the channel/oxbow borings shown on this figure?	The former river channel is shown in Figure 2-8.
52.	4.3.2.4 para 1 lines 4-6	Will geophysics be used to determine the deepest part of the channel? If so, how do the geophysical properties of the channel differ from those of the surrounding sediments? If not, what other techniques are planned to delineate the channel?	Geophysics is being used to evaluate burial depth in the channel. Direct excavation (Jacobs Engineering Drum and Debris Investigation) and soil borings (CH2M HILL monitoring well installations) will also be used to delineate the channel.
53.	4.4.2 para 1 lines 3-4	What are "several area types"? What is the hydrogeologic justification for screening 70 temporary wells "from 10 to 20 bgs"? EPA has seen no evidence that contamination at Taku Gardens extends only to a depth of 20 ft bgs and these 70 wells will not provide any new data to fill that data gap.	Smear zone soil samples and groundwater monitoring will help delineate sources of contamination. The majority of the monitoring wells will be screened across the water table. Two deep wells will be installed within the hydraulic capture zone adjacent to the Base water supply wells. Locations of monitoring wells are presented in Figure 4-4. The FCS Management Team agreed with these locations.
54.	4.4.2, para 2, line 2	If 2-inch PVC well casings are left without protective casing, they may not last until "results of initial sampling have been analyzed" in an area where simultaneous "removal actions" are ongoing.	All monitoring wells will have protective casings not necessarily cast in concrete until the final wells have been determined.
55.	4.4.2 para 3 line 4	This is the first statement in this WP indicating the depth of the DW wells and the fact that they are Base wells, not "off-site production wells" as stated in Section 3.3.4. This information must be added to Section 2.1.2.	This information has been added to revised Section 2.1.2..

Reviewer: Jacques Gusmano, EPA Region X			
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56.	4.4.2.1 para 1 line 3	Will MWs in test pits be installed after the pit is backfilled with clean material?	The monitoring wells will be installed after the pits are backfilled with existing soils that is not contaminated. Any debris encountered will also be removed. Please refer to Jacobs Engineering Drum and Debris Investigation work plan.
57.	4.4.2.1 line 1 para 5-7	If the gradient is known, why was it not included in Section 2.1.2? What figure is the POL plume shown on as it is not on Figure 4-5? Also, what are "extensions of soil borings'?	Section 2.1.2 has been revised. Groundwater flow direction is depicted on Figure 2-6. The sentence about monitoring wells as extensions of soil borings was deleted.
58.	4.4.2.2 para 2 line 2-4	EPA recommends that the use of a Multiple Interface Probe (MIP) on a direct-push rig instead of headspace samples collected with a split-spoon sampler and a hollow-stem auger for this type of screening, if the boreholes are only going to 20 feet or "subsurface soil near the water table." This system is faster, more accurate, and provides a vertical profile through the entire vadose zone.	Comment noted.
59.	4.4.2.3 para 1 line 9	There is no way to distinguish MWs in the former river channel on Figure 4-5.	The former river channel is shown in the figure in Work Plan Addendum #4 showing monitoring well locations.
60.	4.4.2.3	Table 4-? A table is needed that lists the well number, location coordinates, total depth, screened interval, and purpose (POL plume delineation, former river channel delineation, etc.) for each of the 70 temporary and permanent monitoring wells planned for this project. Only with this table can EPA determine whether 7, 70, or 700 wells are needed, whether there are data gaps in vertical and lateral coverage, and the adequacy of the two-year RI groundwater monitoring plan	Consistent with the dynamic planning element of the Triad Approach, a series of Addenda providing additional details and information about the purpose and procedures for selected RI investigation elements were prepared to supplement the RI Management Work Plan. Addendum 4 supplements the Groundwater Investigation and provides the proposed monitoring well locations. Additional monitoring well locations were added as additional historical data became available.
61.	Figure 4-5	This figure must show the POL plume and the former river channel as well as distinguish the objective of each MW by differences in well symbols or colors.	Figure 2-6 depicts the POL plume and former channel. Monitoring wells were selected to provide sitewide coverage for locating sources, to characterize groundwater quality downgradient of anomalies, and to confirm historical data which exceeded screening levels.
62.	Figure 4-6	This figure needs to show GW contours and general flow directions. Where are the boundaries of the "former river channel" (oxbow) shown on this figure?	Figure 4-3 shows the locations of all monitoring wells, the groundwater flow direction, and the boundaries of the former river channel. Groundwater flow information will be refined after monitoring depth to groundwater in the new wells.
63.	Figure 4-6	{ Figure 4-6b} A new, smaller-scale figure needs to be added that shows the locations of the Chena River, DW wells, former river channel, contaminant plumes, and GW contours/flow direction in relation to the Taku Gardens location.	In Section 2, Figure 2-2 has been added to show the drainage swales.
64.	4.8.2	We need a Task for Literature Review. Cristal and Therese collected historic data that may demonstrate UXO type, use and disposal practices. Thus far this info has not been entered in any study or report.	A literature review was conducted by US Army DPW and the results have been included in the Conceptual Site Model for MEC. This has been added to Section 2 of the RI management Plan. Additional literature review may be completed, as needed, to support the MEC Hazard Analysis.
65.	References	We need the Geophysical Task here not in the Appendix. CH2MHill will take all evidence, including geophysical to determine remediation requirements for explosive as well as chemical constituent risk.	CH2MHill will take all evidence, including geophysical to determine remediation requirements for explosive and chemical risk.CH2M Hill has used the latest geophysical data to locate proposed sampling locations in relation to identified debris disposal areas. CRREL is handling the geophysics work; their work plan is included as a separate tab in the RI Management Plan.

Reviewer: Jacques Gusmano, EPA			
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1.	Addendum 3	EPA also accepts addendum 3 to the Work Plan as final.	Comment noted.
2.	General	As I mentioned on our conference call, I would add ground water flow direction to this figure so reviewers can determine if wells are downgradient of suspected sources. That said, I would double check the location of MW 13 to see that it is downgradient of the new metal debris discovery. As already mentioned, having all wells on one graphic is a good idea, with the figure title changed to reflect that fact. If all existing wells are still useable, then it looks like we have good downgradient coverage of obvious individual potential sources. Therefore, if the above changes/double checks are made, EPA approves this G.W.Well location map.	Groundwater flow direction has been added. The location of Monitoring Well 13 was shifted north so it is directly downgradient of the anomaly near the substation.
3.	Decision Trees	The main problem I have is that the groundwater figure does not refer to the Risk Assessment as the others do. All data needs to be first screened for the Reporting Limit, and after QA/QC, for the Screening Level, then a determination is made if sufficient data exists to evaluate nature and extent , then a Risk Assessment is conducted. I have attached a Work Plan from another RI/FS; this work plan has had many comments by EPA but I wanted you to look at the figures 3-7 and 3-8 as an example that I think will address most comments on your decision tree. Several people at CH2MHill are familiar with this Work Plan. You will notice that these example figures divide the site and address particular Goals; you also might consider this approach. As far as modeling goes, obviously real time data is better but for determining past contamination or predicting future migration rates, or truth testing confusing data, modeling is appropriate. As you see in the example figure, they include all data and modeling. The comments on non-risk issues are addressed during the FS process, specifically screening against ARARS. The ADEC petroleum cleanup criteria and groundwater degradation would be "to be considered ARARS".	The groundwater decision tree has been modified based on comments from all involved agencies.
4.	Addendum 4	EPA agrees with ADEC comments on the #4 addendum. With the placement of a well downgradient of the newly discovered debris, on the Southeast corner of the site, and the modifications suggested by ADEC, EPA approves this Work plan.	Comment noted

Reviewer: Sharon Richmond, Alaska Department of Environmental Conservation
Date: September 12, 2007

Item No.	Section/ Page/ Para	Comments	Response
1.	General	I reviewed the proposed locations. I think this will provide a good general coverage. I have the following suggestions: 1. Proposed MW13 be moved a little bit northeast so that it is immediately downgradient of the newly discovered anomaly. 2. Indicate groundwater flow direction on this figure. 3. Change title. The figure also shows proposed locations in the low probability area. 4. One thing I found missing is a description of how the proposed locations were chosen, other than a mention of as-builts and contract drawings. It appears as if areas with dense metal debris were avoided, more wells are located in the VOC/POL area, and locations are proposed in areas with a higher potential for contamination or greater risk if contamination is found (i.e., the slough channel, down-gradient of debris, within Well 3559 capture zone, etc.) but I think it would be good to document how these locations were chosen. Otherwise, locations are approved.	These suggestions have been implemented. Monitoring wells were selected to provide sitewide coverage for locating sources, to characterize groundwater quality downgradient of anomalies, and to confirm historical data that exceeded screening levels.

Reviewer: Sharon Richmond, Guy Warren, Marty Brewer, Earl Crapps, Alaska Department of Environmental Conservation
Date: September 7, 2007

Item No.	Section/ Page/ Para	Comments	Response
1.	General	Suggest including decision trees for new stockpiles, confirmation sampling for excavations and drum removal, clean backfill determination, and characterization of waste stream during drum removal.	These diagrams can be developed as needed. However, these actions are remedial responses and removal actions which are part of the FS not the RI.
Decision Trees			
2.	Groundwater	I strongly suspect that groundwater contamination reached steady-state conditions a long time ago so I don't expect modeling to demonstrate that surface water will be affected or the WSW is threatened. With this expectation, it is quite possible that no groundwater remedial actions will be considered for the entire site with this decision tree. Also, this is an entirely risk-based decision tree that does not consider addressing aquifer degradation (e.g., DEC requirement to remove free product to the greatest extent practicable). It also does not address the possibility that groundwater that is not present at the northern property boundary or within the WSW capture zone might require treatment. Please revise.	The Flow Chart for Groundwater has been revised to indicate that in addition to site characterization and risk evaluation, groundwater monitoring results will be available during the FS stage when suitable remedial actions will be identified and evaluated, including compliance with ADEC requirements (e.g., aquifer degradation). As stated in the RI Management Plan, the purpose of the groundwater investigation is to determine the nature and extent of contamination and to use sample data that exceeds screening criteria in the baseline risk assessment. All data obtained, during the groundwater investigation however will be retained in the project data base. Groundwater (and soil) sampling data combined with existing site data, risk information and modeling information will be available to use to enhance the Conceptual Site Model, understand current and future aquifer conditions, and complete the FS where remedial actions are identified, screened, evaluated and ranked relative to the nine CERCLA criteria which includes ARARs such as ADEC requirements.
3.	Groundwater	Please define water supply well.	The term water supply well actually refers to the water supply capture zone model a zone previously modeled for the FCS (potable) supply well located in the NE corner of the site.
4.	Groundwater	If GW concentrations exceed screening criteria then these contaminants should be included in the risk assessment. We do not recommend modeling to evaluate current risk when actual data will be available.	As stated in the Interim Draft RI Management Plan, groundwater concentrations that exceed screening criteria will be identified and used in the baseline risk assessment. Modeling will be done to evaluate future risk potential not current risk conditions. The decision diagram has been revised to show this.
5.	Sound Berm	I think it's acceptable to use the model to demonstrate whether contaminants might reach the WSW in the future and then to conduct the feasibility study, if necessary.	Comment noted.
6.	Sound Berm	Suggest using field screening to delineate contamination before collecting discrete samples.	The Sound Berm Addendum (No.1) states that agency approval will be obtained before discrete samples are collected; field screening procedures can be evaluated, if needed, at that time.
7.	Sound Berm	Need to add a decision point that if concentrations are above cleanup levels (not screening levels), then remedial action would be taken & no further investigation or remedial action is necessary. (Not all cleanup levels are risk-based; need to consider environmental degradation.)	If sound berm MI samples exceed cleanup levels (1/10 ADEC criteria) then additional discrete sampling will be conducted. As stated in the Sound Berm Addendum (No. 1), agency approval will be obtained before any discrete sampling is performed, so possible field screening procedures could be considered at that time. If screening levels are exceeded, additional testing would be used to support appropriate remedial response. If ADEC cleanup levels are exceeded so that a remedial action is necessary, it is most likely that the affected material would be disposed of at an offsite disposal or treatment facility. In that case, characterization samples would be developed to meet the facility's acceptance criteria. Verification samples would also be developed if needed, to demonstrate the remedial action is satisfactory
8.	Soil/Gas	Box under "Source Characterization and Nature & Extent" Add "soil samples" to this box.	The footnote for the soil Gas Decision tree indicates that results from soil and groundwater results will be combined to conduct the soil gas investigation.

Reviewer: Sharon Richmond, Guy Warren, Marty Brewer, Earl Crapps, Alaska Department of Environmental Conservation
Date: September 7, 2007

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9.	Soil/Gas	I suggest using soil gas, soil, and groundwater data to make a decision regarding whether additional analysis is necessary. I'm concerned about using only one sample to determine risk. Suggest adding a box for "Potential Risk?" using all data.	As stated in Addendum 4, the soil gas investigation results will be combined with the results from the groundwater and soil investigation source evaluations. As agreed by the FCS Management Team, two sub-slab soil gas samples will be collected at each building.
10.	Soil/Gas	Outdoor air is not addressed.	Potential exposure and risk to ambient air will be addressed as part of the Baseline Risk Assessment for surface and subsurface soil. Per standard risk assessment guidance, ambient air concentrations of vapors and dust will be modeled from these soil results. In addition, background outdoor vapor concentrations have been collected and will be evaluated as well.
11.	Subsurface Soil	Add a box to address the point where subsurface soil will be treated or removed. See earlier comments.	Text revised accordingly.
12.	Subsurface Soil	Should delineate extent of contamination as the step before asking if there is enough data for risk assessment. Sharon: Agree. Suggest adding a box with "Map distribution of detected analytes to define sources and extent of contamination".	The bottom box will be modified to say 'map detected concentration, including locations of screening level exceedances.
13.	Subsurface Soil	Under Acceptable Risk – No "Gather additional data for Feasibility Study if needed" While other decision trees (Sound Berm) use "No Further Investigation. Use information to design remedial action." Please use consistent terminology between Decision trees.	Text revised accordingly.
14.	Sediment	Decision tree should follow the process through the risk assessment to be consistent with other Decision trees. Should include Yes/No for results of RA.	Decision diagram has been revised to be consistent with other diagrams.
DQOs			
15.	General	Suggest including decision trees for new stockpiles, confirmation sampling for excavations and drum removal, clean backfill determination, and characterization of waste stream during drum removal. Marty and Earl suggested organizing the DQO tables by matrix, then by sample type (characterization, waste determination, etc.)	These diagrams can be developed as needed. These actions, however, are remedial responses and removal actions which are part of the FS not the RI.
16.	Groundwater	Recommendation against using modeling to evaluate risk.	The text has been revised to indicate that results will be used for the baseline risk assessment and to model possible future concentrations in groundwater.
17.	Groundwater	EPH/VPH are listed under analytes to evaluate risk. These will not be used to evaluate risks, but only to aide in delineating contamination.	The project will use the EPH & VPH data to help characterize the aromatic-aliphatic equivalent carbon distribution of the GRO, DRO and RRO hydrocarbons; supply information to allow representative phase partitioning calculations; and help assess the fate and transport of the bulk hydrocarbons. The EPH and VPH data may be used to help interpret the cumulative GRO, DRO and RRO risk calculations, and to assess alternative cleanup levels, if necessary.
18.	Groundwater	The second objective compares results to the ADEC Drinking Water Criteria while the decision tree uses Risk Based Screening levels. Revise for consistency.	This section has been revised.
19.	Groundwater	Change POL to VOC in first Data To Be Collected cell.	Text has been revised.
20.	Groundwater	Suggest adding potential exposure at SAS as well as drinking water and eco-risk for wells along northern boundary.	The groundwater sample results obtained from wells along the northern boundary will be screened for ecological risk.
21.	Groundwater	It is possible that groundwater not exceeding risk-based screening criteria will require treatment. Suggest adding comparison to Table C cleanup levels here and in decision tree.	Table C is referenced in the DQO Table. It is difficult to see how water that does not exceed risk based criteria (1/10 of ADEC cleanup levels) would require remedial action. Treatment issues, however, would be considered in the FS not the RI.

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Date: September 7, 2007

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22.	Sound Berm	Suggest considering the use of field screening as suggested above.	The Sound Berm Addendum (No.1) states that agency approval will be obtained before discrete samples are collected; field screening procedures can be evaluated if needed, at that time.
23.	Sound Berm	See previous comments regarding the possibility for soil removal/treatment.	If ADEC cleanup levels are exceeded such that a remedial action is necessary in the Sound Berm, it is most likely the affected material would be disposed of at an offsite disposal or treatment facility. In that case, characterization samples would be developed to meet the facility's acceptance criteria and validation samples would be developed if necessary to demonstrate the response was complete.
24.	Sound Berm 3rd par under Data Evaluation	Correct typos-- eht should be the and sample should be samples.	Typos have been corrected.
25.	Sound Berm	Suggest adding "If the RSD results for a triplicate do not meet the ADEC criterion, the usefulness of the data will be evaluated under the Other Considerations column.	Text will be added as suggested.
26.	Soil Piles	Add VOCs for soil piles in the northwest.	"VOCs" for NW piles has been added.
27.	Soil Piles	1st paragraph under Other Considerations column-- suggest changing the work "limit" to "select".	Text has been revised.
28.	Soil Piles	Please address confirmation sampling after disposal of all contaminated soil piles.	Confirmational sampling will be conducted if disposal of contaminated soil piles is necessary. This DQO process is intended to characterize the content of the piles not to verify cleanup actions.
29.	Soil Piles	Aside from Fort Wainwright landfill acceptance criteria, what other criteria will be used to evaluate other disposal and/or treatment options? Sharon: soil will either go to OIT or Outside as RCRA waste. OK by me to add a statement to this effect.	Addendum and Flow chart both indicate that if soil piles are not acceptable for Fort Wainwright Landfill, the Army will dispose of this material through DRMO which has established and approved waste acceptance criteria for hazardous and non-hazardous wastes.
30.	Soil Piles	What about use of stockpiled soil as clean fill and analytes chosen for new stock piles? Sharon: This DQO table only refers to existing soil piles. All of these will be disposed of. The analyte list for existing soil piles was chosen from previously collected data. The analyte list for new stock piles was more conservative because we don't know what we'll get. I strongly suggest preparing a DQO table and decision tree for stock piles that will be generated this year.	Comment noted. However the generation of new soils and stock piles is not part of the RI but part of the site construction activities.
31.	Soil Gas	Data To Be Collected. Please recognize that I have not accepted the use of one sample per duplex to determine whether there is a risk for vapor intrusion.	Per agreement with the FCS Management Team, two sub-slab soil gas samples will be collected at each building.
32.	Soil Gas	Sub-slab as well as soil vapor data should be used for source delineation.	Text included.
33.	Soil Gas	Outdoor air is not addressed.	Potential exposure and risk to ambient air will be addressed as part of the Baseline Risk Assessment for surface and subsurface soil. Per standard risk assessment guidance, ambient air concentrations of vapors and dust will be modeled from these soil results. In addition, background outdoor vapor concentrations have been collected. Ambient air samples were collected at the same time as other soil gas samples, in an open garage, in open air on site, and on the fence on the west side of the site.
34.	Subsurface Soil	Residential risk is not addressed. What levels will be used to compare results to evaluate whether there is a potential risk.	Residential risk will be considered in upper two feet of soil and that excavation worker exposures considered in subsurface soils (0-15 ft bgs). Soil concentrations will be used to estimate aggregate risk for applicable exposure scenarios, and results will be compared against regulatory risk targets. Excess lifetime cancer risk values will

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Date: September 7, 2007

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			be compared to the "point of departure" range of 10-6 to 10-4 that is generally used by regulatory agencies.
35.	Subsurface Soil	Need to address identification and delineation of potential source areas.	Text has been added as suggested.
36.	Subsurface Soil	Need to discuss excavation confirmation sampling DQOs.	Confirmational sampling is not part of the RI. Disposal and verification is either addressed in the FS or more likely, in specific sampling plans, developed to address a remedial action.
37.	Subsurface Soil	EPH/VPH will not be used to assess risk, only to delineate contamination.	The project will use the EPH & VPH data to help characterize the aromatic-aliphatic equivalent carbon distribution of the GRO, DRO and RRO hydrocarbons; supply information to allow representative phase partitioning calculations; and help assess the fate and transport of the bulk hydrocarbons. The EPH and VPH data may be used to help interpret the cumulative GRO, DRO and RRO risk calculations, and to assess alternative cleanup levels, if necessary.
38.	Subsurface Soil	Include TICs for SVOCs.	Since TICs are of uncertain identify and quantity, they will be addressed qualitatively as part of the uncertainties discussion of the risk assessment.
39.	Subsurface Soil	Under Subsurface soil samples there is a row for "Characterize subsurface conditions and potential impacts to ground water." The objective implies ground water sampling but I don't think this is the intent. Might be clearer to revise the objective to read: "Characterize subsurface conditions and potential SOIL impacts to ground water"	Text has been added as suggested.
40.	Subsurface Soil	Change POL plume to VOC plume.	Text has been added as suggested.
41.	Subsurface Soil	It is possible that subsurface soil not exceeding risk-based criteria will require treatment.	It is difficult to see how soil that does not exceed risk based criteria (1/10 of ADEC cleanup levels) would require remedial action. Treatment issues, however, would be considered in the FS not the RI.
42.	Sediment	EPH/VPH can't be used for risk assessment.	The EPH and VPH data may be used to help interpret the cumulative GRO, DRO and RRO risk calculations, and to assess alternative cleanup levels, if necessary.

Comments on the Conceptual Site Model for Munitions Response Area
Reviewer: Guy Warren, EPS, Alaska Department of Environmental Conservation
Date: September 5, 2007

Item No.	Section/ Page/ Para	Comments	Response
1.	General	Please explain why an integrated CSM that addresses both MEC and HTRW projects was not completed for this project. EM 1110-1-1200 specifically provides for an integrated CSM and recommends its use "when the potential for OE (MEC) and HTRW exist on a site". It is also very helpful to include line numbers in the report to facilitate comments	Comment Noted – The CSM was developed per management team request and was not integrated with the HTRW CSM because in our professional judgment separate CSMs are easier to follow. The CSM follows guidance in Section 2.6 of the referenced document.
2.	Section 2.1 Page 3	Top of page three, Text States: Artillery first arrived with the 36th field artillery Battalion at Ladd Field in the summer of 1951, about 5 years before closure. Therefore, the window of time when MEC could have reached the facility is believed to be narrow." This statement implies that the only source of MEC is from the Artillery battalion and that burial pits constructed prior to their arrival will not contain MEC. This is not accurate considering the M47 chemical bombs, 20-pound frag bomb and other ordnance items identified to date. Please revise for accuracy. This section should also reference the comprehensive summary of aerial photo interpretation presented in this or another document.	Agree – Text will be modified to indicate that the Battalion is not the only possible source of MEC. The comprehensive photo interpretation will also be referenced. Oasis, 2007a. Preliminary Source Evaluation 1 Narrative Report, Former Communications Site, For Wainwright, Alaska, Interim Final.
3.	Section 2.2 Page 3	Second paragraph: The acronym MPPEH stands for Material Potentially Presenting an Explosive Hazard. In addition this is not the appropriate term to describe these items. These Items should be considered Discarded Military Munitions (DMM) as they are "Military Munitions that have been abandoned without proper disposal" and these items are not considered UXO.	Agree – MPPEH will be deleted along with UXO and replaced with DMM.
4.	Table 1 Page 3	A note should be added to the table that an uninvestigated anomaly exists in Area D that could potentially contain additional items of concern (ordnance, drums, etc.)	Agree – A note will be added to the subject table as indicated. The note will also state that the anomaly may be related to MEC, non-MEC, or a combination of both.
5.	Section 2.2 Page 3	Second paragraph Text States: Additional items found, but not included in the table because they were not related to ordnance were…" These items (with the possible exception of the smoke tank) would be more accurately described as Munitions Debris. Text continues "ordnance were uncovered, including six items from the test pit and two from the debris piles." However Table 2 identifies 9 ordnance items. Please revise for consistency.	Agree – The subject items will be identified as MD. The listing of Items in Table 2 inadvertently tallied to 9 rather than 8, the table will be corrected.
6.	Table 2 Page 4	It appears that the risk determination for the AN M1A1 20-lb. frag bomb may contain an error. Although the unintentional detonation of this MEC would be "catastrophic" the "hazard probability" may more accurately be judged to be "unlikely". This is because only one of these DMM have been identified to date (Seldom) and the likelihood of unintentional detonation is very low because the MEC was unfuzed DMM. ADEC recommends that the risk determination of this DMM be reevaluated and corrected if appropriate.	Agree - Risk from HE is Critical in Severity with a probability of encounter at seldom for and overall risk of "Moderate" during a non-intrusive encounter. The risk associated with direct excavation without construction support per USACE EP 75-1-2 is II-C, "High Risk". This risk can be reduced to "Moderate" with the application of Construction Support per EP 75-1-2. This method also applies to Item 4 in the subject table.
7.	Table 2 Page 4	Item #2 in this table contains confusing information. The Description says "M47 Series crushed with burster tube" and the evaluation states "Shipping plug in nose with burster tube No HE". Does this mean that the buster tube while present did not contain HE? Please clarify.	Agree – the Evaluation column of the subject table will be revised to state the following from the Explosive Ordnance Incident Report; Shipping Plug in Nose and Burster tube running entire length.
8.	Table 2 Page 4	Item #3: Did this item contain a live explosive warhead as well as propellant? Please include this information in the table	Agree – the Evaluation column of the subject table will be revised to indicate the presence of HE.
9.	Table 2 Page 4	Despite previous comments this is the most comprehensive summary I have seen to date regarding the munition items previously found at the site.	Thanks

Comments on the Conceptual Site Model for Munitions Response Area
Reviewer: Guy Warren, EPS, Alaska Department of Environmental Conservation
Date: September 5, 2007

Item No.	Section/ Page/ Para	Comments	Response
10.	Table 3 Table 2 Page 5	Please include location and date found in this table. To be consistent between table 2 and 3 Disposition of the item should be included in Table 2 as well.	Agree – Dates were added to Table 3 (now Table 2-5); however specific information regarding locations and depths of the items are not present in the Explosive Ordnance Incident Reports or noted in available reports. Table 2 (now Table 2-4) was revised to indicate disposition of the items. Items 1 through 6 were disposed of by detonation. Explosive Ordnance Incident Reports could not be located for Items 7 and 8 to confirm disposition.
11.	Section 2.2 Page 5	Text States: "The results of geophysical investigations, soil borings, and the phase II Preliminary Source Evaluation indicate large areas under the current surface contain scrap metal laced with DMM, potentially including MPPEH, munitions debris, and MC." Awkward sentence. Suggest rewording to state: Geophysical surveys indicate large areas of buried subsurface metal. Subsurface investigation of these areas identified the presence of DMM and other Munition Debris buried along with large quantities of scrap metal. Laboratory results suggest that Munitions Constituent contamination may also be present.	Agree – the subject sentence was deleted and replaced with suggested text and a cross reference to Section 2.4.2.3.
12.	Section 2.3 Page 6	Second Paragraph: "The Majority of the MPPEH items discovered" as indicated in comment #4 it would be more accurate to call these items Discarded Military Munitions (DMM). This term is used to describe these items in the remainder of the document.	Agree – will also remove MPPEH from the balance of the document and replace with DMM.
13.	Section 2.3 Page 6	Area A has not been found to be a risk for performing operations that generate heat, shock and friction. If this were true it would not be possible to operate a track hoe in the area because a track hoe bucket contacting debris creates heat, shock and friction. Area A has, in fact, been found to have a "moderate to high risk" to contain MEC that is not UXO, is unfuzed and is not shock sensitive. Also, claiming that the area contains MEC that is susceptible to heat, shock and friction contradicts the Work Plan which states that it is safe to work in this area with a trackhoe which will create some "heat, shock, and friction" when it is removing the debris. As previously stated, the Work Plan and the CSM must agree. The Army and its contractor should reevaluate this statement and either change the Work Plan (to not allow mechanized removal of the debris) or the CSM (to agree with the work plan that the MEC are not susceptible to the heat, shock and friction that is planned during the debris removal).	Agree - Refer to Response to Comment No. 1. The risk is assigned as "Moderate" assuming the application of Construction Support and Avoidance per USACE EP 75-1-2. As such the Work Plan and CSM are in agreement in regard to risk.
14.	Section 2.3 Page 6	Last sentence in section: "To date, MEC and MD have not been discovered outside of Area A." This is not entirely accurate considering Table 3 lists DMM items found in the vicinity of the gas station. Recommend revising map of area A or stating that additional items have been found in this area.	Agree – the text was revised to include the location of the gas station as immediately northeast of the site.

Comments on the Conceptual Site Model for Munitions Response Area
Reviewer: Guy Warren, EPS, Alaska Department of Environmental Conservation
Date: September 5, 2007

Item No.	Section/ Page/ Para	Comments	Response
15.	Table 5	Physical Profile: According to EM 1110-1-1200 the Physical Profile should include a description of factors that affect the Location (aerial extent and vertical extent), Movement, detection, and recovery of MEC. Release Profile: Please review EM 1110-1-1200 and revise accordingly. Guidance states: "Release Mechanisms include those physical processes that contribute to the relocation of MEC in the environment." Ie excavation, erosion, frost heave, etc. Please review EM 1110-1-1200 and ensure that this CSM is consistent with the guidance provided therein.	Agree – information on the Physical Profile and release profile will be revised to include available information as detailed in Table 2-1 of the subject guidance. The CSM is consistent with the reference document, Refer to Response to Comment No.1.
16.	Section 5.0 Page 11	Second Sentence: "For example, only eight items.." Table 2 indicates nine items. Please revise for accuracy.	Agree – items in table were misnumbered and will be corrected
17.	Section5.0 Page 11	First paragraph: This is mixing apples and oranges. The individual MEC may be judged to be "low", "moderate" or "high" hazard. The hazard associated with the individual items is based on the guidance set forth in Army Field Manual (FM) 100-14 (Risk Management). Area A overall is judged to be "moderate to high" probability for encountering MEC. The hazard determination for the entire site is based on guidance set forth in EP 75-1-2 (MEC Support during HTRW and Construction activities). These are two different things and they are mixed together in this paragraph.	Agree – Risk per FM 100-14 is assigned based on risk associated with the individual item as well as the probability of an encounter. The hazard can then be mitigated through the application of Construction Support and Avoidance per USACE Engineering Pamphlet 75-1-2.

Responses to Comments
Field Sampling Plan

Responses to Comments
FWA102 Former Communications Site
Field Sampling Plan
Fort Wainwright, Fairbanks, Alaska

Reviewer: Marlene Brewer, ADEC

Item No.	Page/ Section	COMMENTS	REVIEW CONFERENCE A - comment accepted W - comment withdrawn (if neither, explain)	RESPONSE	BACKCHECK
1. (25 is item number in original)	Page 2-1 Section 2.1.1	Text states that soils with elevated VOC measurements will be considered for additional sampling. Please define what constitutes an elevated reading. How will field screening results be used to determine what samples shall be sent to the lab for definitive analysis?	A	Elevated readings are any reading above background readings on the photoionization detector. Field screening results will be used to locate monitoring wells to confirm the extent of the POL plume (See Groundwater Investigation, POL Plume). Groundwater samples will provide the definitive results. Field screening results will also be used to select specific soil sample intervals to be sent to the laboratory during installation of soil borings.[1]	
2.	Page 2-1 Section 2.1.1	Is any field to fixed lab sample results evaluation of correlation proposed? It is suggested.	**D**	As other information will be used to select sample intervals for laboratory analysis, and since fixed lab soil and groundwater samples will be analyzed, correlation with the photoionization detector results is not planned.	
3.	Page 2-2 Section 2.1.2	Suggest discussing the background assessment first in this section, then how site readings will be evaluated as compared to background.	**D**	Radiological screening was performed during test pit investigations in 2006 and no radiological contamination was detected. Therefore radiological screening will not be performed. If aircraft gauges or dials are recovered during test pit operations, then radiological screening will be performed. The section on radiological screening will be move to an appendix.	
4.	Page 2-2 Section 2.1.2	Please specify the sensitivity of the Ludlum Model 12 rate meter.	**D**	See response to comment number 28.	
5.	Page 2-10 Section 2.2.3.3	Please specify the analytes soil gas sampling will be conducted for.	**D**	Analytes for soil gas as described in the Work Plan, Soil Gas Investigation section are VOC by method TO15. A complete list of analytes are included in Work Plan Addendum #3 and will be included in the Interim Draft RI Management Plan.	

[1] Per decision at the 6/6 meeting, up to three soil samples will be collected at each soil boring: one in the shallow vadose zone, one at the rig geologist's discretion, and one in the smear zone. The photoionization detector will be used by the rig geologist to select the depth for the middle sample.

Reviewer: Marlene Brewer, ADEC

Item No.	Page/ Section	COMMENTS	REVIEW CONFERENCE A - comment accepted W - comment withdrawn (if neither, explain)	RESPONSE	BACKCHECK
6.	Page 2-11 Section 2.3.1.1	Suggest rephrasing the 1st sentence to state that MI surface soil sampling will be used for risk screening rather than risk assessment as Figure 4-2 and associated text states that if MI results exceed risk based screening levels then further investigation is required.	**A**	The text will be modified as suggested.	
7.	Page 2-12 Section 2.3.1.1	Please note that the analytical laboratory should be made aware of the MI sample requirements.	**A**	Comment noted. We are working closely with the analytical laboratory on this.	
8.	Page 2-12 Section 2.4	Please indicate how boreholes will be logged. Continuous logging is suggested to obtain all available data on subsurface strata.	**A**	Boreholes will be continuously logged. This will be clarified in the text.	
9.	Page 2-12 Section 2.4	Please indicate how boreholes will be decommissioned. (i.e. bentonite grout or chips) in this section or refer to Section 2.5.	**A**	Reference to Section 2.5 will be added.	
10.	Page 2-19 Section 2.5.2.3	The use of multiple groundwater sampling procedures is discouraged as it lends to data inconsistencies. Suggest low flow sampling.	**A**	Comment noted. Low flow sampling will be conducted for all groundwater sampling unless yield is not sufficient.	
11.	Page 2-23 Section 2.6	Is any long term water level surveying planned to evaluate possible seasonal fluctuations? If not, it is suggested.	**D**	Comment noted. However, no water level surveying is planned. Water levels have been monitored in various seasons and elevations have not been found to vary more than 5 feet.	
12.	Page 2-24 Section 2.7.1	Suggest Real Time Kinematic (RTK) GPS over hand-held GPS measurement.	**A**	Differentially-corrected GPS with sub-meter accuracy will be used to record horizontal sample locations. Top of casing elevations for monitoring wells will be surveyed to the nearest 0.01 feet.	
13.	Page 2-26 Section 2.8.4	A discussion of heavy equipment decontamination is needed before finalization of the work plan and field work begins.	**A**	All equipment will undergo dry, gross decontamination, including removal of potentially contaminated materials by use of a shovel or other hand tools and stiff bristle brushes.	
14.	Page 2-28 Section 2.10.1	Field duplicates should be collected for each matrix including sediment, surface water, and soil gas.	**A**	Field duplicates (or triplicates for MI sampling) will be collected for each matrix.	
15.	Page 2-30 Table 2-4	Suggest using SO for soil designation; SW for surface water; GW for groundwater; and WX for unknown waste.	**A**	A revised sample identification system has been implemented with similar designations.	
16.	Page 2-30 Section 2.11.2	Suggest additional section discussing field forms to be used.	**A**	An additional section will be added to discuss field forms.	

Reviewer: Marlene Brewer, ADEC

Item No.	Page/ Section	COMMENTS	REVIEW CONFERENCE A - comment accepted W - comment withdrawn (if neither, explain)	RESPONSE	BACKCHECK
17.	Page 3-1 Table 3-1 & 3-2	Extractible and Volatile Hydrocarbon Speciation by analytical method NW EPH/VPH are presented in the table, but no mention of these analyses is made prior to this table. It is assumed these analytical results are needed for input into the 4-phase calculator which has not been approved for use by ADEC and shall not be used for this project. These analyses will impact the analytical costs and provide no value to the project and it is therefore recommended they be deleted from the table and any further project consideration.	**D**	The VPH and EPH test methods provide information on the aromatic and aliphatic concentrations in select equivalent carbon groups. This data has value for assessing human health risks, understanding chemical fate and transport, and assessing the feasibility of and designing remedial approaches (if needed). These methods will be included for soil and groundwater samples to be collected in the POL area, and any other areas where POL contamination is encountered at the site.	
18.	Page 3-2 Table 3-1	No prior discussion of the use of low level volatiles data is presented. If low level volatile analysis is going to be used, it warrants a discussion that it should only be used in conjunction with medium level data and not as stand alone.	**A**	Medium-level and low-level VOC analysis will be conducted.	
19.	Page 3-1 through 3-2	Additional sample volume is recommended to account for MS/MSD samples and to provide additional volume in case of breakage or sample re-extraction/analysis.	**D**	This is noted in Tables 4-1 and 4-2	
20.	Page 3-3 Table 3-2	Suggest striking the footnote that states that filtered samples for dissolved metals analysis will be collected on a project specific basis. No discussion of collecting dissolved metals samples has been presented for this project to my knowledge.	**A**	Deleted footnote	
21.	Page 3-6 Section 3.4	Last sentence states that the lab will notify CH2MHLL of any discrepancies within 24 hours of receipt of samples. Please provide additional text as whom will have the responsibility of communicating any discrepancies to the project team and whom will have the authority to initiate corrective actions.	**A**	Added text that lab project manager will notify CH2M HILL point of contact.	
22.	Appendix C of SAP	Appendix C is not referenced in the text of the SAP. Please reference where appropriate.	**A**	The USACE procedures will be referenced in the text.	
23.	Page 2-11 Section 2.3.1.1	More detail is needed in the discussion of the use of the multi-increment sampling approach for surface sampling, specifically in the matter of how samples will be randomly collected. Work Plan Figure YY is mentioned in this section, but could not be located.	**A**	Additional details on the multi-increment sampling approach, with an updated figure will be provided in the FSP.	
24.	Page 2-10 Section 2.2.3.3	Appendix B is referenced as a field log form erroneously. Appendix A should be referenced instead.	**A**	The appendix reference will be updated.	

Reviewer: Julie Sharp-Dahl

Item No.	Page No., Spec. Paragraph	COMMENTS	REVIEW CONFERENCE A - comment accepted W - comment withdrawn (if neither, explain)	RESPONSE	BACKCHECK
1.	Beckman's comments/ General	I requested Gloria Beckman of Oasis perform a review of the revised FSP. The items Gloria noted that require consideration/revision are captured in the document (she used the track-changes function). I reviewed her revised document and concur with those items not addressed below. Remove "CH2MHILL" globally and replace with "Contractor"- JEG will also be using (some of) this plan.		We have addressed Gloria's comments and have provided a response to her comments within the document (also posted on FTP site). "CH2M HILL" was replaced with "Contractor"	
2.	Sec. 1 Introduction	Ignore Beckman's comment about sample numbers- this will be detailed in the task specific Work Plan Addendums. See Fosbrook's recommendation to each Addendum that reads: "The Army, EPA and ADEC agreed have to conduct the RI/FS for FCS utilizing the tri-ad approach. A Management Plan addressing the methods of the overall site management, QAPP and sampling techniques etc has been prepared and should be utilized for additional information. This document is one of many workplans that provide detailed information to the spefic task of the RII/FS. This approach was determined to be the most effective, efficient and appropriate method for investigating this site". I recommend adding something like this language to FSP so that the reader can be assured the details are available, but reside in the task specific addendums.		Agreed. Sample numbers are included in the Work Plans. Cristal's intro paragraph was added.	
3.	Sec. 2.1 Field Screening	If possibility of doing radiological screening, put Beckman recommended info in. If not, delete.		Radiological screening is not planned since such materials have not been identified on site. However, it was decided to keep the radiological procedures in an appendix in case they are needed.	
4.	**Sec. 2.2.1 Utility clearance**	Use SOW language and detail what the Contractors will be doing on site regarding "clearance" for utilities within the fence line, as well as who will do the utility locates outside the housing project fence line. Have a site/field manager make the contacts with DPW/other installation POCs. Not just a "field team member". We'd like to have one face interacting with the Installation POCs.		The SOW language on utility locates and clearance was added. Text was updated to specify that the field manager would interact with installation POCs.	
5.	**Sec 2.3.1**	Don't provide too much detail of specifics that can be found in other plans (re: 10 g soil in 10 mL MeOH for VOCs- this should be somewhere on its own so that level of detail here is not necessary?).		This is a good idea, but per discussion with Earl Crapps, we committed to adding more detail to the FSP for MI sampling, so we'll keep it in there.	

Reviewer: Julie Sharp-Dahl					
Item No.	**Page No., Spec. Paragraph**	**COMMENTS**	**REVIEW CONFERENCE A - comment accepted W - comment withdrawn (if neither, explain)**	**RESPONSE**	**BACKCHECK**
6.	**Sec. 2.3.1.2 MI Sampling**	Modify first sentence about use for risk- MI cannot be used for risk at this point (not sure even if it can be used to characterize soil for FTW Landfill disposal…) I'd just reference the ADEC guidance (but include the guidance in the RI MP)…most of the details will be provided in the task specific WP addendums (such as how the Berm WP Addendum reads).		We stated that for Sound Berm, MI samples would be used as risk screening, and if they exceeded screening levels, then discrete samples would be collected. Per discussion with Earl Crapps, we committed to adding more detail to the FSP for MI sampling, so we'll keep it in there.	
7.	**Sec. 2.5.2.1, 3rd paragraph, MW Installation**	50 ppm on the PID is too high. Use 20 ppm (FTW's cut off is 20 ppm for military construction projects).		This change was made.	
8.	**Sec.2.5.2.3 GW Sampling**	Put in the detail from the contract SOW language: low flow sampling and all stability criteria MUST be met, and recorded (see excel sheets provided which detail what information is required to be reported with the GW analytical results). Stability criteria must be measured using the flow-through cell (no Do, etc don't get goofy) - these criteria may become very critical for use in the FS stage (perhaps we'll consider natural attenuation monitoring?) Please state somewhere that NAPL will be measured and how. Dissolved iron and manganese not needed (yet). Groundwater samples will not be field filtered.		Language from the SOW on low-flow sampling was inserted into the text. Per our discussion on 7/27/07 with our data management people, we plan to capture the information on the USACE field data sheets in our field database. This information will be linked to each monitoring well for each sampling event and will be delivered to USACE as required. Inserted text on measuring NAPL with an interface probe. Deleted text on dissolved iron and manganese and filtering groundwater samples.	
9.	*Sec 2.7 Survey*	The survey data shall be tied to the Construction control monuments in the Civil (and other design) documents provided. Monument W-2 will be used for the vertical control and W-3 & W-4 for the horizontal control.		The specified control monuments were not used at the time of the survey. However, our surveyor will remobilize and tie in to the requested survey coordinates.	
10.	*Sec 2.8.5*	Coordinate with JEG- the gloves, over-booties (highly recommended for going into EZ/hot area, take off when going out), etc can go in the final waste drum and go off-site with the waste.		This was added to the text.	

Reviewer: Julie Sharp-Dahl					
Item No.	**Page No., Spec. Paragraph**	**COMMENTS**	**REVIEW CONFERENCE A - comment accepted W - comment withdrawn (if neither, explain)**	**RESPONSE**	**BACKCHECK**
11.	*Sec. 2.9 Decon*	Discuss with JEG protocol for decon on heavy equipment/other tool sin PCB area. IDW facility may not want the decon water from that area. Revisit waste streams and where they go. FTW Landfill will take Construction-related waste, but the paper waste from field offices is municipal waste and cannot go to Landfill, etc. Get rid of CH2MHILL and use the word "Contractor" or something else- this plan will be used by CH & JEG, and others? Why NWI- provide detail that they are the Army's waste contractor- give Bldg # and contact phone #.		Disposition of various waste streams were revisited based on the provided comments. "CH2M HILL" was replaced with "Contractor" NWI is the Army's contractor running the IDW facility. Building number and contact phone were included.	
12.	*Sec. 2.10*	How will PE samples be coordinated and submitted? Nothing here. Please add since there's a section in the QAPP that talks about these QA samples. I recommend being VERY careful with how you send these samples in – we have had the lab sub-sample from jars that were submitted for another test (i.e. labs are treating "all jars equal") Discuss with Bernice or Mike Utley-they know the issue.		Information on PE samples was added. Comment noted on being careful on submittal of PE samples to the laboratory. We plan to submit the PE samples with distinct location IDs to prevent "sharing" of sample.	
13.	*Sec. 2.12*	Not sure if this is the section for this concern: when will you obtain the USAEC AP# for the wells you will have become permanent wells? Likley there will be 70 some temp wells, 15 to become permanent. Permanent wells under USACE contract get an AP# from our geotechnical group. Please provide some information onwhen that will happen and the process (submit the surveyed well logs, get it OK'd get the AP#- that's the new well #)t.		This was added to a new section titled "Monitoring Well Labeling", see Section 2.5.2.4.	
14.	*Table 3-1*	Edit AK101 preservation (25-50 g in 25 mL MeOH).		This table was updated and is in concurrence with the reviewed tables in the QAPP.	
15.	*Sec. 3-2*	Shipping: We must follow IATA not DOT (since Anchorage is an International airport).		DOT was changed to IATA.	
16.		End of comments			

Reviewer: Gloria Beckman, Oasis

Item No.	Page No., Spec. Paragraph	COMMENTS	REVIEW CONFERENCE A - comment accepted W - comment withdrawn (if neither, explain)	RESPONSE	BACKCHECK
1.	Table of Contents	Include Appendices in TOC		Will add	
2.	Abbrevia-tions, iv	Delete abbreviations/acronyms not used in documents (3-D, CEPOA, CQAR, DGGS, dpm, EAC, FAA, RCAG, VORTAC		Will delete	
3.	Intro, 1-1, para 1	Delete FW 102		Will delete	
4.	Intro, 1-1, para 1	general sampling approach with numbers and locations of samples is included in the Work Plan		Will leave as-is. This FSP presents the PROCEDURES, or HOW samples of various types will be collected. The Work Plan presents the approach with numbers and locations of samples.	
5.	Intro, 1-1, para 1	Need more information on what samples will be collected and what rationale was used to determine matrix and sample procedure, location, etc. This FSP goes right into how to collect a soil gas sample but does not discuss where or why		Same response as above	
6.	2.1, 2-1, para 1	site investigations (RI??).		Will change wording to RI	
7.	2.1, 2-1, first bullet	Where are the instructions? Please include in appendix		Manufacturer's instructions for the PID and flow-through cell are too large to be copied and included in appendices. Manufacturer's instructions will be kept in the instrument case or in in a file in the job trailer.	
8.	**2.1, 2-1, 2nd para**	Why is Appendix A on Radiological Testing part of this plan? Present list of screening methods/detectors that will be used.		Radiological testing procedures are included as a precaution in case any aircraft gauges or dials are found. No change proposed. The methods and detectors are presented in Appendix A. No changed proposed	
9.	2.1.1, 2-1, 1st para	Specify resealable freezer bag as some storage bags will register up to 500 ppm on the PID		Will specify this	
10.	2.1.1, 2-2, 1st para	how do you plan to heat the sample and test the temp to see that it reaches 40 degrees and does not exceed 60 degrees?		Will add: The resealable freezer bags will be placed inside a heated vehicle	
11.	2.2.1, 2-2, 1st para	Can most resent geophysical data of the site be used or information collected last year by NWI?		Most recent geophysical data will be used in addition to the magnetic instruments. No change proposed.	
12.	2.2.1., 2-2, 2nd para	Do you know which utilities are live?		Electrical and glycol lines are "live". DPW will de-energize electrical and stop circulation of glycol during sampling. This will be coordinated closely with DPW. No change proposed	
13.	2.2.2, 2-2, section title	Locations??		See work plan (WP Addendum #3 or the latest draft of the RI Management Plan.	

Reviewer: Gloria Beckman, Oasis

Item No.	Page No., Spec. Paragraph	COMMENTS	REVIEW CONFERENCE A - comment accepted W - comment withdrawn (if neither, explain)	RESPONSE	BACKCHECK
14.	2-2, 2.2.2.1, 1st bullet	Note: These systems and their installation can be obtained from geotechnical firms that provide direct push installation		This sentence will be deleted. Reference to Figure 2-1 will remain.	
15.	2-2, 2.2.2.1, 2nd bullet	that is Tedlar bags, Summa canisters		Reference to Tedlar bags will be removed. Summa canisters will be used.	
16.	2-3, 2.2.2.1, 4th bullet	The soil gas probes must be decontaminated before use by using soap and potable water rinse (decon process?). Once decontaminated, the probes must be shown to be free of contaminates. At a minimum, a suitably sensitive organic vapor meter should be used for this purpose (do you really expect to pick up VOCs with a PID on cold material? I recommend deleting this statement). Any probe that does not pass decontamination should not be used.		This statement will be deleted.	
17.	2-3, 2.2.2.1, 5th bullet	How will you handle and store decontaminated soil gas probes in a manner that prevents contamination?		This is up to the drillers. We will monitor to ensure that it is being done. No change proposed.	
18.	2-3, 2.2.2.1, 6th bullet	"Inspect each gas probe assembly for ware and faulty parts. Replace probe tips, o-rings, adapters, and probe rods, as needed." This should be done before decon.		Will state that this should be done before decontamination.	
19.	2-3, 2.2.2.1, 7th bullet	Leak check each probe assembly before use. This is conveniently accomplished by inserting the probe tip and applying a vacuum that is greater than the anticipated vacuum that will be encountered during sampling (which is?).		Greater than the vacuum on the Summa canister. Will change sentence to reflect this	
20.	2-3, 2.2.2.1, 8th bullet	Experience has shown that fully assembled probes (that is, transfer line is connected to the PRT assembly) before being driven provide a much more trouble-free installation (that is, fewer leaks) than probes installed with (should be without?) the transfer line in place. Installing probes with the transfer line in place requires the use of a slotted drive cap and slotted pull cap. This practice is highly recommended (You are performing the work why make a recommendation?		Yes, good catch: will edit to read, "… than probes without the transfer line…" Will delete the sentence.	
21.	2-3	Missing Figure 2-1		Reviewer did not have the PDF version. No action	
22.	2-5, 2.2.2.2, 1st bullet	"It is common practice" : State what will be done		Sentence will be edited to read, "Gas probes will be installed using the "direct push" method…"	

Reviewer: Gloria Beckman, Oasis

Item No.	Page No., Spec. Paragraph	COMMENTS	REVIEW CONFERENCE A - comment accepted W - comment withdrawn (if neither, explain)	RESPONSE	BACKCHECK
23.	2-5, 2.2.2.2, 3rd bullet	Removal of the probes is to be conducted by trained personnel		In this case, drillers. No change proposed	
24.	2-6, 2.2.3.1, 1st para	May be useful to provide specific requirements for materials used to design system for field personnel and future reference.		Specific equipment has been procured and is on site ready for use. No change proposed.	
25.	2-7, 2.2.3.1, 1st bullet	If tedlar bags will not be used, delete reference in previous text.		Earlier reference to Tedlar bags was deleted. No change proposed.	
26.	2-7, 2.2.3.1, 2nd bullet	What flow rate will be used? What are you collecting the sample, what tests? AirToxics typically require leaving some vacuum in the canister so lab can verify that container did not leak in transit.		We will use flow regulators set to a flow rate of 200 ml/minute. Residual vacuum will left in the canister for the lab to verify no leaks occurred. The analysis is VOCs by TO15. This will be specified in the text.	
27.	2-7, 2.2.3.2, 2nd bullet	Record the leak check date and time on the field sampling log (Appendix B). (No mention of Appendix A made at this point.)		Disagree. Appendix A is the radiological procedures. No change proposed	
28.	2-8, 2.2.3.3, 6th bullet	add remaining canister vacuum, analytical method,) and any other observation pertinent to the sampling event on the field sampling log (Appendix B).		Final canister vacuum is included on the soil gas sampling log.	
29.	2-9, 2.3.1, Section Title	why collect surface soils?		We are not certain that additional discrete surface soil samples will need to be collected. This FSP is designed to be robust and cover a variety of sampling methods that may be required. MI surface soil samples will be collected at the Sound Berm and at Soil Piles. No change.	
30.	2-9, 2.3.1.1, subsection title	Discrete Sampling Approach (locations?)		See Work Plan Addenda and Interim Draft RI Management Plan. No change	

Reviewer: Gloria Beckman, Oasis

Item No.	Page No., Spec. Paragraph	COMMENTS	REVIEW CONFERENCE A - comment accepted W - comment withdrawn (if neither, explain)	RESPONSE	BACKCHECK
31.	2-9, 2.3.1.1, 1st para	ADEC requires use of a 4-ounce container for AK101, can lab meet benzene criteria with 10 gram sample?) and preserving with the prespiked methanol. The lab-provided methanol pump(what is pump?) should be used to cover the soil Discuss use of pre-tared sample containers, some labs do not spike methanol provided for SW8260B, need non-preserved volume for %Moisture determination…..		Note that we are doing both low and medium level VOC analysis. Text will be changed to: Volatile samples, if collected, will be collected directly out of the hand auger bucket using lab-specified equipment (such as Easy Sampler™ soil sampler) for both medium-level and low-level analysis. Medium-level analysis will be collected in the same container with the AK101 sample by extruding 30-50 grams of soil into a 4-oz jar and preserving with the prespiked methanol. The lab-provided methanol pump should be used to cover the soil. Note: Wear safety glasses when using the methanol, it may be under pressure. Record how much methanol was used to preserve each sample. The laboratory uses this to quantitate detectable target analytes. Low-level analysis will be collected by extruding 5 grams of soil into each of two 40 ml VOA vials pre-preserved with 1 gram of sodium bisulfate/5 mls of water. The methanol pump is a calibrated device used to dispense exact volumes of methanol. No change proposed	
32.	2-9, 2.3.1.2, sub-section title	Why using this method? Provide rationale		Rationale provided in the Work Plan. No change.	
33.	2-9, 2.3.1.2, para 1	The decision units or “exposure areas” are sections of the Sound Berm.		This discussion was expanded to include soil piles also.	
34.	2-10, 2.3.1.2., para 2	This is a large berm, do you really think a 2ft sample will characterize the soil stockpiled in the berm?		Per discussion at our June 6-7 meeting, we have no reason to believe the interior of the berm is different than the exterior. No change proposed.	
35.	2-10, 2.3.1.2, para 4	incremental sample and put into the same 4-oz jar (40 mil vial is previously mentioned)		There are different requirements for MI VOAs vs discrete VOAs. No change proposed	
36.	2-10, 2.3.1.2, para 4	As soon as a sample is added to the jar, an equal amount of methanol will be added(this implies 30 to 60 grams of sample and 30 to 60 ml methanol?? Should specify 1 gram if following statement is correct)		This procedure has been modified per recent discussion with ADEC. The entire volume of methanol will be added to the jar prior to addition of the sample	

Reviewer: Gloria Beckman, Oasis

Item No.	Page No., Spec. Paragraph	COMMENTS	REVIEW CONFERENCE A - comment accepted W - comment withdrawn (if neither, explain)	RESPONSE	BACKCHECK
37.	2-11, 2.3.1.2., para 1	This is more of a replicate sampling than duplicate. Extra volume should be collected, sieved and placed in separate sample containers.		Procedures for locating duplicate and triplicate samples have been modified per recent discussions with ADEC. Duplicate and triplicate samples will be taken from other quadrants in the same cell. The quadrant will be determined randomly using roll of the dice, but it will not be the same quadrant as the original sample. The text will be modified to reflect this.	
38.	2-11, 2.3.2, Section Title	Provide rationale for collecting samples and locations		This is provided in the Work Plan. No change proposed	
39.	2-11, 2.3.2, para 3	Be consistent when discussing methanol preserved samples and specify if sample will be collected for VOCs or AK101) Keep in mind sediment samples typically have high percent moisture. You may want to consider collecting a larger sample, 50 grams. "For unpreserved samples, the sample containers will be filled to the top, taking care to prevent soil from remaining in the lid threads before being ": This is a sediment not soil, this type of direction was not mentioned in previous sample procedures. Recommend mentioning how to collect a methanol preserved sample once and do it completely. You can then reference the previous sample collection procedure. Samplers may be confused with the piece meal approach as describing the procedure. Also add marking meniscus of methanol level on the jar and need to place containers in an up right position to keep methanol from leaking.		This section will be updated to reference earlier sections. Text about keeping sample jars upright and marking the level of methanol will be added.	
40.	2-11, 2.4 Title	Provide rational for this sampling and locations)		This is provided in the Work Plan.	
41.	2-11, 2.4.2, 1st para	How would you define a shallow boring ? Why not use the direct push rig?		This sentence will be deleted. All borings will be completed with a hollow stem auger rig.	
42.	2-12, 2.4.2, 1st full para	This section is too vague and not clearly written. Where is this procedure provided?). Why multiple choice? What analyses?),What SOP? Where is it located?).		Text was updated. This ASTM method is provided in an appendix We will use 3-inch O.D. Text will be updated 140 lb hammer. Text will be updated. Analyses for subsurface soil samples is provided in the Work Plans. Text was updated to reference Section 2.8 Equipment Decontamination.	

Reviewer: Gloria Beckman, Oasis

Item No.	Page No., Spec. Paragraph	COMMENTS	REVIEW CONFERENCE A - comment accepted W - comment withdrawn (if neither, explain)	RESPONSE	BACKCHECK
43.	2-12, 2.5, section title	Grab Sample?? What is rationale for additional wells?		The word "grab" will be deleted. Rationale for additional wells is provided in the Work Plan.	
44.	2-12, 2.5.2.1, 1st para, 2nd sentence	Is this included as appendix to FSP?. The typical monitoring well casing will be cons		This guidance document was added as an appendix	
45.	2-12, 2.5.2.1, 1st para	The screen will typically be a 10-ft-long		Will delete "typically". All screens will be 10' long.	
46.	2-12, 2.5.2.1, 1st para, last sentence	is the site work plan different from the RI work plan?		This sentence will be deleted.	
47.	2-17, 2nd para	Is this OVM the same instrument mentioned as a PID earlier?		"organic vapor meter" will be replaced with PID	
48.	2-17, 2.5.2.2, 1st para	How will these parameters be measured?		The FCS Management team has approved well development using stabilization of turbidity only. Other parameters will be monitored during purging. This section has been updated accordingly.	
49.	2-18, 2.5.2.2, 1st bullet	The following info is provided later in a table. Remove this information and reference table, and move table to this position.		See response to comment # 48. The table of stabilization criteria will stay in the section on well purging.	
50.	2-18, 2.5.2.2., 2nd para	"If none of these conditions have been achieved after 4 hours" Should this be based on volume removed and not time?		Good comment. ADEC guidance was reviewed and text was modified to, "After surging, the well should be pumped until 10 well volumes of water are removed or until parameters have stabilized, as previously discussed."	
51.	2-18, 2.5.2.3, 1st para	Please specify how the field sampler will decide which method should be used. For example: low flow for metals and volatiles, etc.		Use of electric submersible or peristaltic pump will be a field decision. No change to text proposed. Reference to low-flow sampling technique recommended by the Environmental Protection Agency (EPA) (EPA/540/S-95/504, April 1996) was added to the text.	
52.	2-18, 2.5.2.3, 2nd para	Backup water quality field monitoring equipment (such as dissolved oxygen meters) will be provided in case of equipment malfunction (This does not make sense. What is the purpose?		The purpose is to have additional meters available in case one malfunctions. This was requested by USACE and will be provided. No change.	
53.	2-19, 3rd para	Recommend only using a flow-through cell		A flow-though cell will be used. The text will be modified to clarify this	

Reviewer: Gloria Beckman, Oasis

Item No.	Page No., Spec. Paragraph	COMMENTS	REVIEW CONFERENCE A - comment accepted W - comment withdrawn (if neither, explain)	RESPONSE	BACKCHECK
54.	2-19, 4th para	VOCs should be collected first.		Agreed. This will be added to the text	
55.	2-19, 4th para	Why collect filtered samples when you are using a low flow procedure? Are these parameters for MNA? This FSP really needs to define what methods are associated with each sample collection method rationale behind sample collection.		Samples will not be filtered. Dissolved iron and manganese will not be collected. This will be clarified in the text	
56.	2-20, 1st full para	You mention a time limit vs volume earlier.		This paragraph will be deleted. We do not expect low permeability formations at the FCS.	
57.	2-20, 2.5.2.4., 1st para	Will any wells be permanent?)		Yes, some of the temporary wells will become permanent. The rest will be abandoned.	
58.	2-20,"B"	"Monitoring wells that are not known to…" This sentence should be reworded.		Subsections A, B, and C were deleted and replaced with the following text: "Well abandonment will be performed according to procedures outlined in Recommended Practices for Monitoring Well Design, Installation, and Decommissioning (ADEC, 1992)."	
59.	2-21, 1st bullet	Is this a reference to a document? Add reference and where this document can be located		No, Section A is the preceding subsection. No change proposed.	
60.	3-6, 1st full para	What about IATA regulations you may need to consider flying samples to CA.		The reference will be changed from DOT to IATA since Anchorage is an international airport	

Reviewer: Bob Brock					
Item No.	**Drawing Sht. No., Spec. Para.**	**COMMENTS**	**REVIEW CONFERENCE A - comment accepted W - comment withdrawn (if neither, explain)**	**CONTRACTOR RESPONSE**	**USAED RESPONSE ACCEPTANCE (A-AGREE) (D-DISAGREE)**
1.	Section 2.1.2	Revised approach for radiological screening		This section has been revised to state that radiological screening will be conducted if airplane dials or gauges are found. Screening procedures were moved to Appendix A.	
2.	Table 2-3	Add drums and drum contents to this table; work will be performed in accordance with JE's work plan which will be incorporated into the RI Management Plan		JE's work plan will be incorporated into the RI Management Plan.	

Reviewer: Mike Utley

Item No.	Drawing Sht. No., Spec. Para.	COMMENTS	REVIEW CONFERENCE A - comment accepted W - comment withdrawn (if neither, explain)	CONTRACTOR RESPONSE	USAED RESPONSE ACCEPTANCE (A-AGREE) (D-DISAGREE)
1.	Section 2.3.1.1	What is a "hand auger bucket"? How will you be sure a uniform sample is collected per increment? How will VOCs be handled? How will you ensure the 30 sub samples are collected randomly? Need to determine how multiple analyses per jar should be handled per ADEC (MI technique)		Additional detail was included in this section to answer the questions.	
2.	Section 2.4.2	Please change reference from ASTM to EM 200-1-3; please change SOP reference to FSP		EM 200-1-3 (Appendix C, C.6.4.3) references ASTM 1586, which we include in our FSP. No change proposed.	
3.	Section 2.10.1 / 2.10.2	ADEC guidance indicates that duplicate and triplicate sampling procedures be lined out specifically. Please indicate exactly how these samples will be collected.		Additional detail on collection of MI duplicate and triplicate samples was included in Section 2.3.	
4.	Table 3-1	Please verify VOC preservation with analytical laboratory; some labs are not able to meet required detection limits with a 1:2 soil:methanol ratio. (and Table 3-2) Please remove references to NW EPH/VPH methods. (We aren't running those, to my knowledge)		Requirements for VOC preservation were verified with the laboratory. EPH/VPH will be run on samples which show signs of obvious hydrocarbon contamination.	
5.	Forms	Some forms appear to be cut off at bottom. Please investigate and correct if necessary		This was investigated. The forms are ok as is.	

Reviewer: EPA

Item No.	Page/ Section	COMMENTS	REVIEW CONFERENCE A - comment accepted W - comment withdrawn (if neither, explain)	RESPONSE	BACKCHECK
1.	Section 2.1.1	Please describe what criteria will be used for determining whether the VOC measurements are "elevated".		PID readings > 20 ppm will be considered elevated.	
2.	Section 2.3.1.1 Para 1	See comments in work plan about the used of MI Sampling in this scernio		Comments noted and addressed. This section was revised.	
3.	Section 2.3.1.1 para 2	Please describe the specifics of how sampling will be done "randomly" and provide "coverage of the entire unit".		Additional details were included in Section 2.3.	
4.	Section 2.3.1.1 para 3	"The sieved sample…." The analytical suite cannot include VOCs after this aggressive sample management		Agreed. The text has been revised to state that VOCs are collected directly from the hand auger bucket into preserved sample jars.	
5.	Section 2.3.1.1 para 3	Please clarify how VOC and SVOC samples will not be affected by this air drying and sieving. Please describe how these results will then be comparable to previous sampling programs.		The text has been revised to state that VOCs are collected directly from the hand auger bucket into preserved sample jars. The FCS Management Team has agreed that MI sampling will be used to screen the Sound Berm and Soil Piles for risk. Additional discrete sampling can be conducted as needed.	
6.		The description of "air dry at room temperature" would seem to imply that the drying will be done in a building. If this building is offsite, does this sentence imply that contaminated materials will be transported back onsite? Please describe the regulatory implications of taking material offsite and then bringing it back onsite.		The text has been revised. No air drying will be performed on site. The MI samples will be rough screened and sent to the laboratory.	
7.	Section 2.5 section heading	This section should be titled "Monitoring Well Installation and Groundwater Sampling."		Agreed. The text was changed.	
8.	Section 2.5	There is no discussion in the entire section of any aquifer (slug/pump) testing on any of the 70 new wells. Without testing, how will GW velocities and contaminant migration rates be determined for Taku Gardens contaminants?		Transducers will be placed in monitoring wells near the base supply wells and results of drawdown will be used to adjust existing estimates for hydraulic properties related to GW migration.	
9.	Section 2.5	This section contains no discussion of methods or plans for use of direct-push technology (DPT) in GW sampling and delineation of contaminant nature and extent. Why is DPT sampling discussed in Appendix D if it is not also going to be used for these purposes, especially if most temporary wells are only going to a depth of 20 feet?		DPT has been removed from the plan.	

Reviewer: EPA					
Item No.	**Page/ Section**	**COMMENTS**	**REVIEW CONFERENCE A - comment accepted W - comment withdrawn (if neither, explain)**	**RESPONSE**	**BACKCHECK**
10.	Section 2.5.2.1 section heading	Monitoring Well Installation" is not a "Sampling Procedure		Comment noted. Section heading for 2.5 was changed.	
11.	Section 2.5.2.1 para 1	What hydrogeological basis is used to specify 10-foot screen lengths for the MWs and for screening 70 MWs across the water table? Are the solvents at Taku Gardens LNAPLs? If so, this is the only known occurrence of LNAPL solvents. A more detailed evaluation of the objective of each well is needed before 70 of them are drilled.		Screening wells across the water table is the recommended method for locating sources of contamination and characterizing groundwater. Two deep wells (30' and 50' bgs) will be installed at the site, and additional deep wells can be installed if warranted at a later date. Monitoring well locations were selected to provide sitewide coverage for locating sources, to delineate the known POL plume, to evaluate the former river channel, to characterize groundwater quality downgradient of anomalies, and to evaluate locations where historical data exceeded screening levels.	
12.	Section 2.5.2.1 para 1	What is the justification for using pre-pack well screens on permanent monitoring wells at significantly higher cost over in-situ sand packs?		Our costs for pre-pack well screens are not significantly higher than in-situ sand packs.	
13.	Section 2.5.2.1 para 1	What slot sizes are "appropriate for the site geology"? That should be known by this time since a number of existing MWs have been placed at the site. This FSP should include specific details for this project, not generic specs cut-and-pasted from other work plans.		The 0.01 mm slot size was selected based on experience and using past boring logs from the site.	
14.	Section 2.5.2.1 para 4	} No "clean cuttings" or cement-bentonite grout should be used for the permanent MWs, and probably even the temporary ones, at Taku Gardens. Bentonite-only grout should be slurried around the solid casing using a tremie pipe from the top of the hydrated bentonite pellet seal to the ground surface, unlike the well construction shown in Figures 2-4 and 2-5. This is due to the severe frost heave of the casing that can occur in permafrost areas every spring and fall. No packed cuttings, cement-bentonite grout, concrete around the protective casing, or upper seal should be allowed to contact the solid PVC well casing. In addition, the lid of the protective casing or flush-mount box should be at least 6 inches to one foot above the PVC cap to prevent casing damage. This is Alaska, not Florida! Ground surface elevations can change feet, not 100ths of a foot, between		Comment noted.	

Reviewer: EPA

Item No.	Page/ Section	COMMENTS	REVIEW CONFERENCE A - comment accepted W - comment withdrawn (if neither, explain)	RESPONSE	BACKCHECK
15.	Section 2.5.2.1 para 5	Please describe how the use of PVC casing will not affect vinyl chloride concentrations.		Comment noted.	
16.	Section 2.5.2.1 para 5	Where is discussion in this section of the 70 temporary MWs that may be installed? Where is discussion of the flush-mount well installation as shown in Figure 2-5?		Installation of monitoring wells is addressed in Work Plan Addendum #4, which has been approved by the FCS Management Team. A flush-mount well was installed in the playground of the SAS Building.	
17.	Figure 2-4 and 2-5	See Comment above. No cuttings, cement-bentonite grout, or concrete should be allowed to contact the PVC casing.		Comment noted.	
18.	Section 2.5.2.3.1/ 1-3	No purge" sampling should be eliminated from this FSP. It is not acceptable to EPA even for temporary wells		Comment noted. No purge sampling was removed from the FSP.	
19.	Section 2.5.2.3.2/ 1/3	flow sampling is also preferred for VOCs, such as for the POL and solvent plumes found at Taku Gardens		Comment noted. Low flow sampling will be performed for all analyses.	
20.	Section 2.5.2.3.2/ 2/2	A flow-through cell should be used, not a "large beaker." Such cells are readily available from several sources.		A flow-through cell will be used to monitor stabilization of parameters during purging.	
21.	Section 2.5.2.3.4?/ Title	Why does Subsection "3.5.2.3.4" follow Subsection "2.5.2.3.3"? This seems to indicate that these subsections were lifted from another Work Plan that may or may not have been for an Alaska site. This may explain why some of the MW specifications and sampling procedures included in the FSP are not applicable to areas overlying thick permafrost		The section numbering was fixed.	
22.	Section 2.5.2.4/1/1	Why are the 70 temporary MWs first discussed in the FSP under "Well Abandonment"? Why are construction specs for these 70 wells also very briefly mentioned in this section and not discussed at all in the "Monitoring Well Installation" section?		The number of temporary wells was deleted from this section. Proposed monitoring wells are discussed in Work Plan Addendum #4.	
23.		Please describe whether any wells would be useful for the FS or later project stages.		Yes, wells will be useful to characterize and delineate extent of contaminant sources that will be addressed in the FS.	
24.	Section 2.5.2.4/A	Do the abandonment procedures discussed in detail in this section comply with State of Alaska Well Abandonment Procedures? If so, the state regulations should be cited.		Recommended Practices for Monitoring Well Design, Installation, and Decommissioning (ADEC, 1992) is referenced in the text.	

Reviewer: EPA

Item No.	Page/ Section	COMMENTS	REVIEW CONFERENCE A - comment accepted W - comment withdrawn (if neither, explain)	RESPONSE	BACKCHECK
25.	Section 2.5.2.4?/C	Why is surface casing discussed in considerable detail when these MWs were previously specified as being installed with a hollow-stem auger (HSA) drill rig? These sound like specs for deep wells installed with a casing-drive rotary rig, not a DPT- or HSA-rig. Maybe a rotary rig is needed for the 180-foot MWs that are to be installed near the water-supply wells, according to the Work Plan, but the use of a rotary rig is not discussed in any of the plans for this site.		The discussion of protective casing in the section on well installation refers to the protective casing for the above ground monitoring well stick up. There are no plans to use an air rotary drill on this project.	
26.	Figure 2-?	Several detailed cross sections need to be added to show interbedded gravels, sands, silts, clays, borehole locations, existing MWs and water-supply well screen depths, etc., in order for the field geologist to better estimate the location of the water table and plumes at each MW location		Based on experience and existing site boring logs, the water table is very consistent at this site. Detailed cross sections will be included with the RI report.	
27.	Table 2-?}	A table is needed that lists the well number, location coordinates, total depth, screened interval, and purpose (POL plume delineation, former river channel delineation, etc.) for each of the 70 temporary and permanent monitoring wells planned for this project. Only with this table can EPA determine whether 7, 70, or 700 wells are needed, whether there are data gaps in vertical and lateral coverage, and the adequacy of the two-year RI groundwater monitoring plan.		Monitoring well locations were selected to provide sitewide coverage for locating sources, to delineate the known POL plume, to evaluate the former river channel, to characterize groundwater quality downgradient of anomalies, and to evaluate locations where historical data exceeded screening levels. The FCS Management Team has approved Work Plan Addendum #4 for Monitoring Wells. A table with well details and purpose will be provided to the FCS Management Team.	
28.	Section 2.7.1 para 5	Vertical site control appears critical, since reports state that back fill is going to be added, the foundation elevations seem critical for all future site management. Accordingly, all elevations will need to be factored or re-taken once the final grades are determined and achieved.		Agreed. A topographic survey has been conducted for the entire site. In addition, the elevation of top of casing for all monitoring wells will be surveyed to the nearest 0.01 foot.	
29.	Section 2.10.1	The Quality Assurance Plan also discussed “ambient blanks” (Section 3.1.4), which are different than trip blanks.		Comment noted.	
30.	Section 2.10.4	The Quality Assurance Plan also discussed “ambient blanks” (Section 3.1.4), which are different than trip blanks		Comment noted.	

Responses to Comments
Site Safety and Health Plan

Responses to Comments
FWA102 Former Communications Site
Site Safety and Health Plan
Fort Wainwright, Fairbanks, Alaska

Reviewer: Marlena Brewer, Alaska Department of Environmental Conservation, Contaminated Sites Program				
Comment No.	**Page/ Section**	**COMMENTS/RECOMMENDATION**	**CH2M HILL A - Agree D - Disagree**	**CH2M HILL RESPONSE**
1.	Page 4 of H&S Plan Site Map for H&S Plan	The site map identifying the pertinent health and safety locates was not present, but only provided as a file link. It is suggested a hard copy map be included in the H&S plan.	**A**	The appropriate site map will be provided.
2.	Page 18 of H&S Plan Section 2.8.3	Other potential routes of exposure might include injection via puncturing the skin by debris; and ocular exposure to vapors or particulate matter.	**A**	These additional potential exposure routes will be added to the section.
3.	Page 17 of H&S Plan Section 2.6	Text states that no radiological hazards are expected and they are therefore not discussed. Is this prudent at this point?	**D**	Radiological screening was performed during test pit investigations in 2006 and no radiological contamination was detected. Therefore radiological screening will not be performed. If aircraft guages or dials are recovered during test pit operations, then radiological screening will be performed.
4.	Page 18 of H&S Plan Section 2.7	Contaminants of concern were limited to DRO, GRO, and PCBs in the table. However, the COC list includes more, and more critically what about potential unknowns? Suggest providing a title and number to the table.		
5.	Page 18 of H&S Plan Section 2.7	No discussion of encountering drums containing unknown substances was provided, but this seems warranted.		

Responses to Comments
Community Involvement Plan

Responses to Comments
FWA102 Former Communications Site
Community Involvement Plan
Fort Wainwright, Fairbanks, Alaska

Reviewer: Marlena Brewer, ADEC

Comment No.	Page/ Section	COMMENT/RECOMMENDATION	CH2M HILL A - Agree D - Disagree	CH2M HILL RESPONSE
1.	Community Involvement Plan	Text states that CH2MHLL will assist the Army in updating the existing Community Involvement Plan for Ft Wainwright (ENSR, 2003). A discussion of this plan seems needed in addition to a summary of any community involvement activities regarding the specific site to date.	**A**	CH2M HILL has been scoped to update the Community Involvement Plan, in consultation with USACE and DPW. CH2M HILL will also be responsible for fact sheets, presentation materials and facilitation for Public Meetings. CH2M HILL will also establish and maintain the Administrative Record for this project at three Fairbanks locations. The existing Community Involvement Plan will be added to the RI Management Plan, and the text will discuss update of the plan and the proposed fact sheets and public meetings.

Responses to Comments
Risk Assessment Work Plan

Responses to Comments
FWA102 Former Communications Site
Risk Assessment Work Plan, May 2007
Fort Wainwright, Fairbanks, Alaska

Reviewer: Jacques Gusmano, EPA			
Item No.	**Section/ Page/ Para**	**Comments**	**Response**
1.	General	EPA accepts the responses to the Risk Assessment Work Plan and agrees that it may go final. Thanks for being so well organized and responsive on this complicated and fast paced project.	Comment Noted.

Reviewer: EPA
Date: June 5, 2007

Item No.	Section/ Page/ Para	Comments	Response	Back Check
1.	General	The *Draft Human Health and Ecological Risk Assessment Work Plan* (May 2007) (RAWP) needs further development in order to describe what data are needed, how it intends to use such data, and information from the risk assessment that needs to go to other work plans. EPA (1991a) states: "The primary purpose of the baseline risk assessment is to provide risk managers with an understanding of the actual and potential risks to human health and the environment posed by the site and any uncertainties associated with the assessment. This information may be useful in determining whether a current or potential threat to human health or the environment exists that warrants remedial action." In this regard, it is puzzling that the RAWP does not address the potential risks associated with UXO and metal debris exposure when describing how the risk assessment will be done (Section 4), although these hazards were mentioned earlier in Sections 2 and 3.	The methods for assessment of hazards associated with Munitions or Explosives of Concern (MEC) will be included as part of a separate section of the revised RI Work Plan.	Addressed in Section 1.1 and 4.0
2.	General	EPA has established standard procedures for the risk assessment (e.g., EPA 1989). It is therefore also puzzling that the RAWP does not address guidance on several technical issues: Soil comparisons to background (Section 4.2.2.2). It proposes to use existing basewide data and compare them to maximum site concentrations in an unspecified area. The adequacy of existing background data, the use of censored data, and an appropriate statistical test do not appear to have been considered, which are issues discussed by EPA (2002a). The results from multi-increment (MI) sampling appear to be difficult to apply in similar statistical tests. Metal speciation. Although metals analysis is proposed, RAWP does not address speciation and bioavailability, which are discussed by EPA (2007). Vapor intrusion. RAWP proposes to use detected soil gas VOC concentrations for the future indoor air exposure scenario (Section 4.2.3.1). It should address a tiered approach (EPA 2002b). Upper bound exposure. EPA (2002c) recommends using upper confidence limits for exposure point concentrations. Although the RAWP discusses this concept (Section 4.2.3.1), it does not describe how this step is consistent with the MI sampling approach. Current Alaska guidance specifically mentions that future guidance will consider the use of MI sampling in risk assessments (ADEC 2007). Characterization of uncertainty. Although the RAWP does include EPA (1989) in its reference list, it does not describe an approach to uncertainty, which is one technical component in that guidance. EPA (2002d, 2004) suggests a range of exposures be estimated, representing central tendency and an upper bound. Ecological risk assessment. Although the RAWP cites EPA's ecological risk assessment guidance, its minimal discussion suggests that data needs that could contribute to the sampling and analysis plan, and the subsequent data use have not yet been addressed.	• Data from a 1994 background metals study for Ft. Wainwright will be used. The study contains background levels for arsenic, barium, cadmium, chromium, and lead. • Default values for metals bioavailability will initially be assumed. If specific metals contribute substantially to site risk, bioavailabily and speciation evaluations may be considered. • Based on the results of previous findings from passive soil gas surveys, a site-specific (Tier 3) evaluation will be conducted for the site, using data from beneath actual residential buildings. In areas with known VOC contamination, the density of active sampling will be increased to assess the extent of contamination. • MI sampling results will not be used for risk assessment. • The risk assessment will initially consider reasonable maximum exposure estimates using, to the extent available, default exposure assumptions. For areas or pathways that indicate the potential for unacceptable risk, other central tendency estimates may be considered. Text will be added to indicate this. • As indicated in Section 5.3, ecological exposure pathways are limited, and the ecological risk methodology is initially limited to a screening phase (also see Table 3-4 DQO No. 3). Once initial screening is completed, the need for additional data will be discussed with the regulators.	Addressed in Sections 4.2.2.2 and 4.3.1

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Date: June 5, 2007

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3.	General	The RAWP could also contribute to other work plans by calculating preliminary remediation goals (PRGs), and examining screening criteria to ensure that field techniques and laboratory detection limits are adequate for the risk assessment. Its list of references cites PRG guidance (EPA 1991b), but does not actually apply it.	Risk-based screening criteria are used to establish data adequacy, as shown in the QAPP Section 5.6 and associated tables. RI analytical data will be used to calculate baseline risk following ADEC and EPA guidance. If risk is identified, site-specific remediation goals will be developed during the FS.	√
4.	General	References - Alaska Department of Environmental Conservation (ADEC). 2007. Draft Guidance on Multi-Increment Soil Sampling. March 2007. - EPA. 1989. Risk Assessment Guidance for Superfund. Vol. 1. Human Health Evaluation Manual. Part A. EPA/540/1-89/002. December 1989 - EPA. 1991a. Role of the Baseline Risk Assessment in Superfund Remedy Selection Decisions. OSWER Directive 9355.0-30. April 22, 1991. - EPA. 1991b. Risk Assessment Guidance for Superfund. Vol. 1. Human Health Evaluation Manual. Part B. Development of Risk-based Preliminary Remediation Goals EPA/540/R-92/003. December 1991. - EPA. 2002a. Guidance for Comparing Background and Chemical Concentrations in Soil for CERCLA Sites. EPA 540-R-01-003. September 2002. - EPA. 2002b. OSWER Draft Guidance for Evaluating Vapor Intrusion to Indoor Air Pathway. EPA 530-D-02-04. November 2002. - EPA. 2002c. Calculating Upper Confidence Limits for Exposure Point Concentrations at Hazardous Waste Sites. OSWER 9285.6-10. December 2002. - EPA. 2002d. Risk Characterization Handbook. EPA 100-B-00-002. December 2002. - EPA. 2004. Risk Assessment Guidance for Superfund. Vol. 1. Human Health Evaluation Manual. Part E. Supplemental Guidance for Dermal Risk Assessment. EPA/540/R/99/005. July 2004. - EPA. 2007. Framework for Metals Risk Assessment. EPA 120/R-07/001. March 2007.	Comment Accepted.	
5.	1.1	"No further action for locations with no identified unacceptable risk" Please describe the criteria that will be used for making these decisions.	Comment Accepted. Text will be added to note that excess lifetime cancer risk values will be compared to the "point of departure" range of 10^{-6} to 10^{-4} that is generally used by regulatory agencies, to determine which constituents should be evaluated in the FS. Hazard index values exceeding 1 for toxicologically similar chemicals will also be addressed in the FS.	Text added Section 1.1
6.	2.1.1	North Wind, 2006). Needs to be included in the reference list	Comment Accepted.	Added to list
7.	2.1.2	Oasis, 2007) Needs to be included in the reference list.	Comment Accepted.	Added to list
8.	2.1.3.1	Plan should consider that some animals and plants will come back once the area is developed, and reopened.	Residential developments are not considered as suitable habitat to support wildlife populations. Wildlife would not be expected to frequent the occupied development since the area will be disturbed by normal activities and vegetation would be maintained.	√

Reviewer: EPA
Date: June 5, 2007

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9.	2.1.3.1	The Integrated Natural Resources Management Plan for U.S. Army Garrison Alaska (Army 2006a) Needs to be included in the reference list	Comment Accepted.	
10.	Section 3, first para	Page: 4 Figure 2-2 in the RI work plan shows 10 areas.	Section 2 of the WP has been revised and the original five subareas will be used. Text in Section will be updated accordingly.	Text revised
11.	3.2.1.	. The depths of the water supply wells range from 80 to 182 feet deep (US Army 1997), Needs to be included in the reference list	Comment Accepted.	
12.	3.3	unfrozen zones potentially isolated or interconnected (USGS, 1999)" Needs to be included in the reference list	Comment Accepted.	
13.	3.4.1	Page: 4 Risk assessment should also address UXO and the metal debris.	See response to Comment 1.	√
14.	3.4.2.	CEM [figure 3-1] doesn't show volatilization from subsurface soil, but the fifth bullet above mentions this transport mechanism. The two need to be reconciled. Also, there are some current offsite residents that may be exposed to contamination that has gone offsite	Comment partially accepted: CEM will be modified to show that vapors volatilizing from subsurface soil will be evaluated during the risk assessment. Should groundwater sample results along with modeling show that contamination has or could migrate offsite to current residential areas, then a complete exposure pathway is possible. If this pathway is determined to be complete, then risk estimates will be calculated.	Added subsurface soil to air volatization on CEM
15.	3.4.3	Page: 4 There are current offsite residents that may be exposed to contaminants that are migrating or have migrated offsite. Please reconsider including these in the CEM.	See response to Comment 14. The CEM will be modified to show the potential for offsite exposures via ambient dusts and vapors, and vapor intrusion from groundwater.	
16.	4.2	It is not clear what the basis is for deciding whether the data are acceptable for the risk assessment. Please describe.	Comment Accepted: Text will be added to Section 4.2.1 to describe the data usability evaluation that will be conducted.	Text added to 4.2.1
17.	4.2.2	"Small" areas will presumably have only a few samples, possibly as low as one if the multi-increment sampling approach is used. Please consider the implications of a small number of samples in accomplishing the steps described in Sections 4.2.2.1 and 4.2.2.2.	Comment Accepted: MI sampling data will not be used for the RA.	√
18.	4.2.2.1	Page: 4 Since the plan is to use soil multi-increment sampling, it is not clear how this criterion would be applied. Please describe.	Comment Accepted: MI sampling data will not be used for the RA.	√
19.	4.2.2.1	Page: 4 Please describe the qualitative or quantitative approach that will be used for characterizing the uncertainty.	The test will be changed to note that the uncertainty evaluation will be qualitative	Text added to 4.2.2.1
20.	4.2.2.1	The use of multi-increment sampling will tend to "dilute" the potential for detected chemicals. A high concentration in a single area may not be detected by this sampling approach. The plan should explain how possible small areas of high chemical concentrations will be addressed in the risk assessment.	Comment Accepted: MI sampling data will not be used for the RA.	√

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Item No.	Section/ Page/ Para	Comments	Response	Back Check
21.	4.2.2.2	Page: 5 The applicability of these base "background" levels should be considered.	Comment Accepted: Available background data from Fort Wainwright including the Background Metals Analysis for Arsenic, Cadmium, Chromium, and Lead of Ft. Wainwright Alaska, USACE 1994, and the Chemical Data Report Foundation Study HTRW Survey (Revised), Replace Family Housing (FTW-283) Ft. Wainwright, Alaska, or other applicable sources will be used to provide an indication of the contribution of background metals levels to the risk estimates. Justification for the use of these data would be added during the risk assessment along with information on uncertainty.	
22.	4.2.2.2	Page: 5 It is not clear how the use of multi-increment soil sampling will allow this background comparison.	Comment Accepted: MI sampling data will not be used for the RA.	√
23.	4.2.2.4	Please describe the process that will be used to select surrogate toxicity factors	Constituents without toxicity factors will be evaluated to see if factors for structurally and toxicologically similar compounds could be used to provide an estimation of risk. Generally, toxicity factors exist for the most toxic and common compounds.	Text added to 4.2.2.4
24.	4.2.3.1.	"EPCs will be calculated for each analyte using EPA's statistical program ProUCL, Version 3.00.02 (EPA, 2006)" A new version of ProUCL will be issued soon	Comment Accepted: Since the Draft RA WP was submitted, EPA has issued a new version of ProUCL. Therefore, the RA will use the latest version (4.0).	Fixed – 4.2.3.1
25.	4.2.3.1, bullet 1	Page: 5 It is unclear how a UCL will be calculated from the soil multi-increment sampling results. The field sampling plan is also proposing air drying and sieving, which will affect concentrations. Please describe how these results will then be comparable to the results of other sampling programs.	Comment Accepted: MI sampling data will not be used for the RA.	√
26.	4.2.3.1, bullet 2	The RI work plan proposes not to sample at the sledding hill because the area will receive significant fill. Please describe how these approaches are consistent with the EPA risk assessment guidance.	Areas where at least 2 feet of clean fill are added would eliminate surface soil pathways for the covered soil, and would not require risk evaluation.	√ - added footnote to 2nd bullet
27.	4.2.3.1 bullet 3	Page: 5 The RI work plan proposes to use multi-increment sampling on the berm. Please describe how this is consistent with the proposed aggregation of surface soil data, and the estimation of a UCL.	Comment Accepted: MI sampling data will not be used for the RA.	√
28.	4.2.3.1. bullet 4	Page: 5 The subsurface sampling will occur in test pits, at the "smear" zone above the groundwater table, and direct push samples with high PID readings. Please describe how these data will be used in estimating subsurface exposure point concentrations.	95%UCL concentrations will be calculated for each relevant exposure area, under the assumption that soil exposures would be integrated spatially over the duration of exposure.	√
29.	4.2.3.1 bullet 5	Page: 5 The EPA guidance on soil gas (cited earlier) recommends a tiered approach. Has this guidance been examined in order to determine whether additional samples may be needed? With the houses vacant, the risk assessment work plan may want to consider indoor air sampling.	See response to Comment 2, third bullet. Subslab soil gas samples are planned to provide an initial estimate of risk for existing buildings. If estimated risks using modeling approaches are shown to be unacceptable, then indoor air sampling may be considered.	Added footnote to 5th bullet

Reviewer: EPA
Date: June 5, 2007

Item No.	Section/ Page/ Para	Comments	Response	Back Check
30.	4.2.3.1 bullet 6	Page: 6 What groundwater modeling is proposed? Please describe method and what estimates from the model may be used. Will filtered or unfiltered samples be used?	The recommended groundwater analysis will utilize a regional numerical groundwater flow model that was previously developed for the Fort Wainwright area, along with more detailed site information that will be collected during the upcoming field efforts. The collection and analysis of this site specific data will significantly improve the accuracy of our analysis in the vicinity of Taku Gardens. Additional details on proposed groundwater modeling will be provided in the Work Plan. Unfiltered samples will be used. No samples will be filtered.	
31.	4.3.1.1	Delete "x 365 days/year" in the following equation	Comment Accepted	√ - deleted
32.	4.3.1.2	"Dermal absorption factor values will be obtained from the dermal assessment guidance (EPA, 2001)" Page: 6 Not included in the reference list.	Comment Accepted: Correct reference will be added	
33.	Table 4-2	There is an asterisk in the table, but no explanatory note. Please reconcile.	The following footnote was inadvertently left off the table: "The exposure duration for future residents may be adjusted to account for a reasonable maximum residence time at Fort Wainwright of about 8 years."	√
34.	4.5.3.	Page: 6 Other chemicals that may need special procedures include chromium, PCBs, and dioxins/furans. Please explain how these chemicals will be handled in the risk assessment.	Comment Accepted: Text will be added describing how these chemicals will be handled in the risk assessment.	Done in Sections 4.2.2.4 and 4.5.4
35.	Section 5, 1st para	Page: 6 Please provide details on species, endpoints, acceptable media samples, chemical concentration comparisons, risk estimate methods, toxicity reference values, criteria for the decisions, and the approach to uncertainty.	Comment noted. Some additional details will be added to the Work Plan to describe the screening values and data that will be used to evaluate ecological risk. Because ecological exposure pathways are limited, ecological methodology is initially limited to a screening phase.	Text added to Section 5.3
36.	5.2, last sentence	Page: 6 Please describe the method(s) for choosing which samples to use, and the concentrations to be compared.	Sediment samples collected from the drainage swale and groundwater samples collected from the site (including the former river slough) will be compared to media-specific concentrations. As an initial screening, these data will be directly compared against available sediment screening benchmarks (e.g., NOAA Screening Quick Reference Tables [SQuiRTs]) and ambient water quality criteria.	Text added to Section 5.3

Reviewer: ADEC

Item No.	Section/ Page/ Para	Comments	Response	Back Check (A-Agree) (D-Disagree) (Back check by)
1.	2-1 of Risk Assessment Work Plan, Section 2.2	Some mention of the historic river bed should be made as it is an important geologic feature of the site.	Comment Accepted. A discussion of the historic river bed will be added	A MB Please provide additional text for review.
2.	2-1 of Risk Assessment Work Plan, Section 2.2	Are all soils on site native of Ft. Wainwright? Was any fill material brought on site which is not consistent with the general soil geology description provided in the text?	We understand that some of the soil used to construct the Sound Berm was imported from other sites on Ft. Wainwright. The soil description listed in this section applies to the fill material as well as native soils.	A MB Please provide text to this effect in the RA work plan.
3.	3-4 and throughout the document, 3.4.3	0-0.5 ft below ground surface (bgs) is not consistent with ADEC's definition of surface soil as 0-2ft bgs. 0-10ft bgs is not consistent with ADEC's 2-15ft bgs definition of subsurface soil.	Comment Accepted: Soil data from 0-2 ft bgs will be addressed as surface soil, and soil data from 0-15 ft bgs (or to water table, whichever is shallower) will be addressed as subsurface soil, for the purposes of exposure estimates for risk assessment.	A MB Revised throughout
4.	4-3, 4.2.3.1	MI sampling results may be used to evaluate risks due to surface soil exposure in order to determine if further action is necessary for a given decision unit. However, the surface soil EPC derived from the MI sampling approach shall not be used in cumulative risk calculations considering risks posed by exposure to all media (surface soil + subsurface soil + groundwater + surface water + vapor).	Comment Accepted: MI sampling data will not be used for the RA.	A MB √
5.	4-4, 4.3	*CEM* denoting the Conceptual Site Model Figure 3-1 should be *CSM*.	CEM is specifically used for this work plan, to avoid confusion with the conceptual site model Section 2 of the RI Work Plan	D MB The CSM is a dynamic model that will be revised as additional site information is obtained.
6.	Table 4-1 and 4-2	"*" footnote - Adjustment of the residential exposure duration to 8 years is not acceptable. Please use the default residential exposure duration period as appropriate.	Risk estimates will initially be calculated based on the default residential 30 year exposure duration. For locations where potential risk is noted, additional risk estimates may be calculated assuming 8 years. These two risk descriptors will allow for more informed risk management decisions for the site.	A MB Please provide this explanation in the work plan for clarification.
7.	Table 4-1	Footnotes d & f – Please provide a basis (other than best professional judgment) for the selection of the exposure duration and frequencies for site visitors/recreational uses and future excavation workers.	Default exposure factors are not available for these scenarios, so these factors were selected based on anticipated site-specific conditions using the risk assessors best professional judgment. Excavation worker exposure duration is based on mean work tenure of 6.6 years, per EPA Exposure Factors Handbook, and assumes a utility repair event of 4 work-weeks. Recreational user scenario was limited to a 10-yr old child (roughly old enough to ride a bike independently to the site), and includes a duration that roughly coincides with the body weight assumed. Ultimately, risk estimates for residents would be most conservative and are anticipated to drive risk-management decisions (if any) at the site.	A MB These assumptions should be discussed in the work plan as appropriate.

Reviewer: ADEC

Item No.	Section/ Page/ Para	Comments	Response	Back Check (A-Agree) (D-Disagree) (Back check by)
8.	4-12, 4.3.2.3	Any site specific adjustments such as temperature and soil type, to inputs into the J&E model should be discussed in more detail and approved prior to use. For instance soil temperature may not be adjusted for site specific conditions.	The RI will collect any site-specific data needed to do the J&E calculation. The revised approach of collecting soil gas beneath the building slab will decrease the impacts of variances and uncertainties in vadose zone structural heterogeneities such as clay or silt lenses or porosity and permeability changes, and will provide much more defensible results. To the greatest extent possible, site-specific building dimensions and design values for air exchange rates will be used.	D MB Temperature is a variable input parameter which will not remain constant throughout the year. Moreover, there is not an approved method for taking soil temperature. Using the default temperature will provide a more conservative estimate of risk. The use of other site specific parameters in the J&E model such as soil type and building specs is recommended.
9.	4-12, 4.3.3	Please specify that the *health conservative screening values* for petroleum, oils, and lubricants are 1/10 of the ADEC Method 2 ingestion and inhalation cleanup levels.	The phrase "health-conservative screening values" will be deleted, to indicate that the cleanup level tables will be used.	Please clarify that 1/10 the cleanup level will be used for screening for risk. – Text revised
10.	4-16, 4.4.2	Please refer to ADEC's RAPM for appropriate sources of toxicity values.	Comment Accepted.	A MB Please reference the RAPM and list appropriate sources of toxicity values.
11.	4-16, 4.5	Please refer to comment 59 on the use of MI sample results for risk assessment.	Comment Accepted: MI sampling data will not be used for the RA.	A MB √
12.	4-18, 4.5.3	Please add additional text to state that the variability will be assessed prior to using the mean lead concentration in the lead model.	Comment Accepted.	A MB Please provide a discussion of how variability will be evaluated.
13.	5-1 Section 5	Please provide the Ecoscoping worksheets completed in the process of determining if ecological risks should be considered.	EcoScoping Forms for the FCS were presented in Appendix F of the *Preliminary Source Evaluation 1 Narrative Report* (OASIS Environmental, 2007).	A MB √ - already there in 5.2 Please refer to this document as appropriate in this work plan.

Reviewer: ADEC				
Item No.	**Section/ Page/ Para**	**Comments**	**Response**	**Back Check (A-Agree) (D-Disagree) (Back check by)**
14.	5-1, Section 5	The ecoscoping and development of an ecological CSM should be completed prior to the risk assessment work plan.	The ecoscoping evaluation was conducted as part of the PSE and the results were used to develop the ecological CEM. The ecological CEM is depicted as part of Figure 3-1.	A MB √ - already there Please refer to this document as appropriate in this work plan.
15.	5-1, Section 5	The ecological risk assessment section is inadequate as presented and requires much more discussion.	Comment noted. Some additional details will be added to the WP to describe the screening values and data that will be used to evaluate ecological risk. Because ecological exposure pathways are limited, ecological methodology is initially limited to a screening phase.	MB Additional text is requested for review along with screening levels.
16.	6-1, Section 6	Please refer to the RAPM for the risk assessment reporting procedures and elaborate on this section accordingly.	Comment Accepted.	MB Who is DEQ? Should that have been ADEC? fixed

Lisa Geist, US Army Corps of Engineers, Environmental Engineering
Date: May 31, 2007

Item No.	Section/ Page/ Para	Comments	Response	Back Check (A-Agree) (D-Disagree)
1.	Page 3-2, Section 3.4	Potentially Complete Exposure Pathways. Why caveat route of intake with "feasible"?	Comment Accepted. "Feasible" will be removed.	Removed "feasible"
2.	Page 3-4, Section 3.4.3 and Figure 3-1	Surface soil definition. While 0-0.5 ft is appropriate, note that the ADEC defines surface soil as 0 – 2 feet, and evaluates subsurface soils from 2 – 15 feet bgs based on the potential for exposure to subsurface soils during excavation.	Comment Accepted: Soil data from 0-2 ft bgs will be addressed as surface soil, and soil data from 0-15 ft bgs (or to water table, whichever is shallower) will be addressed as subsurface soil, for the purposes of exposure estimates for risk assessment.	Changed throughout the document and added footnote about water table
3.	Figure 3-1	Exposure to subsurface soils may be a potentially complete exposure pathway for residents and maintenance workers.	Subsurface soil exposure is typically addressed for residents and maintenance workers in cases when soil is expected to be turned over during future construction activities. Since invasive construction activities are already complete at the site, subsurface soil exposures are not complete (with the exception of volatiles potentially migrating to indoor air). The text will be changed to note that future exposure to subsurface soil by residents and maintenance workers is not anticipated for this reason.	
4.	Page 3-6, 1st para.	Are the digging restrictions referred to permanent? Is this a valid assumption for the residential housing area?	Text in this section will be reworded to state that this pathway may be complete unless digging restrictions are implemented.	Text revised
5.	Page 3-6	Need to resolve definition of surface soil (0-2 ft for ADEC) and subsurface soil (2-15 ft per ADEC).	See response to Comment 2	√
6.	Page 3-7	The text describes the identification of chemicals of potential concern as those that are "considered the <u>most important</u> to the human health evaluation". This text seems awkward, or subjective. Perhaps more accurate description is… considered potential risk drivers?	Text will be changed to indicate that these constituents are the ones that are considered to contribute to risk at the site.	Text revised
7.	Page 4-2, Section 4.2.2	Delete repetitive use of "Former" before FCS.	Comment Accepted.	Deleted "Former"
8.	Page 4-2, Section 4.2.2	How will contaminants in soil gas be identified?	The target analyte list is to include the full TO15 list at every location.	√
9.	Page 4-2, Section 4.2.2.1	Typo. …particular exposure medium will not **be** selected as COPCs…	Comment Accepted.	Text revised
10.	Page 4-2, Section 4.2.2.2	Define UTL acronym.	Comment Accepted.	Acronym defined
11.	Page 4-3, Section 4.2.2.4	Typo, need closing parenthesis after text "Section 4.4"	Comment Accepted.	Fixed typo
12.	Page 4-3, Section 4.2.3.1	The EPA website indicates version 4 is coming soon for ProUCL, and previous versions are not available for download.	Comment Accepted. Version 4.0 of ProUCL is now available and will be used.	Text edited
13.	Page 4-3, Section 4.2.3.1	Typo as written – …will be calculated **from?** analytical data…	Comment Accepted.	Text revised
14.	Page 4-3, Section 4.2.3.1	What is meant by using the multi-incremental composite sampling for determining EPCs for future residential scenario? What is the size of your decision unit? How does use of this data coincide with previous text about calculating 95%UCLs?	Comment Accepted: MI sampling data will not be used for the RA.	√

Lisa Geist, US Army Corps of Engineers, Environmental Engineering
Date: May 31, 2007

Item No.	Section/ Page/ Para	Comments	Response	Back Check (A-Agree) (D-Disagree)
15.	Page 4-3, Section 4.2.3.1	How will you be aggregating analytical data for recreational/site visitor scenario? Why would this be different than the data used for residential scenario? Need to discuss size of each 'exposure area' over which data will be evaluated and/or 'aggregated'.	The 95%UCL will be calculated for each COPC for each exposure area, for both recreational users and residents. The EPCs for residents will be on a resident-specific basis, whereas the recreational user/site visitor EPCs will be from larger areas (yet to be defined)	√
16.	Page 4-3, Section 4.2.3.1	Again, need to agree on definition of surface soils, 0-0.5 ft or 0-2 ft, and subsurface soils (10 ft or 15 ft).	See response to Comment 2	Revised throughout document
17.	Page 4-4, Section 4.2.3.1	What will be used to do the groundwater transport modeling?	The recommended groundwater analysis will utilize a regional numerical groundwater flow model that was previously developed for the Fort Wainwright area, along with more detailed site information that will be collected during the upcoming field efforts. The collection and analysis of this site specific data will significantly improve the accuracy of our analysis in the vicinity of Taku Gardens. Additional details on proposed groundwater modeling will be provided in the Work Plan.	A
18.	Table 4-1	Will the note about possible adjustment to exposure duration to account for reasonable maximum residence time at Fort Wainwright (8 yrs), only be made for the future resident scenario? Why limit maintenance worker, and site visitor/recreational user to 3 years exposure duration, if potential total residence time is 8 years? What is the difference between maintenance worker and future excavation worker, such that excavation worker has twice the exposure duration?	The tenure of 8 yrs applies to on-Post residents. Maintenance worker exposure duration will be expanded to 6.6 years (mean work tenure, per EPA Exposure Factors Handbook), to be consistent with the excavation worker. Recreational user was limited to a 10-yr old child (roughly old enough to ride a bike independently to the site), and includes a duration that roughly coincides with the body weight assumed.	A
19.	Table 4-2	Need to explain * in footnote	The following footnote was inadvertently left off the table: "The exposure duration for future residents may be adjusted to account for a reasonable maximum residence time at Fort Wainwright of about 8 years."	√
20.	Page 4-12, Section 4.3.3	Do you mean DRO/RRO/GRO for "petroleum hydrocarbon fractionation data"? Or do you intend to use more specific breakdowns for smaller carbon chains (Washington methods, VPH, EPH, etc)?	Washington EPH/VPH data, to help interpret degree of TPH weathering that has occurred at the site	Revised text to discuss EPH/VPH
21.	Page 4-12, Section 4.3.3	The phrase "health-conservative screening values" is confusing. ADEC guidance states that screening comparison are to use 1/10th the most conservative of either the ingestion or inhalation values from Tables B1 or C.	The phrase "health-conservative screening values" will be deleted, to indicate that the cleanup level tables will be used.	Revised text
22.	Page 4-13, Section 4.4.1.1	HHRA – first time this acronym is used.	Comment Accepted.	Defined acronym
23.	Page 4-16	Note, if trichloroethylene is a COPC, new guidance is forthcoming regarding use of CalEPA toxicity values instead of EPA values.	Comment Accepted.	√
24.	Page 4-18	Perhaps clarify that the mean lead concentration is also the average or arithmetic mean, based on EPA guidance. EPA does not recommend using the upper confidence level on the mean, which Section 4.2.3 specifies calculating.	Comment Accepted.	Text added
25.	Page 5-2	Typo – **Guidelines** for Ecological Risk Assessment	Comment Accepted.	Fixed typo

Lisa Geist, US Army Corps of Engineers, Environmental Engineering
Date: May 31, 2007

Item No.	Section/ Page/ Para	Comments	Response	Back Check (A-Agree) (D-Disagree)
26.	Page 5-2, Section 5.3	Perhaps more clear to state: …by initiating the process of problem formulation for the site and **comparing** media-specific concentrations with screening levels…	Comment Accepted.	Text added
27.	Page 6-1	Typo: **ADEC**	Comment Accepted.	Fixed typo
28.	Page 7-1, Section 7	References are not always in chronological order (e.g., EPA 2005). Text often includes multiple references for a particular author/year, but not found in references. Missing references cited in text: ADEC. 2000. Guidance for Cleanup of Petroleum Contaminated Sites ADEC. 2007. Eco Scoping Guidance. ADEC. 2005. Conceptual Site Model Guidance. ? ADEC. 2002. Cumulative Risk Guidance. ? EPA. 1997. Exposure Factors Handbook. EPA. 1997. Supplemental ERA Guidance, Region 10. EPA. 2001. Dermal Risk Assessment Guidance (per text) EPA. 2003. Johnson-Ettinger Model ?? USACE. 1994. Background Data Fort Wainwright Oasis. 2007. PSE ENSR. 1998. Ecological Risk Assessment Northwind. 2006. Document? US Army. 2006a. Integrated Natural Resources Mgmt Plan… US Army. 1997. Document? USGS. 1999. Document?	Comment Accepted. Missing references will be added.	A
29.	General	Need to verify all cited documents are properly included in the Reference section AND properly referred to in the text, numerous instances where references are missing, or improperly referred to in text, e.g. EPA, 1989a does not exist.	Comment Accepted.	A
30.	General	Why isn't the EPA 2001 Guidance RAGS Volume 1, Human Health Evaluation Manual, Part D Standardized Planning, Reporting, and Review of Superfund Risk Assessments used as a reference? This guidance requires submittal of planning tables in prescribed formats.	Due to the expedited nature of the RI/FS for this site, the rigorous RAGS, Part D guidance documentation recommendations will not be followed for this risk assessment.	√
31.	General	Did you utilize the screening process described in the EPA 2002 OSWER Draft Guidance for Evaluating the Vapor Intrusion to Indoor Air Pathway from Groundwater and Soils (Subsurface Vapor Intrusion Guidance)?	Consistent with the EPA 2002 OSWER Draft Guidance, the soil gas MDL will be screened against a value that is 10-fold (assumed attenuation) the Region 6 Screening Value for ambient air.	
32.	General	Verify any acronyms used in text are listed in Abbreviations section. Verify acronyms are spelled out at first use.	Comment Accepted.	

Responses to Comments
Quality Assurance Project Plan

Responses to Comments
FWA102 Former Communications Site
QAPP Combined Comments
Fort Wainwright, Fairbanks, Alaska

Reviewer: Mike Utley

Item No.	Drawing Sht. No., Spec. Para.	COMMENTS	OASIS Verification to QAPP	CH2M HILL RESPONSE	
1.	Section 3.1	Triplicates should be added to discussion (for MI technique)	Added		
2.	Table 4-1	Please verify VOC preservation with analytical laboratory; some labs are not able to meet required detection limits with a 1:2 soil:methanol ratio. AK101 and AK102/103 are repeated on Tables 4-1 and 4-2	Will require response to comment by CH and identification of laboratory AK information corrected	Lab is STL Sacramento and it is verified that required RLs can be met.	
3.	Section 4.3	Please add that the laboratory will be required to email all sample receiving documentation to receipt.cooler@poa02.usace.army.mil within 24 hours of sample receipt. Please note NPDLWO number: 07-072 – please ensure that this number is present on all COCs for this project.	Email address added. NPDLWO number not added. Assume it is provided in FSP.	NPDLWO number added to requirement on COC.	
4.	Section 5.2	Please add Sensitivity to PARCC(S) discussion	Added		
5.	Section 5.2.1	Discussion of MI precision evaluation should be included here. (RSD calculation per ADEC guidance)	No discussion of triplicate samples added to this section.	Added text to discuss RSD requirement for triplicate samples to the precision section.	
6.	Section 5.3.1	Please ensure that selected laboratory agrees with MDL procedure; not all labs conduct MDL studies exactly the same way	No lab identified , no way to confirm.	Lab identified in Section 2. MDL studies were submitted along with PE studies and Self-declaration form as required by USACE.	
7.	Section 5.3.2	Please note that QSM requires RL = 3 * MDL; granted, this is not always achievable in light cleanup limits; these should be noted on a case by case basis.	Not addressed (Text reads 3 to 10 times)	Corrected	
8.	Section 5.4.2	Toxaphene is a multipeak compound, similar to PCBs; some labs do not report Toxaphene in their SW8081 LCS's. Please investigate and add to discussion if necessary	No discussion added for 8081 method	Confirmed that STL Sacramento analyzes a LCS for toxaphene. No discussion added.	
9.	Section 5.6	Why isn't the most stringent ADEC value included in the comparison (migration to GW)?	Table only contains ingestion criteria. No explanation provided in DQO section on how criteria were selected or what impact RLs above action limits will have.	Text added: Screening levels presented in this QAPP are used to select the appropriate RLs. They are not added as PRGs. The EPA screening criteria are generally lower than the ADEC Table B1 and B2 values. The migration to groundwater values are not included because we do not believe all the values represent risk-based values. The inhalation values have been added to the tables.	

Reviewer: Mike Utley					
Item No.	**Drawing Sht. No., Spec. Para.**	**COMMENTS**	**OASIS Verification to QAPP**	**CH2M HILL RESPONSE**	
10.	General	Please add discussion about PE samples, their evaluation, and what corrective actions will be taken in the event of a failure. (PEs are a requirement of the contract)	Text added. Does not discuss discontinued use of a lab if PE fail or using another lab until corrective action is evaluated. Text specifies the PE sample program is the responsibility of the USAED.	Added	

Reviewer: Marlena Brewer, Alaska Department of Environmental Conservation					
Comment No.	**Page/ Section**	**COMMENT/RECOMMENDATION**	**A = Agree D = Disagree**	**COMMENTS**	
72.	Page 3-1 Table 4-1 & 4-2	Extractible and Volatile Hydrocarbon Speciation by analytical method NW EPH/VPH are presented in the table, but no mention of these analyses is made prior to this table. It is assumed these analytical results are needed for input into the 4-phase calculator which has not been approved for use by ADEC and shall not be used for this project. These analyses will impact the analytical costs and provide no value to the project and it is therefore recommended they be deleted from the table and any further project consideration. If retained, VPH soil should be field preserved with methanol; VPH water collected in preserved 40 ml vials.	**A**	This was removed from the QAPP	
73.	Page 3-2 Table 4-1	No prior discussion of the use of low level volatiles data is presented. If low level volatile analysis is going to be used, it warrants a discussion that it should only be used in conjunction with high/medium level data and not as stand alone. High level VOCs should be collected in the same manner as AK101 samples; 4 oz amber glass, septa lid, methanol preserved.	**A**	Low-level VOC removed.	
74.	Page 3-1 & 3-2 Table 4-1 & 4-2	AK101 and AK102/AK103 are listed twice in these tables.	**A**	Fixed duplication	
75.	Page 3-3 Table 3-2	Suggest striking the footnote that states that filtered samples for dissolved metals analysis will be collected on a project specific basis. No discussion of collecting dissolved metals samples has been presented for this project.	**A**	Deleted footnote	
76.	Page 3-4 and throughout the document Section 3.4.3	0-0.5 ft below ground surface (bgs) is not consistent with ADEC's definition of surface soil as 0-2ft bgs. 0-10ft bgs is not consistent with ADEC's 2-15ft bgs definition of subsurface soil. Soil depth consideration **should not** rely upon possible future conditions (additional topsoil).	**D**	Not a QAPP issue	
77.	Page 1-1 of QAPP Section 1.1	Why is the Uniform Federal Policy QAPP not referenced for the development of this QAPP?	**A**	Add as reference	
78.	Page 1-1 of QAPP Section 1-1	Why is there no discussion of the PSE I in this section? Some discussion is also needed as to why there have been two preliminary source evaluations and the site has still not been adequately characterized. Recommend revising this section to give more information as to the site history including a timeline of events and summary of data collected to date.	**D**	I think discussion of PSEs belongs in the workplan or FSP – not in the QAPP.	
79.	Page 1-2 of QAPP Section 1.3	Project objective and scope is way too generalized. A summary of specific objectives and scope for the site as a whole and each sub area should be discussed. This section should address the purpose of the project (objective) and to what ends it will be executed (scope). A flow diagram may be used to summarize the project decision logic.	**D**	Reference FSP	

Reviewer: Marlena Brewer, Alaska Department of Environmental Conservation					
Comment No.	**Page/ Section**	**COMMENT/RECOMMENDATION**	**A = Agree D = Disagree**	**COMMENTS**	
80.	Page 2-1 of QAPP Section 2.1	Although project /task organization and roles/responsibilities will be presented in individual work plans, it seems necessary to present the information in this document as well and specifically for the QA tasks. Specific training and certification is needed for several tasks (munitions, HAZCAT analysis,	**D**	Reference FSP	
81.	Page 2-1 of QAPP Section 2.2	Specific training and certification beyond that presented in the text is needed for several project tasks worth discussing.	**D**	Certification for field crew should be in FSP	
82.	Page 3-1 of QAPP Section 3.1	How will quality control sample frequency and results be evaluated during the project?	**A**	Added text	
83.	Page 3-1 of QAPP Table 4-1	Please refer to comments pertaining to Table 4-1 and 4-2 of the SAP.	**A**	Removed TPH speciation	
84.	Page 5 of QAPP Section 4.3	No discussion is provided regarding the transfer of samples from the primary contracted lab to a subcontracted secondary lab in case that capacity or hold time issues arise. Suggest adding text to discuss how chain of custody will be maintained and recorded for such circumstances.	**A**	This was added to section 4.2	
85.	Page 5-1 of QAPP Section 5.1	Please reiterate what field screening techniques will be used for this project. Some summary of field screening data quality assurance is warranted in this section as well or reference the sampling plan as appropriate.	**A**	Reference to FSP	
86.	Page 5-1 of QAPP Section 5.1	Will TICs data be considered screening or definitive?	**A**	Added text, not definitive	
87.	Page 5-1 of QAPP Section 5.2	What criteria will used to evaluate precision, accuracy, representativeness, completeness, and comparability? Please provide reference for criteria.	**??**	It is stated in each section what the criteria are or there is a reference to the tables.	
88.	Page 5-4 of QAPP Section 5.3.4	No prior discussion was provided as to how TICs would be evaluated further for site characterization and risk assessment. Will estimated concentrations be considered definitive and results used for risk assessment?		Add text – won't be used in risk assessment, TIC will not be considered definitive	
89.	Page 5-4 of QAPP Section 5.4	How will elements of quality control be evaluated and who will do this?	**??**	Not sure what this means? QC samples are reviewed during data validation.	
90.	Page 5-7 of QAPP Section 5.5.2	Please confirm that confirmation analysis shall be performed within method required hold time.	**A**	Added text	
91.	Page 5-10 of QAPP Table 5-2	Please delete Table 5-2 Reporting Limit Objectives for Method NW VPH/EPH as these analyses will not be used for this project.	**A**	Deleted	

Reviewer: Marlena Brewer, Alaska Department of Environmental Conservation					
Comment No.	**Page/ Section**	**COMMENT/RECOMMENDATION**	**A = Agree D = Disagree**	**COMMENTS**	
92.	Page 7-1 of QAPP Section 7 Analytical Procedures	Please provide text as to how the contracted laboratory will be evaluated to assure that analytical DQOs will be met as specified in the work plan.	**A**	Text added	
93.	Page 8-1 of QAPP Section 8.2.1	100% data review by the primary analyst and senior analyst or section supervisor. Will this requirement be specified in the contracted laboratory's statement of work?	**A**	Lab has reviewed QAPP and no issue was noted with this comment.	
94.	Page 8-3 of QAPP Section 8.2.2	The Case Narrative bullet only states that secondary labs should be indicated as to what analyses they performed. No prior chain of custody discussion was provided as to how secondary labs would be used for this project. It is highly recommended that text be added to expand upon this point. Otherwise, secondary labs may be used without advance project approvals that do not meet project analytical DQOs.	**D**	The text states that the case narrative will document which analyses were performed at each of the labs. Text was added in Section 4.2 noting that the hardcopy will contain COCs from all labs used. The Lab SOW notes that the main lab is responsible to obtain prior approval to use a sub lab and to provide all sub lab data in correct formats.	
95.	Page 5-23 th 5-46 of QAPP Tables 5-14 th 5-34	Please provide reference for the limits presented in the tables (method specific, DOD QSM, etc.) Suggest footnote reference.	**A**	Added footnote	
96.	Page 5-47 th 5-64 of QAPP Tables 5-35 th 5-45	Please provide reference for the calibration and quality control requirements per method. Suggest footnote reference. Please delete VPH/EPH from tables.	**A**	Added footnote	
97.	Page 7-2 of QAPP Table 7-1	Please delete VPH/EPH from table.	**A**	Deleted	
98.	Page 8-1 Section 8.2	In the case a secondary laboratory is needed to support the project, please provide some text as to how data will be managed.	**D**	This is documented in the project-specific SOW. The lab is responsible for getting us the data per contract if they use a sub lab. The data is not managed differently when it goes through data validation.	
99.	Page 8-6 of QAPP Section 8.3.1	In discussing the Level 4 validation, please confirm if analytical results will be back calculated from the initial and continuing calibrations to confirm the result reported.	**A**	Added text	
100.	Page 8-6 of QAPP Section 8.3.1	Please specify the data validation and verification frequency are project wide or by sub-area to be addressed in individual work plan addendum or by analytical method and matrix. Recommend that data from all methods and matrices are validated at the specified frequency, not just some an arbitrary percentage of total data.	**A**	Added text to specify these items.	

Reviewer: Marlena Brewer, Alaska Department of Environmental Conservation					
Comment No.	**Page/ Section**	**COMMENT/RECOMMENDATION**	**A = Agree D = Disagree**	**COMMENTS**	
101.	Page 9-1 of QAPP Section 9.1	Please describe the *laboratory validation process* to be conducted.	**??**	I am not sure what they mean, lab data validation procedures are described in Section 8.2.1.	
102.	Page 9-1 of QAPP Section 9.1	Performance standards should be presented on how the performance evaluation (PE) samples shall demonstrate the laboratory's capability to support the project analytical DQOs (i.e. What is the level of acceptability for PE results? What are the corrective actions/consequences of failing? It is highly recommended that the PE samples be submitted to the lab at the onset of field activities prior to analysis of actual site samples.	**A**	Added text	
103.	Page 9-1 of QAPP Section 9.2	Who else may perform external audits of the project other than USACE?	**A**	Added that ADEC and CH2M HILL may perform audits if necessary	
104.	Page 13-1 of QAPP Section 13.2	The ADEC lab checklist must be completed for ***each*** analytical data package.	**A**	The text was revised to note this as a requirement and not as optional	
105.	Page 13-1 Section 13.1 and 13.3	Please specify that summary analytical data tables with appropriate data qualification flags in addition to a complete sample summary table with location information for each sample will be provided in the hard copy and electronic deliverables.	**A**	Added text	
106.	QAPP MI QA/QC	If MI sampling is proposed for surface soil sampling, a section on MI sample QA/QC is needed in the QAPP.	**A**	Added to text and to Section 8 tables	
107.	General	Document page numbering was inconsistent throughout the document. It is recommended that the document page numbering be corrected and the table of contents updated accordingly.	**A**	revised	

Reviewer: Marlena Brewer, Alaska Department of Environmental Conservation					
Comment No.	**Page/ Section**	**COMMENT/RECOMMENDATION**	**OASIS Review of Changes to QAPP**	**CH2M HILL RESPONSE**	
108.	Page 3-1 Table 4-1 & 4-2	Extractible and Volatile Hydrocarbon Speciation by analytical method NW EPH/VPH are presented in the table, but no mention of these analyses is made prior to this table. It is assumed these analytical results are needed for input into the 4-phase calculator which has not been approved for use by ADEC and shall not be used for this project. These analyses will impact the analytical costs and provide no value to the project and it is therefore recommended they be deleted from the table and any further project consideration. If retained, VPH soil should be field preserved with methanol; VPH water collected in preserved 40 ml vials.	All referenced were removed from the QAPP with the exception of Table 7-1.	Removed from Table 7.1.	
109.	Page 3-2 Table 4-1	No prior discussion of the use of low level volatiles data is presented. If low level volatile analysis is going to be used, it warrants a discussion that it should only be used in conjunction with high/medium level data and not as stand alone. High level VOCs should be collected in the same manner as AK101 samples; 4 oz amber glass, septa lid, methanol preserved.	Low-level VOCs removed from Table 4-1. VOC and GRO will be collected together in the same 40ml VOA vials and preserved with methanol prespiked with surrogate. This revision was made to the table.		
110.	Page 3-1 & 3-2 Table 4-1 & 4-2	AK101 and AK102/AK103 are listed twice in these tables.	Corrected		
111.	Page 3-3 Table 3-2	Suggest striking the footnote that states that filtered samples for dissolved metals analysis will be collected on a project specific basis. No discussion of collecting dissolved metals samples has been presented for this project.	This still appears in the QAPP table 4.2.	The footnote has been removed from Table 4.2.	
112.	Page 3-4 and throughout the document Section 3.4.3	0-0.5 ft below ground surface (bgs) is not consistent with ADEC's definition of surface soil as 0-2ft bgs. 0-10ft bgs is not consistent with ADEC's 2-15ft bgs definition of subsurface soil. Soil depth consideration should not rely upon possible future conditions (additional topsoil).			
113.	Page 1-1 of QAPP Section 1.1	Why is the Uniform Federal Policy QAPP not referenced for the development of this QAPP?	Reference Added		
114.	Page 1-1 of QAPP Section 1.1	Why is there no discussion of the PSE I in this section? Some discussion is also needed as to why there have been two preliminary source evaluations and the site has still not been adequately characterized. Recommend revising this section to give more information as to the site history including a timeline of events and summary of data collected to date.	Information on the PSE1 was not added.	Section revised.	
115.	Page 1-2 of QAPP Section 1.3	Project objective and scope is way too generalized. A summary of specific objectives and scope for the site as a whole and each sub area should be discussed. This section should address the purpose of the project (objective) and to what ends it will be executed (scope). A flow diagram may be used to summarize the project decision logic.	Not addressed.	DQO descriptions added to Section 1.	

Reviewer: Marlena Brewer, Alaska Department of Environmental Conservation					
Comment No.	**Page/ Section**	**COMMENT/RECOMMENDATION**	**OASIS Review of Changes to QAPP**	**CH2M HILL RESPONSE**	
116.	Page 2-1 of QAPP Section 2.1	Although project /task organization and roles/responsibilities will be presented in individual work plans, it seems necessary to present the information in this document as well and specifically for the QA tasks. Specific training and certification is needed for several tasks (munitions, HAZCAT analysis,		Table of CH2M HILL contacts added.	
117.	Page 2-1 of QAPP Section 2.2	Specific training and certification beyond that presented in the text is needed for several project tasks worth discussing.	Not added.	There are no special training requirements for the chemists and data managers. We will not discuss training and certification for field crew in the QAPP.	
118.	Page 3-1 of QAPP Section 3.1	How will quality control sample frequency and results be evaluated during the project?	Frequency was addressed. Evaluation was addressed for all but the field duplicates and field type blanks. Text does not discuss corrective actions when contaminants are found in field, rinsate, ambient and trip blanks.	Referred to Tables 8.1 through 8.4 for FD and FB evaluation. Added text to discuss corrective actions when excessive contamination is found in field, rinsate, ambient and trip blanks.	
119.	Page 3-1 of QAPP Table 4-1	Please refer to comments pertaining to Table 4-1 and 4-2 of the SAP.	Addressed		
120.	Page 5 of QAPP Section 4.3	No discussion is provided regarding the transfer of samples from the primary contracted lab to a subcontracted secondary lab in case that capacity or hold time issues arise. Suggest adding text to discuss how chain of custody will be maintained and recorded for such circumstances.	Not discussed	This text was added to Section 4.2: If analyses are to be subcontracted to another laboratory or another location within the laboratory network, copies of COCs transferring custody to the secondary laboratory must also be included in the laboratory data package and must also include the information listed above. The primary laboratory must notify the CH2M HILL chemist for approval prior to subcontracting analyses to a laboratory not identified in the original proposal. This text was added to Section 4.3: A subcontract laboratory must notify the primary laboratory of any such discrepancies within 24 hours of its receipt of the samples. The primary laboratory will relay this information to the CH2M HILL project chemist within 24 hours of notification.	
121.	Page 5-1 of QAPP Section 5.1	Please reiterate what field screening techniques will be used for this project. Some summary of field screening data quality assurance is warranted in this section as well or reference the sampling plan as appropriate.	Section 6 field methods was added		

Reviewer: Marlena Brewer, Alaska Department of Environmental Conservation					
Comment No.	**Page/ Section**	**COMMENT/RECOMMENDATION**	**OASIS Review of Changes to QAPP**	**CH2M HILL RESPONSE**	
122.	Page 5-1 of QAPP Section 5.1	Will TICs data be considered screening or definitive?	Text defines use as both qualitative and quantitative.	Yes – but it is noted that the TIC will NOT be definitive.	
123.	Page 5-1 of QAPP Section 5.2	What criteria will used to evaluate precision, accuracy, representativeness, completeness, and comparability? Please provide reference for criteria.	Added tables and references the QSM with the exception of representativeness. References the FSP for this information.	Only references the FSP for the portion of representativeness that is based on statistical sampling design. Added a note that standard analytical procedures are described in the QAPP.	
124.	Page 5-4 of QAPP Section 5.3.4	No prior discussion was provided as to how TICs would be evaluated further for site characterization and risk assessment. Will estimated concentrations be considered definitive and results used for risk assessment?	Does not address use for risk assessment. See previous comment.	Noted that TICs will NOT be used for risk assessment.	
125.	Page 5-4 of QAPP Section 5.4	How will elements of quality control be evaluated and who will do this?	Not addressed	Text added: Elements of quality control will be evaluated by the project chemistry team following data validation guidelines defined in Section 8.3.	
126.	Page 5-7 of QAPP Section 5.5.2	Please confirm that confirmation analysis shall be performed within method required hold time.	Addressed		
127.	Page 5-10 of QAPP Table 5-2	Please delete Table 5-2 Reporting Limit Objectives for Method NW VPH/EPH as these analyses will not be used for this project.	Addressed	VPH/EPH <u>will</u> be used on this project. RLs will stay.	
128.	Page 7-1 of QAPP Section 7 Analytical Procedures	Please provide text as to how the contracted laboratory will be evaluated to assure that analytical DQOs will be met as specified in the work plan.	Not addressed.	Text added: The contract laboratory will be evaluated to make sure that analytical DQOs are met by comparison of laboratory RLs, QC criteria, and analytical requirements with those listed in Tables 5-1 through 5-45. This process is accomplished during the data validation process.	
129.	Page 8-1 of QAPP Section 8.2.1	100% data review by the primary analyst and senior analyst or section supervisor. Will this requirement be specified in the contracted laboratory's statement of work?		Correct. 100% of data is reviewed by analyst and supervisor.	
130.	Page 8-3 of QAPP Section 8.2.2	The Case Narrative bullet only states that secondary labs should be indicated as to what analyses they performed. No prior chain of custody discussion was provided as to how secondary labs would be used for this project. It is highly recommended that text be added to expand upon this point. Otherwise, secondary labs may be used without advance project approvals that do not meet project analytical DQOs.	Additional discussion was not provided on secondary labs	Added note in Section 4.2 that prior approval must be obtained from the project chemist if a subcontract lab was not identified in the original lab proposal.	

Reviewer: Marlena Brewer, Alaska Department of Environmental Conservation					
Comment No.	**Page/ Section**	**COMMENT/RECOMMENDATION**	**OASIS Review of Changes to QAPP**	**CH2M HILL RESPONSE**	
131.	Page 5-23 th 5-46 of QAPP Tables 5-14 th 5-34	Please provide reference for the limits presented in the tables (method specific, DOD QSM, etc.) Suggest footnote reference.	Limits reference the QSM, ADEC, or method specific		
132.	Page 5-47 th 5-64 of QAPP Tables 5-35 th 5-45	Please provide reference for the calibration and quality control requirements per method. Suggest footnote reference. Please delete VPH/EPH from tables.	Addressed		
133.	Page 7-2 of QAPP Table 7-1	Please delete VPH/EPH from table.	Not addressed	VPH added back into QAPP. The VPH and EPH test methods provide information on the aromatic and aliphatic concentrations in select equivalent carbon groups. This data has value for assessing human health risks, understanding chemical fate and transport, and assessing the feasibility of and designing remedial approaches (if needed).	
134.	Page 8-1 Section 8.2	In the case a secondary laboratory is needed to support the project, please provide some text as to how data will be managed.	Not addressed	Removed reference to “primary” laboratory. All data will be handled the same.	
135.	Page 8-6 of QAPP Section 8.3.1	In discussing the Level 4 validation, please confirm if analytical results will be back calculated from the initial and continuing calibrations to confirm the result reported.	Addressed		
136.	Page 8-6 of QAPP Section 8.3.1	Please specify the data validation and verification frequency are project wide or by sub-area to be addressed in individual work plan addendum or by analytical method and matrix. Recommend that data from all methods and matrices are validated at the specified frequency, not just some an arbitrary percentage of total data.	By Method and Matrix		
137.	Page 9-1 of QAPP Section 9.1	Please describe the *laboratory validation process* to be conducted.	Not addressed. Not clear who or where flags specified in QC tables will be applied to data.	Removed reference to laboratory validation process. This was not referring to the project chemist data validation, but of USACE’s approval of a lab according to the required USACE submittals prior to project startup. MDL, QC criteria and self-declaration forms were submitted.	

Reviewer: Marlena Brewer, Alaska Department of Environmental Conservation					
Comment No.	**Page/ Section**	**COMMENT/RECOMMENDATION**	**OASIS Review of Changes to QAPP**	**CH2M HILL RESPONSE**	
138.	Page 9-1 of QAPP Section 9.1	Performance standards should be presented on how the performance evaluation (PE) samples shall demonstrate the laboratory's capability to support the project analytical DQOs (i.e. What is the level of acceptability for PE results? What are the corrective actions/consequences of failing? It is highly recommended that the PE samples be submitted to the lab at the onset of field activities prior to analysis of actual site samples.	Level of acceptability was not defined. No discussion of submission prior to field effort.	It is stated that the PE sample must be within known acceptance criteria. If accuracy criteria are not met, a second PE sample is submitted. If a second PE does not meet accuracy criteria, a lab audit may be performed and a secondary lab used until acceptable corrective action is implemented and successful PE submitted. USACE will provide PE samples to CH2M HILL at the project site. CH2M HILL will submit the PE samples to the lab with the other samples.	
139.	Page 9-1 of QAPP Section 9.2	Who else may perform external audits of the project other than USACE?	Addressed		
140.	Page 13-1 of QAPP Section 13.2	The ADEC lab checklist must be completed for ***each*** analytical data package.	Addressed		
141.	Page 13-1 Section 13.1 and 13.3	Please specify that summary analytical data tables with appropriate data qualification flags in addition to a complete sample summary table with location information for each sample will be provided in the hard copy and electronic deliverables.	Addressed		
142.	QAPP MI QA/QC	If MI sampling is proposed for surface soil sampling, a section on MI sample QA/QC is needed in the QAPP.	Triplicate sample analysis is only information added to the QAPP in regard to MI sample collection.	MI sampling procedures discussed in FSP. Text was added to the Precision section 5.2.1 also.	
143.	General	Document page numbering was inconsistent throughout the document. It is recommended that the document page numbering be corrected and the table of contents updated accordingly.	Still some page numbering issues (See Section 5)	Table of Contents and page numbers were edited.	

Reviewer: Marlena Brewer, Alaska Department of Environmental Conservation						
Comment No.	**Page/ Section**	**COMMENT/RECOMMENDATION**	**OASIS Review of Changes to QAPP**	**CH2M HILL RESPONSE**	**ADEC 2ND BACKCHECK**	**CH2M HILL RESPONSE TO ADEC 2ND BACKCHECK**
1.	Page 3-1 Table 4-1 & 4-2	Extractible and Volatile Hydrocarbon Speciation by analytical method NW EPH/VPH are presented in the table, but no mention of these analyses is made prior to this table. It is assumed these analytical results are needed for input into the 4-phase calculator which has not been approved for use by ADEC and shall not be used for this project. These analyses will impact the analytical costs and provide no value to the project and it is therefore recommended they be deleted from the table and any further project consideration. If retained, VPH soil should be field preserved with methanol; VPH water collected in preserved 40 ml vials.	All referenced were removed from the QAPP with the exception of Table 7-1.	Removed from Table 7.1.	EPH and VPH are present in all tables.	Correct – added back to QAPP as requested
2.	Page 3-2 Table 4-1	No prior discussion of the use of low level volatiles data is presented. If low level volatile analysis is going to be used, it warrants a discussion that it should only be used in conjunction with high/medium level data and not as stand alone. High level VOCs should be collected in the same manner as AK101 samples; 4 oz amber glass, septa lid, methanol preserved.	Low-level VOCs removed from Table 4-1. VOC and GRO will be collected together in the same 40ml VOA vials and preserved with methanol prespiked with surrogate. This revision was made to the table.		Low level VOCs (sodium bisulfate) analysis should be included for those analytes for which the methanol preserved method cannot meet project specific DQOs. AK101 preservation is incorrect. It requires a 4oz jar with septumated lid and 25g soil and 25mL surrogated methanol. GRO and VOCs may be collected in one jar, but the different hold times should be adhered to by the lab for each method as appropriate.	Low-level VOCs added to preservation table, and Tale 5-8 added to compare low-level RLs with SLs. GRO collection procedure modified to 25g to 25ml methanol in 4-oz jar Method specific HT are listed in tables in section 4
3.	Page 3-1 & 3-2 Table 4-1 & 4-2	AK101 and AK102/AK103 are listed twice in these tables.	Corrected			
4.	Page 3-3 Table 3-2	Suggest striking the footnote that states that filtered samples for dissolved metals analysis will be collected on a project specific basis. No discussion of collecting dissolved metals samples has been presented for this project.	This still appears in the QAPP table 4.2.	The footnote has been removed from Table 4.2.		

Reviewer: Marlena Brewer, Alaska Department of Environmental Conservation						
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5.	Page 3-4 and throughout the document Section 3.4.3	0-0.5 ft below ground surface (bgs) is not consistent with ADEC's definition of surface soil as 0-2ft bgs. 0-10ft bgs is not consistent with ADEC's 2-15ft bgs definition of subsurface soil. Soil depth consideration **should not** rely upon possible future conditions (additional topsoil).			No discussion of soil depths was provided in response to comment.	The FSP has been revised. MI sampling of surface soil 0 – 0.5 ft bgs has been dropped from the program. ADEC's definitions of surface soil and subsurface soil.
6.	Page 1-1 of QAPP Section 1.1	Why is the Uniform Federal Policy QAPP not referenced for the development of this QAPP?	Reference Added		UFP QAPP was not referenced.	Changed reference from full Quality Systems Manual to the specific QAPP section
7.	Page 1-1 of QAPP Section 1-1	Why is there no discussion of the PSE I in this section? Some discussion is also needed as to why there have been two preliminary source evaluations and the site has still not been adequately characterized. Recommend revising this section to give more information as to the site history including a timeline of events and summary of data collected to date.	Information on the PSE1 was not added.	Section revised.	The PSE I does not include all known source area information to date as the text states. It does not include the 2006 data contained within the PSE II report.	Modified text to read that the PSE includes data up to the 2006 field event.
8.	Page 1-2 of QAPP Section 1.3	Project objective and scope is way too generalized. A summary of specific objectives and scope for the site as a whole and each sub area should be discussed. This section should address the purpose of the project (objective) and to what ends it will be executed (scope). A flow diagram may be used to summarize the project decision logic.	Not addressed.	DQO descriptions added to Section 1.	Section 1.1.1 first two bullets state that risks will be evaluated for the direct contact pathway. Inhalation of outdoor air is also a completed pathway that must be evaluated. Also, possible contaminate sources and extent are to be determined which would call for evaluation of potential migration of soil contaminants to groundwater as well. Migration to groundwater cleanup levels should therefore be included in the DQO table.	Migration to indoor air, outdoor air, and groundwater pathways will be evaluated as part of the risk assessment. Text '(by direct contact)' will be deleted from the first two bullets.

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9.	Page 2-1 of QAPP Section 2.1	Although project /task organization and roles/responsibilities will be presented in individual work plans, it seems necessary to present the information in this document as well and specifically for the QA tasks. Specific training and certification is needed for several tasks (munitions, HAZCAT analysis,		Table of CH2M HILL contacts added.		
10.	Page 2-1 of QAPP Section 2.2	Specific training and certification beyond that presented in the text is needed for several project tasks worth discussing.	Not added.	There are no special training requirements for the chemists and data managers. We will not discuss training and certification for field crew in the QAPP.	It is worth noting that there are specific training and/or certification requirements for specific tasks on this project. This QAPP not only applies to chemists and data managers, but every individual on the project including field staff. ADEC does have criteria for "qualified persons" that must be met for all field samplers in addition to the HAZWOPER training. The work plan should specify these ADEC criteria will be met.	Added text: All field personnel collecting samples during this project will meet ADEC criteria for qualified persons. In addition, the field personnel will also be Occupational Safety & Health Administration Hazardous Waste Operations and Emergency Response Standard trained
11.	Page 3-1 of QAPP Section 3.1	How will quality control sample frequency and results be evaluated during the project?	Frequency was addressed. Evaluation was addressed for all but the field duplicates and field type blanks. Text does not discuss corrective actions when contaminants are found in field, rinsate, ambient and trip blanks.	Referred to Tables 8.1 through 8.4 for FD and FB evaluation. Added text to discuss corrective actions when excessive contamination is found in field, rinsate, ambient and trip blanks.	No mention of possible impact to data usability (i.e. possible bias of sample results, cross contamination, ect.).	Added a reference to tables in Section 8 that describe how data will be flagged in response to exceedances and that biases and impacts to data usability will be discussed in the data quality report following validation.
12.	Page 3-1 of QAPP Table 4-1	Please refer to comments pertaining to Table 4-1 and 4-2 of the SAP.	Addressed			

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13.	Page 5 of QAPP Section 4.3	No discussion is provided regarding the transfer of samples from the primary contracted lab to a subcontracted secondary lab in case that capacity or hold time issues arise. Suggest adding text to discuss how chain of custody will be maintained and recorded for such circumstances.	Not discussed	This text was added to Section 4.2: If analyses are to be subcontracted to another laboratory or another location within the laboratory network, copies of COCs transferring custody to the secondary laboratory must also be included in the laboratory data package and must also include the information listed above. The primary laboratory must notify the CH2M HILL chemist for approval prior to subcontracting analyses to a laboratory not identified in the original proposal. This text was added to Section 4.3: A subcontract laboratory must notify the primary laboratory of any such discrepancies within 24 hours of its receipt of the samples. The primary laboratory will relay this information to the CH2M HILL project chemist within 24 hours of notification.		
14.	Page 5-1 of QAPP Section 5.1	Please reiterate what field screening techniques will be used for this project. Some summary of field screening data quality assurance is warranted in this section as well or reference the sampling plan as appropriate.	Section 6 field methods was added			

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15.	Page 5-1 of QAPP Section 5.1	Will TICs data be considered screening or definitive?	Text defines use as both qualitative and quantitative.	Yes – but it is noted that the TIC will NOT be definitive.	Some decision logic may be needed for handling TICs. If TICSs are reported, they should be confirmed, further investigation of the site may be warranted, and risks may be evaluated if toxicity data is available.	Text added: For nontarget peaks meeting the 10 percent threshold, the mass spectrum will be compared to referenced spectra in the current National Institute of Standards and Technology library, using a computer search routine. If the spectral match has a fit of 80 percent or better, the substance name representing the best fit will be reported as the tentative identity of the compound. If the spectral fit is less than 80 percent, the peak will be reported as "Unknown RRT x.xxx", where x.xxx is the relative retention time in minutes. In either case, an estimated concentration will be calculated by comparing the peak area to that of the internal standard, using a response factor of 1.00. The estimated concentration will be shown on the laboratory data report and will not be considered as definitive data, however, if toxicity data is available the TIC data may be included in the risk assessment.

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16.	Page 5-1 of QAPP Section 5.2	What criteria will used to evaluate precision, accuracy, representativeness, completeness, and comparability? Please provide reference for criteria.	Added tables and references the QSM with the exception of representativeness. References the FSP for this information.	Only references the FSP for the portion of representativeness that is based on statistical sampling design. Added a note that standard analytical procedures are described in the QAPP.		
17.	Page 5-4 of QAPP Section 5.3.4	No prior discussion was provided as to how TICs would be evaluated further for site characterization and risk assessment. Will estimated concentrations be considered definitive and results used for risk assessment?	Does not address use for risk assessment. See previous comment.	Noted that TICs will NOT be used for risk assessment.	If available toxicity data is available, TICs may be included in the risk assessment.	Added comment that if toxicity data is available for a TIC, it may be included in the risk assessment.
18.	Page 5-4 of QAPP Section 5.4	How will elements of quality control be evaluated and who will do this?	Not addressed	Text added: Elements of quality control will be evaluated by the project chemistry team following data validation guidelines defined in Section 8.3.		
19.	Page 5-7 of QAPP Section 5.5.2	Please confirm that confirmation analysis shall be performed within method required hold time.	Addressed			
20.	Page 5-10 of QAPP Table 5-2	Please delete Table 5-2 Reporting Limit Objectives for Method NW VPH/EPH as these analyses will not be used for this project.	Addressed	VPH/EPH <u>will</u> be used on this project. RLs will stay.	VPH/EPH data may be used to assess contaminant extent and fate and transport in the development of feasibility strategies, but it will not be used for risk assessment purposes.	Added footnote at the bottom of table 5-2 stating this.

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21.	Page 7-1 of QAPP Section 7 Analytical Procedures	Please provide text as to how the contracted laboratory will be evaluated to assure that analytical DQOs will be met as specified in the work plan.	Not addressed.	Text added: The contract laboratory will be evaluated to make sure that analytical DQOs are met by comparison of laboratory RLs, QC criteria, and analytical requirements with those listed in Tables 5-1 through 5-45. This process is accomplished during the data validation process.	The lab should be evaluated before analyses to assure they are capable to support the project. The data validation process is a follow up to make sure they did meet project objectives.	Added/revised text to read: This process is accomplished prior to project startup by evaluating the USACE required submittals that include MDLs and RLs for all methods to be performed, results of last three PE studies, and QC limits for all methods to be performed. This information will also be submitted and reviewed for all sister and subcontract laboratories the main laboratory will use throughout the course of the project. Compliance with DQOs will also be evaluated throughout the project during the data validation process
22.	Page 8-1 of QAPP Section 8.2.1	100% data review by the primary analyst and senior analyst or section supervisor. Will this requirement be specified in the contracted laboratory's statement of work?		Correct. 100% of data is reviewed by analyst and supervisor.		
23.	Page 8-3 of QAPP Section 8.2.2	The Case Narrative bullet only states that secondary labs should be indicated as to what analyses they performed. No prior chain of custody discussion was provided as to how secondary labs would be used for this project. It is highly recommended that text be added to expand upon this point. Otherwise, secondary labs may be used without advance project approvals that do not meet project analytical DQOs.	Additional discussion was not provided on secondary labs	Added note in Section 4.2 that prior approval must be obtained from the project chemist if a subcontract lab was not identified in the original lab proposal.	The project chemist must therefore assure that any secondary lab used can meet all of the same project objectives as the primary lab. This may better be a project team level decision.	Noted in Section 7 that all USACE required documentation will submitted and reviewed for all sister and subcontract laboratories the main laboratory will use throughout the course of the project.
24.	Page 5-23 th 5-46 of QAPP Tables 5-14 th 5-34	Please provide reference for the limits presented in the tables (method specific, DOD QSM, etc.) Suggest footnote reference.	Limits reference the QSM, ADEC, or method specific			

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25.	Page 5-47 th 5-64 of QAPP Tables 5-35 th 5-45	Please provide reference for the calibration and quality control requirements per method. Suggest footnote reference. Please delete VPH/EPH from tables.	Addressed			
26.	Page 7-2 of QAPP Table 7-1	Please delete VPH/EPH from table.	Not addressed	VPH added back into QAPP. The VPH and EPH test methods provide information on the aromatic and aliphatic concentrations in select equivalent carbon groups. This data has value for assessing human health risks, understanding chemical fate and transport, and assessing the feasibility of and designing remedial approaches (if needed).	Comment accepted with the caveat that this data will not be used for risk assessment purposes. Please remove any reference to the use of this data for such purposes.	Added footnote at the bottom of table 5-2 stating VPH/EPH data may be used to assess contaminant extent and fate and transport in the development of feasibility strategies, but it will not be used for risk assessment purposes.
27.	Page 8-1 Section 8.2	In the case a secondary laboratory is needed to support the project, please provide some text as to how data will be managed.	Not addressed	Removed reference to "primary" laboratory. All data will be handled the same.		
28.	Page 8-6 of QAPP Section 8.3.1	In discussing the Level 4 validation, please confirm if analytical results will be back calculated from the initial and continuing calibrations to confirm the result reported.	Addressed			
29.	Page 8-6 of QAPP Section 8.3.1	Please specify the data validation and verification frequency are project wide or by sub-area to be addressed in individual work plan addendum or by analytical method and matrix. Recommend that data from all methods and matrices are validated at the specified frequency, not just some an arbitrary percentage of total data.	By Method and Matrix		Still did not address the frequency according to the project overall or by sub-areas.	Changed the section to read that the data validation frequencies are site-wide and not per individual sub area.
30.	Page 9-1 of QAPP Section 9.1	Please describe the *laboratory validation process* to be conducted.	Not addressed. Not clear who or where flags specified in QC tables will be applied to data.	Removed reference to laboratory validation process. This was not referring to the project chemist data validation, but of USACE's approval of a lab according to the required USACE submittals prior to project startup. MDL, QC criteria and self-declaration forms were submitted.	Please provide text to note that the lab meets USACE requirements to include MDL, QC, and self-declaration.	Added Section 9.1 Laboratory Approval. This lists USACE requirements to include MDL, QC, and self-declaration for all labs to be performing work on project.

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31.	Page 9-1 of QAPP Section 9.1	Performance standards should be presented on how the performance evaluation (PE) samples shall demonstrate the laboratory's capability to support the project analytical DQOs (i.e. What is the level of acceptability for PE results? What are the corrective actions/consequences of failing? It is highly recommended that the PE samples be submitted to the lab at the onset of field activities prior to analysis of actual site samples.	Level of acceptability was not defined. No discussion of submission prior to field effort.	It is stated that the PE sample must be within known acceptance criteria. If accuracy criteria are not met, a second PE sample is submitted. If a second PE does not meet accuracy criteria, a lab audit may be performed and a secondary lab used until acceptable corrective action is implemented and successful PE submitted. USACE will provide PE samples to CH2M HILL at the project site. CH2M HILL will submit the PE samples to the lab with the other samples.	When will PE samples be submitted to the lab?	USACE plans to order the samples during the field season, have the vendor send them to CH2M HILL, and have them incorporated into the sampling scheme as real world samples. This should happen relatively early in the scheme of things, so we can order another in case of a failure. Text was added to denote this should happen relatively early in the scheme of things, so we can order another in case of a failure.
32.	Page 9-1 of QAPP Section 9.2	Who else may perform external audits of the project other than USACE?	Addressed			
33.	Page 13-1 of QAPP Section 13.2	The ADEC lab checklist must be completed for ***each*** analytical data package.	Addressed			
34.	Page 13-1 Section 13.1 and 13.3	Please specify that summary analytical data tables with appropriate data qualification flags in addition to a complete sample summary table with location information for each sample will be provided in the hard copy and electronic deliverables.	Addressed			
35.	QAPP MI QA/QC	If MI sampling is proposed for surface soil sampling, a section on MI sample QA/QC is needed in the QAPP.	Triplicate sample analysis is only information added to the QAPP in regard to MI sample collection.	MI sampling procedures discussed in FSP. Text was added to the Precision section 5.2.1 also.		
36.	General	Document page numbering was inconsistent throughout the document. It is recommended that the document page numbering be corrected and the table of contents updated accordingly.	Still some page numbering issues (See Section 5)	Table of Contents and page numbers were edited.		

Reviewer: _____

Comment No.	Page/ Section	COMMENT/RECOMMENDATION	CH2M HILL A = Agree D = Disagree	CH2M HILL COMMENTS	
144.	General	This document references EPA's QA/R-5 (EPA 2001a) but incorrectly includes "Program", not "Project" in the document title. The QAP title suggests a program plan, but its organization is closer to the style of the quality assurance project plan (QAPP). Indeed, in the second paragraph of Section 1.1, it calls itself a "Quality Assurance Project Plan". The document, however, does not follow EPA's QAPP guidance (EPA 2001a, 2002).	**A**	Changed "Program" to "Project" The scope called for the QAPP to be based on QSM, which it is.	
145.	General	The project could use an overall quality assurance program plan (EPA 2001b), which would be the "umbrella" document under which individual projects would be conducted. The project also needs at least one QAPP (and possibly more to cover the variety of activities), and that document should address EPA's QAPP guidance (EPA 2001a, 2002). Because the project data will be managed in a geographic information system (GIS), the project should also address EPA's guidance for a geospatial QAPP (EPA 2003).	**D**	Only one QAPP will be developed…Addendums will be written if changes occur. Geospatial discussions are not appropriate for this QAPP.	
146.	General	As the project team develops its project approach and quality system, it should also consider the latest EPA guidance on data quality objectives (EPA 2006).	**D**	DQO process described in FSP	
147.	Section 3.1	The ADEC guidance for multi-increment sampling also discusses triplicate samples.	**A**	Added	
148.	Section 3.1	The field sampling plan calls these "equipment rinsate blanks". Please use consistent terminology.	**A**	Revised	
149.	Section 4.1	No chemical agent degradation products are listed. Please explain the rationale for this omission.	**D**	These are included as explosives by SW8321 and transitional explosives by SW8330	
150.	Table 4-1 and 4-2	Two rows above are repeated from the first page of this table. Delete.	**A**	Deleted	
151.	Section 5.2.1	What are the goals for precision?	**A**	Made a note the goals are in Tables	
152.	Section 5.2.2	What are the goals for accuracy?	**A**	Made a note the goals are in Tables	
153.	Section 5.2.3	Page: 21 What are the goals for representativeness?	**A**	Additional text added	
154.	Section 5.2.5	What are the goals for comparability?	**A**	Additional text added	
155.	Section 5.6	The risk assessment plan did not report the development of any preliminary remediation goals (PRGs). Thus, it is not clear whether the risk assessor was consulted as to the appropriateness of the columns in these tables. Please clarify whether the risk assessor prepared PRGs, and that they were included in these columns.	**A**	Text added in section 11.2 on how data will be compared to the screening levels for reconciliation with DQOs and submission for risk assessment.	

Reviewer: Gloria Beckman (QAPP)

Item No.	Drawing Sht. No., Spec. Para.	COMMENTS	REVIEW CONFERENCE A - comment accepted W - comment withdrawn (if neither, explain)	CH2M HILL RESPONSES	USAED RESPONSE ACCEPTANCE (A-AGREE) (D-DISAGREE)
1.	Acronyms	Please define PE and PT	**A**	Defined PE. Removed PT, they are the same thing.	
2.	Introduction and Background d	These sections are too vague and should include more information on why the analytical data will be collected, how it will be used, how the action/screening limits were established, etc. Suggest beefing up the DQO, moving the information to a section earlier in the QAPP and tying the action limits to objectives of the project and defining realistic RLs and action limits.	**A**	Background section revised. DQO descriptions added to Section 1	
3.	1.2 Background	230 cubic yards of PCB-contaminated soil was removed. None of the previous reports use tons. Not sure where this came from unless waste management folks weighed the waste and reported actual weight in tons. Use of tons implies more than 230 cubic yards were removed (appr. 345 ton if you use the 1.5 ton to 1 cy conversion). Background does not mention the PSE 1.	**A**	Reference to cubic tons was removed PSEI added to background discussion	
4.	General	How will USACE, EPA and ADEC approve the QAPP or field sampling if labs have not been identified?	**A**	Added project laboratory name and contacts to Section 2.2	
5.	General	QA/QC personnel organization chart or table of people to contact would be beneficial.	**A**	Added chart for PM, data management and chemistry contacts	
6.	3.1.3 and 3.1.4	Equipment Rinsate Blanks and Field Blanks appear to be the same. Recommend omitting Field Blanks	**A**	Deleted field blanks, they were specific to surface water, which there are none for this project.	
7.	3.1.1	Field duplicate criteria were not defined. Recommend using criteria provided in ADEC checklist.	**A**	Added reference to Tables 8.1 through 8.6 where criteria are defined.	
8.	Table 4-1	Table does not contain chemical agent breakdown methods per EPA comment on QAPP ADEC refers to AK103 as residual range organics and not motor oil range organics. Please conform to standard reference through out the document so as not to confuse end users or labs. Latest SW-846 references current SW6010 and SW8151 as SW6010B and SW8151A.	**A**	Chemical warfare agents and breakdown products have not been detected in recent sampling and have been excluded from the project and are not included in the QAPP. Changed motor oil to residual throughout document Changed SW6010 and SW8151 to SW6010B and SW8151A throughout document	
9.	Table 4-3	TO-15 holding time per EPA is 14 days. Could not find a reference to 25 day holding time.	**A**	Changed to 14 days	

Reviewer: Gloria Beckman (QAPP)					
Item No.	**Drawing Sht. No., Spec. Para.**	**COMMENTS**	**REVIEW CONFERENCE A - comment accepted W - comment withdrawn (if neither, explain)**	**CH2M HILL RESPONSES**	**USAED RESPONSE ACCEPTANCE (A-AGREE) (D-DISAGREE)**
10.	Section 5.0	See previous comment on DQO section. Should provide definable features of work and how project objectives are supported by analytical methods, action limits, etc. No mention of why various matrices will be collected. What is the data collection design for the project as stated in the first paragraph last sentence? Pagination is off in this section	**A**	DQO description moved to section 1 and better description added.	
11.	Section 5.1	What screening level data will be generated?	**A**	Added Section 6 about field analytical methods	
12.	5.2.5	Comparability: What is a PT sample? Which audit reports will be used to evaluate comparability? How will this allow review of comparability or assure data meets criteria?	**A**	Changed to "PE". Comparing PE study data between different labs offers a way of comparing lab accuracy and precision.	
13.	Section 5.6	Introduction to this section is weak and should connect the RLs to the DQOs. Really need to identify a lab to complete this section or allow approval. Who applies the Q flag to the data and where would it appear? EPA comment on whether PRGs were established and approved by risk assessor does not appear to have been addressed. Are PRGS being used? PRG is include as acronym but I could not find it in the QAPP.	**A**	Q flag is applied by the lab, it is a requirement of QSM. The data validation flags are described separately in tables in Section 8. PRG was in section 5.6, but removed as acronym and replaced in text to say "screening levels" to match the tables. Text added: Site-specific preliminary remediation goals have not yet been prepared. Screening levels presented in this QAPP are used to select the appropriate RLs. Screening levels are likely well below risk based remediation goals. Analytical data will be used to calculate baseline risk following ADEC and EPA guidance. If risk is identified, site-specific remediation goals will be developed.	
14.	Tables Reporting Limit Objectives	RLs exceed the action limits for multiple analytes. Why not use the most conservative ADEC pathway criteria instead of ingestion? When establishing reporting limits for metals that do not have action levels, may want to consider background levels.	**A**	Screening levels presented in this QAPP are used to select the appropriate RLs. They are not added as PRGs. The EPA screening criteria are generally lower than the ADEC Table B1 and B2 values. The migration to groundwater values are not included because we do not believe all the values represent risk-basked values. The inhallation values have been added to the tables. Note is added in Section 11.2 that an analyte with no SL will be evaluated against historical detections.	

Reviewer: Gloria Beckman (QAPP)					
Item No.	**Drawing Sht. No., Spec. Para.**	**COMMENTS**	**REVIEW CONFERENCE A - comment accepted W - comment withdrawn (if neither, explain)**	**CH2M HILL RESPONSES**	**USAED RESPONSE ACCEPTANCE (A-AGREE) (D-DISAGREE)**
15.	Table 5-8	RLs for SW8270 SIM should be low enough to meet the PAH action limits. I am surprised to see so many RLs above action limits.	**A**	PAH lab RLs and MDLs added to tables, ADEC SLs met.	
16.	Table 7-1	TO-15 is not on this table.	**A**	Added	
17.	Section 8.1	Should define period of record retention. Lab will typically review QAPP not Work Plan. This information is also valuable to future data users and should be documented in the QAPP.	**A**	Changed to 10 years	
18.	Section 8.2.2	USACE typically requires the submittal of GC chromatogram for all fuel methods in the Level III and Level IV packages.	**A**	Added this as a requirement in section 8.2.2	
19.	Section 8.2.3	State what type of electronic deliverable is/are required (COELT and/or SEDD). Future data users will not have access to the lab SOW for this information and it is necessary to know what format lab used. Does the lab add the flags previously mentioned in QC tables to the hard copy or electronic data? Where are the J, B, and Q flags defined?	**A**	Stated here that the lab will deliver CH2M HILL LabSpec7. Later in Section 13, deliverable to USACE and ADEC is described as COELT.	
20.	Section 8.3	Will CH2M Hill validate the electronic deliverables?	**A**	Yes – added note in section 8.3 that all hardcopy results will be verified against EDD results. It is also stated in this section that data qualifiers will be applied to the electronic data.	
21.	Section 11.2	Should reference location of project DQOs. Please add a reference for the EPA Region VI Preliminary Remediation Goals. This information should be in the DQO section and not at the back of the QAPP.	**A**	DQO description moved to section 1.	
22.	Section 13.1	Will usability as it applies to the project DQO be discussed in the DQR?	**A**	Yes	
23.	Section 13.2	Please specify where or how ADEC checklists will be submitted. Recommend submittal with the draft/final reports.	**A**	Added text that data validator will fill out the checklists and they will be submitted to USACE and ADEC along with the draft/final reports.	
24.	Section 13.3	Is SEDD required?	**A**	No – this is not a FUDS project..	
25.	References	Inorganic Functional Guidelines were updated in 2004. References recommended by EPA comment were not added: EPA QA/.G-4 2006 EPA QA/R2 EPA QA G5 EPAQA/G-5G EPA/240/R-03/003 Mar 2003	**A**	Updated and added references.	

Reviewer: _____

Comment No.	Page/ Section	COMMENT/RECOMMENDATION	CH2M HILL A = Agree D = Disagree	CH2M HILL COMMENTS	
156.	General	This document references EPA's QA/R-5 (EPA 2001a) but incorrectly includes "Program", not "Project" in the document title. The QAP title suggests a program plan, but its organization is closer to the style of the quality assurance project plan (QAPP). Indeed, in the second paragraph of Section 1.1, it calls itself a "Quality Assurance Project Plan". The document, however, does not follow EPA's QAPP guidance (EPA 2001a, 2002).	**A**	Changed "Program" to "Project" The scope called for the QAPP to be based on QSM, which it is.	
157.	General	The project could use an overall quality assurance program plan (EPA 2001b), which would be the "umbrella" document under which individual projects would be conducted. The project also needs at least one QAPP (and possibly more to cover the variety of activities), and that document should address EPA's QAPP guidance (EPA 2001a, 2002). Because the project data will be managed in a geographic information system (GIS), the project should also address EPA's guidance for a geospatial QAPP (EPA 2003).	**D**	Only one QAPP will be developed…Addendums will be written if changes occur. Geospatial discussions are not appropriate for this QAPP.	
158.	General	As the project team develops its project approach and quality system, it should also consider the latest EPA guidance on data quality objectives (EPA 2006).	**D**	DQO process described in FSP	
159.	Section 3.1	The ADEC guidance for multi-increment sampling also discusses triplicate samples.	**A**	Added	
160.	Section 3.1	The field sampling plan calls these "equipment rinsate blanks". Please use consistent terminology.	**A**	Revised	
161.	Section 4.1	No chemical agent degradation products are listed. Please explain the rationale for this omission.	**D**	These are included as explosives by SW8321 and transitional explosives by SW8330	
162.	Table 4-1 and 4-2	Two rows above are repeated from the first page of this table. Delete.	**A**	Deleted	
163.	Section 5.2.1	What are the goals for precision?	**A**	Made a note the goals are in Tables	
164.	Section 5.2.2	What are the goals for accuracy?	**A**	Made a note the goals are in Tables	
165.	Section 5.2.3	Page: 25 What are the goals for representativeness?	**A**	Additional text added	
166.	Section 5.2.5	What are the goals for comparability?	**A**	Additional text added	
167.	Section 5.6	The risk assessment plan did not report the development of any preliminary remediation goals (PRGs). Thus, it is not clear whether the risk assessor was consulted as to the appropriateness of the columns in these tables. Please clarify whether the risk assessor prepared PRGs, and that they were included in these columns.	**A**	Text added in section 11.2 on how data will be compared to the screening levels for reconciliation with DQOs and submission for risk assessment.	

Interim Draft

Field Sampling Plan

FWA 102 Former Communications Site
Fort Wainwright, Alaska

Prepared for

Department of the Army
U.S. Army Corps of Engineers,
Alaska District

P.O. Box 6898
Elmendorf AFB, Alaska 99506-6898

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Abbreviations and Acronyms

AAC	*Alaska Administrative Code*
ADEC	Alaska Department of Environmental Conservation
ADOT&PF	Alaska Department of Transportation and Public Facilities
API	American Petroleum Institute
Army	Department of the Army
ASTM	ASTM International (formerly American Society for Testing and Materials)
bgs	below ground surface
BTEX	benzene, toluene, ethylbenzene, and xylenes
°C	degrees Celsius
CFR	Code of Federal Regulations
COC	chain of custody
CRREL	Cold Regions Research and Engineering Laboratory
DO	dissolved oxygen
DPW	Directorate of Public Works
DRO	diesel-range organics
ECC	Environmental Compliance Consultant
EPA	U.S. Environmental Protection Agency
EPH	extractable petroleum hydrocarbon
°F	degrees Fahrenheit
FCS	Former Communications Site
FS	feasibility study
FSP	Field Sampling Plan
ft	foot/feet
GPS	global positioning system
GRO	gasoline-range organics
HCl	hydrochloric acid
HDPE	high-density polyethylene

Hg	mercury
HNO_3	nitric acid
IATA	International Air Transport Association
ID	identification
IDW	investigation-derived waste
MCL	maximum contaminant level
MI	multi-increment
mL	milliliter
mm	millimeter
MS	matrix spike
MSD	matrix spike duplicate
NAPL	nonaqueous phase liquid
NTU	nephelometric turbidity unit
NWI	North Wind Inc.
OD	outside diameter
oz	ounce
PCB	polychlorinated biphenyl
PE	performance evaluations
PID	photoionization detector
PPE	personal protective equipment
ppm	parts per million
PVC	polyvinyl chloride
QA	quality assurance
QAPP	quality assurance program plan
QC	quality control
RCRA	Resource Conservation and Recovery Act
RI	remedial investigation
RPM	Remedial Project Manager
SOP	standard operating procedure
UCL	upper confidence limit

USACE	U.S. Army Corps of Engineers
VOA	volatile organic analyte
VOC	volatile organic compound
VPH	volatile petroleum hydrocarbons

SECTION 1

Introduction

This document is the Field Sampling Plan (FSP) for the Remedial Investigation (RI) that will be conducted at the Former Communications Site (FCS) at Fort Wainwright, Alaska. This work is projected to occur during 2007 and 2008. The purpose of this FSP is to document the procedures that will be used to collect and handle the necessary data to support a thorough baseline human health and ecological risk assessment. A discussion of the general sampling approach with numbers and locations of samples is included in the RI Work Plan. The Quality Assurance Project Plan (QAPP) contains specific protocols with quality assurance (QA) and quality control (QC) requirements designed to ensure that environmental data collected will be of the appropriate quality to achieve the project objectives. This FSP describes how the samples will be collected.

The Department of the Army (Army), U.S. Environmental Protection Agency (EPA), and Alaska Department of Environmental Conservation (ADEC) have agreed to conduct the RI/feasibility study (FS) for the FCS using the triad approach. A Management Plan addressing the methods of overall site management, QAPP, and this FSP have been prepared and should be referenced for additional information. This document is one of many work plans that provide detailed information on specific RI tasks. This approach was determined to be the most effective, efficient, and appropriate method for investigating this site.

SECTION 2

Field and Sampling Procedures

2.1 Field Screening

Field instruments will be used for the collection of field data and measurement of various conditions observed during the RI. In general, the following steps should be taken when using field instruments:

- Before field use, remove the instrument from its container and assemble and clean it according to the manufacturer's instructions.
- Before commencement of field activities each day, calibrate the instrument according to the manufacturer's instructions. Record the instrument's identification (ID) and serial number, along with the calibration process/results, in the field logbook and/or calibration logbook.
- Use the instrument to make the appropriate physical/chemical measurements and clean/decontaminate the instrument, if necessary, after each measurement.
- If erroneous measurements are observed or if changes in environmental conditions warrant recalibration, recalibrate the instrument as specified by the manufacturer. Record the recalibration information in the field logbook and/or the calibration logbook.
- At the end of each day, clean and decontaminate the instrument then return it to the storage location. Recharge instrument, as necessary.
- Perform factory maintenance and calibration at the intervals specified by the manufacturer. Have repairs, maintenance, and calibration performed by trained individuals according to the manufacturer's requirements. Record repairs, maintenance, and calibration in the field logbook or instrument calibration/maintenance logbook.

Radiological screening was performed during test pit investigations in 2006 and no radiological contamination was detected. Therefore, radiological screening will not be performed. If aircraft gauges or dials are recovered during test pit operations, then radiological screening will be performed.

2.1.1 Photoionization Detector Monitoring Procedures

The photoionization detector (PID) will be used to measure the organic vapor concentrations during field activities. Either a 10.6eV or an 11.7eV discharge lamp for the miniRAE PID will be used depending on the type of compound of concern. In general, a portion of each sampling interval will be placed in a resealable freezer bag and allowed to equilibrate so that volatile organic compound (VOC) concentrations in the headspace equal concentrations in the soil sample. A minimum temperature of 40 degrees Fahrenheit (°F) for the sample will be reached, with 60°F being the optimum temperature. The samples will be warmed by placement inside a heated vehicle. PID results will be recorded in the sampling log and in the field logbook. Soils with elevated VOC measurements will be considered for additional sampling.

2.1.2 Radiological Field Screening

Radiological field screening will be conducted if airplane dials, gauges, or similar parts are excavated. These field screening procedures are included in Appendix A.

2.2 Soil Gas Sampling Procedures

Two types of soil gas samples will be collected: sub-slab soil gas samples from Buildings, and soil gas samples in open areas. Sub-slab samples will be collected following the Standard Operating Procedure for the Collection of Sub-Slab Vapor Samples Using Summa™ Canisters, included in Appendix B. Procedures for installation and sampling of soil gas in open areas is described in the subsections below.

2.2.1 Utility Clearance

Non-Taku Gardens-specific utility locates will be performed by the owning organization as necessary: (1) GCI will locate cable and civilian lines; (2) 507th Signal Co will locate the military telephone and cable; (3) Honeywell will locate alarm cables; (4) Fort Wainwright Directorate of Public Works (DPW) will locate military buried power, overhead power, steam/condensate, water, and sewer; and (5) Golden Valley Electric Association (GVEA) will locate the intertie between Fort Wainwright and the local power grid. Fort Wainwright DPW will de-energize select electrical utilities as needed to ensure the safety of site workers.

Taku Gardens-specific utility clearances (communication, electrical, glycol, sewer, and water) will be performed using available as-built information from the family housing construction project, geophysical information provided by Cold Regions Research and Engineering Laboratory (CRREL), and magnetometer and/or induced current methodologies, when appropriate. It is understood that not all utilities have tracer tape associated with them and that there is no standard depth for the various utility runs. Based on the results of this approach, soil gas installations shall stay a minimum of six feet away from the field determined location of each utility.

The above described approach shall constitute “reasonable care” and as such Contractor will not be liable for any utilities damaged performing intrusive activities so long as this approach is followed. The results of the utility clearances in the field notes and shall obtain photographs of sufficient clarity, scale and composition in order to clearly show the items of interest as appropriate.

As a final check before drilling at each location, field personnel will visually inspect the area. Overhead lines and surface features (such as utilidor access vaults, pipe stickups, and disturbed ground surfaces) that may indicate the possible presence of buried lines will be noted in the field logbook and sketched as appropriate. As a standard practice, one or more photographs will be taken showing the location of the excavation or boring relative to a known or recognizable permanent feature (such as a building or utility pole) and any ground markings indicating buried utilities or other structures. If questions arise regarding an underground utility, or in the event of an emergency, the field manager will contact the DPW.

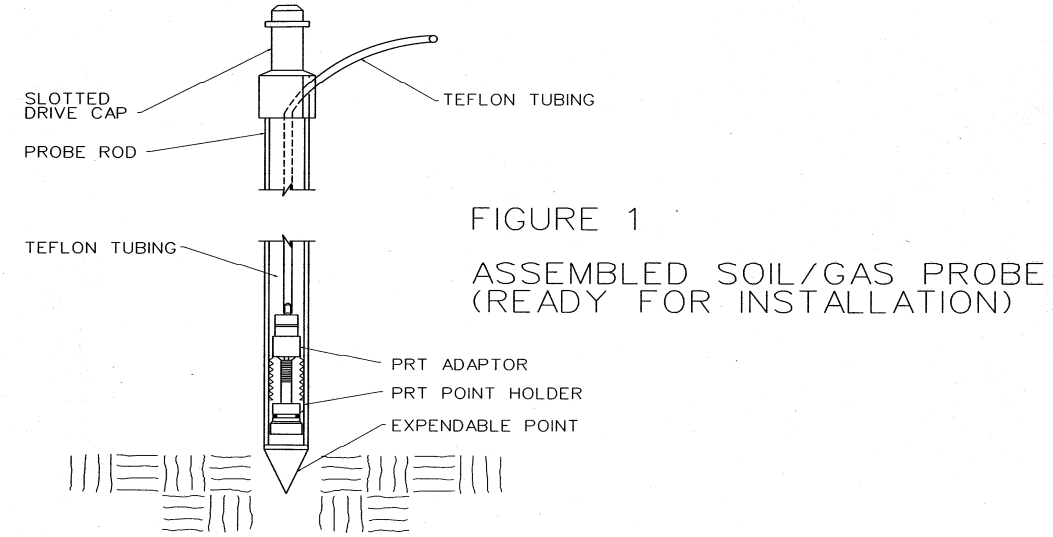
2.2.2 Gas Probe Installation

2.2.2.1 System Setup

System setup will include the following:

- Obtain soil gas sampling probes, in sufficient quantity to conduct the assessment without delay to the sampling effort (Figure 2-1).
- Coordinate the hardware (that is, size of tubing, fittings, sampling interface assembly) that mates the soil gas probe sampling line to the sampling system (that is, Summa canisters). This step is critical to achieve a leak-free system. All connections should be inert gas tight compression fittings (that is, Swagelok or equal) and all sample transfer lines should be made of Teflon tubing.
- Complete a Utility survey before installation of gas probes at a given location.
- Decontaminate soil gas probes with soap and potable water rinse before use.
- Handle and store decontaminated soil gas probes in a manner that prevents contamination.
- Inspect each gas probe assembly for ware and faulty parts. Before decontamination, replace probe tips, o-rings, adapters, and probe rods, as needed.
- Leak check each probe assembly before use. This is accomplished by inserting the probe tip and applying a vacuum that is greater than the anticipated vacuum that will be encountered during sampling (i.e., the Summa canister vacuum). Any probe assembly that leaks should be repaired and pass a leak check before use. Once an assembly has passed a leak check, it should not be disassembled before use.
- Fully assemble probes (connect transfer line to the PRT assembly) before driving probe to provide a much more trouble-free installation (that is, fewer leaks). Install probes with the transfer line in place using a slotted drive cap and slotted pull cap (Figure 2-1).

FIGURE 2-1
Assembled Soil/Gas Probe (Ready for Installation)

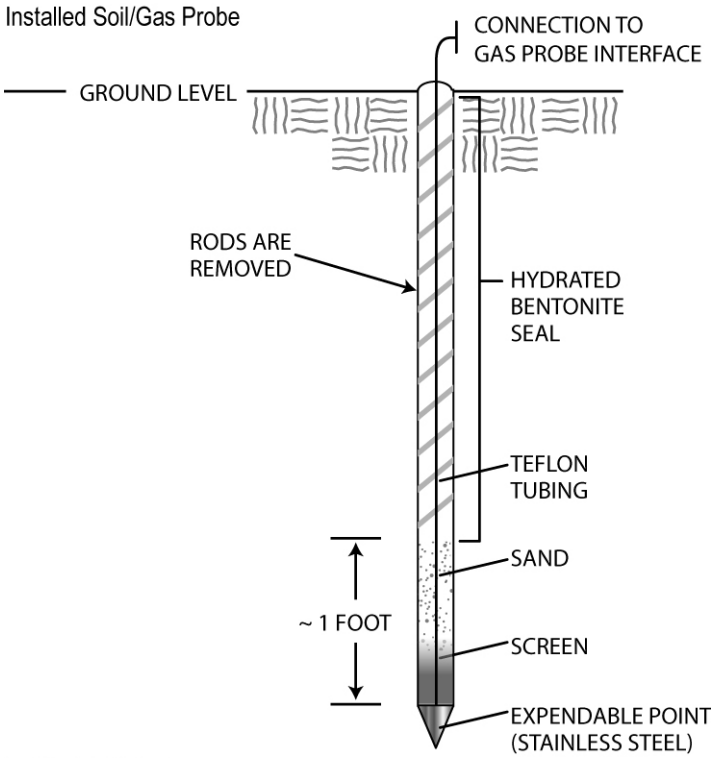


2.2.2.2 Procedures

The following procedures should be used for gas probe installation:

- Install soil gas probes using the "direct push" method using a machine specifically designed for this purpose. Operation of direct push machinery shall be performed only by personnel trained in its use.
- Drive the probes to 6 feet (ft) below ground surface (bgs).
- Remove the rods, leaving Teflon tubing connected to the stainless steel disposable tip. Removal of the probes is to be conducted by trained personnel using the direct push machinery.
- Pour clean sand down the borehole to fill approximately 1 ft with sand (estimated volume 2 cups of sand).
- Add bentonite slurry into borehole to form an air-tight seal around the tubing. Figure 2-2).

FIGURE 2-2
Installed Soil/Gas Probe



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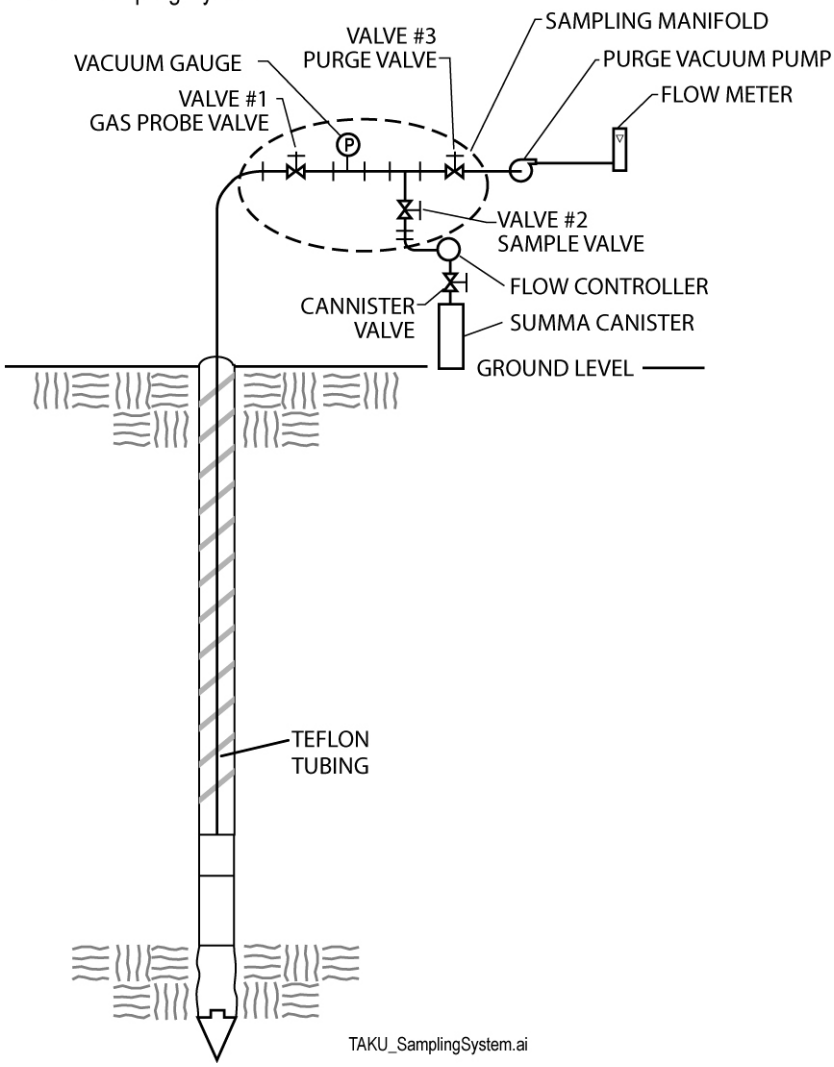
2.2.3 Sample Collection

2.2.3.1 System Setup

System setup will include the following:

- Acquire all the necessary hardware and sampling equipment shown in Figure 2-3.
- Assemble or obtain the necessary fittings and vacuum gauge to create a soil gas probe and sampling manifold, as shown in Figure 2-3. This manifold must be clean, free of oils, and flushed free of VOCs before use. Only gas tight fittings, such as Swagelok or equivalent, should be used.

FIGURE 2-3
Soil Gas Sampling System



- Summa canisters are pre-evacuated by the laboratory. In some cases (that is, project-specific QA) the vacuum will need to be verified in the field before use. This is accomplished with a vacuum gauge and instructions supplied by the laboratory.

Use flow regulators supplied by the laboratory to control the flow of soil gas into the canister. A flow rate of 200 milliliters (mL) per minute will be used. Residual vacuum will be left in the canister for the lab to verify that no leaks occurred. The specified analysis will be VOCs by method TO15.

2.2.3.2 System Leak Checking and Purging

The following steps will be taken for system leak checking and purging:

- Sampling System Assembly: Make sure the sampling system is assembled (Figure 2-3). The leak check enclosure is placed over the sample probe before connection of the sample line to the sampling manifold and the purge system. Do not connect the canister at this time.
- Physical Leak Check: Perform a leak check of the sample manifold system by:
  - Making sure the gas probe valve (valve #1) is closed, and the sample valve (valve #2) is open.
  - Opening the purge valve (valve #3), and starting the purge pump.
  - Closing the sample valve (valve #2), and achieving a vacuum gauge reading of 10 inches of mercury (Hg) or to a vacuum that will be encountered during sampling, which ever is greater.
  - Closing off the purge valve (valve #3), turning off the purge pump, and observing no loss of vacuum within the sampling manifold system for a period of 30 seconds to ensure a leak-free system. Repair any leaks before use.
  - Recording the leak check date and time on the field sampling log (Appendix C).
- System Purge: A purge of the soil gas probe and sampling manifold system is required. This is accomplished by the following:
  - Purging is conducted by pulling soil gas through the system at a rate of between 150 mL per minute for a time period sufficient to achieve a purge volume that equals at least 3 dead volumes (internal volume of the in ground annular space, sample line, and sampling manifold system). For the 6–ft sample depth, a 10-minute purge is a conservative duration for purging.
  - Opening the sample valve (valve #2) and the purge valve (valve #3), and starting the purge pump.
  - Starting the soil gas probe purge by opening the gas probe valve (valve #1), and closing the sample valve (valve #2) at the same time, and then starting timing.
  - Closing the purge valve (valve #3), and monitor the vacuum in the manifold and probe if the vacuum gauge reads greater than 15 inches during the purge. If there is no significant change after a minute, then there is the lack of a significant amount of

soil gas, and the vacuum is too great to take a soil gas sample. Several things can cause this, as follows (consult with the project manager, and take corrective action):

  - The soil formation is too "tight" (that is, high clay or moisture content). Try a different depth or location.
  - With a GeoProbe-style probe system, the expendable tip may not have released when the probe was retracted. Try retracting the probe a little further, or using a long thin rod to poke the tip loose.
  - If water is visible in the flexible soil gas tubing, stop the purging immediately. It is not possible to take a soil gas sample at that depth or location.

- Closing the purge valve (valve #3) at the end of the predetermined purge time (10 minutes) and after the system is verified to be leak free. Do not open it again. Doing so will result in loss of the purge integrity and requires repurging.
- Recording the purge date, time, purge rate, leak check result, and purge volume on the field sampling log (Appendix C).
- Immediately moving on to the sampling phase. Little to no delay should occur between purging and sampling.

2.2.3.3 Sampling

Sampling procedures include the following:

- Verify that Summa canisters are certified clean and evacuated by the laboratory to near absolute zero pressure. Care should be used at all times to prevent inadvertent loss of canister vacuum. Never open the canister's valve, unless the intent is to collect sample.
- Attach the canister to the flow restrictor, and then connect the flow restrictor to the sample valve (valve #2) on the sampling manifold.
- Confirm that the sampling system valves are set as follows before taking the sample: (1) the purge valve (valve #3) is confirmed to be closed, gas probe valve (valve #1) is open, and (2) the sample valve is (valve #2) is open.
- Slowly open the canister's valve approximately one full turn.
- Close the sample valve (valve #2) and the canister's valve after sampling for the appropriate amount of time (determined from the flow controllers sent with the canisters). Remove the canister from the sampling manifold.
- Record the sampling date, time, canister ID, flow controller ID, remaining canister vacuum, analytical method, and any other observation pertinent to the sampling event on the field sampling log (Appendix C).
- Fill out all appropriate documentation (sampling forms, sample labels, chain of custody [COC], sample tags).
- Disassemble the sampling system.
- Refer to specific canister sampling instructions for details on tubing connections (Appendix D).

2.2.3.4 Sample Handling and Shipping

Sample handling and shipping will include the following:

- Pack the sample canisters in a rigid wall shipping container, such as a cooler or heavy-duty cardboard box (ice is not required) if shipping is required. Never pack the cans with other objects or materials that could cause punctures or damages.
- Place a custody seal over the openings to the shipping container.
- Ship immediately to the laboratory for analysis.

2.3 Surface Soil Sampling Procedures

2.3.1 Surface Soil

2.3.1.1 Discrete Sampling Approach

Discrete surface soil sampling will be conducted using a decontaminated stainless steel hand auger to collect a sample over the 0 to 2 ft bgs interval. Volatile samples, if collected, will be collected directly out of the hand auger bucket using lab-specified equipment (such as Easy Sampler™ soil sampler) for both medium-level and low-level analysis. Medium-level analysis will be collected in the same container with the AK101 sample by extruding 30 to 50 grams of soil into a 4-ounce (oz) jar and preserving with the prespiked methanol. The lab-provided methanol pump should be used to cover the soil. Note: Wear safety glasses when using the methanol, it may be under pressure. Record how much methanol was used to preserve each sample, and mark the level of methanol on the outside of the jar. The laboratory uses this to quantitate detectable target analytes. Low-level analysis will be collected by extruding 5 grams of soil into each of two 40 mL volatile organic analyte (VOA) vials pre-preserved with 1 gram of sodium bisulfate/5 mLs of water.

For nonvolatile samples, empty the contents of each hand auger from 0 to 2 ft bgs into a stainless steel bowl. Mix the soil in the bowl so it is all represented uniformly in the bowl, then fill the sample jars using a stainless steel spoon or clean gloved hand.

The hand auger must be decontaminated between sample locations using procedures described in the Equipment Decontamination section. Equipment rinsate blanks will be collected to ensure no cross-contamination, described in the Field Quality Control Sample section.

2.3.1.2 Multi-Increment Sampling Procedures for the Sound Berm

Multi-increment (MI) surface soil sampling will be conducted on the Sound Berm as a risk-screening tool. If MI results exceed the risk screening criteria, then discrete samples will be collected. A decision tree for use of the MI sample data is included in the RI Work Plan.

The decision units or “exposure areas” are sections of the Sound Berm. Each decision unit will have an MI sampling grid that will be 10 cells long and 3 cells wide, yielding 30 incremental sample locations. The grid cell length should be one-tenth of the length of the decision unit, and the grid cell width should be approximately one-third of the soil berm width. An example grid for a 250-ft long decision unit is shown in Figure 2-4.

FIGURE 2-4
Example MI Sampling Grid[1]

Columns	Rows	1		2		3		4		5		6		7		8		9		10		
		25		25		25		25		25		25		25		25		25		25		250 Total Length (ft)
		A	B	A	B	A	B	A	B	A	B	A	B	A	B	A	B	A	B	A	B	Side of
1	12	C	D	C	D	C	D	C	D	C	D	C	D	C	D	C	D	C	D	C	D	Sound Berm
		A	B	A	B	A	B	A	B	A	B	A	B	A	B	A	B	A	B	A	B	Top of
2	12	C	D	C	D	C	D	C	D	C	D	C	D	C	D	C	D	C	D	C	D	Sound Berm
		A	B	A	B	A	B	A	B	A	B	A	B	A	B	A	B	A	B	A	B	Side of
3	12	C	D	C	D	C	D	C	D	C	D	C	D	C	D	C	D	C	D	C	D	Sound Berm

total width (ft) = 36

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Notes
[1] Length and width of each decision unit varies

Each grid cell is divided into quadrants (marked A, B, C, and D). For 8 of the 9 decision units, the incremental samples will be collected from the same quadrant in each decision unit. The quadrant that is sampled will vary randomly between decision units. A roll of the dice will be used to select the quadrant that is sampled in each MI sample area (1 equals quadrant A, 2 equals quadrant B, 3 equals quadrant C, 4 equals quadrant D, a roll of 5 or 6 should be rerolled until you get a 1 through 4 value). After determining which quadrant is to be sampled, locate the approximate center of that quadrant, and use it as the first sampling point and as a point of origin to lay out the remaining sample locations. Drive a stake or piece of rebar into the ground at the origin, attach a cloth measuring tape to the rebar and stretch the tape out, and mark the remaining sample locations along that row of cells. Measure perpendicular to the origin, and mark the origin for the second and third rows of samples and repeat. Mark the sample locations with survey lath or pin flags. Start collecting the incremental samples.

Triplicate samples will be collected and analyzed at 10 percent of the decision units in accordance with the ADEC *Draft Guidance on Multi-Increment Soil Sampling* (Appendix E). For the Sound Berm, this means one triplicate sample in Decision unit 9. A roll of the dice will be used to select alternate sample quadrants within each cell; duplicate and triplicate samples may not be taken from the same quadrant.

The incremental samples will be taken from the top and sides of the Sound Berm. Any grass or surface organic layer will not be included in the sample. Soil samples will be collected to provide a representative soil column within the 0 to 2 ft depth using a 3-inch diameter, stainless steel, hand auger bucket.

For MI sampling for non-volatiles, a bulk soil sample of the entire 3-inch column (e.g. the 3-inch hand auger from 0-24 inches or approximately 60 grams of soil per decision unit) will be coarse screened with a 6-millimeter (mm) (0.25-inch) sieve and this entire sample will be shipped to the laboratory. The laboratory will sieve (#10 sieve to 2-mm size), subsample, and distribute through the lab for analysis. For MI sampling of metals, the laboratory will digest 10 grams of sample to achieve a fundamental error requirement of less than 15. percent.

For MI sampling for volatile samples (VOC and gasoline-range organic [GRO]), the samples will be collected in the field at the 2-ft depth; no sieving is permitted. For 30 subsamples, 1 to 2 grams must be collected from each incremental sample and put into the same 4-oz jar. The entire initial aliquot of methanol must be in the sampling jar prior to the addition of the soil increments. Lab-provided syringes will be used to collect 1 mL of sample

(approximately 1 gram) from each incremental sample location. Care should be taken so no spillage or splashing occurs as the samples are added. The soil must be completely submerged in methanol, if additional methanol is added it must be properly documented in the COC. At completion, 30 grams of soil and approximately 30 mLs of the prespiked methanol will be in the 4-oz jar. Sample jars should remain upright to prevent leakage. The level of methanol may be marked to indicate if spillage occurred.

2.3.1.3 Multi-Increment Sampling Approach for Soil Piles

MI sampling will be conducted on soil piles to characterize the piles for off-site disposal at the Fort Wainwright Landfill or via DRMO. If the 95 percent upper confidence limit calculated from each MI result exceeds the Fort Wainwright Landfill disposal criteria, then the pile(s) will be sent to DRMO for appropriate offsite disposal.

There is significant size difference between the soil piles. Therefore, some of the smaller soil piles located close to each other are grouped together into one decision unit. Larger soil piles are divided into more than one decision unit. Volume of soil piles, grouping of piles into decision units, and proposed analyses are specified in the RI Work Plan (see RI Work Plan Addendum #2, final).

MI sampling will be conducted per ADEC guidance (Appendix E), with specifics as identified in RI Work Plan, Addendum #2 Soil Piles. Both surface and subsurface samples will be collected from each pile as specified in the RI Work Plan, Addendum #2.

Immediately following sample collection, the incremental hand auger holes will be closed by pushing surrounding soil into the hole.

Soil remaining after sampling will be returned to the ground surface of the decision unit.

2.3.2 Sediment Samples

Sediment samples will be collected as grab samples from the sediment in the drainage swale. The samples will be collected with a stainless steel hand trowel or equivalent equipment. A hand shovel may be used, if necessary, to expose a fresh or representative surface for sampling.

Samples to be analyzed for volatile components will be collected first and quickly placed into the designated sample container. Samples to be analyzed for all other analytes will then be placed in the appropriate containers.

Sample containers will be filled, as required by the analytical method. Reference Section 2.3.1 of this FSP for specific sample procedures related to collection of volatile analyses. Prevent soil from remaining in the lid threads before being sealed to prevent potential contaminant migration from the sample. Place samples in an upright position to prevent leaking. Pertinent observations made during sampling, such as the presence of odor or staining, will be recorded in the field logbook.

2.4 Subsurface Soil Sampling Procedures

2.4.1 Utility Clearance

Utility clearance for subsurface soil sampling will be performed as presented in Section 2.2.1 of this FSP.

2.4.2 Hollow-Stem Auger Soil Borings

Soil borings will be drilled with a truck-mounted drill rig using hollow-stem auger drilling methods. Oil, grease, or other threading compounds will not be used on any tools that enter the borehole.

Split-barrel sampling will be performed following the procedures described in American Society for Testing and Materials (ASTM) D1586-99 (Appendix F). Soil samples will be collected with 3-inch outside diameter (OD), split-barrel samplers driven with a 140- or 300-pound hammer. Because soil samples will be collected for chemical analysis, they must be obtained with split-barrel samplers that have been decontaminated following the procedures specified in Section 2.8 of this FSP. Wells will be abandoned as outlined in Section 2.5 of this FSP.

2.5 Monitoring Well Installation and Groundwater Sampling

2.5.1 Utility Clearance

Utility clearance for groundwater monitoring well installations will be performed as presented in Section 2.2.1 of this FSP.

2.5.2 Sampling Procedures

2.5.2.1 Monitoring Well Installation

Monitoring wells will be installed using a truck- or all-terrain-vehicle-mounted drill rig and hollow-stem auger methods. Installation methods will comply with *Recommended Practices for Monitoring Well Design, Installation, and Decommissioning* (ADEC, 1992) (Appendix G). The typical monitoring well casing will be constructed of a minimum 2-inch-diameter (2.375-inch-OD by 2.067-inch-inside diameter), Schedule 40, flush-joint threaded, polyvinyl chloride (PVC) pipe. The screen will be a 10-ft-long, prepack screen with slot sizes appropriate for the site geology. Well screens will bridge the water table so that approximately 5 ft of screen is submerged. Casing and screen sections will be coupled with threaded joints; PVC solvent or glue will not be used. Monitoring well construction details for shallow water-table wells are shown in Figures 2-5 and 2-6.

When the borehole has been augered to the bottom depth of the well, a prepacked well screen and a sufficient length of riser pipe capable of reaching above the ground surface will be lowered through the augers to the bottom of the boring. Clean, fine sand will be added as the augers are removed, if the borehole is not collapsing completely.

Once the augers have been withdrawn to the top of the screened interval, clean, fine sand will be added very slowly and tamped, if possible, to fill in any remaining voids. The sand will be added until 1 to 2 ft covers the top of the well screen. When sufficient sand has been placed, 1 to 2 ft of bentonite chips or pellets will be installed as a seal. The bentonite will be hydrated, as necessary, with a minimum amount of clean, potable water. Above the bentonite seal, the borehole annulus will be backfilled with either clean cuttings (defined as cuttings with a headspace reading of less than 20 parts per million [ppm] on a PID) or a bentonite grout up to about 5 ft bgs.

From 5 to 3 ft bgs, a second bentonite seal should be placed. After this second bentonite seal has been hydrated, the protective casing (if an aboveground well is installed) will be set into

the bentonite seal. The well riser will be cut off to stand 2 ft above the ground surface. The top of the protective casing should extend 6 inches above the top of the riser. A 6-inch block may be set on top of the riser to hold the protective casing (with locking lid on) in place. Cement/bentonite grout will then be poured between the borehole annulus and the outside of the protective casing from 3 ft bgs upward. The grout will extend to the surface and become part of a surface pad, whose form shall already be placed (minimum 2-ft diameter and dug 4 inches into the ground).

A reference point on the top of the PVC casing (used as the water-level elevation reference) will be marked with a cut notch and permanent ink. Well completion details will be recorded by field personnel in the field logbook and on a Well Installation Diagram form (Appendix C).

2.5.2.2 Well Development

Newly constructed wells will be developed before being sampled to remove fines from the borehole, enhance the flow of formation water through the well, and provide water samples with a minimal amount of suspended solids. Wells will be developed by surging and pumping using a surge block and a submersible pump. During the development process, groundwater turbidity will be monitored.

The following instructions describe the techniques for developing monitoring wells:

- Record the water level and total depth of the well using a water-level indicator. Note any accumulated sediment thickness, and record all information in a logbook.
- Remove approximately 1 to 2 pints of water from the well with the submersible pump or disposable bailer. Measure turbidity.
- Remove sediment from the bottom of the well by lowering the pump or bailer slowly into the well so that the pump or bailer intake is within 1 to 1.5 ft of the bottom of the well or measured sediment accumulation. Slowly raise and lower the bailer or pump (with the pump motor off) to create a mild surging effect at the bottom of the well. This will bring any sediment that has settled at the bottom into suspension. Do not agitate the water violently. A general rule for well development is to start slowly and gently and to gradually increase agitation as the well is developed. After several surge strokes, remove the bailer or turn the pump on, and pump out the sediment-laden water. Repeat this process until the accumulated sediment has been removed.
- Develop the well from the bottom of the screened interval upward by alternately using the surge block and the bailer or pump. This will account for settlement that will occur as the filter pack is reworked as a result of surging. Raise and lower the surge block for 2 to 3 minutes, starting roughly 2 to 3 ft above the base of the screen. Remove the surge block and lower the pump so that the intake is 2 to 3 ft above the base of the screen. Turn the pump on and remove water until it becomes clearer, or gently remove several bailers of water. Record turbidity for each staged interval and continue surging and pumping until to within 10 percent or 5 nephelometric turbidity units (NTUs).

As the turbidity stabilizes and the clarity of the water improves, the surge block can subsequently be moved up in 2- to 3-ft intervals, and the process repeated until the entire screened interval has been developed, after which time pumping should continue at a rate

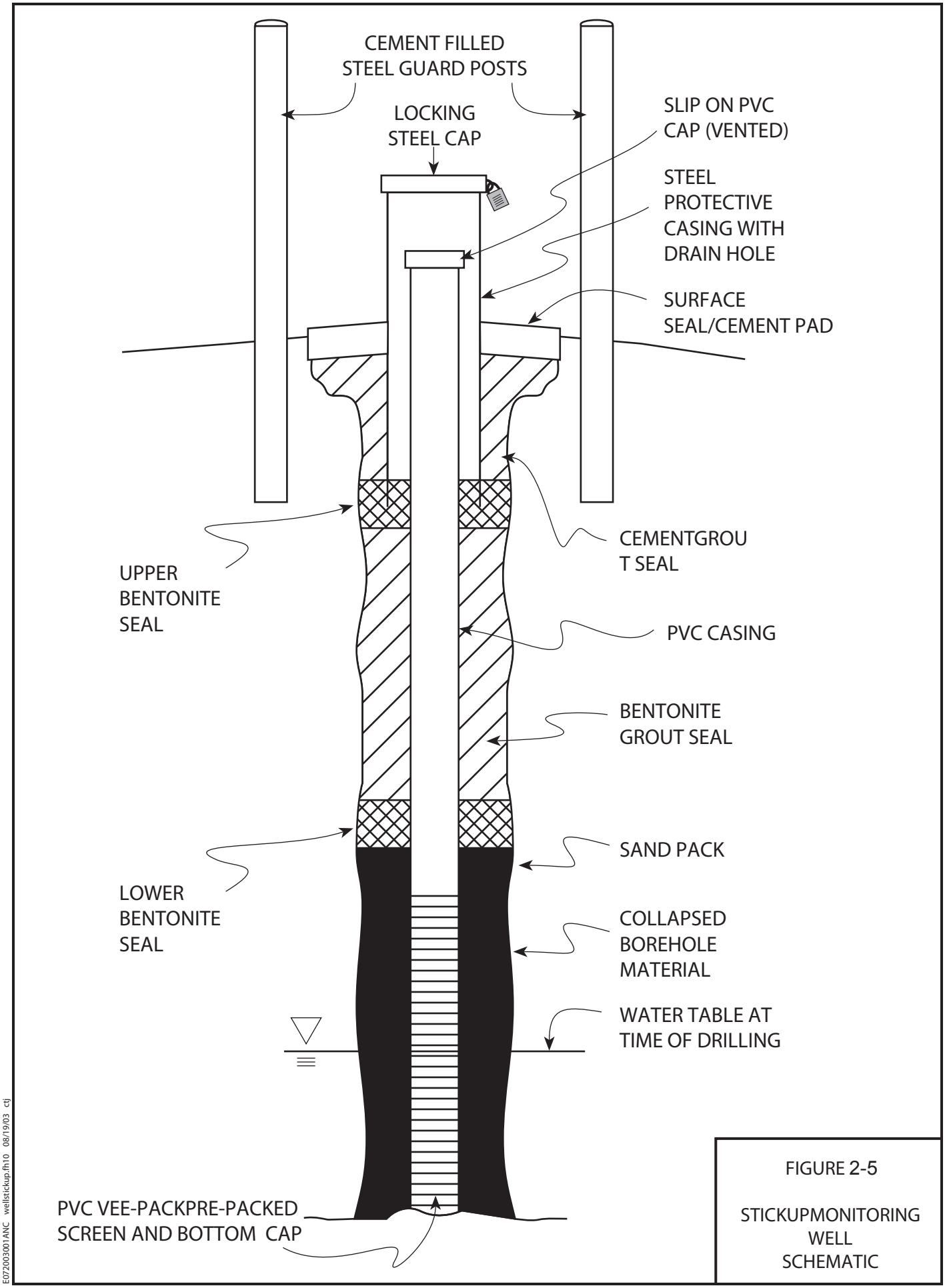

FIGURE 2-5

STICKUPMONITORING
WELL
SCHEMATIC

E072003001ANC wellstickup.fh10 08/19/03 ctj

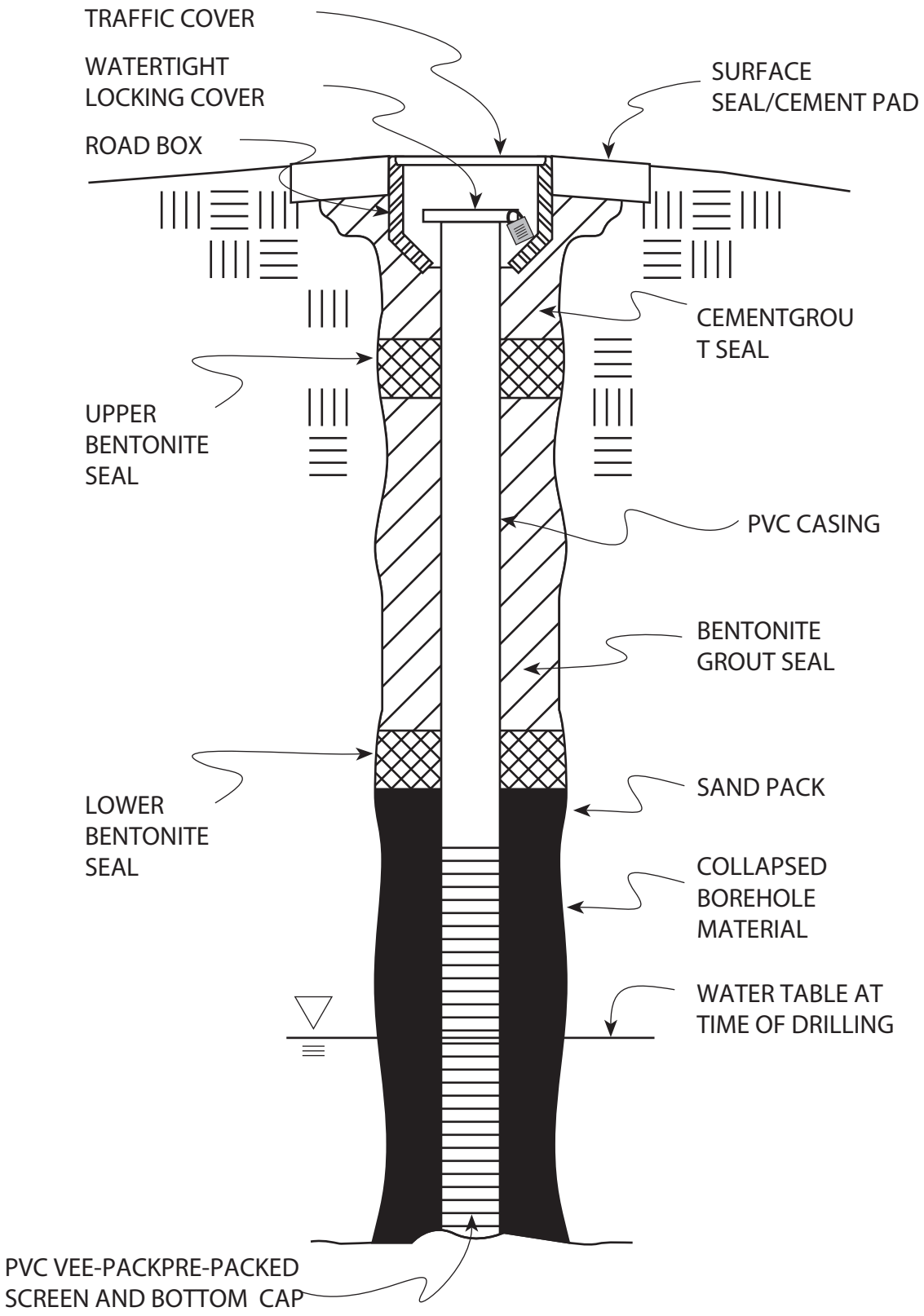

FIGURE 2-6

FLUSHMOUNT MONITORING WELL SCHEMATIC

E072003001ANC wellflush.fh10 08/19/03 ctj

intended to avoid dewatering the screened interval, with turbidity recorded at regular intervals.

After surging, the well should be pumped until 10 well volumes of water are removed or until turbidity has stabilized, as previously discussed. All well development data will be recorded on a Well Development Log form (Appendix C).

2.5.2.3 Groundwater Sampling

Monitoring wells shall be sampled after development using an electric submersible pump or peristaltic pump in accordance with ADEC regulations, and applicable U.S. Army Corps of Engineers (USACE) engineering manuals using the low-flow sampling technique recommended by the Environmental Protection Agency (EPA) (EPA/540/S-95/504, April 1996).

The low flow "minimum aeration" method is the preferred purge method and is expected to be used for purging all wells at the FCS. Details regarding the pumping method, parameter readings, purge volumes, and samples collected should be recorded in the field logbook and on a Well Purge and Sampling Field Sheet (Appendix C). Backup water quality field monitoring equipment (such as dissolved oxygen [DO] meters) will be provided in case of equipment malfunction.

Low Flow "Minimum Aeration." This method emphasizes minimal stress to the groundwater by low water-level drawdown and low pumping rates to collect samples with minimal alterations to water chemistry (EPA, 2002) (Appendix F, ASTM D6771-02). This is the preferred method for natural attenuation monitoring, which requires careful measurements of DO and redox-sensitive analytes, such as iron and manganese.

Wells are purged and sampled using a submersible or peristaltic pump and disposable sampling tubing. The pump intake should be placed approximately at the midpoint of the saturated screen length. The well should be purged at a low flow rate (usually less than 1 liter per minute), such that the purging rate does not lower the water level more than 0.3 ft. The purging rate can be controlled, as needed, using the pump's variable speed flow controller. The water level should be measured frequently during purging to ensure that the water level has not dropped lower than desired.

During purging, pH, electrical conductivity, oxygen-reduction potential, turbidity, and DO will be measured with probes in a flow-through cell. Field personnel should monitor for air bubbles in the tubing and particulate buildup within the flow-through cell, as this may affect DO, redox, and turbidity measurements. Indicator parameters and water-level measurements should be recorded in a field notebook or well sampling forms every 3 to 5 minutes. Purging is complete once the parameters have stabilized to within the ranges presented in Table 2-1 for three consecutive readings.

TABLE 2-1
Criteria for Stabilization of Indicator Parameters During Purging

Field Parameter	Stabilization Criterion
pH	+/- 0.1 pH units
Specific Electrical Conductance	+/- 3 percent Siemens per centimeter
Oxygen-Reduction Potential	+/- 10 millivolts

TABLE 2-1
Criteria for Stabilization of Indicator Parameters During Purging

Field Parameter	Stabilization Criterion
Turbidity	+/- 10 percent NTUs (for values greater than 10 NTU)
Dissolved Oxygen	+/- 0.3 milligrams per liter

Source: EPA, 2002.

NTU = nephelometric turbidity unit

Once parameters have stabilized, water samples for laboratory analysis should be collected without altering the flow rate or interrupting the flow. VOC analytes should be collected first. The samples should be collected from the pump discharge before water has passed through the flow-through cell or beaker. Sample containers should be filled by allowing the pump discharge to flow gently along the inside wall of the container to minimize turbulence.

Stabilization of water quality parameters is the primary criterion for sample collection by this method. If parameter stabilization is not occurring and the procedure has been strictly followed, the field team leader may elect to collect the sample after a minimum of three or maximum of six casing volumes have been removed (EPA, 2002).

2.5.2.4 Monitoring Well Labeling

Permanent monitoring wells will receive USAEC AP numbers. The field manager will submit the surveyed well logs to the USACE geotechnical contact Marcus Palmer: (907) 753-2665, to get the AP number for the well.

2.5.2.5 Well Abandonment

Temporary monitoring wells will be installed under the scope of the RI. These wells will be installed and developed identical to permanent monitoring wells (that is, prepacked screens). Upon completion of the RI, all temporary monitoring wells that are not made permanent will be abandoned according to the procedures below.

Boreholes and monitoring wells may be abandoned by sealing in place using grout or by removing or drilling out the well riser and sealing the remaining borehole. Surface casings may be abandoned by similar means. Well abandonment will be performed according to procedures outlined in *Recommended Practices for Monitoring Well Design, Installation, and Decommissioning* (ADEC, 1992) (Appendix G).

2.6 Water-Level and NAPL Surveys

Water levels in each well and in selected groundwater probes will be measured with an electronic sounder. Water levels will be documented in the field logbook. For a water-level survey, all water levels in a sampling area will be measured on the same day. The following protocol will be employed while collecting water-level data:

- An electronic sounder will be used to measure water levels in all wells and groundwater probes; an electronic interface probe will be used to measure water levels and the

thickness of free product in those wells and groundwater probes where free product is anticipated.

- That portion of the probe cable submerged below fluid levels in wells will be cleaned according to the decontamination procedure described in Section 2.8, Equipment Decontamination, of this FSP.
- Interface probes and electronic sounders will be kept clean and will be maintained in accordance with manufacturer's instructions.
- A permanent mark at the top of the PVC well casing groundwater probe will serve as the point of reference for water-level measurements in that well or probe.

If odors, staining, sheen, or nonaqueous phase liquid (NAPL) are encountered, thickness of NAPL will be measured with an oil/water interface probe. Thickness of NAPL will be recorded in the field logbook and entered into the field database.

2.7 Civil Surveying

The following general site survey standards will be applied. All surveys will be fully documented and geo-referenced using WGS84 UTM Zone 6N Coordinate System, with elevations to the NAVD88 vertical datum.

2.7.1 Topographic Survey

A topographic survey will be conducted on the existing surface of the site to evaluate areas where additional cut or fill will be required to reach final grade. Horizontal Control work will be done using either standard surveying techniques or Global Positioning System (GPS) techniques. If standard surveying techniques are used, all horizontal control work will comply with Third Order Class I, as outlined in the FGDC *Geospatial Positioning Accuracy Standards, Part 4: Standards for Architecture, Engineering, Construction (A/E/C), and Facility Management*. If a global positioning system (GPS) is used, the relative horizontal accuracy shall conform to the *FGDC Geospatial Positioning Accuracy Standards, Part 2: National Standard for Spatial Data Accuracy*. The surveyor will provide coordinates of all points X, Y, and Z to the nearest .01 ft. The topographic survey will be tied to existing control monuments at the site.

Daily information will be recorded in field book format, and any data collector information will be provided All level and horizontal traverse networks shall be closed to the starting point and the errors recorded. If the errors are higher than the standards previously outlined, the surveyor shall rerun the horizontal and vertical traverses until the errors are eliminated within the acceptable range. Field notes shall include the date, names of the crew, weather conditions, barometric pressure, and all collected survey data information.

2.7.2 Survey of Sample Locations

Differentially corrected GPS measurements will be used to record soil and soil gas sample locations to submeter accuracy.

Coordinates and elevations of all newly installed monitoring wells will be surveyed. Well elevations will be surveyed at the top of the PVC riser pipe and at the ground surface. The

elevations at each monitoring well must be tied directly to the primary control using differential leveling techniques and reported the nearest 0.01 ft.

A survey base map will be prepared for the entire project limits and shall include the following information:

- Project Control
- Soil borings, monitoring wells, geologic features and infrastructure
- Horizontal and vertical control statement
- Projection/coordinates table, scale, units, source

2.8 Equipment Decontamination

Decontamination of sampling equipment must be conducted consistently to ensure the quality of the samples collected. All equipment that comes into contact with potentially contaminated samples will be decontaminated. Disposable equipment intended for one-time use that is factory wrapped generally does not need to be decontaminated before use, unless evidence of contamination is present.

2.8.1 Sampling Equipment

Media sampling equipment, including split-barrel samplers, bailers, spoons, trowels, and pumps used to collect samples for chemical analyses, will be decontaminated before each use. The decontamination procedure will consist of the following steps:

- Nonionic detergent wash
- Potable water rinse
- Distilled/deionized water rinse
- Air drying
- Wrapping sampler in new aluminum foil (shiny side out)

Exterior surfaces and accessible interior portions of submersible, centrifugal, and bladder pumps will be cleaned before each use, using the previously mentioned steps. Pumps, however, will not need to be wrapped in aluminum foil.

The wastewater from the decontamination activities will be disposed of according to the methods described in Section 2.9 of this FSP.

2.8.2 Field Measurement Equipment

Decontamination and cleaning of the PID, flow-through cell, and other field equipment will be performed in accordance with the manufacturer's instructions. At the end of each day, and when otherwise deemed necessary (that is, contact with potential contaminants), the instrument will be cleaned and decontaminated.

2.8.3 Personnel

Personnel decontamination shall be completed as detailed in the Site Safety and Health Plan.

2.8.4 Heavy Equipment

All equipment will undergo dry, gross decontamination, including removal of potentially contaminated materials by use of a shovel or other hand tools and stiff bristle brushes.

2.8.5 PCB Exclusion Zone

For materials from the polychlorinated biphenyl (PCB) exclusion zone, decontamination will take place using the following procedures

- Bag gloves, booties and coverall, and dispose in containers of contaminated soil leaving the site.
- Wash boots, if soil contaminated.
- Clean field equipment (drill augers, sampling equipment) using dry methods to minimize liquid waste. Follow up with Alconox/water mixture. The wastewater from the decontamination activities will be containerized, sampled, and results forwarded to DRMO with the containerized water for proper disposal.

2.9 Investigation-Derived Waste (IDW)

Investigation-derived waste (IDW) generated during this investigation will include general refuse, soil cuttings, groundwater retrieved during well development and sampling activities, and decontamination wastes, including wash water, plastic sheeting, etc., as well as a variety of waste items that could be removed from test pits or debris piles for investigatory purposes. In general, wastes or environmental media (soil or groundwater) that are suspected or known to be contaminated will be left onsite where they are found. Removal of contaminated soil or water for other than investigatory purposes is not authorized under this project. However, when the Remedial Project Managers (RPMs) determine that it is not practical or safe to return material to where it was found (such as large quantities of scrap steel), the material may be removed and handled as waste. Table 2-2 summarizes the anticipated waste streams and disposal paths.

The following are important details for handling IDW at the FCS:

- All IDW must have covered storage with the FCS (such as tarping)
- All IDW that exceeds ADEC/EPA levels will be processed through DRMO/Environmental Compliance Consultant (ECC) and must have validated laboratory analyses for each container. CONTRACTOR will be responsible for characterizing all waste, filling out manifests, profiles, and coordinating disposal activities with ECC/DPW, Fort Wainwright.

All containers will be labeled with a unique number and must have the CONTRACTOR point of contact name and phone number on the container. See additional labeling instructions in Appendix H. Because there is no knowledge at this site that indicates the generated wastes will exhibit a hazardous characteristic or will contain listed wastes, all wastes generated during these investigatory activities will be initially considered to be nonregulated IDW in accordance with existing DPW environmental office procedures. Potentially hazardous waste will be containerized (such as 55-gallon drums, over-packs, and supersacks) or otherwise secured, as directed by the installation environmental office.

TABLE 2-2
Anticipated Waste Streams and Disposal Paths

Waste Stream	Disposition
Refuse	All general refuse (e.g., paper towels, plastic sheeting, paper, etc.) not having the potential to contain hazardous material will be placed in the dumpster and disposed as municipal waste.
PPE	PPE will be placed in containers for disposal as nonregulated waste, unless it was generated within a known area of contamination, in which case it will be placed in a container with similar contaminants for disposal.
Debris	Debris (e.g., scrap metal, wood, concrete, asphalt, rubber, etc.) encountered during the investigation will be visually examined during the RI. Debris will be transported to the installation landfill for disposal.
Asbestos Containing Material (ACM)	ACM or potential ACM that is encountered will be handled only by personnel qualified to handle asbestos in Alaska. The material will be properly bagged, labeled, manifested, and transported by CONTRACTOR to the installation landfill for disposal.
OE Scrap	OE scrap will be certified for disposal by qualified personnel in accordance with applicable regulations and transported by CONTRACTOR to Fort Wainwright landfill for disposal.
Wastewater	Wastewater from decontamination operations, well development, groundwater sampling, etc., will be containerized and managed onsite until analytical results are available after which, it will be transferred to the installation environmental office for proper disposal.
Waste Items	Waste items that are identifiable (e.g., labeled containers, light ballasts, gas cylinders, batteries, etc.) will be transferred to the installation environmental office for proper disposal. Unknown waste material will be identified by analytical testing or other means before it is transferred to the Army's Environmental Staging Facility (i.e., DRMO).
Soil	Soil encountered during excavation, drilling, or other operations, will be replaced to the location from which it originated (e.g., soil piles onsite, test pit excavations, boreholes, etc.). If obviously contaminated soil is encountered, (high PID readings, staining, etc.), the soil will be containerized, analyzed, characterized, and delivered to DRMO for disposal.

PID = photoionization detector
PPE = personal protective equipment
RI = remedial investigation

CONTRACTOR is responsible for identifying all wastes. CONTRACTOR is responsible for making hazardous waste determinations, complete disposal facility profiles, hazardous waste manifests, as well as arranging for transportation and disposal.

North Wind, Inc. (NWI), the current IDW facility contractor, will be called at least 24 hours in advance to schedule IDW dropoff at the Army's Environmental Staging Facility located at the southeast corner of the intersection of Warehouse Road and the Davis Highway, Building # 3489B. The NWI contact at the IDW facility is Dan McGauhey (907) 441-7750. NWI personnel handle documentation of the IDW delivered to the facility.

After receipt of validated analytical data and waste determination, IDW soil is transported to DRMO and left on pallets. IDW water is transported to DRMO in temporary containers and offloaded into the facility's treatment system.

IDW NAPL is generally handled by ECC. Upon notification of the production of NAPL, DPW personnel can schedule ECC to pick up NAPL IDW.

Other IDW, such as personal protective equipment (PPE) and sampling materials, will be disposed of as nonregulated waste. Additional guidance on the handling/management of contaminated soil, and prohibitions for the Fort Wainwright Landfill are included in Appendix H.

2.10 Field Quality Control Samples

Quality control samples will be collected to monitor accuracy, precision, and the presence of field contamination for definitive analytical methods to be performed by the contracted primary laboratory. All field QC samples will be sent double-blind to the laboratory along with regular field samples. They will be labeled similar to regular field samples to disguise them.

Performance evaluations (PE) of the primary laboratories using performance evaluation samples will be done exclusively by USACE at a frequency decided by USACE. This will happen early in the project so that a second PE sample can be ordered in case of a failure.

Performance audits quantitatively assess the data produced by a measurement system. A performance audit involves submitting project-specific PE samples for analysis for each analytical method used in the project. The project-specific PE samples are selected to reflect the expected range of concentrations for the sampling program. The performance audit answers questions about whether the measurement system is operating within control limits and whether the data produced meet the analytical QA specifications.

The project-specific PE samples are made to look as similar to field samples as possible and are submitted as part of a field sample shipment so that the laboratory is unable to distinguish between them and project samples. This approach ensures unbiased sample analysis and reporting by the laboratory.

2.10.1 Field Duplicate Samples

A field duplicate is an independent sample collected as close as possible to the original sample from the same source under identical conditions and is used to document sampling and analytical precision. Field duplicates will be collected for subsurface and groundwater samples at a minimum frequency of one per 10 samples (10 percent) for each matrix and for each type of analysis. The sampling locations for field duplicate samples will be recorded in the field logbook.

2.10.2 Field Triplicate Samples

Field triplicates for surface soil will be collected as a requirement of the MI approach. Triplicate samples will be collected and analyzed at 10 percent of the decision units for each type of analysis in accordance with the ADEC *Draft Guidance on Multi-Increment Soil Sampling* (Appendix E). See Section 2.3.1 of this FSP for additional detail for MI triplicate samples. The sample locations for field triplicate samples will be recorded in the field logbook.

2.10.3 Equipment Rinsate Blanks

Equipment rinsate blanks will be collected to evaluate field sampling and decontamination procedures by pouring deionized water over the decontaminated equipment. Equipment rinsate blanks will be collected at a minimum of one per 20 samples (5 percent) each day that sampling equipment is decontaminated in the field. The equipment blanks will be analyzed by the laboratory for the same parameters specified for the corresponding matrix.

2.10.4 Trip Blanks

Trip blanks are used to monitor for contamination during sample shipping and handling, and for cross-contamination through volatile component migration among the collected samples. They are prepared in the laboratory by pouring organic-free water into a volatile component sample container. They are then sealed, transported to the field, stay sealed while volatile component samples are taken, and transported back to the laboratory in the same cooler as the volatile component samples. One trip blank should accompany each volatile component sample cooler.

2.10.4 Matrix Spike/Matrix Spike Duplicate

Matrix spike (MS) and matrix spike duplicate (MSD) samples consist of duplicate field sample aliquots spiked by the laboratory with analytes of concern to evaluate the effects of the matrix on the recoveries of these analytes. The need for MS/MSD samples will be specified on a project basis in the site-specific work plans. When required, MS/MSDs will be collected at the frequency of one per 20 samples (5 percent) of each matrix collected from each site, and designated on the COC for use as MS/MSD samples by the laboratory. The duplicate aliquots for MS/MSD analyses should be collected simultaneously or in immediate succession with the parent sample. They will be treated in exactly the same manner as the parent sample during storage and shipment. The sampling locations for the MS/MSD samples will be documented in the field logbook.

2.11 Sample Documentation and Tracking

2.11.1 Sample Labeling

Sample containers should be received from the laboratory prelabeled with the analysis designation and required preservative. Site- and time-dependent information will be added to the labels with indelible ink. The labels will be protected from water and solvents with clear, label-protection tape. Each label will contain the following information:

- Project name
- Name of collector
- Date and time of collection
- Place of collection
- Sample number
- Preservation
- Method of analysis

Sample identification and tracking procedures will incorporate the sample numbering system outlined in Table 2-3. Field QA and QC samples will be labeled and numbered so that the laboratory cannot distinguish them from other site samples.

TABLE 2-3
Sample Identification System
Examples of Sample Designations

Group	Digit	Item	Example Code
1	1-2	Calendar year	07
2	3-4	General location	Fort Wainwright = FW
3	5	Area designation	A = Area A B = Area B C = Area C D = Area D E= Area E T = Miscellaneous other sites
4	6-7	Sample type	SB = Soil Berm SP = Soil Pile MW = Monitoring well BB = Soil Boring SG = Soil Gas SW = Surface Water SS = Surface Soil IW = Investigation-Derived Waste
5	8-9	Sample number (or monitoring well number)	01, 02, 03...
6	10-12	Sample Depth (optional)	-05, -10, -15….

Note: The sample numbers will be cross-referenced in the field logbook with the associated soil boring or monitoring well number.

2.11.2 Field Logs

The project field supervisor will be required to maintain a field logbook of daily activities. A separate logbook will be used for each project. It will be bound with consecutively numbered pages. All entries will be legibly written in black ink. Any entry errors are corrected by drawing one solid line through the incorrect entry followed by the user's initials and date. The bottom of each page is signed and dated by the individual making the entries. Factual and objective language will be used. All entries will be complete and accurate enough to allow reconstruction of each field activity. Activities should be recorded contemporaneously.

The field logbook cover will include the following information:

- Job name, contract and delivery order numbers
- Site activity name
- Start date
- End date of last logbook entry

Daily entries of the following minimum information will be recorded in the logbook as follows.

- Date and time, expressed in 24-hour (military) format
- Sampling start/stop times
- Weather conditions
- Personnel present
- Level of personal protection
- Field observations
- Site identification (visual sketches where appropriate)
- Location of sampling points (visual sketches where appropriate)
- Description of sample
- Sample identification number
- Number of samples taken
- Time of sample collection
- Number of QA/QC samples taken
- Type of field instrumentation
- Names of people collecting samples
- Decontamination procedures
- Any visitors to site and their level of protection
- All calibrations done
- Any other field instruments
- Any general observations or notes
- Any deviations from the sampling plan

2.11.3 Field Forms

Field forms including test pit logs, boring logs, well installation diagram, well development log, well purge and sampling field sheet, and soil gas sampling data sheet will be used during field work as appropriate. All original field forms will be kept on file.

2.11.4 Photographs

Photographs will be taken in the field to document sampling locations and conditions. Photographs of all samples will be taken with the sample number and depth clearly visible. A photographic log will be kept in which the date, location, and direction the photographer is facing (if appropriate) will be recorded. Photographs and/or slides and their negatives will be labeled, placed in a binder, and submitted at the end of the project.

2.11.5 Documentation Control

Project files will be maintained by the project task manager. Documents will be kept in the project files. Project personnel may keep their own duplicate files; however, all original documents will be placed in the official project file. Field logs of boring, sampling, and well installation activities will be maintained by the field supervisor and submitted to the task manager after the field effort.

2.12 Other Field Procedures

Other field procedures may be used for certain tasks. Information pertaining to those procedures will be provided in FSP addenda.

SECTION 3

Sample Handling and Custody Requirements

3.1 Containers and Preservatives

The primary and QA laboratories will provide the required sample containers for all samples. All containers will have been cleaned and certified to be free of the analytes of concern for the project. No sample containers will be reused. Preservatives, if required, will be added by the primary or QA laboratory before shipment of the sample containers to the field. The adequacy of preservation will be verified by the laboratory upon receipt of the samples, and additional preservative will be added, if necessary.

The containers, minimum sample quantities, required preservatives, and maximum holding times are shown in Tables 3-1 and 3-2. Nonvolatile bulk MI samples will be sent directly to the laboratory, and the laboratory is responsible for subsampling into appropriate sample containers.

TABLE 3-1
Sample Collection Summary–Soil/Sediment

Parameter	Analytical Method[a]	Container[b,c]	Preservative	Maximum Holding Times
Gasoline-Range Organics	AK101	1 x 4-ounce wide-mouth amber glass	Add 25 grams sample to 4-oz jar. Add 25 mLs methanol that is prespiked with surrogate, 4°C (VOC – SW8260 analyzed from same container)	28 days to analysis
Diesel-Range Organics/Residual Range Organics	AK102/AK103	1 x 4- ounce wide-mouth amber glass[d]	4°C	14 days to extraction 40 days to analysis
Extractable Hydrocarbon Speciation	NW EPH	1 x 4- ounce wide-mouth amber glass	4°C	14 days to extraction 40 days to analysis
Volatile Hydrocarbon Speciation	NW VPH	2 x 40-mL VOA vial, septa lid	Add 5 grams sample to 40-mL VOA vial with methanol	14 days to analysis
Metals	SW6010B/SW6020/ SW7000	1 x 4- ounce glass[d]	4°C	28 days for mercury; 6 months for all others
Organochlorine Pesticides	SW8081A	1 x 4- ounce glass[d]	4°C	14 days to extraction 40 days to analysis

TABLE 3-1
Sample Collection Summary–Soil/Sediment

Parameter	Analytical Method[a]	Container[b,c]	Preservative	Maximum Holding Times
Polychlorinated Biphenyls	SW8082	1 x 4- ounce glass[d]	4°C	14 days to extraction 40 days to analysis
Chlorinated Herbicides	SW8151A	1 x 4- ounce glass[d]	4°C	14 days to extraction 40 days to analysis
Volatile Organic Compounds	SW8260B	1 x 4- ounce wide-mouth amber glass	Add 25 grams sample to 4-oz jar. Add 25 mLs methanol that is prespiked with surrogate, 4°C (GRO – AK101 analyzed from same container)	14 days to analysis
Low-level Volatile Organic Compounds	SW8260B	2 x 40 mL VOA vials	Add 5 grams sample to 40-mL VOA vial pre-preserved with 1 gram sodium bisulfate/5 mL water, 4°C	14 days to analysis
Semivolatile Organic Compounds	SW8270C/SW8270C -SIM	1 x 4- ounce glass[d]	4°C	14 days to extraction 40 days to analysis
Dioxins/Furans	SW8290	1 x 4- ounce glass[d]	4°C, store in dark	30 days to extraction 40 days to analysis
Transitional Explosives	SW8321	1 x 4- ounce glass[d]	4°C	14 days to extraction 40 days to analysis
Explosives	SW8330	1 x 4- ounce glass[d]	4°C	14 days to extraction 40 days to analysis

[a]Unless otherwise specified, method numbers refer to U.S. Environmental Protection Agency *Test Methods for Evaluation of Solid Waste, Physical and Chemical Methods*, SW-846, 3rd edition, Revision 4, 1996.
[b]All glass containers have polytetrafluoroethylene-lined lids.
[c]Triple the amount per laboratory for samples designated for matrix spike/matrix spike duplicate.
[d]Samples may be collected together in one 16-ounce jar.

°C = degrees Celsius
EPH = extractable petroleum hydrocarbon
mL = milliliter
VOA = volatile organic analyte

TABLE 3-2
Sample Collection Summary–Aqueous/Liquid

Parameter	Analytical Method[a]	Container[b,c]	Preservative	Maximum Holding Times
Gasoline-Range Organics	AK101	3 x 40-mL amber glass, septa lid	No headspace HCl to pH<2 4°C	14 days to analysis
Diesel/Residual Range Organics	AK102/AK103	1 x 1-liter amber glass	HCl to pH<2 4°C	14 days to extraction 40 days to analysis
Extractable Hydrocarbon Speciation	NW EPH	1 x 1-liter amber glass	HCl to pH<2 4°C	14 days to extraction 40 days to analysis
Volatile Hydrocarbon Speciation	NW VPH	3 x 40-mL amber glass, septa lid	No headspace HCl to pH<2 4°C	14 days to analysis
Metals (except Chromium VI)	SW6010B/SW6020/ SW7000	1 x 500-mL HDPE	HNO_3 to pH<2 4°C	28 days for mercury 6 months for all others
Organochlorine Pesticides/	SW8081A	1 x 1-liter amber glass	4°C	7 days to extraction 40 days to analysis
Polychlorinated Biphenyls	SW8082	1 x 1-liter amber glass	4°C	7 days to extraction 40 days to analysis
Chlorinated Herbicides	SW8151A	1 x 1-liter amber glass	4°C	7 days to extraction 40 days to analysis
Volatile Organic Compounds	SW8260B	3 x 40-mL amber glass, septa lid	HCl to pH<2, 4°C; no headspace	14 days to analysis
Semivolatile Organic Compounds	SW8270C/ SW8270C-SIM	1 x 1-liter amber glass	4°C	7 days to extraction 40 days to analysis
Dioxins/Furans	SW8290	2 x 1-liter amber glass	4°C, store in dark	30 days to extraction 40 days to analysis
Transitional Explosives	SW8321	1 x 1-liter amber glass	4°C	7 days to extraction 40 days to analysis
Explosives	SW8330	1 x 1-liter amber glass	4°C	7 days to extraction 40 days to analysis

[a]Unless otherwise specified, method numbers refer to U.S. Environmental Protection Agency *Test Methods for Evaluation of Solid Waste, Physical and Chemical Methods*, SW-846, 3rd edition, Revision 4. 1996.
[b]All glass containers have polytetrafluoroethylene-lined lids.
[c]Triple the amount per laboratory for samples designated for matrix spike/matrix spike duplicate.

°C = degrees Celsius
EPH = extractable petroleum hydrocarbon
HCl = hydrochloric acid
HDPE = high-density polyethylene
HNO3 = nitric acid
H_2SO_4 = sulfuric acid
mL = milliliter

3.2 Chain of Custody (COC)

Procedures must be taken to preserve and ensure the integrity of all samples from the time of collection through analysis. Records of the custody of samples must be maintained both in the field and in the laboratory. A sample is considered to be in someone's custody if it is in their physical possession or view, locked up, or kept in a secured and restricted area. Until the samples are shipped, custody will be the responsibility of the sampling team leader.

COC records document sample collection and shipment to the laboratory. A COC form will be completed in duplicate, as a minimum, for each sampling event. The original COC form will be delivered with the sample shipping cooler, and the copy will be retained in the field documentation files. The COC form will identify the contents of each shipment and maintain the custodial integrity of the samples. All COC forms will be signed and dated by the responsible sampling team personnel. The "relinquished by" box will be signed by the responsible sampling team personnel, and the date, time, and air bill number (if applicable) will be noted on the COC.

Custody seals will be placed across the front and back edges of each sample cooler lid to maintain its integrity until it is opened by the laboratory. The shipping coolers containing the samples will be sealed with a custody seal any time they are not in someone's possession or view before shipping. All custody seals will be signed and dated by the responsible sampling team personnel.

The following information must be documented on the COC as a minimum:

- Project name, project number, and project manager's name
- Unique sample identification (no dashes, spaces, or commas)
- Date and time of sample collection
- Matrix
- Number of sample containers
- Analyses required
- Designation of MS/MSD samples
- Preservative used
- Name and signature of sampler, receiver
- Bill of lading or transporter tracking number (if applicable)
- Requested turnaround time

Custody must be maintained at the laboratory once samples are received until all tests are completed. This will be accomplished using an internal custody system that requires samples to be kept in a secured and restricted area when not in use, and to be checked out and checked back in by the analysts who use them. Internal custody records must be maintained by the laboratory as part of the documentation file for each sample.

3.3 Sample Packaging and Transport

To minimize the potential for degradation and to maintain a temperature of approximately 4 degrees Celsius (°C), samples will be chilled in a cooler with an ice substitute (for example,

blue ice) or ice in a resealable plastic bag. The COC form, and QA sample form, if required, will be filled out in indelible ink, placed in a resealable plastic bag, and taped to the inside lid of the shipping cooler. It is anticipated that most project samples will be environmental samples in small volumes. Environmental samples are samples with contaminant concentrations significantly reduced by normal environmental weathering processes such as volatilization to the air, degradation caused by exposure to sunlight and microbes, or simple mixing with soil or groundwater. As such, the samples present little shipping hazard in terms of corrosiveness, flammability, and explosiveness.

The following procedures will be followed in packing environmental samples:

- Check the sample container caps to make sure they are tightened properly. (Samples for volatile components must be discarded and recollected if the cap is loose.)
- Tape over the drain hole on the inside of the cooler.
- Place a layer of cushioning material in the bottom of the cooler.
- Enclose each bottle in a separate, clear, plastic bag and seal each bag. Place the bottles upright in the cooler so that they will not touch against each other during shipment.
- Place additional cushioning material around sample bottles, and fill voids between bottles.
- Place ice substitute between samples and over the containers to preserve them at approximately 4°C. (Note: Loose bagged ice is not acceptable if coolers are transported by commercial aircraft.)
- Fill the cooler with cushioning material.
- Tape the cooler drain shut from the outside of the cooler.
- Place completed COC form inside a resealable bag, and tape the bag to the inside lid of the cooler.
- Close and latch the cooler. Wrap a strong adhesive tape around the ends of the cooler to secure it, making sure to cover the spigots at the bottom and any open space between the lid and the cooler. Tape the cooler latch closed with strapping tape.
- Seal the cooler with custody seals in two places, on the front and the rear, and seal the cooler with strapping tape. The signature on the custody seals should match the signature on the COC.
- Attach the completed shipping label to the top of the cooler; print “Laboratory Samples” and “This End Up” on the top of the cooler, and put upward-pointing arrows on all four sides. Place “Fragile” and “Chill, Do Not Freeze” labels on at least one side.

If the coolers are not to be delivered by hand to the project laboratory but shipped to the laboratory, the samples will be packaged for shipment according to International Air Transport Association (IATA) regulations. Marking and labeling procedures will be consistent with IATA regulations. The method of shipment, courier name(s), and other

pertinent information will be entered on the COC form. Air bills will be properly completed, and copies will be retained and placed in the project file.

For environmental samples, no IATA marking, labeling, or shipping papers are required, and there are no IATA restrictions on the mode of transportation.

For hazardous samples, the following procedures must be followed:

- Place the sample container inside a 1-quart- or 1-gallon-size paint can. Fill the void space with vermiculite. Place the paint can in a cooler and pack as previously described.
- Complete a carrier-approved air bill or shipper's certification for restricted articles, providing the following information in the order listed:
  - "Flammable Liquid, No. UN 1993" or "Flammable Solid, No. UN 1325"
  - "Limited Quantity" (or "Ltd. Qty.")
  - Net weight or net volume of total sample material in cooler
  - "Laboratory Samples"
  - "Cargo Aircraft Only"
- Affix a corporate address label to the cooler with the address of the laboratory.

U.S. Department of Transportation regulations do not apply to transport by government-owned vehicles, including aircraft.

3.4 Transfer of Custody and Shipment

When transferring the samples, the individuals relinquishing and receiving the samples will sign, date, and note the time on the COC form. If the samples are required to be shipped, the primary or QA laboratory coordinators will be notified of when and how samples were sent. Notification will include the following information:

- Date of shipment
- Name of shipping company
- Air bill number
- Number of coolers
- Name, phone number, and facsimile number of point of contact
- Estimated date of shipment arrival
- Type of samples (water, sediment, or soil)

On receipt of each sample cooler and after verification of the COC records, the primary or QA laboratory will provide a cooler receipt form documenting any discrepancies such as, but not limited to, the following:

- Inappropriate sample containers or preservation
- Broken sample containers
- Cooler temperature outside range of 2°C to 6°C (where applicable)
- Missing COC form or QA sample form
- Errors on COC or QA sample form
- Missing custody seals

The laboratory manager will notify the CH2M HILL chemist Bernice Kidd of any such discrepancies within 24 hours of its receipt of the samples.

SECTION 4

References

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Appendix A
Radiological Screening

APPENDIX A

Radiological Field Screening

The Ludlum Model 12 rate meter will be used for field screening purposes to survey aircraft parts (i.e. gauges, dials) or areas of concern to ensure they are not radioactive. The Ludlum Model 12 rate meter, when combined with the Model 44-9 Pancake GM Detector, is capable of detecting the presence of alpha, beta, and gamma/X-ray radiation. Background radiation is always present. This instrument will be used to qualitatively determine if radioactive materials are present above these background levels. The Ludlum meter will be used to survey metal debris during test pit excavation to ensure that it does not contain radioactive materials (e.g. heavy equipment and aircraft gauges, dials, and other parts). A background scan of the area to establish a base line of data will be completed and recorded in the field logbook. This instrument will be used to qualitatively determine if radioactive materials are present above these background levels. If at any point, radiation is detected at levels greater than double the normal background reading, STOP WORK, leave the area, and notify supervision immediately.

The instrument must be source-checked daily prior to use, and is to be used only by individuals who have current Radiological Worker II training. The check source will be kept in a secure, locked location when not in use, and properly labeled as a radioactive source. A Radiological Worker II trained individual shall be assigned as Source Custodian, and documented in the project logbook.

Instructions for Use

1. Daily, prior to use, the instrument shall be source-checked to ensure it is functional. Perform the following:

    a. Inspect the exterior of the meter and probe for damage.

    b. Turn the meter on and perform a battery test. The meter should deflect to within the "Bat Test" area of the scale. If not, change the batteries in accordance with the user manual.

    c. Make sure the switch settings on the unit are set to:

        1. Aud – On

        2. F S (Fast or Slow response time) – S

        3. Rotary knob – X1

    d. Source-check the instrument by holding the face of the pancake probe next to the check source. The meter should deflect to the right and click audibly. If not, turn the unit off and contact project supervision. Return the source to the source storage location.

    e. Record the date and time of the source check in the project log book.

2. Field screening

   a. Make sure the unit is on.

   b. Before starting screening for the day, note the normal background reading as indicated by the meter in an area outside of the work area. Record in logbook.

   c. Holding the pancake probe very close to, but not in contact with, the material to be surveyed for several seconds.

      NOTE: Alpha particles do not travel very far through matter, including air. The probe must be very close (within ¼" typically) to the material in question to detect alpha radiation.

      If the meter shows more than two times (2X) the normal background reading recorded above, STOP WORK, leave the area, notify project supervision, and control the area to prevent others from getting close to the area of elevated radiation. Supervision should contact a qualified radiation protection person for additional guidance prior to resuming work.

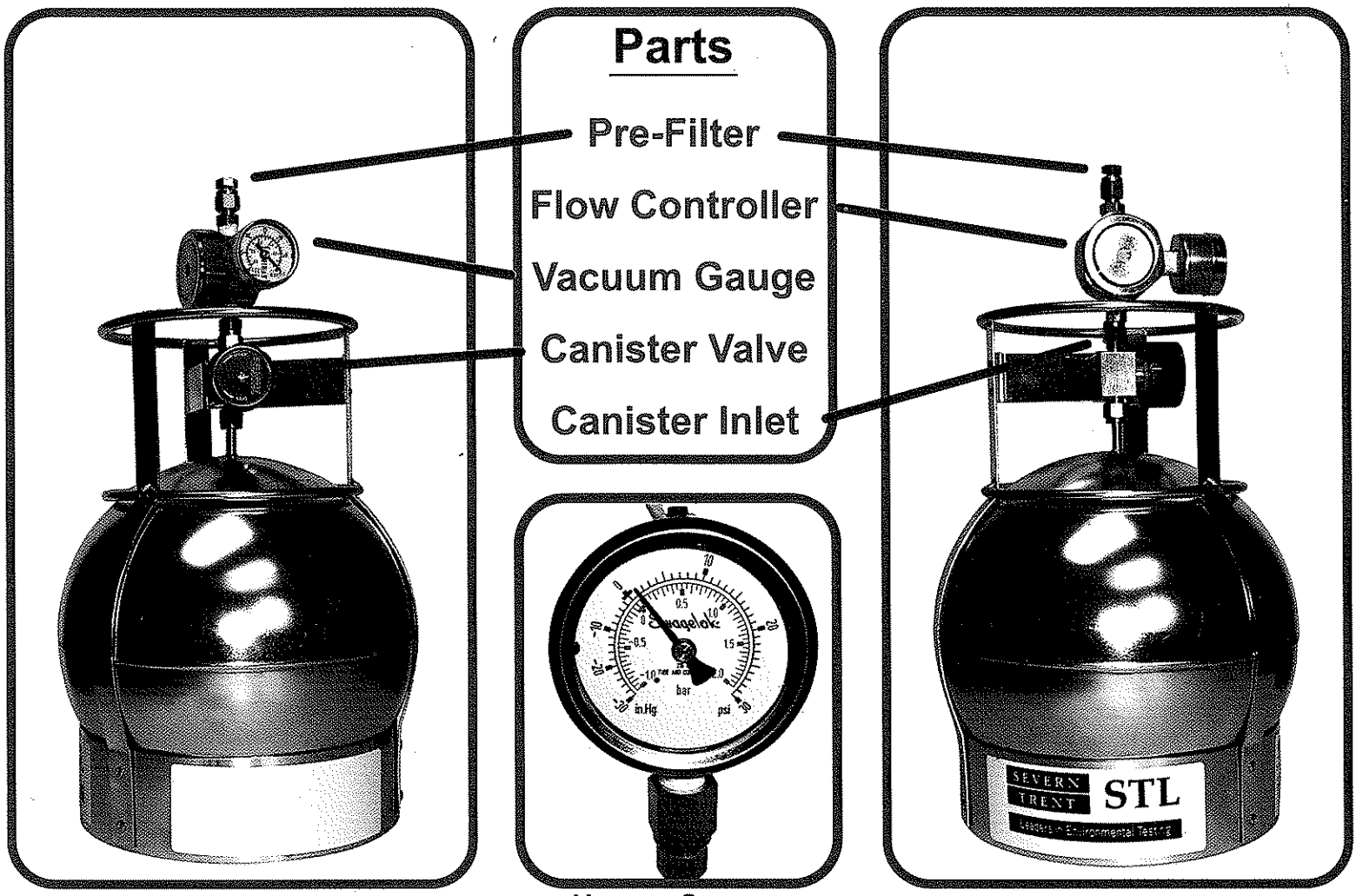
      If the meter shows an increase in radiation levels as evidenced by an increase in the "clicking" rate and/or deflection of the meter to the right, but less than two times the normal background level, segregate the item and notify supervision for guidance.

   d. Turn the unit off when not in use and at the end of the day to conserve the batteries.

Appendix B
Standard Operating Procedure for the Collection of Sub-Slab Vapor Samples Using Summa™ Canisters

SEVERN TRENT STL

Canister Sampling Instructions



Vacuum Gauge

1. Remove the dust cap from the canister valve.

2. GRAB SAMPLES: Attach the vacuum gauge (using a 9/16" wrench) to the canister inlet, open the canister valve, and note the vacuum reading on the sample tag attached to the canister. Close the canister valve, disconnect the vacuum gauge, and go to step 5.

3. TIME INTEGRATED SAMPLES: Attach the flow controller (1/4" female Swagelock fitting) to the "canister inlet" (1/4" male Swagelock fitting), tightening the threaded nut until it is hand tight. **NOTE:** be careful not to cross the threads.

4. Use a 9/16-inch wrench to completely tighten the flow controller to the canister inlet. **NOTE:** Once completely tightened to the canister, the flow controller should not be able to be turned on the top of the canister by hand.

5. To start sampling, turn the canister valve clockwise, one and 1/2 to two turns. Note the start time on the sample tag attached to the canister.
(TIME INTEGRATED SAMPLES: Check the initial vacuum of the canister with the "vacuum gauge" provided by opening the canister valve and record the vacuum reading on the sample tag attached to the canister).

6. To stop sampling, note the stop time, check and note the final vacuum, and close the canister valve at the end point, by turning clockwise until snug. If the valve is not closed at the end point the canister will eventually go to ambient pressure.

7. After closing the valve, remove the flow controller from the canister, replace the dust cap, and place all equipment in the packaging and box in which they were received. Complete the chain of custody form and return the samples to STL.

Appendix C
Field Forms

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PROJECT NUMBER	TEST PIT NUMBER SHEET 1 OF 1

TEST PIT LOG

PROJECT : LOCATION : LOGGER :

ELEVATION : CONTRACTOR :

EXCAVATION EQUIPMENT USED : DATE EXCAVATED:

WATER LEVEL : APPROX. DIMENS: Length: Width: Max. Depth:

DEPTH BELOW SURFACE (FT)	INTERVAL (FT)	NUMBER AND TYPE	SOIL DESCRIPTION SOIL NAME, USCS GROUP SYMBOL, COLOR, MOISTURE CONTENT, RELATIVE DENSITY, OR CONSISTENCY, SOIL STRUCTURE, MINERALOGY.	COMMENTS DIFFICULTY IN EXCAVATION, RUNNING GRAVEL CONDITION, COLLAPSE OF WALLS, SAND HEAVE, DEBRIS ENCOUNTERED, WATER SEEPAGE, GRADATIONAL CONTACTS, TESTS, INSTRUMENTS.
0.5				
1.0				
1.5				
2.0				
2.5				
3.0				
3.5				
4.0				
4.5				
5.0				
5.5				
6.0				
6.5				
7.0				

CH2MHILL

PROJECT NUMBER	BORING NUMBER
	SHEET 1 OF 2

SOIL BORING LOG

PROJECT : LOCATION :

ELEVATION : DRILLING CONTRACTOR :

DRILLING METHOD AND EQUIPMENT USED :

WATER LEVELS : START : END : LOGGER :

DEPTH BELOW SURFACE (FT)	INTERVAL (FT)	RECOVERY (IN)	#/TYPE	STANDARD PENETRATION TEST RESULTS 6"-6"-6"-6" (N)	SOIL DESCRIPTION: SOIL NAME, USCS GROUP SYMBOL, COLOR, MOISTURE CONTENT, RELATIVE DENSITY, OR CONSISTENCY, SOIL STRUCTURE, MINERALOGY.	COMMENTS: DEPTH OF CASING, DRILLING RATE, DRILLING FLUID LOSS, TESTS, AND INSTRUMENTATION. OVM (ppm): %G %S %F
5						
10						
15						
20						
25						

CH2MHILL

PROJECT NUMBER	BORING NUMBER
	SHEET 2 OF 2

SOIL BORING LOG

PROJECT : LOCATION :

ELEVATION : DRILLING CONTRACTOR :

DRILLING METHOD AND EQUIPMENT USED :

WATER LEVELS : START : END : LOGGER :

DEPTH BELOW SURFACE (FT)	INTERVAL (FT)	RECOVERY (IN)	#/TYPE	STANDARD PENETRATION TEST RESULTS 6"-6"-6"-6" (N)	SOIL DESCRIPTION: SOIL NAME, USCS GROUP SYMBOL, COLOR, MOISTURE CONTENT, RELATIVE DENSITY, OR CONSISTENCY, SOIL STRUCTURE, MINERALOGY.	COMMENTS: DEPTH OF CASING, DRILLING RATE, DRILLING FLUID LOSS, TESTS, AND INSTRUMENTATION. OVM (ppm): %G %S %F
35						
40						
45						
50						
55						

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PROJECT NUMBER	WELL NUMBER
	SHEET 1 OF 1

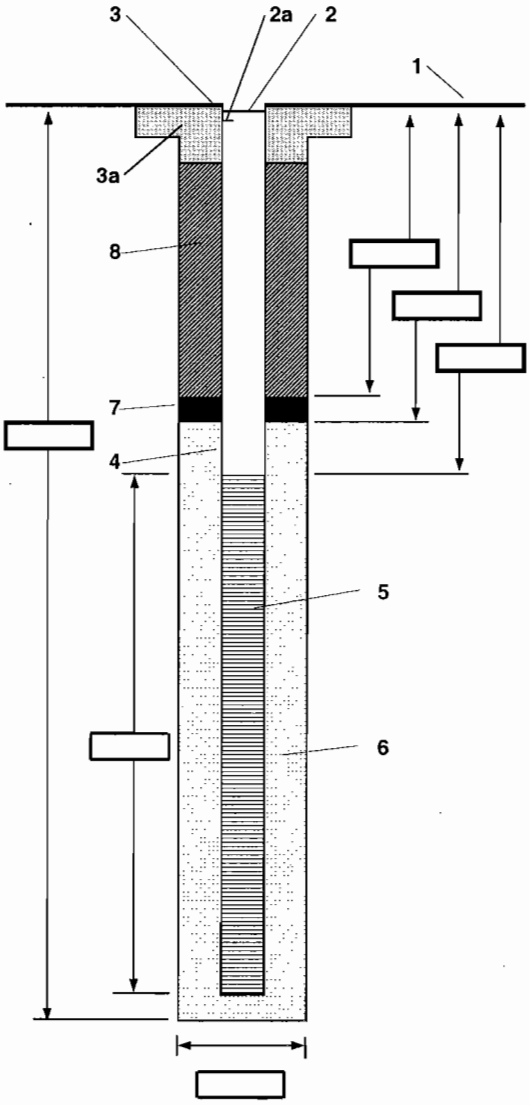
WELL INSTALLATION DIAGRAM

PROJECT : LOCATION :

DRILLING CONTRACTOR :

DRILLING METHOD AND EQUIPMENT USED :

WATER LEVELS : START : END : LOGGER :



1- Ground elevation at well _____

2- Top of casing elevation _____
   a) vent hole? _____

3- Wellhead protection cover type _____
   a) concrete pad dimensions _____

4- Dia./type of well casing _____

5- Type/slot size of screen _____

6- Type screen filter _____
   a) Quantity used _____

7- Type of seal _____
   a) Quantity used _____

8- Grout
   a) Grout mix used _____
   b) Method of placement _____
   c) Vol. of well casing grout _____

Development method _____

Development time _____

Estimated purge volume _____

Comments _____

PROJECT NUMBER	PROBE NUMBER SHEET 1 OF 1

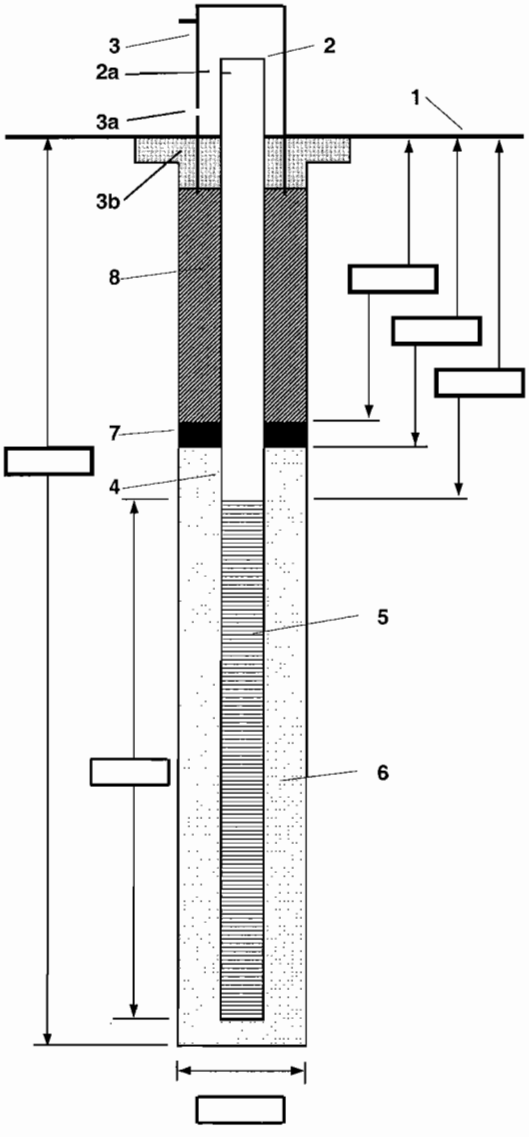
GROUNDWATER PROBE DIAGRAM

PROJECT : LOCATION :

DRILLING CONTRACTOR :

DRILLING METHOD AND EQUIPMENT USED :

WATER LEVELS : START : END : LOGGER :



1- Ground elevation at probe _____

2- Top of probe elevation _____
   a) vent hole? _____

3- Wellhead protection cover type _____
   a) weep hole? _____
   b) concrete pad dimensions _____

4- Dia./type of probe casing _____

5- Type/slot size of screen _____

6- Type screen filter _____
   a) Quantity used _____

7- Type of seal _____
   a) Quantity used _____

8- Grout
   a) Grout mix used _____
   b) Method of placement _____
   c) Vol. of well casing grout _____

Development method _____

Development time _____

Estimated purge volume _____

Comments _____

CH2MHILL

WELL PURGE AND SAMPLING FIELD SHEET

PROJECT SITE:

PROJECT # 169073

		CASING DIAMETER	GAL/FT OF CASING		
WELL DEPTH (FT):				**SAMPLE ID**	
DEPTH TO WATER (FT):				**WELL ID**	
WATER COLUMN (FT):				**INTERVAL**	
GAL/FT OF CASING				**SAMPLER**	
CASING VOLUME (GAL)				**DATE**	
NO. OF VOLUMES min.(3)				**TIME**	
PURGE VOLUME (GAL)					

METHOD OF PURGING (circle one)

PUMP: SUB CENT PERIST OTHER:

TIME ON:

FLOW RATE (gpm):

PUMP TIME (min):

VOL PURGED (gals):

BAILER: **TEFLON** SS OTHER:

BAILER VOL.. (gal)

REQUIRED PULLS:

VOL. PURGED (gals):

OTHER:

FIELD PARAMETERS	FIELD MEASUREMENTS					
	1st	2nd	3rd	4th	5th	6th
TIME						
VOL (gal)						
pH (s.units)						
TEMP (C)						
COND (umhos/cm)						
TURBIDITY (NTU)						
REDOX (-/+ mV)						
DO (mg/L)						

SAMPLE PARAMETERS: GRAB COMPOSITE

SAMPLE TYPE: PROJECT DUPLICATE QA EQUIPMENT BLANK OTHER :

FILTERED? Y / N 1.0um 0.45um OTHER:

OBSERVATIONS

COLOR: CLEAR , AMBER , TAN , BROWN , GREY , MILKY WHITE , OTHER:

ODOR: NONE , LOW , MEDIUM , HIGH , VERY STRONG , H2S , FUEL LIKE , CHEMICAL ?, UNKNOWN

TURBIDIT NONE , LOW , MEDIUM , HIGH , VERY TURBID. HEAVY SILTS

COMMENTS:

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SAMPLE TRACKING LOG

Project #

Page of

Sample						Shipment				
Date	ID	Location	Depth	Matrix	Type	Cooler ID	Ship Date	Method	Shipped To	Date Received

Downhole Soil Gas Sampling Data Sheet

Boring Name: _____ Date: _____

Arrival time: _____ Departure time: _____

Nominal Sample Depth:_____

Weather Conditions (rain in last 24 hours?) No _____ Yes ____ Sampling Crew Initials: _____

Daily Maximum Pump Vacuum: _____ (-20 to -30 inches of Hg)

Sampling System Leak Check *The system must hold vacuum for a minimum of one minute and not lose more than 10% of the maximum pump vacuum. If the system fails the leak check procedure, check all fittings and re-test the system.*

Sample Train Leak check (performed before each sample)

Initial Vacuum Reading: _____

Final Vacuum Reading (after one minute): _____

Sample Train Leak Check after Probe Placement (before purge)Vacuum Reading: _____

Distance Probe Driven: _____

Distance Retracted: _____

Maximum PID Reading During Purge: _____

PID Serial Number: _____

Purge Vacuum: _____

Purge Volume: _____

Purge Time: _____

(Two liters per minute or less)

COC #: _____

Sample ID #: _____

Canister ID #: _____

Duplicate Sample ID *: _____

Sample Depth (ft bgs): _____

Formation Type: _____
(from boring log)

Sample Collection Time: _____

Sample Start Time: _____

Initial Canister Vacuum (inches of Hg): _____

Final Canister Vacuum (inches of Hg): _____

Sample Stop Time: _____

Duration: _____

Tedlar® Bag Leak Check: _____

Comments:

Appendix D
Canister Sampling Instructions

Appendix C
Environmental Sampling Instructions

C.1 Sampling Strategies

C.1.1 Scope and application. This instruction discusses strategies that can be employed to sample various media, including but not limited to soils, sediments, or water. Several different types of sampling strategies exist that can be categorized as either statistical or nonstatistical methods. Applications and limitations of each sampling strategy will be briefly described.

C.1.2 Sampling strategies. One of the main goals of any investigation is to collect samples that are representative of the site conditions so that an accurate assessment of contamination can be made with a minimum number of samples. Based on the conceptual site model (CSM) , crucial pathways and media requiring assessment are identified, and are later used to evaluate whether the data make sense for what is known about the site. The various sampling strategies available can be grouped into two basic categories: statistical and nonstatistical methods. To ensure that samples are as representative as possible, statistics are often used to design an appropriate sampling strategy and to provide a sound basis for supporting project decisions. Depending on data needed to support project decisions, input from an environmental statistician may be obtained. In addition, software programs (e.g., DQO Pro, DEFT, DataQuest, Visual Sampling Plan) are available to aid in the evaluation of various sampling scenarios and the uncertainty associated with them. Classical statistical methods are most applicable to sampling media that are considered fairly homogeneous (e.g., ground water, surface water). However, because of the spatial variability of soils, application of sampling strategies using classical statistical techniques may be limiting. The use of geostatistical methods is recommended for sediments and soils to account for the variability of the media. A related factor to consider is the distribution of the contaminant within the environmental medium, and how this may impact the use of the data or what is considered representative. Information on how the contaminant was dispersed at the time of waste generation, spill, or discharge may help in assessing whether the contamination is present on a molecular scale (e.g., solvent or solution spills) or on a macroscale (e.g., lead shot, ammunition debris, and TNT chunks). The latter situation increases the likelihood that samples may exhibit a high short-range heterogeneity, and the challenge of obtaining representative samples becomes even more difficult. The use of compositing and homogenizing techniques can improve representativeness of the samples (i.e., when amenable to the eventual physical/chemical analyses) by invoking the physical process of averaging. Refer to Instructions E-2 and E-3 of Appendix E for additional information on homogenizing and compositing techniques and to E-4 for information on the collection, handling, and storage of solid volatile organic analysis (VOA) samples. Statistics can also be used to determine the number of samples required to reach a prescribed level of uncertainty. However, when statistical calculations result in an unacceptably high number of samples being defined, the use of field analytical technologies or field screening techniques should be pursued to reduce the cost of sample analyses while maintaining a desired level of site coverage. Refer to Appendix H for additional information on this subject. Typically, more than one sampling strategy or approach is necessary when several media or types of contamination are under investigation, and most sampling plans employ a combination of sampling strategies. The following text and Table C-1 summarize basic descriptions, applications, and limitations for some frequently used sampling strategies. Additional references are also included to provide more detailed discussions on the subjects.

C.1.2.1 Classical statistical sampling. A discussion of statistical sampling is presented in the following sections. For a detailed discussion of classical statistical methods see U.S. Environmental Protection Agency (USEPA) EPA/530/SW-89/026, EPA/SW-846 (Volume II)), Gilbert (1987), and Pitard (1993).

Table C-1
Comparison of Sampling Strategies

Sampling Strategy	Description	Application	Limitations
		Classical Statistical Sampling Strategies	
Simple random sampling	Representative sampling locations are chosen using the theory of random chance probabilities.	Sites where background information is not available and no visible signs of contamination are present.	May not be cost-effective for samples located too close together. Does not take into account spatial variability of media.
Stratified random sampling	Site is divided into several sampling areas (strata) based on background or site survey information; each stratum is evaluated using a separate random sampling strategy.	Large sites characterized by a number of soil types, topographic features, past/present uses, or manufacturing/storage areas.	Often more cost-effective than random sampling. More difficult to implement in the field and analyze results. Does not take into account spatial variability of media.
Systematic grid sampling	Most common statistical strategy; involves collecting samples at predetermined, regular intervals within a grid pattern.	Best strategy for minimizing bias and providing complete site coverage. Can be used effectively at sites where no background information exists. Ensures that samples will not be taken too close together.	Does not take into account spatial variability of media.
Hot-spot sampling	Systematic grid sampling strategy tailored to search for hot spots.	Sites where background information or site survey data indicate that hot spots may exist.	Does not take into account spatial variability of media. Trade-offs between number of samples, chance of missing a hot-spot, and hot-spot size/shape must be weighed carefully.
Geostatistical approach	Representative sampling locations are chosen based on spatial variability of media. Resulting data are analyzed using kriging, which creates contour maps of the contaminant concentrations and the precision of concentration estimates.	More appropriate than other statistical sampling strategies because it takes into account spatial variability of media. Especially applicable to sites where presence of contamination is unknown.	Previous investigation data must be available and such data must be shown to have a spatial relationship.
		Nonstatistical Sampling Strategies	
Biased sampling	Sampling locations are chosen based on available information.	Sites with specific known contamination sources.	Contaminated areas can be overlooked if they are not indicated by background information or visual signs of contamination. Best if used with statistical approach, depending on the project objectives.
Judgmental sampling	An individual subjectively selects sampling locations that appear to be representative of average conditions.	Homogeneous, well-defined sites.	Not usually recommended due to bias imposed by individual, especially for final investigations.

C.1.2.1.1 Simple random sampling. Simple random sampling is the most basic statistical approach and is usually applied when minimal site background information (e.g., past practices, uses of hazardous materials, etc.) is available and visible signs of contamination are not evident during the initial site survey. This strategy uses the theory of random chance probabilities to choose representative sampling locations. Each sample location is chosen independently of any previously chosen sample location. It is most effective when the number of available sampling points is large enough to lend statistical validity to the random selection process. The simple random sampling approach may be more costly than other statistical methods since a larger number of samples may be required to characterize the site.

C.1.2.1.2 Stratified random sampling. Investigations of large sites that encompass a number of soil types, topographic features, or land uses may benefit by using a modified random sampling approach, called stratified random sampling. In this strategy, the site is divided into different sampling areas (strata) that are internally homogeneous based on existing data and background information. The division of the site into strata is based on the assumption that each stratum is more internally homogeneous than the site as a whole. Each stratum is sampled at locations based on a simple random sampling approach. By grouping similar sampling points and treating each group separately, each with its own individual random sampling scheme, the precision of the study is increased. In addition, this approach controls the variability due to contaminant concentration, location, terrain type. etc., and it often results in more efficient allocation of resources than would be possible with a simple random sampling method. Sampling analyses from each stratum may be used to determine the mean or total contaminant concentration within the stratum. However, data from each stratum may be used to make comparisons between the different strata or combined to provide information about the entire site.

C.1.2.1.3 Systematic grid. Systematic grid sampling, sometimes referred to as systematic random sampling, is the most common statistical sampling strategy. It involves collecting samples at predetermined. regular intervals (i.e., within a grid pattern). The location of the first sampling point is selected at random and all subsequent sample locations are determined using a systematic pattern from that point. This approach is typically used when a large site (e.g., measured in acres) must be sampled to characterize the presence and distribution of contaminants. The grid-based option is probably the best classical statistical sampling strategy for minimizing bias and providing complete site coverage. The most basic grid system is a straight line between two points on which regularly spaced sampling locations are designated. This one- dimensional sampling grid may be used for sampling along a straight drainage ditch or other man-made feature. However, most soil sampling schemes require a two-dimensional grid system for locating sampling points. The following types of grids are generally used: square, triangular, or other systematic pattern. Sampling is usually performed at each grid-line intersection. However, sampling in the center of each grid square/triangle or obtaining a composite of samples within a grid square/triangle is also acceptable.

C.1.2.1.4 Hot-spot sampling. "Hot spots" are usually defined as small, localized areas of a media that are characterized by high contaminant concentrations. In order to detect hot spots, a special systematic grid sampling approach is necessary. However, because all of the media cannot be sampled, there is still a possibility that hot spots exist even if none are discovered during the sampling process. Statistical approaches for detection of hot spots are discussed in Gilbert (1987). A hot-spot sampling plan should consider the following factors:

- Grid spacing and geometry. A triangular grid pattern increases the efficiency of the hot-spot search. In addition, the probability of finding hot-spots increases as the spacing between grid points decreases.

- Hot-spot shape/size. The larger a hot spot is, the more likely it is to be discovered. The shape of the hot spot also affects the probability of its being detected. Narrow or small-circular patterns may escape detection because they are located between grid sampling locations. Large-circular and wide-elliptical hot spots are the easiest to find.

- False negative rate. This measures the probability that a hot spot will be missed even if one is present.

C.1.2.1.5 Geostatistical approach. Classical statistical methods for the design of sampling projects are well-known and have been the standard approach in the past. However, these strategies have one major

drawback—they do not take the natural variability of the media into account. As such, they may not adequately characterize contamination at sites, especially those sites that are fairly heterogeneous and/or where the presence of contamination is unknown. Consequently, classical statistical methods are most appropriately applied to sites where the source of contamination is known (e.g., a landfill, waste pile, etc.) or small sites where the entire area is to be remediated as a unit (e.g., in the case of soils, the entire site will be solidified). To more accurately characterize sites where the presence of contamination is unknown, statisticians now believe that geostatistical methods are more appropriate than classical statistical methods because they take into account the spatial variability of the media when estimating contaminant concentrations. Geostatistical methods may be used for sampling naturally occurring materials such as soils or ground water and man-made units such as landfills or waste piles. Characterization of any media is difficult because contaminant levels are spatially correlated. This means that contaminant concentrations from samples taken close together are more likely to be similar than contaminant concentrations from samples taken farther apart (regional variability). Geostatistics describes how to sample and analyze regional variability by defining the representativeness of a sample in terms of its range of correlation or zone of influence. For example, a sample location selected through geostatistics will represent a circular area with a radius less than or equal to the zone of influence. In other words, the sample would be representative of the media within the circular area. A two- stage sampling approach is typically used in geostatistical sampling strategies. Initially, a sampling survey is performed to collect basic data. These data are used to create a graph that defines the distance over which samples are representative. This graph is then used to dictate the shape, size, and orientation of another systematic grid that is used in the second, final sampling event. Geostatistical sampling strategies are relatively complex, and further discussions of this approach are found in Engineer Technical Letter (ETL) 1110-1-175, Borgman and Quimby (1988), and Gilbert (1987).

C.1.2.2 Nonstatistical sampling. Types of nonstatistical sampling are described as follows.

C.1.2.2.1 Biased sampling. Biased sampling is used to evaluate sites with specific, known sources of contamination (e.g., the site survey discovered visible signs of contamination or records indicate that certain locations are suspect based on past/present practices). As such, sampling locations are chosen based solely on available information.

C.1.2.2.2 Judgmental sampling. In judgmental sampling schemes, an individual subjectively selects the sampling locations that appear to be representative of average conditions. If the individual is knowledgeable, judgmental sampling can result in accurate estimates of site conditions. Although a certain amount of judgment is necessary in any sampling approach, total reliance on judgment decisions is not recommended because an individual's bias often leads to poor quality data and improper conclusions. However, if judgmental sampling is necessary, multiple samples should be collected to add some measure of precision.

C.1.3 Potential problem. Table C-1 shows the limitations associated with these sampling strategies.

C.2 Ground Water Sampling

C.2.1 Scope and application. This instruction presents guidelines for collecting representative ground water samples from temporary and permanent ground water monitoring wells and, where applicable, from other direct push well screen samplers. Guidance for the installation of temporary wellpoints by direct push methods for sampling ground water at discrete points may be found in American Society for Testing and Materials (ASTM) D 6001. Typical ground water monitoring wells are 5 or 10 cm (2 or 4 in.) in diameter and are constructed of polyvinyl chloride (PVC) or stainless steel. Instructions presented herein are intended to include sample collection from wells that have not been completed as production or extraction wells. The instructions can be used to identify an appropriate sampling protocol for the acquisition of a representative sample. Instruction C-4, "Potable Water Sampling," includes procedures for sampling permanent production wells or any other well constructed with a discharge tap. Instructions for purging and sampling wells by the following techniques are included in this section: bailer, portable submersible pump, bladder pump, hand pump, centrifugal pump, peristaltic pump, air lift pump, and low-flow sampling.

C.2.2 Sampling strategies. Sampling strategies are developed by the project team to satisfy project-specific data needs identified in the hazardous, toxic, and radioactive waste (HTRW) technical planning process. The sampling strategy developed for a particular site will influence several project decisions, including, but not limited to, sampling locations, types of samples, sampling frequency, and sampling and analytical protocols. Sampling strategies may be significantly influenced by such factors as physical site constraints, safety, and cost, to name a few. The technical planning process that results in the development of the sampling strategy is critical because of the difficulty in acquiring representative samples, the reduction of contaminant action levels, and the problems associated with trace level cross-contamination. Successful investigations of hazardous waste sites are highly dependent on an effective sampling scheme. Development of a sampling scheme for purposes of characterizing a hazardous waste site should follow the fundamentals of the scientific approach. A successful sampling scheme requires a logical design to allow an evaluation of potential contaminants in relation to background conditions, vertical extent, horizontal extent, and mobility in various media. Additional guidance may be found in ASTM D 5903.

C.2.2.1 Sampling locations. Sampling at hazardous waste sites is usually conducted in an attempt to identify contamination and to define its extent and variability. With such an objective, it is most logical to choose sample locations that will yield the most information about site conditions. During evaluation of a site, sampling can be conducted by random, systematic, or biased sampling. Instruction C-1 discusses random, systematic, and biased sampling in detail. Often biased and random sampling techniques can be used together to thoroughly address an entire site. Some wells may be biased to potentially contaminated areas (e.g., former wastewater lagoons, former process or disposal areas), or potentially impacted areas (e.g., down-gradient locations). In areas less likely to be contaminated or areas with little available background information, random samples may be used to allow adequate assessment of the entire site. Ground water monitoring wells are positioned at locations and depths to satisfy ground water monitoring objectives. Ground water samples collected from monitoring wells are evaluated as discrete samples collected from the same location. Ground water samples collected from the same well are distinguished from one another because they are distributed through time. Unless each ground water monitoring well has a sampler dedicated to the well, the order of sampling monitoring should be from the least contaminated to the most contaminated.

C.2.2.2 Sample type. Ground water samples are typically discrete samples. A discrete (grab) sample is a discrete aliquot representative of a specific location at a given point in time. The sample is collected at once and at a particular point in the sample matrix. The representativeness of such samples is defined by the nature of the materials being sampled. In general, since contamination in ground water disperses over time and distance, it will take more grab samples to characterize the extent of contamination as the time from a release increases.

C.2.2.3 Suggested samplers. Each sampling technique presents various disadvantages and advantages for its application. For example, sample disturbance, sample volume, chemical/physical reactivity between potential contaminants and sampling tool materials, well diameter, depth to ground water, limitations of lift capacity of the sampling device, specified analytical parameters, and ease of decontamination vary from technique to technique. The advantages and disadvantages of each sampling technique are presented in the discussion of the technique.

C.2.2.4 Sample frequency. Contaminant concentrations in ground water vary across both time and space. Therefore, it is important to consider the potential temporal variability of the data collected. Determination of the number of samples needed to characterize a site is dependent upon the objectives and the site-specific conditions. For example, if the objective of the event is to determine whether the site is contaminated, a limited number of samples from properly chosen locations will yield useful information. If, however, the site is contaminated and the objective is to establish the boundaries of the ground water contamination or trends in the data over time, a greater number of samples may be needed. Often statistical considerations can be helpful in determining sampling strategy.

C.2.3 Sample preservation and handling. Many chemical constituents and physicochemical parameters that are to be measured or evaluated in ground water monitoring programs are not chemically stable, and therefore sample preservation is required. Appropriate preservation techniques for various parameters and sample containers that should be used for each constituent or common set of parameters are specified in Appendix B. These preservation methods and sample containers are based on "Test Methods for Evaluating Solid Waste: Physical/Chemical Methods" (EPA/SW-846). Procedures and techniques for transporting the samples to the offsite laboratory are discussed in Instruction F-2 of Appendix F, "Packaging and Shipping Procedures." Improper sample handling may alter the analytical results of the sample, causing the results to be invalid. Samples should be transferred in the field from the sampling equipment directly into the container required for that analysis or set of compatible parameters. The sample should then be preserved in the field as specified in Appendix B. Because of the low analytical detection limits required for certain data uses, care must be taken when collecting the sample to avoid the loss/gain of any contaminants. The samples for volatile analysis should be carefully transferred directly from the sample collection device to the sample container to minimize contaminant loss through agitation/volatilization or adherence to another container. Samples should be collected in the order of the parameters listed in Section C.2.3.1. If more than one container is required per parameter, the sample should be split equally among all containers until filled. Containers used to collect samples for organic analyses should not be prerinsed with water because of the possibility of preservation loss or the loss/gain of contaminants that may taint the analytical results. Decisions to filter samples are dictated by sampling objectives. Consideration should be given to what the application of field filtration is trying to accomplish. For assessment of dissolved concentrations of major ions and trace metals, 0.1-• m filters are recommended, although 0.45-• m filters are normally used for most regulatory programs. In-line filtration is recommended because it provides better consistency through less sample handling and minimizes sample exposure to the atmosphere. Filters must be prerinsed following manufacturers' recommendations or using a minimum of 1 L of ground water following purging and before sampling. Further information on filtration considerations and consequences is given in Instruction E-1, Appendix E.

C.2.3.1 Sample containers. When metals are the analytes of interest, high-density polyethylene containers with polytetrafluoroethylene-lined polypropylene caps should be used. (Polytetrafluoroethylene is commonly referred to using the registered name of Teflon. Polytetrafluoroethylene will be referred to as PTFE.) When organics are the analytes of interest, glass bottles with PTFE-lined caps should be used. Refer to Appendix B or the specific analytical method for acceptable containers. Containers should be cleaned based on the analyte of interest. Instruction E-6, "Decontamination Procedures" (Appendix E), contains

additional information on appropriate glassware cleaning protocols. If precleaned bottles are used, the cleanliness of each lot of precleaned bottles should be verified by the container supplier or in the laboratory and appropriate paperwork (i.e., certificates) retained with other field documentation. Refer to Appendix B for information on the required size and type of sample containers. Samples should be collected and containerized in the order of the volatilization sensitivity of the parameters. The following is a preferred collection order for some common ground water parameters:

- Volatile organics (VOA)
- Purgeable organic carbon (POC)
- Purgeable organic halogens (POX)
- Total organic halogens (TOX)
- Total organic carbon (TOC)
- Extractable organics
- Total metals
- Dissolved metals
- Phenols
- Cyanide
- Sulfate and chloride
- Turbidity
- Nitrate and ammonia
- Radionuclides

C.2.3.2 Sample preservation. Methods of sample preservation are relatively limited and are generally intended to retard biological action, retard hydrolysis, and reduce sorption effects. Preservation methods are generally limited to pH control, chemical addition, cooling, and protection from light. Prepreserved sample containers are not recommended. Because different amounts of preservative may be necessary to bring the sample to the required pH, it is recommended to add the preservative to the container in the field and to verify that the pH of the sample has been achieved. This information should be documented within field logbooks. The sampler should refer to Appendix B or the specific preservation method in EPA/SW-846 for the appropriate preservation technique.

C.2.3.3 Special handling for VOA samples. Water samples to be analyzed for purgeable organic compounds should be stored in 40-mL vials with septum inserts and screw caps. The septum should be placed on the sample vial so that the PTFE side is in contact with the sample. The 40-mL vials should be completely filled to prevent volatilization. Extreme caution should be exercised when filling a vial to avoid any turbulence that could also produce volatilization. The sample should be carefully poured down the side of the vial to minimize turbulence. As a rule, it is best to pour the last few drops into the vial gently so that surface tension holds the water in a convex meniscus. The septum is then applied and some overflow is lost, but air space in the bottle is eliminated. After the bottle is capped, it should be turned over and tapped to

check for bubbles. If any bubbles are present, the procedure must be repeated. Care should be taken to ensure that no loss of preservative occurs, if applicable.

C.2.3.4 Special precautions for trace contaminant sampling. Contaminants can be detected in the parts per billion and/or parts per trillion ranges. Therefore, extreme care must be taken to prevent cross-contamination of these samples. The following general precautions should be taken when sampling:

- A clean pair of new disposable gloves should be worn each time a different location is sampled, and gloves should be donned immediately before sampling.
- To prevent cross-contamination between samples, it is suggested that the multiple VOA vials from each sampling location be sealed in a separate smaller plastic bag when the sampled medium is suspected of containing high concentrations of volatile organics.
- Sample containers filled with source or waste samples or samples suspected of containing high concentrations of contaminants should be placed in separate plastic bags immediately after collecting and preserving, and activated carbon should be included in the bags to prevent cross-contamination.
- If possible, background samples and source samples should be collected by different field teams. If different field teams cannot be used, all background samples should be collected first and placed in separate ice chests or shipping containers. Samples of waste or highly contaminated samples should never be placed in the same ice chest as environmental samples. It is good practice to enclose waste or highly contaminated samples in a plastic bag before placing them in ice chests. Ice chests or shipping containers for source samples or samples suspected to contain high concentrations of contaminants should be lined with new, clean plastic bags.
- If possible, one member of the field team should take all the notes, fill out sample tags, field sheets, etc., while the other members collect all of the samples.
- Sample collection activities should proceed progressively from the suspected least contaminated area to the suspected most contaminated area.
- Field personnel should use equipment constructed of PTFE, stainless steel, or glass that has been properly precleaned. PTFE or glass is preferred for collecting samples where trace metals are of concern.
- Adequate field control samples should be collected.

C.2.4 Sampling methods. Sampling instructions for the most common techniques for collecting ground water samples from ground water monitoring wells are presented in this section. A summary of the methods is presented in Table C-2. Additional information is presented in EPA/540/S-95/504, EPA/625/R-93/003a, ASTM D 4448, ASTM D 6232, and ASTM D 6452. Additional information on the installation, development, and decommissioning of monitoring wells can be found in ASTM Standards D 5092, D 5299, and D 5521. After installation, the well should be developed to remove any fine material adjacent to the well casing. Wells should not be sampled immediately after development, due to the time needed to reach chemical equilibrium with the well construction materials. This lag time may often extend beyond 1 week. Consequently, well development is not addressed in this sampling and analysis guidance document. Refer to EM 1110-1-4000 for further information on well development. Once a well has been

Table C-2
Summary of Ground Water Sampling Techniques

	Advantages				Disadvantages			
Method	Compatible Construction Material	Ease of Use	Economical	External Power Source Needed	VOC Degassing	Ease of Decontamination	Large Water Volumes	Restrictive Ground Water Depth
Bailer	●	●	●			●		
Submers-ible Pump	●			●	●		●	
Bladder Pump	●			●				
Hand Pump	●	●	●		●			
Centrifu-gal Pump			●	●	●		●	●
Peristaltic Pump	●			●	●	●		●
Air-Lift Pump		●		●	●		●	●
Passive Samplers	●	●	●					

located and properly identified, field measurements should be noted in a bound field logbook. A cross-reference should be made between the previously recorded physical location/identification locating the well to be sampled to ensure the proper well has been selected. Misidentification of a sampling point in the field will result in erroneous data that may affect management decisions. Also included in field measurements are the physical measurements of the well and its physicochemical parameters. Physical measurements that may be recorded in the field logbook include the presence and diameter of protective casing, diameter and construction material of the well casing, total depth of well from the top of casing, surveyors' mark, depth from top of casing to water, and the volume of water in the well and filter pack. The volume of water can be calculated by the submerged length of the well and calculating the volume of water in the submerged casing and filter pack. The total depth of the well should not be measured before sampling, but be obtained from well logs. Measuring to the bottom of the well casing may cause resuspension of settled solids from the formation materials and require longer purging times for turbidity equilibration. The well depth should be measured after sampling is complete. Volumes of water in various well casing diameters are listed in Table C-3.

Table C-3
Water Volume in Casing

Nominal Casing Diameter centimeters (inches)	Water Volume liters/linear meter (gallons/linear foot)
5.1 (2)	2.03 (0.16)
10.2 (4)	8.11 (0.65)
15.2 (6)	18.24 (1.47)
20.3 (8)	32.43 (2.61)
25.4 (10)	50.67 (4.08)
30.5 (12)	72.96 (5.88)

The volume of water in the filter pack should be calculated assuming a porosity of 30 percent within the filter pack. The volume of water present in the well casing and filter pack may be calculated as shown in the following example:

Assumptions: 2-in. well casing; well depth is 100 ft below ground surface, ground water depth is 20 ft below the ground surface, and the boring diameter is 8 in.

Volume of water in well = (well depth - depth to water) × (water volume in casing)
= (100 - 20) ft (0.1632 gal/ft)
= 13.0 gal

Volume of water in filter pack = (volume of filter pack) × 30%/231 in.^{3}/gal
= {[(•) (8 in.)^2/2] × 80 ft (12 in./ft)} × 0.3/231 in.^{3}/gal
= 58.7 gal

Total volume in well casing and filter pack = 13 gal + 58.7 gal
= 71.7 gal

The volume of water in any size casing can be determined using the following formula:

No. of gallons = $5.8752 \times C^2 \times H$

where C = casing diameter, ft

H = height of water column, ft

Besides the physical measurements taken as described previously and other information that may identify the well, physicochemical information such as dissolved oxygen, pH, specific conductance, temperature, and turbidity should be recorded initially (and in that order), during purging and before sampling (see Section C.2.4.1).

C.2.4.1 Well purging. To obtain a representative sample of ground water from a ground water monitoring well, the water that has stagnated and/or thermally stratified in the well casing must be purged or evacuated. The purging procedure allows fresh or representative ground water to enter the well. The optimum or preferred method to ensure that fresh water representative of the aquifer in contact with the well screen is being sampled is to perform a controlled sampling experiment. When indicator parameters such as specific conductance, pH, temperature, turbidity, and dissolved oxygen are stabilized, the well is presumed to be adequately flushed for the representative sample. In some instances, purging rates must be kept below 500 mL/min to avoid overpumping or pumping the well to dryness. Guidance on recommended stabilization criteria for the indicator parameters is included within the individual sampling equipment instructions. Ideally, wells should never be pumped to dryness. To accomplish this, pump rates may be adjusted, sometimes to less than 500 mL/min, and pumping times extended. Pumping with low-flow rates may also reduce the need for filtering water samples. Additional guidance on low-flow purging may be found in EPA/540/S-95/504. The volume of purging is significantly less in low-flow sampling, because the flow rate is designed to be low enough that flow is being induced only horizontally through the screen at a rate that replaces the evacuated water. This flow rate (typically 100-500 mL/min) will also have minimal effect on entraining particulates, which lowers the sample turbidity, which is crucial to metals analyses. The well can be purged or evacuated in several ways. In any instance it is paramount to ensure that the purging procedure does not cause cross-contamination from one well to the next. Therefore, the preferred method

employs dedicated equipment and pumps. Because, commonly, it may not be practicable to dedicate a pump to a specific well, it is permissible to decontaminate this equipment, using approved methods. Tubing should always be dedicated and never used for more than one well. The selection of an evacuation method most often relies on the depth to water (DTW) in the well. If the static DTW is less than 7.6 m (25 ft), a hand pump or bailer may be the best method for evacuation. If the static DTW is greater than 7.6 m (25 ft), a submersible pump should be used. As mentioned earlier, care must be taken to ensure that this does not act as a route of cross-contamination. Pumps should be decontaminated between well locations. During evacuation, pump intake must not be set greater than 1.8 m (6 ft) below the dynamic water level. This requires that the evacuation device be lowered as purging continues and the water level drops. Hand bailing may be utilized with a static water level greater than 7.6 m (25 ft) if a submersible pump is not available or with a static water level less than 7.6 m (25 ft) if other conventional pumps are not available. However, use of a bailer is not recommended because it has the potential to aerate the well water, produce inadequate removal of fines, concentrate floating product on the bailer that may introduce contamination, introduce contaminants from inside the well casing, and cause nonsteady removal of water, which may result in dilution instead of evacuation of the well. In general, the mechanics of the hand-bailing method for well purging may introduce contamination potential and variability. There are many pumps that may be used for well purging. Not all pumps are acceptable under all conditions. The preferred and most commonly used pumps are centrifugal and peristaltic pumps (when depth to water is less than 7.6 m (25 ft)) and submersible pumps (when depth to water is greater than 7.6 m (25 ft)). Information on various pumps and methods of purging is provided later in this instruction. Recent studies have found that some in situ ground water sampling devices minimize or eliminate the need for purging (EPA/600/S4-90/028). These devices are stand-alone systems installed directly into the subsurface and are not used to sample existing ground water monitoring wells. For existing ground water monitoring wells, innovative samplers have been developed that sample the ground water monitoring well without the need to purge the well initially. These diffusion samplers have shown through case studies to be an effective means of acquiring volatile organic compound (VOC) samples (Vroblesky and Hyde 1997). Occasionally, a light, nonaqueous phase layer (LNAPL) (floating product) may be present in a monitoring well designated for sampling. If it is suspected that the well contains an LNAPL, an interface probe should be used to verify its presence. If an LNAPL is present, the thickness should be measured and an appropriate inert bailer should be used to collect a sample of the floating product. Whenever possible, measurements of the free product should be taken using either steel tape and paste or an interface probe. A bailer can significantly under- or overestimate the thickness of free product in the well and should not be used for determining the elevations of air/free product and free product/water interfaces. The use of bailers should be limited to verification of the presence of free product in a well or collection of a sample of it (EPA/510/R-96/001). Collection of a ground water sample may not be appropriate if an LNAPL is present in the well, for the sampler will likely become contaminated as it passes through the LNAPL to reach and sample the ground water below.

C.2.4.2 Bailers. Bailers are one of the simplest and most commonly used sampling methods for sampling ground water monitoring wells (Figure C-1).

C.2.4.2.1 Applicability. Bailers are constructed of a variety of materials compatible with the parameter of interest. They are economical and convenient enough that a separate bailer may be dedicated to each well to minimize cross-contamination. An external power source is not required. Bailers provide a low surface-to-volume ratio, which reduces degassing of VOCs. Cross-contamination can be a problem if the bailer is not adequately decontaminated. Bailers offer a relatively limited sample volume and may not be desirable for purging a well if large amounts of water need to be removed from the well for purging. The sampling technique used with bailers may, however, cause a surging action on the well, which may increase the turbidity of the well sample. Consequently, bailers have a higher potential for loss of volatiles and are not recommended for either volatile or metals sampling. Where representative numbers for metals and

volatiles are required, it is recommended that the low-flow procedures detailed in Section C.2.4.9 be utilized.

C.2.4.2.2 Method summary and equipment. Bailers are manufactured in numerous types, sizes, and construction materials. Bailers are typically weighted lengths of pipe attached to a cord with a check valve at the lower end. They are typically constructed of PVC, PTFE, or stainless steel. The PTFE bailer is recommended if the bailer is used to collect ground water samples for VOC analysis. Bailers can be dedicated to a specific well, i.e., used only for purging and sampling that well. Dedicated bailers are typically stored to prevent cross-contamination or, less preferably, left hanging in the well itself. It should be noted that stainless steel bailers left stored in a well will likely rust under high-humidity conditions. The bailer should be decontaminated after each use. Disposable bailers are also available and are cost-effective for certain investigations. Haul lines for bailers may consist of PTFE-coated stainless steel cable, polyethylene rope, or nylon rope. Of these three, nylon rope is the least desirable because it may introduce contaminants. The use of braided rope is discouraged, because it cannot be decontaminated. For each sampling event, the rope for dedicated bailers should be changed following purging and before sampling. For nondedicated bailers, rope should be changed between wells. After removal, the rope should be properly discarded.

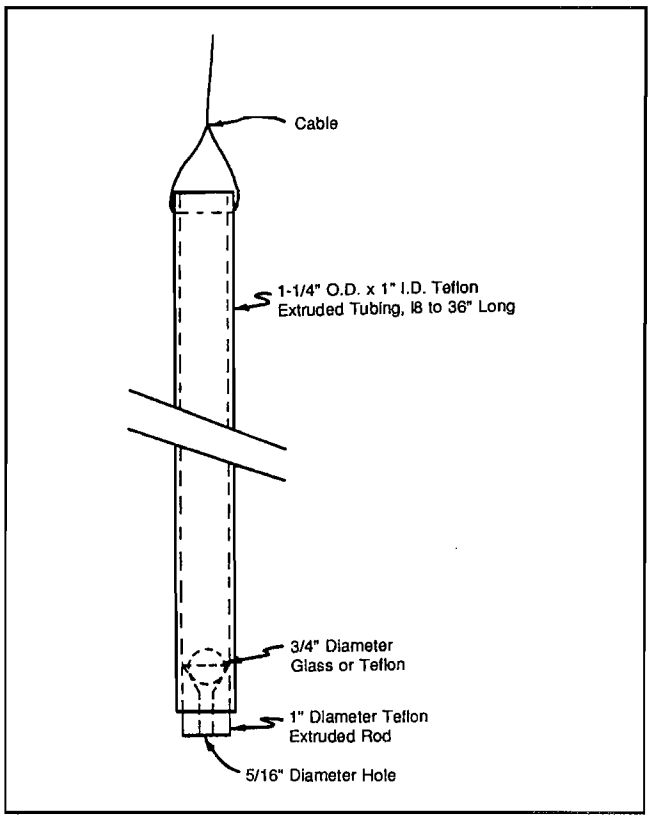

Figure C-1. Bailer (to convert dimensions to mm, multiply by 25.4)

C.2.4.2.3 Sampling procedure.

- Prepare the work area outside the well by placing plastic sheeting on the ground to avoid cross-contamination.
- Determine the saturated water column in the well using an electronic water level indicator. Calculate the fluid volume in the casing and determine the amount of water to be removed for purging.
- Attach a decontaminated bailer to cable or line for lowering, or use dedicated bailer already in well.
- Lower bailer slowly until it contacts water surface.
- Allow bailer to sink and fill with a minimum of surface disturbance.
- Slowly raise bailer to surface. Do not allow bailer line or bailer to contact ground.

- Purge well until the dissolved oxygen (DO), pH, specific conductance, temperature, and turbidity are each at equilibrium, and begin sampling. Equilibrium is established as follows: ±10 percent for DO, ±0.2 pH units, ±3 percent for specific conductance, ±1 degree Celsius for temperature, and ±10 percent for turbidity. (If redox potential is used as an indicator, ±10 mV should be used as the stabilization criterion.)

- Ensure that equilibrium is established by making three consecutive readings, where one casing volume is pumped between each reading.

- Collect VOA samples first following guidelines specified within this appendix.

- Fill sample bottles for remaining parameters by tipping bailer to allow slow discharge from top to flow gently down the side of the sample bottle with minimum entry turbulence. If a bottom drain is present on the bailer, recommended that a slow steady flow be achieved.

- Repeat these steps as needed to acquire sufficient volume to fill all sample containers.

- Preserve the sample as necessary and verify that the pH is sufficient for the criteria.

- Verify that a PTFE liner is present in the cap. Secure the cap tightly.

- Label the sample bottle with an appropriate label. Be sure to include all necessary information.

- Place filled sample containers on ice immediately along with the required trip blank, if analyzing for VOCs.

- Record the information in the field logbook and field sheet, and complete all chain-of-custody documents (see Instruction F-1, "Documentation," in Appendix F).

- Thoroughly decontaminate the bailer after each use, regardless of whether the bailer is dedicated to one well or used to sample other wells.

- Close well.

C.2.4.3 Portable submersible pump. Portable submersible pumps are an effective technique for pumping large volumes of water at a steady rate but require an external electrical power source.

C.2.4.3.1 Applicability. Advantages of submersible pumps include their ability to pump variable amounts from various depths. This advantage makes these pumps applicable not only for purging and sampling but also for aquifer characterization tests. Pumping rates for various units range from as little as 100 mL per minute to 3,784 L per minute (1,000 gpm). The pumping rate for most units can be individually adjusted. Disadvantages of submersible pumps are that they require an external electrical power source and may be difficult to decontaminate between wells. The propeller construction of the pump assembly may cause degassing of volatile organic compounds; therefore, some states or USEPA regions may restrict the use of submersible pumps when sampling for VOCs.

C.2.4.3.2 Method summary and equipment. For submersible pumps, the pump assembly, the electric drive motor, and associated hoses and electrical cables are suspended from a steel cable or discharge pipe and submerged in the well. Intake is typically located between the motor and the pump assembly.

Horsepower, head, and lift capacity range widely. Submersible pumps are available for 5-cm (2-in.) and larger wells. Some pumps are constructed of stainless steel and PTFE to maintain sample integrity. Submersible pumps far exceed the pumping limitations of other sampling equipment.

C.2.4.3.3 Sampling procedure. Recommended sampling procedures are as follows:

- Prepare the work area outside the well by placing plastic sheeting on the ground to avoid cross-contamination.
- Determine the saturated water column in the well using an electronic water level indicator. Calculate fluid volume in the casing and determine the amount of water to be removed for purging.
- Lower the decontaminated pump to below the water level and begin pumping. Collect or dispose of purged water in an acceptable manner. Lower the pump as required to maintain submergence.
- Measure rate of discharge frequently. A bucket and stopwatch are commonly used.
- Purge well until the DO, pH, specific conductance, temperature, and turbidity are each at equilibrium, and begin sampling. Equilibrium is established as follows: ±10 percent for DO, ±0.2 pH units, ±3 percent for specific conductance, ±1 degree Celsius for temperature, and ±10 percent for turbidity. (If redox potential is used as an indicator, ±10 mV should be used as the stabilization criterion.)
- Ensure that equilibrium is established by making three consecutive readings, where one casing volume is pumped between readings.
- Reduce the pump discharge rate to less than 500 mL/min. Collect VOA samples first following guidelines specified within this appendix.
- Fill bottles for remaining parameters by allowing pump discharge to flow gently down the side of the bottle with minimal entry turbulence. Cap each bottle as filled.
- Preserve the sample as necessary and verify that the pH is sufficient for the criteria.
- Ensure that the PTFE liner is present in the cap. Secure the cap tightly.
- Label the sample bottle with an appropriate label. Be sure to complete the label with all necessary information.
- Place filled sample containers on ice immediately, along with the required trip blank, if analyzing for VOCs.
- Complete chain-of-custody documents, field logbook, and field sheet (see Instruction F-1, "Documentation," in Appendix F).
- Pull pump and allow system to drain and decontaminate.
- Close well.

C.2.4.4 Bladder pump. Bladder pumps employ a closed collection system that eliminates agitation and air or gas contact with the sample (Figure C-2).

C.2.4.4.1 Applicability. Advantages of the bladder pump include its ideal design for sampling wells for VOC analysis from wells as small as 5 cm (2 in.) in diameter. The pump can pump water from various depths and at adjustable rates. It can operate in low-yielding wells without the possibility of burning out the pump if the well is pumped dry. The inlet for the pump body is typically at the lower end, thus requiring minimum submergence. Top-ended inlet pumps are also available for floating product recovery. Disadvantages of the bladder pump include its relatively low pumping rate. It also requires an outside power source of compressed air or gas and may be difficult to decontaminate between wells.

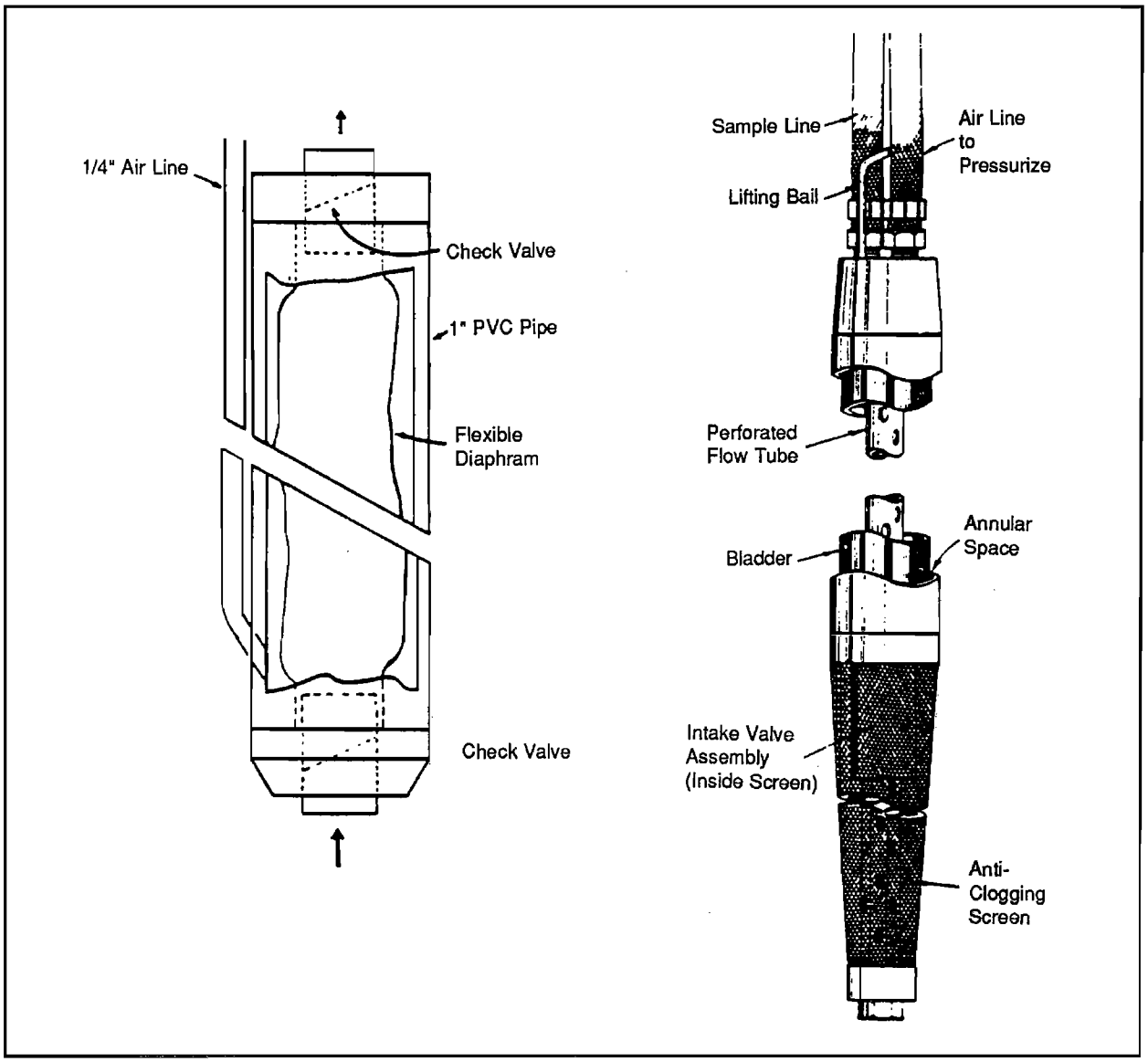

Figure C-2. Bladder pump (to convert dimensions to mm, multiply by 25.4)

C.2.4.4.2 Method summary and equipment. The closed system provides the best method available for sampling wells for VOCs. The pump fills through a lower check valve under hydrostatic pressure, collapsing the bladder in the pump body. The bladder is then pressurized with gas or air causing it to expand, thus applying pressure in the pump body. The bladder is pressurized using a control box and air compressor assembly. This in turn closes the lower check valve and forces the contents of the pump body up through the sample line check valve. Venting the bladder will allow the pump to refill and begin another cycle. An inflatable packer is often used in conjunction with bladder pumps to reduce the amount of water to be purged for sampling. The packer is often positioned immediately above the well screen so that only water in the screened area of the well will require purging once the packer is properly inflated.

C.2.4.4.3 Sampling procedure. Recommended sampling procedures are as follows:

- Prepare the work area outside the well by placing plastic sheeting on the ground to avoid cross-contamination.

- Determine the amount of water to be removed for purging. Determine the saturated water column in the well using an electronic water level indicator. Calculate the fluid volume in the casing if an inflatable packer is not present in the well. If an inflatable packer is present in the well, refer to construction diagrams of the well to determine the saturated water column below the packer. Make sure that the packer is not within the screened interval.

- Attach a pressurized air hose to the packer connection (if present) and inflate packer to proper pressurization level, typically 60 to 80 psi. After the packer is inflated, reattach pressurized air hose to the bladder pump connection and purge the well as discussed in Section C.2.4.4.2.

- Measure the rate of discharge frequently. A bucket of known volume and a stopwatch are commonly used.

- Purge well until the DO, pH, specific conductance, temperature, and turbidity are each at equilibrium, and begin sampling. Equilibrium is established as follows: ±10 percent for DO, ±0.2 pH units, ±3 percent for specific conductance, ±1 degree Celsius for temperature, and ±10 percent for turbidity. (If redox potential is used as an indicator, ±10 mV should be used as the stabilization criterion.)

- Ensure that equilibrium is established by making three consecutive readings, where one casing volume is pumped between each reading.

- Collect VOA samples first following guidelines specified within this appendix.

- Fill sample bottles of remaining parameters by allowing pump discharge to flow gently down the side of the bottle with minimal entry turbulence. The pump discharge rate should be less than 500 mL/min. Cap each bottle as filled.

- Preserve the sample as necessary and verify that the pH is sufficient for the criteria.

- Check that a PTFE liner is present in the cap. Secure the cap tightly.

- Label the sample with an appropriate label. Be sure to complete the label with all necessary information.

- Place filled sample containers on ice immediately along with the required trip blank, if analyzing for VOCs.

- Complete chain-of-custody documents, field logbook, and appropriate field sheet (see Instruction F-1, "Documentation," in Appendix F).

- Depressurize packer (if present), remove the pump, and close well.

C.2.4.5 Hand pumps. Hand pumps are positive displacement pumping systems designed for developing, purging, and sampling (for some analyses) 5-cm (2-in.) or larger ground water monitoring wells.

C.2.4.5.1 Applicability. Hand pumps do not require an external power source. Units are easily transported. A sustained pumping rate can be achieved. The hand pump could cause cross- contamination if the unit is not thoroughly decontaminated. The hand pump may not be suitable for collecting samples for VOCs because the pump creates a vacuum pressure on the water during operation, which may result in degassing of volatile compounds.

C.2.4.5.2 Method summary and equipment. Hand pumps are readily transportable and can be used to provide sampling in remote areas. Hand operation enables the user to vary the pumping rate to more than 4 gpm at depths exceeding 30 m (100 ft). Hand pumps are typically constructed of offset sizes of PVC piping and check valves. Typically, a small-diameter pipe resides within a larger diameter pipe. The small-diameter pipe is forced up and down and the resulting movement creates a positive displacement.

C.2.4.5.3 Sampling procedure. Recommended sampling procedures are as follows:

- Prepare the work area outside the well by placing plastic sheeting on the ground to prevent cross-contamination.

- Determine the saturated water column in the well using an electronic water level indicator. Calculate the fluid volume in the casing and determine the amount of water to be removed for purging..

- Lower the decontaminated hand pump assembly into the well and begin operating the pump in a steady motion.

- Measure the rate of discharge frequently. A bucket of known volume and a stopwatch are commonly used.

- Purge well until the DO, pH, specific conductance, temperature, and turbidity are each at equilibrium, and begin sampling. Equilibrium is established as follows: ±10 percent for DO, ±0.2 pH units, ±3 percent for specific conductance, ±1 degree Celsius for temperature, and ±10 percent for turbidity. (If redox potential is used as an indicator, ±10 mV should be used as the stabilization criterion.)

- Ensure that equilibrium is established by making three consecutive readings, where one casing volume is pumped between each reading.

- Collect VOA samples first.

- Fill sample bottles for remaining parameters by allowing pump discharge to flow gently down the side of the bottle with minimal entry turbulence. The pump discharge rate should be less than 500 mL/min. Cap each bottle as filled.

- Preserve the sample as necessary and verify that the pH is sufficient for the criteria.

- Check that a PTFE liner is present in the cap. Secure the cap tightly.

- Label the sample with an appropriate label. Be sure to complete the label with all necessary information.

- Place filled sample containers on ice immediately along with the required trip blank, if analyzing for VOCs.

- Complete chain-of-custody documents, field logbook, and appropriate field sheet (see Instruction F-1, "Documentation," in Appendix F).

- Remove the pump assembly and decontaminate.

- Close the well.

C.2.4.6 Centrifugal pump. A centrifugal pump is a type of suction pump used to purge wells.

C.2.4.6.1 Applicability. Advantages of centrifugal pumps include their ability to provide substantial pumping rates and their ready availability. Disadvantages are that they require an external power source and may be difficult to decontaminate between wells. The materials with which these pumps are constructed may frequently be incompatible with certain sample analytes. The centrifugal pump is not suitable for collecting samples for VOC analysis because the pump creates a vacuum pressure on the water during operation, which results in degassing of volatile compounds. These pumps cannot pull water more than 6 m (20 vertical ft).

C.2.4.6.2 Method summary and equipment. Centrifugal pumps are a type of suction pump. An impeller rotating inside the pump chamber discharges water by centrifugal force. The resulting pressure drop in the chamber creates a suction that causes water to enter the intake pipe in the well. Since entrance of water into the intake depends on atmospheric pressure, the height of the intake lift is limited to about 6 m (20 ft) at sea level and less at higher altitudes. Discharge rates from 19 to 151 L per minute (5 to 40 gpm) can be attained and water can be pushed as high as 46 m (150 ft) above the pump. Pumps are typically motorized by a small gasoline engine attached to the pump.

C.2.4.6.3 Sampling procedure. Recommended sampling procedures are as follows:

- Prepare the work area outside the well by placing plastic sheeting on the ground to avoid cross-contamination.

- Determine the saturated water column in the well using an electronic water level indicator. Calculate the fluid volume in the casing and determine the amount of water to be removed for purging.

- Lower decontaminated intake hose into well.

- Prime pump with distilled water and start pump.

- Containerize or discharge purge water accordingly.

- Measure the rate of discharge frequently. A bucket of known volume and a stopwatch are commonly used.

- Purge well until the DO, pH, specific conductance, temperature, and turbidity are each at equilibrium, and begin sampling. Equilibrium is established as follows: ±10 percent for DO, ±0.2 pH units, ±3 percent for specific conductance, ±1 degree Celsius for temperature, and ±10 percent for turbidity. (If redox potential is used as an indicator, ±10 mV should be used as the stabilization criterion.)

- Ensure that equilibrium is established by making three consecutive readings, where one casing volume is pumped between each reading.

- Collect VOA samples first.

- Fill sample bottles for remaining parameters by allowing pump discharge to flow gently down the side of the bottle with minimal entry turbulence. The pump discharge rate should be less than 500 mL/min. Cap each bottle as filled.

- Preserve the samples as necessary and verify that the pH is sufficient for the criteria.

- Check that a PTFE liner is present in the cap. Secure the cap tightly.

- Label the sample bottle with an appropriate label. Be sure to complete the label with all necessary information.

- Place filled sample containers on ice immediately, along with the required trip blank, if analyzing for VOCs.

- Complete chain-of-custody documents, field sheet, and field logbook (see Instruction F-1, "Documentation," in Appendix F).

- Close the well.

C.2.4.7 Peristaltic pump. Peristaltic pumps operate in a manner similar to that of centrifugal pumps but displace the fluid by mechanical peristalsis (Figure C-3).

C.2.4.7.1 Applicability. An advantage of the peristaltic pump is its design, which isolates the sample from the moving part of the pump and allows for easy decontamination by removal or replacement of the flexible tubing. Tubing can be dedicated to wells to reduce decontamination time. Disadvantages of these pumps include their low pumping rates and their limited height of intake lift (less than 6 m (20 ft)). These pumps also require an outside power source and, like other suction pumps, are not suitable for collecting samples for VOC analysis because of potential degassing effects.

C.2.4.7.2 Method summary and equipment. A flexible sampling tube is mounted around the pump chamber, and rotating rollers compress the tubing, forcing fluid movement ahead (the peristaltic effect) and

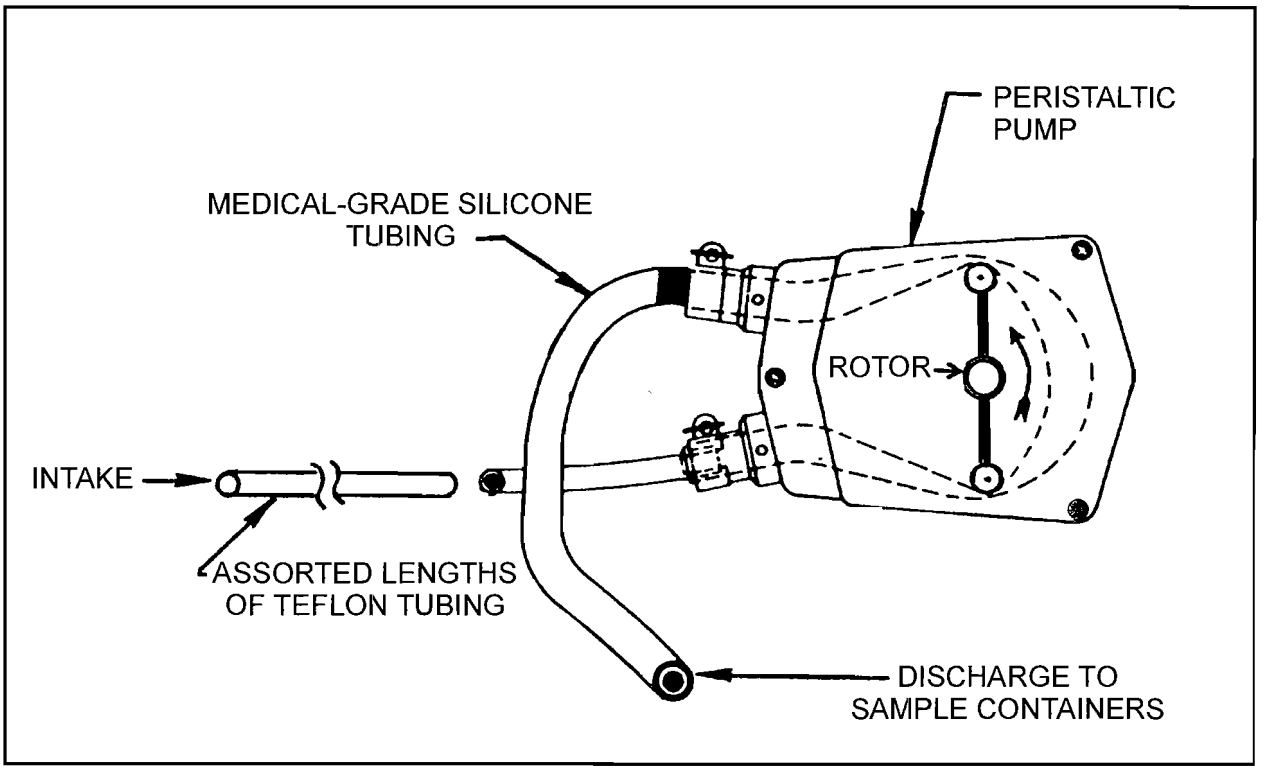

Figure C-3. Peristaltic pump

inducing suction behind each roller (Figure C-3). Peristaltic pumps generally have very low pumping rates suitable only for sampling shallow water tables in small-diameter wells.

C.2.4.7.3 Sampling procedures. Recommended sampling procedures are as follows:

- Prepare the work area outside the well by placing plastic sheeting on the ground to avoid cross-contamination.

- Determine the saturated water column in the well using an electronic water level indicator. Calculate the fluid volume in the casing and determine the amount of water to be removed for purging.

- Install clean medical-grade silicone tubing in the peristaltic pump head and attach the silicone tubing to the glass tubing outlet from the sample bottle.

- Attach the inlet glass tubing from the sample bottle to the required length of new PTFE suction line and lower to the midpoint of the well screen, if known, or slightly below the existing water level.

- Purge well until the DO, pH, specific conductance, temperature, and turbidity are each at equilibrium, and begin sampling. Equilibrium is established as follows: ±10 percent for DO, ±0.2 pH units, ±3 percent for specific conductance, ±1 degree Celsius for temperature, and ±10 percent for turbidity. (If redox potential is used as an indicator, ±10 mV should be used as the stabilization criterion.)

- Ensure that equilibrium is established by making three consecutive readings, where one casing volume is pumped between each reading.

- Collect VOA samples, if required, with a bailer following guidelines established within this appendix.

- Fill sample bottles for remaining parameters by allowing pump discharge to flow gently into the bottle with minimal entry turbulence. Pump discharge should be less than 500 mL/min. Cap each bottle as filled.

- Preserve the samples as necessary and verify that the pH is sufficient for the criteria.

- Verify that a PTFE liner is present in the cap. Secure the cap tightly.

- Label the sample bottle with an appropriate label. Be sure to complete the label with all necessary information.

- Place filled sample containers on ice immediately along with the required trip blank, if analyzing for VOCs.

- Complete chain-of-custody documents, field sheet, and field logbook (see Instruction F-1, "Documentation," in Appendix F).

- Allow system to drain, then disassemble. Decontaminate or replace tubing for next sampling.

- Close the well.

C.2.4.8 Air lift pump. Air lift pumps are usually used for developing or purging recovery wells rather than monitoring wells because of their ease of use and their ability to maintain moderate flow rates. Air lift pumps are not recommended for sampling monitoring wells. Because of the contact with well water and the source gas, the sample could be chemically altered. Depending on the source gas, the pH could be altered, oxidation and degassing of VOCs could occur, and lubricating oils from the air compressor could be introduced.

C.2.4.9 Low-flow (minimal-drawdown) sampling. This method uses any adjustable rate pump that can maintain low flow (typically less than 0.5 L/min) and minimize drawdown. Drawdown ideally should be less than <10 cm (4 in.) during the entire purging and sampling process. Typically used pumps include submersible centrifugal pumps, bladder pumps, and peristaltic pumps. Some pumps are better suited than others, given the well and aquifer constraints. Submersible pumps, for example, have reportedly had difficulty maintaining low flow in shallow 6- to 7.6-m (<20- to 25-ft) aquifers and may overheat under those circumstances. Additional equipment required includes an electronic water level indicator (accurate to 0.3 cm (± 0.01 ft), a multiparameter probe (dissolved oxygen, turbidity, redox potential, pH, temperature, and specific conductivity), and a flow-through cell compatible with the probe.

C.2.4.9.1 Applicability. Low-flow sampling is generally applicable in any instance where a representative nonturbid sample of the aquifer is desired. It is particularly appropriate in low-yield formations where the well would go dry if pumped at higher rates. It is also important to use low-flow techniques in wells that produce samples with high turbidity, which can result in high metals analytical results. Low-flow sampling induces a lower velocity through the screen, which entrains fewer particulates.

Another important advantage is that less purge water is produced, significantly decreasing the costs for handling and disposing of Investigation Derived Wastes (IDW). To implement low-flow sampling appropriately, the water level in the well being sampled needs to be monitored continuously, and the actual flow rate must be measured and adjusted to maintain drawdown in the well to less than 10 cm (4 in.).

C.2.4.9.2 Method summary and equipment. The pump must also be inserted into the well in a way that minimizes the disturbance of any sediments within the well casing, particularly those in the bottom of the well. In no circumstances should the water level probes or pumps be allowed to hit the bottom of the well before or during sampling. If possible the point where water enters the pump should be at least 0.6-0.9 m (2-3 ft) above the bottom of the well. The pump should be turned on at the lowest setting possible, and that setting should be raised gradually until a continuous flow is achieved from the discharge tube. During this time the water level needs to be monitored and the flow rate adjusted to maintain the drawdown to less than 10 cm (4 in.) if possible. In no circumstances should the water level be allowed to break suction in the pump. The pump is to be turned off when that happens and turned on again when sufficient recharge has occurred. If there is a stagnant column of water in the casing above the screen, it is essential that the water level not be allowed to come down to the screen. If this should appear imminent, the pump should be shut off and the well allowed to recover before purging continues. There are wells that even at pumping rates of 100-200 mL/min will not be able to recharge sufficiently. In those circumstances the sampling team needs to reassess the sampling goals for that location and determine whether there are other more appropriate ways to obtain a representative sample. To successfully monitor the representativeness of the water sample the most sensitive parameters (DO, redox potential, and turbidity) must be measured along with the traditional parameters of pH, temperature, and conductivity. To accurately measure DO and redox requires the use of a flow-through cell, which allows water to be pumped directly from the well and contact the probe(s) without contacting the atmosphere. There is no acceptable alternative to the flow-through cell for accurate measurement of DO and redox. Readings should be taken of all parameters every 3-5 minutes. If after three casing volumes have been removed from the well the turbidity is not <5, this should be noted in the log and the samples should be collected.

C.2.4.9.3 Sampling procedures. Recommended sampling procedures are as follows:

- Prepare the work area outside the well by placing plastic sheeting on the ground to avoid cross-contamination.

- Determine the saturated water column in the well using an electronic water level indicator. NOTE: Do not tag the bottom of the well since the total depth should be on the well construction diagram. Anything that hits the bottom of the well risks disturbing any fines that are there, and they may subsequently be entrained in the sample. Calculate the fluid volume in the casing and determine the amount of water to be removed for purging.

- Connect the pump tubing to the flow-through cell and connect the multiparameter probe to the cell.

- Purge well until the DO, pH, specific conductance, temperature, and turbidity are each at equilibrium, and begin sampling. Equilibrium is established as follows: ±10 percent for DO, ±0.2 pH units, ±3 percent for specific conductance, ±1 degree Celsius for temperature, and ±10 percent for turbidity. (If redox potential is used as an indicator, ±10 mV should be used as the stabilization criterion.)

- Establish equilibrium by making three consecutive readings, with 3 to 5 minutes between each reading.

- Detach the tubing from the flow-through cell and collect VOA samples first.
- Collect VOA samples, if required, following guidelines established within this appendix. Fill sample bottles for remaining parameters by allowing pump discharge to flow gently into the bottle with minimal entry turbulence. Pump discharge should be less than 500 mL/min. Cap each bottle as filled.
- Preserve the samples as necessary and verify that the pH is sufficient for the criteria.
- Verify that a PTFE liner is present in the cap. Secure the cap tightly.
- Label the sample bottle with an appropriate label. Be sure to complete the label with all necessary information.
- Place filled sample containers on ice immediately along with the required trip blank, if analyzing for VOCs.
- Complete chain-of-custody documents, field sheet, and field logbook (see Instruction F-1, "Documentation," in Appendix F).
- Allow system to drain, then disassemble. Decontaminate or replace tubing for next sampling.
- Close the well.

C.2.4.10 Emerging and innovative sampling procedures. All of the standard samplers described in this appendix for the sampling of ground water disrupt equilibrium during the sampling event to some degree. This may lead to obtaining a sample that is not representative of the actual environmental conditions or contaminant concentrations. New sampling devices and sampling procedures have been designed to minimize the disturbance to the medium during sampling, circumvent the need to purge the well, and minimize the influence on and any bias to the results that this disturbance, the stagnant water above or below the well screen, or fines contained within the monitoring well may impose. Recent studies have shown the application of diffusion samplers to the acquisition of samples for VOCs, a chemical parameter susceptible to loss from the disturbance imposed by purging and sampling (Vroblesky and Hyde 1997). The diffusion samplers are constructed of polyethylene bags containing deionized water that is strategically hung within the screened interval of the monitoring well and left for a predetermined time (e.g., 11-54 days). Polyethylene is shown to allow the transmission of various halogenated and aromatic VOCs, and is used as a semipermeable membrane to allow the diffusion of VOCs from the ground water to the deionized water contained within the bags. The sampler may also be designed to have multiple discrete cells that are vertically separated. This configuration allows the monitoring of VOC concentrations as they pertain to different depth intervals. After the sampling period, the diffusion samplers are collected from the wells by the attached strings, and the water is gently poured from the sampler into 40-mL VOA vials through the PTFE stopcock. Samples are then processed in the same manner as other sampling techniques. The diffusion samplers are commercially available; easy to deploy, retrieve, and sample; and an inexpensive alternative for the acquisition of VOC samples in ground water monitoring wells or other water bodies.

C.2.4.11 Decontamination procedures. All equipment that will enter the well must be decontaminated before entry. The inside surface of pumps and tubing apparatus must be decontaminated by drawing the decontamination solution through the equipment. Field measurement equipment such as water level indicators should be cleaned as described in Instruction E-6, Appendix E. If the sampling equipment is being

prepared for later use, it should be wrapped in cleaned foil. The sampling equipment should remain wrapped in this manner until immediately before use. Additional sampling devices may be needed onsite to ensure an adequate drying time. The requirement for dedicated equipment should apply to all bailers used for collecting samples. Bailers, other sampling equipment, and sample bottles must be physically separated from generators during transport and storage. Decontamination procedures for field equipment are discussed in Instruction E-6 (Appendix E).

C.2.4.12 Field control sample requirements. Field control samples are collected by the sampling team to determine whether the data are of suitable quality. They include blanks, replicates, and/or background (upgradient) samples. Quality Assurance (QA) samples are replicates sent to a referee (QA) laboratory and analyzed to evaluate the contractor's laboratory performance. Quality Control (QC) samples are blind replicates collected by the sampling team for analysis by the primary laboratory. A detailed discussion of field control samples is contained in Instruction G-2 (Appendix G).

C.2.4.13 Documentation requirements. Bound field logbooks should be used for the maintenance of field records. Record all aspects of the site setup and sample collection and handling as outlined previously and in Instruction F-1 of Appendix F.

C.3 Surface Water Sampling

C.3.1 Scope and application.

C.3.1.1 This instruction presents guidelines for collecting representative samples from surface water bodies. Surface water bodies can be classified into two primary types: flowing and standing. Flowing bodies include industrial effluent, municipal wastewater, rivers, sewers, leachate seeps, streams, or any other lotic water body. Standing bodies include lagoons, ponds, nonaqueous (e.g., surface impoundments), lakes, or any other lentic water body. Surface water samples can be collected from various depths of the water bodies using some of the techniques described herein. Instructions for sampling surface water bodies using the following techniques are included: hand-held bottle, dipper, pond sampler, peristaltic pump, Kemmerer sampler, weighted bottle, and Bacon bomb sampler.

C.3.1.2 Storm water runoff sampling is another type of surface water sampling done to acquire the qualitative and quantitative data necessary to complete National Pollution Discharge Elimination System (NPDES) storm water permits, and to determine the effectiveness of storm water management plans. NPDES permits are issued by the state for permanent areas that due to their purpose or mission (e.g., petroleum, oils, and lubricants (POL), runway, hazardous waste (HW) storage area) may pose a potential environmental risk from storm water runoff through the area. The permit should define the appropriate sampling locations and testing requirements based on the location and types of contaminant sources present and site topography. Sampling of storm water runoff is based on simple standard sampling techniques to acquire representative grab and composite samples from key runoff locations to monitor for visual properties and analytical chemistry parameters as defined by the NPDES permit. Further details on storm water runoff sampling requirements may be found in 40 CFR 122.21(g)(7), 40 CFR 136, and EPA/833/B-92/001.

C.3.2 Sampling strategies. Sampling strategies are developed by the project team to satisfy project-specific data needs that are identified in the HTRW technical planning process. The sampling strategy developed for a particular site will influence several project decisions, including but not limited to sampling locations, types of samples, sampling frequency, and sampling and analytical protocols. For instance, ecological risk assessment may require the need for colocated surface water and sediment samples. Sampling strategies may be significantly influenced by such factors as physical site constraints, safety, and cost, to name a few. The technical planning process that results in the development of the sampling strategy is critical because of the difficulty in acquiring representative surface water samples, the reduction of contaminant action levels, and the problems associated with trace level cross-contamination. Successful investigations of hazardous waste sites are highly dependent on an effective sampling scheme. Development of a sampling scheme to characterize a hazardous waste site should follow the fundamentals of the scientific approach. A successful sampling scheme requires a logical design to allow an evaluation of potential contaminants in relation to background conditions, vertical extent, horizontal extent, and mobility in various media. Regulations covering storm water runoff sampling require that it be performed during a qualifying storm event. The following criteria must be met for the storm event to qualify and the resulting data to be considered a valid data record: the storm event must be preceded by 72 hours of dry weather (rainfall <2.5 cm (<0.1 in.)), the variance in the duration and total rainfall of the storm event may not exceed 50 percent of the average storm event, the storm must produce greater than 2.5 cm (0.1 in.) of rain, and the storm must produce runoff.

C.3.2.1 Sampling locations. Sampling at hazardous waste sites is usually conducted in an attempt to identify contamination and to define its extent and variability. With such an objective, it is most logical to choose sample locations that will yield the most information about site conditions. However, other factors such as accessibility, sampling equipment requirements, and demands on the sampling team need to be considered when selecting locations. When a site is evaluated, sampling can be conducted by random, systematic, or biased sampling. Biased samples are those collected at locations that were chosen based on

historical information, knowledge about the behavior of the contaminants, and/or knowledge about the effects of the physical system on the fate of the contaminant. Random sampling depends on the theory of random chance probabilities to choose the most representative sample. Often biased and random sampling techniques can be used together to address an entire site thoroughly. Some samples may be biased to potentially contaminated areas or potentially impacted areas (e.g., downstream from discharge pipe). In areas less likely to be contaminated or areas with little available background information, random samples may be used to allow adequate assessment of the entire site. Due to the nature of the media, locations for surface water samples are restricted to locations within the water body under evaluation. However, variations of those within the water body may include depth, horizontal location, and time. Storm water runoff sampling locations are defined within the NPDES permit based on the mission and purpose of the evaluated areas and the site topography. Each sample location is defined by the facility name and outfall number.

C.3.2.2 Types of samples. The type of sample should be designated when selecting a sampling method. Surface water samples may be discrete (grab) or composite samples. A discrete (grab) sample is defined as a discrete aliquot representative of a specific location at a given point in time. The sample is collected at one particular point in the sample matrix. The representativeness of such samples is defined by the nature of the materials being sampled. In general, as sources vary over time and distance, the representativeness of grab samples will decrease. Composites are samples composed of two or more specific aliquots (discrete samples) collected at various sampling locations and/or different points in time. Analysis of this type of sample produces an average value and can, in certain instances, be used as an alternative to analyzing a number of individual grab samples and calculating an average value. It should be noted, however, that compositing can mask the presence of contaminants by diluting isolated concentrations of analytes that may be present in the environmental matrix. Regulations covering storm water runoff sampling require that both grab and flow-weighted composite samples be collected. Grab storm water samples are discrete samples, normally collected within the first 30 minutes after the onset of runoff from the storm event or as soon as practicable, but no later than within the first 60 minutes of storm water runoff discharge. To comply with 40 CFR 136, grab sampling techniques are required for several potential analytical chemistry parameters (e.g., pH, temperature, VOCs, oil and grease, fecal coliform, fecal streptococcus, cyanide, total phenols, and residual chlorine). Flow-weighted composite samples are taken during the first 3 hours (or an entire event if less than 3 hours in length) of the storm event. It is a mixed sample from one location, combining discrete samples at specified time intervals in specific volumes that are proportional to the runoff flow. Details on the procedures for measuring or estimating rainfall and runoff flow rates should be referenced from EPA/833/B-92/001.

C.3.2.3 Suggested samplers. Each sampling technique presents various disadvantages and advantages for its application. For example, desired depth, tidal influences, sample disturbance, sample volume, chemical/physical reactivity between potential contaminants and sampling tool materials, and ease of decontamination vary from technique to technique. The following sections discuss the advantages and disadvantages of each sampling technique.

C.3.2.4 Sample frequency. Determination of the number of samples needed to characterize a site depends upon sampling objectives and site-specific conditions. For example, if the objective of the event is to determine whether the site is contaminated, a limited number of samples from properly chosen locations will yield useful information. If, however, the site is known to be contaminated and delineation of the contamination is the objective, a greater number of samples may be needed. In many cases, statistical considerations can be helpful in determining sampling strategy. It may also be necessary to strategically plan the timing of sampling. For example, industrial discharges may be more likely during working hours. Storm water runoff sampling frequency requirements are defined within the facility's NPDES permit.

C.3.3 Sample preservation and handling. Many of the chemical constituents and physicochemical parameters that are to be measured or evaluated in monitoring programs are not chemically stable; therefore, sample preservation is required. Appropriate preservation techniques for various parameters are specified in Appendix B. In addition, sample containers that should be used for each constituent or common set of parameters are specified in Appendix B. These preservation methods and sample containers are based on EPA/SW-846. Procedures and techniques for transporting the samples to the offsite laboratory are discussed in Instruction F-2, "Packaging and Shipping Procedures," in Appendix F. Improper sample handling may alter the analytical results of the sample, causing the results to be invalid. Samples should be transferred in the field from the sampling equipment directly into the container that is required for that analysis or set of compatible parameters and in sufficient volumes, including number of sample containers, to allow appropriate analyses. The sample should then be preserved in the field as specified in Appendix B. Because of the low analytical detection limits that are required for assessment of ecological risk and other data uses, care must be taken when collecting the sample to avoid the loss of any contaminants. The samples for volatile analysis should be carefully transferred directly from the sample collection device to the sample container in order to minimize contaminant loss through agitation/ volatilization or adherence to another container. Samples should be collected in the order listed in Section C.3.3.1 When more than one container is required per parameter, the sample should be split equally among all containers until they are filled. Containers used to collect samples for organic analyses should not be prerinsed with water because of the possibility of preservation loss or the loss/gain of contaminants that may taint the analytical results.

C.3.3.1 Sample containers. When metals are the analytes of interest, HDPE containers with PTFE-lined polypropylene caps should be used. When organics are the analytes of interest, glass bottles with PTFE-lined caps should be used. Refer to Appendix B or the specific analytical method to designate an acceptable container. Containers should be cleaned based on the analyte of interest. Instruction E-6, "Decontamination Procedures," (Appendix E) contains additional information on appropriate glassware cleaning protocols. If precleaned bottles are used, the cleanliness of each lot of precleaned bottles should be verified by the container supplier or in the laboratory and appropriate paperwork (i.e., certificates) retained with other field documentation. Refer to Appendix B for information on the required size, number, and type of sample containers. Samples should be collected and containerized in the order of the volatilization sensitivity of the parameters. A preferred collection order for some common parameters follows:

- VOA
- POC
- POX
- TOX
- TOC
- Extractable organics
- Total metals
- Dissolved metals
- Phenols
- Cyanide
- Sulfate and chloride

- Turbidity
- Nitrate and ammonia
- Radionuclides

C.3.3.2 Sample preservation. Methods of sample preservation are relatively limited and are generally intended to retard biological action and hydrolysis and to reduce sorption effects. Preservation methods are generally limited to pH control, chemical addition, refrigeration, and protection from light. Prepreserved sample containers are not recommended. Because of the potential loss of preservative if field errors occur and because different amounts of preservative may be necessary to bring the sample to the required pH, it is recommended to add the preservative to the container in the field and verify that the pH of the sample has been achieved. This information should be documented within field logbooks. The sampler should refer to Appendix B or the specific preservation method in EPA/SW-846 for the appropriate preservation technique.

C.3.3.3 Special handling for VOA samples. Water samples to be analyzed for purgeable organic compounds should be stored in 40-mL vials with septum inserts and screw caps. The septum should be placed on the sample vial so that the PTFE side is in contact with the sample. The 40-mL vials should be completely filled to prevent volatilization, and extreme caution should be exercised when filling a vial to avoid any turbulence that could also produce volatilization. The sample should be carefully poured down the side of the vial to minimize turbulence. As a rule, it is best to gently pour the last few drops into the vial so that surface tension holds the water in a convex meniscus. The septum is then applied and some overflow is lost, but air space in the bottle is eliminated. After the bottle is capped, it should be turned over and tapped to check for bubbles. If any bubbles are present, the procedure must be repeated. Care should be taken to ensure that no loss of preservative occurs, if applicable.

C.3.3.4 Special precautions for trace contaminant sampling. Contaminants can be detected in the parts per billion and/or parts per trillion ranges. Therefore, extreme care must be taken to prevent cross-contamination of these samples. The following general precautions should be taken when sampling:

- A clean pair of new disposable gloves should be worn each time a different location is sampled, and gloves should be donned immediately prior to sampling.
- To prevent cross-contamination between samples, it is suggested that the multiple vials from each sampling location be sealed in separate smaller plastic bags when the sampled medium is suspected of containing high concentrations of volatile organics.
- Sample containers filled with source or waste samples or samples suspected of containing high concentrations of contaminants should be placed in separate plastic bags immediately after collecting and preserving, and activated carbon should be included in the bags to prevent cross-contamination.
- If possible, background samples and source samples should be collected by different field teams. If different field teams cannot be used, all background samples should be collected first and placed in separate ice chests or shipping containers. Samples of waste or highly contaminated samples should never be placed in the same ice chest as environmental samples. It is good practice to enclose waste or highly contaminated samples in a plastic bag before placing them in ice chests. Ice chests or shipping containers for source samples or samples suspected to contain high concentrations of contaminants should be lined with new, clean, plastic bags.

- If possible, one member of the field team should take all the notes and fill out sample tags, field sheets, etc., while the other members collect all of the samples.
- Sample collection activities should proceed progressively from the suspected least contaminated area to the suspected most contaminated area.
- Field personnel should use equipment constructed of PTFE, stainless steel, or glass that has been properly precleaned. PTFE or glass is preferred for collecting samples where trace metals are of concern.
- Adequate field control samples should be collected.

C.3.4 Sampling methods. Sampling instructions for the most common techniques for collecting surface water samples are presented in this section. Additional guidance on surface water sampling methods may be found in EM 200-1-2 and EPA/600/2-80/018. Prior to sample collection, water body characteristics (size, depth, flow) should be recorded in the field logbook. Sampling should proceed from downstream locations to upstream locations so that disturbance related to sampling does not affect the samples collected on the upstream side. In addition, if sediment samples are to be collected at the same locations as water samples, the water samples must be collected first. If the project requirements make it necessary to distinguish the concentration of metals in solution from the concentration of metals associated with solids, filtration of the surface water will be required. Filtration techniques are discussed in Instruction E-1 (Appendix E) of this manual. The factors that will contribute to the selection of a surface water sampler include the width, depth, and flow of the surface water body location being sampled, and whether the sample will be collected from the shore or a vessel. For flowing liquids an additional concern must be addressed. Tidal influence should be determined, and its influence on sample collection should be detailed in the sampling plan. At a minimum, the stage of the tide at the time of sample collection should be recorded. Consideration should be given to sampling at varied tidal stages. Samplers may encounter situations where rate of flow affects their ability to collect a sample. For fast-flowing rivers and streams, it may be nearly impossible to collect a midchannel sample at a specific point. Low- flowing streams and leachate seeps present the opposite problem. In these cases, the sampler should attempt to find a location where flow is obstructed and a pool is created. If this is not possible, the only way to obtain a sample may be to dig into the sediment with a decontaminated trowel to create a pooled area where the liquid will accumulate. However, this method is not recommended since the sample is likely to be highly turbid. If the banks are not sloping, sampling personnel may be able to collect the liquid directly into the sample bottle from the edge of the water body. In some instances where the liquid to be sampled cannot be reached, a pond sampler, by virtue of its extension capabilities, may be necessary. In these cases, the pond sampler should be assembled to ensure that sampling personnel are not in danger of falling into the water body being sampled. In cases where access is restricted, or data objectives require a sample taken from the middle of the water body, a boat, barge, or other stable working platform may be necessary. For a stream, channel, or river, the sample should be collected at middepth. For standing liquid, the sample should be collected just below the surface or at middepth. Specific sampling strategies may be altered depending on the contaminants of concern. For instance, when sampling for hydrocarbons or other light nonaqueous phase liquids, it may be better to sample at the surface. Once the sample is obtained, it should be transferred directly into the sample bottle. The sampling device should be decontaminated before the next sample is taken. If sampling below the water surface is required, some of the samplers discussed in the following sections will allow collection of discrete representative liquid samples at various depths. Proper use of the sampling device chosen includes slow lowering and retrieval of the sample, immediate transfer of the liquid into the sampling container, and notation in the logbook of the depth at which the sample was collected.

C.3.4.1 Hand-held bottle.

C.3.4.1.1 Applicability. Filling the sample containers directly is advantageous when the sample might be significantly altered during transfer from a collection vessel into another container. This would affect samples being collected for VOC analysis. The hand-held bottle is not applicable for samples required at depth.

C.3.4.1.2 Method summary and equipment. Samples from shallow depths can be readily collected by merely submerging the sample containers.

C.3.4.1.3 Sampling procedure. The recommended sampling procedure follows:

- Spread new plastic sheeting on the ground at each sampling location to keep sampling equipment decontaminated and to prevent cross-contamination. If access to sampling location is restricted, locate a boat, barge, or other stable working platform adjacent to the area to be sampled.
- Submerge the sample container with the cap in place with minimal surface disturbance so that the open end is pointing upstream.
- Allow the device to fill slowly and continuously using the cap to regulate the speed of water entering the bottle.
- Retrieve the sample container from the surface water with minimal disturbance.
- Preserve the sample as necessary and verify that the pH is sufficient for the criteria.
- Verify that a PTFE liner is present in the cap. Secure the cap tightly.
- Label the sample bottle with an appropriate sample label. Be sure to complete the label carefully and clearly, addressing all the categories or parameters.
- Place filled sample containers on ice immediately along with the required trip blank, if analyzing for VOCs.
- Record the information in the field logbook and complete the chain-of-custody form and field sheets (See Instruction F-1, "Documentation," in Appendix F).

C.3.4.2 Dippers and pond samplers. Method Reference: ASTM D 5358.

C.3.4.2.1 Applicability. Dippers and pond samplers prevent unnecessary contamination of the outer surface of the sample bottle that would otherwise result from direct immersion in the source. Dippers and pond samplers can be either reused or discarded. Discarding the samplers would eliminate the need for decontamination. With the pond sampler, samples can be obtained at distances as far as 3 m (10 ft) from the edge of the source, preventing the technician from having to contact the source physically. The tubular handle may bow when sampling very viscous liquids if sampling is not done slowly. Dippers and pond samplers perform similar functions, except that the length of the dipper is smaller.

C.3.4.2.2 Method summary and equipment. The pond sampler consists of an adjustable clamp attached to the end of a two- or three-piece telescoping aluminum or fiberglass pole that serves as the handle. The clamp is used to secure a sampling beaker (Figure C-4).

C.3.4.2.3 Sampling procedure. The recommended sampling procedure follows:

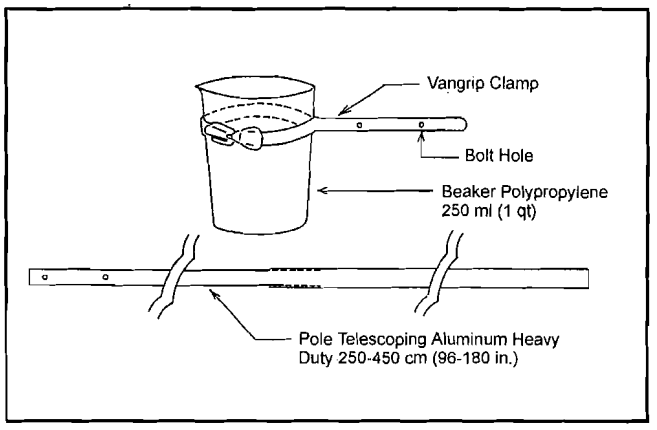

Figure C-4. Pond sampler

- Spread new plastic sheeting on the ground at each sampling location to keep sampling equipment decontaminated and to prevent cross-contamination. If access to sampling location is restricted, locate a boat, barge, or other stable working platform adjacent to the area to be sampled.
- Assemble the dipper or pond sampler. If appropriate, make sure that the sample container and the bolts and nuts that secure the clamp to the pole are tightened properly.
- Collect samples by slowly submerging the precleaned dipper or pond sampler with minimal surface disturbance. Make sure that the open end is pointed upstream.
- Retrieve the dipper or pond sampler from the surface water with minimal disturbance.
- Remove the cap from the sample bottle and slightly tilt the mouth of the bottle below the edge of the dipper/sampler.
- Empty the sampler slowly, allowing the sample stream to flow gently down the side of the bottle with minimal entry turbulence.
- Continue delivery of the sample until the bottle is filled.
- Preserve the sample as necessary and verify that the pH is sufficient for the criteria.
- Check that a PTFE liner is present in the cap. Secure the cap tightly.
- Label the sample bottle with an appropriate sample label. Be sure to complete the label carefully and clearly, addressing all the categories or parameters.
- Place filled sample containers on ice immediately, along with the required trip blank, if analyzing for VOCs.
- Record the information in the field logbook and complete the chain-of-custody documents and field sheets (See Instruction F-1, "Documentation," in Appendix F).
- Properly clean and decontaminate the equipment prior to reuse or storage.

C.3.4.3 Peristaltic pump. Method Reference: EPA/600/4-84/076

C.3.4.3.1 Applicability. An advantage of the peristaltic pump is its design, which isolates the sample from the moving part of the pump and allows for easy decontamination by removal or replacement of the

flexible tubing. This method can both extend the lateral reach of the sampler and allow sampling from depths below the water surface. Disadvantages of these pumps include their low pumping rates and their limited height of intake lift (less than 6 m (20 ft)). These pumps also require an outside power source and, like other suction pumps, are not suitable for collecting samples for VOC analysis because of potential degassing effects.

C.3.4.3.2 Method summary and equipment. Peristaltic pumps displace fluid by mechanical peristalsis. A flexible sampling tube is mounted around the pump chamber, and rotating rollers compress the tubing, forcing fluid movement ahead (the peristaltic effect) and inducing suction behind each roller (Figure C-3).

C.3.4.3.3 Sampling procedure. The recommended sampling procedure follows:

- Spread new plastic sheeting on the ground at each sampling location to keep sampling equipment decontaminated and to prevent cross-contamination. If access to sampling location is restricted, locate a boat, barge, or other stable working platform adjacent to the area to be sampled.

- Install clean, medical-grade silicone tubing in the pump head, as instructed by the manufacturer. Attach the silicone tubing to the glass tubing outlet from the sample bottle. If the sampling device is not constructed as shown in Figure C-3 and the sample bottle is filled directly from the discharge line of the peristaltic pump, the sample will be in direct contact with the intake tubing, the pump head, and the discharge tubing prior to release to the sample container. In this situation, PTFE tubing must be used for the discharge line to avoid cross-contamination of the samples from contaminant leaching that would occur from other "less inert" tubing.

- Select the length of suction intake tubing necessary to reach the required sample depth and attach it to the intake side of the sample bottle. Heavy-wall PTFE or a diameter equal to the required pump tubing will suit most applications. (A heavier wall will allow for a slightly greater lateral reach.)

- If possible, allow several liters of sample to pass through the system before actual sample collection. Collect this purge volume and return it to the source after the sample aliquot has been withdrawn.

- Collect VOA samples, if required, with an alternative sampling device following guidelines established in this appendix.

- Fill the necessary sample bottles by allowing pump discharge to flow gently down the side of bottle with minimal entry turbulence. Cap each bottle as filled.

- Preserve the sample as necessary and verify that the pH is sufficient for the criteria.

- Check that a PTFE liner is present in the cap. Secure the cap tightly.

- Label the sample bottle with an appropriate label. Be sure to complete the label with all necessary information.

- Place filled sample containers on ice immediately, along with the required trip blank, if analyzing for VOCs.

- Record the information in the field logbook and complete the chain- of-custody documents and field sheets (See Instruction F-1, "Documentation," in Appendix F).

- Allow system to drain, then disassemble it. Decontaminate tubing if necessary; otherwise discard appropriately.

C.3.4.4 Kemmerer sampler. Method References: ASTM D 4136 and EPA/540/P-91/005, Standard Operating Procedure (SOP) #2013, "Surface Water Sampling."

C.3.4.4.1 Applicability. The Kemmerer sampler is a practical method for collecting discrete, at-depth samples where the collection depth exceeds the lift capacity of pumps. The use of the Kemmerer sampler is limited, however, because it is typically constructed of brass.

C.3.4.4.2 Method summary and equipment. The Kemmerer sampler is a messenger-activated water sampling device that is used to sample water from a specific depth (Figure C-5). In the open position, water flows easily through the device. Once the device is lowered to the desired depth, a messenger is dropped down the sample line tripping the release mechanism and closing the container. In the closed position, the bottle is sealed at the top and bottom, isolating the sample during retrieval.

C.3.4.4.3 Sampling procedure. The recommended sampling procedure follows:

- Spread new plastic sheeting on the ground at each sampling location to keep sampling equipment decontaminated and to prevent cross-contamination. If access to sampling location is restricted, locate a boat, barge, or other stable working platform adjacent to the area to be sampled.

- Inspect Kemmerer sampler to ensure that sample drain valve is closed (if equipped).

- Measure and mark sampler line at desired sampling depth.

- Open bottle by lifting top stopper-trip head assembly.

- Gradually lower bottle until desired sample depth is reached.

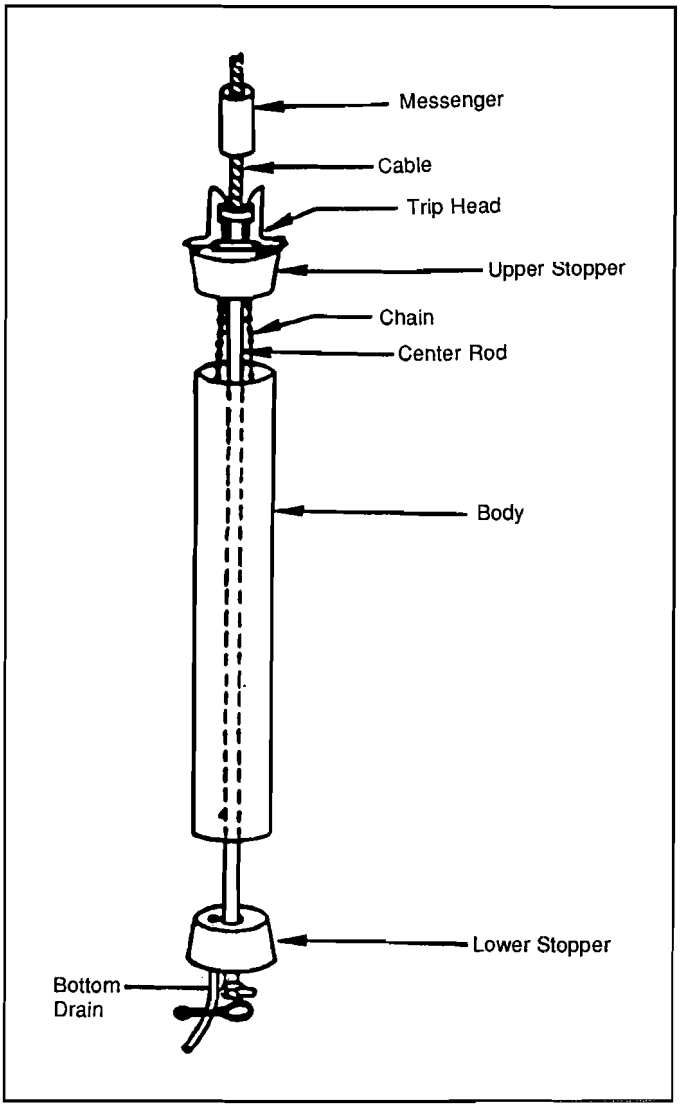

Figure C-5. Kemmerer sampler

- Place messenger on sample line and release.
- Retrieve sampler; hold sampler by center stem to prevent accidental opening of bottom stopper.
- Rinse or wipe off exterior of sampler body.
- Recover sample by grasping lower stopper and sampler body with one hand (gloved), and transfer sample by either lifting top stopper with other hand and carefully pouring contents into sample bottles or holding drain valve (if present) over sample bottle and opening valve.
- Allow sample to flow slowly down the side of the sample bottle with minimal disturbance.
- Preserve the sample as necessary and verify that the pH is sufficient for the criteria.
- Check that a PTFE liner is present in the cap. Secure the cap tightly.
- Label the sample bottle with an appropriate label. Be sure to complete the label with all necessary information.
- Place filled sample containers on ice immediately, along with the required trip blank, if analyzing for VOCs.
- Record the information in the field logbook and complete all chain-of-custody records and field sheets (See Instruction F-1, "Documentation," in Appendix F).
- Decontaminate sampler.

C.3.4.5 Weighted bottle. Method References: ASTM D 4057 and ASTM E 300.

C.3.4.5.1 Applicability. The weighted bottle can be used to obtain samples from a specific depth. The glass construction of the sampler can make the use of this sampler more desirable than the Kemmerer in some sampling situations.

C.3.4.5.2 Method summary and equipment. The weighted bottle can be used for collecting representative samples from a specific depth. The sampler consists of a glass bottle, a weighted sinker, a bottle stopper, and a line that is used to lower and raise the sampler during sampling. Once the sampler is lowered to the desired sampling depth, the stopper is opened, and the bottle is filled and retrieved to the surface.

C.3.4.5.3 Sampling procedure. The recommended sampling procedure follows:

- Spread new plastic sheeting on the ground at each sampling location to keep sampling equipment decontaminated and to prevent cross- contamination. If access to sampling location is restricted, locate a boat, barge, or other stable working platform adjacent to the area to be sampled.

- Assemble the weighted bottle sampler as shown in Figure C-6.
- Measure and mark the sampler line at the desired sampling depth.
- Lower the sampling device to the predetermined depth.
- When the sampler is at the required depth, pull out the bottle stopper with a sharp jerk of the sampler line and allow the bottle to fill completely. (This is usually evidenced by the cessation of air bubbles.)
- Retrieve the sampler.
- Rinse or wipe off the exterior of the sampler body.

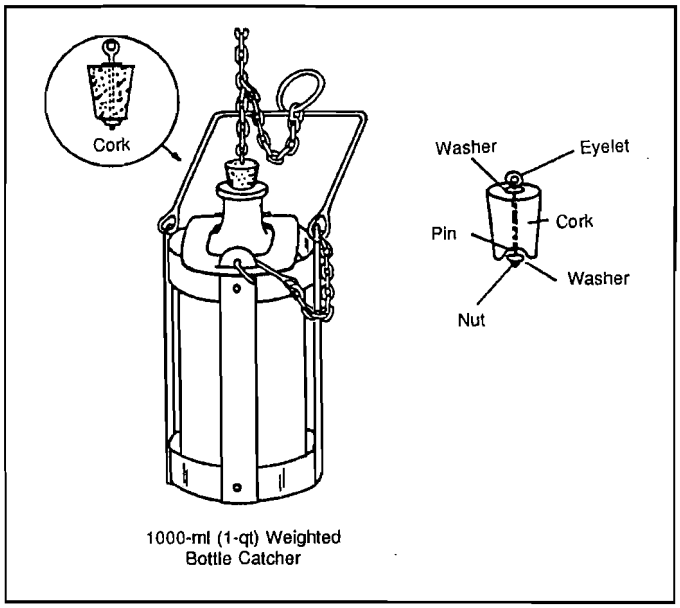

Figure C-6. Weighted bottle

- Allow sample to flow slowly down the side of sample bottle with minimal disturbance.
- Preserve the sample as necessary and verify that the pH is sufficient for the criteria.
- Check that a PTFE liner is present in the cap. Secure the cap tightly.
- Label the sample bottle with an appropriate label. Be sure to complete the label with all necessary information.
- Place filled sample containers on ice immediately, along with the required trip blank, if analyzing for VOCs.
- Record the information in the field logbook and complete all chain-of-custody records and field sheets (see Instruction F-1, "Documentation," in Appendix F).
- Decontaminate sampler.

C.3.4.6 Bacon bomb sampler. Method Reference: EPA/540/P-91/005, SOP #2013.

C.3.4.6.1 Applicability. The Bacon bomb sampler is a widely used, commercially available sampler, designed for sampling petroleum products and viscous liquids (Figure C-7). It is very useful for sampling larger storage tanks because the internal collection chamber is not exposed to a product until the sampler is triggered. It is useful in collecting samples at various vertical locations. Like the weighted bottle sampler, the Bacon sampler remains unopened until it reaches the desired sampling depth. The Bacon sampler is difficult to decontaminate, and it is difficult to transfer the sample into the sample bottles. The possibility of aerating the sample exists if the sampler does not completely fill with water and air is entrapped in the sampler during retrieval.

C.3.4.6.2 Method summary and equipment. The Bacon bomb sampler is constructed of brass or stainless steel and is available in two sizes: 37 mm (1.5 in.) or 87 mm (3.5 in.) in diameter. Samplers range in volume from 0.1 L to 1 L (4 oz to 32 oz). The Bacon bomb sampler is equipped with a trigger that is spring loaded. When opened, the trigger allows liquid to enter the collection chamber. When the trigger is released, liquid is prevented from flowing into or out of the collection chamber.

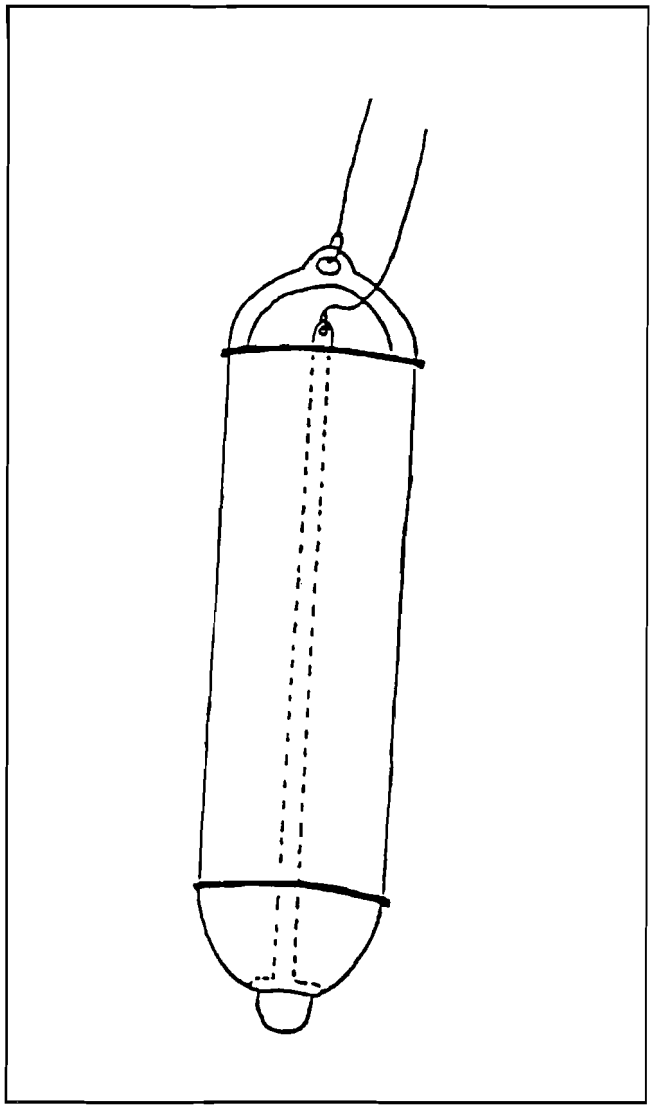

Figure C-7. Bacon bomb sampler

C.3.4.6.3 Sampling procedure. The recommended sampling procedure follows:

- Spread new plastic sheeting on the ground at each sampling location to keep sampling equipment decontaminated and to prevent cross-contamination. If access to sampling location is restricted, locate a boat, barge, or other stable working platform adjacent to the area to be sampled.
- Measure and mark the sampler line at the desired sampling depth.
- Lower the Bacon bomb sampler carefully to the desired sampling depth, allowing the line for the trigger to remain slack at all times. When the desired depth is reached, pull the trigger line taut.
- Release the trigger line and retrieve the sampler.
- Transfer the sample to the sample bottles by pulling on the trigger. Allow the sample to flow down the side of the sample bottle with minimal disturbance.
- Preserve the sample as necessary and verify that the pH is sufficient for the criteria.
- Check that a PTFE liner is present in the cap. Secure the cap tightly.
- Label the sample bottle with an appropriate label. Be sure to complete the label with all necessary information.
- Place filled sample containers on ice immediately, along with the required trip blank, if analyzing for VOCs.

- Record the information in the field logbook and complete all chain-of-custody records and field sheets (see Instruction F-1, "Documentation," in Appendix F).

- Decontaminate the sampler.

C.3.4.7 Storm water runoff sampling techniques.

C.3.4.7.1 Applicability. Grab and flow-weighted composite samples are required to complete NPDES storm-permit requirements.

C.3.4.7.2 Method summary and equipment. Samples of storm water runoff are taken into the sample containers directly, or a bucket and transferred to the appropriate sample bottle containers.

C.3.4.7.3 Grab sampling procedure. The sampling procedure is as follows:

- After rain begins to fall, record the date and time rain started to produce storm water runoff, facility number, outfall number, height of water in a measurement device (i.e., rain gauge), sample number, sample type, other items as directed on the NPDES storm water field sheet (see EPA/833/B-92/001).

- Lower the sample container or stainless steel or PTFE sampling bucket into the center of the runoff flow where turbulence is at a maximum. Hold the sample container so the opening faces upstream. Avoid stirring up bottom sediments and keep sample free of uncharacteristic floating debris.

- Allow the device to fill, using care not to overfill the bottle.

- Preserve the sample as necessary and verify that the pH is sufficient for the criteria.

- Verify that a PTFE liner is present in the cap. Secure the cap tightly.

- Conduct visual observations as appropriate and record them in field log book.

- Label the sample bottle with an appropriate sample label. Be sure to complete the label carefully and clearly, addressing all the categories or parameters.

- Place filled sample containers on ice immediately along with the required trip blank, if analyzing for VOCs.

- Record the information in the field logbook and complete the chain-of-custody form and field sheets (See Instruction F-1, "Documentation," in Appendix F).

C.3.4.7.4 Flow-weighted composite sampling procedure. Flow-weighted composite sampling techniques are appropriate for most chemical parameters, with the exception of those noted as requiring grab sampling techniques within C.3.2.2 and 40 CFR 136. The aliquots for flow-weighted composite samples must be collected within the first 3 hours (or during the entire event if the storm is less than 3 hours). Equal aliquots may be collected at the time of sampling and then flow-proportioned and composited in the laboratory, or the aliquots taken may be based on the flow rate at the time of sample collection and composited in the field. Regulations require that a minimum of 15 minutes must separate the collection of

each sample aliquot, and that a minimum frequency of three sample aliquots within each hour of discharge be maintained. To help meet regulatory requirements, suggest sample aliquots be collected at 20-minute intervals. Use the following procedure:

- After rain begins to fall, record the date and time rain started to produce storm water runoff, facility number, outfall number, height of water in the measurement device (i.e., rain gauge), sample number, sample type, other items as directed on the NPDES storm water field sheet (see EPA/833/B-92/001).

- Determine and record runoff flow at this time as noted within EPA/833/B-92/001. Determine appropriate volume for sample aliquot.

- Lower the sample container (for lab compositing) or stainless steel or PTFE sample aliquot measuring device (for onsite compositing) into the center of the runoff flow where turbulence is at a maximum. Record the time and water depth. Hold the sample container so the opening faces upstream. Avoid stirring up bottom sediments and keep sample free of uncharacteristic floating debris.
- Allow the device to fill with appropriate volumes based on flow observed, or suggest a minimum of 1000 mL be acquired for each aliquot (for lab compositing). NOTE: The laboratory should also be consulted to determine the overall sample volumes necessary for the required analyses to ensure that sufficient volumes of individual sample aliquots are collected to support the composite sample.

- Repeat the steps for bullets 2-4 for each aliquot of the composite sample, retaining each storm water sample aliquot in separate, labeled sample containers. As stated in Section C.3.4.7.4, regulations dictate a minimum frequency of three sample aliquots within each hour of the storm event for the first 3 hours or duration of the storm event, if less than 3 hours.

- If field compositing is performed and after the sample aliquots have been collected, combine appropriate volumes of sample aliquots into stainless steel or PTFE bucket to create the flow-weighted composite sample. Fill appropriate sample bottles with the composite sample mixture, using care not to overfill the bottle.

- Preserve the sample if necessary and verify that the pH is sufficient for the criteria.

- Verify that a PTFE liner is present in the cap. Secure the cap tightly.

- Conduct visual observations as appropriate and record them in field logbook.

- Label the sample bottle with an appropriate sample label. Be sure to complete the label carefully and clearly, addressing all the categories or parameters.

- Place filled sample containers on ice immediately.

- Record the information in the field logbook and complete the chain-of-custody form and field sheets (see Instruction F-1, "Documentation," in Appendix F).

C.3.4.8 Emerging and innovative sampling procedures.

C.3.4.8.1 Disadvantages of standard samplers. All of the standard samplers presented previously for the sampling of surface water disrupt equilibrium during the sampling event. This may lead to obtaining a sample that is not representative of the actual environmental conditions or contaminant concentrations. These routine sampling techniques also acquire a one-time sample, which reflects only environmental conditions at the time of sampling, and they are unable to assess episodic contamination. Additionally, there is little understanding of the correlation between routine surface water sample results and the concentrations of truly dissolved or bioavailable contaminants. Many of the Applicable, Relevant, and Appropriate Requirements (ARARs) for surface water, which are aquatic toxicity data or water quality criteria, are based on dissolved contamination concentrations. Therefore, the use of standard sampling techniques to generate data for comparison with these criteria may not be appropriate.

C.3.4.8.2 New sampling devices and procedures. New sampling devices and sampling procedures have been designed to minimize the disturbance to the medium during sampling to minimize any bias in the results. Recent studies have shown the application of semipermeable membrane devices (SPMDs) to the sampling of surface water bodies (Petty et al. 1995; Ellis et al. 1995). This type of sampler is designed to mimic the bioconcentration process by capturing only the dissolved/bioavailable contaminant concentrations and is an alternative to performing tissue analyses of various species or aquatic organisms. It is also unique in that it assesses episodic contamination, due to the residence time within the medium under investigation. Although the use of this technique may not be fully accepted by a data user or regulating authority without some initial redundancy to routine procedures, the advantages it offers are compelling. SPMDs are commercially available; easy to deploy, retrieve, and sample; and very low maintenance. They are also able to detect contaminants at lower concentrations than routine surface water samples due to their ability to concentrate the contaminants within the lipid phase, as well as extending residence times, which may further enhance contaminant detection at low levels.

C.3.4.8.3 SPMDs. SPMDs (Figures C-8 and C-9) are constructed of thin-walled nonporous polymer lay-flat tubes (of low-density polyethylene, polypropylene, PVC, or silicone) containing a large molecular weight (• 600 daltons) nonpolar liquid (of neutral lipids - such as triolein, or silicone fluids) as a sequestered medium. The SPMD is housed within a protective shroud to avoid damage to the SPMD during sampling events. The semipermeable membrane (i.e., high-density polyethylene) film has pore sizes of approximately 10 • , which effectively control the rate of dissolved contaminants uptake into the device. The SPMD capacity to sequester organic contaminants is dependent on the lipid/water partition coefficient K_{LW} for that organic target analyte. This K_{LW} value can be approximated from the value for the octanol/water partition coefficient K_{ow} for the target analyte. SPMDs may be suspended to a specified depth (e.g., 0.5 or 1 m) of the surface water body, secured by floats and anchors for a period of several days to weeks. In general, the rate of contaminant uptake increases as water temperature increases and decreases as the device is biofouled by aquatic organisms. If water is clear and photosensitive compounds are being evaluated, the SPMD should be shaded to reduce contaminant loss through degradation. Heterotrophic growth may be minimized by periodic treatment (dipping) of the SPMD into a biocide, and/or the protective shroud may be manufactured of materials (i.e., copper screen) that inhibit biofouling. Post sampling, the SPMDs are collected and placed in clean jars or cans on ice for cooling. Ship SPMD samples to the laboratory within 24 hours. Holding time studies for SPMDs have been sporadic and have not assessed all potential contaminants. However, one study determined that freezing of SPMDs caused no loss of herbicide concentrations during 6 months.

C.3.4.8.4 SPMD uses. SPMDs may be used to screen for polynuclear aromatic hydrocarbons (PAHs), organochlorine pesticides, polychlorinated biphenyls (PCBs), herbicides, methyl mercury complexes, alkylated selenides, etc. Unfortunately, the analytical chemistry and data reduction procedures used for SPMDs are more labor intensive than routine environmental samples. Generally, the analytical procedures involve the following: initial cleaning and integrity inspection of the membrane; spiking SPMD media with

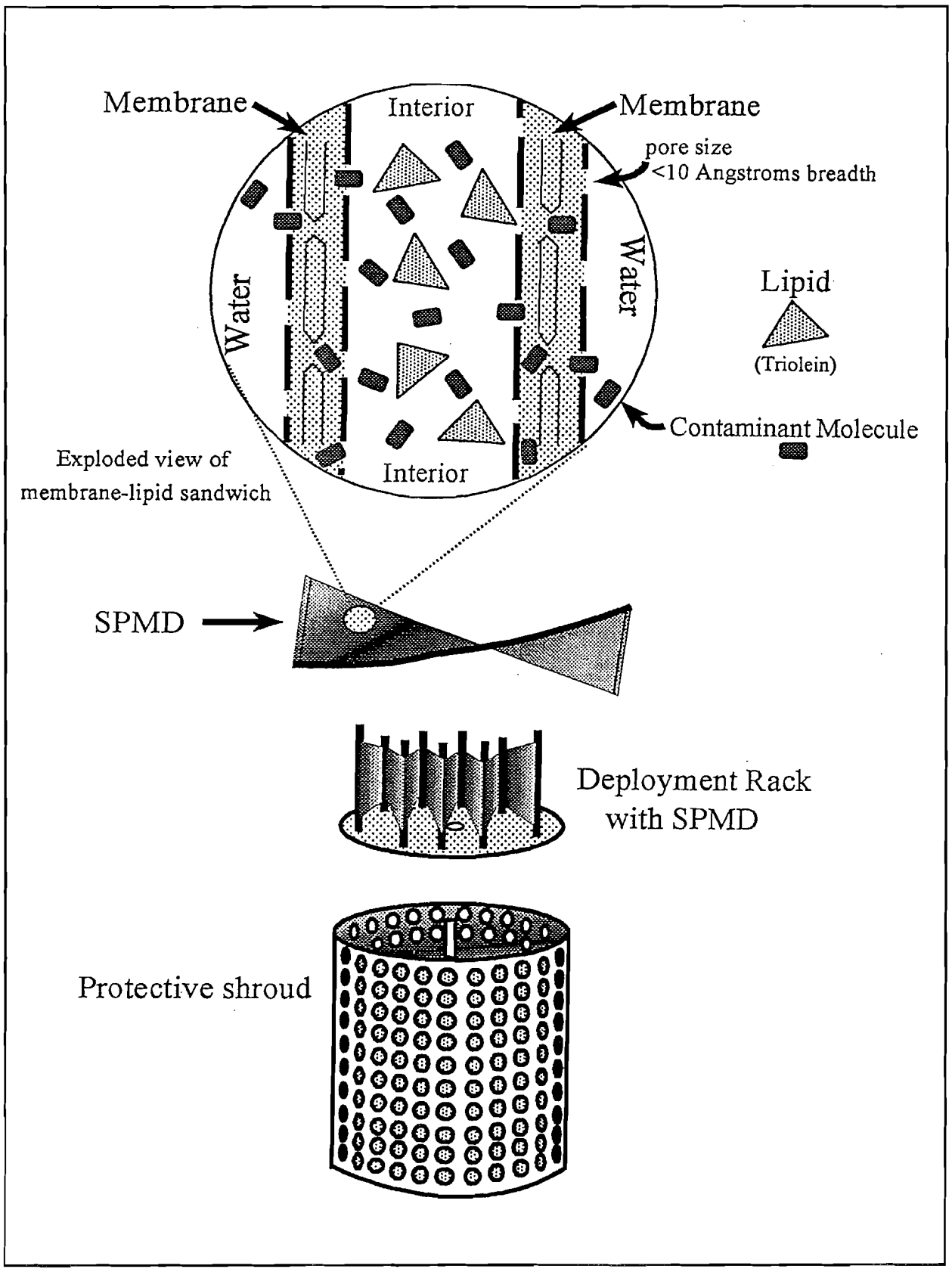

Figure C-8. Schematic of a semipermeable membrane device (SPMD)

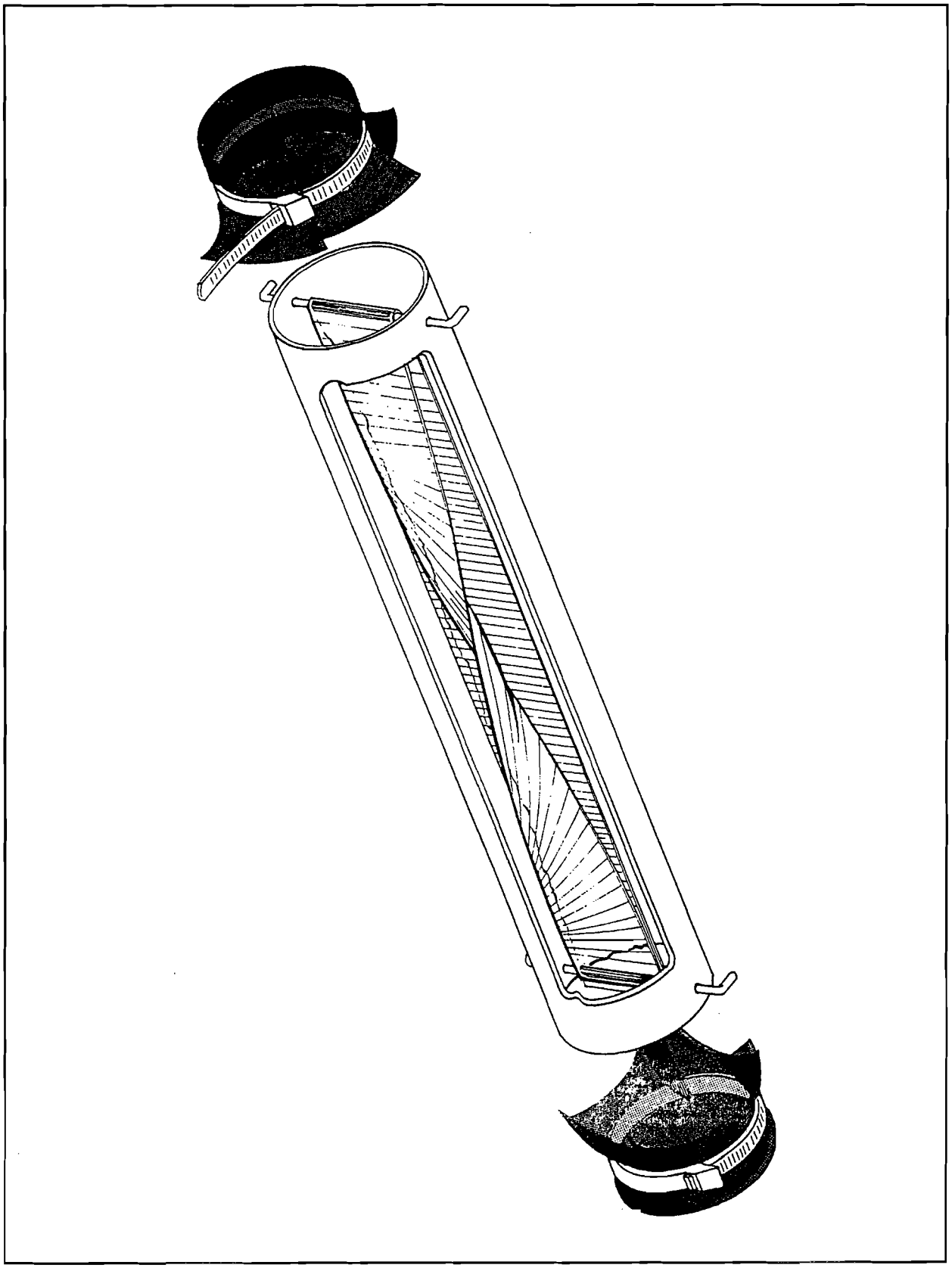

Figure C-9. Cutaway representation of an SPMD and protective shroud

surrogates or internal standards; placing SPMD in an appropriate solvent (i.e., hexane) to perform dialysis; undergoing sulfur cleanup of dialysates (if applicable); performing size exclusion chromatography (i.e., gel permeation column); performing additional chromatographic cleanups (florisil, silica gel); and performing final solvent exchange (if applicable) and solvent reduction procedures. Finally the extract undergoes analysis by gas chromatograph or high-performance liquid chromatograph configured with appropriate detectors. Currently, a major disadvantage of SPMDs is that few environmental laboratories have any experience with dialysis procedures. Concentrations of contaminants from SPMD data are calculated with information from these partitioning coefficients, the uptake rate constant, and exposure times. Refer to Petty et al. (1995) and Ellis et al. (1995) for details on the mathematical model used for this calculation.

C.3.5 Decontamination procedures. All equipment that will enter the water must be decontaminated prior to its entry. The inside surface of pumps and tubing apparatus must be decontaminated by drawing the decontamination solution through the equipment. Sampling equipment should be decontaminated, as described in Instruction E-6 (Appendix E). The sampling equipment should be placed in plastic bags until immediately prior to use. Additional sampling devices may be needed onsite to ensure an adequate drying time. During transport and storage, sampling equipment and sample bottles must be physically separated from engines/ generators that are used to power some sampling equipment.

C.3.6 Field control samples requirements. Field control samples are collected by the sampling team to determine whether the data are of suitable quality. They include blanks, replicates, and/or background (upgradient) samples. QA samples are replicates sent to a referee (QA) laboratory and analyzed to evaluate the contractor's laboratory performance. QC samples are blind replicates collected by the sampling team for analysis by the primary laboratory. A detailed discussion of field control samples is presented in Instruction G-2 (Appendix G).

C.3.7 Documentation requirements. Bound field logbooks should be used for the maintenance of field records. Record all aspects of the site setup, sample collection, and handling as outlined above and in Instruction F-1 of Appendix F.

C.4 Potable Water Sampling

C.4.1 Scope and application. This instruction presents guidelines for collecting representative potable water (tap water) samples. Discussions are based on the assumption that a supply tap is available for sampling the selected location, for example, a residence. Under this assumption the only applicable sampling method would be the hand-held bottle. The sampling methods discussed in Instruction C-2, "Ground Water Sampling," or C-3, "Surface Water Sampling," should be reviewed if other sampling methods are required for collecting a sample. Discussions presented in this section are a review of the protocols and procedures that should be used when collecting water samples from a tap.

C.4.2 Sampling strategies. Sampling strategies are developed by the project team to satisfy project-specific data needs that are identified in the HTRW technical planning process. The sampling strategy developed at a particular site will influence several project decisions, including, but not limited to, sampling locations, type of samples, sampling frequency, and sampling and analytical protocols. Sampling strategies may be significantly influenced by such factors as physical site constraints, safety, and cost, to name a few. The technical planning process that results in the development of the sampling strategy is critical because of the difficulty in acquiring representative samples, the reduction of contaminant action levels, and the problems associated with trace level cross-contamination. Successful investigations of hazardous waste sites are highly dependent on an effective sampling scheme. Development of a sampling scheme for purposes of characterizing a hazardous waste site should follow the fundamentals of the scientific approach. A successful sampling scheme requires a logical design to allow an evaluation of potential contaminants in relation to background conditions and contaminant degradation in various media.

C.4.2.1 Sampling locations. Potable water is usually sampled in an attempt to discover contamination and to define its variability. With such an objective, it is most logical to choose sample locations that will yield the most information about the water supply system. When a site is evaluated, sampling can be conducted by random, systematic, or biased sampling. Biased samples are those collected at locations that were chosen based on historical information, knowledge about the behavior of the contaminant(s), and/or knowledge about the effects of the physical system on the fate of the contaminant. Random sampling depends on the theory of random chance probabilities to choose the most representative sample. Potable water samples may also be collected for evaluating contamination in a particular well, assessing contamination due to a water piping system, or identifying the need for alternate water supply systems. When residential wells are sampled, the sample tap should not be located after a household purification system (i.e., water softening or filtration). In these cases an outdoor tap may have to be sampled. During assessment of water piping systems, contamination of both the hot and cold water sources should be considered. Depending upon the project data quality objectives (DQOs) and/or tap configuration, this may entail the acquisition of individual hot and cold water source samples, or opening both taps simultaneously during the sampling activity. Often biased sampling techniques are used to identify potentially contaminated or impacted areas. Water taps are stationary and are typically sampled for purposes of evaluating drinking water regulations or contaminant impact on local drinking water supplies. Selection of a sampling location is an investigation objective.

C.4.2.2 Type of sample. The type of sample should be designated when selecting a sampling method. Potable water samples are typically discrete samples. A discrete (grab) sample is defined as a discrete aliquot representative of a specific location at a given point in time. The sample is collected at once and at one particular point in the sample matrix. The representativeness of such samples is defined by the nature of the materials being sampled. In general, as sources vary over time and distance, the representativeness of grab samples will decrease.

C.4.2.3 Suggested samplers. The sample container is normally used to collect a potable water sample. Use of additional sampling equipment is not recommended. Sample disturbance, sample volume, and chemical/physical reactivity between potential contaminants and the sampling container should be considered when collecting the potable water sample.

C.4.2.4 Sample frequency. Determination of the number of samples needed to characterize a site is also dependent upon the objectives and site-specific conditions. For example, if the objective of the event is to determine whether the site is contaminated, a limited number of samples from properly chosen locations will yield useful information. If, however, additional factors influencing contamination are the objectives, a greater number of samples may be needed. Timing for collecting samples may also be crucial. In many cases statistical considerations can be helpful in determining sampling strategy.

C.4.3 Sample preservation and handling. Because many of the chemical constituents and physicochemical parameters that are to be measured or evaluated in potable water monitoring programs are not chemically stable, sample preservation is required. Appropriate preservation techniques for various parameters and sample containers that the sampler should use for each constituent or common set of parameters are specified in Appendix B. These preservation methods and sample containers are based on EPA/SW-846. Procedures and techniques for transporting the samples to the offsite laboratory are discussed in Instruction F-2, "Packaging and Shipping Procedures," in Appendix F. Improper sample handling may alter the analytical results of the sample, causing the results to be invalid. Samples should be collected in the container that is required for that analysis or set of compatible parameters and be in sufficient volumes to allow the appropriate analyses. The sample should then be preserved in the field as specified in Appendix B. Because of the low analytical detection limits that are required for assessment of drinking water standards and risk assessment data uses, care must be taken when collecting the sample to avoid the loss of any contaminants. Samples for volatile analysis should be taken in a manner that minimizes contaminant loss through agitation/volatilization. Samples should be collected in the order of the parameters listed in Section C.4.3.1. When more than one container is required per parameter, the sample should be equally split among all containers until they are filled. Containers used to collect samples for organic analyses should not be prerinsed with water because of the possibility of preservation loss or the loss/gain of contaminants that could taint the analytical results.

C.4.3.1 Sample containers. When metals are the analytes of interest, high-density polyethylene containers with PTFE-lined polypropylene caps should be used. When organics are the analytes of interest, glass bottles with PTFE-lined caps should be used. Refer to Appendix B or the specific analytical method to designate an acceptable container. Containers should be cleaned based on the analyte of interest. Instruction E-6, "Decontamination Procedures," Appendix E, contains additional information on appropriate glassware cleaning protocols. If precleaned bottles are used, the cleanliness of each lot of precleaned bottles should be verified by the container supplier or in the laboratory and appropriate paperwork (i.e., certificates) retained with other field documentation. Refer to Appendix B for information on the required size, number, and type of sample containers. Samples should be collected and containerized in the order of the volatilization sensitivity of the parameters. A preferred collection order for some common parameters follows:

- VOA
- POC
- POX
- TOX

- TOC
- Extractable organics
- Total metals
- Dissolved metals
- Phenols
- Cyanide
- Sulfate and chloride
- Turbidity
- Nitrate and ammonia
- Radionuclides

C.4.3.2 Sample preservation. Methods of sample preservation are relatively limited and are generally intended to retard biological action and hydrolysis and reduce sorption effects. Preservation methods are generally limited to pH control, chemical addition, refrigeration, and protection from light. Prepreserved sample containers are not recommended. Because of the potential for preservative loss if field errors occur, or if different amounts of preservative may be necessary to bring the sample to the required pH, it is recommended to add the preservative to the container in the field and verify that the pH of the sample has been achieved. This information should be documented within field logbooks. The sampler should refer to Appendix B or the specific preservation method in EPA/SW-846 for the appropriate preservation technique.

C.4.3.3 Special handling for VOA samples. Water samples to be analyzed for purgeable organic compounds should be stored in 40-mL septum vials with screw caps. Septa should be placed on the sample bottle so that the PTFE side is in contact with the sample. The 40-mL vials should be completely filled to prevent volatilization, and extreme caution should be exercised when filling a vial to avoid any turbulence that could also produce volatilization. The sample should be carefully poured down the side of the vial to minimize turbulence. As a rule, it is best to gently pour the last few drops into the vial so that surface tension holds the water in a convex meniscus. The septum is then applied and some overflow is lost, but air space in the bottle is eliminated. The bottle is then capped and should be turned over and tapped to check for bubbles. If any bubbles are present, the procedure must be repeated. Care should be taken to ensure that no loss of preservative occurs, if applicable.

C.4.3.4 Special precautions for trace contaminant sampling. Contaminants can be detected in the parts per billion and/or parts per trillion ranges. Therefore, extreme care must be taken to prevent cross-contamination of these samples. The following general precautions should be taken when sampling:

- A clean pair of new, disposable gloves should be worn each time a different location is sampled and gloves should be donned immediately prior to sampling.

- Sample containers for source samples or samples suspected of containing high concentrations of contaminants should be placed in separate plastic bags immediately after collecting, preserving, tagging, etc.

- If possible, background samples and source samples should be collected by different field teams. If different field teams cannot be used, all background samples shall be collected first and placed in separate ice chests or shipping containers. Samples of waste or highly contaminated samples should never be placed in the same ice chest as environmental samples. It is good practice to enclose waste or highly contaminated samples in a plastic bag with activated carbon to minimize cross-contamination potential.

- If possible, one member of the field team should take all the notes, fill out sample tags, field sheets, etc., while the other members collect all of the samples.

- Sample collection activities should proceed progressively from the suspected least contaminated area to the suspected most contaminated area.

- Field personnel should use equipment constructed of PTFE, stainless steel, or glass that has been properly precleaned. PTFE or glass is preferred for collecting samples where trace metals are of concern.

- Adequate field control samples should be collected.

C.4.4 Sampling methods. When potable water is being sampled, utmost care must be taken to ensure that samples are representative of the water being sampled. This is important not only from a technical and public health perspective, but also from a public relations standpoint. Poor sampling techniques may result in incorrect results (either by not detecting a compound that is present or by contaminating the sample and falsely indicating a compound that is not present). If incorrect results are disclosed to the public, it may be impossible to change public opinion when correct results are reported. As discussed in Appendix C-2, "Ground Water Sampling," potable water wells must be purged before the sample is collected. This procedure ensures that water representative of the formation or source is sampled. The tap should be opened and allowed to flow to purge the system. Sampling should be performed after the DO, pH, conductivity, temperature, turbidity, and redox potential (if necessary) have reached equilibrium. The initial purging procedure ensures that any contaminants that might have entered the area of the tap from external sources have been avoided. Potable water samples should be representative of the water quality within the household or office under investigation. The sampling tap must be protected from exterior contamination associated with being too close to the sink bottom or to the ground. Contaminated water or soil from the faucet exterior may enter the bottle during the collecting procedure since it is difficult to place a bottle under a low tap without grazing the neck interior against the outside faucet surface. Leaking taps that allow water to flow from around the stem of the valve handle and down the outside of the faucet or taps in which water tends to run up on the outside of the lip are to be avoided as sampling locations. Aerator, strainer, and hose attachments on the tap must be removed before sampling. These devices can harbor a bacterial population if they are not cleaned routinely or replaced when worn or cracked. Whenever a steady stream of water cannot be obtained from taps, after such devices are removed, a more suitable tap should be sought. Taps where the water flow is not steady should be avoided because temporary fluctuation in line pressure may cause sheets of microbial growth or scale that are lodged in some pipe section or faucet connection to break loose. A smooth-flowing water stream at moderate pressure without splashing should be obtained. Then, without changing the water flow, which could dislodge some particles in the faucet, the samples can be collected. Occasionally, samples are collected to determine the contribution of transmission pipes, water

coolers, water heaters, etc., to the quality of water in private residences, offices, etc. The purpose of these investigations may be to determine if metals, e.g., lead, are being dissolved into the water supply. In these cases, it may be necessary to ensure that the water source has not been used for a specific time interval, e.g., over a weekend or a 3- or 4-day holiday period. Samples collected may consist of one sample of the initial flush and another sample after the indicator parameters have reached equilibrium. Regardless of the type of sample bottle being used, the bottle septum and/or cap should not be placed on the ground or in a pocket. Instead, the bottle should be held in one hand and the septum and/or cap in the other, using care not to touch the PFTE side of the septa or inside of the cap. Exercise care not to lose the PTFE liner in certain bottle caps. Contaminating the sample bottle with fingers or permitting the faucet to touch the inside of the bottle should be avoided. Sample bottles should not be rinsed before use. When filling any container, care should be taken not to splash drops of water from the ground or sink into either the bottle or cap. To avoid dislodging particles in the pipe or valve, the stream flow should not be adjusted while sampling. Name(s) of the resident or water supply owner/operator and the resident's exact mailing address, as well as his or her home and work telephone numbers, should always be obtained. This information is required to inform the residents or water supply owner/operators of the results of the sampling program.

C.4.4.1 Hand-held Bottle.

C.4.4.1.1 Applicability. Filling the sample containers directly is advantageous when the sample might be significantly altered during transfer from a collection vessel into another container. This would affect samples collected for VOC analysis.

C.4.4.1.2 Method summary and equipment. Samples can be readily collected by directly filling the sample containers.

C.4.4.1.3 Sampling procedure. The sampling procedures previously discussed in this section should be addressed, if appropriate. The following are additional sampling procedures:

- If applicable, place plastic sheeting on the ground surface to prevent cross- contamination of samples.

- If applicable, remove aerator, strainer, and hose attachments on the tap before sampling.

- Purge well or source and tap lines initially at a high flow rate for a minimum of 5 to 10 minutes. Then adjust the flow to low to moderate and verify that the DO, pH, specific conductance, temperature, and turbidity are each at equilibrium. Equilibrium is established as follows: ±10 percent for DO, ±0.2 pH units, ±3 percent for specific conductance, ±1 degree Celsius for temperature, and ±10 percent for turbidity. (If redox potential is used as an indicator, ±10 mV should be used as the stabilization criterion.)

- Begin sampling by filling the sample containers slowly and continuously following the parameter order and guidance outlined in this instruction.

- Preserve the sample if necessary and verify that the pH is sufficient for the criteria.

- Check that a PTFE liner is present in the cap. Secure the cap tightly. Refer to C.4.3.3 for instructions on capping of VOA samples.

- Label the sample bottle with an appropriate sample label. Be sure to complete the label carefully and clearly, addressing all the categories or parameters.

- Place filled sample containers on ice immediately, along with the required trip blanks if analyzing for VOCs.

- Record the information in the field logbook and complete the chain-of-custody form and field sheets (see Instruction F-1, "Documentation," in Appendix F).

C.4.5 Field control samples requirements. Field control samples are collected by the sampling team to determine whether the data are of suitable quality. They include blanks, replicates, and/or background or upgradient samples. QA samples are replicates sent to a referee (QA) laboratory and analyzed to evaluate the contractor's laboratory performance. QC samples are blind replicates collected by the sampling team for analysis by the primary laboratory. A detailed discussion of field control samples is contained in Instruction G-2, Appendix G.

C.4.6 Documentation requirements. Bound field logbooks should be used for the maintenance of field records. Record all aspects of the sample collection and handling as outlined previously and in Instruction F-1, Appendix F.

C.5 Sediment Sampling

C.5.1 Scope and application. This section presents guidelines for collecting representative sediment and sludge samples from surface water bodies. Sediment can be considered as any material that is submerged/saturated (at least temporarily) or suspended in any surface water body. This includes sludges, lake bottom sediments, perennial and intermittent stream sediments, and marine sediments. For discussion purposes, sampling devices are classified into the following categories according to applicability: surface sediments/shallow water (scoop and tube samplers), subsurface sediments/shallow water (hand auger/tube sampler, and hand-driven split-spoon sampler), surface sediments/deep water (Ponar, Ekman, and Smith-McIntyre samplers), and subsurface sediments/deep water (gravity and piston corer, vibratory coring device, and box core sampler).

C.5.2 Sampling strategies. Sampling strategies are developed by the project team to satisfy project-specific data needs that are identified in the HTRW technical planning process. The sampling strategy developed for a particular site will influence several project decisions, including, but not limited to, sampling locations, types of samples, sampling frequency, and sampling and analytical protocols. For instance, generation of an ecological risk assessment may require the need for colocated surface water and sediment samples. Sediment sampling must also determine whether the biota and/or underlying sediments are to be evaluated. Sampling strategies may be significantly influenced by such factors as physical site constraints, safety, and cost, to name a few. Additionally, the complexity, dynamic nature, and thin stratification of sediments may pose special challenges when determining appropriate sampling protocols. The technical planning process that results in the development of the sampling strategy is critical because of the difficulty in acquiring representative samples, the typically low-level contaminant action levels associated with sediments, and the problems associated with trace level cross-contamination. Successful investigations of hazardous waste sites are highly dependent on an effective sampling scheme. Development of a sampling scheme for purposes of characterizing a hazardous waste site should follow the fundamentals of the scientific approach. A successful sampling scheme requires a logical design to allow an evaluation of potential contaminants in relation to background conditions, vertical extent, horizontal extent, and mobility in various media. The USEPA is also an important source for guidance on sediment sampling. QA/QC guidance for sampling and analysis of sediments may be found in EPA/823/B-95/001.

C.5.2.1 Sampling locations. Sampling at hazardous waste sites is usually conducted in an attempt to discover contamination and to define its extent and variability. With such an objective, it is most logical to choose sample locations that will yield the most information about site conditions. During evaluation of a site, sampling can be conducted by random, systematic, or biased sampling. Biased samples are those collected at locations that were chosen based on historical information, knowledge about the behavior of the contaminant(s), and/or knowledge about the effects of the physical system on the fate of the contaminants. Random sampling depends on the theory of random chance probabilities to choose the most representative sample. Often biased and random sampling techniques can be used together to address an entire site thoroughly. Some samples may be biased to potentially contaminated areas (e.g., lagoons, former process or disposal areas) or potentially impacted areas (e.g., sediment downstream from a discharge pipe, or exposure area of a susceptible population). In areas less likely to be contaminated or areas with little available background information, random samples may be used to allow adequate assessment of the entire site. Due to the nature of the media, locations for collecting sediment samples are restricted to those within the water body under evaluation. Variations of locations for collecting sediment samples include sample location and depth. Sediment depositional patterns should be considered against the sample objectives when deciding the sediment sample locations. These patterns differ between standing and flowing bodies of water. Generally, for flowing water (e.g., streambeds or riverbeds), the depositional areas are normally found inside bends and downstream of islands or obstructions. Areas directly downstream of the joining of two streams should be avoided because the flows and sediments may not immediately mix. For standing water bodies,

the center of the mass or a discharge point should be sampled for sediments. As discussed in Section C.5.2, selection of sample locations should satisfy investigation objectives.

C.5.2.2 Types of samples. The type of sample should be designated when selecting a sampling method. Sediment samples can be discrete (grab) or composite. A discrete (grab) sample is defined as a discrete aliquot representative of a specific location at a given point in time. The sample is collected at once and at one particular point in the sample matrix. The representativeness of such samples is defined by the nature of the materials being sampled. In general, as sources vary over time and distance, the representativeness of grab samples will decrease. Composites are samples composed of more than one specific aliquot (discrete samples) collected at various sampling locations or depths. Analysis of this type of sample produces an average value and can in certain instances be used as an alternative to analyzing a number of individual grab samples and calculating an average value. It should be noted, however, that compositing can mask the presence of contaminants by diluting isolated concentrations of analytes that may be present in the environmental matrix. When surficial sediments are sampled, the objectives of a project should determine whether any organic matter or strictly sediments should be sampled. The organic matter present may represent the primary contaminant source that aquatic species uptake.

C.5.2.3 Suggested samplers. Samplers for this medium are dictated significantly by project objectives of surficial versus subsurface samples and site constraints of the water depth. Each sampling technique presents various disadvantages and advantages for its application. For example, sample disturbance, sample volume, chemical/physical reactivity between potential contaminants and sampling tool materials, and ease of decontamination vary from technique to technique. The advantages and disadvantages of each sampling technique are discussed in the following sections.

C.5.2.4 Sample frequency. Determination of the number of samples needed to characterize a site is also dependent upon sampling objectives and site-specific conditions. For example, if the objective of the event is to determine whether the site is contaminated, a limited number of samples from properly chosen locations will yield useful information. If, however, the site is known to be contaminated and delineation of the contamination is the objective, a greater number of samples may be needed. In many cases, statistical considerations can be helpful in determining sampling strategy.

C.5.3 Sample preservation and handling. Many of the chemical constituents and physicochemical parameters that are to be measured or evaluated in investigation programs are not chemically stable; therefore, sample preservation is required. Appropriate preservation techniques for various parameters are specified in Appendix B. In addition, sample containers that should be used for each constituent or common set of parameters are specified in Appendix B. These preservation methods and sample containers are based on EPA/SW-846. Procedures and techniques for transporting the samples to the offsite laboratory are discussed in Instruction F-2, "Packaging and Shipping Procedures," in Appendix F. Improper sample handling may alter the analytical results of the sample, causing the results to be invalid. When subsequent analysis allows, sediment samples should be collected using a clean stainless steel scoop, spoon, or trowel and placed into a clean stainless steel or other appropriate homogenization container. The sample should be mixed thoroughly to obtain a homogeneous, representative sample prior to placement into the sample container. Refer to Instruction E-2 of Appendix E for a discussion of homogenization procedures. When compositing of samples collected from different locations or depths is desired, all components of the composite sample are mixed in the homogenization container before the composite sample is placed in the sample container. Refer to Instruction E-3 of Appendix E for a discussion of compositing procedures. The sample should then be preserved in the field as specified in Appendix B. Because of the low analytical detection limits that are required for certain data uses, care must be taken when collecting the sample to avoid the loss or gain of any contaminants. For example, the samples packaged for volatile analysis should not be

homogenized or composited. They should be taken as described in Instruction E-4, "Collection, Handling, and Storage of Solid Samples for VOC Analysis" (Appendix E).

C.5.3.1 Sample containers. When metals are the analytes of interest, wide-mouth glass containers with PTFE-lined polypropylene caps should be used. When organics are the analytes of interest, glass bottles with PTFE-lined caps should be used. Refer to Appendix B or the specific analytical method to designate an acceptable container. Containers should be cleaned based on the analyte of interest. Instruction E-6, "Decontamination Procedures," Appendix E, contains additional information on appropriate glassware cleaning protocols. If precleaned bottles are used, the cleanliness of each lot of precleaned bottles should be verified by the container supplier or in the laboratory and appropriate paperwork (i.e., certificates) retained with other field documentation. Refer to Appendix B for information on the required size and type of sample containers. Samples should be collected and containerized in the order of the volatilization sensitivity of the parameters. A preferred collection order for some common parameters follows:

- VOA
- POC
- POX
- TOX
- TOC
- Extractable organics
- Total metals
- Phenols
- Cyanide
- Sulfate and chloride
- Turbidity
- Nitrate and ammonia
- Radionuclides

C.5.3.2 Sample preservation. Methods of sample preservation are relatively limited and are generally intended to retard biological action and hydrolysis and to reduce sorption effects. Preservation methods for sediment samples are dependent on the type of analyses. For nonvolatile analyses, sample preservation is generally limited to refrigeration and/or protection from light. Volatile sediment sample preservation is based on whether the analysis is to be low-level or medium-level analysis. Refer to Instruction E-4 of Appendix E for details. The sampler should refer to Appendix B or the specific preservation method in EPA/SW-846 for the appropriate preservation technique.

C.5.3.3 Special handling for VOA samples. Samples to be analyzed for purgeable organic compounds should be acquired as described in Instruction E-4 of Appendix E, "Collection, Handling, and Storage of Solid Samples for VOC Analysis."

C.5.3.4 Special precautions for trace contaminant sampling. Contaminants can be detected in the parts per billion and/or parts per trillion ranges. Therefore, extreme care must be taken to prevent cross-contamination of these samples. The following general precautions should be taken when sampling:

C.5.3.4.1 A clean pair of new, disposable gloves should be worn each time a different location is sampled and gloves should be donned immediately prior to sampling.

C.5.3.4.2 To prevent cross-contamination between samples, it is suggested that the multiple VOA vials from each sampling location be sealed in separate smaller plastic bags when the sampled medium is suspected of containing high concentrations of volatile organics.

C.5.3.4.3 Sample containers filled with source or waste samples or samples suspected of containing high concentrations of contaminants should be placed in separate plastic bags immediately after collecting and preserving, and activated carbon should be included in the bags to prevent cross-contamination.

C.5.3.4.4 If possible, background samples and source samples should be collected by different field teams. If different field teams cannot be used, all background samples should be collected first and placed in separate ice chests or shipping containers. Samples of waste or highly contaminated samples should never be placed in the same ice chest as environmental samples. It is good practice to enclose waste or highly contaminated samples in a plastic bag before placing them in ice chests. Ice chests or shipping containers for source samples or samples suspected to contain high concentrations of contaminants should be lined with new, clean, plastic bags.

C.5.3.4.5 If possible, one member of the field team should take all the notes, fill out sample tags, field sheets, etc., while the other members collect all of the samples.

C.5.3.4.6 Sample collection activities should proceed progressively from the suspected least contaminated area to the suspected most contaminated area.

C.5.3.4.7 Field personnel should take precautions to prevent contamination from sampling equipment. Some sediment samplers, particularly grab samplers, are constructed of metal and some may be electroplated or painted to prevent corrosion. PTFE-coated or stainless steel samplers are preferable. All samplers should be properly decontaminated before each use. When grab samplers are used, samples should be taken from the center of the mass of sediment retrieved by the sampler, avoiding material that has come in contact with the walls of the sampler. Liner materials or tubes for tube samplers should be selected to avoid sample contamination. For example, plastic liners or tape used to seal containers may be a source of contamination for organic compounds.

C.5.3.4.8 Adequate field control samples should be collected.

C.5.4 Sampling methods. Prior to sample collection, water body characteristics (size, depth, flow) should be recorded in the field logbook. Sampling should proceed from downstream locations to upstream locations so that disturbance from sampling does not affect sampling quality. Additionally, if surface water samples will be collected at the same locations as sediment samples, the water samples must be collected first. Factors that contribute to selection of a sampler include the width, depth, flow, and bed characteristics of the surface water body to be sampled, the volume of sample required, and whether the sample will be collected from the shore or a vessel. In collecting sediment samples from any source, care must be taken to

use appropriate sampling devices that minimize disturbance and sample washing as the sample is retrieved through the liquid column. Sediment fines may be carried out of the sample during collection and retrieval if the liquid above is flowing or deep. This may result in collection of a nonrepresentative sample due to the loss of contaminants associated with these fines. While a sediment sample is usually expected to be a solid matrix, the sampler should not place the sample in the sample bottle and then decant the excess liquid. If the sample is collected properly, any liquid in the bottle is representative of sediment conditions. As with surface water sampling, tidal influence on the water body should be determined, and the effect of the tide on the sediment sample collection should be detailed in the sampling plan. Consideration should be given to sampling at varied tidal stages. In addition, the stage of the tide at the time of sample collection should be recorded. In some instances, the dimensions of the water body dictate that a barge or boat must be used. The barge or boat should be positioned upstream (if there is flowing water) of the desired sample location. As the sampler is lowered it may be carried slightly downstream, depending upon the device used and the force of the flow. The device chosen for sample collection in this case will, again, depend upon the depth and flow of the liquid above the sample location and the bed characteristics of the surface water. The following are sampling instructions for the most common techniques for collecting sediment and sludge samples. For additional information see EM 1110-1-1906, EM 1110-2-5027, Plumb (1981), Mudrock and MacKnight (1991), and Spigolon (1993a, b). In addition, a comparison of the general characteristics of various sediment-sampling devices for chemical, physical, and biological studies can be found in ASTM D 4387, D 4823 and E 1391. The most appropriate device for a specific study depends on the study objectives, sampling conditions, parameters to be analyzed, and cost-effectiveness of the sampler. There are basically three types of devices used to collect sediment samples: dredges, grab samplers, and corers.

- A **dredge** is a vessel that is dragged across the bottom of the surface being sampled, collecting a composite of surface sediments and associated benthic fauna. This type of sampler is used primarily for collecting indigenous benthic fauna rather than samples for chemical analyses. Because the sample is mixed with the overlying water, no pore-water studies can be made of dredged samples. Additionally, because the walls of the dredge are typically nets, they act as a sieve and only the coarser material is trapped, resulting in the loss of fine sediments and water-soluble compounds. As noted earlier, this sample washing may potentially bias results to the low side. At best, results of dredge sampling are considered qualitative since it is difficult to determine the actual surface sampled by the dredge. For these reasons, dredge samplers are not addressed within this instruction.

- **Grab** samplers have jaws that close by a trigger mechanism upon impact with the bottom surface. Grab samplers offer the advantage of being able to collect a large amount of material in one sample, but they have the disadvantage of giving an unpredictable depth of penetration. Substantial contaminant variation with depth is unlikely in shallow channel areas without direct contamination inputs, in areas that have frequent ship traffic, or from sediments that are dredged at short intervals. In these situations, bottom sediments are frequently resuspended and mixed by ship scour and turbulence, effectively preventing stratification. In such cases, surface grab samples represent the mixed sediment column. Grab samplers are also appropriate for collecting surficial samples of reference or control sediments.

- **Core** samplers are basically tubes that are inserted into the sediment by various means to obtain a cylinder or box sample of material at known depths. Corers can be simple, hand-operated devices used by scuba divers, or they can be large, costly, motor-driven mechanisms that can collect samples from great depths. Corers are recommended whenever sampling to depth is required, or when the variation in contamination with depth is of concern. However, this type of data is necessary only if excavation of infrequently disturbed sediments below the mixed layer is planned. A few types of corers are a gravity corer, a piston corer, a vibra-corer, a split- spoon

core sampler, and a box core sampler. The choice of corer design depends on factors such as the objectives of the sampling program, sediment volumes required for testing, sediment characteristics, water depth, sediment depth, and currents or tides.

C.5.4.1 Surface sediments/shallow water: Scoop or trowel. Method Reference: ASTM D 5633.

C.5.4.1.1 Applicability. The scoop or trowel method is a very accurate procedure for collecting representative samples. This method can be used in many sampling situations but is limited to sampling exposed sediments or sediments in surface waters less than 150 mm (6 in.) deep, with nominal flow. The scoop or trowel sampler is not effective for sampling in waters more than 150 mm (6 in.) deep, or when flow causes a loss of fines from sample washing.

C.5.4.1.2 Method summary and equipment. The simplest, most direct method of collecting sediment samples is with the use of a stainless steel scoop or trowel (Figure C-10). A stainless steel scoop or trowel can be used to collect the sample, and a stainless steel bowl can be used to homogenize the sample when applicable to the subsequent analysis. The scoop or trowel should not be chrome-plated if metals are contaminants of concern.

C.5.4.1.3 Sampling procedure. The sampling procedure is as follows:

- Spread new plastic sheeting on the ground at each sampling location to keep sampling equipment decontaminated and to prevent cross-contamination.
- Sketch or photograph the sample area and note any recognizable features for future reference.
- Insert scoop or trowel into material and remove sample.
- Begin sampling with the acquisition of any grab VOC samples, conducting the sampling with as little disturbance as possible to the media. Refer to Instruction E-4 (Appendix E) for additional information on the collection, handling, and storage of solid VOC samples.
- If homogenization of the sample location is appropriate for the remaining analytical parameters or if compositing of different locations is desired, the sample is transferred to a stainless steel bowl for mixing.
- Repeat these steps as necessary to obtain sufficient sample volume.
- Thoroughly mix remaining sample as outlined in Instructions E-2 and E-3 (Appendix E) as appropriate, collect suitable aliquots with a stainless steel laboratory spoon or equivalent, and transfer into an appropriate sample bottle.
- Check that a PTFE liner is present in cap. Secure the cap tightly.
- Label the sample bottle with the appropriate sample label. Be sure to complete the label carefully and clearly, addressing all the categories or parameters.
- Place filled sample containers on ice immediately.

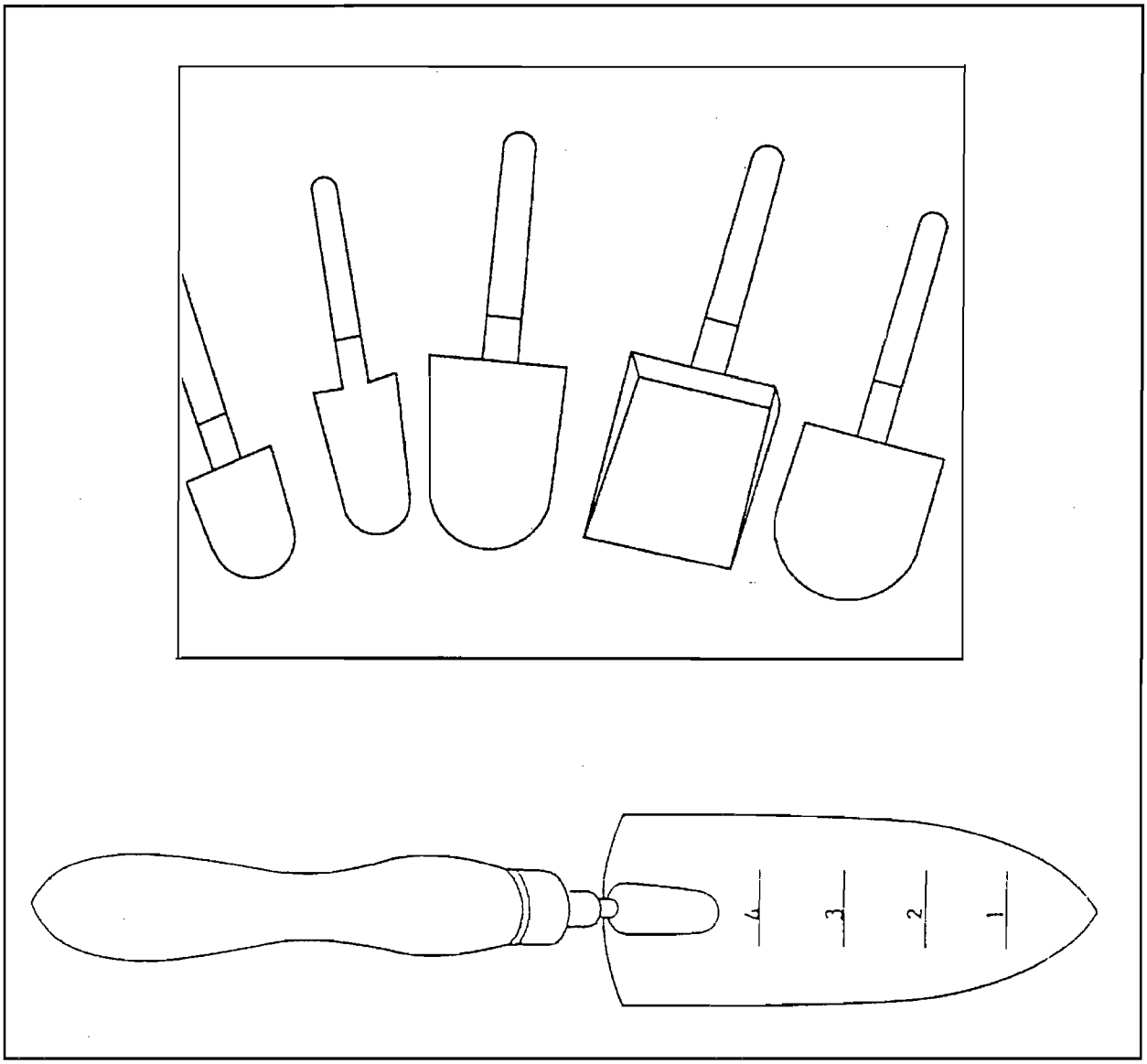

Figure C-10. Scoop trowel

- Complete all chain-of-custody documents and field sheets and record in the field logbook (see Instruction F-1, "Documentation," Appendix F).

- Decontaminate sampling equipment after use and between sample locations.

C.5.4.2 Surface sediments/shallow water: Tube sampler. Method References: ASTM D 4700 and D 4823.

C.5.4.2.1 Applicability. Equipment for the tube sampler is portable and easy to use (Figure C-11). Discrete sediment samples can be collected efficiently. Disadvantages of the tube sampler include its inability to collect sediment samples in water bodies greater than a few feet in depth and its inability to penetrate gravelly or rocky sediments.

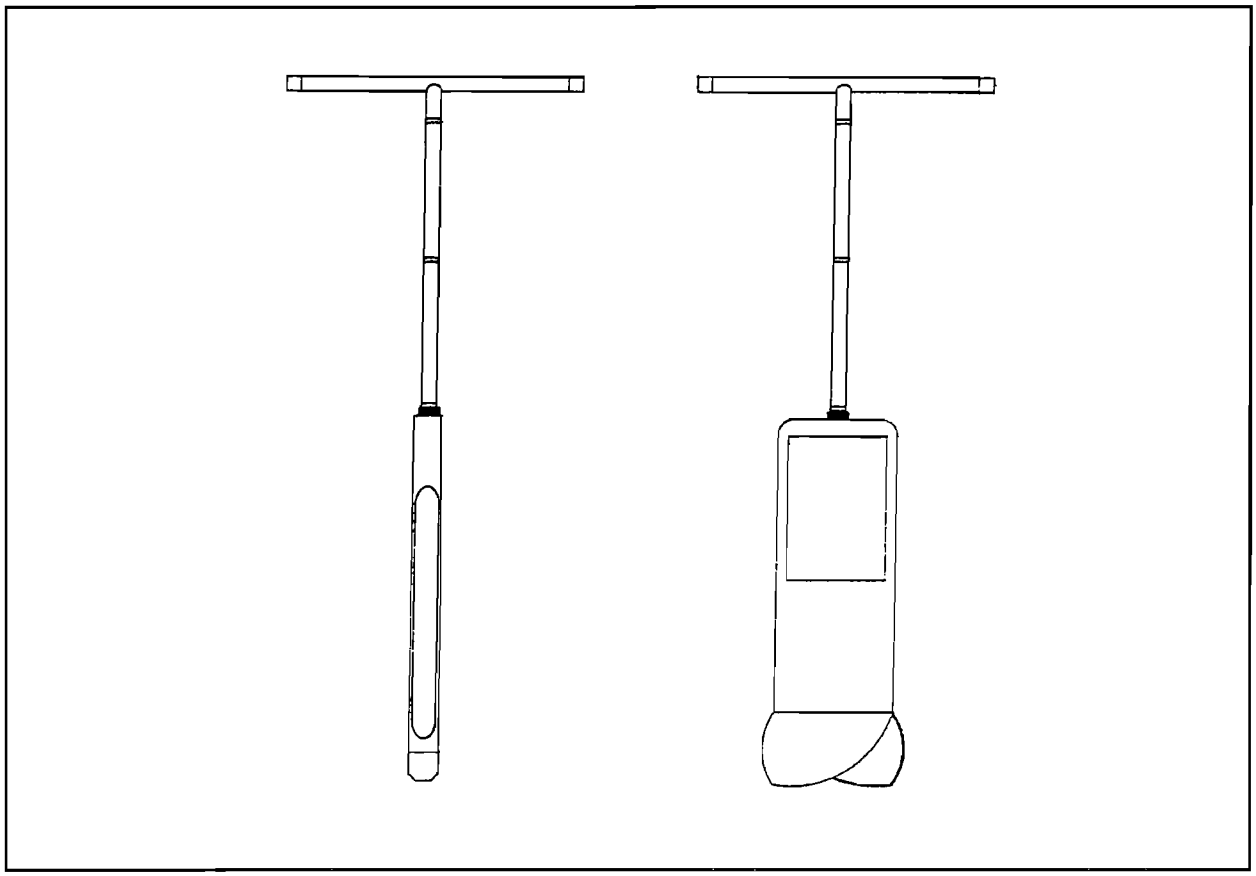

Figure C-11. Tube sampler and bucket auger

C.5.4.2.2 Method summary and equipment. Tube samplers are a simple and direct method for obtaining sediment samples. The tube sampler is forced into the sediment, then withdrawn and the sample is collected. In noncohesive soils, sample retention may be a problem.

C.5.4.2.3 Sampling procedure. The sampling procedure is as follows:

- Spread new plastic sheeting on the ground at each sampling location to keep sampling equipment decontaminated and to prevent cross-contamination. If access to sampling location is restricted, locate a boat, barge, or other stable working platform adjacent to the area to be sampled.
- Sketch or photograph the sample area and note any recognizable features for future reference.
- Gradually force tube sampler into sediment.
- Carefully retrieve the tube sampler.
- Remove sediment core from tube sampler and place core on a clean working surface.
- Begin sampling with the acquisition of any grab VOC samples, conducting the sampling with as little disturbance as possible to the media. Refer to Instruction E-4 (Appendix E) for additional information on the collection, handling, and storage of solid VOC samples.

- If homogenization of the sample location is appropriate for the remaining analytical parameters or if compositing of different locations is desired, transfer the sample to a stainless steel bowl for mixing.
- Repeat these steps as necessary to obtain sufficient sample volume.
- Thoroughly mix remaining sample as outlined in Instructions E-2 and E-3 as appropriate and collect suitable aliquots with a stainless steel laboratory spoon or equivalent, and transfer into an appropriate sample bottle.
- Secure the cap tightly.
- Label the sample bottle with the appropriate sample label. Be sure to complete the label carefully and clearly, addressing all the categories or parameters.
- Place filled sample containers on ice immediately.
- Complete all chain-of-custody documents and field sheets, and record in the field logbook (see Instruction F-1, Documentation).
- Decontaminate sampling equipment after use and between sample locations.

C.5.4.3 Subsurface sediments/shallow water: Hand auger and tube sampler. Method Reference: ASTM D 1452.

C.5.4.3.1 Applicability. Equipment for the hand auger and tube sampler is portable and easy to use (Figures C-11 and C-12). Discrete sediment samples can be collected efficiently. Disadvantages of the hand auger include its inability to collect sediment samples in water bodies greater than a few feet in depth and its inability to penetrate gravelly or rocky sediments. Also, hand augers may not be an effective method for augering into very soft sediments since the borehole may collapse prior to sampling.

C.5.4.3.2 Method summary and equipment. Hand augers are a simple and direct method for obtaining sediment samples. Although the maximum sampling depth for the hand auger is typically 1.5 m (5 ft), greater depths can be sampled depending on the sediment type. Hand augers come in various dimensions and various types. The bucket auger bit is used to bore a hole to the desired sampling depth and is then withdrawn. The auger tip is then replaced with the tube sampler, which is lowered into the borehole and forced into the sediment at the

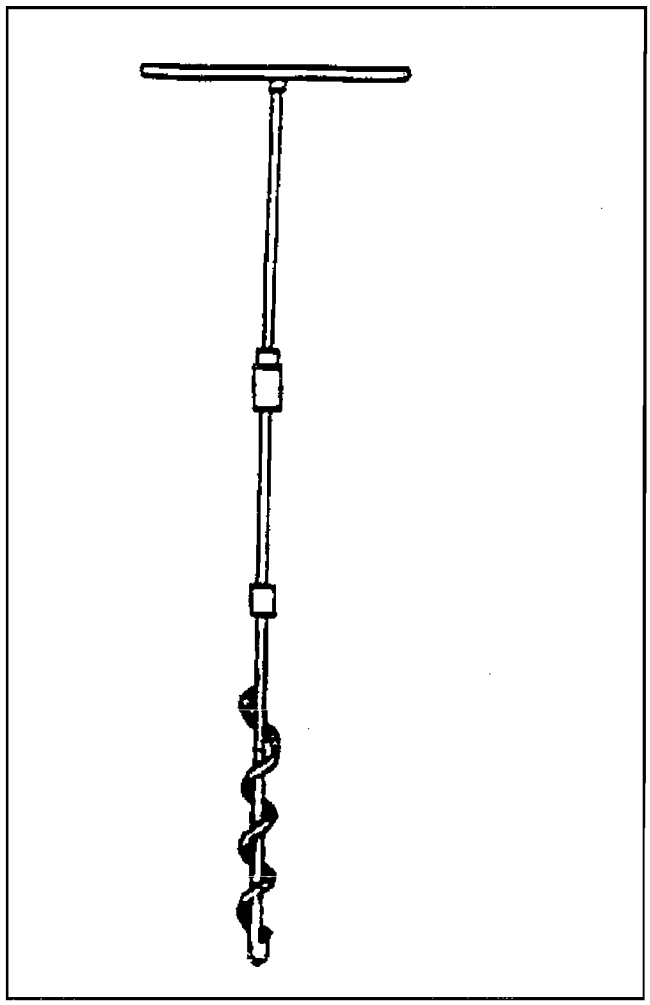

Figure C-12. Hand auger and tube sampler

desired depth. The corer is then withdrawn and the sample is collected. Potential problems encountered with this method include the collapsing or sloughing of the borehole after removal of the bucket auger. Relocating the borehole with the tube sampler may also be difficult if the water is turbid.

C.5.4.3.3 Sampling procedure. The sampling procedure is as follows:

- Spread new plastic sheeting on the ground at each sampling location to keep sampling equipment decontaminated and to prevent cross-contamination. If access to sampling location is restricted, locate a boat, barge, or other stable working platform adjacent to the area to be sampled.
- Sketch or photograph the sample area and note any recognizable features for future reference.
- Attach the auger bit to a drill rod extension and attach the T-handle to the drill rod.
- Begin drilling. Periodically remove accumulated sediment to prevent accidentally brushing loose material into the borehole when removing the auger.
- After reaching the desired depth, slowly and carefully remove the auger from boring.
- Remove the auger tip from drill rods and replace with a precleaned or decontaminated thin-wall tube sampler. Install proper cutting tip.
- Carefully lower the tube sampler down borehole, and gradually force it into the sediment. Take care to avoid scraping the borehole sides. Avoid hammering the drill rods to facilitate coring because the vibrations may cause the boring wall to collapse.
- Carefully retrieve the tube sampler and unscrew drill rods.
- Remove cutting tip and remove core from device.
- Begin sampling with the acquisition of any grab VOC samples, conducting the sampling with as little disturbance as possible to the media. Refer to Instruction E-4 for additional information on the collection, handling, and storage of solid VOC samples.
- If homogenization of the sample location is appropriate for the remaining analytical parameters or if compositing of different locations is desired, transfer the sample to a stainless steel bowl for mixing.
- Repeat these steps as necessary to obtain sufficient sample volume.
- Thoroughly mix remaining sample as outlined in Instructions E-2 and E-3 as appropriate, collect suitable aliquots with a stainless steel laboratory spoon or equivalent, and transfer into an appropriate sample bottle.
- Secure the cap tightly.
- Label the sample bottle with the appropriate sample label. Be sure to complete the label carefully and clearly, addressing all the categories or parameters.
- Place filled sample containers on ice immediately.

- Complete all chain-of-custody documents and field sheets, and record information in the field logbook (see Instruction F-1, "Documentation," Appendix F).

- Decontaminate sampling equipment after use and between sample locations.

C.5.4.4 Subsurface sediments/shallow water: Hand-driven split-spoon core sampler.

C.5.4.4.1 Applicability. The split-spoon core sampler may be used for obtaining sediment samples in cohesive and noncohesive sediments. Similar to the hand auger, the hand-driven split-spoon sampler can be used only in shallow water. However, because it is hammered into place, it can sometimes penetrate sediments that are too hard to sample with a hand auger.

C.5.4.4.2 Method summary and equipment. The split-spoon sampler is a 50.8-mm- (2-in.) diam, thick-walled, steel tube that is split lengthwise (Figure C-13). A cutting shoe is attached to the lower end; the upper end contains a check valve and is connected to the drill rods. For sediment sampling, the split-spoon sampler is usually attached to a short driving rod and driven into the sediment with a sledge hammer or slide hammer to obtain a sample.

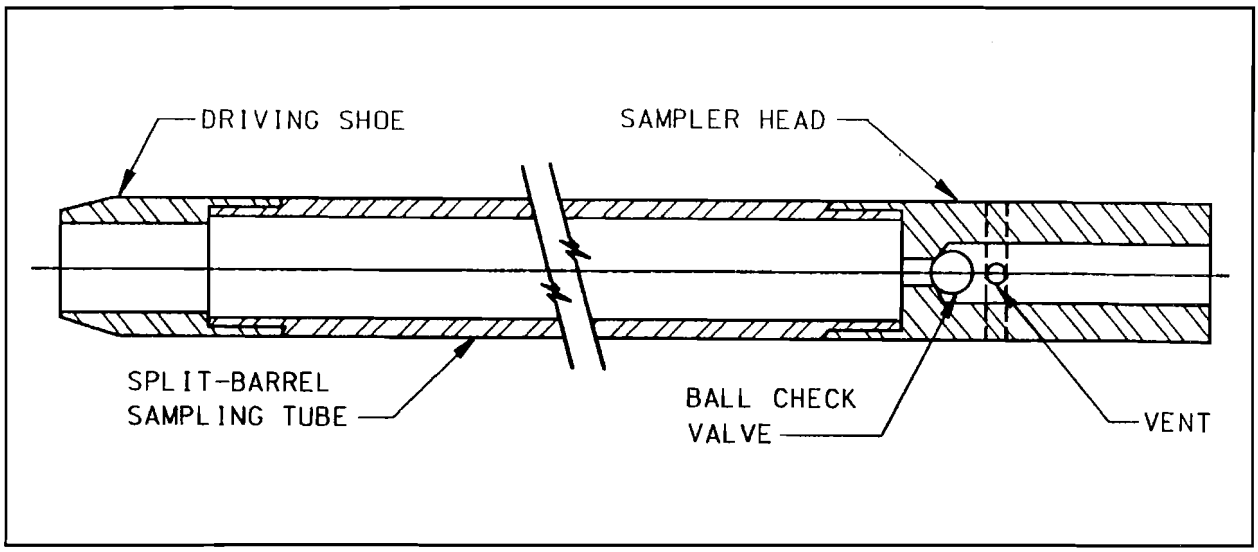

Figure C-13. Standard split-spoon sampler

C.5.4.4.3 Sampling procedure. The sampling procedure is as follows:

- Spread new plastic sheeting on the ground at each sampling location to keep sampling equipment decontaminated and to prevent cross- contamination. If access to sampling location is restricted, locate a boat, barge, or other stable working platform upstream to the area to be sampled.

- Sketch or photograph the sample area and note any recognizable features for future reference.

- Assemble the sampler by aligning both sides of barrel and then screwing the drive shoe on the bottom and the heavier headpiece on top.

- Lower the sampler into position perpendicular to the material to be sampled.

- Drive the tube into the sediments with a sledge hammer. Do not drive past the bottom of the headpiece as this will result in compression of the sample.

- Withdraw the sampler and open by unscrewing drive shoe, head, and splitting barrel. If split samples are desired, use a decontaminated stainless steel knife to split the tube contents in half longitudinally.

- Begin sampling with the acquisition of any grab VOC samples, conducting the sampling with as little disturbance as possible to the media. Refer to Instruction E-4 for additional information on the collection, handling, and storage of solid VOC samples.

- If homogenization of the sample location is appropriate for the remaining analytical parameters or if compositing of different locations is desired, transfer the sample to a stainless steel bowl for mixing.

- Repeat these steps as necessary to obtain sufficient sample volume.

- Thoroughly mix remaining sample as outlined in Instructions E-2 and E-3 as appropriate, collect suitable aliquots with a stainless steel laboratory spoon or equivalent, and transfer into an appropriate sample bottle.

- Secure the cap tightly.

- Label the sample bottle with the appropriate sample label. Be sure to complete the label carefully and clearly, addressing all the categories or parameters.

- Place filled sample containers on ice immediately.

- Complete all chain-of-custody documents and field sheets, and record information in the field logbook (see Instruction F-1, "Documentation," Appendix F).

- Decontaminate sampling equipment after use and between sample locations.

C.5.4.5 Surface sediments/deep water: Ponar sampler. Method References: ASTM D 4342 and EPA/540/P-91/005, SOP #2016.

C.5.4.5.1 Applicability. Ponar samplers are capable of sampling most types of sludges and sediments from silts to granular materials. They are available in hand-operated sizes to winch- operated sizes. Ponars are relatively safe and easy to use, prevent escape of material with end plates, reduce shock waves, and have a combination of the advantages of other sampling devices. Ponar samplers are more applicable for a wide range of sediments and sludges because they penetrate deeper and seal better than spring-activated types (e.g., Ekman samplers). Penetration depths will usually not exceed several centimeters in sand. Greater penetration is possible in fine-grained material, up to the full depth of the sampler for soft sediments. Ponar samplers are not capable of collecting undisturbed samples. As a result, material in the first centimeter of sediment cannot be separated from the rest of the sample. Ponars can become buried in soft sediment.

C.5.4.5.2 Method summary and equipment. The Ponar sampler is a clamshell-type scoop activated by a counter-lever system (Figure C-14). The shell is opened, latched in place, and slowly lowered to the bottom. When tension is released on the lowering cable, the latch releases and the lifting action of the cable on the lever system closes the clamshell.

C.5.4.5.3 Sampling procedure. The sampling procedure is as follows:

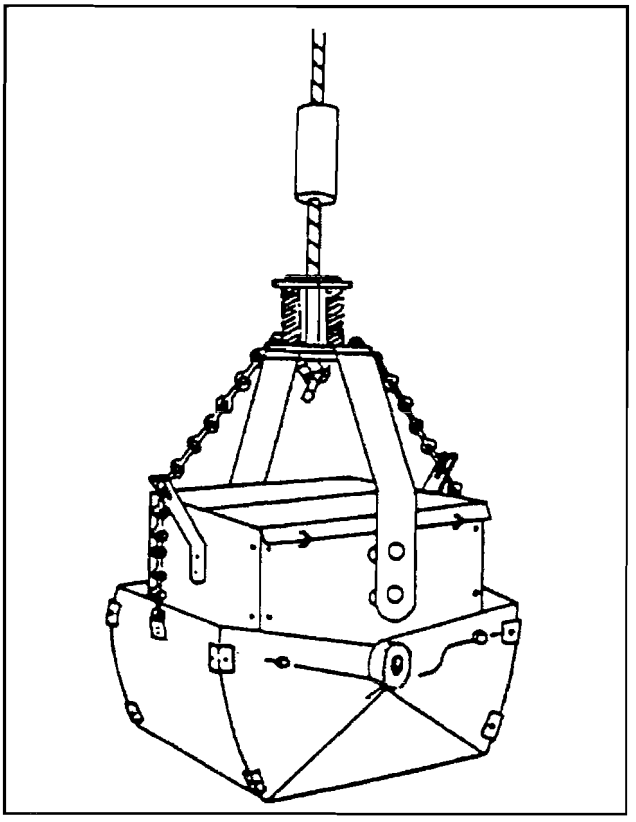

Figure C-14. Ponar sampler

- Spread new plastic sheeting on the ground at each sampling location to keep sampling equipment decontaminated and to prevent cross-contamination. If access to sampling location is restricted, locate a boat, barge, or other stable working platform upstream of the area to be sampled.
- Sketch or photograph the sample area and note any recognizable features for future reference.
- Attach a decontaminated Ponar to the necessary length of sample line. Solid braided 5-mm (3/16-in.) nylon line is usually of sufficient strength; however, 20-mm (3/4-in.) or greater nylon line allows for easier hand hoisting.
- Measure the depth to the top of the sediment with a weighted object.
- Mark the distance to the top of the sediment on the sample line with a proximity mark 1 m above the sediment. Record depth to top of sediment and depth of sediment penetration.
- Open sampler jaws until latched. From this point, support the sampler by its lift line, or the sampler will be tripped and the jaws will close.
- Tie the free end of sample line to fixed support to prevent accidental loss of sampler.
- Begin lowering the sampler until the proximity mark is reached.
- Lower the sampler at a slow rate of descent through last meter until contact is felt.
- Allow sample line to slack several centimeters. In strong currents, more slack may be necessary to release mechanism.
- Slowly raise Ponar grab sampler to clear surface.
- Drain free liquids through the screen of the sampler, being careful not to lose fine sediments.
- Place Ponar into a stainless steel or PTFE tray and open. Lift Ponar clear of the tray, and set aside for decontamination.

- Begin sampling with the acquisition of any grab VOC samples, conducting the sampling with as little disturbance as possible to the media. Samples should be taken from the center of the mass of sediment, avoiding material that has come in contact with the walls of the sampler. Refer to Instruction E-4 for additional information on the collection, handling, and storage of solid VOA samples.

- Repeat these steps until sufficient sample volume has been collected for remaining parameters.

- If compositing of different locations is desired, transfer additional discrete samples to a stainless steel bowl for mixing.
- Thoroughly mix remaining sample as outlined in Instructions E-2 and E-3 as appropriate, collect suitable aliquots with a stainless steel laboratory spoon or equivalent, and transfer into an appropriate sample bottle.

- Label the sample bottle with the appropriate sample label. Be sure to complete the label carefully and clearly, addressing all the categories or parameters.

- Place filled sample containers on ice immediately.

- Complete all chain-of-custody documents and field sheets and record information in the field logbook (see Instruction F-1, "Documentation," Appendix F).

- Decontaminate sampling equipment after use and between sample locations.

C.5.4.6 Surface sediments/deep water: Ekman grab sampler. Method References: ASTM D 4343 and EPA/540/P-91/005, SOP #2016.

C.5.4.6.1 Applicability. The Ekman sampler collects a standard size sample. The Ekman sampler is not useful in rough waters or if vegetation is on the bottom.

C.5.4.6.2 Method summary and equipment. The Ekman sampler (Figure C-15) is another clamshell-type grab sampler and works similarly to the Ponar sampler described previously. However, because the Ekman sampler is much lighter than the Ponar sampler, it is easier to handle and can even be attached to a pole for shallow applications. The Ekman sampler is unsuitable for sampling rocky or hard bottom surfaces.

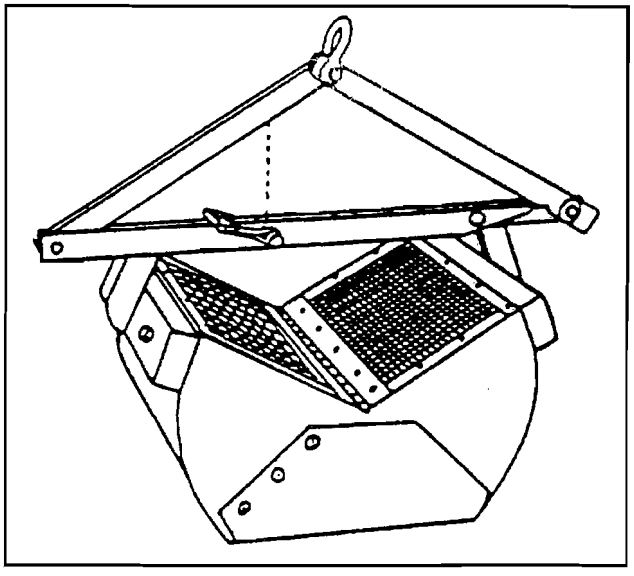

Figure C-15. Ekman sampler

C.5.4.6.3 Sampling procedure. The sampling procedure is as follows:

- Spread new plastic sheeting on the ground at each sampling location to keep sampling equipment decontaminated and to prevent cross-contamination. If access to

sampling location is restricted, locate a boat, barge, or other stable working platform upstream of the area to be sampled.

- Sketch or photograph the sample area and note any recognizable features for future reference.
- Attach a decontaminated Ekman sampler to the necessary length of sample line or in shallow waters to the end of a pole. Because the Ekman sampler is lightweight, solid braided 5-mm (3/16-in.) mylar line is sufficient.
- Measure the depth to the top of the sediment with a weighted object. Record the depth to top of sediment.
- Mark the distance to top of sediment on the sample line and add a proximity mark 1 m above the first mark so that the person taking the sample will know when he is approaching sediment.
- Open sampler jaws until latched. From this point, support the sampler by its lift line, or the sampler will be tripped and the jaws will close.
- If using a sample line, tie the free end of the sample line to fixed support to prevent accidental loss of sampler.
- Begin lowering the sampler until the proximity mark is reached.
- Lower the sampler at a slow rate of descent through the last meter until contact is felt.
- If using a sample line, place a messenger on the sample line and release, allowing the messenger to slide down to the sample line and activate the spring. Record the depth of sediment penetration by the sampler.
- Slowly raise Ekman grab sampler to clear surface.
- Drain free liquids through the screen of the sampler, being careful not to lose fine sediments.
- Place Ekman sampler into a stainless steel or PTFE tray and open. Lift Ekman sampler clear of the tray and set aside for decontamination.
- Begin sampling with the acquisition of any grab VOC samples, conducting the sampling with as little disturbance as possible to the media. Samples should be taken from the center of the mass of sediment, avoiding material that has come in contact with the walls of the sampler. Refer to Instruction E-4 for additional information on the collection, handling, and storage of solid VOA samples.
- Repeat these steps until sufficient sample volume has been collected for remaining parameters.
- If compositing of different locations is desired, transfer additional discrete samples to stainless steel bowl for mixing.

- Thoroughly mix remaining sample as outlined in Instructions E-2 and E-3 as appropriate, collect suitable aliquots with a stainless steel laboratory spoon or equivalent, and transfer into an appropriate sample bottle.

- Label the sample bottle with the appropriate sample label. Be sure to complete the label carefully and clearly, addressing all the categories or parameters.

- Place filled sample containers on ice immediately.

- Complete all chain-of-custody documents and field sheets and record information in the field logbook (see Instruction F-1, "Documentation," Appendix F).

- Decontaminate sampling equipment after use and between sample locations.

C.5.4.7 Surface sediment/deep water: Smith-McIntyre grab sampler. Method Reference: ASTM D 4344.

C.5.4.7.1 Applicability. The Smith-McIntyre grab sampler can be used in rough water because of its large and heavy construction. It reduces premature tripping and can be used in depths up to 1,050 m (3,500 ft). The flange on the jaws reduces material loss. It is good for sampling all sediment types. However, because of its large and heavy construction, the Smith-McIntyre sampler is cumbersome to operate.

C.5.4.7.2 Method summary and equipment. The Smith-McIntyre grab sampler (Figure C-16) is also a type of clam-shell-style grab sampler and works similarly to the Ponar sampler described previously.

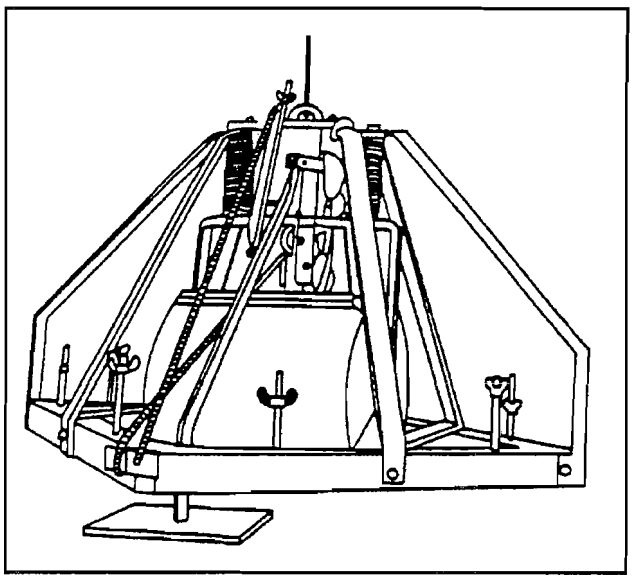

Figure C-16. Smith-McIntyre sampler

C.5.4.7.3 Sampling procedure. The sampling procedure is as follows:

- Spread new plastic sheeting on the deck of a boat or barge to keep sampling equipment decontaminated and to prevent cross-contamination.

- Sketch or photograph the sample area and note any recognizable features for future reference.

- Attach a decontaminated Smith-McIntyre sampler to the necessary length of sample line. Because the Smith-McIntyre sampler is large and heavy, a winch should be used for hoisting and lowering the sampler.

- Measure the depth to the top of the sediment with a weighted object.

- Mark the distance to top of sediment on the sample line with a proximity mark 2.5 cm (1 in.) above the sediment. Record depth to top of sediment and depth of sediment penetration.

- Open sampler jaws until latched. From this point, support the sampler by its lift line, or the sampler will be tripped and the jaws will close.

- If using a sample line, tie the free end of sample line to fixed support to prevent accidental loss of sampler.

- Begin lowering the sampler until the proximity mark is reached.

- Lower the sampler at a slow rate of descent through last meter until contact is felt.

- Allow sample line to slack several centimeters. In strong currents, more slack may be necessary to release mechanism.

- Slowly raise Smith-McIntyre grab sampler to clear surface.

- Drain free liquids through the screen of the sampler, being careful not to lose fine sediments.

- Place Smith-McIntyre sampler into a stainless steel or PTFE tray and open. Lift Smith-McIntyre sampler clear of the tray and set aside for decontamination.

- Begin sampling with the acquisition of any grab VOC samples, conducting the sampling with as little disturbance as possible to the media. Samples should be taken from the center of the mass of sediment, avoiding material that has come in contact with the walls of the sampler. Refer to Instruction E-4 for additional information on the collection, handling, and storage of solid VOA samples.

- Repeat these steps until sufficient sample volume has been collected for remaining parameters.

- If compositing of different locations is desired, transfer additional discrete samples to stainless steel bowl for mixing.

- Thoroughly mix remaining sample as outlined in Instructions E-2 and E-3 as appropriate, collect suitable aliquots with a stainless steel laboratory spoon or equivalent, and transfer into an appropriate sample bottle.

- Label the sample bottle with the appropriate sample label. Be sure to complete the label carefully and clearly, addressing all the categories or parameters.

- Place filled sample containers on ice immediately.

- Complete all chain-of-custody documents and field sheets and record information in the field logbook (see Instruction F-1, "Documentation," Appendix F).

- Decontaminate sampling equipment after use and between sample locations.

C.5.4.8 Subsurface sediments/deep water: Gravity and piston corers. Method References: EM 1110-1-1906, ASTM D 4823, Mudroch and MacKnight (1991), and American Public Health Association (1995).

C.5.4.8.1 Applicability. Gravity corers are capable of collecting samples of most sludges and sediments. They collect essentially undisturbed samples that represent the profile of strata that may develop in sediments and sludges during variations in the deposition process. The gravity corer may be limited to cores of 1 to 2 m (3 to 6.5 ft) in depth, depending on sediment grain size, degree of sediment compaction, and velocity of the drop. Because gravity corers can compact the sample and distort the vertical profile, a vibratory corer is recommended to minimize sample compaction and when vertical stratification in a core sample is of interest. If the samples will not be sectioned prior to analysis and compaction is not a problem, the gravity (free-fall) corers may be the simplest alternative. The piston corer is similar to a gravity corer but also has a piston inside the tube that remains stationary during sediment penetration and creates a vacuum that helps pull the sampler into the sediment. The piston corer uses both gravity and hydrostatic pressure. Refer to Figure C-20 within Instruction C-6 for a schematic of a piston corer (sampler). As the cutting edge of the corer penetrates the sediments, an internal piston remains at the level of the sediment/water interface, preventing sediment compression and overcoming internal friction.

C.5.4.8.2 Method summary and equipment. The gravity corer uses weights attached to the head of the sampling tube to push the tube into the sediment. It is a metal tube with a replaceable tapered nosepiece on the bottom and a ball or other type of check valve on the top. The check valve allows water to pass through the corer on descent but prevents a washout during recovery. The tapered nosepiece facilitates cutting and reduces core disturbance during penetration. Most corers are constructed of brass or steel, and many can accept plastic liners and additional weights.

C.5.4.8.3 Sampling procedure. The sampling procedure is as follows:

- Spread new plastic sheeting on the ground at each sampling location to keep sampling equipment decontaminated and to prevent cross-contamination. If access to sampling location is restricted, locate a boat, barge, or other stable working platform upstream of the area to be sampled.
- Sketch or photograph the sample area and note any recognizable features for future reference.
- Attach a decontaminated corer to the required length of sample line. Solid braided 5-mm (3/16-in.) nylon line is typically sufficient; 20-mm (3/4-in.) nylon, however, is easier to grab during hand hoisting.
- Secure the free end of the line to a fixed support to prevent accidental loss of the corer.
- Allow corer to free fall through liquid to bottom.
- Retrieve corer with a smooth, continuous lifting motion. Do not bump corer as this may result in some sample loss.
- Remove nosepiece from corer and slide sample out of corer into stainless steel or PTFE pan.
- Begin sampling with the acquisition of any grab VOC samples, conducting the sampling with as little disturbance as possible to the media. Refer to Instruction E-4 for additional information on the collection, handling, and storage of solid VOA samples.
- Repeat these steps until sufficient sample volume has been collected for remaining parameters.
- If compositing of different locations is desired, transfer additional discrete samples to stainless steel bowl for mixing.

- Thoroughly mix remaining sample as outlined in Instructions E-2 and E-3 as appropriate, collect suitable aliquots with a stainless steel laboratory spoon or equivalent, and transfer into an appropriate sample bottle.

- Check that a liner is present in cap. Secure the cap tightly.

- Label the sample bottle with the appropriate sample label. Be sure to complete the label carefully and clearly, addressing all the categories or parameters.

- Place filled sample containers on ice immediately.

- Complete all chain-of-custody documents and field sheets and record information in the field logbook (see Instruction F-1, "Documentation," Appendix F).

- Thoroughly decontaminate the gravity corer after each use.

C.5.4.9 Subsurface sediments/deep water: Vibratory coring device.

C.5.4.9.1 Applicability. Vibratory corers are capable of collecting samples of most soils, sediments, and sludges. For penetration greater than 2 m (6.5 ft), a vibratory corer is generally preferred.

C.5.4.9.2 Method summary and equipment. The vibratory system consists of a tripod that supports a core tube. An external power source is necessary to drive a top head and cause vibrations. The vibratory motion causes the soil sediments to become fluidized and the core tube to slip through the soil or sediment. It is capable of obtaining 3- to 7-m cores in a wide range of sediment types by vibrating a large diameter core barrel through the sediment column with little compaction. For additional information, see EM 1110-1-1906, Finkelstein and Prins (1981), Meisburger and Williams (1981), U.S. Army Engineer Waterways Experiment Station (1982), and Smith (1993).

C.5.4.9.3 Sampling procedure. The sampling procedure is as follows:

- Locate a boat, barge, or other stable working platform over the area to be sampled.

- Sketch or photograph the sample area and note any recognizable features for future reference.

- Assemble a decontaminated vibratory corer and connect an external power source (i.e., air compressor).

- Attach decontaminated corer to the required length of sample line to reach the top of the soil or sediment.

- Lower the corer down to the top of sediments and begin vibratory coring until the core tube has fully penetrated.

- Carefully retrieve the core tube and remove the core liner.

- Begin sampling with the acquisition of any grab VOC samples, conducting the sampling with as little disturbance as possible to the media. Refer to Instruction E-4 for additional information on the collection, handling, and storage of solid VOA samples.

- If homogenization of the sample location is appropriate for the remaining analytical parameters or if compositing of different locations is desired, transfer the sample to a stainless steel bowl for mixing.

- Label the sample bottle with the appropriate sample label. Be sure to complete the label carefully and clearly, addressing all the categories or parameters.

- Thoroughly mix remaining sample as outlined in Instructions E-2 and E-3 as appropriate, collect suitable aliquots with a stainless steel laboratory spoon or equivalent, transfer into an appropriate sample bottle, secure cap tightly, and put the container on ice.

- Complete all chain-of-custody documents and field sheets and record information in the field logbook (see Instruction F-1, "Documentation," Appendix F).

- Thoroughly decontaminate the vibratory corer after each use.

C.5.4.10 Subsurface sediments/deep water: Box core sampler.

C.5.4.10.1 Applicability. The corer that disturbs the sediments the least is a box corer. One advantage of the box corer is its ability to collect a large amount of sample with the center of the sample virtually undisturbed. Box corers are not generally recommended for use in sandy sediments since they have difficulty retaining the sample upon withdrawal.

C.5.4.10.2 Method summary and equipment. The box corer is a large box-shaped sampler that is deployed inside a frame. After the frame is brought to rest on the bottom, heavy weights lower the open-ended box into the sediment. A bottom door then swings shut upon retrieval to prevent sample loss.

C.5.4.10.3 Sampling procedure. The sampling procedure is as follows:

- Locate a boat, barge, or other stable working platform over the area to be sampled.

- Sketch or photograph the sample area and note any recognizable features for future reference.

- Assemble decontaminated box corer into the sample frame.

- Attach decontaminated box corer and frame to the required length of sample line, cable, or rope to reach the top of the soil or sediment.

- Secure the free end of the line to a fixed support to prevent accidental loss of the corer, if applicable.

- Lower the box corer and frame down to the sediments. Weights will force the box corer into the sediments for sample collection.

- Carefully retrieve the box corer with a smooth, continuous lifting motion. The box bottom will swing shut upon retrieval.

- Open the bottom lid to remove sample out of corer into stainless steel or PTFE pan.

- Begin sampling with the acquisition of any grab VOC samples, conducting the sampling with as little disturbance as possible to the media. Refer to Instruction E-4 for additional information on the collection, handling, and storage of solid VOA samples.

- Repeat these steps until sufficient sample volume has been collected for remaining parameters.

- If compositing of different locations is desired, transfer additional discrete samples to a stainless steel bowl for mixing.

- Thoroughly mix remaining sample as outlined in Instructions E-2 and E-3 as appropriate, collect suitable aliquots with a stainless steel laboratory spoon or equivalent, transfer into an appropriate sample bottle.

- Check that a liner is present in cap. Secure the cap tightly.

- Label the sample bottle with the appropriate sample label. Be sure to complete the label carefully and clearly, addressing all the categories or parameters.

- Place filled sample containers on ice immediately.

- Complete all chain-of-custody documents and field sheets and record information in the field logbook (see Instruction F-1, "Documentation," Appendix F).

- Thoroughly decontaminate the box corer after each use.

C.5.5 Decontamination procedures. All equipment that will enter the sediment must be decontaminated as described in Instruction E-6 (Appendix E). Sampling equipment should be placed in plastic bags until immediately prior to use. Additional sampling devices may be needed onsite to ensure an adequate drying time.

C.5.6 Field control sample requirements. Field control samples are collected by the sampling team to determine whether the data are of suitable quality. They include blanks, replicates, and/or background samples. QA samples are replicates sent to a referee (QA) laboratory and analyzed to evaluate the contractor's laboratory performance. QC samples are blind replicates collected by the sampling team for analysis by the primary laboratory. A detailed discussion of field control samples is contained in Instruction G-2 (Appendix G).

C.5.7 Documentation requirements. Bound field logbooks should be used for the maintenance of field records. Record all aspects of the site setup, sample collection, and handling as outlined previously and in Instruction F-1, Appendix F.

C.5.8 Analytical techniques for sediment samples. Techniques for chemical analysis of sediments have some inherent limitations. Interferences encountered as part of the sediment matrix, particularly in samples from heavily contaminated areas, may limit the ability of a method to detect or quantify some analytes at the required levels. Sediment analyses usually require lower reporting limits than for soils because regulatory or effects levels are, in general, lower in sediments than in soil. These lower reporting levels may require a change in calibration of analytical instrumentation using lower concentration standards. Lower spiking concentrations will probably be required to better represent the recoveries in low concentration samples. For many metals analyses in marine/estuarine areas, the concentration of salt may

be much greater than the analyte of interest and can cause unacceptable interference in certain analytical techniques. For this reason and the need for lower detection limits, analytical methods for soils may need to be modified or different methods selected. The analyses for semivolatile and VOCs may also need to be modified to achieve lower detection limits and cleanup of this complex matrix. Extensive cleanup is required because of the likely presence of biological macromolecules, which accumulate in sediments; sulfur from sediments with low or no oxygen; and oil and/or grease in the sediment. In addition to all of the previously stated differences between soil and sediment analyses, sediments may require the analysis for other constituents. For example, knowing the concentration of TOC is important for evaluating the bioavailability of neutral organics (i.e. PAH's. PCB's, dioxin, and chlorinated pesticides). In areas with marinas or high ship and boat use, it may be necessary to analyze the sediment for tri-butyl tin (TBT), a highly toxic and persistent component of antifouling paint.

C.6 Soil Sampling

C.6.1 Scope and application. This instruction presents guidance for collecting representative soil samples. Soil sampling can be classified into two primary types: surface and subsurface. Instructions for sampling surface and subsurface soils by the following techniques are included in this instruction: spade and scoop, hand auger and tube sampler, split-spoon sampler, ring-lined barrel sampler, thin-walled (Shelby) tube, continuous tube sampler, piston sampler, core barrel sampler, direct push, and site characterization and analysis penetrometer system (SCAPS). EM 1110-1-1906 also addresses these and other types of geotechnical soil sampling, which may be adapted for environmental purposes.

C.6.2 Sampling strategies. Sampling strategies are developed by the project team to satisfy project-specific data needs that are identified in the HTRW technical planning process. The sampling strategy developed for a particular site will influence several project decisions, including, but not limited to, sampling locations, sample depths, types of samples, sampling frequency, and sampling and analytical protocols. Clarification of key definitions may need to be addressed. For instance, surface soils should be defined in terms of depth requirements. For depending on the data use, surface soils may be defined as the 0-5 cm (0-2 inch), or the 0-15 cm (0-6 inch) depth interval. Sampling strategies may also be significantly influenced by such factors as matrix and contaminant characteristics, physical site constraints, safety, and cost, to name a few. Soil sampling pose a variety of challenges due to the natural variability of the media, the lack of understanding of contaminant migration through the vadose zone, and the logistical problems of sampling at increased depths. Additionally, the particle size distribution of the soils must be evaluated against the scale of the contaminant. Contaminants present on a macro-scale (i.e., lead shot, solid contaminant material or chunks) is more susceptible to bias during sampling procedures, than contaminants found on a molecular scale. The technical planning process that results in the development of the sampling strategy is critical because of these difficulties in acquiring representative samples, the reduction of contaminant action levels, and the problems associated with trace level cross-contamination. Development of a sampling scheme to characterize a hazardous waste site should follow the fundamentals of scientific approach. A successful sampling scheme requires a logical design to allow an evaluation of potential contaminants in relation to background conditions, vertical extent, horizontal extent, and mobility in various media.

C.6.2.1 Sampling locations. Sampling at hazardous waste sites is usually conducted in an attempt to discover contamination and to define its extent and variability. With such an objective, it is most logical to choose sample locations that will yield the most information about site conditions. During evaluation of a site, sampling can be conducted by random, systematic, or biased sampling. Biased samples are those collected at locations that were chosen based on historical information, knowledge about the behavior of the contaminant(s), and/or knowledge about the effects of the physical system on the fate of the contaminant. Random sampling depends on the theory of random chance probabilities to choose the most representative sample. Often, biased and random sampling techniques can be used together to thoroughly address an entire site. Some samples may be biased to potentially contaminated areas (e.g., stained soil, former process or disposal areas) or potentially impacted areas (e.g., areas of stressed vegetation). In areas less likely to be contaminated or areas with little available background information, random samples may be used to allow adequate assessment of the entire site. Because of the nature of the media, soil samples can vary considerably across a site. Physical properties of the soil, including grain size and cohesiveness, may limit the depth from which samples can be collected and the method required to collect them. In most soils, hand-powered equipment can be used only to a depth of approximately 120 to 150 cm (4 to 5 ft). At greater depths, soil sampling is normally performed with a drill rig or other mechanically driven device.

C.6.2.2 Types of samples. The type of sample should be designated when selecting a sampling method. Application techniques for sample methods include discrete (grab) or composite samples. A

discrete (grab) sample is defined as a discrete aliquot representative of a specific location at a given point in time. The sample is collected immediately and at one particular point in the sample matrix. The representativeness of such samples is defined by the nature of the materials being sampled. In general, as sources vary over time and distance, the representativeness of grab samples will decrease. Composites are samples composed of two or more specific aliquots (discrete samples) collected at various sampling locations or depths. Analysis of this type of sample produces an average value and can, in certain instances, be used as an alternative to analyzing a number of individual grab samples and calculating an average value. It should be noted, however, that compositing can mask the presence of contaminants by diluting isolated concentrations of analytes that may be present in the environmental matrix. Samples can be collected manually if soil conditions are favorable and the desired depth of sampling is not too great. Manual sampling involves minimal initial cost, and the method is well suited to a relatively small or specific number of samples. At depths greater than 120 to 150 cm (4 to 5 ft), manual sampling will probably not be possible, and a mechanically driven drilling device will be required. Depending on the sampling requirements of the site, the use of a mechanical drilling device can substantially increase the cost of a sampling investigation. However, it is usually the only method available to obtain soil samples at depths greater than a few feet. There are a great variety of mechanical drilling devices available for soil sampling. Discussions concerning the use of mechanical drilling devices will be limited to the actual tools used to collect the soil samples.

C.6.2.3 Suggested samplers. Each sampling technique presents various disadvantages and advantages for its application. For example, sample disturbance, sample volume, chemical/physical reactivity between potential contaminants and sampling tool materials, and ease of decontamination varies from technique to technique. Subsurface soil conditions themselves will restrict the application of certain samplers. For example, the thin-walled tube sampler is not applicable for sampling sands. Discussions of the advantages and disadvantages of each sampling technique are presented in the following sections.

C.6.2.4 Sample frequency. Determination of the number of samples needed to characterize a site also depends on the objectives and the site-specific conditions. For example, if the objective of the event is to determine whether the site is contaminated, a limited number of samples from properly chosen locations will yield useful information. If, however, the site is known to be contaminated and delineation of the contamination is the objective, a greater number of samples may be needed. In many cases statistical considerations can be helpful in determining sampling strategy. Additional guidance concerning sample frequency can be found in other U.S. Army Corps of Engineers (USACE) guidance and in ASTM D 5911, D5254, and D5792.

C.6.3 Sample preservation and handling. Many of the chemical constituents and physicochemical parameters that are to be measured or evaluated in soil investigation programs are not chemically stable; therefore, sample preservation is required. Appropriate preservation techniques for various parameters are specified in Appendix B. In addition, sample containers that the sampler should use for each constituent or common set of parameters are specified in Appendix B. These preservation methods and sample containers are based on EPA/SW-846. Procedures and techniques for transporting the samples to the offsite laboratory are discussed in Instruction F-2, "Packaging and Shipping Procedures," Appendix F. Improper sample handling may alter the analytical results of the sample, causing the results to be invalid. When subsequent analysis allows, soil samples should be collected using a clean stainless steel scoop, spoon, or trowel and placed into clean stainless steel or other appropriate homogenization containers. Homogenization procedures are discussed in Instruction E-2, Appendix E. The sample should be mixed thoroughly to obtain a homogeneous, representative sample prior to placement into the sample container. When composited samples from different locations or depths are desired, all components of the composite sample are mixed in the homogenization container before the composite is placed in the sample container. Compositing procedures are discussed in Instruction E-3, Appendix E. The sample should then be preserved in the field as specified in Appendix B. Because of the low analytical detection limits that are required for certain data

uses, care must be taken when collecting the sample to avoid the loss or gain of any contaminants. For example, the samples packaged for volatile analysis should not be homogenized or composited. They should be handled in a manner as outlined in Instruction E-4, "Collection, Handling, and Storage of Solid Samples for VOC Analysis" in order to minimize contaminant loss through agitation/ volatilization.

C.6.3.1 Sample containers. When metals are the analytes of interest, wide-mouth glass jar containers with PTFE-lined polypropylene caps should be used. When organics are the analytes of interest, glass bottles with PTFE-lined caps should be used. Refer to Appendix B or the specific analytical method to designate an acceptable container. Containers should be cleaned based on the analyte of interest. Instruction E-6, "Decontamination Procedures," contains additional information on appropriate glassware cleaning protocols. If precleaned bottles are used, the cleanliness of each lot of precleaned bottles should be verified by the container supplier or in the laboratory and appropriate paperwork (i.e., certificates) retained with other field documentation. Refer to Appendix B or the specific analytical method for information on the required size and type of sample containers. Samples should be collected and containerized in the order of the volatilization sensitivity of the parameters. A preferred collection order for some common parameters follows:

- VOA
- POC
- POX
- TOX
- TOC
- Extractable organics
- Total metals
- Cyanide
- Sulfate and chloride
- Nitrate and ammonia
- Radionuclides

C.6.3.2 Sample preservation. Methods of sample preservation are relatively limited and are generally intended to retard biological action and hydrolysis and to reduce sorption effects. Preservation methods for soil samples are dependant on the type of analyses. For nonvolatile analysis, sample preservation is generally limited to refrigeration and/or protection from light. Volatile soil sample preservation is based on whether analysis is to be low-level or medium-level analysis. Refer to Instruction E-4, Appendix E, for details. The sampler should refer to Appendix B or the specific preservation method in EPA/SW-846 for the appropriate preservation technique.

C.6.3.3 Special handling for VOA samples. Samples to be analyzed for purgeable organic compounds should be acquired as described in Instruction E-4 of Appendix E, "Collection, Handling, and Storage of Solid Samples for VOC Analysis."

C.6.3.4 Special precautions for trace contaminant sampling. Contaminants can be detected in the parts per billion and/or parts per trillion ranges. Therefore, extreme care must be taken to prevent cross-contamination of these samples. The following general precautions should be taken when sampling:

- A clean pair of new, disposable gloves should be worn each time a different location is sampled and gloves should be donned immediately prior to sampling.

- All work should be conducted on a clean surface, such as a stainless steel table.

- To prevent cross-contamination between samples, it is suggested that the multiple vials from each sampling location be sealed in separate smaller plastic bags when the sampled medium is suspected of containing high concentrations of volatile organics.

- Sample containers filled with source or waste samples or samples suspected of containing high concentrations of contaminants should be placed in separate plastic bags immediately after collecting and preserving, and activated carbon should be included in the bags to prevent cross-contamination.

- If possible, background samples and source samples should be collected by different field teams. If different field teams cannot be used, all background samples should be collected first and placed in separate ice chests or shipping containers. Samples of waste or highly contaminated samples should never be placed in the same ice chest as environmental samples. It is good practice to enclose waste or highly contaminated samples in a plastic bag before placing them in ice chests. Ice chests or shipping containers for source samples or samples suspected to contain high concentrations of contaminants should be lined with new, clean, plastic bags.

- If possible, one member of the field team should take all the notes, fill out sample tags, field sheets, etc., while the other members collect all of the samples. This is especially important when subjective decisions such as soil type and descriptions are being made.

- Sample collection activities should proceed progressively from the suspected least contaminated area to the suspected most contaminated area.

- Field personnel should take precautions to prevent contamination from sampling equipment. Most soil samplers are constructed of metal. Stainless steel samplers are preferable. All samplers should be properly decontaminated and inspected for visible signs of deterioration before each use. Samples should be taken from the center of the mass of soil retrieved by the sampler, avoiding material that has come in contact with the walls of the sampler. Liner materials or tubes for tube samplers may be selected to avoid sample contamination. For example, plastic liners or tape used to seal containers may be a source of contamination for organic compounds.

- Adequate field control samples should be collected.

C.6.4 Sampling methods. Presented in the following sections are sampling instructions for the most common techniques of collecting soil samples. Prior to sample collection, the soil sampling location and characteristics (soil type, depth) should be recorded in the field logbook. Selection of soil sampling equipment is usually based on the depth of the samples. Manual techniques are usually selected for surface or shallow subsurface soil sampling. At greater depths, mechanically driven equipment is usually required to overcome torque induced by soil resistance and depth. Additional information on collecting soil samples is presented in EPA/540/4-91/001, EPA/625/R-93/003A, ASTM D 4700, ASTM D 6169, and D 5730. ASTM Standards for specific applications of waste management include D 4547 and C 998.

C.6.4.1 Spade and scoop. Method Reference: ASTM D 5633.

C.6.4.1.1 Applicability. The spade and scoop method is a very accurate, representative method for collecting surface and shallow subsurface soil samples. This method is usually limited to soil depths less than 30 cm (1 ft).

C.6.4.1.2 Method summary and equipment. The simplest, most direct method of collecting surface soil samples is to use a spade and stainless steel scoop (Figure C-10 in Instruction C-5). A typical garden spade can be used to remove the top cover of soil to the required depth, but the smaller stainless steel scoop should be used to collect the sample. When a garden spade is used, the spade should be decontaminated before use; and if the spade is driven into the soil with the sampler's field boot, the boot should be covered with a clean disposable overboot. Typical garden-type scoops are many times plated with chrome or other metals and would, therefore, be inappropriate for sampling when analyzing for metals.

C.6.4.1.3 Sampling procedure. The guidance provided for use in shallow sediment collection, Section C.5.4.1.3, is appropriate for surficial soils collection with a spade or scoop.

C.6.4.2 Hand auger and tube sampler. Method Reference: ASTM D 1452 and D 4700.

C.6.4.2.1 Applicability. Equipment for the hand auger is portable and easy to use. Discrete subsurface soil samples can be collected efficiently without the use of a drill rig. Disadvantages of the hand auger include its limited sampling depth. The tube sampler may not penetrate gravelly or rocky soils.

C.6.4.2.2 Method summary and equipment. Hand augers are the simplest and most direct method for sampling subsurface soil samples (Figure C-11 and Figure C-12). Although the maximum sampling depth for the hand auger is typically 1.5 m (5 ft), greater depths can be sampled depending on the soil type. Hand augers come in various diameters and various types. The auger bit is used to bore a hole to the desired sampling depth and then withdrawn. The auger tip is then replaced with the tube corer, lowered into the borehole, and forced into the soil at the completion depth. The corer is then withdrawn and the sample is collected.

C.6.4.2.3 Sampling procedure. The guidance provided for use in sediment collection, Section C.5.4.3.3, is appropriate for soils collection with a hand auger and tube sampler.

C.6.4.3 Split-spoon sampler. Method Reference: ASTM D 1586.

C.6.4.3.1 Applicability. The split-spoon sampler is used for sampling subsurface soil in cohesive- and noncohesive-type soils. It is used extensively for collecting subsurface soil samples for chemical analysis. The split-spoon sampler will require a drill rig and crew for collecting samples greater than 1.5 m (5 ft).

C.6.4.3.2 Method summary and equipment. The split-spoon sampler is typically a 5- to 11.5-cm- (2- to 4-1/2-in.-) diam., thick-walled, steel tube that is split lengthwise (Figure C-13). If a 5-cm- (2-in.-) diam. split-spoon sampler is used, then standard penetration tests can be taken to determine the density of the soil. A cutting shoe is attached to the lower end; the upper end contains a check valve and is connected to the drill rods. When a boring is advanced to the point that a sample is to be taken, drill tools are removed and the sampler is lowered into the hole on the bottom of the drill rods. The sampler is driven into the ground in accordance with the standard penetration test (Appendix B of EM 1110-1-1906). Recently, the U.S. Army Engineer District, Mobile, has remanufactured the connection between the split-spoon sampler

and the drill rods headpiece from threads to a quick connect/release mechanism. The sampler is referred to as the Sanford quick-connect split- spoon sampler, named after its designer, Johnny Sanford. The Sanford split-spoon sampler (Figure C-17) is manufactured with one-half of the split spoon permanently attached to the sampler head, the other half sliding up into the head, and the driving shoe threaded onto both halves completing the assembly. By eliminating the need to screw and unscrew the upper end of the split tube, there is less disturbance to the soil core and a significant amount of time is saved.

C.6.4.3.3 Sampling procedure. The sampling procedure is as follows:

- Place plastic sheeting on the ground around the sampling location to prevent cross-contamination.
- Assemble the sampler by aligning both sides of the barrel and then screwing the drive shoe on the bottom and the sampler head on top. The Sanford quick-connect split-spoon sampler is assembled as noted in the preceding section.
- Place the sampler in a perpendicular position on the material to be sampled.
- Drive the tube, using a sledge hammer or drill rig if available. Do not drive past the bottom of the headpiece because this will result in compression of the sample.
- Record the length of the tube that penetrated the material being sampled and the number of blows required to obtain this depth. Typically, the number of blows per 15 cm (6 in.) of depth is recorded.
- Withdraw the sampler, disconnect from the drill rods (if necessary), and open it by unscrewing the drive shoe and head and splitting the barrel. Record appropriate information for soil core logging per EM 1110-1-4000 (i.e., soil depth, type, and classification).
- Begin sampling with the acquisition of any grab VOC samples, conducting the sampling with as little disturbance as possible to the media. If split samples are desired, a decontaminated stainless steel knife should be used to split the tube contents in half longitudinally. Refer to Instruction E-4 for additional information on the collection, handling, and storage of solid VOA samples.
- If homogenization of the sample location is appropriate for the remaining analytical parameters or if compositing of different locations is desired, transfer the sample to a stainless steel bowl for mixing. Refer to Instructions E-2 and E-3, Appendix E, respectively, for procedures to follow for these techniques.
- Transfer sample into an appropriate sample bottle with a stainless steel laboratory spoon or equivalent.
- Secure the cap tightly.
- Label the sample bottle with the appropriate sample label. Be sure to label the bottle carefully and clearly, addressing all the categories or parameters.
- Place filled sample containers on ice immediately.

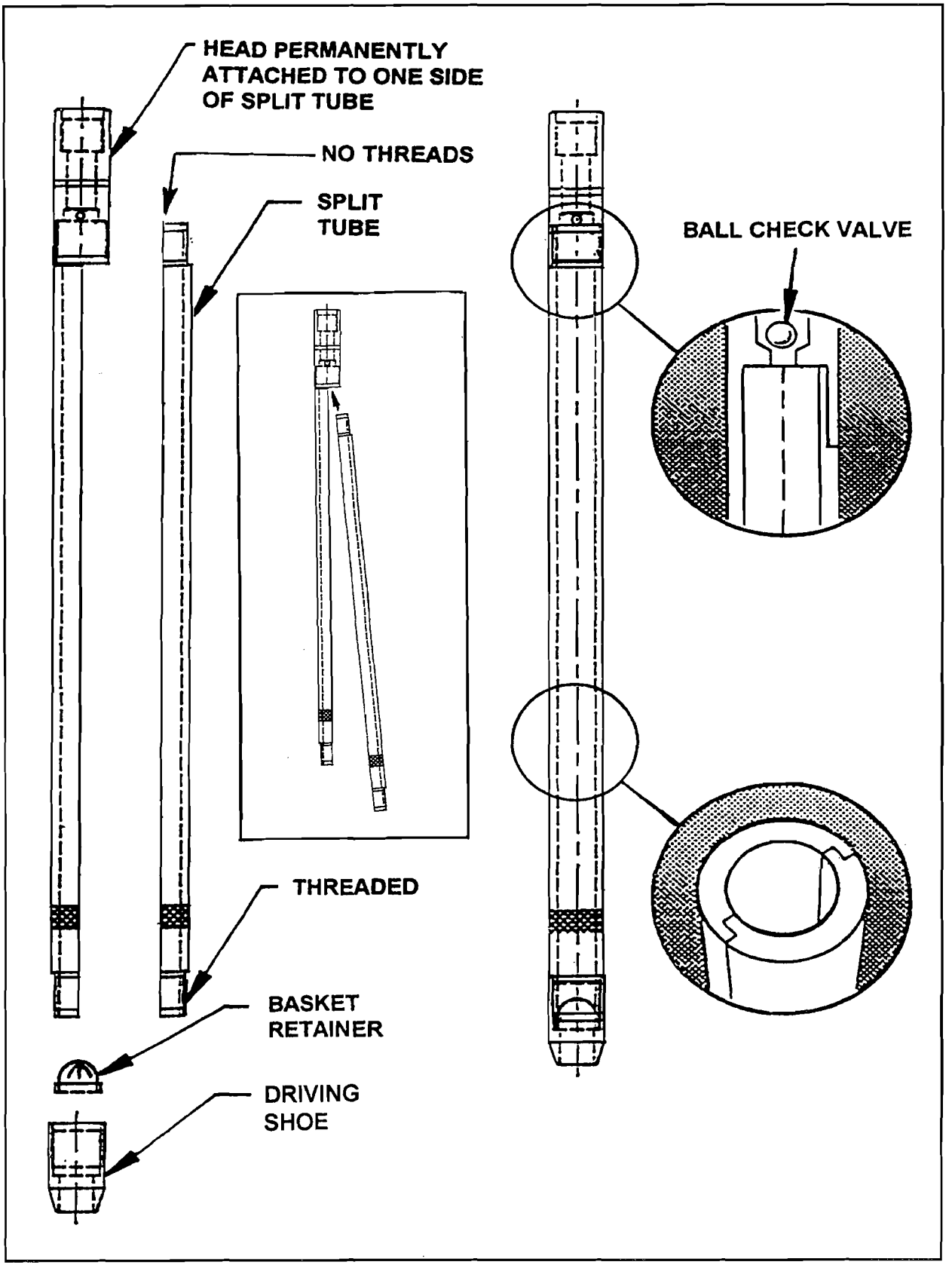

Figure C-17. Sanford quick-connect split-spoon sampler

- Complete all chain-of-custody documents and record information in field logbook (see Instruction F-1, "Documentation," Appendix F). Prepare samples for shipment (see Instruction F-2, "Packaging and Shipping Procedures," Appendix F).

- Decontaminate sampling equipment after use and between sampling locations.

C.6.4.4 Ring-lined barrel sampler. Method Reference: ASTM D 3550.

C.6.4.4.1 Applicability. The ring-lined barrel sampler provides the ability to collect samples without losing volatiles or moisture. Soil is contained in the rings, and the sampler can be easily and quickly capped after it is removed. The relatively small size of the rings allows easy sample shipping and handling. However, the opportunity for describing the soil is diminished because most of the soil is concealed in the ring apparatus. Since rings are not always accepted by the laboratory, prior arrangements should be made with the laboratory.

C.6.4.4.2 Method summary and equipment. Ring-lined barrel samplers are typically 7.5 cm (3 in.) in diameter and are used to obtain representative subsurface soil samples with a split sampling barrel that has removable rings. The rings are typically constructed of plastic, stainless steel, or brass and fit inside the barrel assembly. Rings are commonly used within the California Modified sampler and are typically 7.5 cm (3 in.) long.

C.6.4.4.3 Sampling procedure. The sampling procedure is as follows:

- Place plastic sheeting on the ground around the sampling location to prevent cross- contamination.

- Assemble the sampler by placing eight 7.5-cm- (3-in.-) long rings in the 60-cm- (2-ft-) long sampler. Align both sides of the barrel and screw the drive shoe on the bottom and the heavier headpiece on top.

- Place the sampler in a perpendicular position on the material to be sampled.

- Drive the tube, using a sledge hammer or drill rig if available. Do not drive past the bottom of the headpiece because this will result in compression of the sample.

- Record the length of the tube that penetrated the material being sampled and the number of blows during each 15-cm (6-in.) increment.

- Withdraw the sampler and open it by unscrewing the drive shoe and head and the splitting barrel. Remove the sampling rings. Trim the soil at the end of the rings so that it is flush with the endings. For chemical samples, cap the end of the rings with a PTFE-lined plastic cap. For geotechnical samples, a plastic cap is suitable.
- Label the sample ring with the appropriate sample label. Be sure to complete the label carefully and clearly, addressing all the categories or parameters.

- Place sealed sample rings on ice immediately.

- Complete all chain-of-custody documents and record information in the field logbook (see Instruction F-1, "Documentation," Appendix F). Prepare samples for shipment (see Instruction F-2, "Packaging and Shipping Procedures," Appendix F).

- Decontaminate sampling equipment after use and between sampling locations.

C.6.4.5 Thin-walled (Shelby) tube sampler. Method Reference: ASTM D 1587.

C.6.4.5.1 Applicability. Thin-walled tube samplers allow collection of undisturbed samples in cohesive-type soils (i.e., clays). They are used primarily for collecting soil samples for certain geotechnical tests. Thin-walled tube samplers are not the ideal containers for transporting samples to the laboratory for chemical analysis due to their size. The opportunity for describing the soil is diminished because most of the soil is concealed in the tube.

C.6.4.5.2 Method summary and equipment. The thin-walled tube sampler is designed to take undisturbed samples in cohesive-type soils (Figure C-18). The thin-walled tube sampler is available in either brass, galvanized steel, plain steel, or stainless steel and is manufactured in either 76- or 91-cm (30- or 36-in.) lengths. These tubes normally have an outside diameter of 7.5 to 12.5 cm (3 to 5 in.); however, the 7.5-cm (3-in.) diameter is the most commonly used. Thin-walled tube samplers are usually used for sampling cohesive soils for geotechnical evaluation, rather than chemical analysis.

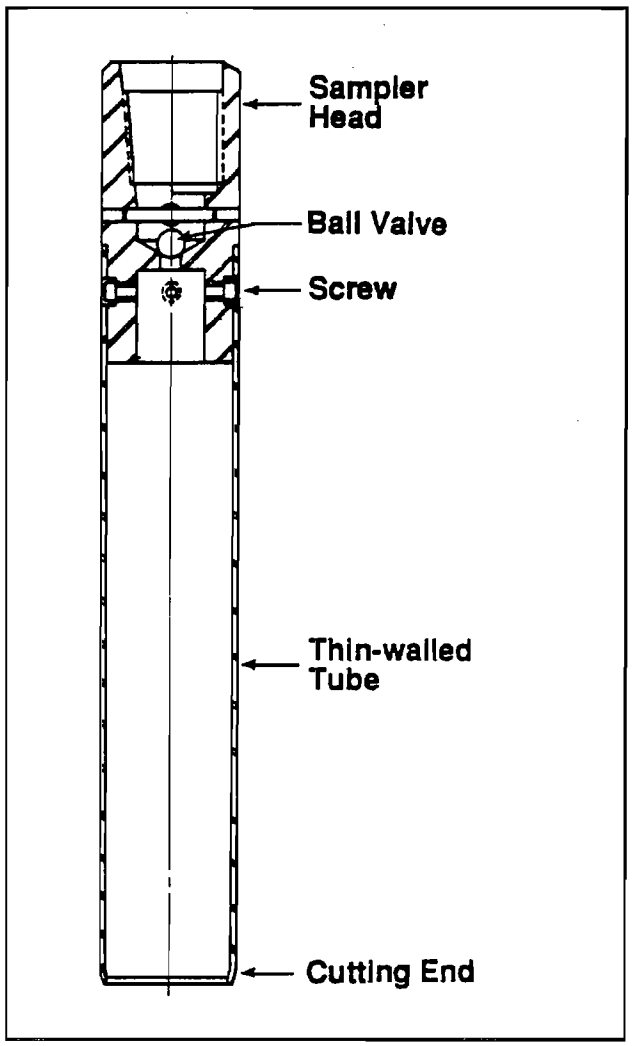

Figure C-18. Standard thin-walled (Shelby) tube sampler

C.6.4.5.3 Sampling procedure. The sampling procedure is as follows:

- Place plastic sheeting on the ground around the sampling location to prevent cross-contamination.

- Place the sampler in a perpendicular position on the material to be sampled.

- Push the tube into the soil by a continuous and rapid motion, without impact or twisting. In no instance should the tube be pushed further than the length provided for the soil sample.
- When the soil is so hard that a pushing motion will not penetrate the sample sufficiently for recovery, it may be necessary to collect a disturbed sample with the split-spoon sampler. Extremely dense and hard soils may result in damage to the thin-walled tube sampler.

- Before pulling out the tube, rotate the tube at least two revolutions to shear off the sample at the bottom. For geotechnical analysis, seal the ends of the tube with wax or rubber packers to preserve the moisture content. In such instances, the procedures and preparation for shipment

should be in accordance with ASTM D 1587. For chemical samples, seal the ends of the tube with PTFE-lined plastic caps.

- Label the sample tube with the appropriate sample label. Be sure to complete the label carefully and clearly, addressing all the categories or parameters.

- Complete all chain-of-custody documents and record information in the field logbook (see Instruction F-1, "Documentation," Appendix F). Prepare samples for shipment (see Instruction F-2, "Packaging and Shipping Procedures," Appendix F).

- Decontaminate sampling equipment after use and between sampling locations.

C.6.4.6 Continuous tube sampler. Method Reference: ASTM D 4700.

C.6.4.6.1 Applicability. The continuous tube sampler provides good samples for describing soil profiles because of the long length of the samples. Discrete samples for chemical analysis can be collected only within a 1.5-m (5-ft) increment. This sampler may not be effective in noncohesive soil types and requires the use of a drilling rig.

C.6.4.6.2 Method summary and equipment. The continuous tube sampler fits within a hollow-stem auger and is prevented from rotating as the auger is turned. The sampling tube can be split or solid barrel and can be used with or without liners of various metallic and nonmetallic materials. The sampler is illustrated in Figure C-19, and is typically 1.5 m (5 ft) long and 5 to 15 cm (2 to 6 in.) in diameter.

C.6.4.6.3 Sampling procedure. The sampling procedure is as follows:

- Place plastic sheeting on the ground around the sampling location to prevent cross- contamination.

- Lock the sampler in place inside the hollow-stem auger with its open end protruding a short distance beyond the end of the auger.

- Advance the auger while soil enters the nonrotating sampling tube.

- After advancing the length of the sampling tube, withdraw the sampler and remove the liner (if used) and cap. If a split-tube sampler is used, and chemical samples are desired, use a decontaminated stainless steel knife to divide the split-tube contents in half longitudinally.

- Begin sampling with the acquisition of any grab VOC samples, conducting the sampling with as little disturbance as possible to the media. Refer to Instruction E-4 for additional information on the collection, handling, and storage of solid VOA samples.

- If homogenization of the sample location is appropriate for the remaining analytical parameters or if compositing of different locations is desired, transfer the sample to a stainless steel bowl for mixing.

- Thoroughly mix remaining sample as outlined in Instructions E-2 or E-3 as appropriate and collect the sample into an appropriate sample bottle with a stainless steel laboratory spoon or equivalent.

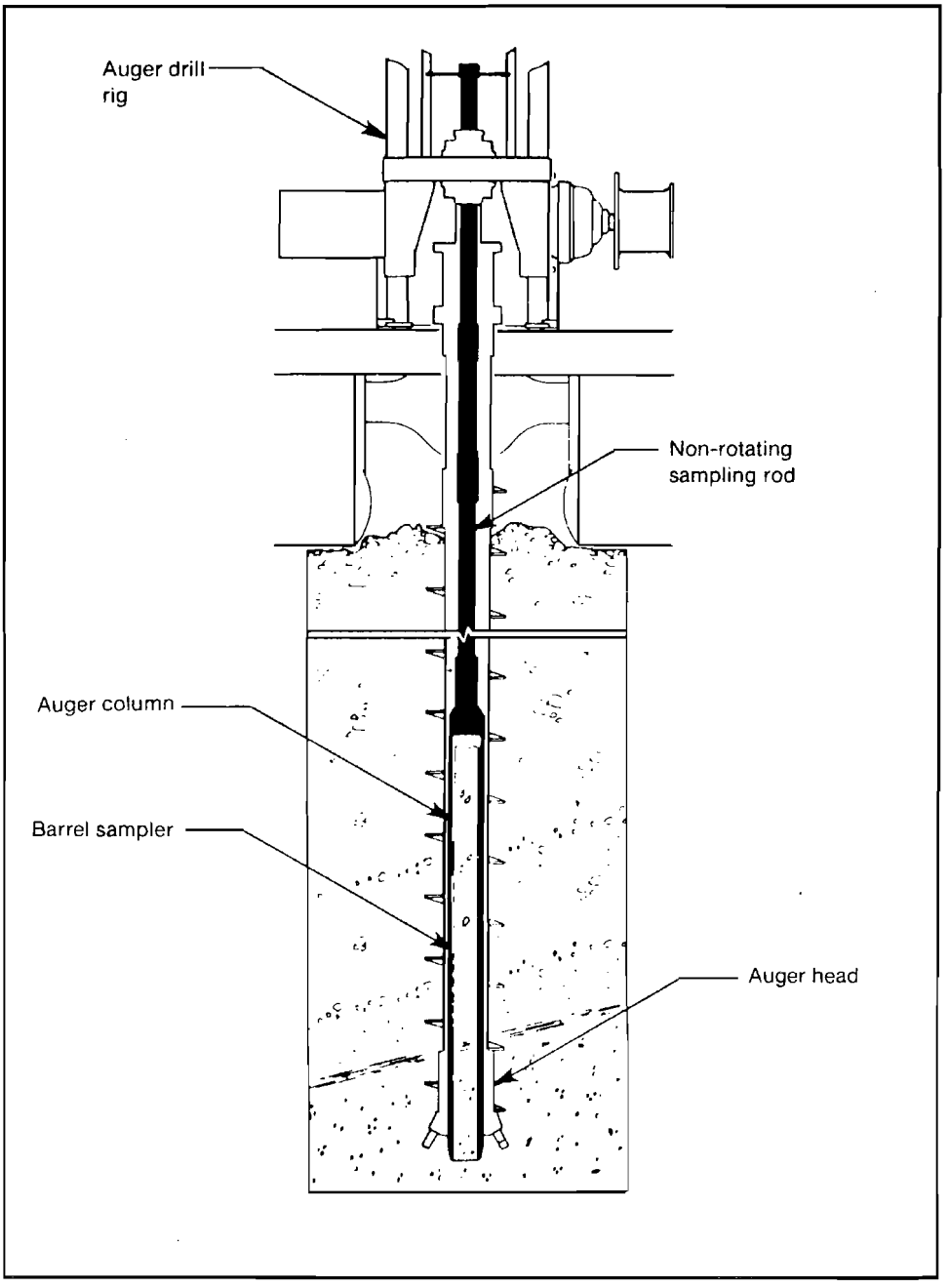

Figure C-19. Continuous tube sampler

- Secure the cap tightly.
- Place filled sample containers on ice immediately.
- Label the sample bottle with the appropriate sample label. Be sure to complete the label carefully and clearly, addressing all the categories or parameters.

- Complete all chain-of-custody documents and record information in the field logbook (see Instruction F-1, "Documentation," Appendix F). Prepare samples for shipment (see Instruction F-2, "Packaging and Shipping Procedures," Appendix F).

- Decontaminate sampling equipment after use and between sampling locations.

C.6.4.7 Piston sampler. Method Reference: ASTM D 4700.

C.6.4.7.1 Applicability. Piston samplers are used to collect soft subsurface soils that cannot be collected using other techniques.

C.6.4.7.2 Method summary and equipment. The piston sampler (Figure C-20) consists of a sampling barrel with a piston that is retracted during sampling. Retraction of the piston creates a vacuum within the sample barrel that aids in retaining the sample in the barrel. Various piston type samplers are available, and each should be operated per the manufacturer's recommendations. EM 1110-1-1906 and EPA/625/R-93/00a discuss the use of a piston sampler.

C.6.4.7.3 Sampling procedure. The sampling procedure is as follows:

- Assemble decontaminated piston sampler and attach to rods that will lower the sampler down the borehole.

- Lower sampler to the desired depth. Advance the sampler into the soil while actuating the piston to create a vacuum within the sample barrel.

- Carefully remove the piston sampler from the bore hole.

- Begin sampling with the acquisition of any grab VOC samples, conducting the sampling with as little disturbance as possible to the media. Refer to Instruction E-4 for additional information on the collection, handling, and storage of solid VOA samples.

- If homogenization of the sample location is appropriate for the remaining analytical parameters or if compositing

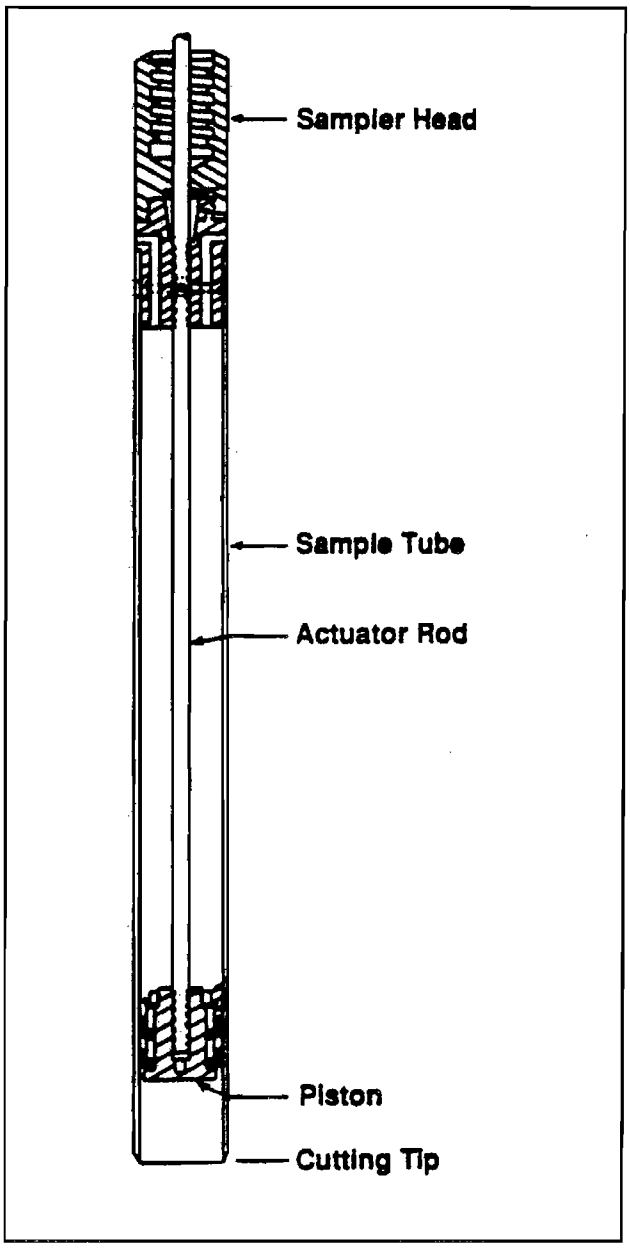

Figure C-20. Piston sampler (after ASTM D 4700, reprinted, with permission, from the Annual Book of ASTM Standards, copyright American Society for Testing and Materials, 100 Barr Harbor Drive, West Conshohocken, PA 19428-2959)

of different locations is desired, transfer the sample to a stainless steel bowl for mixing. Refer to Instructions E-2 and E-3, Appendix E, respectively, for procedures on these techniques.

- Collect the sample into an appropriate sample bottle with a stainless steel laboratory spoon or equivalent.

- Label the sample bottle with the appropriate sample label. Complete the label carefully and clearly, addressing all the categories or parameters.

- Place the sample in an appropriate container and put the container on ice.

- Complete all chain-of-custody documents and field sheets and record in the field logbook (see Instruction F-1, "Documentation," Appendix F). Prepare samples for shipment (see Instruction F-2, "Packaging and Shipping Procedures," Appendix F).

- Thoroughly decontaminate the sampler after each use.

C.6.4.8 Core barrel. Method Reference: ASTM D 2113.

C.6.4.8.1 Applicability. Core barrel or rotating core samplers advance by cutting away rock or soil material using a circular cutting bit as the shoe of the stationary inner core barrel advances into the rock or soil. Core barrel sampling is used primarily for collecting samples for rock profiling purposes. Rock samples are not typically submitted for chemical analysis.

C.6.4.8.2 Method summary and equipment. Core barrel drilling is used to obtain samples of rock or soils that are too hard to sample by soil sampling methods. Double-tube core barrels work the best. Core bits used for this type of sampling are typically impregnated with diamonds or carbide slugs that cut through the formation allowing a continuous sample to be collected.

C.6.4.8.3 Sampling procedure. The sampling procedure is as follows:

- Place the core barrel into position with the bit touching the ground or the surface to be cored.

- Continue core drilling until core blockage occurs or until the net length of the core barrel has been drilled.

- Remove the core barrel from the hole and disassemble it as necessary to remove the core.

- Refer to ASTM D 5079 "Preserving and Transporting Rock Core Samples" and EM 1110-1-1906 for sample handling procedures.

- Place the recovered core in a core box with the upper end of the core at the upper left corner of the core box. Cores should be placed in the core box as a book would read, from left to right and top to bottom, within the longitudinal separators. Space blocks or plugs should be securely placed at the beginning of each core run. The space blocks should be plainly marked with the depth of the core run. Spacers should also be securely placed in the proper positions in the core boxes and properly marked to show the location and actual extent of any voids and/or core losses during drilling.

- When a hole is completed, a space block marked "Bottom of Hole," or "BOH" should be securely placed after the last core run. Appropriately marked space blocks should also be inserted in the core boxes to fill the spaces formerly occupied by core that has been removed for testing.

- Core boxes should be marked on the outside to indicate the top and bottom, and the inside upper left corner of the box should be permanently marked with the letters UL to indicate the upper left corner.

- Soft or friable cores should be wrapped in plastic film or sealed in wax.

- When samples are collected with a core barrel and placed into a core box, the core samples should be photographed in the core box as soon as possible after the core samples are retreived and the box is labeled.

- The core box lid should be marked both inside and outside with the project name, hole number, location, surface elevation, box number, and depths for the beginning and end of core in the box. The ends of the core box should be marked with the project name, hole number and box number.

C.6.4.9 Direct Push Soil Sampling. Method Reference: ASTM D 6282.

C.6.4.9.1 Applicability. The direct push soil sampling method is widely used as a preliminary site characterization tool for the initial field activity of a site investigation. Direct push sampling is an economical and efficient method for obtaining discrete soil and water samples without the expense of drilling and its related waste cuttings disposal costs.

C.6.4.9.2 Method summary and equipment. The sampling method, known as the direct push method, involves sampling devices that are directly inserted into the soil to be sampled without drilling or borehole excavation. Direct push sampling consists of advancing a sampling device into the subsurface by applying static pressure, impacts, or vibration or any combination thereof to the aboveground portion of the sampler extensions until the sampler has been advanced its full length into the desired soil strata. No specific guidance or standards document the "direct push sampling method," but the guidance is a modification of standards from the Shelby tube, split spoon, piston, and penetrometer methods. The method is employed under various protocols by commercial entities and called by various proprietary names (i.e., Geoprobe). Direct push methods may be used to collect soil, and in some cases, the method may be combined with sampling devices capable of water and/or vapor sampling. The equipment generally used in direct push sampling is small and relatively compact allowing for better mobility around the site and access to confined areas. Direct push insertion methods include static push, impact, percussion, other vibratory driving, and combinations of these methods using direct push equipment adapted to drilling rigs, cone penetrometer units (the reference standard for which is ASTM D 5778-95, and specially designed percussion/direct push combination machines. Standard drilling rods used for rotary drilling are sometimes used when sampling is done at the base of drill holes. A direct push soil sampling system consists of a sample collection tool; hollow extension rods for advancement, retrieval, and transmission of energy to the sampler; and an energy source to force penetration by the sampler.

C.6.4.9.3 Sampling procedure. The sampling procedure is as follows:

- Assemble decontaminated direct push sampling device that will be pushed into the ground to collect data or samples.

- Advance the sampling device into subsurface soils by applying static pressure, impacts, or vibration or any combination thereof to the aboveground portion of the sampler extensions until the sampler has been advanced its full length into the desired soil strata.

- Sampling can be continuous for full-depth borehole logging or incremental for specific strata sampling. Samplers used can be protected for controlled specimen gathering or unprotected for general data collection.

- Recover the sampler from the borehole and remove the soil sample from the sampler.

- Begin sampling with the acquisition of any VOC samples, conducting the sampling with as little disturbance as possible to the media. Refer to Instruction E-4 for additional information on the collection, handling, and storage of solid VOA samples.

- If homogenization of the sample location is appropriate for the remaining analytical parameters or if compositing of a different location is desired, transfer the sample to a stainless steel bowl for mixing. Refer to Instructions E-2 and E-3, Appendix E, respectively.

- Transfer sample into an appropriate sample bottle using a stainless steel spoon or equivalent.

- Check that a PTFE liner is present in the cap. Secure the cap tightly.

- Label the sample bottle. Complete the label completely and clearly, addressing all the categories and parameters.

- Place filled sample containers on ice immediately.

- Complete chain-of-custody documents and field sheets and record in the logbook (see Instruction F-1, "Documentation," Appendix F).

- Prepare samples for shipment (see Instruction F-2, "Packaging and Shipping Procedures," Appendix F).

- Decontaminate the equipment following each probe or sample.

C.6.4.10 Site Characterization and Analysis Penetrometer System (SCAPS).

C.6.4.10.1 Applicability. The SCAPS system provides the capability to conduct rapid site characterization and real-time analysis of contaminated soil and ground water in situ. SCAPS may be used to determine areas free of contamination, optimize the selection of monitoring well locations, and provide onsite three-dimensional visualization of soil stratigraphy and contaminant plumes. SCAPS site characterization may save from 25 to 30 percent of site characterization costs compared with those of conventional drill and sampling techniques. SCAPS sensors have the capability for determining soil classification/layering and detecting contaminants simultaneously. Geotechnical and contaminant sensing technologies currently available include soil classification; electrical resistivity; POL; explosives; VOCs; and gamma-emitting radionuclides. Regulatory certification has been granted for the SCAPS POL and is ongoing for VOCs, explosives, and metals sensors under the Environmental Security Technology Certification Program (ESTCP) and by the USEPA Consortium for Site Characterization Technologies, the California EPA Environmental Technology Certification Program, and reciprocity via the Interstate Technology Regulatory Cooperation

(ITRC) Workgroup. SCAPS technology has been transitioned to USACE, Department of Defense, Department of Energy, USEPA, and other government agency users and to the private sector through licensing and Cooperative Research and Development Agreements (CRADA).

C.6.4.10.2 Method summaries and equipment. The SCAPS platform consists of a 20-ton truck (Figure C-21) equipped with vertical hydraulic rams that are used to force a cone penetrometer into the ground at a speed of 2 cm/sec to depths of approximately 50 m in nominally consolidated fine-grained soils. During a vertical push, data are continuously collected and recorded with 2-cm depth resolution. The truck consists of two separate enclosed compartments (i.e., the data acquisition/processing room and the hydraulic ram/rod handling room). SCAPS multisensor penetrometer probes are equipped to measure tip and sleeve resistances simultaneously to determine soil stratigraphy, layer boundaries, and soil type as well as contaminant-specific sensor data to determine the presence of pollutants in each soil strata. SCAPS data acquisition consists of real-time data acquisition, electronic signal processing equipment, and a postprocessing computer for three-dimensional visualization of stratigraphy and contaminant plumes. The soil sampler used with the cone penetrometer consists of a lined steel cylinder with a retractable tip. The liner (typically a plastic type material) is placed in the sampler and the retractable tip is set at the bottom end of the sampler. The sampler is then advanced to the top of the interval where the soil sample is to be collected. The tip is remotely released and the sampler is pushed ahead into the interval to be sampled. Using this procedure, the soil sampler is pushed to the desired depth and the sample is collected without producing soil cuttings typically generated during soil boring activities. This type of soil sampler can be used with equipment other than cone penetrometers. A mobile laboratory truck may accompany the SCAPS to augment field analytical capabilities with the addition of an ion trap mass spectrometry and/or gas chromatography to analyze vapor samples collected by SCAPS samplers. In addition, the SCAPS can inject grout into the borehole through the probes as they are being withdrawn from the ground. This maintains isolation of contaminants in the subsurface.

C.6.4.10.3 Sampling procedures. The sampling procedures are as follows:

- Assemble decontaminated cone penetrometer device that will be pushed into the ground to collect data or samples.

- Push the data collection tip to the desired depth and record the data on the onboard computer. For the soil sampler, advance the sampler to the top of the interval to be sampled, release the tip, and advance the sampler to collect the soil sample.

- Following removal of the soil sample, backfill the hole by pumping grout through the tip as it is retracted, using the tremie method, or by pouring the grout into the hole from the ground surface.

- Remove the liner from the soil sampler and begin sampling with the acquisition of any VOC samples, conducting the sampling with as little disturbance as possible to the media. Refer to Instruction E-4 for additional information on the collection, handling, and storage of solid VOA samples.

- If homogenization of the sample location is appropriate for the remaining analytical parameters or if compositing of a different location is desired, transfer the sample to a stainless steel bowl for mixing. Refer to Instructions E-2 and E-3, Appendix E, respectively, for procedures to follow for these techniques.

- Transfer sample into an appropriate sample bottle using a stainless steel spoon or equivalent.

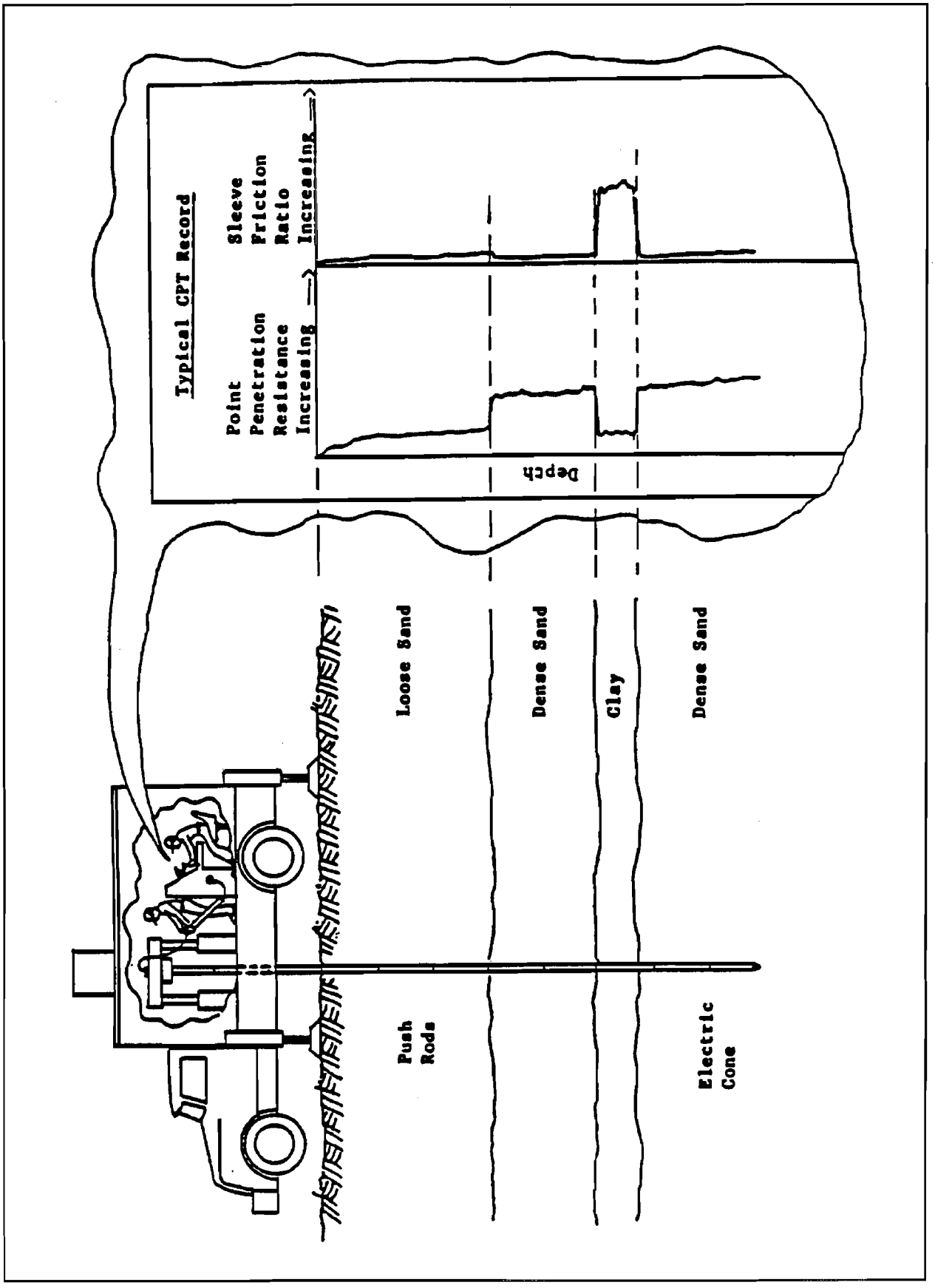

Figure C-21. Site characterization and analysis penetrometer system (SCAPS) truck schematic (CPT = cone penetrometer testing)

- Check that a PTFE liner is present in the cap. Secure the cap tightly.

- Label the sample bottle. Complete the label completely and clearly, addressing all the categories and parameters.

- Place filled sample containers on ice immediately.

- Complete chain-of-custody documents and field sheets and record in the logbook (see Instruction F-1, "Documentation," Appendix F).

- Prepare samples for shipment (see Instruction F-2, "Packaging and Shipping Procedures," Appendix F).

- Decontaminate the equipment following each probe or sample.

C.6.4.10.4 Field analysis capabilities. The SCAPS has the following capabilities:

- Thermal Desorption VOC Sampler: detects and maps solvent and hydrocarbon contamination in both the vadose and saturated zones. Extracts vapor from in situ soil at penetrometer tip and retrieves vapor samples to surface for analysis.

- Hydrosparge VOC Sensing System: samples ground water by direct push tool, strips VOC from ground water by helium flow ("sparging"), and retrieves VOCs for analysis in ion trap mass spectrometer or other device.

- Explosives Sensor: incorporates electrochemical sensors inside the tip for analyzing unexploded ordnance in the contaminated strata; incorporates geophysical sensors for soil classification simultaneous with chemical analyses output at surface.

- Multiport Sampler (MPS): contains vertically stacked sampling modules independently operated from the surface for collecting multiple vapor samples in a single penetration without cross-contamination; alternative immediate retrieval of collected samples or retention for later retraction of probe.

- Laser Induced Fluorescence (LIF) Petroleum, Oil, and Lubricant (POL) Sensor: uses ultraviolet laser to induce fluorescence in POL contaminants in situ; returned fluorescent energy processed for spectral analysis of components in POL.
- Laser Induced Breakdown Spectroscopy (LIBS): a high-power focused laser creates a plasma (dissociates molecules and atoms in soil and energizes them) that emits electromagnetic radiation, which can then be analyzed by spectrometer for atomic content.

- X-Ray Fluorescence (XRF) Metals Sensor: uses x-ray excitation to fluoresce metal atoms independent of chemical states; characteristic energy emissions identify specific metals to well below 100 ppm concentrations.

- Enhanced Spectral Gamma Sensor: detects gamma radiation from radio nuclides for identification by gamma ray spectroscopy.

C.6.5 Decontamination procedures. All sampling equipment must be decontaminated prior to its use. Sampling equipment should be decontaminated as described in Instruction E-5 (Appendix E). The sampling equipment should be placed in plastic bags until immediately prior to use. Additional sampling devices may be needed onsite to ensure an adequate drying time.

C.6.6 Field control sample requirements. Field control samples are collected by the sampling team to determine whether the data are of suitable quality. They include blanks, replicates, and/or background samples. QA samples are replicates sent to a referee (QA) laboratory and analyzed to evaluate the contractor's laboratory performance. QC samples are blind replicates collected by the sampling team for analysis by the primary laboratory. A detailed discussion of field control samples is contained in Instruction G-2 (Appendix G).

C.6.7 Documentation requirements. Bound field logbooks should be used for the maintenance of field records. Record all aspects of the site set up, sample collection and handling as outlined above and in Instruction F-1, Appendix F.

C.7 Surficial Sampling

C.7.1 Scope and application. This instruction presents guidelines for collecting representative samples from various surfaces. Surficial sampling is used to assess the existence and/or extent of contamination on various surfaces rather than in a soil, water, or air matrix. For example, the contamination of the interior of a building may be assessed by collecting wipe samples of the process vessels and ventilation ducts. Surface samples are not typically analyzed for VOCs. Typical sample parameters include PCBs, dioxans/furans, pesticides, semivolatiles, metals, and explosives. Surface samples are typically divided into three media: nonporous surfaces, porous surfaces, and dust/soot. Nonporous surfaces can be sampled by wipe sampling; porous surfaces can be sampled by chipping or coring the surface; and dust/soot can be sampled by vacuum or sweep sampling. Instructions for these techniques are included in this section. If these methods are difficult to implement due to irregular surface shapes or other limitations, a rinsate sample can be collected.

C.7.2 Sampling strategies. The data from surficial sampling are typically required for risk assessments or compliance issues. Therefore, the sampling strategy is based either on a biased approach to locate and/or identify contamination or a systematic approach for decontamination verification.

C.7.2.1 Sampling locations. Sampling at hazardous waste sites is usually conducted in an attempt to discover contamination and to define its extent and variability. With such an objective, it is most logical to choose sample locations that will yield the most information about site conditions. Surficial sampling can be conducted by either biased or systematic sampling. Biased samples are those collected at locations that were chosen based on historical information, knowledge about the behavior of the contaminant(s), and/or knowledge about the effects of the physical system on the fate of the contaminant. Specific requirements for selecting sampling locations may be applicable for risk assessments or verification of cleanup levels. For example, sampling locations for verification of PCB cleanup levels are established in 40 CFR 761. Additional guidance for selecting sampling locations can be found in EPA/600/2-85/028, EPA/560/5-85/026, and EPA/560/5-86/017.

C.7.2.2 Types of samples. Surficial samples are discrete samples. Discrete (grab) samples are defined as a discrete aliquot representative of a specific location at a given point in time. The sample is collected immediately and at one particular point in the sample matrix. Representativeness of such samples is defined by the nature of the materials being sampled.

C.7.2.3 Suggested samplers. Each sampling technique presents various disadvantages and advantages for its application. For example, sample disturbance, sample volume, compatibility with planned chemical analysis, and chemical/physical reactivity between potential contaminants and sampling tool materials vary from technique to technique. Discussions of the advantages and disadvantages of each sampling technique are presented in the following sections.

C.7.2.4 Sample frequency. Determination of the number of samples needed to characterize a site also depends on the objectives and the site-specific conditions. For example, if the objective of the event is to determine whether site equipment is contaminated, a limited number of samples from properly chosen locations will yield useful information. If, however, the site structures are known to be contaminated and delineation of the contamination is the objective, a greater number of samples may be needed. Confirmatory sampling for the effectiveness of the decontamination procedure may warrant specific sample frequency requirements. In many cases statistical considerations can be helpful in determining sampling strategy.

C.7.3 Sample preservation and handling. Many of the chemical constituents and physicochemical parameters that are to be measured or evaluated in investigation programs are not chemically stable; therefore, sample preservation is required. Chip, core, sweep, and vacuum samples should be handled in the

same fashion as sediment/soil samples. Wipe samples do not designate a specific preservation technique, but the use of amber glass may provide protection from light, and/or cooling may be employed as precautionary measures. Appropriate preservation techniques for various parameters are specified in Appendix B. In addition, sample containers that the sampler should use for each constituent or common set of parameters are specified in Appendix B. These preservation methods and sample containers are based on EPA/SW-846. Procedures and techniques for transporting the samples to the offsite laboratory are discussed in Instruction F-2, "Packaging and Shipping Procedures," Appendix F.

C.7.3.1 Sample containers. Chip, core, and sweep samples should be placed in sample jars as designated for soil samples by the chemical parameters of interest. Wipe samples should be placed in amber jars. The cleanliness of each lot of precleaned bottles should be verified by the container supplier or in the laboratory and appropriate paperwork (i.e., certificates) retained with other field documentation. Vacuum samples involve the acquisition of dust onto an air monitoring filter cassette, which includes the appropriate pore size (i.e., 0.8 micron) polycellulose acetate filter. Post sampling, end plugs are secured on the filter cassette for shipment to the laboratory.

C.7.3.2 Sample preservation. Methods of sample preservation are relatively limited and are generally intended to retard biological action and hydrolysis and to reduce sorption effects. Preservation methods are generally limited to refrigeration and protection from light. The sampler should refer to Appendix B or the specific preservation method in EPA/SW-846 for the appropriate preservation technique.

C.7.3.3 Special precautions for trace contaminant sampling. Contaminants can be detected in the parts per billion and/or parts per trillion range. Therefore, all equipment must be thoroughly inspected for cleanliness prior to use and extreme care be taken to prevent cross-contamination of these samples. The following general precautions should be taken when sampling:

- A clean pair of new, disposable gloves and shoe covers, if necessary, should be worn each time a different location is sampled. Gloves should be donned immediately prior to sampling. Remove and immediately dispose of shoe covers and gloves when sampling is complete.

- Avoid disturbing or tracking dust between locations by identifying and clearly marking all sampling locations upon arrival at the sampling site, and avoiding walking through or disturbing the marked areas prior to sampling.

- The appropriate template size should be identified within the project Sampling and Analysis Plan (SAP). Templates may be made of reusable aluminum or plastic or disposable cardboard or plastic. All templates should be thin (<3 mm (1/8 in.)), be able to lie flat, and must have accurately known inside dimensions. If reusable templates are employed, they must be decontaminated between sample (or subsample) locations.

- If appropriate, the solvent (including the required grade) in which the contaminants are most soluble should be identified.

- Sample containers should not be opened until needed to collect each sample. Sample containers for source samples or samples suspected of containing high concentrations of contaminants should be placed in separate plastic bags immediately after collecting, preserving, tagging, etc.

- If possible, background samples and source samples should be collected by different field teams. If different field teams cannot be used, all background samples should be collected first and placed in separate ice chests or shipping containers. Samples of waste or highly contaminated

samples should never be placed in the same ice chest as environmental samples. It is good practice to enclose waste or highly contaminated samples in a plastic bag before placing them in ice chests. Ice chests or shipping containers for source samples or samples suspected to contain high concentrations of contaminants should be lined with new, clean, plastic bags. In general, sample collection activities should proceed progressively from the suspected least contaminated area to the suspected most contaminated area.

- If possible, one member of the field team should take all the notes, fill out sample tags, field sheets, etc., while the other members collect all of the samples. The exact areas sampled should be recorded in the logbook.

- Adequate field control samples should be collected. For vacuum and wipe samples, a blank is mandatory to identify potential interferences from the filter/gauze, solvent (wipe only), or sample containers.

C.7.4 Sampling methods. The following are sampling instructions for the most common techniques for collecting surface samples.

C.7.4.1 Surface wipe sample.

C.7.4.1.1 Applicability. This method of monitoring surficial contamination is intended for nonvolatile species (e.g., PCBs) on nonporous surfaces (e.g., metal, glass). Sample points should be carefully chosen and should be based on site history, manufacturing processes, personnel practices, obvious contamination, and available surface area.

C.7.4.1.2 Method summary and equipment. Surface wipe sampling methods vary and are dependent on the data objectives.

C.7.4.1.3 Sampling procedure. A generalized procedure is presented here for reference.

- Place a clean, appropriately sized square template cutout over the area to be sampled (Toxic Substances Control Act (TSCA) requires 100 cm^2). Secure the template to avoid any shifting during the sampling activity. Do not touch or walk on marked areas. Areas should be documented by a drawing of the floor plan, if applicable, in the field logbook. Unique sample number identifiers should be included within the drawing.

- Remove a gauze pad from the box of gauze using decontaminated tongs (filter paper may also be used). Be sure to use a new pair of surgical gloves.

- Soak the gauze or filter pad in appropriate solvent.

- Using a decontaminated pair of tongs, wipe the area framed by the template cutout with the moistened gauze in one direction.

- Without allowing the gauze to contact any other surface, fold the gauze with the exposed side in, and then fold it again to form a 90-degree angle in the center of the gauze.

- Place the gauze in an amber laboratory sample container, angle first, and replace the container cap.

- Secure the cap tightly.

- Label the sample bottle with the appropriate sample label. Be sure to complete the label properly and clearly, addressing all categories or parameters.

- Place a filled sample container on ice immediately, if desired.

- Complete all chain-of-custody documents and record information in the field logbook (see Instruction F-1, "Documentation," Appendix F). Prepare the samples for shipment (see Instruction F-2, "Packaging and Shipping Procedures," Appendix F).

- Mark the area of the cutout using a paint stick, if possible.

- Record the location data, station number, sample time, date, and names of the sampling crew in the field logbook or log sheet for each wipe sample. In addition, document the sampling locations by including a drawing or dimensioned sketch in the field logbook or log sheet if the sampled area cannot be marked by a paint stick or if locating the area from the field notes would be difficult.

- Dispose of generated waste material properly.

C.7.4.2 Chip/core sample.

C.7.4.2.1 Applicability. This method of monitoring surficial contamination is intended for nonvolatile analytes (e.g., PCBs) on porous surfaces (e.g., cement, brick, wood). Suggested sampling points include floors near process vessels, storage tanks, loading docks, etc.

C.7.4.2.2 Method summary and equipment. Samples from porous surfaces can be obtained by breaking up a designated surface with a chisel, brushing up the chipped pieces, and transferring the sample into a bottle. A core sample can also be collected using appropriate power tools. However, most confirmatory sampling requires that only the upper 6 mm (1/4 in.) of the media be sampled. Core samples may require further sample handling (i.e., sawing) to isolate this portion of the sample for analysis, or may risk diluting contaminants that may be present only in the upper 6 mm (1/4 in.) if the sample is analyzed as a whole, and are therefore discouraged.

C.7.4.2.3 Sampling procedure. Once the sample location has been determined, measured, and marked off, sample collection can begin as follows:

- Place a clean, appropriately sized template cutout over the area to be sampled. The template may be square, U-, or L-shaped, as appropriate to the area under assessment. Secure the template to avoid any shifting during the sampling activity. Do not touch or walk on marked areas. If applicable, areas should be documented by a drawing of the floor plan in the field logbook. Unique sample number identifiers should be included within the drawing.

- Use a decontaminated chisel and hammer to break up the surface to be sampled (TSCA requires 100 cm^2). Avoid scattering pieces. Chip the area to less than 6 mm (1/4 in.) in depth.

- Record the depth at which the chips were taken.

- Collect the chipped pieces using new clean gloves and a pair of decontaminated tongs.

- Transfer the sample directly into the sample bottle.

- Secure the cap tightly.

- Label the sample bottle with the appropriate sample label. Be sure to complete the label carefully and clearly, addressing all the categories or parameters.

- Place the filled sample container on ice immediately.

- Complete all chain-of-custody documents and record in field logbook (see Instruction F-1, "Documentation," Appendix F). Prepare samples for shipment (see Instruction F-2, "Packaging and Shipping Procedures," Appendix F).

- Decontaminate sampling equipment after use and between sampling locations.

C.7.4.3 Vacuum dust sample.

C.7.4.3.1 Applicability. This sampling method is used to monitor surficial contamination for carpeted or noncarpeted areas. Sampling is typically intended to assess residential or industrial dust contamination associated with metals species (e.g., lead). Sample points should be carefully chosen and should be based on traffic areas, dust migration pathways, potential exposure of most susceptible personnel (e.g., the bedroom of youngest/oldest resident), obvious contamination, and available surface area. Undisturbed areas such as an attic may be used to assess historic dust concentrations.

C.7.4.3.2 Method summary and equipment. Surface dust samples are vacuumed onto a filter with the use of a calibrated air monitoring pump. Samples may be a composite of subsampled areas or individual samples taken from each location, depending on the project data objectives. All sampling locations should be clearly defined within the Field Sampling Plan portion of the SAP.

C.7.4.3.3 Sampling procedure. A generalized procedure is presented here for reference.

- Place a clean, appropriately sized template cutout over the areas to be sampled (e.g., 0.09 to 0.03 m^2 (1 to 3 ft^2)). The template may be square, U-, or L-shaped, as appropriate to the area under assessment. Secure the template to avoid any shifting during the sampling activity. Do not touch or walk on marked areas. Areas should be documented by a drawing of the floor plan in the field logbook. For composite samples, areas should be numbered to depict the sequence of sample collection. For individual samples, unique sample location identifiers should be included within the drawing.

  (1) For carpeted areas, suggest placing templates at any high-traffic area in the room (e.g., immediately inside doorways into room).

  (2) For noncarpeted (hard-surface) areas, suggest placing templates in areas where dust is likely to migrate (e.g., immediately adjacent to wall or at the edges of the room).

- Connect the inlet port of a portable, battery-operated air monitoring pump (capable of maintaining a flow rate of 3.0 L/min through a filter cassette) to tubing sized to fit tightly on the outlet side of the air monitoring filter cassette. Pump flow must be calibrated to the project-specified flow rate per manufacturer's instructions using a soap bubble airflow meter or calibrated rotameter.

- Connect the collection nozzle (i.e., stainless steel or carbon-impregnated plastic machined/molded to form a thin rectangular opening of 1.3 mm by 1.2 mm (1/2 in. by 3/64 in.) for the sampling end and the other machined/molded to accept tubing) to tubing sized to fit tightly on the inlet side of the filter cassette.

- Hold the vacuum in the sampling position above the template, turn on the air monitoring pump, and ensure the flow rate is at 3.0 ± 0.2 L/min (or as specified in project SAP).

- Execute the vacuuming technique as follows:

  (1) First pass: Hold the collection attachment at a 45-degree angle to the surface and move from one side of the template to the opposite side. The rate of movement should be approximately 1.5 to 2 seconds for each stroke. Continue in the same direction until the entire area has been vacuumed.

  (2) Second pass: Repeat the above procedure in a direction 90 degrees from the first pass.

  (3) Third pass: Repeat this procedure in the same direction as the first pass.

- Remove the filter (dust) cassette from the tubing attachments and secure with end caps.

- Label the filter (dust) cassette with pertinent sample information as defined in Instruction F-1, Appendix F.

- Complete all chain-of-custody documents and record information in the field logbook (see Instruction F-1, "Documentation," Appendix F). Prepare the samples for shipment (see Instruction F-2, "Packaging and Shipping Procedures," Appendix F).

- Record all measurements onto a drawing of the floor plan, including the location data, station number, sample time, date, and names of the sampling crew, in the field logbook or log sheet for each vacuum sample.

- Dispose of generated waste material properly.

C.7.4.4 Sweep sample.

C.7.4.4.1 Applicability. This method of monitoring surficial contamination is intended for nonvolatile analytes (e.g., PCBs) in the residue found in porous (e.g., asphalt) or nonporous (e.g., metal) surfaces. Sweep sampling allows collection of dust/residue that may help in the assessment of contaminant determination and delineations. Sample points should be carefully chosen and should be based on traffic areas, dust migration pathways, potential exposure personnel, obvious contamination, and available surface area. Undisturbed areas such as an attic may be used to assess historic dust concentrations.

C.7.4.4.2 Method summary and equipment. Dust and residue samples can be collected with a bristle brush and dustpan in places where solvents cannot be used or when large amounts of dust/residue make wipe samples impractical.

C.7.4.4.3 Sampling procedure. Once the sample location has been determined, measured, and marked off, sample collection can begin as follows:

- Put on clean, chemical-resistant gloves (separate pair for each location).

- Place a clean, appropriately sized template cutout over the area to be sampled. Templates may be square, U-, or L-shaped, as appropriate to area under assessment. Secure the template to avoid any shifting during the sampling activity. Do not touch or walk on marked areas. Areas should be documented by a drawing of the floor plan in the field logbook. For composite samples, areas should be numbered to depict the sequence of sample collection. For individual samples, unique sample location identifiers should be included within the drawing.

- Sweep all residues from the area to be sampled into the dustpan.

- Transfer the sample directly into the sample bottle.

- Secure the cap tightly.

- Label the sample bottle with the appropriate sample label. Be sure to complete the label carefully and clearly, addressing all the categories or parameters.

- Place a filled sample container on ice immediately.

- Complete all chain-of-custody documents and record in field logbook (see Instruction F-1, "Documentation," Appendix F). Prepare samples for shipment (see Instruction F-2, "Packaging and Shipping Procedures," Appendix F).

- Decontaminate sampling equipment after use and between sampling locations.

C.7.5 Decontamination procedures. All nondisposable templates and sampling equipment must be decontaminated prior to its use. Field equipment should be cleaned as described in Instruction E-6, Appendix E. The sampling equipment should be placed in a plastic bag until immediately prior to use. Additional sampling devices may be needed onsite to ensure an adequate drying time.

C.7.6 Field control samples requirements. Field control samples are collected by the sampling team to determine whether the data are of suitable quality. They include blanks, replicates, and/or background samples. A detailed discussion of field control samples may be found in Instruction G-2, Appendix G, and is summarized in the following sections as they are applied to surficial sampling.

C.7.6.1 Duplicate/split samples. True duplicate/split samples cannot be collected in a surficial or dust/soot sampling program. The sampling medium (i.e., filter or gauze) used to collect the sample cannot be divided to obtain a duplicate/split sample because the contaminants will not be spread evenly on the sample medium. The same surface area cannot be sampled a second time to obtain a duplicate/split sample because the first sample will remove the contaminants from the area under assessment. Collecting a sample from an area adjacent to the first sampling area is a viable alternative for collecting a duplicate/split sample. However, the sample is not a true duplicate/split sample and the contaminant concentrations in the samples from the adjacent area may not be the same.

C.7.6.2 Blank samples. Vacuum and wipe blanks are samples collected in the field to determine if any interference has been caused by the sample collection materials (i.e., filters/gauze, solvent (wipe only), or sampling equipment). These blanks are obtained by preparing the sample medium for sampling, placing the solvent on the gauze if applicable, and placing the sampling medium in the sample containers, or securing

the sample for shipment as directed within the instruction. The sample medium does not contact any sampling surface.

C.7.6.3 Background samples. Background samples are recommended to be taken in conjunction with chip/core samples. Background samples should be taken using the same procedures used to obtain the field samples. The samples should be obtained from an uncontaminated area of the same matrix used to collect the field samples. The rationale for collecting background samples is to determine if there are any interferences inherent in the porous matrix.

C.7.6.4 Rinsate blank samples. Rinsate samples consist of reagent water collected from a final rinse of surfaces after decontamination procedures have been performed. The purpose of the rinsate samples is to determine the thoroughness of the decontamination procedures performed.

C.7.7 Documentation requirements. Bound field logbooks should be used for the maintenance of field records. Record all aspects of the site setup, sample collection and handling as outlined in the preceding sections and in Instruction F-1, Appendix F.

C.8 Air and Soil Gas Sampling

C.8.1 Air sampling. This section addresses the aspects of gas phase sampling and analysis for HTRW projects. This type of sampling can involve four categories of sample collection and measurements: soil gas in situ or extractive; surface area emission flux; point source emissions or remediation process streams, including in-place control and containment systems; and ambient air at the site perimeter or at off-site receptor locations. The media sampled for soil gas or surface area emissions are typically gaseous phase samples. Point source, process streams, and ambient air sampling can involve either gaseous phase samples or particulate matter.

C.8.2 Soil gas sampling.

C.8.2.1 Scope and application. Soil gas monitoring of the vadose zone is used to measure characteristics of the soil atmosphere as an indirect indicator of contamination in or below the sampling horizon. The information may be used for health and safety purposes, to detect and monitor migration of volatile contamination of soils within the vadose zone, to support the design of a soil vapor extraction system, to assess the extent of ground water volatile organics contamination, to verify underground storage tanks integrity and monitor for any subsurface discharges, and to aid in locating ground water monitoring wells, extraction wells, recovery trenches, etc. It is also used for general reconnaissance, and as a screening technique when large areas are being evaluated that have little or no information available on past waste disposal practices. The primary limitation to this type of sampling is that it is not a stand-alone technique, and additional sampling of environmental media is necessary to determine the source and extent of contamination. Soil gas samples may be analyzed onsite, or samples containerized and shipped to a laboratory for offsite chemical analyses. The overall effectiveness of a soil gas sampling method to depict subsurface conditions accurately is dependent on several factors, including soil permeability; infiltration moisture; barometric pressure changes; volatility of the contaminant; the presence of any underground obstacles or conduits, pavements, or other features affecting pathways; the presence of interfering chemical compounds, etc. Soil gas sampling technology is most effective in mapping low-molecular-weight, halogenated, or aromatic hydrocarbons that possess high vapor pressures and low aqueous solubilities (e.g., benzene, toluene, trichloroethylene, trichloroethane, vinyl chloride, etc.)

C.8.2.2 Sampling strategies. Sampling strategies are developed by the project team to satisfy project-specific data needs that are identified during the HTRW technical planning process. Sampling strategies will vary based on the intended purpose of the soil gas survey; and they are significantly influenced by such factors as site physical constraints, soil types and stratigraphy, background information available, and type of contamination, to name a few. When soil gas sampling is used to optimize monitoring wells or soil boring locations or monitor the integrity of underground storage tanks, a sampling strategy based on a judgmental or biased approach is recommended. However, when soil gas sampling is used for general site reconnaissance, the use of a statistical sampling method (i.e., a systematic grid approach) is typically used. Many projects use a combination of these sampling strategies. For instance, an initial sampling may be done by a predetermined regularly spaced grid pattern to identify presence of contamination, followed by a judgmental or close, irregularly spaced grid pattern approach to refine the delineation of the contamination detected. Grid spacing shape and size should be based on the project objectives and allowable uncertainty in the decision-making process, but be flexible enough to allow modifications in the field to account for site characteristics, or generated results. The technical planning process that results in the development of project soil gas sampling strategy is critical because of the difficulty in acquiring representative soil gas samples.

C.8.2.3 Sampling locations. Sampling at hazardous waste sites is usually conducted in an attempt to discover contamination and to define its extent and variability. With such an objective, it is most logical to choose sample locations that will yield the most information about site conditions. As noted in the

preceding section, a soil gas sampling survey can be conducted by following random, systematic, or biased sampling strategies. The same information used to select the sampling strategy is used to choose the soil gas sampling locations. Sample locations must account for a variety of physical properties of the soil, including grain size, cohesiveness, organic matter, moisture content, geographic fractures, and overall soil permeability. In addition, the properties of the chemical contaminants must also be considered, including volatility, solubility or immiscibility in water, and degradation potential. Appropriate sampling depths are determined by assessing these factors and the depth to ground water, the source, soil stratigraphy, and features that enhance or impede the movement of the soil gas. Multiple depth sampling is also an option, when complex geologic settings are encountered.

C.8.2.4 Sampling techniques and sample types. Soil gas samples may be generated in conjunction with an active or passive sampling system. The samples themselves may be a whole air sample or a sorbent sample composed of an absorbent/adsorbent medium that collects contaminants during a specified time frame.

C.8.2.4.1 Active soil gas sampling system. An active soil gas sampling system involves the forced movement of bulk soil gas from the vadose zone to a collection device through a probe or similar apparatus by the influence of a vacuum pump. The air within the system may be monitored real-time through a sample port with an appropriate detector (e.g., photoionization detector or flame ionization detector) or coupled directly to an analytical system for direct monitoring readout documentation. Active soil gas systems may also be sampled with a gas-tight syringe for onsite gas chromatograph analysis, or whole air samples collected in tedlar bags, glass bulbs, summa canisters, or other containment devices for subsequent onsite or offsite analyses. Refer to Figure C-22 for an illustration of a summa canister for the collection of whole air samples. The active soil gas sampling system may also be configured to collect a sorbent sample. Refer to Figure C-23 for a schematic of a sorbent media cartridge for the collection of sorbent samples. In this way, the probe is connected to a collection device designed to extract and trap chemical contaminants from the airstream by adsorption. This technique is especially useful when very low-level contamination is present that is below the instrument sensitivity capabilities for whole air samples, and preconcentration of the contaminants onto the adsorbent medium is necessary. Some sorbent media can also be used to segregate interfering compounds (e.g., reactive or oxygenated organic compounds), for the medium can be treated or designed so the inferences will not be adsorbed or easily desorbed from the collection medium. Sorbent samples are also beneficial when the chemical contaminants are more amenable or more efficiently removed and detected by extraction techniques. The collection medium is typically activated charcoal, silica gel, activated alumina, various porous polymers, or molecular sieve adsorbents that have been prepared by thermal (or solvent) desorption treatment. Limitations in the use of sorbent samples include interactions between the

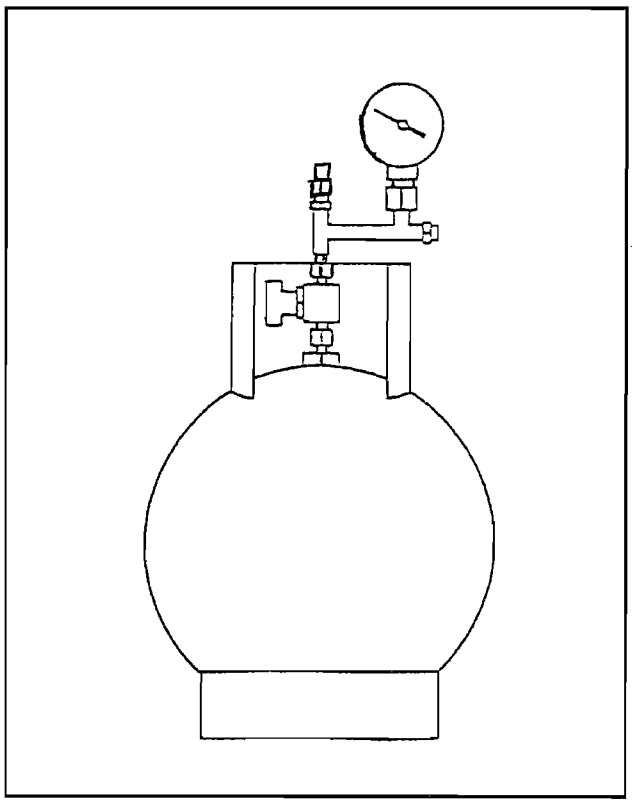

Figure C-22. Rigid whole air collection canister (summa canister)

contaminants and the sorption medium, the release of artifacts during the desorption process, and high humidity, which can significantly impact the adsorption efficiency of the sorption medium. Advantages in using an active soil gas sampling system include the quick turnaround for data and the ability to tailor the survey as it progresses. Limitations of an active soil gas system include its cost compared to that of passive techniques and its susceptibility to meteorological effects, i.e., false negative results when rainfall or snowmelt occurs. This is due to infiltration water driving the contaminant vapors ahead of the infiltrating front and drawing clean atmospheric air into the zone to be sampled. Driven probes also tend to degrade the natural soil permeability around the body of the probe due to soil compaction during probe insertion. This may severely impede the active soil gas flow in moist, heavy clay soils.

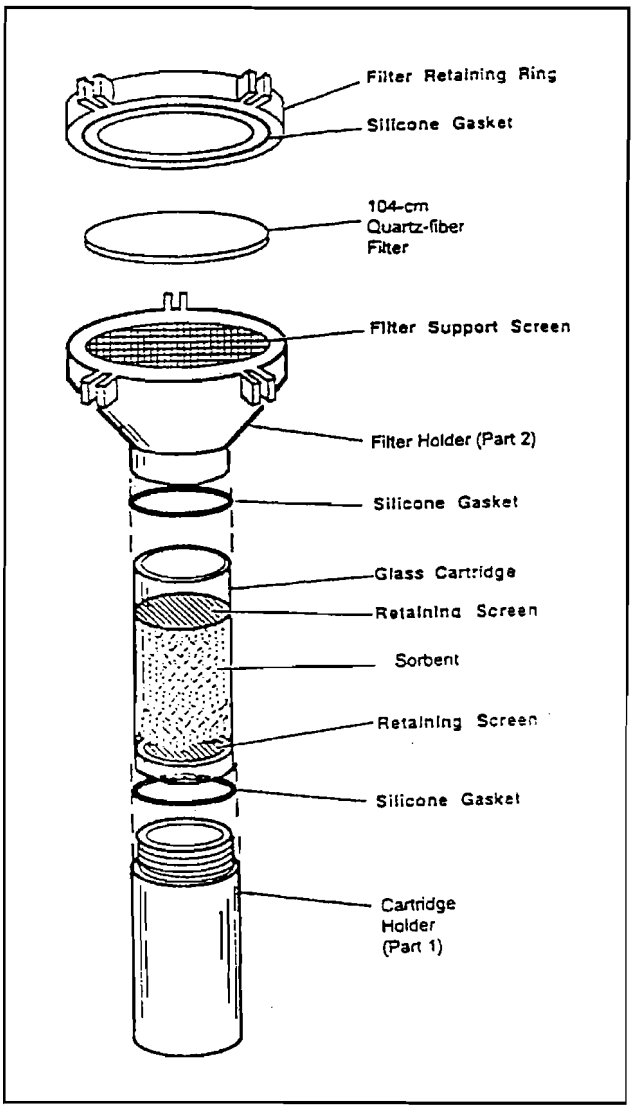

Figure C-23. Sorbent media (resin) cartridge

C.8.2.4.2 Passive soil gas sampling system. A passive soil gas sampling system entails placing a collection device in the subsurface or on the surface of the ground and allowing the atmosphere in the device to come to compositional equilibrium with the soil atmosphere. A passive soil gas sampling system may be used to collect whole air samples. This approach may be used to monitor contaminant emissions for health and safety purposes (i.e., methane emissions from a landfill) and is discussed in Section C.8.3. More commonly, the passive soil gas sampling techniques are used in conjunction with a sorbent medium. Several varieties of these collection devices exist, with slightly different configurations. However, the basis for sampling is the same, in that it is the passive movement of contaminants in soil to a sorbent medium contained in a collection device over a specified period of time. Several types of sorption media are available, which, due to their adsorption properties, will reduce the contaminant concentration directly adjacent to the device. This induced concentration sink helps maintain continuous migration of contaminants from the vadose zone toward the collection device by diffusion and mass transfer. The rate of contaminant migration is limited by many of the same factors affecting the active soil gas sampling techniques. These include soil physical characteristics and the physical and chemical properties of the contaminants. In addition, caution must be exercised during installation or backfilling to avoid cross-contamination of the sorbent media. Typical residence times for the collection devices range from several days to weeks to complete. The passive-sorbent sample system is not recommended when the ground is frozen or when saturated soil conditions exist. Advantages to the use of a passive soil gas sampling system include its nominal cost, its lower susceptibility to meteorological changes, and the addition of less volatile contaminants that may be analyzed. Limitations include the following: time frames for data retrieval are

long, which necessitates the need for more samples for thorough coverage, and it is not appropriate for use with soil vapor extraction system design.

C.8.2.5 Sample preservation and handling. Methods for preservation of whole air and sorbent samples are relatively limited and are generally intended to retard thermal and photodegradation. Preservation methods for whole and sorbent samples are typically avoidance of heat or light. This may be as simple as placing samples potentially exposed to light (i.e., tedlar bags) in dark plastic garbage sacks, and keeping out of direct sunlight. Sorbent samples preservation will vary based on the sorbent medium used. Therefore, follow any procedures identified by the vendor or manufacturer.

C.8.2.6 Collection of adequate field control samples. Field control samples are collected by the sampling team to determine whether the data are of suitable quality. They may include blanks, replicates, and/or background samples (atmospheric blanks). The application, type, and frequency of field control sample acquisition should be based on the purpose of the soil gas survey and the associated data quality requirements. Field control samples taken in conjunction with soil gas sampling techniques are typically limited to a variety of field blanks to assess potential cross-contamination sources and contribution. Field blanks used include trip (travel) blanks, sample container blanks, and sample probe blanks. Field replicates may be taken. However, due to the difficulty in acquiring representative replicate air or adsorbent samples, taking field replicates is not commonly practiced. A detailed discussion of field control samples is contained in Instruction G-2, Appendix G.

C.8.2.7 Sampling methods. Due to a variety of configurations for passive soil gas sampling methods, defer to the individual manufacturer's installation and instruction manual. The following encompasses general procedures for an active soil gas sampling system. Additional procedures may be necessary based on the manufacturer's specifications. Method Reference: ASTM D 5314.

C.8.2.7.1 Applicability. Active soil gas sampling systems are widely used as a preliminary site characterization tool for the initial field activity of a site investigation. Active and passive soil gas sampling systems are an economical and efficient method for obtaining information on potential subsurface contamination without the expense of drilling and its related waste cuttings disposal costs.

C.8.2.7.2 Method summary and equipment. The active soil gas sampling system involves sampling devices that are directly inserted into the soil to be sampled without drilling/excavation, or into the soil ahead of the auger or drill bit if performing deep sampling or vertical profiling. The active soil gas sampling consists of advancing a sampling device into the subsurface by applying static pressure, impacts, or vibration or any combination thereof to the aboveground portion of the sampler extensions until the sampler has been advanced its full length into the desired soil depth or strata. The equipment generally used to drive the sample probe is small and relatively compact allowing for mobility around the site and access to confined areas. The probe is then retracted slightly to remove the expendable drive point or open a sample port and create a void where soil gas may enter the sample probe. A vacuum is drawn on the system with a pump to induce the flow of soil gas through the sample probe to the surface where whole air or sorbent samples may be acquired.

C.8.2.7.3 Active soil gas sampling procedure. The sampling procedure is as follows:

- Assemble decontaminated active soil gas sampling probe device, consisting of a drive point, point holder, a hollow extension pipe, or other equipment as specified by a manufacturer. Push the apparatus into the ground to collect samples (Figure C-24).

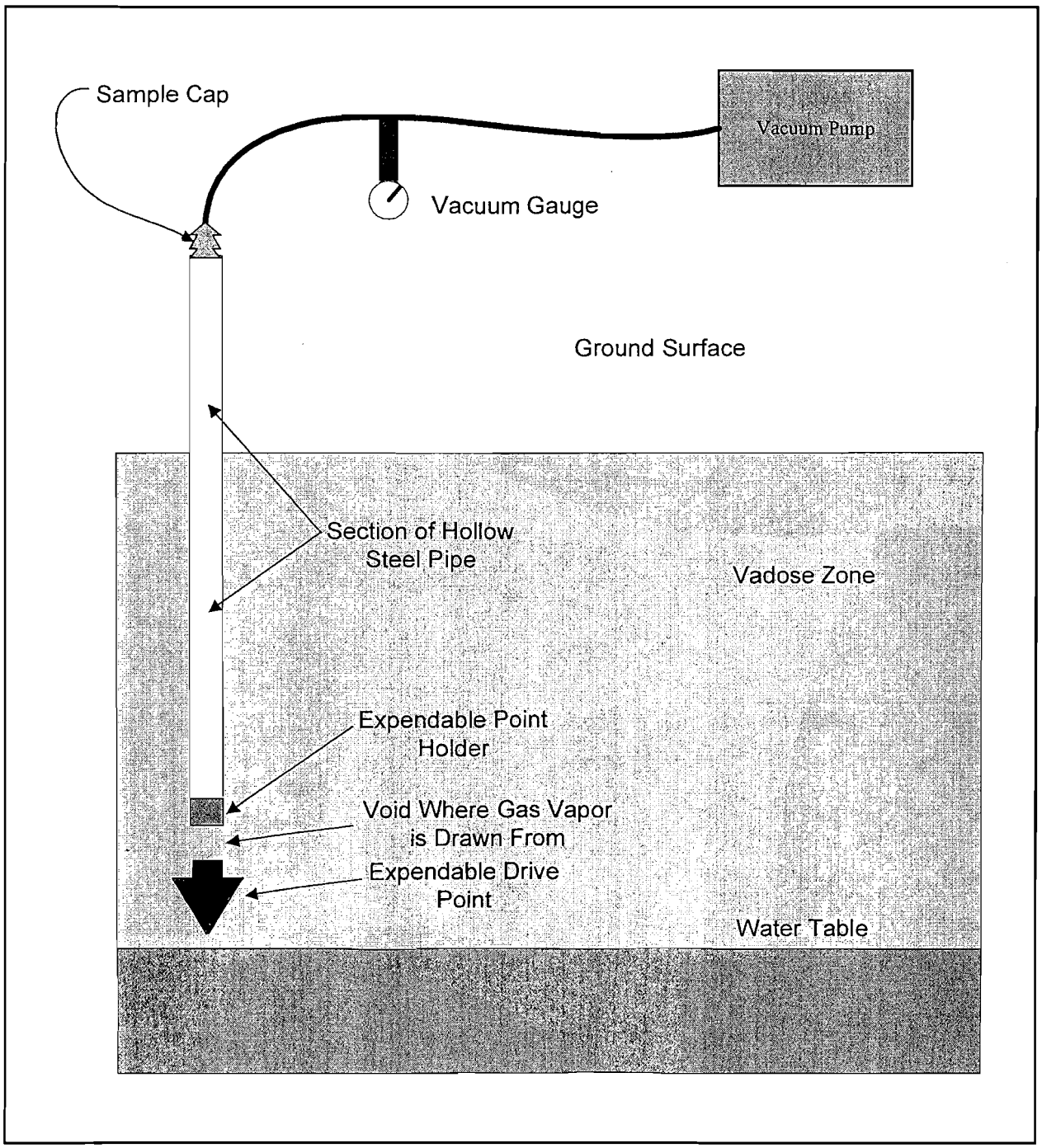

Figure C-24. Active soil gas apparatus

- Advance the sample probe by applying static pressure, impacts, or vibration or any combination thereof to the aboveground portion of the sampler extensions until the sampler has been advanced its full length into the desired soil depth or strata (typically 1.5 to 3 m (5 to 10 ft)).

- Sample probes may be fitted with detachable drive tips, which become removed from the steel pipe when the probe is retracted.

- Attach the flexible tubing with appropriate sampling port or sorbent media cartridge, followed with additional flexible tubing to a vacuum pump.

- Extract gas through the probe via the vacuum pump. Five probe volumes should be extracted prior to sampling. A qualitative check for leaks or short circuits is performed by monitoring the vacuum and flow rates. A drop in vacuum or too low a vacuum may indicate system problems. Quantitative leak checks may also be used to verify that the system performance is acceptable at the highest vacuum required by the project. Project-specific acceptance criteria should be established when necessary.

- Begin sampling with appropriate sample containers through a sampling port set between the probe and the pump. These may include real-time monitors (photoionization detector or flame ionization detector), gas-tight syringes, tedlar bags, summa canisters, etc., for a whole air sample. Or preset the appropriate sorbent media and cartridge at the same location between the probe and the vacuum pump.

- Close off appropriate valves for sample containers. Samples should be protected from heat and light.

- Label the sample containers. Complete the label completely and clearly, addressing all the categories and parameters.

- Complete chain-of-custody documents and field sheets and record in the logbook (see Instruction F-1, "Documentation," Appendix F).

- Samples not analyzed immediately should be prepared for shipment to the laboratory (see Instruction F-2, "Packaging and Shipping Procedures," Appendix F).

- Decontaminate the equipment following each probe or sample.

C.8.2.8 Decontamination procedures. All sampling equipment must be disposable or decontaminated prior to its use. Sampling equipment should be decontaminated as described in Instruction E-6 (Appendix E).

C.8.2.9 Documentation requirements. Bound field logbooks should be used for the maintenance of field records. Record all aspects of the site setup and sample collection, preparation, and handling, and all field analytical reportables (i.e., calibration data, sample and QC results, chromatograms, etc.) as outlined previously and in Instruction F-1, Appendix F.

C.8.3 Surface emission flux measurements

C.8.3.1 Scope and application. Surface emission flux rate sampling for gaseous compounds involves the isolation of either an "as-is" surface area or a prepared "scraped" area to collect and quantify the release of contaminants of concern. A flux chamber is used to cap the surface area being evaluated while the chamber is continuously swept by the injection of an inert gas or air. The resulting gaseous mixture is then sampled and analyzed. The rate of contaminant emission from the source area is calculated based on the flow rate of the incoming inert gas and the concentrations of contaminants found in the mixed gas sample. This type of sample collection and measurement is often selected when indoor or localized ambient air contamination is of concern due to contaminant migration from known or suspected HTRW sites. Emission

flux data are collected to provide more accurate site-specific contaminant emission data than may be obtained from predictive models. The calculated emission data can be used for contaminant fate and transport calculations, risk assessment, or determination of the rate of release to the atmosphere. In effect, this measurement may improve the accuracy of the "migration" rate from a source to the gaseous phases. The results of such measurements are expressed in units of contaminant flux rate per time (i.e., mass/area/time), most commonly reported as • g/min•m^2. Primary limitation of this technique is the lack of analytical sensitivity of the gas mixture due to the dilution from the injected inert gas.

C.8.3.2 Sampling strategies. Sampling strategies are developed by the project team to satisfy project-specific data needs that are identified in the HTRW technical planning process. The sampling strategy developed at a particular site will vary based on the intended purpose of the flux emission data. Flux chamber sampling strategy must address the VOC source, most likely route of travel, potential and real receptors affected by the VOC migration, and any target receptors with unique characteristics. Sampling strategies are based on subdividing areas into zones, and then sampling within each zone to assess zone variability. Many flux chamber applications and sampling strategies are either based on judgmental decisions or biased to site-specific conditions. For example, the effect of VOCs in creating an indoor air problem may necessitate the sampling of specific basement floor fractures and cracks. Also affecting the sampling strategy are the varying effects of changing meteorological conditions. The sample collection method must preserve the project concept of a representative sample. This may include maintaining sufficient duration for real-time measurements or obtaining a sufficient number of grab samples or a sufficient number of sample aliquots for compositing of time-integrated samples.

C.8.3.3 Sampling locations. Sampling locations will be determined by both the site-specific characteristics and the nature of the contaminants of concern. For indoor air issues, the sampling locations will likely be selected based on the receptors (buildings/structures/occupants) of concern. For emission flux data to be used for risk assessment or site-specific emission modeling, sampling locations should be located based on known or suspected contaminant sources and the most likely route of migration. For instance, migration may be determined through soil or concrete slab fractures, fuel emissions based on the known location of an underground storage tank or transport pipe, landfill cover deficiencies or openings, specific areas of a lagoon system, etc.

C.8.3.4 Sampling techniques and sample types. Figure C-25 shows a schematic of a flux chamber apparatus. A similar device that enables the user to sweep inert gas continually over a surface area and collect liberated volatile compounds from the isolated head space may be used. The specific application and contaminants of concern will usually dictate the design features of the sampler. Design parameters address the relative volume of the head space of the steady-state flux chamber and any special features for flotation, such as when evaluating a liquid source area. The volatiles swept from the flux chamber headspace can be monitored directly using field instruments or measurement devices, a sample can be collected from a series of grab samples and analyzed onsite, or a sample can be collected as aliquots and composited to constitute a time-integrated sample. In general, the liquid or solid surface is selected and prepared for the flux chamber application, as necessary. The characteristics of the sampling equipment and procedures are determined by the source media, the contaminants of concern, the detection limit measurement objectives, and the method of sample collection or detection. Flux chambers utilize an inert sweep gas from compressed cylinders of nitrogen or "zero air," or a purification system established for use with ambient air. For the latter approach, the effectiveness of the cleaning step should be verified. Refer to ASTM D 5314 for additional guidance on this type of sampling.

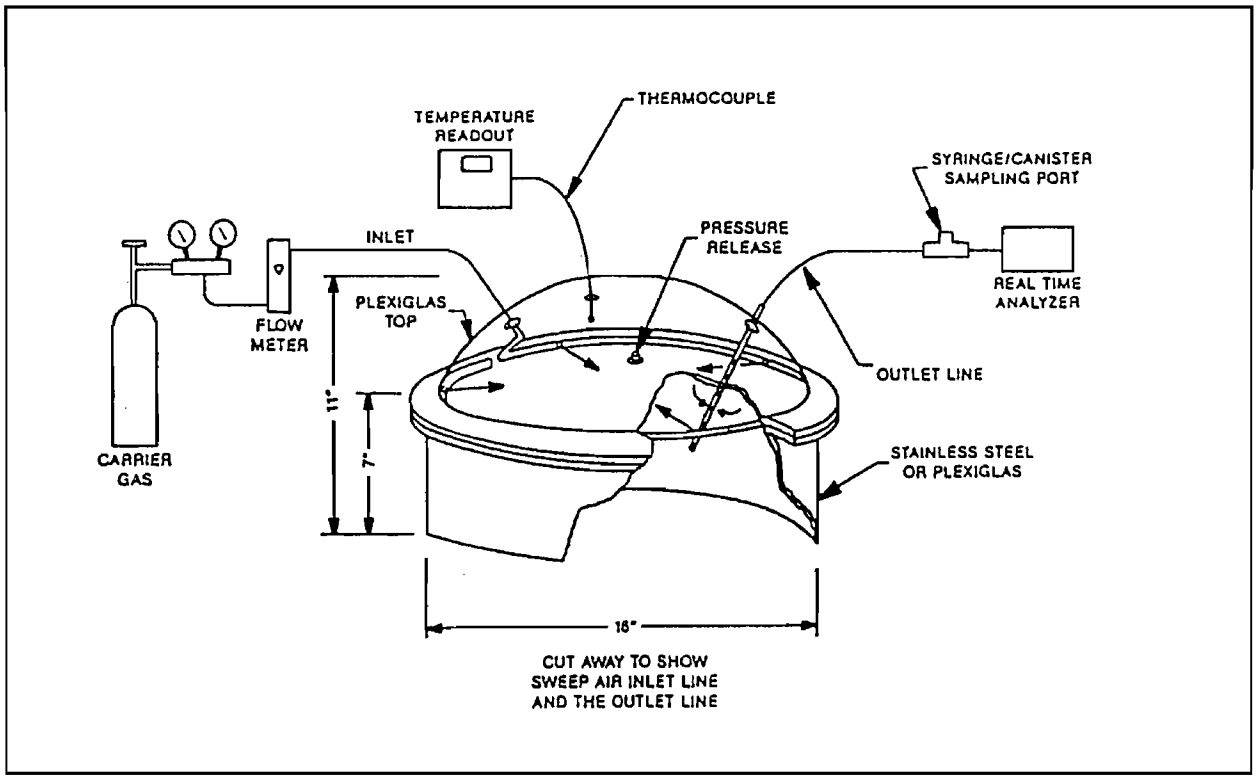

Figure C-25. Flux chamber apparatus

C.8.3.5 Sample preservation and handling. Methods for preservation of whole air and sorbent samples are similar to those identified for soil gas samples (Section C.8.2.4). Preservation of some absorption media samples may include cooling to 4°C ± 2°C to avoid contaminant loss or degradation. Glass collection cartridges may also be packed in metal containers to avoid breakage and photodegradation of contaminants.

C.8.3.6 Collection of adequate field control samples. Field control samples are collected to verify the integrity of the sampling system as interference-free, to evaluate reproducibility of the sampling procedures, and to determine whether the data are of acceptable quality. Field control samples include a variety of blanks, system checks, and the acquisition of replicate samples.

C.8.3.6.1 A system check should be done that isolates the flux chamber from the emission surface area, usually by inserting a sheet of inert and impermeable material on top of the surface area during a flux rate determination. This is also considered a field method blank. For whole air samples, method blanks should include collection of the sweep gas directly into a flexible or rigid container. This blank verifies sweep gas integrity.

C.8.3.6.2 For surface emission sampling, the flux chamber effluent may be split to collect duplicate whole air samples or duplicate media absorption to evaluate method precision. These samples may be composited from multiple grab aliquots, or successive grab samples taken by an emission extraction tee tube. For media absorption duplicates or split whole air samples, the flow rate and sampling times for each individual aliquot collected must be accurately measured and recorded. Audit gas standards can also be used

to evaluate system measurement performance but can add significant costs to the sampling and analysis program.

C.8.3.7 Sampling methods. Several varieties of devices may be configured to obtain a surface emission measurement. Time-integrated samples are collected for subsequent contaminant identification and quantitation using sorption media or whole air samples as discussed in Section C.8.2.4.1. Based on the sampler design, specifications must be established for its use. This includes identifying all sampling and support equipment necessary; establishing SOPs for sample collection; identifying the type of samples and sample containers used; determining the type, rate, and total volume of sweep gas; and determining the volume of emissions needed to meet the detection limit requirements. Such samples can be analyzed onsite or transported offsite for analyses. The utility of whole air samples is that one sample can be analyzed in duplicate, or by using separate aliquots, several different analytical procedures for different parameters or classes of compounds can be determined. For example, a gaseous landfill emissions whole air sample is typically analyzed for chlorinated and nonchlorinated VOCs, methane, sulfur gases and atmospheric "balance gases" including O_2, CO, and CO_2. Samples may also be collected on sorption media, such as Tenax, XAD-II, etc. Refer to the appropriate EPA Compendium Methods (EPA/600/4-84/041, EPA/625/R-96/010a, and EPA/625/R-96/010b) to determine the absorption medium needed. Collection of sorbent medium samples offers the ability to concentrate contaminants of concern to achieve a lower detection limit or long-term integrated sampling. For projects for which absorption media is selected as the sampling approach, recommend using the EPA Compendium Method TO-17 (EPA/625/R-96/010b) absorbance media evaluation and performance verification procedures.

C.8.3.8 Decontamination procedures. Requirements for decontamination of flux chambers are limited to specific applications such as after initial installation or if the chamber is moved from a potentially high concentration source area to a lower concentration or a trace-level source area. During field use, decontamination is usually limited to flushing the chamber with the sweep gas, either by placing the chamber on an inert surface or after placing the chamber at the measurement location and flushing to a steady-state emission concentration. When more thorough decontamination is necessary, follow procedures established in Instruction E-6 of Appendix E.

C.8.3.9 Documentation requirements. Documentation requirements are based on the information needed to support the final emission flux calculations. Critical field data are needed from both the site and sample perspectives. Record barometric readings during sampling events. This may be accomplished with an onsite barometer or from monitoring a local National Weather Station. Also record the temperature of the source matrix. The specifications should be used to determine the flux chamber dimensions. Note that any sampler-to-surface gaskets or sealants may alter the actual area of the flux. Document any carrier and calibration gases information, including cylinder serial number, contaminant and balance gases used, contaminant concentrations and any error associated with that concentration, cylinder gas pressure, cylinder receipt and expiration date, vendor providing the cylinder gas, a description of regulator gas pressure, gas flow rate measurement devices, and gas flow rate. It is highly recommended that the gas cylinder pressure be recorded during use to document the pressure decrease relative to time usage. Some contaminant concentrations become unpredictable when cylinder pressures drop below a certain pressure. Additional information needed may be referenced from the appropriate EPA or ASTM method.

C.8.4 Point source emissions and process sampling.

C.8.4.1 Scope and application. Point source sampling for HTRW projects is normally performed due to regulatory requirements to evaluate a remediation process, or to characterize a contaminant concentration for remediation feasibility, or system design and optimization. This type of sampling includes

the collection of gaseous phase or particulate matter (PM) and PM-related compounds. Regulatory emission compliance testing will involve specified USEPA sampling and analysis procedures. System process measurements are generated to evaluate efficiency of a recovery process, to determine operating parameters during system startup, or to verify the performance requirements of an Air Pollution Control system. These system measurements should utilize the most cost-effective method that produces data of acceptable quality for the defined use. Point source emissions gas phase sampling may also be required to evaluate emissions from a localized surface area that is directed through a single exit point or a vent system.

C.8.4.2 Sampling strategies. For point source emission sampling to meet compliance requirements, the regulation and specified method should be used to define the sampling strategy. To monitor system performance or contaminants associated with a remediation process, the sampling strategy should address the most representative sample extraction points for the inlet and outlet sample waste streams. The sampling strategy for measurements involving particulate-related contaminants must address sampling inhomogeneity, particulate stratification, and sampling velocity rate to satisfy the required gaseous/particulate separation and to comply with the measurement definition of particulate matter. Sampling for PM and PM-related compounds requires sample acquisition at an "isokinetic" sampling rate. Isokinetic sampling rate is defined as the collection of a gas/particulate sample through a tapered inlet sampling nozzle at the same velocity as the sample stream.

C.8.4.3 Sampling locations. Sampling locations for compliance monitoring are defined within the appropriate method, and address both the extraction point of the sample, relative to system design, as well as the total number of extraction points. For process waste stream sampling, the sampling location will be dictated by the type of information needed, the part of the system being evaluated, and the limitations of available sampling locations. Most sampling locations and sampling points are performed according to USEPA methodologies.

C.8.4.4 Sampling techniques and sample types. Most gas phase samples and particulate matter measurements are performed using extractive sampling procedures. The sampling techniques must address representative sample acquisition, sample transport and integrity, sample conditioning (when applicable), and sample contaminant separation and collection. For the majority of such measurements, the sample is extracted from the source and pulled through a sampling train with the use of a vacuum pump. The sampling train will separate particulate matter from the gaseous contaminants. Collection of the gaseous contaminants relies on either the capture on a sorbent (resin) media or in a liquid impinger absorption. Figure C-26 depicts a typical extractive sampling system including the extraction probe, the filter, heating device, postfilter volatile contaminant collection media, and condenser (impinger) absorption for collection of other contaminants.

C.8.4.4.1 Gas phase contaminants. Point source sampling systems designed to collect VOCs can either involve a PM system or function as a gas-phase-only type of collection. Systems established to collect VOC exclusively should remove and discard any particulate matter from the gas stream using a filtration procedure that minimizes method interferences. The filtration methods may include the use of a filter as depicted in Figure C-23 or use of a glass/quartz wool plug placed at the inlet of the sampling probe. For VOC sampling, heating the extraction probe and filtration devices is not necessary unless moisture condensation will result in a method interference. The gas phase contaminants may be collected on a sorbent medium, within a specified solvent, or by collection of a whole-air sample. Methods for the determination of VOCs can be found in 40 CFR Parts 60, 61, and 266 and EPA/SW-846, Chapter 10.

C.8.4.4.2 Particulate matter (PM) and PM-related compounds. Particulate matter samples and associated data can involve determining the gravimetric mass of PM collected for a given sample volume,

or the subsequent chemical analysis of that collected PM. Most point source sampling systems are designed to collect the PM in the "front half" of the collection system, followed by the collection of semivolatile organic compounds (SVOCs) and/or metals in absorption media. Figure C-26 depicts the extraction probe followed by the temperature-controlled filter. In terms of PM, the recovery of material from the method-specified collection points from the sampling probe assembly and the front half of the filter assembly, along with the material captured on the filter, is defined as PM. The PM adhering to the surfaces of the sampling nozzle, probe liner, and filter holder front half are recovered by brushing and then rinsing the PM into a collection vessel using an appropriate solvent such as acetone, methylene chloride, toluene, distilled water, etc. The mass of the PM is determined gravimetrically after solvent evaporation by subtracting the tare weight of the filter from the final weight of the sample and filter. For semivolatiles and some metals, it is necessary to collect and analyze both the collected PM and additional parts of the collection train.

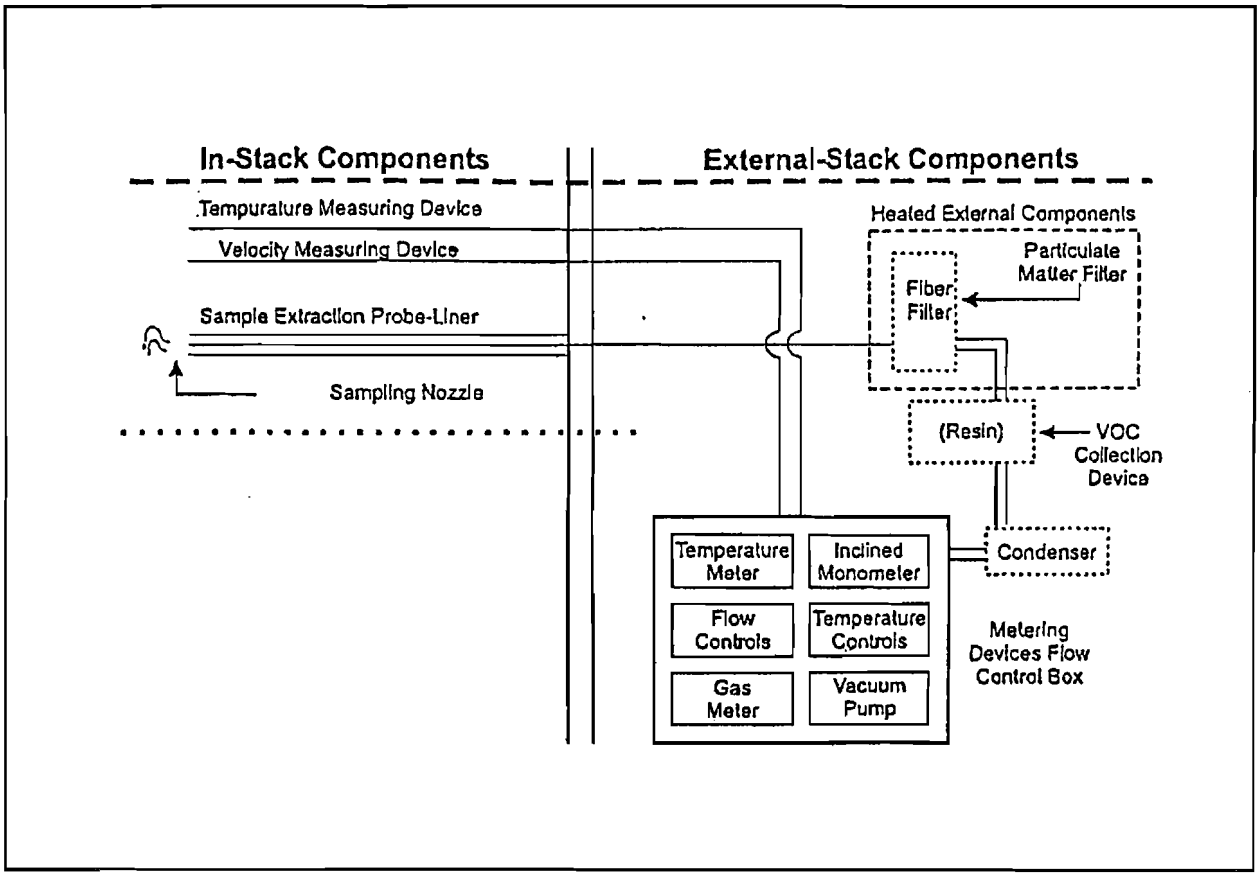

Figure C-26. Extractive sampling system

- The determination of SVOC is accomplished by recovering the probe and filter particulate and those SVOCs collected in the postfilter collection media. Commonly used collection media include Tenax and XAD-II resins. The PM is extracted using an appropriate solvent. Separately, or combined with the PM, the collection media is also extracted and the resulting extract is analyzed for the contaminants of concern. SVOC classes for HTRW projects include PCBs, dioxins/furans, PAHs, and project-specific SVOCs. The determination of both PM and SVOC can be accomplished using a single sample collection. However, it must be verified that the PM gravimetric weighing conditions specified by the method do not compromise the sample by loss

of other target analytes. Methods for the collection and analysis for these SVOCs are included in 40 CFR Parts 60 and in EPA/SW-846, Chapter 10.

- The determination of metals of interest is accomplished by recovering the probe and filter particulate and metals collected in the postfilter collection system. The metals collection system subsequent to the filter usually consists of acidic impinger solutions. When PM and metals are to be determined, the organic collection resins cannot be used in the sampling train. Methods for the determination of metals in point source emissions or process streams are included in 40 CFR Parts 60 and 266, and EPA/SW-846, Chapter 10.

C.8.4.4.3 Instrumental measurements. Most instrumental measurements of point source emissions are performed using Continuous Emission Monitors (CEMs). Applications to USEPA emission regulations require the use of CEMs. However, an equivalency program has been established to allow the use of alternative instrumental measurements proven equivalent to the regulatory specified standard. Gas phase measurements performed for purposes other than regulatory compliance may be accomplished by other means, so that the measurement DQOs are met.

C.8.4.5 Sample preservation and handling. Methods for preservation of process or point source emission samples include temperature and environmental control by method-specified procedures. In general, sample preservation of cooling to 4°C ± 2°C is recommended for organic samples. Absorption cartridges should be covered with clean aluminum foil for sample holding and shipment for analysis. Collection media such as filters and impingers do not typically require preservation except when noted within the method.

C.8.4.6 Collection of adequate field control samples. Field control samples are collected by the sampling team as specified by the project. Most sampling methods specify collecting reagent blanks and conducting field blank recovery. A method blank is collected by assembling the entire train as for sampling and recovering the sampling train components using method procedures. For point source sampling, duplicate samples are not routinely taken. This adds considerable time and cost to the project and is seldom required from a regulatory standpoint. Acquisition of duplicate samples for PM and PM-related parameters is also discouraged due to the significant difficulty in collecting these samples.

C.8.4.7 Point source or process sampling methods. Sampling methods are categorized based on the subsequent analyses. Unique sampling protocols are used for the acquisition of volatile contaminants, particulate matter, semivolatile and metals contaminant/particulate-related matter and physical parameters. Point source compliance test methods have been codified in four 40 CFR references: Part 51, Appendix M, Part 60, Appendix A, Part 61, Appendix B, and Part 266, IX. Point source sampling done to support HTRW projects has also been included within the most recent update of Chapter 10 of EPA/SW-846. Information on these methods can be utilized by accessing the USEPA Technology Transfer Network located at www.epa.gov/ttn and using the Emission Measurement Center technical site. Other testing groups, i.e., ASTM, have issued similar test methods that may be considered alternative sampling methods. Gas phase contaminants and physical characteristics are often measured by field instruments when long-term sample monitoring or a high number of sample measurements are required. Instrumental methods available for gas phase measurements are typically CEMs. Performance specifications, which qualify the applicability of the selected CEM to an emission, are found in 40 CFR Parts 60 and 266. Technical direction and operating performance requirements for CEMs used for operational monitoring can be found in 40 CFR Part 60, Appendix F.

C.8.4.8 Decontamination procedures. For most point source emission and process streams sampling, sampling train components should be thoroughly cleaned in a laboratory environment, using prescribed or project-defined protocols.

C.8.4.9 Documentation requirements. For all point source emission and process stream sampling methods the documentation of a considerable amount of sampling data is required. Methods for PM and PM-related contaminants require the periodic recording of operational data and sampling train parameters. Refer to National Source Performance Standards 40 CFR 60 (NSPS) Method 5 and other PM-related methods to provide field sampling data sheets outlining the required parameters to be recorded.

C.8.5 Ambient air sampling.

C.8.5.1 Scope and application. Ambient air measurement for HTRW projects can involve onsite, site perimeter, or offsite sampling locations. The measurements may involve particulate matter, gaseous contaminants, or meteorological parameters. With the exception of meteorological monitoring, onsite air measurements are typically performed for worker health and safety purposes, and the requirements are specified in the project site safety and health plan. USACE guidance to determine the applicability of this type of sampling may be referenced from EP 1110-1-21. The site perimeter and offsite air measurements are typically performed for regulatory compliance, as a result of an Air Pathway Analysis, to assure nearby public health and safety, to confirm effectiveness of process and onsite emission controls, and to comply with project requirements.

C.8.5.2 Sampling strategies. Sampling strategies are developed by the project team to satisfy project-specific data needs that are identified in the HTRW technical planning process. The sampling strategy developed at a particular site must include permanent and mobile sampling site collections, coordination of sampling locations with meteorological conditions and site activities, contingency sampling based on survey or optimized ambient air monitoring, and sampling based on site-specific sensitive receptors, terrain features, etc. Sampling strategies are often limited by site-specific characteristics and activities that vary during the project. Refer to EM 200-1-5 or EPA/451/R-93/007 for information on the development of ambient air monitoring sampling strategies.

C.8.5.3 Sampling locations. Sampling locations for site perimeter or offsite ambient air sampling are dependent on project data objectives. In the simplest form of perimeter monitoring, a single sample at a downwind location would require periodic sampling during pertinent activities. If the objectives include calculating a net site contribution, then a corresponding upwind sample will be required. If short-term (less than 24-hour) sampling is required, a mobile sampling apparatus that is moved to accommodate the changing downwind location or a minimum of four permanently established sampling locations which are operated only periodically will be necessary. Greater limitations are usually experienced for offsite sampling locations and frequencies than at the perimeter due to location accessability, power supplies, and neighborhood acceptability and environments. For some longer term HTRW projects a real-time perimeter monitoring system may be most feasible. An alternative "sector monitoring" sampling strategy may be applicable. Offsite sample locations may pose additional difficulties due to location accessability, power availability, and community acceptance.

C.8.5.4 Sampling techniques and sample types. A variety of sampling and measurement techniques are available that address ambient air monitoring at HTRW project sites for general classes of VOCs, SVOCs, particulate matter, metals, and meteorological parameters.

C.8.5.4.1 Gas phase contaminants. Gaseous ambient air contaminants can be measured directly with onsite instrumentation or by sample collection and analyses. Collection of gaseous ambient air VOC components of interest is typically accomplished by collecting a "whole-air" sample within a flexible or rigid container or by absorption of the compounds within a collection resin. Figure C-22 depicts a summa canister, which has an internal surface that maintains sample component stability. Figure C-23 depicts an absorption resin collection cartridge, which collects and concentrates the VOCs of interest. Several of the Compendium TO-methods specifically address VOCs including TO-1, -2, and -14 (EPA/600/4-84/041), -16, and -17 (EPA/625/R-96/010b). These methods should be selected to satisfy project-specific components of interest, the applicability of the method to site-specific conditions, and the ability of the method to provide project-required data quality objectives.

C.8.5.4.2 Particulate matter (PM) and related compounds. The collection of PM in ambient air is typically accomplished by passing the sample through a preweighed filter. The filter is subsequently reweighed for a quantitative determination of the PM. PM in ambient air is categorized as total suspended particulate or some size fractionation. These fractionations range from a PM less than 10 microns (PM-10) to a lesser size such as PM-2.5. To determine the appropriate categories, the PM-10 or PM-2.5 is quantified gravimetrically as mass per volume after separation from the larger total PM. Similar to point source PM measurements, ambient air PM can be collected to determine SVOCs or metals. A typical total suspended particulate matter collection device is depicted in Figure C-27.

- SVOCs sampling includes the collected PM fraction of the sample, and the fraction that passes through a filter media and is collected on an appropriate sorption medium. Most SVOC collections are performed using a filter followed by a sorbent media of polyurethane foam or XAD-II resin. The SVOC classes often required for HTRW projects include PAHs, pesticides, PCBs, dioxins/furans, etc. When projects require more than one of these SVOC classes, recommend that procedures for sample collection, recovery, preparation, and analysis be combined. Also recommend that project-specific SOPs be generated to assure that the procedures meet project sensitivity and QC requirements.

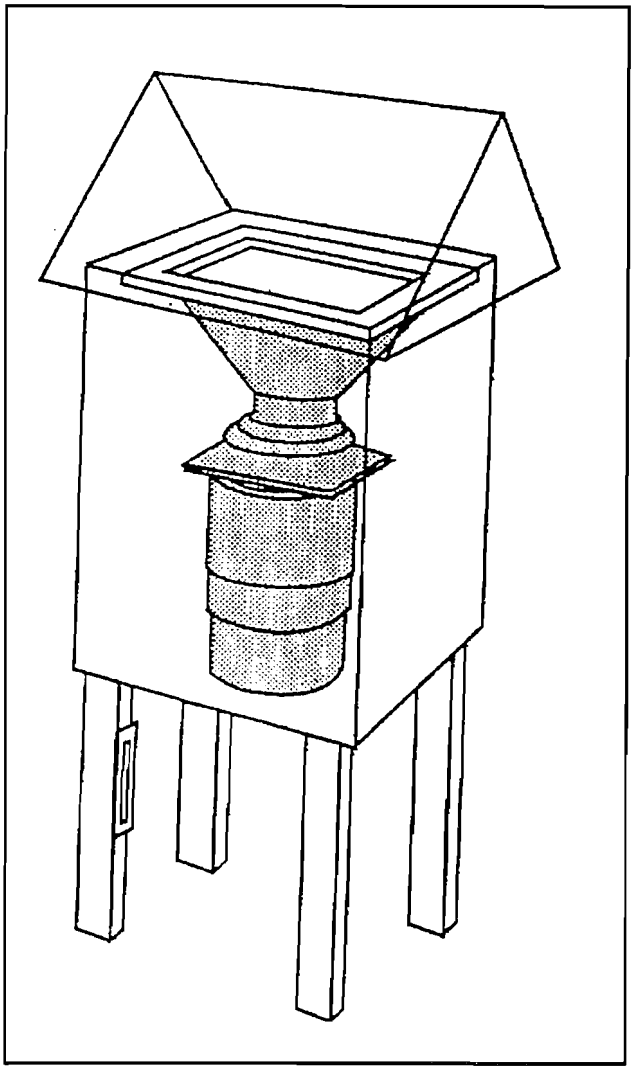

Figure C-27. Total suspended particulate matter sampling system

- Sampling and analysis for metals in ambient air are usually accomplished by using the total suspended particulate collected sample after reweighing. A fraction of the collected filter/PM is digested for the appropriate analytical procedure. The selection of the collection filter media must be performed with care relative to the required metal measurement method detection limit and the method-required filter blank correction. Factors including the metals of concern and the amounts of their presence in the blank filter are crucial to filter media selection.

C.8.5.4.3 Instrumental measurements. A variety of ambient air instrumentation and measurement technologies have been developed to support the USEPA ambient air programs and serve as criteria pollutant monitors. Many of these vendor instruments and monitors have been granted equivalency status by USEPA to monitor for criteria pollutants such as nitrogen dioxide (NO_2), sulfur dioxide (SO_2), ozone (O_3), and PM-10. These instruments have met the equivalency criteria set by USEPA and will generate equivalent results if performed following the specified operating requirements. For other ambient air sampling uses, the instrument selected for the measurement must meet the project DQOs.

C.8.5.5 Sample preservation and handling. Methods for preservation of whole air and sorbent samples range from the simplified canister, which is shipped at ambient conditions, to the enclosure and low temperature maintenance of recovered VOC collection cartridges. Factors to be considered for sample preservation include the sample contaminant loss and degradation during storage and shipment, sample media breakdown or breakthrough, etc. The EPA Compendium Methods (EPA/600/4-84/041, EPA/625/R-96/010b) may not identify the sample preservation necessary for all site specific samples or environments. Additional measures may be necessary, such as the storage of flexible VOC bags or collected resins within enclosed containers, or aluminum foil for protection from photodegradation.

C.8.5.6 Collection of adequate field control samples. Field control samples are collected to verify that the sampling system is interference-free and to determine whether the data are of acceptable quality. For ambient air sampling, recommend a variety of blanks be incorporated to evaluate the sampling and measurement system. These include evacuated canisters and resin collection media blanks, reagent sampling, and recovery blanks. When site conditions exist that may invalidate or jeopardize results, recommend the collection of backup samples (i.e., VOC) in series with the method media.

C.8.5.7 Sampling methods. There are seven codified USEPA methods (40 CFR Part 50), including total suspended particulates, carbon monoxide (CO), SO_2, O_3, NO_2, lead (Pb), and particulate matter less than 10 microns (PM-10). USEPA also allows the use of equivalent measurement methods for ambient air criteria pollutant monitoring. When these methods serve compliance monitoring, include quality control procedures and results to support the data quality required. The QC procedures outlined within several standard methods may serve as a guideline for air methods that do not specify appropriate QC procedures. Other EPA ambient air methods used for HTRW projects have been published as EPA guidance methods within USEPA (EPA/600/4-84/041, EPA/625/R-96/010b). These methods are referenced as the "TO" methods and include TO-1 through TO-17. For inorganic matter parameters that can be used for HTRW projects, the USEPA has published guidance methods (EPA/625/R-96/010a).

C.8.5.8 Decontamination procedures. Decontamination procedures for ambient air sampling applies to the sampling apparatus and the reuse of sample containers (i.e., summa canisters or flexible bags for whole air samples). Decontamination of apparatus is accomplished by flushing the equipment with a inert gas until the system is found to be interference-free. If flushing the system is ineffective, more thorough procedures for decontamination as identified in Instruction E-6 of Appendix E should be used. Decontamination of flexible bags may be accomplished by a series of inflate-and-deflate steps, using the inert gas until the filled

bag is analyzed and found to be contaminant-free. Generally, filling and evacuating three successive times is taken to be acceptable. For any given site application, this should be confirmed.

C.8.5.9 Documentation requirements. Documentation requirements for ambient air sampling should encompass all aspects of the site setup and sample collection and handling as outlined within this instruction and in Instruction F-1, Appendix F. This includes documenting the sample equipment and apparatus preparatory phase inspection and quality check before field activities begin. Sampling equipment calibration may include volumetric measurement devices and flow controllers. Certification of VOC sampling systems include equipment certification. The cleanliness of each lot of precleaned sample containers or collection media should be verified by the container supplier or the laboratory, and appropriate paperwork (i.e., certificates) retained with other field documentation.

Appendix E
DRAFT Guidance on Multi-Increment Soil Sampling

State of Alaska

DEPARTMENT OF ENVIRONMENTAL CONSERVATION

DIVISION OF SPILL PREVENTION AND RESPONSE

CONTAMINATED SITES PROGRAM

Draft Guidance on Multi-Increment Soil Sampling

March 2007

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I. Purpose and Applicability

Introduction

The purpose of this guidance is to summarize the requirements for effective design and implementation of multi-increment soil sampling undertaken as part of the remediation of contaminated sites in Alaska. The multi-increment sampling (MI) process, as described in this guidance, may provide a more representative view of mean contaminant concentrations than traditional sampling approaches if applied correctly.

By regulation, the Alaska Department of Environmental Conservation (DEC) Contaminated Sites Program relies upon either of two methods to guide its decisions on the completion of remedial activities at sites contaminated with oil and hazardous substances (18 AAC 75.380(c)(1)) and (18 AAC 78.276(e)(1)). These methods are the maximum contaminant concentration detected in soil, or a statistically valid 95% Upper Confidence Limit (UCL) of the mean. An MI approach, if systematically planned and implemented, can accurately determine an average concentration representative of the soil contained within a defined area, i.e. the "decision unit." DEC will evaluate the MI sampling results, including the 95% UCL and calculated Relative Standard Deviation (RSD) of triplicate samples, for contaminated site status determinations. DEC has determined that an MI approach is acceptable when supported by the project-specific data quality objectives and if applied according to this guidance and an approved workplan. DEC has further determined that an MI approach, if applied according to this guidance, fulfills the intent of the regulations to protect human health and the environment.

Applicability

DEC will consider the use of MI for characterization or confirmation sampling purposes in order to meet data quality objectives that rely upon the mean soil concentration of an approved decision unit. Some examples of circumstances where MI may be appropriate include characterization from a surface release (i.e., aboveground storage tank), characterization or confirmation sampling of a stockpile or biocell, and excavation pit confirmation sampling.

Because this is a new protocol, DEC initially encourages the use of MI at sites where soil is contaminated with petroleum hydrocarbons only. DEC should be notified prior to initiating the systematic planning process if it appears there is an appropriate use of MI for non-petroleum contaminants. This guidance will be updated periodically to incorporate sampling for additional contaminants of concern and to address the possible use of MI in conducting risk assessments. MI is meant to supplement, not replace, existing department approved approaches or statistical approaches. This guidance is not a comprehensive procedures manual, nor does it substitute for multi-day MI training courses offered by private vendors.

II. Multi-Increment Sampling Theory

The objective of environmental sampling is to quantify some property of the media sampled, such as the amount of a contaminant present in soil at a given site. Traditionally, environmental cleanup programs across the nation have relied on discrete sampling to characterize environmental media. However, the number of discrete samples often collected at a contaminated site does not lend itself to statistically valid interpretation and cannot accurately quantify contaminant concentrations due to the heterogeneity of environmental media. In other words, it is impossible to identify the true mean of a population without the census of every data point. In the case of a 3,000 cubic yard soil stockpile, for example, the entire mass would have to be analyzed to determine the true mean concentration. Since it is impossible to sample and analyze the entire population due to practical considerations and cost limitations, statistical methods are used to determine a representative concentration.

A theory of particulate sampling was developed by geologist Pierre Gy to improve the quality of data gathered in support of mineral exploration and mining (Pitard, 1993). The MI approach described herein is based upon Gy's theories and is applicable to environmental sampling at contaminated sites.

Sources of Error

Heterogeneity is the norm when dealing with contaminated environmental media. A large portion of sampling error is a result of compositional and distributional heterogeneity. **Compositional heterogeneity** describes the variability of contaminant concentrations between the particles that make up the population. This type of heterogeneity results in fundamental error (FE). FE is a result of not representing proportional concentrations of all of the particles in the population. To minimize FE, it is imperative that enough mass be collected and analyzed to represent all particles in the exact proportion found in the population.

Distributional heterogeneity occurs when particles are not randomly distributed across the population due to slight spatial variations. Spatial variability will be missed if all samples are collected from one place. This type of heterogeneity results in grouping and segregation error (GSE). To minimize GSE, it is imperative to collect sample increments randomly and in enough locations to capture the spatial variability.

MI controls these two major types of sampling error in most situations. GSE is controlled by collecting multiple randomly located sample increments to address distributional heterogeneity. In general, a minimum of 30-50 random increments are required to address GSE; however, if greater distributional heterogeneity is expected more increments would be required.

FE is managed by collecting and analyzing sufficient sample mass to adequately address compositional heterogeneity. FE is directly related to the particle size of the population and the sample mass analyzed as illustrated by the following equation (Pitard, 1993).

$$FE = \sqrt{\frac{20(d^3)}{m}}$$

Where:
FE = Sampling fundamental error
20 = Sampling constant
d = maximum particle size (centimeters)
m = sample mass analyzed (grams)

Fundamental Error
The maximum fundamental error recommended by DEC for the purposes of this guidance is 15%.

The majority of organic contaminant mass in most situations is present in the 2mm fraction or less (medium sand to clay). Assuming a soil sample sieved to 2 millimeters (mm) and a minimum sample mass of 30 grams (g) is analyzed, the calculated FE will be under 15%. For atypical situations where the particle size is greater than 2 mm or the sample mass is less than 30 g, FE must be calculated using the above equation and reported to DEC. If FE exceeds 15% the data may be rejected.

Volatile samples ***must not*** be sieved (as discussed in the sampling procedures section). Additionally, these default assumptions (2 mm and 30 g) do not offer the same benefit for metals analyses because the sample mass normally digested and analyzed in the laboratory is relatively small (1 g). Control or reduction of fundamental error with this smaller sample mass is not feasible with sieving alone. For metals analyses, sample grinding (to decrease particle size) and/or increased digestion mass would be required. DEC intends to address MI sampling for metals in the next edition of this guidance.

MI Contrasted to Composite Sampling

Multi-increment sampling ***is not*** the same as simple composite sampling. A multi-increment sample is collected within a decision unit, whereas a composite may be collected without regard to a specific decision unit. Unlike MI, composite sampling does not adequately address sampling FE or GSE. A composite sample is a simple combination of discrete samples. A multi-increment sample is a representative sample for a given decision unit. Although the physical process of collection is similar, the information derived from each process is different. As such, composite sampling cannot provide representative decision unit population data.

III. Decision Unit Identification

A decision unit is the defined area or volume in question, that is, the area or volume about which we need to make a decision. To be valid, MI sampling must be used in conjunction with an appropriate decision unit. Therefore, the identification and delineation of the decision unit is one of the most important factors when using MI.

The Dilution Effect

There is a critical item to keep in mind when identifying decision units and developing the MI work plan: MI may not be used to "dilute" contamination and therefore underestimate the need for cleanup. This may occur if the decision unit inappropriately incorporates large, uncontaminated areas in addition to real source areas.

Decision units will rarely be neat, geometric shapes, except perhaps in the case of a stockpile or treatment cell. It is unacceptable to simply draw a circle or a box around a source area and call it the decision unit for the purposes of site characterization without providing thorough documentation for the boundaries. If a source area is unknown or has been removed, the environmental professional must use all available means to delineate the decision unit, including historic photos, site information, interviews with knowledgeable parties, and field screening techniques. Three-dimensional decision units may be necessary when conducting a sub-surface site characterization because contaminants are not expected to be distributed evenly throughout the soil horizons.

Decision units are restricted to actual source zones and must not incorporate large, uncontaminated areas. Decision units may also be too small. For example, areas of high contaminant concentrations, or "hot spots," are essentially independent decision units, but knowing the mean concentration of a 5' x 5' surface stain is probably unnecessary when the hot spot can simply be excavated.

Two applications where MI can be applied in a relatively straightforward manner are treatment stockpiles or open excavations where contaminated soil or an underground storage tank has been removed. Stockpiles should be evaluated in terms of age and whether they have been actively mixed. For example, contaminant concentrations at the bottom of a static stockpile that has been in place for several years may be higher than near the surface. Decision units may need to be horizontal layers in this case.

Decision Unit Approval

Because of the importance of decision unit delineation, the decision unit must be approved by DEC prior to the sampling event in order to ensure DEC's evaluation of the results is not jeopardized. Decision units may not be changed without prior approval by the DEC project manager.

For an excavation, an MI sample would be collected for confirmation once field screening and visual and olfactory evidence indicate all of the contaminated material has been removed. Sample increments may be collected from the bottom and side walls of

the excavation where contaminated soil has been removed. While circumstances will vary on a site-specific basis, typically the bottom of the excavation will be a distinct decision unit. Sidewalls may be combined into a single decision unit or treated independently.

For a source where the final excavation is significantly larger than the original footprint of an above ground or underground storage tank, it may be best to collect increments from beneath the original footprint rather than from over-excavated areas that are less likely to be impacted by potential spills or leaks from the former tank. If the excavation was hindered by the presence of buried utilities, buildings, or bodies of water, and contaminated soil is knowingly left in place, then the area that was left in place may become a new decision unit with the objective of characterizing the remaining contamination.

Many tank excavations also require evaluation of piping and dispensers. These areas may need to be evaluated as separate decision units once field screening and visual and olfactory evidence indicate all contaminated material has been removed.

IV. Sampling Locations

One of the basic tenets of MI is to collect increments from multiple random locations. Random sampling works to eliminate error and addresses distributional heterogeneity by collecting samples from multiple, randomly selected locations (recall that mass is used to eliminate compositional heterogeneity).

The random sampling approach must be proposed in the work plan, and the work plan must be submitted to DEC for approval prior to mobilizing to the field, as required under 18 AAC 75.335 (b). There are several types of random sampling techniques including simple random, stratified random, and systematic random. For the purposes of this guidance, a systematic random approach is recommended in order to establish a consistent protocol. As long as the sampler is not introducing bias into the sampling scheme, however, a different method may be proposed in the work plan if it appears more suitable to the site-specific situation.

In addition to surface sample increment locations, sample depth must also be taken into consideration. For instance, sample increments from a 24-inch deep stockpile should be taken at random depths throughout the stockpile so that samples are not collected directly from the surface. As stated earlier, for deeper or older stockpiles more than one decision unit may be required. For example, one decision unit might be the top two feet of a four-foot deep stockpile, and another decision unit might be two to four feet deep. The objective of dividing the stockpile into more than one decision unit is to characterize deeper soils separately because these soils may not experience the same level of volatilization and contaminant reduction as surface soils unless frequent tilling has occurred. For layered sampling, each increment location within the layer will need randomly generated, three-dimensional sampling coordinates.

Sometimes it may be more efficient to sample directly from the excavator bucket rather than wait for stockpile construction. Because increments need to be spaced equally across the entire decision unit (i.e., every 5th bucket), this works particularly well if the estimated volume determined through site characterization is expected to be relatively accurate. This becomes more difficult when soil is separated into several different stockpiles based on field screening results, or when the estimated volume is not well delineated. In these cases it may be difficult to determine the proper sampling frequency to ensure the entire decision unit is adequately represented.

V. Sampling Procedures

The primary objective of MI is to control the fundamental error (FE) and grouping and segregation error (GSE) associated with discrete sampling. Therefore, **strict adherence to correct field sampling procedures is essential**. The analyses that are applicable to the sampling procedures detailed herein include gasoline range organics (GRO); diesel range organics (DRO); residual range organics (RRO); benzene, toluene, ethylbenzene, and xylenes (BTEX); and polycyclic aromatic hydrocarbons (PAHs). Other volatile- and semi-volatile analyses may be required on a site-specific basis depending on the source of contamination.

Volatile Analyses – GRO, BTEX, Volatile Organic Contaminants

Samples for volatile analyses must be collected before non-volatiles to reduce contaminant losses due to volatilization. To do this, the sampler should go to each of the sample increment locations and collect the much smaller increment for volatile analyses directly into the sample jar that contains the methanol. This is followed by the collection of the larger scoop to be sieved for non-volatile analyses.

Equipment

- Small spoon, spatula, or disposable plastic syringe
- Volatile sample containers
    - 250-500 milliliter (ml) narrow mouth, amber bottles (recommended)
    - 4-8 ounce (oz) amber jars with Teflon lined septum lids

Volatile organics require that samples be field preserved with a minimum1:1 ratio of sample preservative to sample material (1 ml methanol to 1 gram (g) soil). This is a minimum required ratio, and additional sample mass is preferred as long as it is completely submerged by the methanol. The concern with MI is that the collection and sieving of the sample material will lead to volatilization of the contaminants, so **sieving *must not* be performed for any volatile analyses** (GRO, BTEX, or VOCs). To minimize volatilization, each sample increment must be deposited directly into a methanol-preserved sample container.

The proper pre-tared containers must be provided by the laboratory. The amount of sample to be collected, as well as the necessary volume of methanol, must be taken into account when choosing the container. Additionally, the container should be large enough to prevent methanol loss due to splashing, leaking, etc, during the sampling event.

Begin by placing the appropriate amount of methanol into the sample container. Next, go to each of the pre-determined, randomly selected sample increment locations and remove the soil to a depth of six inches or deeper by hand or using a coring device. If using narrow mouth amber bottles, a small, calibrated syringe can be used to “plug” the soil. Depending on site-specific soil types, sampling into alternate, approved volatile containers may require the use of a small spoon or spatula. Collect approximately 2 -5 g

and place the soil sample directly into the methanol. Replace the lid onto the container and proceed to the next increment location.

When sampling from an excavator bucket, be sure to sample from the center and remove at least six inches of soil. For subsurface sampling, collect the soil directly from the hand auger or split spoon into the methanol. Use caution to ensure that the sample increment selected represents soil from the desired depth and not "sluff" material from an upper level.

Because samples for analyses of volatiles cannot be sieved, DEC recommends that total sampling error be minimized by submitting additional mass to the lab for analyses, such as 50 g of soil. Additionally, to the extent possible, the individual increments should consist of the smaller particles (< 2millimeter (mm)) to be similar to the non-volatile sieved sample matrix and to minimize FE. Large rocks or clumps of soil must not be collected as part of the sampling of volatiles, as this will increase the sampling error.

The volatile sampling procedure should be accomplished as quickly as possible to reduce the loss of soil contaminants and methanol due to volatilization. Care must also be taken to prevent the loss of methanol due to splashing during the addition of soil increments and/or spillage during the entire sampling procedure.

Ideally, samples for volatile analyses will be collected after the sampling tools have been field "calibrated" so that the sampler does not end up with fewer increments than required. This can be done by weighing the soil to be sampled on a small balance to determine the approximate mass required from each random increment location. If the final sample mass does not meet minimum requirements, additional soil increments from randomly selected locations may be added, remembering to keep a minimum 1:1 methanol to soil ratio and that the soil must be completely submerged in the methanol. Additional methanol may be necessary and must be documented on the chain of custody appropriately.

Non-Volatile Analyses – DRO, RRO, Semi-Volatiles, PAHs

The project laboratory must be contacted prior to mobilizing to the field to determine the sample mass normally extracted for the required non-volatile analyses. Alaska Methods AK102 and AK103 call for the extraction of from 10-30 g of sample material (soil). For MI purposes, the minimum required amount of material per analysis is 30 g. The DEC project manager must be assured that the laboratory is willing to meet MI-specific requirements prior to approving the work plan. Clear communication between the environmental professional, the lab and DEC prior to field mobilization is essential. A note in the comments

Sample Mass

A sample mass larger than 30 grams is always preferred as long as the lab is capable of handling these samples. Clear communication between the environmental professional, the lab and DEC prior to field mobilization is essential

section of the Chain of Custody form is also recommended. Remember, the more material that can be analyzed, the lower the fundamental error. As long as the lab is capable of handling samples of this size, a sample mass larger than 30 g is always preferred. The analyzed mass should be stated in the lab data report for verification.

Equipment

- Large stainless steel spoon or scoop
- Large clean container (a large stainless steel bowl, Ziploc bags, or 5-gallon bucket)
- #10 (2mm) sieve
- Steel cookie sheet or other tray
- Small spatula or spoon
- Sample containers

For surface sampling, remove the soil to a depth of at least six inches prior to collecting the sample. When sampling from an excavator bucket, be sure to sample from the center and remove at least six inches of soil. For subsurface sampling, collect the soil directly from the hand auger or split spoon. Use caution to ensure that the sample increment selected represents soil from the desired depth and not "sluff" material from an upper level.

Using the large spoon or scoop, collect the sample increment from the appropriate sample location and depth according to the pre-approved work plan. Scoop approximately 30-60 g (1-2 ounces) into the large, clean container and move on to the next sample increment location. Be cautious of oversize material, which means more mass may need to be taken from each increment to end with the 30 – 50 g sub-sample after sieving (a 5 kg field sample is not uncommon). Increments can be sieved directly into the bucket, or they can be bagged and sieved later.

Sub-Sampling for Non-Volatiles

Sub-sampling can be accomplished either in the field or in a laboratory set up to conduct sub-sampling according to the following procedure.

After the 30-50 sample increments have been collected into the bucket, use the #10 sieve to sieve the soil into

Laboratory Analysis

The laboratory must extract and analyze the entire contents of the submitted jar, minus the portion for the percent solids determination. The results may be less defensible if only a sub-sample or fraction of the jar contents is analyzed.

another clean container (another option is to sieve directly into the bucket at the time of collection).[1] Approximately 500 – 1000 g of material following sieving should be available. Once the > 2mm fraction has been removed, spread the remaining soil evenly on the steel tray approximately ½ inch in depth. Roughly divide the tray into 30-50 sections and using the small spatula, collect approximately 1 g (approx. ½ tablespoon) from each of the sections. Because fines tend to settle, scrape the spatula along the bottom of the tray to make sure that every particle size is equally represented in the sample. Place all scoops into a single sample jar (2 or 4 oz as appropriate) to be submitted to the lab. As stated earlier, it will be beneficial in the beginning to use a balance to ensure the proper sample mass is submitted to the lab. The final sample mass per jar submitted to the laboratory, 30-50 g (30 g = approx.1 ounce), must meet the minimum amount of material to be analyzed by the lab. Repeat the process into a second jar and submit to the lab in the event that re-analysis is required.

[1] 18 AAC 75.990(117) identifies soil as "an unconsolidated geologic material, including clay, loam, loess, silt and gravel, tills, or a combination of these materials." The Petroleum Guidance on oversized material: page 41, states that for sites contaminated with gasoline or diesel type products, oversized material (greater than 2 inches in diameter) does not need to be treated or tested unless it has a potential to hold excessive amounts of contamination or contain visible petroleum product on the surface. Shale, schist, limestone, pumice or other porous types of rocks are examples of material that may hold excessive amounts of contamination. These factors should be discussed with the DEC project manager early in the planning process. Such material may need to be addressed through another sampling methodology.

VI. Quality Assurance and Control

Triplicate Sampling

Triplicate samples must be collected in order to verify that an MI sample truly represents the decision unit. The collection of triplicate samples allows for the calculation of relative standard deviation (RSD). This is markedly different from the typical duplicate sample that is collected from the same material as the primary sample. Results of all three samples must be included as part of the report submitted to the DEC.

In general, for sites with only one decision unit, triplicate sampling and analysis is required. For sites with multiple, similar, decision units, a minimum of one triplicate sample set must be collected for every 10 decision units or at a rate of 10%. Additional triplicate samples may be required based on site conditions and/or non-similarity of the decision unit(s). The final number of triplicate samples required will be determined by DEC during work plan development. The appropriate triplicate frequency must be documented and pre-approved in the MI work plan.

To collect samples in triplicate, the sampler may find it useful to mark the initial sample increment locations with flags or stakes. Triplicate samples should never be taken from co-located or adjacent locations. A practical way to achieve this is to move to the right (or left, forward, backward) a pre-determined distance and collect another sample increment for the second sample. Return to the initial sample increment location and move in a different direction and repeat the procedure. The distance between the original and triplicate samples must be adequate enough to evaluate variability. Triplicate sampling locations that are co-located with or immediately adjacent to the original MI sampling point are not acceptable. The exact method the sampler employs to collect the triplicate samples, the approximate locations and how these locations will be determined must all be specified in the workplan submitted for approval. The resulting sampling pattern essentially becomes systematic random so long as the sampler does not introduce any bias to any of the sample increment locations.

Triplicate sampling for excavator buckets will depend on the estimated number of buckets. For 30-50 buckets, three increments would be collected from each bucket; left edge, center (original), and right edge. For excavations estimated to be greater than 50 buckets, triplicate samples must not be collected from the same bucket as the original increment. Rather, the two additional increments should be collected from unique buckets, again to assess variability. For example, if 90-100 buckets were estimated, the original increment would be collected from buckets 1, 4, 7, etc., the duplicate from buckets 2, 5, 8, etc., and the triplicate from buckets 3, 6, 9, etc. Again, triplicate collection must be documented in the workplan submitted for approval.

All multi-increment sampling data must be reported and reviewed in accordance with Technical Memorandum 06-002, *Environmental Laboratory Data and Quality Assurance Requirements*, and the associated Laboratory Data Review Checklist.

Relative Standard Deviation and 95% UCL Calculations

Field triplicates are used to calculate the Relative Standard Deviation (RSD), a measure of data precision. The RSD is calculated as presented below:

$$RSD = \frac{100s}{\bar{\chi}}$$

where:
s = standard deviation
$\bar{\chi}$ = mean

The RSD is used as a quality control measure to assess the MI sampling procedure and the mean concentration of the decision unit. The RSD is an indicator of the data distribution. It is assumed that the data has a normal distribution with a RSD of 30% or less.

Relative Standard Deviation
DEC requires a RSD of 30% or less. At RSDs greater than 35%, the data distribution starts to become non-normal and confidence in the representativeness of the MI sample results diminishes. To ensure an RSD of 30% or less it is imperative to control sampling error as described in this guidance.

Additionally, the standard deviation and the mean are used to calculate the 95% Upper Confidence Limit (UCL) of the contaminant. This is especially relevant for concentrations at or near the action or cleanup level. Site decisions will be determined utilizing the 95% UCL as determined by the following equation:

$$95\%\ UCL = \bar{\chi} + \frac{ts}{\sqrt{n}}$$

where:
$\bar{\chi}$ = mean
t = 95% one-sided student t factor (e.g., for n = 3, t = 2.92)
s = standard deviation
n = number of samples

For example, the DRO Method 2 cleanup level is 250 mg/kg to achieve final site closure. Triplicate sample results are 227, 240, and 281 mg/kg respectively. The mean of this data set is 249 mg/kg, the standard deviation is 28, and the $ts/\sqrt{n}$ factor is 47. The resulting 95% UCL is 296 mg/kg. The cleanup level to achieve final site closure has not been met based on the 95% UCL.

For sites with multiple decision units, the 95% UCL must be calculated for each decision unit utilizing the above equation. In this situation, the $ts/\sqrt{n}$ factor calculated from the triplicate MI results shall be added to the MI result(s) for the remaining decision units. In

the above example, if the MI result for a second decision unit at the site was 232 mg/kg, the 95% UCL for this decision unit would be 279 mg/kg (232 mg/kg + 47).

For sites where multiple triplicate MI samples are collected, the 95% UCL calculation for individual decision units must be discussed in the submitted workplan and approved by the department.

The standard deviation, mean, RSD, and 95% UCL for all decision unit(s) must be calculated by the environmental professional and submitted to DEC as part of the site characterization or cleanup report. For sites with multiple decisions units, the 95% UCL must be calculated and reported per decision unit, utilizing the approved workplan approach.

VII. Summary

MI is a valid alternative to traditional discrete sampling for both characterization and site closure when conducted appropriately and supported by the data quality objectives for the project. DEC recommends that MI be applied initially at sites contaminated with petroleum (GRO, DRO, RRO and petroleum related compounds) until both DEC staff and consultants are proficient with the approach. Other contaminants may be considered on a site-specific basis.

The following steps summarize a valid MI sampling approach:

1. Define the decision unit(s) with DEC input and approval.
2. Identify the random sample locations and depths within each decision unit.
3. Submit the work plan for DEC approval.
4. Collect 30-50 increments per decision unit.
5. Collect triplicate samples at independent locations.
6. For volatiles, field preserve sample directly in methanol; do not sieve.
7. For non-volatiles, sieve to 2 mm, sub-sample appropriately, and submit 30-50 g to the laboratory.
8. Conduct data package Quality Assurance review when laboratory results are received.
9. Calculate and report all relevant quality control parameters.
10. Submit report for DEC review.

References

Pitard, Francis F. Pierre Gy's Sampling Theory and Sampling Practice. 2nd edition. CRC Press. 1993

Appendix F
Standard Test Method for Penetration Test and Split-Barrel Sampling of Soils

Designation: D 1586 – 99

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Standard Test Method for Penetration Test and Split-Barrel Sampling of Soils[1]

This standard is issued under the fixed designation D 1586; the number immediately following the designation indicates the year of original adoption or, in the case of revision, the year of last revision. A number in parentheses indicates the year of last reapproval. A superscript epsilon (ε) indicates an editorial change since the last revision or reapproval.

This standard has been approved for use by agencies of the Department of Defense.

1. Scope *

1.1 This test method describes the procedure, generally known as the Standard Penetration Test (SPT), for driving a split-barrel sampler to obtain a representative soil sample and a measure of the resistance of the soil to penetration of the sampler.

1.2 *This standard does not purport to address all of the safety problems, if any, associated with its use. It is the responsibility of the user of this standard to establish appropriate safety and health practices and determine the applicability of regulatory limitations prior to use.* For a specific precautionary statement, see 5.4.1.

1.3 The values stated in inch-pound units are to be regarded as the standard.

NOTE 1—Practice D 6066 can be used when testing loose sands below the water table for liquefaction studies or when a higher level of care is required when drilling these soils. This practice provides information on drilling methods, equipment variables, energy corrections, and blow-count normalization.

2. Referenced Documents

2.1 *ASTM Standards:*

D 2487 Practice for Classification of Soils for Engineering Purposes (Unified Soil Classification System)[2]

D 2488 Practice for Description and Identification of Soils (Visual-Manual Procedure)[2]

D 4220 Practices for Preserving and Transporting Soil Samples[2]

D 4633 Test Method for Stress Wave Energy Measurement for Dynamic Penetrometer Testing Systems[2]

D 6066 Practice for Determining the Normalized Penetration Resistance Testing of Sands for Evaluation of Liquefaction Potential[3]

3. Terminology

3.1 *Definitions of Terms Specific to This Standard:*

3.1.1 *anvil*—that portion of the drive-weight assembly which the hammer strikes and through which the hammer energy passes into the drill rods.

3.1.2 *cathead*—the rotating drum or windlass in the rope-cathead lift system around which the operator wraps a rope to lift and drop the hammer by successively tightening and loosening the rope turns around the drum.

3.1.3 *drill rods*—rods used to transmit downward force and torque to the drill bit while drilling a borehole.

3.1.4 *drive-weight assembly*—a device consisting of the hammer, hammer fall guide, the anvil, and any hammer drop system.

3.1.5 *hammer*—that portion of the drive-weight assembly consisting of the 140 ± 2 lb (63.5 ± 1 kg) impact weight which is successively lifted and dropped to provide the energy that accomplishes the sampling and penetration.

3.1.6 *hammer drop system*—that portion of the drive-weight assembly by which the operator accomplishes the lifting and dropping of the hammer to produce the blow.

3.1.7 *hammer fall guide*—that part of the drive-weight assembly used to guide the fall of the hammer.

3.1.8 *N-value*—the blowcount representation of the penetration resistance of the soil. The *N*-value, reported in blows per foot, equals the sum of the number of blows required to drive the sampler over the depth interval of 6 to 18 in. (150 to 450 mm) (see 7.3).

3.1.9 ΔN—the number of blows obtained from each of the 6-in. (150-mm) intervals of sampler penetration (see 7.3).

3.1.10 *number of rope turns*—the total contact angle between the rope and the cathead at the beginning of the operator's rope slackening to drop the hammer, divided by 360° (see Fig. 1).

3.1.11 *sampling rods*—rods that connect the drive-weight assembly to the sampler. Drill rods are often used for this purpose.

3.1.12 *SPT*—abbreviation for standard penetration test, a term by which engineers commonly refer to this method.

4. Significance and Use

4.1 This test method provides a soil sample for identification purposes and for laboratory tests appropriate for soil obtained from a sampler that may produce large shear strain disturbance in the sample.

4.2 This test method is used extensively in a great variety of geotechnical exploration projects. Many local correlations and

[1] This method is under the jurisdiction of ASTM Committee D-18 on Soil and Rock and is the direct responsibility of Subcommittee D18.02 on Sampling and Related Field Testing for Soil Investigations.

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[2] *Annual Book of ASTM Standards*, Vol 04.08.

[3] *Annual Book of ASTM Standards*, Vol 04.09.

***A Summary of Changes section appears at the end of this standard.**

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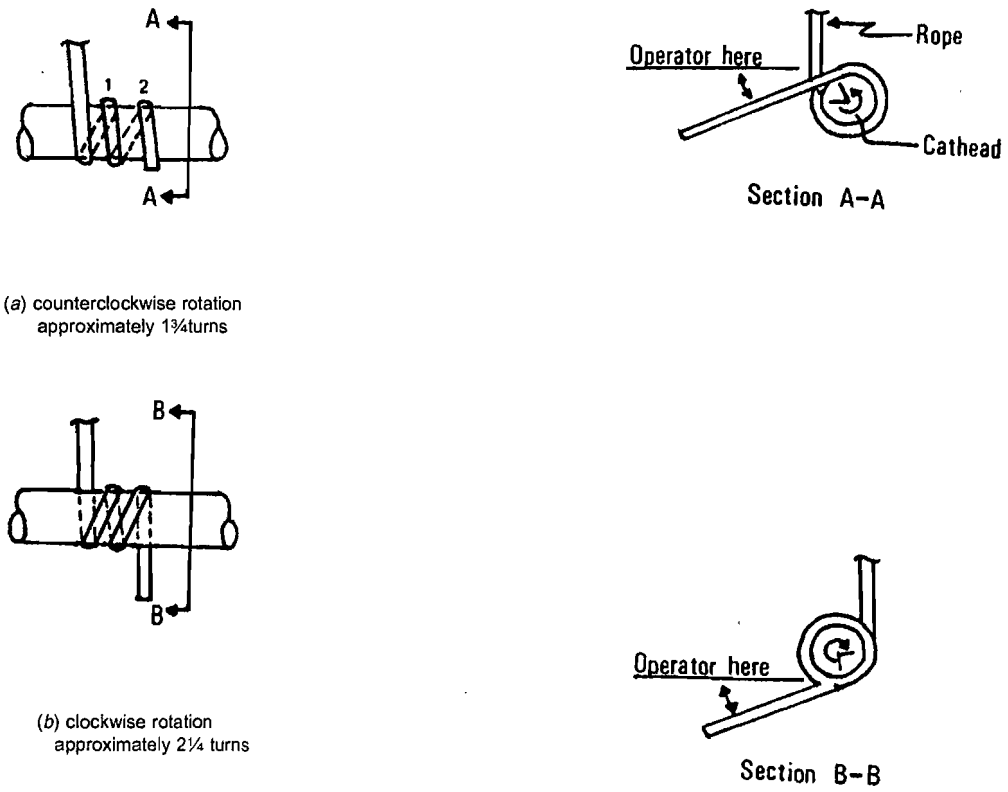

FIG. 1 Definitions of the Number of Rope Turns and the Angle for (*a*) Counterclockwise Rotation and (*b*) Clockwise Rotation of the Cathead

widely published correlations which relate SPT blowcount, or *N*-value, and the engineering behavior of earthworks and foundations are available.

5. Apparatus

5.1 *Drilling Equipment*—Any drilling equipment that provides at the time of sampling a suitably clean open hole before insertion of the sampler and ensures that the penetration test is performed on undisturbed soil shall be acceptable. The following pieces of equipment have proven to be suitable for advancing a borehole in some subsurface conditions.

5.1.1 *Drag, Chopping, and Fishtail Bits*, less than 6.5 in. (162 mm) and greater than 2.2 in. (56 mm) in diameter may be used in conjuction with open-hole rotary drilling or casing-advancement drilling methods. To avoid disturbance of the underlying soil, bottom discharge bits are not permitted; only side discharge bits are permitted.

5.1.2 *Roller-Cone Bits*, less than 6.5 in. (162 mm) and greater than 2.2 in. (56 mm) in diameter may be used in conjunction with open-hole rotary drilling or casing-advancement drilling methods if the drilling fluid discharge is deflected.

5.1.3 *Hollow-Stem Continuous Flight Augers*, with or without a center bit assembly, may be used to drill the boring. The inside diameter of the hollow-stem augers shall be less than 6.5 in. (162 mm) and greater than 2.2 in. (56 mm).

5.1.4 *Solid, Continuous Flight, Bucket and Hand Augers*, less than 6.5 in. (162 mm) and greater than 2.2 in. (56 mm) in diameter may be used if the soil on the side of the boring does not cave onto the sampler or sampling rods during sampling.

5.2 *Sampling Rods*—Flush-joint steel drill rods shall be used to connect the split-barrel sampler to the drive-weight assembly. The sampling rod shall have a stiffness (moment of inertia) equal to or greater than that of parallel wall "A" rod (a steel rod which has an outside diameter of 1⅝ in. (41.2 mm) and an inside diameter of 1⅛ in. (28.5 mm).

NOTE 2—Recent research and comparative testing indicates the type rod used, with stiffness ranging from "A" size rod to "N" size rod, will usually have a negligible effect on the *N*-values to depths of at least 100 ft (30 m).

5.3 *Split-Barrel Sampler*—The sampler shall be constructed with the dimensions indicated in Fig. 2. The driving shoe shall be of hardened steel and shall be replaced or repaired when it becomes dented or distorted. The use of liners to produce a constant inside diameter of 1⅜ in. (35 mm) is permitted, but shall be noted on the penetration record if used. The use of a sample retainer basket is permitted, and should also be noted on the penetration record if used.

NOTE 3—Both theory and available test data suggest that *N*-values may increase between 10 to 30 % when liners are used.

5.4 *Drive-Weight Assembly*:

5.4.1 *Hammer and Anvil*—The hammer shall weigh 140 ± 2 lb (63.5 ± 1 kg) and shall be a solid rigid metallic mass. The hammer shall strike the anvil and make steel on steel contact when it is dropped. A hammer fall guide permitting a free fall

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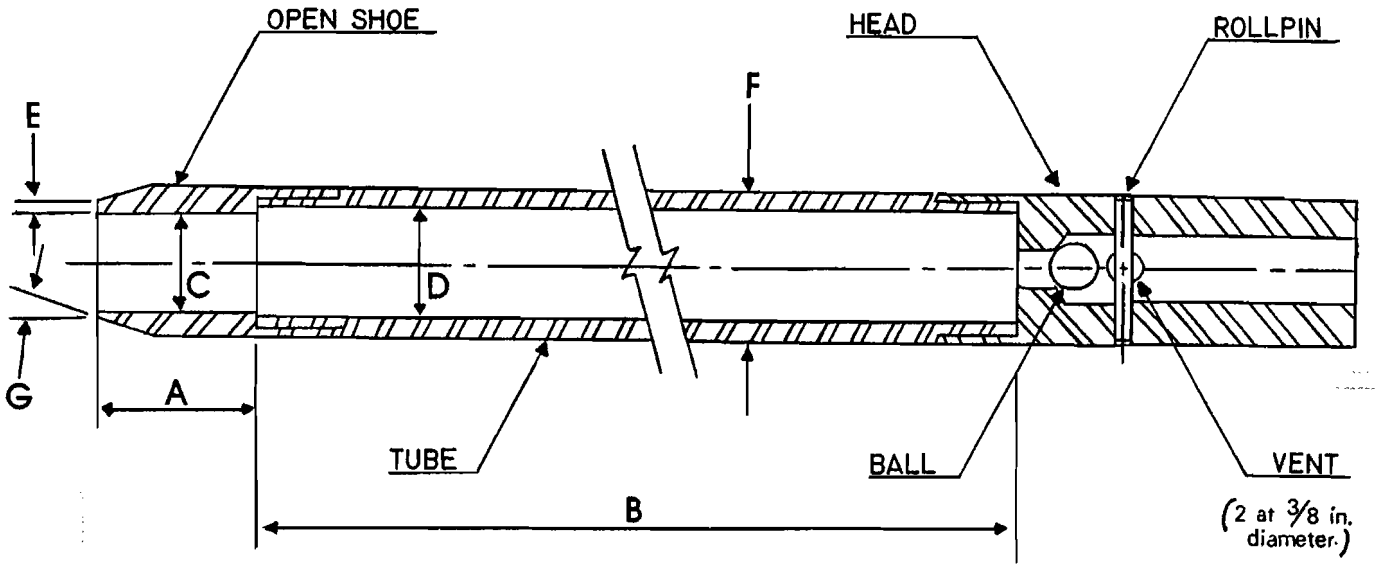

A = 1.0 to 2.0 in. (25 to 50 mm)
B = 18.0 to 30.0 in. (0.457 to 0.762 m)
C = 1.375± 0.005 in. (34.93 ± 0.13 mm)
D = 1.50 ± 0.05 - 0.00 in. (38.1 ± 1.3 - 0.0 mm)
E = 0.10 ± 0.02 in. (2.54 ± 0.25 mm)
F = 2.00 ± 0.05 - 0.00 in. (50.8 ± 1.3 - 0.0 mm)
G = 16.0° to 23.0°

The 1½ in. (38 mm) inside diameter split barrel may be used with a 16-gage wall thickness split liner. The penetrating end of the drive shoe may be slightly rounded. Metal or plastic retainers may be used to retain soil samples.

FIG. 2 Split-Barrel Sampler

shall be used. Hammers used with the cathead and rope method shall have an unimpeded overlift capacity of at least 4 in. (100 mm). For safety reasons, the use of a hammer assembly with an internal anvil is encouraged.

NOTE 4—It is suggested that the hammer fall guide be permanently marked to enable the operator or inspector to judge the hammer drop height.

5.4.2 *Hammer Drop System*—Rope-cathead, trip, semi-automatic, or automatic hammer drop systems may be used, providing the lifting apparatus will not cause penetration of the sampler while re-engaging and lifting the hammer.

5.5 *Accessory Equipment*—Accessories such as labels, sample containers, data sheets, and groundwater level measuring devices shall be provided in accordance with the requirements of the project and other ASTM standards.

6. Drilling Procedure

6.1 The boring shall be advanced incrementally to permit intermittent or continuous sampling. Test intervals and locations are normally stipulated by the project engineer or geologist. Typically, the intervals selected are 5 ft (1.5 mm) or less in homogeneous strata with test and sampling locations at every change of strata.

6.2 Any drilling procedure that provides a suitably clean and stable hole before insertion of the sampler and assures that the penetration test is performed on essentially undisturbed soil shall be acceptable. Each of the following procedures have proven to be acceptable for some subsurface conditions. The subsurface conditions anticipated should be considered when selecting the drilling method to be used.

6.2.1 Open-hole rotary drilling method.

6.2.2 Continuous flight hollow-stem auger method.

6.2.3 Wash boring method.

6.2.4 Continuous flight solid auger method.

6.3 Several drilling methods produce unacceptable borings. The process of jetting through an open tube sampler and then sampling when the desired depth is reached shall not be permitted. The continuous flight solid auger method shall not be used for advancing the boring below a water table or below the upper confining bed of a confined non-cohesive stratum that is under artesian pressure. Casing may not be advanced below the sampling elevation prior to sampling. Advancing a boring with bottom discharge bits is not permissible. It is not permissible to advance the boring for subsequent insertion of the sampler solely by means of previous sampling with the SPT sampler.

6.4 The drilling fluid level within the boring or hollow-stem augers shall be maintained at or above the in situ groundwater level at all times during drilling, removal of drill rods, and sampling.

7. Sampling and Testing Procedure

7.1 After the boring has been advanced to the desired sampling elevation and excessive cuttings have been removed, prepare for the test with the following sequence of operations.

7.1.1 Attach the split-barrel sampler to the sampling rods and lower into the borehole. Do not allow the sampler to drop onto the soil to be sampled.

7.1.2 Position the hammer above and attach the anvil to the top of the sampling rods. This may be done before the sampling

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rods and sampler are lowered into the borehole.

7.1.3 Rest the dead weight of the sampler, rods, anvil, and drive weight on the bottom of the boring and apply a seating blow. If excessive cuttings are encountered at the bottom of the boring, remove the sampler and sampling rods from the boring and remove the cuttings.

7.1.4 Mark the drill rods in three successive 6-in. (0.15-m) increments so that the advance of the sampler under the impact of the hammer can be easily observed for each 6-in. (0.15-m) increment.

7.2 Drive the sampler with blows from the 140-lb (63.5-kg) hammer and count the number of blows applied in each 6-in. (0.15-m) increment until one of the following occurs:

7.2.1 A total of 50 blows have been applied during any one of the three 6-in. (0.15-m) increments described in 7.1.4.

7.2.2 A total of 100 blows have been applied.

7.2.3 There is no observed advance of the sampler during the application of 10 successive blows of the hammer.

7.2.4 The sampler is advanced the complete 18 in. (0.45 m) without the limiting blow counts occurring as described in 7.2.1, 7.2.2, or 7.2.3.

7.3 Record the number of blows required to effect each 6 in. (0.15 m) of penetration or fraction thereof. The first 6 in. is considered to be a seating drive. The sum of the number of blows required for the second and third 6 in. of penetration is termed the "standard penetration resistance," or the "*N*-value." If the sampler is driven less than 18 in. (0.45 m), as permitted in 7.2.1, 7.2.2, or 7.2.3, the number of blows per each complete 6-in. (0.15-m) increment and per each partial increment shall be recorded on the boring log. For partial increments, the depth of penetration shall be reported to the nearest 1 in. (25 mm), in addition to the number of blows. If the sampler advances below the bottom of the boring under the static weight of the drill rods or the weight of the drill rods plus the static weight of the hammer, this information should be noted on the boring log.

7.4 The raising and dropping of the 140-lb (63.5-kg) hammer shall be accomplished using either of the following two methods:

7.4.1 By using a trip, automatic, or semi-automatic hammer drop system which lifts the 140-lb (63.5-kg) hammer and allows it to drop 30 ± 1.0 in. (0.76 m ± 25 mm) unimpeded.

7.4.2 By using a cathead to pull a rope attached to the hammer. When the cathead and rope method is used the system and operation shall conform to the following:

7.4.2.1 The cathead shall be essentially free of rust, oil, or grease and have a diameter in the range of 6 to 10 in. (150 to 250 mm).

7.4.2.2 The cathead should be operated at a minimum speed of rotation of 100 RPM, or the approximate speed of rotation shall be reported on the boring log.

7.4.2.3 No more than 2¼ rope turns on the cathead may be used during the performance of the penetration test, as shown in Fig. 1.

NOTE 5—The operator should generally use either 1¾ or 2¼ rope turns, depending upon whether or not the rope comes off the top (1¾ turns) or the bottom (2¼ turns) of the cathead. It is generally known and accepted that 2¾or more rope turns considerably impedes the fall of the hammer and should not be used to perform the test. The cathead rope should be maintained in a relatively dry, clean, and unfrayed condition.

7.4.2.4 For each hammer blow, a 30-in. (0.76-m) lift and drop shall be employed by the operator. The operation of pulling and throwing the rope shall be performed rhythmically without holding the rope at the top of the stroke.

7.5 Bring the sampler to the surface and open. Record the percent recovery or the length of sample recovered. Describe the soil samples recovered as to composition, color, stratification, and condition, then place one or more representative portions of the sample into sealable moisture-proof containers (jars) without ramming or distorting any apparent stratification. Seal each container to prevent evaporation of soil moisture. Affix labels to the containers bearing job designation, boring number, sample depth, and the blow count per 6-in. (0.15-m) increment. Protect the samples against extreme temperature changes. If there is a soil change within the sampler, make a jar for each stratum and note its location in the sampler barrel.

8. Report

8.1 Drilling information shall be recorded in the field and shall include the following:

8.1.1 Name and location of job,

8.1.2 Names of crew,

8.1.3 Type and make of drilling machine,

8.1.4 Weather conditions,

8.1.5 Date and time of start and finish of boring,

8.1.6 Boring number and location (station and coordinates, if available and applicable),

8.1.7 Surface elevation, if available,

8.1.8 Method of advancing and cleaning the boring,

8.1.9 Method of keeping boring open,

8.1.10 Depth of water surface and drilling depth at the time of a noted loss of drilling fluid, and time and date when reading or notation was made,

8.1.11 Location of strata changes,

8.1.12 Size of casing, depth of cased portion of boring,

8.1.13 Equipment and method of driving sampler,

8.1.14 Type sampler and length and inside diameter of barrel (note use of liners),

8.1.15 Size, type, and section length of the sampling rods, and

8.1.16 Remarks.

8.2 Data obtained for each sample shall be recorded in the field and shall include the following:

8.2.1 Sample depth and, if utilized, the sample number,

8.2.2 Description of soil,

8.2.3 Strata changes within sample,

8.2.4 Sampler penetration and recovery lengths, and

8.2.5 Number of blows per 6-in. (0.15-m) or partial increment.

9. Precision and Bias

9.1 *Precision*—A valid estimate of test precision has not been determined because it is too costly to conduct the necessary inter-laboratory (field) tests. Subcommittee D18.02 welcomes proposals to allow development of a valid precision statement.

9.2 *Bias*—Because there is no reference material for this test method, there can be no bias statement.

9.3 Variations in *N*-values of 100 % or more have been

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observed when using different standard penetration test apparatus and drillers for adjacent borings in the same soil formation. Current opinion, based on field experience, indicates that when using the same apparatus and driller, *N*-values in the same soil can be reproduced with a coefficient of variation of about 10 %.

9.4 The use of faulty equipment, such as an extremely massive or damaged anvil, a rusty cathead, a low speed cathead, an old, oily rope, or massive or poorly lubricated rope sheaves can significantly contribute to differences in *N*-values obtained between operator-drill rig systems.

9.5 The variability in *N*-values produced by different drill rigs and operators may be reduced by measuring that part of the hammer energy delivered into the drill rods from the sampler and adjusting *N* on the basis of comparative energies. A method for energy measurement and *N*-value adjustment is given in Test Method D 4633.

10. Keywords

10.1 blow count; in-situ test; penetration resistance; split-barrel sampling; standard penetration test

SUMMARY OF CHANGES

(1) Added note to Section 1, Scope. The note refers to a related standard, Practice D 6066.

(2) Added Practice D 6066 to Section 2 on Referenced Documents.

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Appendix G
Recommended Practices for Monitoring Well Design, Installation, and Decommissioning

ALASKA DEPARTMENT OF ENVIRONMENTAL CONSERVATION
DIVISION OF ENVIRONMENTAL QUALITY
WATER QUALITY SECTION

Guidance No. 001 – **April, 1992**

RECOMMENDED PRACTICES FOR MONITORING WELL **DESIGN, INSTALLATION, AND DECOMMISSIONING**

PURPOSE: To provide guidance to Regional Administrators regarding recommended practices for design, installation, and decommissioning of groundwater monitoring wells.

BACKGROUND: Groundwater monitoring is required by the Alaska Department of Conservation (ADEC) at facilities regulated by many of the programs it administers. Facilities where monitoring wells may be required or used for these programs include but are not limited to the following: hazardous and solid waste facilities, underground storage tank facilities, and contaminated sites. Regional and district staff, as well as the public, have requested guidelines for the location, design, installation, documentation, and decommissioning of monitoring wells. These guidelines are intended for statewide use. They have undergone review by DEC staff and the regulatedpublic and were developed based on monitoring well regulations and guidelines from Wisconsin, Washington, Oregon, and the U.S. Environmental Protection Agency.

APPLICABILITY: These guidelines are intended to offer direction **for the** installation of permanent and temporary monitoring wells installed at solid waste facilities, underground storage tank sites, contaminated sites, and other sites where groundwater monitoring well installation is required by ADEC programs. They are not regulations and are for guidance purposes only.

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RECOMMENDED PRACTICES FOR MONITORING WELL DESIGN, INSTALLATION, AND DECOMMISSIONING

FINAL

APRIL 1992

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PREFACE

The number of soil and groundwater investigations is increasing at a rapid rate in Alaska Typically monitoring wells are installed to measure groundwater quality. Most of these monitoring wells are installed for, or for investigations that are submitted. to, the Alaska Department of Environmental Conservation. The Department developed these recommended practices in an effort to enhance consistency in the siting, design, installation, decommissioning, and documentation of monitoring wells. Monitoring wells should be constructed in a manner to ensure groundwater samples are representative of the *in-situ* water chemistry. The Department and responsible party have to know the quality of the sampling point, in most cases a monitoring well, though in permafrost areas, well points are sometimes utilized to measure the water quality in the "active thaw zone." The results from these sample points are used to select cleanup actions which cost in the tens to hundreds of thousands of dollars, so taking measures to ensure accuracy is cost-efficient and good practice.

To be most effective, a monitoring well should provide reliable, meaningful information The materials and techniques used for constructing a monitoring well must not materially alter the quality of the water being sampled. An understanding of the chemistry of suspected pollutants and the geologic setting in which the monitoring well is to be constructed play a major role in selecting the drilling technique and well construction material used. To this end, these recommended practices discuss developing a conceptual model of the geologic site conditions, and well design and installation. In many cases, this means that more time and money should be spent to ensure a good quality monitoring well

These recommended practices should not be considered complete nor applicable in all situations. They are not regulations. Depending on the purpose of the well and the

duration of use, a specific monitoring well, or set of wells, may not require construction to these recommended practices. The Department recognizes that regional, climatic, and geographic differences will affect monitoring well design. Because of this, there are "exception" comments with many of the sections of these recommended practices. The important point is that the quality of the sampling point should be known and documented in order to properly interpret the data from the well. This is essential for efficient design of any investigation, detection monitoring, or remediation program.

1.0 PURPOSE

These recommended practices present standards for the location, design., installation, decommissioning, and documentation of monitoring wells and well points in Alaska Monitoring wells should be designed, located, installed, and maintained 'so as to obtain reliable and representative information regarding aquifer characteristics, groundwater flow directions, and chemical and physical characteristics of groundwater. The Department recognizes that the approach and technology available for monitoring are evolving. These recommended practices are not intended to limit reasonable innovation but, rather, to provide a general framework through which innovation can occur.

Monitoring well design and installation should:

(1) Include consideration of site specific hydrogeologic information from all available sources and include development of a conceptual hydrogeologic model of the site.

(2) Be compatible with site specific hydrogeologic conditions, including the physical and chemical properties of the groundwater and any contaminants known or suspected to be present in the groundwater.

(3) Prevent introduction of surface contaminants into the groundwater, prevent vertical movement of water or contaminants benveen water-bearing zones in either the well bore or well annulus, and prevent waste or contamination of groundwater resources.

(4) Minimize sediment and turbidity in water samples, and minimize interference to the results of water quality analyses.

(5) Maximize well efficiency where monitoring wells may later be used in the remediation of groundwater.

(6) For regulated facilities, result in permanent wells which will last for the life of the facility being monitored, including the post-closure care period.

(7) Include consideration for proper decommission when no longer in use or. no longer functioning as designed, or the project is completed.

The National Water Well Association recently completed a handbook on the design and installation of monitoring wells (Aller et al, 1989). This handbook provides detailed discussion of all aspects of monitoring wells. The American Society for Testing and Materials is developing an "ASTM standard" for monitoring wells. The Department recommends that it be followed when it becomes available, with modifications as needed to meet Alaskan conditions.

2.0 APPLICABILITY

The Department recommends persons installing monitoring wells and well points to fulfill regulatory requirements of 18 AAC 15, 60, 62, 70, 71, 72, 73, 75, 78, 80, and 90 follow these recommended practices. In addition, the Department recommends these recommended practices be used when installing groundwater monitoring wells as partial fulfillment of contract terms with the Department.. These recommended practices should also be used when installing monitoring wells as part of an investigation of soil or groundwater contamination. The degree to which any particular monitoring well or well point should meet these recommended practices depends on several factors. These factors include: the type of facility or investigation at which the wells are used, the expected duration of the use of the well, and site-specific conditions.

3.0 LOCATION

3.1. GENERAL. Soil mechanics, geomorphology, geologic structure, stratigraphy, and sedimentary concepts are important in siting a monitoring well or network of wells. This information must be combined with a knowledge of groundwater movement to complete the application of these recommended practices. Therefore, development of a conceptual hydrogeologic model that identifies potential flow paths and target monitoring zone(s) is recommended prior to monitoring well design and installation (see 33 Conceptual Model below).

One important consideration in monitoring well design is proper spatial and vertical location to ensure that the groundwater flow regime is accurately being monitored. Monitoring wells are typically installed in the uppermost permeable water-bearing zone under or adjacent to a regulated facility or potential source of contamination. Consideration should be given to natural, seasonal, and human-caused fluctuations in water table elevation. Natural fluctuations might be caused by infiltration of snowmelt or precipitation, proximity to rivers with seasonal high water levels, or tidal fluctuations. Human-caused fluctuations can result from pumping, wastewater disposal, or paving to decrease infiltration rates.

Location of the screened interval relative to the water table elevation may influence sampling results. For example, a well screened at the water table, with some screen above the water table and some below the water table, will intercept floating petroleum product whereas a well with the top of the screened interval located below the water table will not, under static conditions.

At sites with long-term detection monitoring (more than five years) the location of each well, the elevation of the land surface, and the top of each well casing should be surveyed

by a registered professional surveyor or registered civil engineer engaged in the practice of surveying. The riser pipe should be permanently marked with a reference point for water level measurements. The location survey should achieve a horizontal accuracy of 0.2 foot, and the elevation surveys should achieve **a vertical** accuracy of 0.01 foot. Vertical elevation control should be the National Geodetic Vertical Datum, and horizontal control should be the Universal Transverse Mercator Grid. Sites undergoing contaminant assessment monitoring with a large number of monitoring wells should have the wells surveyed as described above. Some sites with just a few wells may not need this level of detail.

3.2. GOALS OF MONITORING PROGRAM. There are several purposes for groundwater monitoring. They in&de ambient monitoring, source monitoring, case preparation monitoring, and research monitoring (Barcelona et aL, 1983). Wells installed for each of these purposes must satisfy somewhat **different** requirements, and may require different strategies for well design and installation Prior to design and installation there should be clear understanding of what the monitoring program is intended to accomplish. For further discussion of the various purposes of groundwater monitoring see U.S EPA (1987) and Maynard (1988).

33. CONCEPTUAL MODEL Based on avaiiabie information, the monitoring well designer should develop a preliminary hydrogeologic conceptual model of the site to be monitored. The purpose of the conceptual model is to estimate the distribution of the predominant soil and rock units and the flow conditions at the site. This is not a mathematical model nor **a** computer model, though either may be used to aid in understanding the hydrogeologic system. The conceptual model may include estimates of the distribution of aquifer(s) and aquitards at or near the site, hydrologic boundaries, the range of potentiometric surface(s), and other pertinent hydrogeologic properties.

The conceptual model is hypothesized initially using data obtained from a variety of sources such as a literature search, local experience, or field reconnaissance. In areas where the geology is relatively uniform, well-documented in the literature, and substantiated by field reconnaissance, further refinement of the conceptual model may not be necessary unless anomalies are discovered in the well drilling stage. The conceptual model is used in proposing the horizontal location of monitoring wells and the vertical location of the screened interval to ensure that the site is appropriately monitored. The preliminary hydrogeologic conceptual model should be updated as boreholes are completed. Should the borings reveal substantially different information on the geology, the location of monitoring wells may need to be adjusted.

4.0 DESIGN AND INSTALLATION

4.1 GENERAL The Department recommends all monitoring wells be designed and installed by, or under the direct supervision of, a geologist, engineer, or other professional with direct experience in the design and installation of monitoring wells. The Department recommends that all monitoring wells be installed by a licensed contractor qualified and equipped to drill and construct monitoring wells.

Well design and installation should be appropriate to ensure that groundwater samples and water level measurements characterize discrete stratigraphic intervals Well design and installation should prevent the introduction of surface contaminants into the groundwater, and prevent leakage of groundwater or contaminants between stratigraphic intervals in the well bore or along the well annulus. If leakage is detected, it should be corrected or the well should be decommissioned Permanent or temporary surface casing should be used during well drilling and installation in all cases where contaminated groundwater could

migrate in the borehole by gravity flow or under artesian pressure into other water-bearing zones, or where the formations penetrated have a tendency to slough or cave into the borehole and affect filter pack and annular seal placement or integrity.

Monitoring wells may be placed individually or in well clusters. Well clustersshould consist of individual wells in close proximity, screened at varying depths, each installed in its own borehole. Wells consisting of nultiple aquifer completions in a single borehole are not recommended. This is not to exclude multiple port wells in a single casing.

Appropnate measures should be taken to protect all monitoring wells from loss of integrity by soil erosion, soil settlement, shrink-swell soil conditions, frost heaving of soils, damage by vehicles or heavy equipment, and other site specific hazards. Monitoring wells should not be installed in locations where they are subject to periodic or seasonal inundation by floodwaters, unless steps are taken for special watertight construction. The Department discourages persons from completing monitoring wells at- or below-grade unless it is necessary for a site investigation or Underground Storage Tank monitoring, because of the potential for leakage into the well.

4.2 WELL MATERIALS. (1) PURPOSE. Monitoring wells and well points should be constructed of new materials that will not chemically, physically, or biologically affect the groundwater quality or be deleteriously affected by the subsurface environment.

(2) SPECIFICATIONS. The casing should be nonreactive with the subsurface environment and any contaminant the monitoring well may encounter. All casing, well screen and riser pipe should be thoroughly cleaned prior to installation in the well, and should be centered in the borehole. The casing should not affect or interfere with the chemical, physical, radiological, or biological constituents of interest. All monitoring well casing should

conform to ASTM Standards, and will generally be constructed of polyvinyl chloride (PVC), stainless steel, fluoropolymer, or fiberglass materials.

The inside diameter of all well screens and riser pipes should be at least 1.9 inches, except as noted below. The collapse strength of all casing and riser pipe used in monitoring well construction should be great enough to withstand the pressure exerted by the annular seals during seal placement, under conditions when the casing or riser pipe is evacuated of fluid All PVC used in monitoring well construction should conform to ASTM F-480, Standard Specification for Thermoplastic Water Well Casing Pipe and Couplings Made in Standard Dimension Ratios (SDR). Screen and riser pipe assemblies should not contain dissimilar metals, unless separated by a dielectric bushing. Riser pipes should extend to a minimum height of eighteen (18) inches above land surface, except for flush mounts. Riser pipes should be sealed with caps and vented to allow for pressure equalization.

Well screens should be installed in all monitoring wells. All screens should be machine-slotted or continuous wrapped wire-wound. Well screens, riser pipes, casings, annular seals, and other components of the monitoring well should be composed of new materials selected to last for the life of the facility being monitored (including the post closure care period), or the duration of an investigation without contributing contaminants to the groundwater, or loss of structural integrity. Hand cut screens should not be used. The Department recommends that, in general, well screens not exceed ten (10) feet in length, or for piezometers, five (5) feet.

The slot size of the screen should be compatible with the gram size of the filter pack (the screen should be capable of retaining at least ninety (90) percent of the filter pack). Water table variations, site stratigraphy, expected contaminant behavior, and groundwater flow should be considered in selecting the screen composition, length, and position in the

borehole. Where existing contamination is suspected or known, downhole geophysical techniques or groundwater sampling may be necessary to aid in selecting the location of the screened interval. Centering guides should be used to center the well screen in the borehole in deeper wells.

Bottom caps or end plugs should be used on all monitoring wells. Joints, caps, and end plugs should be watertight and secured by welds, threads, or force fittings. Solvents, glues or adhesives should not be used for riser pipe or screen assembly. Well casings should be flush fit on the inside. Monitoring wells installed in competent (non-collapsible) bedrock may be constructed without a well screen.

(3) EXCEPTIONS. Well screens not meeting the requirements of this section may be installed, though, in general, is not recommended by the Department. Riser pipe and well screens for piezometers may be less than 1.9 inches in diameter.

4.3 DRILLING AND SAMPLING METHODS. (1) PURPOSE. Monitoring wells should be installed using proper drilling methods and techniques to avoid introducing contamination or impairing the hydraulic connection between the formation and the well. Improper well installation may cause inaccurate or unrepresentative groundwater sample results.

(2) SPECIFICATIONS. Every appropriate precaution should be taken during drilling and sampling of monitoring wells to avoid introducing contaminants into the borehole. Avoid using drilling mud, synthetic drilling fluids, petroleum- or metal-based pipe joint compounds. and other potential contaminants unless absolutely necessary.

Air drilling systems should have in-line air filters in good working order to remove compressor oils entrained in the air stream. If it is necessary to add water to the borehoie

during drilling, only potable water should be used, and the source of the water should be identified. If it is necessary to add drilling mud to the borehole during drilling to stabilize the hole or control downhole fluid losses, only high yield sodium bentonite clay free of all organic polymer additives should be used.

All equipment placed into the borehole should be properly decontaminated by steam cleaning, high pressure hot water, or similar method before and after use at the site and between boreholes. When possible, upgradient wells should be drilled first Any contaminated cuttings or water removed from the borehole during drilling should be properly managed.

Boreholes should have a minimum inside diameter at least four inches larger than the maximum outside diameter of the riser pipe and screen, to ensure that a tremie pipe may be properly used in the well, and to ensure an adequate annular seal.

Formation samples (if they are collected) should be collected during drilling, preferably using techniques to recover minimally disturbed samples. Appropriate sampling techniques will depend on the drilling method used and the goals of the sampling. Soil samples should not be composited for testing purposes. Additional sampling to determine the presence and concentration of contaminants in soil samples may also be necessary to define the limits of contamination.

Sampling techniques for hollow-stem auger drilling include continuous split barrel core samples, shelby tube (ASTM D-1587), or split spoon (ASTM D-1586) samples. Sampling techniques for rotary drilling include shelby tube samples, split spoon samples, wireline or conventional core samples (ASTM D-21 13), or grab samples. Sampling techniques for cable tool drilling include bailer grab samples. The Department recommends formation samples

be collected every five (5) feet, or at every change of formation, whichever interval is smaller, to the total depth of the hole, except as noted in part 3 of this section.

When installing well clusters, the deepest well in the cluster should be drilled first. Samples should be collected during drilling as described above; shallower wells in the cluster should be drilled after the deepest well and may not need formation samples to define lithology. Sampling may be required to determine contaminant levels during the drilling of all wells. Sampling information from the deeper borehole may be used to determine what interval of the formation should be screened, or where to place seals to prevent communication between aquifers.

If any borehole is drilled deeper than the well to be completed in the borehole, the borehole should be sealed to within one (1) foot of the bottom of the completed interval by a method described in Section 5.0 Decommissioning below. Temporary casing or auger flights may be used to prevent caving of the borehole prior to grouting. Following installation, the top of the seal should be sounded to check for proper placement. The seal should be allowed sufficient time to set or hydrate before completing the well in the borehole above the seal. Any borehole that is drilled and not completed as a monitoring well, and is covered. in the applicability section, should be sealed immediately following drilling, from the bottom of the borehole to land surface using a method described in Section 5.0 Decommissioning, below.

(3) EXCEPTIONS. For site investigations in relatively consistent, uniform geologic settings, formation samples from every borehole may not be required when boreholes are drilled in close proximity. Additional detailed sampling may not be necessary if detailed sample logs have already been obtained from previous borings drilled in the vicinity of the monitoring wells as part of a hydrogeologic site characterization study. Although, in general, the

Department recommends the maximum interval between samples not exceed five (5) feet, the actual maximum sampling interval may be greater depending on the uniformity of the geology and the overall depth of the well.

4.4 FILTER **PACKS.** (1) PURPOSE. The filter pack should minimize the amount of fine materials entering the well, allow for proper well development, and should not inhibit the inflow of water to the well.

(2) SPECIFICATIONS. All permanent groundwater monitoring wells installed in unconsolidated material and used for the collection of water quality samples should be constructed with filter packs. Permanent groundwater monitoring wells installed in bedrock may be constructed without filter packs. When used, the filter pack should be the only material in contact with the well screen. All commercially prepared filter packs installed in permanent groundwater monitoring wells should meet the requirements of this section

The filter pack surrounding the well screen should consist of clean, chemically inert, well-rounded, siliceous material. Filter fabrics should not be used in conjunction with, or in place of, filter packs. The sand or gravel used for filter packs should be hard and durable and should have an average specific gravity of not less than 2.50. The sand and gravel should be visibly free **of clay,** dust, and organic matter. Not more than five percent **of the** sand or gravel should be soluble in hydrochloric acid Thin, flat, or elongated pieces of gravel, the dimension of which exceeds three times the minimum dimension, should not constitute more than two percent of the material by weight. The filter pack for wells installed in unconsolidated material should be sized to retain most of the **surrounding** formation. In unconsolidated material, the filter pack should be either a coarse or medium sand. In bedrock, the filter pack should be a medium or coarse sand or gravel. Do **not use**

crushed limestone or dolomite, material containing clay, or any other material that may adversely impact the performance of the monitoring well.

For wells screened in water-bearing zones composed of non-cohesive granular materials, the grain size of the filter pack should be based upon a representative sieve analysis of the formation materials opposite the well screen. The filter pack is usually selected to have a 30% finer (d-30) grain size that is about four to ten times larger in size than the 30% finer (d-30) grain size of the formation materials being filtered. Usually, the filter pack is selected to have a uniformity coefficient less than 25.

Standard filter packs for a particular screen size may be used if the filter pack characteristics approximate those described above. Alternative methods of choosing filter pack materials may be necessary when the monitoring wells are screened in consolidated rock or in very fine grained sandy or silty formations. The filter pack should be placed using a method that ensures positive placement opposite the well screen without bridging or size segregation of the filter pack material, such as a tremie pipe or other similar method. No filter pack is required for driven well points.

(3) INSTALLATION. The filter pack should extend from one foot beneath the well end cap to two feet above the top of the well screen. The required filter pack height above the top of the well screen may be reduced to six inches to allow for the required volume of annular space sealant to be placed.

Calculations should be made prior to filter pack placement to determine the volume of filter pack material needed to fill the annular space to the appropriate depth. Following installation, the top of the filter pack should be sounded to check for proper placement. A

finer-grained sand filter six (6) inches thick may be placed at the top of the filter pack, and below the bentonite seal, to help prevent infiltration of the bentonite into the filter pack

(4) EXCEPTIONS. Alternate filter pack designs and installation procedures may be more suitable than the method recommended above, depending upon the geologic setting and use of the well. The natural formation may be acceptable as filter pack material if the physical and chemical properties of the formation are consistent with the filter pack specifications stated in paragraph 2 of this section and will limit the passage of formation fines into the well screen. The grain size distribution of the formation should be such that at least SO percent of the formation will be retained by the well screen. If used as filter pack the material should be visibly free of clay, dust, and micaceous and organic matter, and be free of contamination.

4.5 **WELL SEALS.** (1) PURPOSE. Well seals are installed to prevent the transmission of water or contaminants up or down boreholes or along well casings.

(2) SPECIFICATIONS. The fluid sealant should be installed with a tremie tube from the bottom up. Use only potable water to hydrate the mixture. All materials and procedures used in the installation of seals for permanent groundwater monitoring wells should meet the requirements of this section.

(3) TOP OF FILTER PACK SEAL (a) Specifications. All permanent monitoring wells installed with filter packs should be constructed with a seal at the top of the filter pack. The seal should extend a minimum of two feet upward from the top of the filter pack. The filter pack seal should consist of bentonite pellets, bentonite slurry, or similar material The thickness of the seal may be reduced to less than two feet if necessary to allow for the required volume of filter pack to be placed.

(b) Installation When bentonitc pellets are used, the top of filter pack seal should be installed in sequential one foot thick layers. Where bentonite pellets are used above the water table, each one foot layer should be hydrated by pouring water down the borehole before the next layer of pellets is put in place. This process should continue until the required seal thickness is installed. A tape measure, measuring rod or similar device should be used to ensure that the filter pack seal is installed over the proper depth interval.

(4) ANNULAR SPACE SEAL (a) Specifications.

1. All permanent monitoring wells should be installed with an annular space seal that has a permeability of $1x10^{-7}$ centimeters per second or less. For permanent monitoring wells completed with filter packs, the annular space seal should extend from the top of the filter pack to the ground surface concrete seal and should be at least two feet thick. The annular space should be sealed with one of the following materials:

a. Neat cement grout (not recommended for use with schedule 40 PVC well casing nor where there maybe shrinkage that may allow leakage along the casing.),

b. Sodium based bentonite slurry with a mud weight of at least 10.00 pounds per gallon,

c. Sodium based bentonite granules,

d. Sodium based bentonite pellets, and

e. Bentonite - cement grout.

2. Bentonite pellets or granules may be used to seal the annular space under the following restrictions:

a Granular bentonite can be used when there is no standing water in the well above the top of the filter pack seal and the total well depth is less than 25 feet.

b. Bentonite pellets can be used when the depth of standing water in the well is less than 30 feet and the total well depth is less than 50 feet.

(b) Installation.

1. When bentonite pellets or granules are used to seal the annular space they may either be poured freely down the boreholc or added through a tremie pipe. They should be placed so as to not form bridges, gaps, or channels.

2. When the approved grouts or slurries are used to seal the annular space the following procedures should be used.

a For wells less than 40 feet in depth the material may be poured freely down the borehole with or without the use of a tremie pipe. If there is greater than 10 feet of standing water in the well a tremie pipe should be used to install neat cement and bentonite-cement grouts.

b. For wells 40 feet or greater in depth the material should be pumped down the borehole using a tremie pipe.

3. In all instances where a tremie pipe is used to install a slurry or grout, the lower end of the pipe should remain submerged in the sealing material during the

installation process. The Department recommends that when a slurry or grout is used there should be a 24-hour period between the time the annular space seal is installed and the time the protective cover pipe is installed. Any settling in the annular space seal should be filled before the protective cover pipe is installed.

(5) GROUND SURFACE SEAL (a) Specifications. AlI permanent monitoring wells should be constructed with a concrete ground surface seal. The ground surface seal should extend to a minimum of 60 inches below the land surface, where practicable, and the top should slope away from the well casing. The ground surface seal should be installed around the protective cover and should not be placed between the protective cover and the well casing. In situations where permafrost or seasonal frost may cause problems, alternative ground surface seals may be appropriate.

(6) EXCEPTIONS. Alternative sealing procedures may be used to seal the annular space, if they provide equivalent protection. In areas with shallow groundwater the minimum thickness of seals may be reduced.

4.6 SURFACE PROTECTION MEASURES (1) PURPOSE. Permanent monitoring wells should be constructed so the above-ground portion of the well is protected from damage that may affect sampling.

(2) SPECIFICATIONS. (a) Every monitoring well should be capped using a lockable cover, or equivalent, and protected using one of the following methods:

1. If the well is cased with metal and completed above the ground surface. a lockable cap should be attached to the top of the casing.

2. If the well is not cased with metal and completed above the ground surface, a metal protective casing should be installed around the well. The protective casing should extend at least six inches above the top of the well casing and at least two feet into the ground. A lockable cap should be attached to the top of the protective casing.

3. If the well is completed below ground surface, a lockable "water-meter cover" or equivalent, should be installed around the well. A protective cover, level with the ground surface, should be installed with a waterproof seal to prevent the inflow of surface water. The cover should be designed to withstand the maximum expected loadings.

(b) Guard posts should be installed where monitoring wells are completed above ground and installed in areas where they may be needed to protect the wells from damage. The guard posts should consist of three metal posts at least three inches in diameter, and set in concrete. They should be installed in a triangular array around the casing and at least two feet from it. Each post should extend at least three feet above 'and below the ground surface. The above-ground portion should be painted with a bright colored paint.

(c) Other surface protection methods may be used if they meet the intent of protecting the above-ground portion of a monitoring well.

(d) If the well is damaged, the well protection measures and casing should be restored as prescribed by this chapter. If the well is damaged beyond repair, it should be properly decommissioned.

4.7 WELL DEVELOPMENT. (1) PURPOSE. Well development is important for removing any mud "cake" that may have formed on the water bearing formation during drilling and to ensure the well provides water free of suspended solids.

(2) SPECIFICATIONS. The Department recommends that all wells be developed as soon as possible after installation, but not before the well seals and grout have set. In general, wells should be developed more than 24 hours after installation The objective of well development is to remove any water or drilling fluids introduced into the well during drilling, stabilize the filter pack and formation materials opposite the well screen, minimize the amount of fine materials entering the well, and maximize the efficiency of the well and the inflow of water to the well. The entire submerged portion of the screened interval should be developed.

Development may include the use of surge blocks, bailers, or other equipment that frequently reverses the flow of water through the well screen and prevents bridging of formation or filter pack particles. An important factor in any method is that the development work be started slowly and gently and be increased in vigor as the well is developed. Most methods of well development require the application of sufficient energy to disturb the filter pack, thereby freeing the fines and allowing them to be drawn into the well. The coarser fractions then settle around and stabilize the screen The well development method chosen should be documented on the well completion log

During development, water or air should not be introduced into the well. Any contaminated water withdrawn during development should be properly managed. Development should not disturb the annular seal or the formations above the water-bearing zone, or damage the well. Special development techniques that minimize agitation and disturbance of the formation materials may be required in monitoring wells that screen very fine-grained sands

or silt formations. Development should be considered complete only when the water removed from the well is as free of sediment as possible. If water reasonably free of sediment cannot be obtained from the well following development, additional well development or replacement of the well may be necessary.

(3) WELLS THAT CANNOT BE PURGED DRY. All groundwater monitoring wells that cannot be purged dry should be developed by the following procedure:

(a) Alternately surge and purge the well. The surge and purge cycle should consist of several minutes of surging followed by several minutes of purging to remove the fine material collecting in the bottom of the well. This cycle should be continued for a minimum of 30 minutes. The surging should forcefully move formation water in and out of the well screen. The surging should be accomplished by using either a surge block or bailer or by pumping the well sufficiently to cause a drawdown and then allowing the well to recover and repeating the process. The Department recommends that air surging not be used

(b) After surging, the well should be pumped until 10 well volumes of water are removed or until the well produces sediment free water.

(4) WELLS THAT CAN BE PURGED DRY. All permanent groundwater monitoring wells that can be purged dry should be developed by first purging the well dry and then adding one well casing volume of potable water to the well. After the water is added, the well should be surged vigorously for 10 minutes by using either a surge block or bailer. Additional water may be added as necessary to properly develop the well. After surging the well, it should be purged dry again to complete the development process. Water should be added as a last resort. If the well will recover, continued development should occur only with formation water.

(5) EXCEPTIONS. Alternate development procedures may be used if they will not affect the ability of the well to provide representative samples. At locations where a second trip to the well is for the sole purpose of well development and the travel distance is far, well development may occur less than 24 hours after well installation, allowing as much time as possible to pass between installation and development_

4.8 DRIVE POINT WELLS. (1) PURPOSE. For certain conditions drive point wells provide efficient sampling points.

(2) SPECIFICATIONS. Drive point wells with galvanized steel drive points may be used as permanent groundwater monitoring wells with the following restrictions. When used on projects that meet the applicability requirements of Section 2.0, written documentation should be supplied to the Department after installation indicating that the well is to be used for only the following:

(a) for water table elevation measurements,
(b) to monitor parameters with which the casing will not interfere,
(c) where the drive point will not provide a conduit for contaminants to enter the groundwater, and
(d) where information on subsurface stratigraphy is not needed.

In situations where subsurface geologic information is needed, a separate borehole should be advanced to collect the required data

4.9 MONITORING WELLS IN, THROUGH, OR ABOVE PERMAFROST (1) PURPOSE. In certain portions of Alaska, groundwater monitoring requires the installation of monitoring

wells in, through, or above permafrost. This sections describes possible modifications of monitoring wells for the potential effects of permafrost.

(2) SPECIFICATIONS. Monitoring wells should be designed and constructed to minimize their effect on the subsurface thermal regime and to withstand freeze-thaw forces. Monitoring wells that penetrate permafrost should be maintained so that representative groundwater samples can be collected during any time of the year. Monitoring wells installed into permafrost (ie. screened in the seasonal active layer) should be designed and constructed to obtain a representative groundwater sample during the period of thaw. The latter wells should be screened deeper than the greatest expected depth of thaw to prevent them from going dry late in the thawing season.

Artesian wells in permafrost regions require special attention. Groundwater that rises in the casing up into the permafrost zone may freeze; if heat or compressed gas are considered or used to prevent freezing, their impact on volatile constituents in the water or soil should be considered and minimized. In addition, the thawed annulus between the pipe and the permafrost must be firmly scaled to prevent seepage upward from the confined aquifer.

4.10 **TEMPORARY MONITORING WELLS.** (1) PURPOSE. During site investigations temporary monitoring wells may be installed to help define the nature and extent of contamination.

(2) SPECIFICATIONS. Temporary groundwater monitoring wells may be installed according to standards less stringent than those specified for permanent monitoring wells. However, care should still be taken that the wells provide samples representative of the *in-situ* groundwater quality. All temporary monitoring wells should be decommissioned following procedures recommended in this document within 60 days after their installation.

5.0 DECOMMISSIONING

5.1 GENERAL Any well installed under the applicable requirements listed in Section 2.0 which is unusable, or which use has been permanently discontinued, or which is in such disrepair that its continued use is impractical or is an environmental, safety or public health hazard should be decommissioned. The decommissioning procedure should be recorded and reported as requested by the Department.

Each monitoring well should be permanently decommissioned by sealing with grout, or equivalent, at the end of the post-closure care period, when no longer in active use, when irreparable leakage in the well or annular space is known or suspected, or when the integrity of the well is permanently compromised in some other manner.

5.2 METHODS.(1) PURPOSE. Wells should be decommissioned by completely sealing the well bore to prevent the entrance of surface contaminants into the groundwater. Decommissioning must also to prevent vertical movement of water or contaminants between water-bearing zones in both the well casing and the annular space.

(2) SPECIFICATIONS. Wells that were not constructed in accordance with the practices recommended in this guidance or other comparable U.S. Environmental Protection Agency or accepted standard, or wells that are decommissioned to permit the installation of potential sources of contamination (such as solid waste management units) within one hundred feet of the well, should be decommissioned in one of three ways:

(a) Perforate the casing from the bottom to within five feet of the land surface, remove the casing from five feet below the surface to the surface, and pressure grout the casing with

enough grout to fill the annulus. Perforations should be spaced with at 'least four equidistant cuts per row, and one row per foot. Each cut should be at least one and one-half inches long. Shot perforations may also be used.

(b) Withdraw the casing and fill the bore hole with grout or bentonite as the casing is being withdrawn.

(c) An alternative method approved by the department or conforming to ANSI/AWWA Standard A100-84 (Eff 6/14/91, Register 118).

Pipe sealing materials directly to the point of application or emplace by means of a dump bailer or nemie tube. If cement grout, neat cement, or puddled clay are used as sealing materials below the static-water level in the well, they should be placed from the bottom up using methods that avoid segregation or dilution of the material. When a tremie tube is used to place grout, the discharge end should be submerged in the grout to avoid breaking the seal while filling the annular space. For artesian wells, a cement grout or concrete plug should be placed in the confining stratum overlying the artesian zone to prevent upward seepage from the artesian zone. The remainder of the well should be filled with cement grout or bentonite.

(3) EXCEPTIONS. For wells where the water table is greater than 50 feet below the land surface, clean sand may be substituted for grout in the interval between 10 feet above the seasonal high water table and 10 feet below the land surface.

6.0 DOCUMENTATION

6.1 GENERAL The purpose of documentation is provide a record of the well design and installation, and the materials used. This information may be useful in determining, at a later date, if the monitoring well design, installation, or history may be affecting sampling results or the interpretation of site conditions. Unconsolidated deposits should be classified on the borehole log according to the Unified Soil Classification System (USCS), and described in detail according to their texture, color, mineralogy, moisture content, degree of weathering, geologic origin, and other relevant characteristics. The USCS visual method should be used to classify all samples, supplemented by appropriate USCS laboratory tests (ie. mechanical and/or hydrometer gram size tests and Atterberg limits) on a representative number of samples from each stratigraphic unit. A clear description of the classification system used should be included with the log. Descriptions should conform to **ASTM** D-2488. Standard **Practice for Description and Identification** of Soils **(Visual-Manual Procedure)** and **ASTM D-2487. Standard Test Method for Classification of Soils For Engineering Purposes**.

Rock core logs should describe the lithology, mineralogy, color, gram size, degree of cementation, degree of weathering, density and orientation of fractures, other primary and secondary features and physical characteristics of the rock, and the rock quality designation When possible, a clear, labeled, photographic record of all rock cores should also be taken and submitted with rock core logs.

The decommissioning procedure should be documented. The following information, at a minimum should be submitted to the Department: Project name, if appropriate; date; location of well by l/4, l/4, section or smallest legal subdivision; latitude and longitude: well identification number; use of well; method of setting the plug; type and amount of

sealant used; and other information as required by the Department.

A facility or project-unique identification number should be permanently attached or engraved on the inner and outer well casings. The number should consist of a local well number assigned by the project personnel. The Department recommends that a statewide-unique USGS site identification number be obtained for each monitoring well, in addition to a local well number. Copies of all borehole logs should be sent a copy to the Division of Geological and Geophysical Surveys, Department of Natural Resources, P.O. Box 772116, Eagle River, AK. 99577.

6.2 BOREHOLE LOG. A detailed log should be submitted for all boreholes drilled. The log should include the following:

(1) project name,
(2) basic site sketch,
(3) borehole number,
(4) the location of the hole-including,
    a. legal description - i) subdivision, lot, block, or tract information, or ii) section lot, tax lot or government lot number,
    b. meridian township, range, section, and l/4, l/4, l/4, l/4 locations within section,
    c. latitude and longitude, to the nearest second, and
    d. state plane coordinates (if available),
(5) date and time drilling started and finished,
(6) driller's name and affiliation,
(7) site geologist's name and affiliation,
(8) elevation of the land surface surveyed to the nearest 0.1 foot (for those sites where

a site survey is completed),

(9) size (diameter) and total depth of the hole,

(10) type of drilling rig and method of drill@,

(11) type and volume of drilling fluids or additives used, if applicable,

(12) penetration rate or standard penetration resistance, if measured,

(13) sample intervals and percent recovery,

(14) stratigraphic and lithologic information, using Unified Soil Classification System,

(15) depth to water during drilling,

(16) depth to water after water level has stabilized following drilling,

(17) zones of high-permeability or fractures encountered,

(18) contamination observations,

(19) indication of whether frozen ground, ice, or permafrost was encountered. If so, a description, and

(20) any other drilling observations including lost circulation zones or other difficulties encountered during drilling.

6.3 MONITORING WELL COMPLETION LOG. A detailed completion log should be submitted to DGGS for all boreholes drilled. The log should include the following as-built data:

(1) project-unique monitoring well number,

(2) elevation of ground surface and measuring point,

(3) project name,

(4) well installed by,

(5) drilled by,

(6) date construction started and completed,

(7) total depth drilled,

(8) drilling method,
(9) borehole diameter,
(10) diameter and length of the protective cover pipe,
(11) the type of cap and lock,
(12) quantity of filter pack material used,
(13) manufacturer and product name of the filter pack material,
(14) type and quantity of annular space material used and the source and quantity of any water added or removed from the well during development, including information on the size and depth of the hole,
(15) depth of the completed well,
(16) screen type, material, diameter, slot size and percent open area, and location of the top and bottom of the screened interval,
(17) riser pipe material and diameter,
(18) type of joints or fittings used to assemble screen and riser pipe,
(19) the static water level measured to the nearest 0.01 foot, with the date of measurement, and
(20) type of development, time development started and finished.

Readings for field temperature, field specific conductance and field pH should be reported The well constructor should report any decontamination procedures used between well installations.

6.4 SITE MAP. All well locations should be indicated on a plan map drawn to a specified **scale.** The site map should include:

(1) facility and property boundaries,
(2) buildings and roads,

(3) exploratory borings and monitoring wells,
(4) nearby surface water,
(5) legend with location of cross-section, and
(6) bar scale and north arrow.

In addition to the above, an 85 inch by 11 inch map should be submitted showing the general location of wells and facilities on site. Following installation of the wells, an as-built plan map should be submitted specifying the surveyed location of the wells. The vertical location of the top of the well pipes should be referenced to the nearest benchmark for the National Geodetic Survey datum to an accuracy of 0.01 feet, for those sites where a site-specific survey was completed. This plan should show the exact location of the installed well(s) on a horizontal grid system which is accurate to within one foot. The plan should show the wells in relation to each other, to property boundaries, and to a common reference point on the horizontal grid system Direction of groundwater flow should be indicated. For those sites where the well locations are not surveyed, the site map should give the approximate location.

6.5. CONCEPTUAL MODEL One or more hydrogeologic cross-sections should be developed to refine the preliminary hydrogeologic conceptual model. The cross-sections should include:

(1) plots representative of the soil and rock observed in the exploratory borings,
(2) a legend describing the soils using the Unified Soil Classification System,
(3) plot of the borehole depth,
(4) plot of the monitoring well screen interval, if applicable,
(5) groundwater elevation and date of observation, and
(6) horizontal and vertical scale, with units identified.

7.0 REFERENCES

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Maynard, D. L. 1988. An Evaluation of Ground-Water Quality Monitoring in Alaska Alaska Department of Natural Resources, Division of Geological and Geophysical Surveys. Report of Investigations 88-12.39 pp.

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8.0 DEFINITIONS

For the purpose of these recommended practices the following definitions apply.

(1) "Active thaw layef means the surface layers of organic matter and mineral soil which thaw each year in areas of permafrost.

(2) "Annular space seal" means the following: (a) for wells constructed with filter packs, it

is the material placed above the top of the filter pack seal up to the surface concrete seal, and between the well casing and the adjacent formation; (b) for wells constructed in bedrock formations and without well screens, it is the material placed from the bottom of the enlarged drillhole up to the surface concrete seal, and between the well casing and the adjacent formation.

(3) "Aquifer" means geologic formation, group of formations, or part of a formation that is saturated, and is capable of providing a significant quantity of water.

(4) "Aquitard" means lithologic unit that impedes groundwater movement and does not yield water freely to wells or springs but that may transmit appreciable water to or from adjacent aquifers. Where sufficiently thick, aquitards may act as groundwater storage zones.

(5) "Assessment monitoring" means an investigative monitoring program that is initiated after the presence of a contaminant in groundwater has been detected. The objective of this program is to determine the concentration of constituents that have contaminated the groundwater and to quantify the rate and extent of migration of these constituents.

(6) "ASTM" means American Society for Testing and Materials.

(7) "Bailer" means a hollow tubular receptacle, fitted with a check valve at the bottom, used to facilitate withdrawal of fluid from a well or borehole.

(8) "Bedrock" means the solid rock underlying any loose superficial material such as soil, alluvium or glacial drift. Bedrock includes but is not limited to limestone, dolomite, sandstone, shale, and igneous and metamorphic rock

(9) "Bentonite - cement grout" means a mixture of five pounds of sodium based montmorillonite clay with 94 pounds of portland cement and five to six gallons of water.

(10) "Bentonite slurry" means a mixture of sodium based montmorillonite clay and water that has a minimum mud weight of 10 pounds per gallon.

(11) "Borehole" means a circular hole deeper than it is wide constructed in earth material for the purpose of either installing a well or obtaining geologic or groundwater related data Borehole has the same meaning as drill hole.

(12) "Borehole log" means the record of geologic units penetrated, drilling progress, depth, water level, sample recovery, volumes and types of materials used, or other significant observations regarding the drilling of an exploratory borehole or well.

(13) "Casing" means pipe, finished in sections with either threaded connections or beveled edges to be field welded, which is installed temporarily or permanently to counteract caving, to advance the borehole, and/or to isolate the zones being monitored.

(14) "Casing, Protective" means a section of large diameter pipe that is emplaced over the upper end of a smaller diameter monitoring well riser or casing to provide structural protection to the well and restrict access to the well.

(15) "Casing, Surface" means pipe used to stabilize a borehole near the surface during and following the drilling of the borehole.

(16) "Centralizer" means a device that assists in the centering of a casing or riser within a borehole or another casing.

(17) "Clay" means an inorganic soil having a grain size less than.074 millimeters (mm) and a plasticity index of 7 or more.

(18) "Clay slurry" means a mixture of clay and water.

(19) "Coarse sand" means a well-sorted sand with a predominant grain size between 4.76mm and 2.0mm as established by the Unified Soil Classification System.

(20) "Concrete grout" means a slurry mixture of 94 pounds of cement, equal volumes of dry sand and gravel, and five to six gallons of water. The ratio of sand and gravel should not exceed three parts to one.

(21) "Department" means the Alaska Department of Environmental Conservation.

(22) "Detection monitoring" means a program of monitoring for the express purpose of determining whether or not there has been a contaminant release to groundwater.

(23) "Drillhole" means the same as borehoie.

(24) "Filter pack" means a clean silica sand or sand and gravel mixture of rounded grains with a selected grain size and gradation that is installed in the annular space between the borehole wall and the well screen, extending an appropriate distance above the screen, for the purpose of retaining and stabilizing the particles from the adjacent strata The term is used in place of "gravel pack."

(25) "Fine sand" means a well-sorted sand with a predominant grain size between .42mm and .074mm as established by the Unified Soil Classification System.

(26) "Flush-joint or flush-coupled" means casing or riser with ends threaded such that a consistent inside and outside diameter is maintained across the threaded joints or couplings.

(27) "Gravel" means an unconsolidated material with the predominant grain size being between 76.2mm and 4.76mm as established by the Unified Soil Classification System

(28) "Groundwater" means subsurface water permanently or seasonally occurring in the zone of saturation.

(29) "Grout" means a low-permeability material placed in the annulus between the well casing or riser pipe and the borehole wall (ie., in a single cased monitoring well), or between the riser and casing (i.e., in a multi-cased monitoring well), to maintain the alignment of the casing and riser and to prevent movement of groundwater or surface water within the annular space.

(30) "Inside diameter" means the distance, perpendicular to the long axis of the casing, between the inner walls of either a well casing, hollow stem auger, or tremie pipe.

(31) "Medium sand" means a well sorted sand with a predominant grain size between 2.0mm and .42mm as established by the Unified Soil Classification System.

(32) "Monitoring well" means any cased excavation or opening into the ground made by digging, boring, drilling, driving, jetting or other methods for the purpose of determining the physical, chemical, biological, or radiological properties of groundwater.

(33) "Montrnorillonite" means a group of expanding lattice clay materials of the general formula: $R_{.33}Al_2Si_4O_{10}(OH)_2 \circ H_2O$ where R includes one or more of the cations NA', K^+,

Mg^{+2}, Ca^{+2} and possibly others.

(34) "Neat cement grout" means a slurry mixture of 94 pounds of portland cement mixed with 5 to 6 gallons of water.

(35) "Permafrost" means subsurface material in which the naturally occurring temperature has remained below 0 degrees C (32 degrees F) for two or more consecutive years.

(36) "Permanent groundwater monitoring well" means any groundwater monitoring well in place for 60 days or longer.

(37) "Piezometer" means a well installed for the specific purpose of determining the elevation of the potentiometric surface.

(38) "Piezometric surface" has the same meaning as potentiometric surface.

(39) "Potentiometric surface" means an imaginary surface representing the total head of groundwater and is the level to which water will rise in a well.

(40) Purge" means an action that removes water from a well, commonly accomplished using a pump or bailer.

(41) "Reagent grade water" means water that has been treated to remove any impurities that may affect the quality of sample analysis.

(42) "Riser pipe" means the pipe extending from the well screen to or above the ground surface.

(43) "Rotary drilling method" means a drilling method whereby the drillhole is constructed to the depth of casing setting. The permanent well casing is set to the bottom of the drillhole and is not driven.

(44) "Sediment sump" means a blank extension beneath the well screen used'to collect fine-grained material from the filter pack and adjacent strata The term is synonymous with rat trap or tail pipe.

(45) "Sodium based bentonite" means a clay consisting of at least 85 percent sodium montmorillonite.

(46) "Specific gravity" means the weight of a particular volume of substance compared to the weight of an equal volume of water at a reference temperature.

(47) "Static water level" means the elevation of the top of a column of water in **a** monitoring well or piezometer that is not influenced by pumping or conditions related to well installation, hydrologic testing, or nearby pumpage.

(48) "Surge" means an action causing water to move rapidly in and out of the well screen, thereby removing fine material from the surrounding aquifer. surging is commonly accomplished by moving a surge block rapidly up and down under water inside the well casing near the well screen.

(49) 'Target monitoring zone," in detection monitoring programs, means the groundwater flow path from a particular area or facility in which monitoring wells will be screened. The target monitoring zone should be a stratum (strata) in which there is a reasonable expectation that a vertically placed well will intercept migrating contaminants.

(SO) ‘Teflon” means the registered trademark of the DuPont Company for the compound polytetrafluoroethylene.

(5 1) Temporary groundwater monitoring well" means any groundwater monitoring well in place for less than 60 days.

(52) ‘Top of bedrock” means the top of firm rock. Firm rock is indicated by at least 70 percent of the drill cuttings being either (1) angular rock fragments, as in the case of crystalline rock or (2) rock fragments composed of individual grains or rock particles that are cemented together to form an aggregate.

(53) Top of filter pack seal” means the scaling material placed in the annular space above the filter pack and below the annular space seal. The seal should be two feet in length and should consist of bentonite pellets.

(54) ‘Tremie pipe” means a metal pipe or steel wire-braided, rubber-covered hose used to convey well construction materials down a drillhole. Drill stem is acceptable to use as a tremie pipe, as long as it has been thoroughly cleaned of oil, solvents, or other contaminants.

(55) “Unconsolidated material” means that material found above firm bedrock, composed of single sediment particles, individual grains or rock fragments. Unconsolidated material includes but is not limited to clay, silt, sand, gravel, loess, peat and organic soil. For the design of a monitoring well network it is important to know the origin and depositional environment of the material.

(56) “Unified Soil Classification System” means the soil designation system based on the

physical properties of the soil developed from the Airfield Classification System in 1952 and adopted by the United States Army Corps of Engineers.

(57) "Water table" means the surface of unconfined groundwater where the pressure is equal to atmospheric pressure.

(58) "Water table observation well" means any groundwater monitoring well installed for the specific purpose of determining either the elevation of the water table, or the physical, chemical, biological, or radiological properties of groundwater at the water table or both.

(59) "Well" means any drillhole or other excavation or opening in the ground constructed for the purpose of obtaining or monitoring groundwater.

(60) "Well point" means a screening device, equipped with a point at one end, that is meant to be driven into the ground; it may be used for water quality monitoring.

(61) "Well depth" means the distance from the land surface to the bottom of the well screen or drillhole.

(62) "Well screen" means a filtering device used to retain the primary or natural filter pa& usually a cylindrical pipe with openings of a uniform width, orientation, and spacing

(63) "Well volume" means the volume of water standing in the well casing.

(64) "Zone of saturation" means a hydrologic zone in which all the interstices between particles of geologic material or all of the joints, fractures, or solution channels in a consolidated rock unit are filled with water at pressure greater than that of the atmosphere.

Appendix H
USARAK Procedures

U.S. Army Alaska Institutional Controls

Standard Operating Procedure

1. References:

a. AR 200-1, Environmental Protection and Enhancement
b. AR 200-2, Army Institutional Control Program Enforcement
c. USARAK Regulation 200-1 Pamphlet, Hazardous Materials and Regulated Waste Management
d. AR 210-20, Army Installation Master Planning
e. 40 CFR 300, National Oil and Hazardous Substances Pollution Contingency Plan.
f. 42 USC 1901 *et seq.,* Comprehensive Environmental Response, Compensation, and Liability Act of 1980, as Amended by the Superfund Amendments and Reauthorization Act of 1986.
g. Federal Facility Agreements for Forts Richardson and Wainwright
h. Defense-State Memorandum of Agreement.
I. Operable Unit Records of Decision (ROD) and/or other decision documents as appropriate.

2. Purpose. This Standard Operating Procedure establishes the responsibilities, policies and procedures for complying with Department of Defense (DOD), Department of the Army (DA), and US Army Alaska (USARAK) Regulations as well as Federal and State Laws for instituting, maintaining, and enforcing Institutional Controls (IC) on Federal Facilities. These controls have been established to implement the selected remedial actions agreed upon by the U.S. Army (Army), the U.S. Environmental Protection Agency (EPA), and the Alaska Department of Environmental Conservation (ADEC) in accordance with the Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA) as amended by the Superfund Amendment Reauthorization Act (SARA). The details of these agreements may be found in the Decision Documents (DD) and Records of Decision (RODs) which are maintained in the Public Works, Environmental Offices. These agreements have been executed in accordance with the authority cited in Section 1.

Institutional Controls are a legal or administrative action designed to minimize the risk of exposure to contaminates at a source area where contamination has been left in the soil or groundwater. Institutional controls such as water use and property transfer restrictions will supplement engineering controls as appropriate for short- and long-term management to prevent or limit exposure to hazardous substances, pollutants, or contaminants. Typical controls are:

- Installation and maintenance of signs or fences to restrict access to an area;
- Designation of contaminated areas on the Installation Master Plan for distribution to affected units and tenant organizations;

- Periodic publication and distribution of fact sheets identifying the areas of concern;

- Provide all contract agencies with construction, excavation and well installation restrictions.

These controls have been established to prohibit or limit access to or use of the land, surface water, and ground water and are applicable to all known or suspected contaminated sites. The following are examples of the restrictions agreed upon in the RODs:

- Land use restrictions prohibit or limit the construction or renovation of new or existing facilities to include residential area new construction, road repair and realignment, utility work, digging, trenching, excavation, paving, or drilling of soil borings and wells.

- Recreational use of natural resources i.e.. camping, fishing, hunting, etc., and training activities (i.e., bivouac, combat maneuvers, land navigation, construction of fighting positions, etc.) can be prohibited or limited depending on the type of contaminant present.

- Surface water restrictions prohibit ingestion of the water or consumption of fish, or other animal that directly uses a surface water source as a habitat or food source.

- Groundwater restrictions prohibit the drilling of water wells for potable water, fire suppression, irrigation or other purposes.

These restrictions remain in place until EPA, ADEC, and the Army mutually decide the contamination has been reduced, through cleanup activities or natural attenuation, to levels protective of human health and the environment. In making their decision. EPA, ADEC, and the Army will look at levels specified in the ROD or other decision document. If no decision document exists, EPA, ADEC1 and the Army will look at maximum contaminant levels (MCLs) for potable groundwater or risk-based concentrations for soil, sediment, surface water and other uses of groundwater.

3. Scope: These Standing Operating Procedures apply to all USARAK units and activities. Military and Civilian Support Activities, Tenant Organizations and agencies, and Government and Civilian Contractors that occupy, use, build, repair or maintain facilities on USARAK controlled lands.

4. Responsibilities:

a. The Installation Commander or his designee shall approve all Decision Documents and Records of Decision regarding remedial actions and Institutional Controls on USARAK controlled lands. Installation Commander shall also require compliance with these Decision Documents and Records of Decision.

b. Directorate of Public Works shall execute all aspects of the Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA) in accordance with the Defense

Environmental Restoration Program as agreed upon in the Federal Facility Agreements and the Defense-State Memorandum of Agreement. Public Works shall also:

(1) Establish, maintain, and routinely update complete records of all known or suspected sites, restoration actions and institutional controls;

(2) Document all actions and institutional controls in the Installation Master Plan, Base Maps, and Fact Sheets and distribute to affected units, organizations, and tenants at the point they are affected on annual basis.

(3) Ensure that all affected tenants and organizations are informed of:

(a) Known soil and ground water contamination in their areas of operation;

(b) Institutional controls associated with remedial activities;

(c) Potential human health risks and environmental impacts associated with violating the controls;

(d) Potential fines, penalties, and criminal implications resulting from violations of the institutional controls.

(4) Provide oversight and review of all Excavation Clearance Requests to ensure that all activities that involve disturbance of soil or use of groundwater comply with current environmental laws.

(5) Ensure all affected, contracting mechanisms i.e., job order contract, military construction, in-house projects, etc., are modified to include the appropriate environmental information to prevent a violation of Institutional Controls and the potential fines, penalties, and criminal implications resulting from violations of the institutional controls.

USARAK Form 81-E (Excavation Clearance Request) must be appropriately annotated by DPW-Environmental to prevent the undertaking of work inconsistent with established institutional controls at a particular site. If a dispute with a subordinate activity or tenant arises due to DPW-Environmental non-concurrence on Form 81-E with proposed site work because of the potential for an institutional controls violation, the Commander's Policy Memorandum on Institutional Controls shall provide the basis for final resolution.

c. Directorate of Logistics shall determine the necessary protocols and language to be incorporated into their contract mechanisms to inform potential contractors of the environmental status of USARAK Installations regarding contamination. Such language or protocols will emphasize:

(1) The need for contractors to coordinate with USARAK environmental personnel prior to conducting any soil disturbing activities anywhere on USARAK controlled lands, and;

(2) Potential fines, penalties, and criminal implications resulting from violations of the institutional controls.

d. Directorate of Contracting shall determine the necessary protocols and language to be incorporated into their contract mechanisms to inform potential contractors of the environmental status of USARAK Installations regarding contamination. Such language or protocols will emphasize:

(1) The need for contractors to coordinate with environmental personnel prior to conducting any soil disturbing activities or gaining access to fenced or restricted areas associated with institutional controls anywhere on USARAK controlled lands, and;

(2) Potential fines, penalties, and criminal implications resulting from violations of the institutional controls.

e. Directorate of Plans, Training, Security, and Mobilization (DPTSM) shall:

(1) Provide all troop units utilizing the training areas information regarding known and potential sources of contamination in the training areas;

(2) Provide information regarding Institutional Controls and the potential fines, penalties, and criminal implications resulting from violations of the institutional controls;

(3) Provide (through DPW Environmental) maps and related information regarding USARAK sites with institutional controls;

(4) Attend Institutional Controls status update meetings as required by the Installation Commander.

f. U.S. Army Corps of Engineers, Alaska District shall ensure that all contract mechanisms incorporate a complete section that provides a detailed explanation of the following information:

(1) The environmental status of the installation in question and the existence of institutional controls and the potential fines, penalties, and criminal implications resulting from violations of the institutional controls,

(2) The requirements for obtaining work clearance request prior to performing any type of excavation, trenching, or disturbance of soil,

(3) The notification requirements for reporting spills, previously unknown soil or ground water contamination, and;

(4) How to dispose of hazardous and non-hazardous wastes, contaminated soil and ground water, etc., from USARAK controlled lands.

g. All DOD Personnel responsible for initiating DA Form 4283, Work Request, are required to become familiar with the institutional controls within the immediate work area.

h. Civilian Tenant Organizations shall coordinate all work involving the disturbance of soil or installation of a well anywhere on USARAK-controlled lands with the Directorate of Public Works and obtain proper authorization prior to the commencement of work.

i. Defense Reutilization Management Office shall dispose of all investigation derived waste (IDW) in accordance with the appropriate laws and regulations.

5. The following procedures are applicable to all personnel working in areas where institutional controls are in place:

a. If soil or groundwater must be removed from the work site, it shall be:

(1) Containerized in United Nations approved, Performance Oriented Packaging (UN/POP) containers as specified in 49 CFR 178.500, Specifications and Maintenance of Packaging;

(2) Labeled as non-regulated waste, sampled and analyzed for potential contamination, and;

(3) Moved to an approved storage area pending analytical results. The area shall be approved by the Public Works Environmental Office prior to usage.

NOTE: Soil and groundwater shall not be removed from any part of the installation without written authorization from an authorized USARAK representative. All operations involving hazardous waste will be accomplished in accordance with USARAK Regulation 200-1 Pamphlet, *Hazardous Material and Regulated Waste Management.*

b. If contaminated soils, drums, unexploded ordnance or unusual, potentially hazardous debris are found on or around any work site, the agency shall stop work immediately and notify the Installation's Public Works Environmental Office (and Range Control Officer if unexploded ordnance is involved). Work at this site will be suspended until the area is cleared by the Environmental Office (Range Control if unexploded ordnance is involved).

DEPARTMENT OF THE ARMY
HEADQUARTERS, U.S. ARMY ALASKA
600 RICHARDSON DRIVE #5000
FORT RICHARDSON, ALASKA 99505-5000

REPLYTO
ATTENTION OF:

APVR-RPW-EV (200-1c)

MEMORANDUM FOR SEE DISTRIBUTION

SUBJECT: Institutional Controls

1. All organizations conducting activities on United States Army Alaska (USARAK) controlled land are responsible for complying with established Institutional Controls. Institutional controls are administrative, procedural, and regulatory measures to control human access to and usage of property. They are applicable to all known or suspected contaminated sites where contamination has been left in place.

2. These controls have been established to implement the selected remedial actions agreed upon by the U.S. Army (Army), the U.S. Environmental Protection Agency (USEPA), and the Alaska Department of Environmental Conservation (ADEC) in accordance with the Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA) as amended by the Superfund Amendment Reauthorization Act (SARA). These controls also apply to remedial actions agreed upon under Two-Party Compliance Agreements. These agreements are concluded between USARAK and ADEC and apply to petroleum/oil/lubricants- (POL) contaminated sites.

3. Institutional controls such as limitations on access, water use, excavations, and property transfers will supplement engineering controls as appropriate for short-term and long-term management to prevent or limit human and environmental exposure to hazardous substances, pollutants, or contaminants. Specific institutional controls include, among other things: limitations on the depth and location of excavations, prohibition of or restrictions on well drilling and use of ground water, requirements for worker use of personal protective equipment, site monitoring, and prohibition of certain land uses, types of vehicles, etc.

4. Organizational units, tenants, and support/contractor organizations must obtain an Excavation Clearance Request (ECR) (see enclosure) for all soil disturbing activities impacting soils six inches or more below the ground surface. The review process for approval of an ECR begins with the identification of the current status (known or suspected hazardous waste site or “clean” site) of a work location. ECR’s for work in known or suspected hazardous waste sites:

a. will include specific limitations and controls on such work;

b. will include specific institutional control procedures, and notification, monitoring, reporting, and stop work requirements;

c. may include procedures for management, characterization, and disposal of any soil or groundwater encountered or removed;

d. will identify “project managers” for both the unit/contractor requesting the work and DPW Environment Resources.

5. The DPW project manager will conduct on-site inspections of each work site (at which institutional controls apply) to determine continued compliance with the terms and conditions of

the approved ECR. DPW has the authority to revoke ECR approval if the specified terms and conditions are not being met. ECR forms are available at the Customer Service Desks at:

a. Building 730 at Fort Richardson;

b. Building 3015 at Fort Wainwright;

c. Building 605 at Fort Greely.

6. USARAK has negotiated (with USEPA and/or ADEC) decision documents and/or Records of Decision (RODs) that mandate the implementation of institutional controls. USARAK Directorate of Public Works, Environmental Resources Department (PWE), maintains copies of all decision documents and RODs requiring institutional controls in its real property files. PWE provides regularly updated post maps showing all areas affected by institutional controls. These maps can easily be accessed by using an approved intranet mapping interface application. Copies of these maps will be available to each directorate, activity, and tenant organization. To ensure the effectiveness of institutional controls, all organizational units and tenant activities will be informed on an annual basis of institutional controls on contaminated soils and groundwater in effect near their facilities.

7. Institutional controls are enforceable by the U.S. Environmental Protection Agency (USEPA) and the Alaska Department of Environmental Conservation (ADEC). Failure to comply with an institutional control mandated in a decision document or ROD will violate the USARAK Federal Facility Agreement and may result in stipulated fines and penalties. This does not include the costs of corrective actions required due to violation of an established institutional control.

8. Where institutional controls are applicable to any organization, tenant, or activity, land use restrictions shall be incorporated into either a lease or memorandum of agreement, as appropriate. Costs for any and all remedial actions and fines and/or stipulated penalties levied as a result of a violation of an established institutional control shall be funded by the violating activity or organization.

Encl
Excavation Clearance Request

JAMES J. LOVELACE
Major General, USA
Commanding

DISTRIBUTION:
A

8.0 PACKAGING

This section describes selecting, reusing, filling, and managing hazardous materials/regulated waste containers.

Selecting a Suitable Container

A variety of containers, from 1-gallon to 110-gallon overpack drums, boxes, plastic totes, and bags, may be used to package hazardous materials/regulated waste.

Choice of container depends on the:

- Type of waste material
- Quantity of waste

For storing hazardous materials/regulated waste, containers must be:

a. **In good condition.** The container must not be leaking, rusted (i.e., more than minor surface rust), corroded, dented more than 2 inches, or have non-working filler caps/bungs and/or other sealing devices, any bulges, grooves (other than removed metal), dents in seams/corrugations, or be deteriorated in any other way. If a container leaks or is not in good condition, the contents must be transferred to another container that meets all standards, or be placed in an overpack. Any overpack must be filled with absorbent capable of soaking up liquid, as a precaution against leaks within the overpack.

b. **Made of a compatible material.** The container must be made of a material that will not react or deteriorate when in contact with the material or waste. For example, acids, such as battery acid, cannot be placed in a steel drum because acid will corrode the drum and cause it to leak.

c. **Securely closed.** All containers used to store hazardous materials/regulated waste (except trash) must have a cover or lid and must close and seal tightly enough to prevent spills, including release of fumes. Storing wastes in open buckets is not allowed. Containers must be tightly closed (more than finger tight) after every use. Special funnels that are designed not to leak if the container is overturned, and not to allow fumes to escape, are required if the funnel remains attached to the waste container. Open-head containers must not be used for any liquids, unless pre-approved by PWE.

d. **In compliance with DOT requirements.** All containers used to store hazardous materials or regulated waste on post must meet DOT-specified packaging requirements (Performance-Oriented Packaging). If a package has the symbol shown below on it, it is a DOT-approved package.

u
n

Followed by a series of numbers or letters

If in doubt about the suitability of any hazardous materials or regulated waste container, call PWE.

Drums that are 85-gallons or larger are overpack containers for leaking drums, and are not for general use.

Reusing Containers

Empty containers can be reused for storing waste, provided the material remaining in the

container:

a. **Is compatible with the new waste material.** For example, used oil can be placed in a drum previously used for diesel fuel. However, it cannot be placed in a drum that previously contained sodium hydroxide or hydrochloric acid (see Section 7 for information on chemical compatabilities).

b. **Will not contaminate the waste.** For example, solvents will contaminate used oil such that it cannot be burned for energy recovery.

Disposal of empty containers is discussed in Section 5.

Filling Containers

The key steps in filling containers are:

a. **Follow proper personal safety measures.** Always use proper PPE and safety equipment. This information is provided in the site-specific SOPs and MSDSs.

b. **Do not overfill containers.** Allow sufficient headspace for expansion of contents. Generally, a container is considered full when it is 97% filled (e.g., 3 to 4 inches from the top of a 55-gallon drum; 1 to 2 inches from the top of a 5-gallon container; 1-inch from the top of a 1-gallon can). The maximum allowable weight for an open-top drum is 400 kilograms (800 pounds).

c. **Avoid spills.** When filling containers with liquids, be careful to avoid spills. Place absorbent materials around or under a container prior to filling. Use funnels to transfer liquids. Watch the liquid level in the container carefully and do not leave containers unattended when filling (i.e., do not start a transfer pump and then leave the area).

d. **Clean up any spills immediately.** If spillage occurs, the spilled material must be cleaned up immediately and packaged for disposal (see Section 16 for spill information).

Managing Containers

All containers must be immediately marked and labeled (see Section 10) and placed in an approved storage area (see Section 9), where they must remain until pick-up for disposal.

10.0 LABELING and Marking

Hazardous materials and regulated waste ***must be properly labeled and correctly marked at all times. This is necessary so that everyone who works with these materials is aware of hazards and the need for managing hazardous materials and regulated waste in a safe manner to prevent harm to people or damage to property or the environment.***

In this section, the following definitions apply:

Labeling: Refers to the addition of prepared, printed, usually self-adhesive, tags, stickers, placards, or tickets to containers or packages. Includes all such hazard class or descriptive labels required by DOT (49 CFR 171-180) and EPA (40 CFR 260-299) regulations and others such as "bar code labels," etc.

Marking: Refers to the addition of descriptive names, document/requisition numbers, contract line item numbers, gross/net weight numbers, hazardous waste generator unit/activity contact names and phone numbers, descriptive remarks, special instructions, addresses, building number, unit name/number, and similar types of information usually applied by hand using paint, indelible markers, stencils, and so forth. Marking is usually performed onsite by the responsible unit hazardous waste contact persons.

Labeling and Marking Hazardous Materials in Use

All manufacturers' labeling must be kept on hazardous materials. Small amounts of hazardous materials transferred to another container must be marked with the product name and hazard identifiers ("flammable," "corrosive," etc., as appropriate).

Labeling and Marking Regulated Wastes in Storage and for Turn-In

Each waste in temporary storage will fall into one of the following categories:

- *Hazardous waste*
- *Hazardous waste pending analytical results*
- *Non-hazardous waste for energy recovery or recycling*
- *Universal waste*
- *Non-hazardous waste*

Section 5 provides a list of common wastes and classifies each one according to one of these categories: Hazardous Waste, Non-Hazardous Waste for Energy Recovery, Universal Waste, or Non-Hazardous Waste.

In rare instances, a container of unknown, unlabeled, unmarked, and unwanted material (see Section 5.45) must be characterized and disposed. Contact PWE to arrange proper waste characterization. Prior to receiving test results, this waste falls into the category "Hazardous Waste Pending Analytical Results."

Figure 10-1 illustrates container labeling and marking requirements. Regulated waste ***must*** have:

- One of the following completed labels:
  - **HAZARDOUS WASTE**
  - **HAZARDOUS WASTE PENDING ANALYTICAL RESULTS**
  - **NON-HAZARDOUS WASTE FOR ENERGY RECOVERY OR RECYCLING**
  - **UNIVERSAL WASTE**
  - **NON-HAZARDOUS WASTE**
- DOT flammable label (Figure 10-2), if it is a flammable liquid
- Bar code
- Package orientation label (Figure 10-3) (i.e., arrows showing "up" direction)
- Appropriate container markings as specified in Figure 10-1 or in unit SOP.

All information shown on Figure 10-1 must be completed as soon as one drop of waste is added to the container. There is only one exception: the start date on a container in an SAA is completed when the last drop of waste is added to the container, or when the container is prepared for transport out of the SAA.

Figure 0-1
Container Labeling

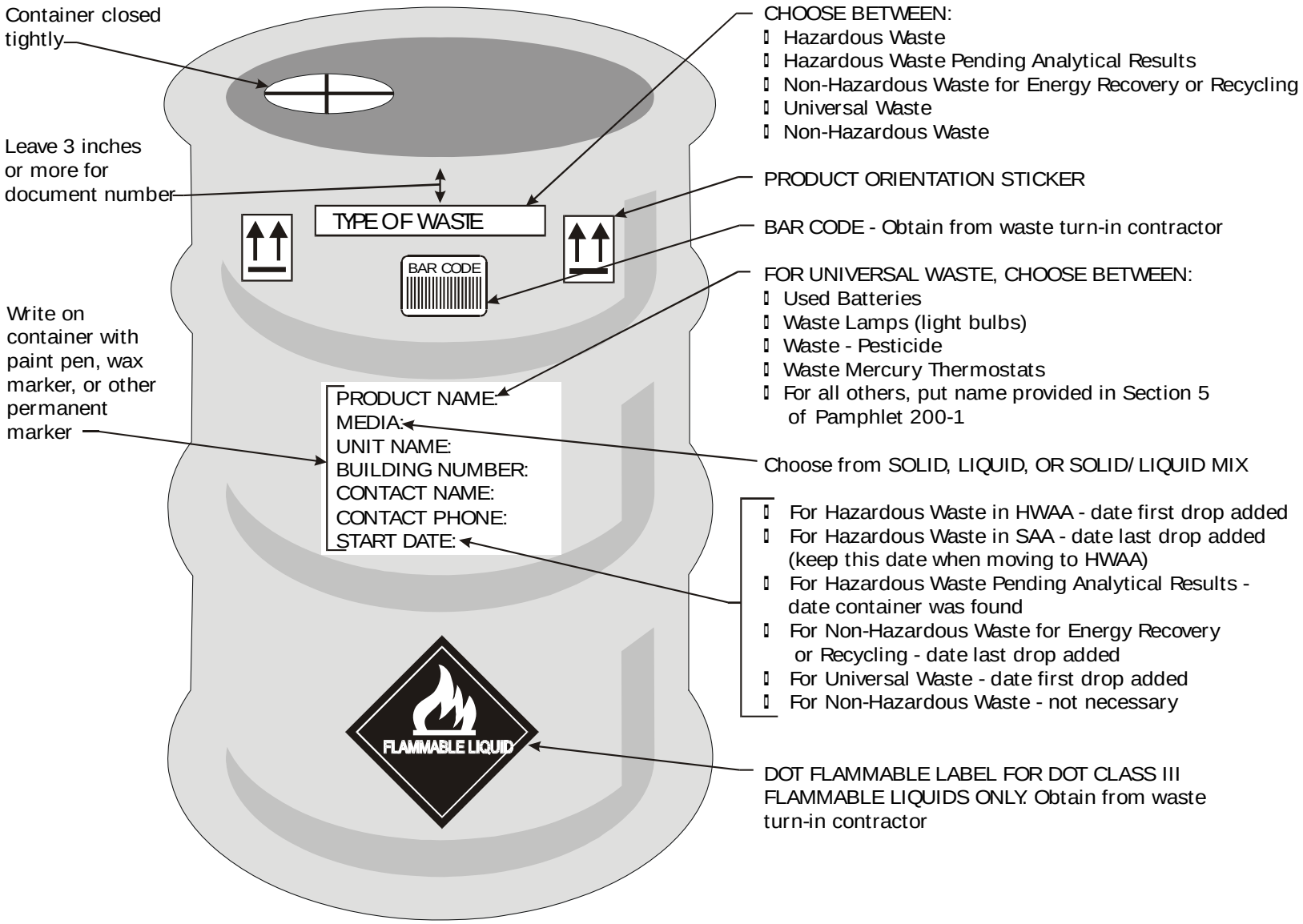
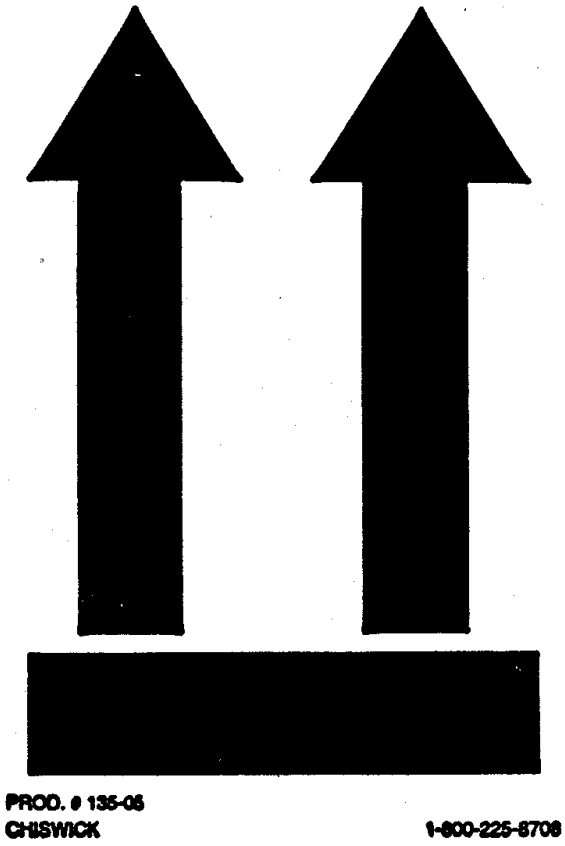


Figure 0-2
DOT Flammable Label

Figure 0-3
Package Orientation Label



HANDLING/MANAGEMENT OF CONTAMINATED SOIL

1. During excavation at construction sites, soil needs to be screened for potential contamination (petroleum, unless other contaminants have been identified). The trigger for field screening is 20ppm. The government PM and Environmental office need to be notified when this occurs. It is not intended for the project to remediate a site. If the planned limits of excavation are reached and contamination is still present, the government PM, Environmental office and ADEC will determine next course of action.

2. Excavated soil needs to be segregated into three stockpiles:

a. Less than 20ppm: This soil can be assumed clean and be reused on site or transported to the FWA landfill, or other designated on-Post location. There is no need for special handling.

b. 20ppm to 99ppm: This soil is assumed contaminated. It will need to be stored in an ADEC approved temporary soil containment cell and tested through an approved lab (IAW 18 AAC 78 and 75). Although assumed contaminated, this soil stands a good chance of being able to be reused or taken to the landfill without remediation.

c. 100ppm and over: This soil is assumed contaminated. It will need to be stored in an ADEC approved temporary soil containment cell and tested through an approved lab (IAW 18 AAC 78 and 75).

3. Containment cells for soils assumed contaminated should be placed within the construction site, if at all possible. Soil cells will need to be managed (cover must be maintained to control dust and prevent water infiltration) until receipt of lab analysis.

4. Upon receipt of lab analysis, soil will/can be moved:

a. Uncontaminated Soil: Soil that is not contaminated, or within limits for the FWA landfill, will be moved by the contractor. These soils will be reused, transported to alternate soil storage area, or to the FWA landfill as appropriate.

b. Contaminated Soil: Soil that is considered contaminated beyond limits acceptable for the FWA landfill will be disposed of by the Environmental office. A remediation contractor will pickup the contaminated soil and cell, thermally treat it, and return it to the FWA landfill or an alternate site.

5. Sampling and Analysis:

a. Sampling and lab analysis is the responsibility of the contractor. Unless other contaminants are known to be present, testing should be done for GRO, DRO, RRO

and BTEX. (For a new spill site, the test should be appropriate to the substance spilled)

b. Generally, one sample is acceptable from the stockpile. The pile should be screened and the sample taken from the site of the highest reading.

c. Sampling from the excavation should conform to numbers required by 18 AAC 78 and 75.

d. The number and type of samples is subject to approval by ADEC, and may deviate from guidance given here and in 18 AAC 78 and 75.

FORT WAINWRIGHT LANDFILL

PROHIBITIONS AND SPECIAL RESTRICTIONS

A. Scavenging and Salvaging is prohibited.
B. Disposal of hazardous wastes, as defined by 40 CFR part 261 is prohibited. Ensure waste meeting this definition is disposed of in accordance with 40 CFR Part 262, Standards Applicable to Generators of Hazardous Waste.
C. Disposal of raw sewage, liquids, radioactive material, explosives, oil, solvents, strong acids, untreated sewage sludge, septage, untreated pathogenic, and other waste defined under 18AAC 60.910(28) is prohibited at this facility.
D. Disposal of lead-acid vehicle batteries is prohibited.
E. Disposal of polluted soil as defined by 18 AAC 60.025 & 330 is prohibited.
F. Disposal of trash other than ***construction debris*** is prohibited. PPE is also prohibited.
G. Drums must be empty and cleaned of fluids prior to crushing. All drums must be crushed and flattened prior to disposal.
H. Ensure that if scrap vehicles are accepted at the landfill, they are drained of all oil and petroleum products and lead-acid batteries removed prior to disposal.
I. Former is invalid FWA does not accept MSW.
J. Disposal of asbestos waste is allowed in accordance with the following requirements; submit to the landfill operator a completed asbestos manifest form with each load of ACM. ACM will be properly contained in leak-tight containers and labeled. Labeling will include description of contents, ACM source location (building number or utilidor location), and the contractor's name and contract number for identification purposes.

Containers may be barrels, drums, or six-mil or thicker plastic bags. The ACM waste will be placed in approved locations only as directed by the landfill operator. All containers will have warning labels attached that state:

CAUTION
CONTAINS ASBESTOS
AVOID OPENING OR BREAKING CONTAINER
BREATHING ASBESTOS IS HAZARDOUS TO YOUR HEALTH

OR

CAUTION
CONTAINS ASBESTOS
AVOID OPENING OR BREAKING CONTAINER
BREATHING ASBESTOS DUST
MAY CAUSE SERIOUS BODILY HARM

K. Questions concerning disposal of solid waste at the Ft Wainwright Landfill can be addressed to the Ft Wainwright Environmental Office at 353-6249.
L. Authorization Cards need to be obtained from the Ft Wainwright Environmental Office, building 3023 phone 353-6249.

APVR-WPW-0 March 23, 2000

MEMORANDUM FOR: DPW Engineering Division

SUBJECT: Operational Changes at Fort Wainwright Landfill

The Fort Wainwright Landfill will no longer accept mixed municipal solid waste after Friday, March 31, 2000.

Contractors will be allowed limited access for disposal of items listed below subject to the conditions listed:

Construction Debris:

- Access must be coordinated at least one day in advance with DPW Grounds Maintenance Shop at 353-7192.
- Contents of the load must be construction materials only with no mixed garbage such as food containers or other household type refuse. Mixed loads will be refused.

Asbestos:

- Loads must be properly documented.
- Access must be coordinated at least one day in advance with DPW Grounds Maintenance Shop at 353-7192.
- Delivery time must be coordinated and must be early enough in the day to allow the operator to cover the material before the end of the day.

The landfill will be open by appointment only during the following hours (excluding federal holidays): Monday – Thursday 0800 to 1600 hours and Friday 0800 to 1500 hours.

A landfill card form DPW Environmental Division will be required for each contractor.

Load sheets will be required for each load at the landfill gate per current practice.

1.8.1 Landfill Cover Requirements

All construction and asbestos containing material (ACM) debris placed in the landfill by the Contractor's operations shall be covered daily. The Contractor shall provide all plant, labor, material, equipment and supervision necessary to cover all construction and ACM debris deposited in the landfill generated by this projects' construction operations. The Contractor shall be responsible for providing cover in accordance with the requirements listed below and in accordance with all local, state and federal regulations. This work is considered incidental to the project requirements and no separate payment will be made for this work.

1.8.1.1 Cover Layer Requirements

a. The material used to cover the construction debris and ACM cells shall be obtained from an approved source(s). See additional requirements listed in paragraph 1.8.1.2 below.

b. Material shall be spread in sufficient quantity and loose thickness to ensure that when compactive effort is applied that the cover material will consolidate easily and uniformly, and that all debris is covered. Loose cover material shall be spread in such a manner in a thickness so as to preclude damage to bagged ACM. Exposed debris or bagged ACM will not be allowed.

c. The maximum compacted thickness shall be 300 mm.

d. Compactive effort shall be applied uniformly across the entire surface employing equipment of a type specifically designed for use in this type of environment. Required compactive effort shall be equivalent to 3-passes of a D-6 dozer or heavier piece of equipment over the entire surface to be covered.

1.8.1.2 Cover Material Source

At the option of the Contractor, suitable cover material may be provided from a source outside of Fort Wainwright or from the material pit located on Old Badger Road.

If the Contractor elects to provide cover material from an outside source, the Contracting Officer prior to the start of any construction or demolition operations shall approve that source.

Should the Contractor elect to use the Old Badger Road material pit, the Contractor is advised that at least one other Contractor will be obtaining material from this site. It shall be the responsibility of the Contractor to coordinate his operations with that of the other Contractor(s).

Under either circumstance, the Contractor shall provide all plant, labor, equipment and supervision necessary for the acquisition, transport and off-loading of the cover material at the landfill.

1.8.1.3 On-site Equipment Storage

Storage of equipment associated with this effort may be stored within the boundary of the landfill. It is the Contractors' responsibility to safeguards against unauthorized access to the equipment during non-duty hours.

1.8.1.4 Environmental Protection

The Contractor shall provide the necessary safeguards for the prevention of POL spills, containment and cleanup, and for dust suppression.

CONSTRUCTION & DEMOLITION (C&D) DEBRIS DEFINITION

C&D debris is defined as those materials resulting from the alteration, construction, destruction, rehabilitation or repair of any manmade physical structure or surrounding site. Materials that can be disposed at the Fort Wainwright landfill are:

lumber to include light weight steel building studs
drywall
brick & concrete
metals
plaster
windows
roofing materials
plumbing fixtures
electrical wiring
heating equipment
asphalt
insulation
carpeting
human waste *(bagged and returned from field exercises)*
asbestos *(in it's own segregated cell - disposal is IAW State & Federal laws)*

.

The Fort Wainwright landfill **cannot** accept

regular household waste
hazardous waste/materials (except asbestos)
tires
light bulbs, tubes or PCB light ballasts
∗mattresses
∗excess/unserviceable TA-50, vehicle components, etc.
∗wall lockers/bed frames
∗desks
∗ refrigerators and white metals

∗ **Turned into the local DRMO for reuse or sale**

Final

Site Safety and Health Plan

FWA 102 Former Communications Site
Fort Wainwright, Alaska

Prepared for

Department of the Army
U.S. Army Corps of Engineers,
Alaska District

P.O. Box 6898
Elmendorf AFB, Alaska 99506-6898

Contract No. W911KB-05-D-0010
Task Order 0009

July 2007

CH2MHILL
301 W. Northern Lights Boulevard, Suite 601
Anchorage, AK 99503

CH2M HILL Health and Safety Plan

This Health and Safety Plan (HSP) will be kept onsite during field activities and will be reviewed as necessary. The plan will be amended or revised as project activities or conditions change or when supplemental information becomes available. The plan adopts, by reference, the *Standards of Practice* (SOPs) in the CH2M HILL *Corporate Health and Safety Program, Program and Training Manual*, as appropriate. In addition, this plan adopts procedures in the project Work Plan. The Safety Coordinator—Haz Waste (SC-HW) is to be familiar with these SOPs and the contents of this plan. CH2M HILL's personnel and subcontractors must sign Attachment 1, "Employee Signoff Form—Field Safety Instructions."

Abbreviations and Acronyms

A	air
JHA	Job Hazard Analysis
BBLPS	Behavior-Based Loss Prevention System
CA	potential occupational carcinogen
CPR	cardiopulmonary resuscitation
CRREL	Cold Region Research and Engineering Laboratory
DMM	discarded military munition
DOT	Department of Transportation
DPW	Department of Public Works
D	drum
EOD	explosive ordnance disposal
FCS	former communication site
FW	Fort Wainwright
FSI	Field Safety Instructions
GFCI	ground fault circuit interrupter
GW	groundwater
HR	heart rate
H&S	health and safety
HSM	Health and Safety Manager
HSP	Health and Safety Plan
IDLH	immediately dangerous to life and health
IDW	investigation-derived waste
kV	kilovolt
L	lagoon
MC	munitions constituent
MEC	munitions and explosives of concern
MSDS	material safety data sheet
NA	not applicable

NL	no limit
OSHA	Occupational Safety and Health Administration
PCB	polychlorinated biphenyl
PEL	permissible exposure limit
PIP	photoionization potential
PPE	personal protective equipment
PTSP	Pre-Task Safety Plan
S	surface soil
SB	soil boring
SC-HW	Safety Coordinator—Haz Waste
SL	sludge
SOP	Standard of Practice
SVOC	semivolatile organic compound
SW	surface water
TK	tank
TLV	threshold limit value
UK	unknown
USACE	U.S. Army Corps of Engineers
UXO	unexploded ordnance
VOC	volatile organic compound

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SECTION 1

Project Information and Description

PROJECT NO: 357465

CLIENT: U.S. Army Corps of Engineers

PROJECT/SITE NAME: Remedial Investigation, FWA-102 Former Communication Site (FCS)

SITE ADDRESS: Fort Wainwright, Alaska

CH2M HILL PROJECT MANAGER: Cory Hinds/ANC

DATE HEALTH AND SAFETY PLAN REVISED: May 2007, revised July 2007

DATE(S) OF SITE WORK: May 2007 through December 31, 2008

SITE ACCESS: Notify client before fieldwork; acquire any necessary base passes.

SITE TOPOGRAPHY: Level ground, unpaved

PREVAILING WEATHER: Wet summers, and extremely cold winters

SITE DESCRIPTION AND HISTORY:

The FCS is currently the site of Taku Gardens, a subdivision that includes 110 new, presently unoccupied residences intended to house Fort Wainwright personnel. Although the recent transfer of members of the 172nd Stryker Brigade to Fort Wainwright has created a pressing need to use this new housing, potential risk from the prior site uses to human health and the environment must first be addressed.

Little written documentation exists that describes activities specifically occurring at the FCS over the course of its use. As a result, much of what is known about the area has been surmised from examining and comparing historical photographs (dating from 1947 to the present), the 1958 post "Master Plans," past geographical surveys, and concurrent military operations at other locations. The results of this historical research indicate there was evidence of varied uses in the area, including the following:

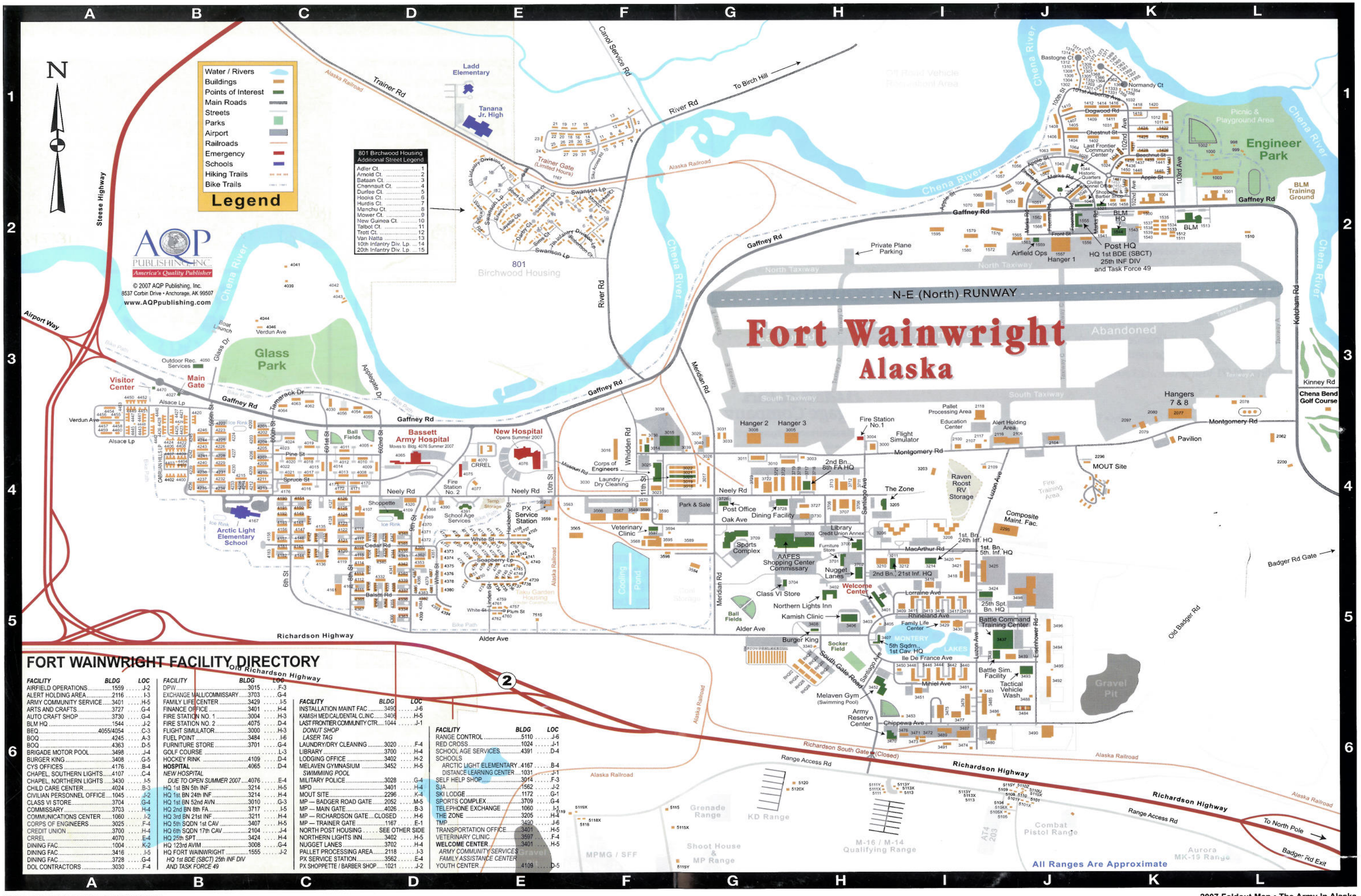
- A salvage/reclamation yard occupying much of the FCS
- Disposal of debris/salvage material in the dry Chena River oxbow that extends through the site, in trenches in the salvage yard area, and possibly in other local depressions
- Garden plots
- Possible fire fighting training activities (as evidenced by potential circular fire pits and a partially dismembered aircraft)
- Barracks and company headquarters extending into the northwest corner of the site
- Ammunition storage
- Communications and radar systems

When site clearing commenced for the housing area in 2003, onsite personnel began encountering metal debris on the ground surface; this resulted in the first geotechnical investigations. During the construction of Taku Gardens, contractors discovered additional metal debris, munitions (and munitions-related materials), fuel, and polychlorinated biphenyl (PCB) contamination, which resulted in further investigation into historic past uses of the area and limiting site access to authorized personnel. One area where PCBs have been detected at high concentrations has been made an exclusion zone with additional access restrictions. The housing development covers approximately 54 acres; however, the contamination associated with past uses of the FCS may expand beyond the boundaries of this area.

The Table 1-1 summarizes the activities and investigations conducted at the FCS to date.

TABLE 1-1
Activities and Investigations Conducted at the Former Communication Site (FCS) to Date

Date	Activity/Investigation	Responsible Party
October 2003	Limited geotechnical Investigation including geophysical investigation and soil boring/soil sample collection	Cold Regions Research and Engineering Laboratory (CRREL) and Shannon and Wilson
November 2003-February 2004	Geotechnical investigation including collection of geological and chemical data from soil borings	U.S. Army Corps of Engineers (USACE)
March 2004-April 2004	Subsurface soil sampling in suspected PCB-contaminated area. Results did not confirm previous detections.	North Wind
March 2004-2006	Explosive ordinance device (EOD) reports filed when suspected EOD was detected during excavation or removal actions	Military ordinance experts
May 2004	Geophysical investigation to detect buried debris and construction waste from former site activities	R&M
2004	Site clearing activities removed some detected buried metal debris that was located in proposed housing locations	Fort Wainwright (FW) Department of Public Works (DPW)
April 2005	Construction of 64 military housing units making up Taku Garden commenced. During construction, debris that impacted housing foundations or roads was removed by the contractor.	Watterson Construction Company
June-October 2005	Site Investigation activities—including investigation of soil and groundwater for fuels and PCBs in targeted areas. Surface wipe sampling also conducted for PCBs to evaluate the potential presence of contaminated dust.	North Wind
September 2005	FW DPW transports 230 cubic yards of PCB-impacted soil from original location of Bldg. 52 to offsite-approved facility for disposal."	North Wind
2006	Field activities in support of the Preliminary Source Evaluation II including soil, soil vapor, geophysical, and debris investigations for PCBs, volatile organic compounds (VOCs), semivolatile organic compounds (SVOCs), petroleum products, pesticides, metals, anions, explosives, perchlorate, and dioxins/dibenzofurans.	North Wind



FORT WAINWRIGHT FACILITY DIRECTORY

FACILITY	BLDG	LOC
AIRFIELD OPERATIONS	1559	J-2
ALERT HOLDING AREA	2116	I-3
ARMY COMMUNITY SERVICE	3401	H-5
ARTS AND CRAFTS	3727	G-4
AUTO CRAFT SHOP	3730	G-4
BLM HQ	1544	J-2
BEQ	4055/4054	C-3
BOQ	4245	A-3
BOQ	4363	D-5
BRIGADE MOTOR POOL	3498	J-4
BURGER KING	3408	G-5
CYS OFFICES	4176	B-4
CHAPEL, SOUTHERN LIGHTS	4107	C-4
CHAPEL, NORTHERN LIGHTS	3430	I-5
CHILD CARE CENTER	4024	B-3
CIVILIAN PERSONNEL OFFICE	1045	J-2
CLASS VI STORE	3704	G-4
COMMISSARY	3703	H-4
COMMUNICATIONS CENTER	1060	I-2
CORPS OF ENGINEERS	3025	F-4
CREDIT UNION	3700	H-4
CRREL	4070	E-4
DINING FAC	1004	K-2
DINING FAC	3416	I-5
DINING FAC	3728	G-4
DOL CONTRACTORS	3030	F-4

FACILITY	BLDG	LOC
DPW	3015	F-3
EXCHANGE MALL/COMMISSARY	3703	G-4
FAMILY LIFE CENTER	3429	I-5
FINANCE OFFICE	3401	H-4
FIRE STATION NO. 1	3004	H-3
FIRE STATION NO. 2	4075	D-4
FLIGHT SIMULATOR	3000	H-3
FUEL POINT	3484	I-6
FURNITURE STORE	3701	G-4
GOLF COURSE		L-3
HOCKEY RINK	4109	D-4
HOSPITAL	4065	D-4
NEW HOSPITAL		
DUE TO OPEN SUMMER 2007	4076	E-4
HQ 1st BN 5th INF	3214	H-5
HQ 1st BN 24th INF	3214	H-4
HQ 1st BN 52nd AVN	3010	G-3
HQ 2nd BN 8th FA	3717	I-5
HQ 3rd BN 21st INF	3211	H-4
HQ 5th SQDN 1st CAV	3407	H-5
HQ 6th SQDN 17th CAV	2104	J-4
HQ 25th SPT	3424	H-4
HQ 123rd AVIM	3008	G-4
HQ FORT WAINWRIGHT	1555	J-2
HQ 1st BDE (SBCT) 25th INF DIV		
AND TASK FORCE 49		

FACILITY	BLDG	LOC
INSTALLATION MAINT FAC	3490	J-6
KAMISH MEDICAL/DENTAL CLINIC	3406	H-5
LAST FRONTIER COMMUNITY CTR	1044	J-1
DONUT SHOP		
LASER TAG		
LAUNDRY/DRY CLEANING	3020	F-4
LIBRARY	3700	H-4
LODGING OFFICE	3402	H-2
MELAVEN GYMNASIUM	3452	H-5
SWIMMING POOL		
MILITARY POLICE	3028	G-4
MPD	3401	H-4
MOUT SITE	2296	K-4
MP — BADGER ROAD GATE	2052	M-5
MP — MAIN GATE	4026	B-3
MP — RICHARDSON GATE	CLOSED	H-6
MP — TRAINER GATE	1167	E-1
NORTH POST HOUSING	SEE OTHER SIDE	
NORTHERN LIGHTS INN	3402	H-5
NUGGET LANES	3702	H-4
PALLET PROCESSING AREA	2118	I-3
PX SERVICE STATION	3562	E-4
PX SHOPPETTE / BARBER SHOP	1021	J-2

FACILITY	BLDG	LOC
RANGE CONTROL	5110	J-6
RED CROSS	1024	J-1
SCHOOL AGE SERVICES	4391	D-4
SCHOOLS		
ARCTIC LIGHT ELEMENTARY	4167	B-4
DISTANCE LEARNING CENTER	1031	J-1
SELF HELP SHOP	3014	F-3
SJA	1562	J-2
SKI LODGE	1172	G-1
SPORTS COMPLEX	3709	G-4
TELEPHONE EXCHANGE	1060	I-1
THE ZONE	3205	H-4
TMP	3420	J-6
TRANSPORTATION OFFICE	3401	H-5
VETERINARY CLINIC	3597	F-4
WELCOME CENTER	3401	H-5
ARMY COMMUNITY SERVICES		
FAMILY ASSISTANCE CENTER		
YOUTH CENTER	4109	D-5

2007 Foldout Map • The Army In Alaska

Project HS&E Change Management Form

This evaluation form should be reviewed on a **continuous** basis to determine if the current site health and safety plan adequately addresses ongoing project work and should be completed whenever new tasks are contemplated or changed conditions are encountered.

Project Task:

Project Number: **Project/Task Manager:**

Name: **Employee #:**

	Evaluation Checklist	Yes	No
1.	Has the CH2MHILL staff listed in the original HSP changed?		
2.	Has a new subcontractor been added to the project?		
3.	Is any chemical or product to be used that is not listed in this HSP?		
4.	Have additional tasks been added to the project that were not originally addressed in the plan?		
5.	Have new contaminants or higher than anticipated levels of original contaminants been encountered?		
6.	Have other safety, equipment, activity or environmental hazards been encountered that are not addressed in the plan?		

If the answer is “YES” to Question 3, an HSP revision is NOT needed. Please take the following actions:

- Add the chemical to the HSP, and ensure employees handling the chemical are trained, and training documentation is attached as well.

If the answer is “YES” to Questions 1, 2 or 4-6, an HSP revision MAY BE NEEDED. Please contact HS&E directly.

1.1 Tasks to be Performed Under this Plan

1.1.1 Description of Tasks

(Reference Field Project Start-up Form)

Refer to project documents (i.e., Work Plan) for detailed task information. A health and safety (H&S) risk analysis (Section 1.2) has been performed for each task and is incorporated in this plan through task-specific hazard controls and requirements for monitoring and protection. Tasks other than those listed in the following subsection require an approved amendment or revision to this plan before tasks begin. Refer to Section 8.2 for procedures related to “clean” tasks that do not involve hazardous waste operations and emergency response (Hazwoper).

1.1.1.1 Hazwoper-Regulated Tasks

- Drilling
- Well installation
- Direct-push sampling
- Groundwater sampling
- Soil sampling
- Investigation-derived waste (IDW) management

1.1.1. 2 Non-Hazwoper-Regulated Tasks

Under specific circumstances, the training and medical monitoring requirements of federal or state Hazwoper regulations are not applicable. It must be demonstrated that the tasks can be performed without the possibility of exposure to use non-Hazwoper-trained personnel. **Prior approval from the Health and Safety Manager (HSM) is required before these tasks are conducted on regulated hazardous waste sites.**

TASKS	CONTROLS
• General site survey (no intrusive tasks)	• Brief on hazards, limits of access, and emergency procedures • Post contaminant areas as appropriate (refer to Section 8.2 for details) • Sample and monitor as appropriate (refer to Section 5.0) • Follow personal protective equipment (PPE) guidelines in Section 4.0

1.2 Task Hazard Analysis

(Refer to Section 2 for hazard controls)

POTENTIAL HAZARDS	TASKS		
	Drilling, Well Installation, and Direct-Push Technology	Groundwater Sampling and Soil Sampling	IDW Management
Flying debris/objects	X		
Noise > 85dBA	X		
Electrical	X	X	
Suspended loads	X		
Buried utilities, drums, tanks	X		
Slip, trip, fall	X	X	X
Back injury	X	X	X
Visible lightning	X	X	X
Fires	X		
Entanglement	X		
Drilling	X		
Heavy equipment	X		X

SECTION 2

Hazard Controls

This section provides safe work practices and control measures used to reduce or eliminate potential hazards. These practices and controls are to be implemented by the party in control of either the site or the particular hazard. CH2M HILL employees and subcontractors must remain aware of the hazards affecting them regardless of who is responsible for controlling the hazards. CH2M HILL employees and subcontractors who do not understand any of these provisions should contact the SC for clarification.

In addition to the controls specified in this section, Project-Activity Self-Assessment Checklists are contained in Attachment 5. These checklists are to be used to assess the adequacy of CH2M HILL and subcontractor site-specific safety requirements. The objective of the self-assessment process is to identify gaps in project safety performance, and prompt for corrective actions in addressing these gaps. Self-assessment checklists should be completed early in the project, when tasks or conditions change, or when otherwise specified by the HSM. The self-assessment checklists, including documented corrective actions, should be made part of the permanent project records, and be promptly submitted to the HSM.

Self Assessment Checklists: The self assessment checklist for the following tasks and exposures are required when the task or exposure is initiated and weekly while the task or exposure is taking place.

- Drilling/Direct-push

2.1 Project-Specific Training

In addition to the basic training requirements for Construction sites the following specialty training is required for the following tasks.

- **Safety Coordinator Training:** CH2M HILL SC must have current SC-HW
- **Hazardous Waste Training:** CH2M HILL employees performing activities specified in Section 1.1.1 must have current Hazwoper training and be medically monitored.
- **Fire Extinguisher:** The assigned SC-HW onsite must take the on-line fire extinguisher training course.
- **Blood-borne Pathogen Training:** The assigned SC-HW onsite must take the CH2M HILL on-line BBP training course.
- **Dangerous Goods Shipping Training:** The assigned SC-HW onsite must take the online DG training course.

2.1.1 Required Forms

The following forms are required to be completed by the drilling subcontractor as part of the Behavior Based Loss Prevention System for drilling operations.

- Activity Hazard Analysis (JHA)
- Pre-Task Safety Plan (PTSP)

2.2 Behavior-Based Loss Prevention System

A Behavior Based Loss Prevention System (BBLPS) is a system to prevent or reduce losses using behavior-based tools and proven management techniques to focus on behaviors or acts that could lead to losses.

The SC and is responsible for implementing the BBLPS on the project site. The Safety Coordinator shall oversee the subcontractor's implementation of their JHAs and PTSPs processes on the project.

2.2.1 Job Hazard Analysis

An Job Hazard Analysis (JHA) defines the activity being performed, the hazards posed and control measures required to perform the work safely. Workers are briefed on the JHA before doing the work and their input is solicited prior, during and after the performance of work to further identify the hazards posed and control measures required. Job Hazard Analysis will be prepared before beginning drilling using the JHA form provided in **Attachment 6**. The JHA shall identify the work tasks required along with potential H&S hazards and recommended control measures for each work task. In addition, a listing of the equipment to be used, inspection requirements and training requirements for the safe operation of the equipment listed must be identified. Subcontractors are required to provide JHAs specific to drilling for acceptance by CH2M HILL. Additions or changes in field activities, equipment, tools or material to perform work or additional/different hazard encountered that require additional/different hazard control measures requires either a new JHA to be prepared or an existing JHA to be revised.

2.2.2 Pre-Task Safety Plans

Daily safety meetings are held with all project personnel in attendance to review the hazards posed and required H&S procedures/JHAs. The PTSPs serve the same purpose as these general assembly safety meetings, but the PTSPs are held between the crew supervisor and their work crews to focus on those hazards posed to individual work crews. At the start of each day's activities, the crew supervisor completes the PTSP, provided in **Attachment 6, "**JHAs/PTSA," with input from the work crew, during their daily safety meeting. The day's tasks, personnel, tools and equipment that will be used to perform these tasks are listed, along with the hazards posed and required H&S procedures, as identified in the JHA. The use of PTSPs, better promotes worker participation in the hazard recognition and control process, while reinforcing the task-specific hazard and required H&S procedures with the crew each day. The use of PTSPs is a common safety practice in the construction industry.

2.3 Project-Specific Hazards

2.3.1 Drilling/Direct-Push

- Only authorized personnel are permitted to operate drill rigs.
- Stay clear of areas surrounding drill rigs during every startup.
- Stay clear of the rotating augers and other rotating components of drill rigs.
- Stay as clear as possible of all hoisting operations. Loads shall not be hoisted overhead of personnel.
- Do not wear loose-fitting clothing or other items such as rings or watches that could get caught in moving parts. Long hair should have it restrained.
- If equipment becomes electrically energized, personnel shall be instructed not to touch any part of the equipment or attempt to touch any person who may be in contact with the electrical current. The utility company or appropriate party shall be contacted to have line de-energized before approaching the equipment.
- Smoking around drilling operations is prohibited.

2.3.2 XO Avoidance

(Reference CH2M HILL SOP HSE-610, Explosives Usage and Munitions Response

Munitions and Explosives of Concern (MEC) consist of unexploded ordnance (UXO), discarded military munitions (DMM) and munitions constituents (MC).

Client-specific instructions for environmental investigation activities is to stop work if an explosive-loaded/visibly contaminated item is discovered and the following steps shall be taken:

- Stop all intrusive operations
- Do not touch, move, or dig near or around suspected ordnance
- Evacuate the area and gather in the designated safe area
- Identify the area on a map or by terrain feature
- Report immediately to the following:

Points of Contact

Fort Wainwright: Joe Malen Environmental Project Specialist	**U.S. Army Corps of Engineers:** **Bob Brock** Project Manager	**CH2M HILL: Cory Hinds** Project Manager
Phone: (907) 353-4512	Phone: (907) 753-5612	Phone: (907) 646-0348
E-mail: joseph.malen@us.army.mil	E-mail: Robert.d.brock@poa02.usace.army.mil	E-mail: c.hinds@ch2m.com

The requirements of this section shall be followed by CH2M HILL employees who are potentially exposed to hazards associated with MEC activities, regardless of the company performing the MEC

operation. These requirements also pertain to MEC Avoidance Subcontractor personnel when CH2M HILL is providing oversight.

- Only qualified UXO Technicians or Explosive Ordnance Disposal (EOD) personnel will locate, identify, handle, remove, transport, store or dispose of MEC items.
- MEC must not be moved or disturbed in any way. There is to be absolutely no handling of MEC by CH2M HILL personnel or any subcontractor. Operations in the vicinity of MEC should only be conducted after a complete work plan, including emergency procedures, has been established.
- Do not activate electronic equipment capable of emitting electromagnetic radiation (radios, cellular phones) in the vicinity of known or suspect electrically initiated MEC.
- Approach ordnance from the side and avoid the forward and rear ends. Munitions may contain an ejection hazard, shaped charge explosive jet hazard, rocket motor, or fuzing sensitive to movement.
- Do not allow unnecessary personnel to remain near MEC.
- Always consider all munitions items to be armed and dangerous.
- Do not assume fired ammunition or MEC to be safe.
- Do not collect souvenirs.

2.4 General Hazards

2.4.1 General Practices and Housekeeping

(Reference CH2M HILL SOP HS-20, *General Practices*)

- Site work should be performed during daylight hours whenever possible. Work conducted during hours of darkness require enough illumination intensity to read a newspaper without difficulty.
- Good housekeeping must be maintained at all times in all project work areas.
- Common paths of travel should be established and kept free from the accumulation of materials.
- Keep access to aisles, exits, ladders, stairways, scaffolding, and emergency equipment free from obstructions.
- Provide slip-resistant surfaces, ropes, and/or other devices to be used.
- Specific areas should be designated for the proper storage of materials.
- Tools, equipment, materials, and supplies shall be stored in an orderly manner.
- As work progresses, scrap and unessential materials must be neatly stored or removed from the work area.
- Containers should be provided for collecting trash and other debris and shall be removed at regular intervals.
- All spills shall be quickly cleaned up. Oil and grease shall be cleaned from walking and working surfaces.

2.4.2 Hazard Communication

(Reference CH2M HILL SOP HS-05, *Hazard Communication)*

The SC-HW is to perform the following:

- Confirm that an inventory of chemicals brought on site by CH2M HILL and subcontractors is available.
- Request or confirm locations of Material Safety Data Sheets (MSDSs) from the client, contractors, and subcontractors for chemicals to which CH2M HILL employees potentially are exposed.
- Before or as the chemicals arrive on site, obtain an MSDS for each hazardous chemical.
- Label chemical containers with the identity of the chemical and with hazard warnings, and store properly.
- Give employees required chemical-specific HAZCOM training using **Attachment 3**.
- Store all materials properly, giving consideration to compatibility, quantity limits, secondary containment, fire prevention, and environmental conditions.

2.4.3 Shipping and Transportation of Chemical Products

(Reference CH2M HILL's Procedures for Shipping and Transporting Dangerous Goods)

Chemicals brought to the site might be defined as hazardous materials by the U.S. Department of Transportation (DOT). All staff who ship the materials or transport them by road must receive CH2M HILL training in shipping dangerous goods. All hazardous materials that are shipped (e.g., by way of Federal Express) or are transported by road must be properly identified, labeled, packed, and documented by trained staff. Contact the HSM or the Equipment Coordinator for additional information.

2.4.4 Lifting

(Reference CH2M HILL SOP HS-29, *Lifting*)

- Proper lifting techniques must be used when lifting any object.
- Plan storage and staging to minimize lifting or carrying distances.
- Split heavy loads into smaller loads.
- Use mechanical lifting aids whenever possible.
- Have someone assist with the lift -- especially for heavy or awkward loads.
- Make sure the path of travel is clear before the lift.

2.4.5 Fire Prevention

(Reference CH2M HILL SOP HS-22, *Fire Prevention*)

- Fire extinguishers shall be provided so that the travel distance from any work area to the nearest extinguisher is less than 100 feet. When 5 gallons or more of a flammable or combustible liquid is being used, an extinguisher must be within 50 feet. Extinguishers must:
- Be maintained in a fully charged and operable condition,
  - Be visually inspected each month, and
  - Undergo a maintenance check each year.
- The area in front of extinguishers must be kept clear.
- Combustible materials stored outside should be at least 10 feet from any building.
- Solvent waste and oily rags must be kept in a fire resistant, covered container until removed from the site.
- Flammable/combustible liquids must be kept in approved containers, and must be stored in an approved storage cabinet.

2.4.6 Electrical

(Reference CH2M HILL SOP HS-23, *Electrical*)

- Only qualified personnel are permitted to work on unprotected energized electrical systems.
- Only authorized personnel are permitted to enter high-voltage areas.
- Do not tamper with electrical wiring and equipment unless qualified to do so. All electrical wiring and equipment must be considered energized until lockout/tagout procedures are implemented.
- Inspect electrical equipment, power tools, and extension cords for damage prior to use. Do not use defective electrical equipment, remove from service.
- All temporary wiring, including extension cords and electrical power tools, must have ground fault circuit interrupters (GFCIs) installed.
- Extension cords must be:
  - Equipped with third-wire grounding.
  - Covered, elevated, or protected from damage when passing through work areas.
  - Protected from pinching if routed through doorways.
  - Not fastened with staples, hung from nails, or suspended with wire.
- Electrical power tools and equipment must be effectively grounded or double-insulated UL approved.
- Operate and maintain electric power tools and equipment according to manufacturers' instructions.
- Maintain safe clearance distances between overhead power lines and any electrical conducting material unless the power lines have been de-energized and grounded, or where insulating barriers have been installed to prevent physical contact. Maintain at least 10 feet from overhead

power lines for voltages of 50 kilovolts (kV) or less, and 10 feet plus ½ inch for every 1 kV over 50 kV.

- Temporary lights shall not be suspended by their electric cord unless designed for suspension. Lights shall be protected from accidental contact or breakage.
- Protect all electrical equipment, tools, switches, and outlets from environmental elements.

2.4.7 Heat Stress

(Reference CH2M HILL SOP HS-09, *Heat and Cold Stress*)

- Drink 16 ounces of water before beginning work. Disposable cups and water maintained at 50°F to 60°F should be available. Under severe conditions, drink 1 to 2 cups every 20 minutes, for a total of 1 to 2 gallons per day. Do not use alcohol in place of water or other nonalcoholic fluids. Decrease your intake of coffee and caffeinated soft drinks during working hours.
- Acclimate yourself by slowly increasing workloads (e.g., do not begin with extremely demanding activities).
- Use cooling devices, such as cooling vests, to aid natural body ventilation. These devices add weight, so their use should be balanced against efficiency.
- Use mobile showers or hose-down facilities to reduce body temperature and cool protective clothing.
- Conduct field activities in the early morning or evening and rotate shifts of workers, if possible.
- Avoid direct sun whenever possible, which can decrease physical efficiency and increase the probability of heat stress. Take regular breaks in a cool, shaded area. Use a wide-brim hat or an umbrella when working under direct sun for extended periods.
- Provide adequate shelter/shade to protect personnel against radiant heat (sun, flames, hot metal).
- Maintain good hygiene standards by frequently changing clothing and showering.
- Observe one another for signs of heat stress. Persons who experience signs of heat syncope, heat rash, or heat cramps should consult the SC-HW to avoid progression of heat-related illness.

SYMPTOMS AND TREATMENT OF HEAT STRESS

	Heat Syncope	Heat Rash	Heat Cramps	Heat Exhaustion	Heat Stroke
Signs and Symptoms	Sluggishness or fainting while standing erect or immobile in heat.	Profuse tiny raised red blister-like vesicles on affected areas, along with prickling sensations during heat exposure.	Painful spasms in muscles used during work (arms, legs, or abdomen); onset during or after work hours.	Fatigue, nausea, headache, giddiness; skin clammy and moist; complexion pale, muddy, or flushed; may faint on standing; rapid pulse and low blood pressure; oral temperature normal or low	Red, hot, dry skin; dizziness; confusion; rapid breathing and pulse; high oral temperature.
Treatment	Remove to cooler area. Rest lying down. Increase fluid intake. Recovery usually is prompt and complete.	Use mild drying lotions and powders, and keep skin clean for drying skin and preventing infection.	Remove to cooler area. Rest lying down. Increase fluid intake.	Remove to cooler area. Rest lying down, with head in low position. Administer fluids by mouth. Seek medical attention.	Cool rapidly by soaking in cool– but not cold– water. Call ambulance, and get medical attention immediately!

2.4.7.1 Monitoring Heat Stress

These procedures should be considered when the ambient air temperature exceeds 70°F, the relative humidity is high (greater than 50 percent), or when workers exhibit symptoms of heat stress.

The heart rate (HR) should be measured by the radial pulse for 30 seconds, as early as possible in the resting period. The HR at the beginning of the rest period should not exceed 100 beats/minute, or 20 beats/minute above resting pulse. If the HR is higher, the next work period should be shortened by 33 percent, while the length of the rest period stays the same. If the pulse rate still exceeds 100 beats/minute at the beginning of the next rest period, the work cycle should be further shortened by 33 percent. The procedure is continued until the rate is maintained below 100 beats/minute, or 20 beats/minute above resting pulse.

2.4.8 Cold Stress

(Reference CH2M HILL SOP HS-09, *Heat and Cold Stress*)

- Be aware of the symptoms of cold-related disorders, and wear proper, layered clothing for the anticipated fieldwork. Appropriate rain gear is a must in cool weather.
- Persons who experience initial signs of immersion foot, frostbite, hypothermia should consult the SC-HW to avoid progression of cold-related illness.
- Observe one another for initial signs of cold-related disorders.
- Obtain and review weather forecast — be aware of predicted weather systems along with sudden drops in temperature, increase in winds, and precipitation.

SYMPTOMS AND TREATMENT OF COLD STRESS			
	Immersion (Trench) Foot	**Frostbite**	**Hypothermia**
Signs and Symptoms	Feet discolored and painful; infection and swelling present.	Blanched, white, waxy skin, but tissue resilient; tissue cold and pale.	Shivering, apathy, sleepiness; rapid drop in body temperature; glassy stare; slow pulse; slow respiration.
Treatment	Seek medical treatment immediately.	Remove victim to a warm place. Re-warm area quickly in warm–but **not** hot water. Have victim drink warm fluids, but **not** coffee or alcohol. Do not break blisters. Elevate the injured area, and get medical attention.	Remove victim to a warm place. Have victim drink warm fluids, but **not** coffee or alcohol. Get medical attention.

2.4.9 Compressed Gas Cylinders

- Valve caps must be in place when cylinders are transported, moved, or stored.
- Cylinder valves must be closed when cylinders are not being used and when cylinders are being moved.
- Cylinders must be secured in an upright position at all times.
- Cylinders must be shielded from welding and cutting operations and positioned to avoid being struck or knocked over; contacting electrical circuits; or exposed to extreme heat sources.
- Cylinders must be secured on a cradle, basket, or pallet when hoisted; they may not be hoisted by choker slings.

2.4.10 Procedures for Locating Buried Utilities

2.4.10.1 Local Utility Mark-Out Service

Name: Joe Malen (U.S. Army — DWP)
Phone: 907/353-4512

- Where available, obtain utility diagrams for the facility.
- Review locations of sanitary and storm sewers, electrical conduits, water supply lines, natural gas lines, and fuel tanks and lines.
- Review proposed locations of intrusive work with facility personnel knowledgeable of locations of utilities. Check locations against information from utility mark-out service.
- Where necessary (e.g., uncertainty about utility locations), excavation or drilling of the upper depth interval should be performed manually
- Monitor for signs of utilities during advancement of intrusive work (e.g., sudden change n advancement of auger or split spoon).
- When the client or other onsite party is responsible for determining the presence and locations of buried utilities, the SC-HW should confirm that arrangement.

2.5 Biological Hazards and Controls

2.5.1 Bees and Other Stinging Insects

Bee and other stinging insects may be encountered almost anywhere and may present a serious hazard, particularly to people who are allergic. Watch for and avoid nests. Keep exposed skin to a minimum. Carry a kit if you have had allergic reactions in the past, and inform the SC-HW and/or buddy. If a stinger is present, remove it carefully with tweezers. Wash and disinfect the wound, cover it, and apply ice. Watch for allergic reaction; seek medical attention if a reaction develops.

2.5.2 Bloodborne Pathogens

(Reference CH2M HILL SOP HS-36, *Bloodborne Pathogens*)

Exposure to bloodborne pathogens may occur when rendering first aid or cardiopulmonary resuscitation (CPR), or when coming into contact with landfill waste or waste streams containing potentially infectious material. Exposure controls and personal protective equipment (PPE) are required as specified in CH2M HILL SOP HS-36, *Bloodborne Pathogens*. Hepatitis B vaccination must be offered before the person participates in a task where exposure is a possibility.

2.6 Radiological Hazards and Controls

Refer to CH2M HILL's Corporate *Health and Safety Program, Program and Training Manual*, and *Corporate Health and Safety Program, Radiation Protection Program Manual*, for standards of practice in contaminated areas.

Hazards	Controls
None Known	None Required

2.7 Contaminants of Concern

(Refer to Project Files for more detailed contaminant information)

Contaminant	Location and Maximum[a] Concentration	Exposure Limit[b]	IDLH[c]	Symptoms and Effects of Exposure	PIP[d] (eV)
Diesel Range Organics	Potential	100 mg/m3 (REL)	NL	Primary system effect is CNS depression. Inhalation of vapors may cause nausea, confusion, drowsiness, convulsions, and coma. Liquid may cause skin and eye irritation.	UK
Gasoline Range Organics	Potential	300 ppm	ND Ca	Eye, skin and mucous membrane irritation; dermatitis, headache, fatigue, blurred vision, dizziness, slurred speech, confusion, convulsions, chemical pneumonia on aspiration, possible liver and kidney damage	UK
PCBs	SB: 50 ppm	0.5 mg/m3	5 Ca	Eye and skin irritation, acne-form dermatitis, liver damage, reproductive effects	UK

[a] Specify sample-designation and media: SB (Soil Boring), A (Air), D (Drums), GW (Groundwater), L (Lagoon), TK (Tank), S (Surface Soil), SL (Sludge), SW (Surface Water).
[b] Appropriate value of PEL, REL, or TLV listed.
[c] IDLH = immediately dangerous to life and health (units are the same as specified "Exposure Limit" units for that contaminant); NL = No limit found in reference materials; CA = Potential occupational carcinogen.
[d] PIP = photoionization potential; NA = Not applicable; UK = Unknown.

2.8 Potential Routes of Exposure

2.8.1 Dermal

Contact with contaminated media. This route of exposure is minimized through proper use of PPE, as specified in Section 4.

2.8.2 Inhalation

Vapors and contaminated particulates. This route of exposure is minimized through proper respiratory protection and monitoring, as specified in Sections 4 and 5, respectively.

2.8.3 Other

Inadvertent ingestion of contaminated media. This route should not present a concern if good hygiene practices are followed (e.g., wash hands and face before drinking or smoking).

SECTION 3

Project Organization and Personnel

3.1 CH2M HILL Employee Medical Surveillance and Training

(Reference CH2M HILL SOPs HS-01, Medical Surveillance, and HS-02, Health and Safety Training)

The employees listed below are enrolled in the CH2M HILL Comprehensive Health and Safety Program and meet state and federal hazardous waste operations requirements for 40-hour initial training, 3-day on-the-job experience, and 8-hour annual refresher training. Employees designated "SC-HW" have completed a 12-hour Safety Coordinator — Haz Waste course, and have documented requisite field experience. An SC-HW with a level designation (D, C, B) equal to or greater than the level of protection being used must be present during all tasks performed in exclusion or decontamination zones. Employees designated "FA-CPR" are currently certified by the American Red Cross, or equivalent, in first aid and CPR. At least one FA-CPR designated employee must be present during all tasks performed in exclusion or decontamination zones. The employees listed below are currently active in a medical surveillance program that meets state and federal regulatory requirements for hazardous waste operations. Certain tasks (e.g., confined-space entry) and contaminants (e.g., lead) may require additional training and medical monitoring.

Pregnant employees are to be informed of and are to follow the procedures in CH2M HILL's SOP HS-04, Reproduction Protection, including obtaining a physician's statement of the employee's ability to perform hazardous activities before being assigned fieldwork.

Employee Name	Office	Responsibility	SC-HW/FA-CPR
Cory Hinds	ANC	Project Manager	Office Support Only – Not in the field
Bobby Huron	SCO	Field Team Leader/SC-HW	Level C; 40-Hr Hazardous Waste; Safety Coordinator-HW; FA-CPR
Reuben Greer	SPK	Field Team Member	Level C ; 40-Hr Hazardous Waste
Jessica Morris	SPK	Field Team Leader/SC-HW	Level C ; 40-Hr Hazardous Waste
Rikke Andersen	RDD	Field Team Member	Level C; 40-Hr Hazardous Waste; Safety Coordinator-HW; FA-CPR
Richy Ricks	SAC	Field Team Member	Level C ; 40-Hr Hazardous Waste
Bob Trebble	ANC	Field Team Member	Level C ; 40-Hr Hazardous Waste
Allan Erickson	PHX	Field Team Member	Level C ; 40-Hr Hazardous Waste
Dan Chern	SAC	Field Team Member	Level C ; 40-Hr Hazardous Waste

3.2 Field Team Chain of Command and Communication Procedures

3.2.1 Client

Contact Name: Bob Brock – U.S. Army Corps of Engineers (USACE)

Phone: 907/753-5612

3.2.2 CH2M HILL

Project Manager: Cory Hinds/ANC

Health and Safety Manager: John Culley/SPK

Field Team Leader/SC-HW: Bobby Horan/SCO

The SC-HW is responsible for contacting the Field Team Leader and Project Manager. In general, the Project Manager will contact the client. The Health and Safety Manager should be contacted as appropriate.

3.2.3 CH2M HILL Subcontractors

(Reference CH2M HILL SOP HS-215, Subcontractor, Contractor, and Owner)

Subcontractor: Discovery Drilling
Subcontractor Contact Name: Kyle Brown
Telephone: 907/344-6431

Subcontractor Tasks: Drilling/Direct-push

Safety Procedures Required: Subcontractor must have their company's safe drilling procedures onsite when field activities commence, or complete the JHA in Attachment 6.

The subcontractors listed above are covered by this HSP and must be provided a copy of this plan. However, this plan does not address hazards associated with the tasks and equipment that the subcontractor has expertise in (e.g., drilling, excavation work, electrical). Subcontractors are responsible for the health and safety procedures specific to their work, and are required to submit these procedures to CH2M HILL for review before the start of field work. Subcontractors must comply with the established health and safety plan(s). The CH2M HILL SC-HW should verify that subcontractor employee training, medical clearance, and fit test records are current and must monitor and enforce compliance with the established plan(s). CH2M HILL's oversight does not relieve subcontractors of their responsibility for effective implementation and compliance with the established plan(s).

CH2M HILL should continuously endeavor to observe subcontractors' safety performance. This endeavor should be reasonable, and include observing for hazards or unsafe practices that are both readily observable and occur in common work areas. CH2M HILL is not responsible for exhaustive observation for hazards and unsafe practices. In addition to this level of observation, the SC-HW is responsible for confirming CH2M HILL subcontractor performance against both the subcontractor's safety plan and applicable self-assessment checklists. Self-assessment checklists contained in **Attachment 6** are to be used by the SC-HW to review subcontractor performance.

Health and safety related communications with CH2M HILL subcontractors should be conducted as follows:

- Brief subcontractors on the provisions of this plan, and require them to sign the Employee Signoff Form included in **Attachment 1.**
- Request subcontractor(s) to brief the project team on the hazards and precautions related to their work.
- When apparent non-compliance/unsafe conditions or practices are observed, notify the subcontractor safety representative and require corrective action – the subcontractor is responsible for determining and implementing necessary controls and corrective actions.
- When repeat non-compliance/unsafe conditions are observed, notify the subcontractor safety representative and stop affected work until adequate corrective measures are implemented.
- When an apparent imminent danger exists, immediately remove all affected CH2M HILL employees and subcontractors, notify subcontractor safety representative, and stop affected work until adequate corrective measures are implemented. Notify the Project Manager and HSM as appropriate.
- Document all oral health and safety related communications in project field logbook, daily reports, or other records.

SECTION 4

Personal Protective Equipment (PPE)

(Reference CH2M HILL SOP HS-07, Personal Protective Equipment, HS-08, Respiratory Protection)

PPE Specifications [a]

Task	Level	PPE	Head	Respirator [b]
General field surveying	D	Work clothes; steel-toe, leather work boots; work glove.	Hardhat [c] Safety glasses Ear protection [d]	None required
• Drilling • Well installation • Direct-push • Groundwater sampling • Soil sampling • IDW management	Modified D	**Coveralls:** Cotton coveralls **Boots:** Steel-toe, chemical-resistant boots OR steel-toe, leather work boots with outer rubber boot covers **Gloves:** Inner surgical-style nitrile & outer chemical-resistant nitrile or butyl gloves.	Hardhat [c] Safety glasses Ear protection [d]	None required

Reasons for Upgrading or Downgrading Level of Protection

Upgrade[e]	Downgrade
• Request from individual performing tasks. • Change in work tasks that will increase contact or potential contact with hazardous materials. • Occurrence or likely occurrence of gas or vapor emission. • Known or suspected presence of dermal hazards. • Instrument action levels (Section 5) exceeded.	• New information indicating that situation is less hazardous than originally thought. • Change in site conditions that decreases the hazard. • Change in work task that will reduce contact with hazardous materials.

[a] Modifications are as indicated. CH2M HILL will provide PPE only to CH2M HILL employees.
[b] No facial hair that would interfere with respirator fit is permitted.
[c] Hardhat and splash-shield areas are to be determined by the SC-HW.
[d] Ear protection should be worn when conversations cannot be held at distances of 3 feet or less without shouting.
[e] Performing a task that requires an upgrade to a higher level of protection (e.g., Level D to Level C) is permitted only when the PPE requirements have been approved by the HSM, and an SC-HW qualified at that level is present.

SECTION 5

Air Monitoring/Sampling

5.1 Air Monitoring Specifications

Instrument	Tasks	Action Levels[a]	Frequency [b]	Calibration
PID: MiniRAE with 10.6 eV lamp or greater	• Drilling • Well installation • Direct-push • Groundwater sampling • Soil sampling • IDW management	<10 ppm → Modified D ≥10 ppm → Stop work; contact HSM	Initially and continuously during task; record every 30-60 minutes	Daily
Visual Dust Monitoring:	• Drilling • Well installation • Direct-push	No visible dust → Modified D Visible dust → Implement control measures or leave area	Continuous observation	N/A

[a] Action levels apply to **sustained** breathing-zone measurements above background **for more than 5 minutes**.
[b] The exact frequency of monitoring depends on field conditions and is to be determined by the SC-HW; generally, every 5 to 15 minutes if acceptable; more frequently may be appropriate. Monitoring results should be recorded. Documentation should include instrument and calibration information, time, measurement results, personnel monitored, and place/location where measurement is taken (e.g., “Breathing Zone/MW-3”, “at surface/SB-2”, etc.).

Air monitoring results may be obtained from other onsite parties if the following conditions are met:

- Instruments are calibrated in accordance with manufacturer’s specifications. Calibration logs and verifications must be kept by the SC-HW.
- Readings must be taken in CH2M Hill employees’ breathing zones (or from an employee who has a higher level of exposure) for the task listed. Results must be recorded as often as is stated above.
- The action levels previously listed must be followed.

5.2 Calibration Specifications

(Refer to the respective manufacturer's instructions for proper instrument-maintenance procedures)

Instrument	Gas	Span	Reading	Method
PID: MiniRAE, 10.6 eV bulb	100 ppm isobutylene	CF=53	53 ppm ±5 ppm	1.5 lpm REG T-Tubing

5.3 Air Sampling

Sampling, in addition to real-time monitoring, may be required by other OSHA regulations where there may be exposure to certain contaminants. Air sampling typically is required when site contaminants include lead, cadmium, arsenic, asbestos, and certain volatile organic compounds. Contact the HSM immediately if these contaminants are encountered.

Method Description: None at this time

SECTION 6

Decontamination

(Reference CH2M HILL SOP *Decontamination*)

The SC-HW must establish and monitor the decontamination procedures and their effectiveness. Decontamination procedures found to be ineffective will be modified by the SC-HW. The SC-HW must ensure that procedures are established for disposing of materials generated on the site.

6.1 Decontamination Specifications

Personnel	Sample Equipment	Heavy Equipment
• Boot wash/rinse • Glove wash/rinse • Outer-glove removal • Body-suit removal • Inner-glove removal • Respirator removal • Hand wash/rinse • Face wash/rinse • Shower ASAP • Dispose of PPE in municipal trash, or contain for disposal • Dispose of personnel rinse water to treatment facility operated by North Wind	• Wash/rinse equipment • Solvent-rinse equipment • Contain solvent waste for offsite disposal	• Power wash • Steam clean Dispose of equipment rinse water to treatment facility operated by North Wind

6.2 Diagram of Personnel-Decontamination Line

No eating, drinking, or smoking is permitted in contaminated areas and in exclusion or decontamination zones. The SC-HW should establish areas for eating, drinking, and smoking. Contact lenses are not permitted in exclusion or decontamination zones.

Figure 6-1 illustrates a conceptual establishment of work zones, including the decontamination line. Work zones are to be modified by the SC-HW to accommodate task-specific requirements.

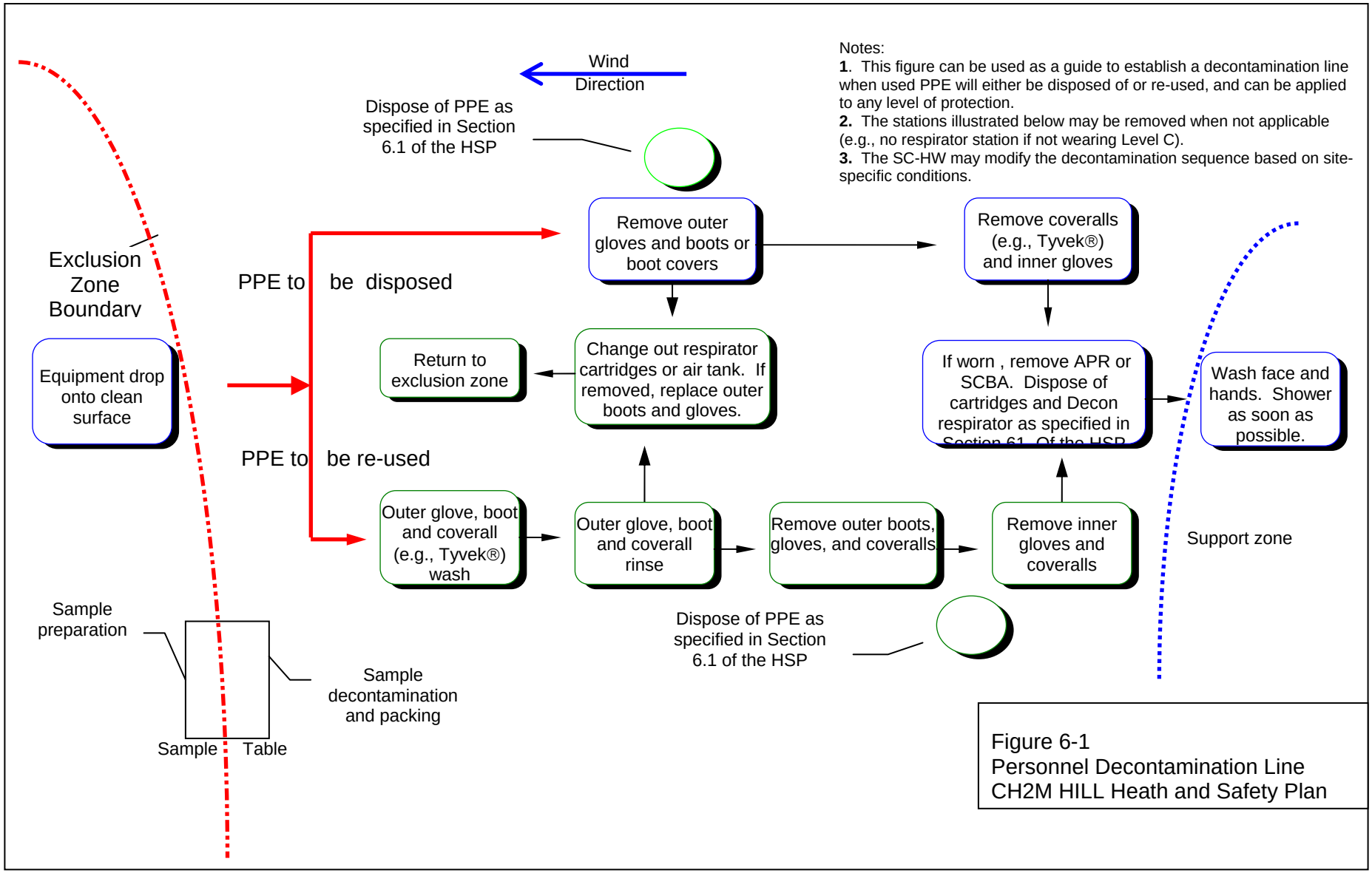


Figure 6-1
Personnel Decontamination Line
CH2M HILL Heath and Safety Plan

SECTION 7

Spill-Containment Procedures

In the event of a spill, the appropriate DPW contact shall be notified within 30 minutes with a description of the material spilled and the approximate volume released. he USACE Oil and Hazardous Substance Spill Notification Form is included as Attachment 7 of this document and will be completed by appropriate personnel.

Sorbent material will be maintained in the support zone. Incidental spills will be contained with sorbent and disposed of properly.

SECTION 8

Site-Control Plan

8.1 Site-Control Procedures

(Reference CH2M HILL SOP HS-11, *Site Control)*

- The SC-HW will conduct a site safety briefing (see below) before starting field activities or as tasks and site conditions change.
- Topics for briefing on site safety: general discussion of Health and Safety Plan, site-specific hazards, locations of work zones, PPE requirements, equipment, special procedures, emergencies.
- The SC-HW records attendance at safety briefings in a logbook and documents the topics discussed.
- Post the Occupational Safety and Health Administration (OSHA) job-site poster in a central and conspicuous location in accordance with CH2M HILL SOP HS-71, *OSHA Postings*.
- Establish support, decontamination, and exclusion zones. Delineate with flags or cones as appropriate. Support zone should be upwind of the site. Use access control at entry and exit from each work zone.
- Establish onsite communication consisting of the following:
  - Line-of-sight and hand signals
  - Air horn
  - Two-way radio or cellular telephone if available
- Establish offsite communication.
- Establish and maintain the “buddy system.”
- Initial air monitoring is conducted by the SC-HW in appropriate level of protection.
- The SCC is to conduct periodic inspections of work practices to determine the effectiveness of this plan – refer to Sections 2 and 3. Deficiencies are to be noted, reported to the HSM, and corrected.

8.2 Hazwoper Compliance Plan

(Reference CH2M HILL SOP Site-Specific Written Safety Plans)

Certain parts of the site work are covered by state or federal Hazwoper standards and therefore require training and medical monitoring. Anticipated Hazwoper tasks (Section 1.1.1) might occur consecutively or concurrently with respect to non-Hazwoper tasks. This section outlines procedures to be followed when approved activities specified in Section 1.1.2 do not require 24- or 40-hour training. Non-Hazwoper-trained personnel also must be trained in accordance with all other state and federal OSHA requirements.

- In many cases, air sampling, in addition to real-time monitoring, must confirm that there is no exposure to gases or vapors before non-Hazwoper-trained personnel are allowed on the site, or while non-Hazwoper-trained staff are working in proximity to Hazwoper activities. Other data (e.g., soil) also must document that there is no potential for exposure. The HSM must approve the interpretation of these data. Refer to subsections 2.5 and 5.3 for contaminant data and air sampling requirements, respectively.
- When non-Hazwoper-trained personnel are at risk of exposure, the SC-HW must post the exclusion zone and inform non-Hazwoper-trained personnel of the:
  - Nature of the existing contamination and its locations
  - Limitations of their access
  - Emergency action plan for the site
- Periodic air monitoring with direct-reading instruments conducted during regulated tasks also should be used to ensure that non-Hazwoper-trained personnel (e.g., in an adjacent area) are not exposed to airborne contaminants.
- When exposure is possible, non-Hazwoper-trained personnel must be removed from the site until it can be demonstrated that there is no longer a potential for exposure to health and safety hazards.
- Remediation treatment system start-ups: Once a treatment system begins to pump and treat contaminated media, the site is, for the purposes of applying the Hazwoper standard, considered a treatment, storage, and disposal facility (TSDF). Therefore, once the system begins operation, only Hazwoper-trained personnel (minimum of 24 hour of training) will be permitted to enter the site. All non-Hazwoper-trained personnel must not enter the TSDF area of the site.

SECTION 9

Emergency Response Plan

(Reference CH2M HILL, SOP *Emergency Response*)

9.1 Pre-Emergency Planning

The SC-HW performs the applicable pre-emergency planning tasks before starting field activities and coordinates emergency response with CH2M HILL onsite parties, the facility, and local emergency-service providers as appropriate.

- Review the facility emergency and contingency plans where applicable.
- Determine what onsite communication equipment is available (e.g., two-way radio, air horn).
- Determine what offsite communication equipment is needed (e.g., nearest telephone, cell phone).
- Confirm and post emergency telephone numbers, evacuation routes, assembly areas, and route to hospital; communicate the information to onsite personnel.
- Field Trailers: Post “Exit” signs above exit doors, and post “Fire Extinguisher” signs above locations of extinguishers. Keep areas near exits and extinguishers clear.
- Review changed site conditions, onsite operations, and personnel availability in relation to emergency response procedures.
- Where appropriate and acceptable to the client, inform emergency room and ambulance and emergency response teams of anticipated types of site emergencies.
- Designate one vehicle as the emergency vehicle; place hospital directions and map inside; keep keys in ignition during field activities.
- Inventory and check site emergency equipment, supplies, and potable water.
- Communicate emergency procedures for personnel injury, exposures, fires, explosions, and releases.
- Rehearse the emergency response plan before site activities begin, including driving route to hospital.
- Brief new workers on the emergency response plan.

The SC-HW will evaluate emergency response actions and initiate appropriate follow-up actions.

9.2 Emergency Equipment and Supplies

The SC-HW should mark the locations of emergency equipment on the site map and post the map.

Emergency Equipment and Supplies	Location
20 LB (or two 10-lb) fire extinguisher (A, B, and C classes)	Required w/ drill rig
First aid kit	Support Zone/Field Vehicle
Potable water	Support & Decon Zone/Field Vehicle
Bloodborne-pathogen kit	Support Zone/Field Vehicle
Cellular phone	Support Zone/Field Vehicle
Eye Wash	Support Zone/Field Vehicle

9.3 Incident Response

In fires, explosions, or chemical releases, actions to be taken include the following:

- Shut down CH2M HILL operations and evacuate the immediate work area.
- Notify appropriate response personnel.
- Account for personnel at the designated assembly area(s).
- Assess the need for site evacuation, and evacuate the site as warranted.

Instead of implementing a work-area evacuation, note that small fires or spills posing minimal safety or health hazards may be controlled.

9.4 Emergency Medical Treatment

The procedures listed below may also be applied to non-emergency incidents. Injuries and illnesses (including overexposure to contaminants) must be reported to Human Resources. if there is doubt about whether medical treatment is necessary, or if the injured person is reluctant to accept medical treatment, contact the CH2M HILL medical consultant. During non-emergencies, follow these procedures as appropriate.

- Notify appropriate emergency response authorities listed in Section 9.8 (e.g., 911).
- The SC-HW will assume charge during a medical emergency until the ambulance arrives or until the injured person is admitted to the emergency room.
- Prevent further injury.
- Initiate first aid and CPR where feasible.
- Get medical attention immediately.
- Perform decontamination where feasible; lifesaving and first aid or medical treatment take priority.
- Make certain that the injured person is accompanied to the emergency room.

- When contacting the medical consultant, state that the situation is a CH2M HILL matter, and give your name and telephone number, the name of the injured person, the extent of the injury or exposure, and the name and location of the medical facility where the injured person was taken.
- Report incident as outlined in Section 9.7.

9.5 Evacuation

- Evacuation routes and assembly areas (and alternative routes and assembly areas) are specified on the site map.
- Evacuation route(s) and assembly area(s) will be designated by the SC-HW before work begins.
- Personnel will assemble at the assembly area(s) upon hearing the emergency signal for evacuation.
- The SC-HW and a "buddy" will remain on the site after the site has been evacuated (if safe) to assist local responders and advise them of the nature and location of the incident.
- The SC-HW will account for all personnel in the onsite assembly area.
- A designated person will account for personnel at alternate assembly area(s).
- The SC-HW will incident reporting as outlined in 9.7

9.6 Evacuation Signals

Signal	Meaning
Grasping throat with hand	Emergency-help me.
Thumbs up	OK; understood.
Grasping buddy's wrist	Leave area now.
Continuous sounding of horn	Emergency; leave site now.

9.7 Incident Notification and Reporting

In the event of an emergency, immediately call….. **911.**

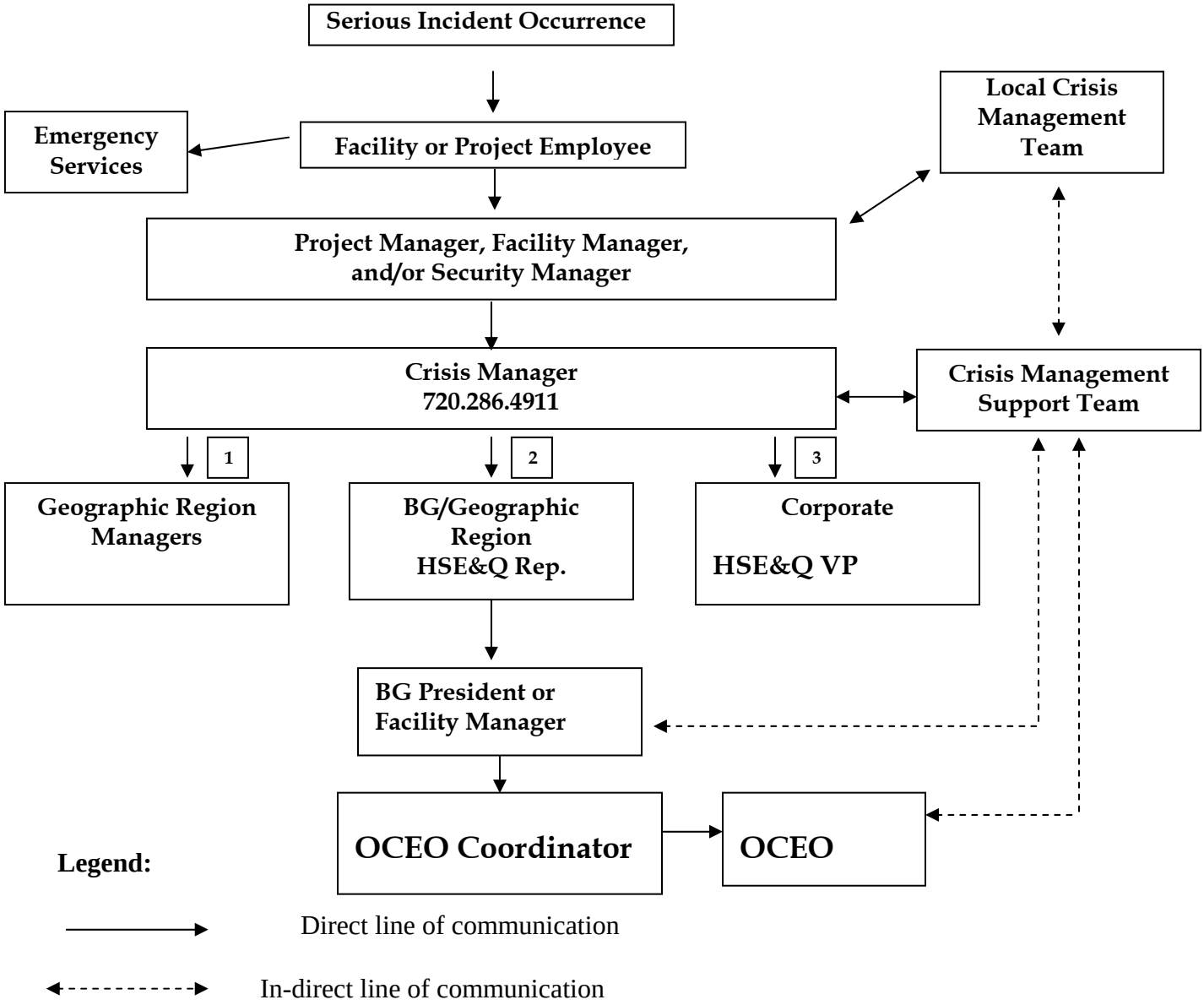
- Severe Bleeding
- Loss of consciousness
- Chest Pain
- Broken bones

All other injuries or illness' (even those that are minor and may only require First Aid) which occur at work, while on business travel or commute must be reported to your supervisor immediately. **After informing their supervisor, the injured employee calls CH2M HILL's contracted Occupational Nurse**.

24-hour CH2M HILL Emergency Nurse Assistance
800/756-1130

- The Occupational Injury Nurse listens to the injured employee to understand the injury/illness.
- Employee is provided guidance on appropriate treatment options (triage).
- Appropriate treatment details are handled by the Occupational Injury Nurse, and Workers Compensation Groups.
- Nurse communicates and troubleshoots with and for employee through full recovery.

Serious Incident Notification Chart



SECTION 10

Approval

This site-specific Health and Safety Plan has been written for use by CH2M HILL only. CH2M HILL claims no responsibility for its use by others unless that use has been specified and defined in project or contract documents. The plan is written for the specific site conditions, purposes, dates, and personnel specified and must be amended if those conditions change.

10.1 Original Plan

Written By: Cory Hinds/ANC **Date:** May 2007

Approved By: **Date:**

John Culley/SPK

10.2 Revisions

Revisions Made By: Jenelle Morris/DEN **Date:** July 26, 2007

Revisions to Plan: Updated staff and behavior based forms.

Revisions Approved By: **Date:** July 26, 2007

Jenelle Morris, CIH

SECTION 11

Attachments

Attachment 1:	Employee Signoff Form — Field Safety Instructions
Attachment 2:	Project-Specific Chemical Product Hazard Communication Form
Attachment 3:	Chemical-Specific Training Form
Attachment 4:	Emergency Contacts
Attachment 5:	Project Activity Self-Assessment Checklists
Attachment 6:	JHAs/PTSA
Attachment 7:	Spill Notification Form (USACE)

Attachment 1
Employee Signoff Form — Field Safety Instructions

CH2MHILL

EMPLOYEE SIGNOFF FORM

Health and Safety Plan

- The CH2M HILL project employees and subcontractors listed below have been provided with a copy of this HSP, have read and understood it, and agree to abide by its provisions.

Project Name: **Project Number:**

EMPLOYEE NAME (Please print)	**EMPLOYEE SIGNATURE**	**COMPANY**	**DATE**

Attachment 2
Project-Specific Chemical Product Hazard Communication Form

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Project-Specific Chemical Product Hazard Communication Form

This form must be completed prior to performing activities that expose personnel to hazardous chemicals products. Upon completion of this form, the SC-HW shall verify that training is provided on the hazards associated with these chemicals and the control measures to be used to prevent exposure to CH2M HILL and subcontractor personnel. Labeling and MSDS systems will also be explained.

Project Name: **Project Number:**

MSDSs will be maintained at the following location(s):

Hazardous Chemical Products Inventory

Chemical	Quantity	Location	MSDS Available	Container Labels	
				Identity	Hazard
Isobutylene	1 liter, compressed	Support Zone			
Hydrochloric acid	< 500 ml	Support Zone / sample bottles			
Nitric acid	< 500 ml	Support Zone / sample bottles			
Sulfuric Acid	< 500 ml	Support Zone / sample bottles			
Sodium hydroxide	< 500 ml	Support Zone / sample bottles			
Methanol	< 1 Gallon	Support/Decon Zones			
Hexane	< 1 Gallon	Support/Decon Zones			
Alconox/Liquinox	< 1liter	Support/Decon Zones			

Refer to SOP HS-05 *Hazard Communication* for more detailed information.

Attachment 3
Chemical-Specific Training Form

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CHEMICAL-SPECIFIC TRAINING FORM

Location:	Project # :
HCC:	Trainer:

TRAINING PARTICIPANTS:

NAME	SIGNATURE	NAME	SIGNATURE

REGULATED PRODUCTS/TASKS COVERED BY THIS TRAINING:

The HCC shall use the product MSDS to provide the following information concerning each of the products listed above.

☐ Physical and health hazards

☐ Control measures that can be used to provide protection (including appropriate work practices, emergency procedures, and personal protective equipment to be used)

☐ Methods and observations used to detect the presence or release of the regulated product in the workplace (including periodic monitoring, continuous monitoring devices, visual appearance or odor of regulated product when being released, etc.)

Training participants shall have the opportunity to ask questions concerning these products and, upon completion of this training, will understand the product hazards and appropriate control measures available for their protection.

Copies of MSDSs, chemical inventories, and CH2M HILL's written hazard communication program shall be made available for employee review in the facility/project hazard communication file.

Attachment 4
Emergency Contacts

Emergency Contacts

Medical Emergency – 911 Facility Medical Response #: Local Ambulance #:	**CH2M HILL Medical Consultant** Health Resources Dr. Jerry H. Berke, M.D., M.P.H. 600 West Cummings Park, Suite 3400 Woburn, MA 01801-6350 1-781-938-46531-800-350-4511 (After hours calls will be returned within 20 minutes)
Fire/Spill Emergency -- 911 Facility Fire Response #: Local Fire Dept #:	**Local Occupational Physician**
Security & Police – 911 Facility Security #: Local Police #:	**Corporate Director Health and Safety** Name: Jerry Lyle/BOI Phone: 208/345-5314 **24-hour emergency beeper: 888-444-1226**
Utilities Emergency Water: Gas: Electric:	**Health and Safety Manager (HSM)** Name: John Culley/SPK Phone: 509/747-2000
Safety Coordinator - Haz Waste (SC-HW) Name: Bobby Horan/SCO Phone: (714) 435-6256	**Regional Human Resources Department** Name: Holly Michel/SEA Phone: 425/453-5000
Project Manager Name: Cory Hinds/ANC Phone: (907) 646-0348 ext: 348	**Corporate Human Resources Department** Name: John Monark/COR Phone: 303/771-0900
Federal Express Dangerous Goods Shipping Phone: 800/238-5355 **CH2M HILL Emergency Number for Shipping Dangerous Goods** Phone: 800/255-3924	**Worker's Compensation and Auto Claims** Sterling Administration Services Phone: 800/420-8926 After hours: 800/497-4566 Report fatalities AND report vehicular accidents involving pedestrians, motorcycles, or more than two cars.

Contact the Project Manager. Generally, the Project Manager will contact relevant government agencies.

Facility Alarms: Vehicle Horn

Evacuation Assembly Area(s): Site Trailer

Facility/Site Evacuation Route(s):

Hospital Name/Address: Fairbanks Memorial Hospital - See map and directions 1650 Cowles St Fairbanks, Alaska 99701	**Hospital Phone #:** (907) 452-8181

Note: For emergencies use army hospital directly across from the site

Directions			Distance
		Total Est. Time: 11 minutes **Total Est. Distance:** 4.08 miles	
START	**1:**	Start out going NORTH on SANTIAGO AVE toward OAK AVE.	0.3 miles
	2:	Turn LEFT onto NEELY RD.	0.9 miles
	3:	Turn RIGHT onto 10TH ST.	0.2 miles
	4:	Turn LEFT onto GAFFNEY RD. Pass through 1 roundabout.	1.4 miles
	5:	Stay STRAIGHT to go onto AIRPORT WAY.	0.9 miles
	6:	Turn LEFT onto COWLES ST.	0.1 miles
END	**7:**	End at **1650 Cowles St** Fairbanks, AK 99701-5925, US	
		Total Est. Time: 11 minutes**Total Est. Distance:** 4.08 miles	

Attachment 5
Forms/Permits

Behavior Based Loss Prevention System

Job Hazard Analysis

Pre-Task Safety Plan

Safe Work Observation

Incident Report Form (use online form when available)

On line IRF/HITS form

Near Loss Investigation/Root Cause Analysis

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JOB HAZARD ANALYSIS

Date Prepared:	Task Risk Assessment Code (RAC): L, M, H, or E
Job/Activity:	
Project:	E = Extremely High Risk
Prepared by(SC):	H = High Risk
Reviewed by (PM/Site Supervisor/H&S):	M = Moderate Risk
Description of the work:	

Severity	Probability: Frequent	Likely	Occasional	Seldom	Unlikely
Catastrophic	E	E	H	H	M
Critical	E	H	H	M	L
Marginal	H	M	M	L	L
Negligible	M	L	L	L	L

Work Activity Sequence (Identify the principal steps involved and the sequence of work activities)	**Potential Health and Safety Hazards** (Analyze each principal step for potential hazards)	**Hazard Controls** (Develop specific controls for each potential hazard)

JOB HAZARD ANALYSIS

Equipment to be used (List equipment to be used in the work activity)	**Inspection Requirements** (List inspection requirements for the work activity)	**Training Requirements** (List training requirements including hazard communication)

PRINT NAME		SIGNATURE	
Supervisor Name:	_____	_____	**Date/Time:**_____
Safety Officer Name:	_____	_____	**Date/Time:**_____
Employee Name(s):	_____	_____	**Date/Time:**_____
	_____	_____	**Date/Time:**_____
	_____	_____	**Date/Time:**_____
	_____	_____	**Date/Time:**_____
	_____	_____	**Date/Time:**_____
	_____	_____	**Date/Time:**_____
	_____	_____	**Date/Time:**_____
	_____	_____	**Date/Time:**_____
	_____	_____	**Date/Time:**_____

CH2MHILL

Pre-Task Safety Plan (PTSP)

Project: _____ Location: _____Date:_____

Supervisor: _____ Job Activity:_____

_____

Task Personnel:

_____

_____

_____

_____

List Tasks:

_____

_____

_____

_____

Tools/Equipment Required for Tasks (ladders, scaffolds, fall protection, cranes/rigging, heavy equipment, power tools):

_____

_____

_____

Potential H&S Hazards, including chemical, physical, safety, biological and environmental (check all that apply):

__ Chemical burns/contact	__ Trench, excavations, cave-ins	__ Ergonomics
__ Pressurized lines/equipment	__ Overexertion	__ Chemical splash
__ Thermal burns	__ Pinch points	__ Poisonous plants/insects
__ Electrical	__ Cuts/abrasions	__ Eye hazards/flying projectile
__ Weather conditions	__ Spills	__ Inhalation hazard
__ Heights/fall > 6 feet	__ Overhead Electrical hazards	__ Heat/cold stress
__ Noise	__ Elevated loads	__ Water/drowning hazard
__ Explosion/fire	__ Slips, trip and falls	__ Heavy equipment
__ Radiation	__ Manual lifting	__ Aerial lifts/platforms
__ Confined space entry	__ Welding/cutting	__ Demolition

Other Potential Hazards (Describe):_____

_____

_____

CH2MHILL

Hazard Control Measures (Check All That Apply):			
PPE __ Thermal/lined __ Eye __ Dermal/hand __ Hearing __ Respiratory __ Reflective vests __ Flotation device	Protective Systems __ Sloping __ Shoring __ Trench box __ Barricades __ Competent person __ Locate buried utilities __ Daily inspections	Fire Protection __ Fire extinguishers __ Fire watch __ Non-spark tools __ Grounding/bonding __ Intrinsically safe equipment	Electrical __ Lockout/tagout __ Grounded __ Panels covered __ GFCI/extension cords __ Power tools/cord inspected
Fall Protection __ Harness/lanyards __ Adequate anchorage __ Guardrail system __ Covered opening __ Fixed barricades __ Warning system	Air Monitoring __ PID/FID __ Detector tubes __ Radiation __ Personnel sampling __ LEL/O2 __ Other	Proper Equipment __ Aerial lift/ladders/scaffolds __ Forklift/heavy equipment __ Backup alarms __ Hand/power tools __ Crane with current inspection __ Proper rigging __ Operator qualified	Welding & Cutting __ Cylinders secured/capped __ Cylinders separated/upright __ Flash-back arrestors __ No cylinders in CSE __ Flame retardant clothing __ Appropriate goggles
Confined Space Entry __ Isolation __ Air monitoring __ Trained personnel __ Permit completed __ Rescue	Medical/ER __ First-aid kit __ Eye wash __ FA-CPR trained personnel __ Route to hospital	Heat/Cold Stress __ Work/rest regime __ Rest area __ Liquids available __ Monitoring __ Training	Vehicle/Traffic __ Traffic control __ Barricades __ Flags __ Signs
Permits __ Hot work __ Confined space __ Lockout/tagout __ Excavation __ Demolition __ Energized work	Demolition __ Pre-demolition survey __ Structure condition __ Isolate area/utilities __ Competent person __ Hazmat present	Inspections: __ Ladders/aerial lifts __ Lanyards/harness __ Scaffolds __ Heavy equipment __ Cranes and rigging	Training: __ Hazwaste __ Construction __ Competent person __ Task-specific (THA) __ Hazcom
Field Notes:_____ _____ _____			

Name (Print): _____

Signature:_____ Date:_____

Safe Work Observation Form		
Project:	Observer:	Date:
Position/Title of worker observed:	Background Information/ comments:	
Task/Observation Observed:		

- Identify and reinforce safe work practices/behaviors
- Identify and improve on at-risk practices/acts
- Identify and improve on practices, conditions, controls, and compliance that eliminate or reduce hazards
- Proactive PM support facilitates eliminating/reducing hazards (do you have what you need?)
- Positive, corrective, cooperative, collaborative feedback/recommendations

Actions & Behaviors	Safe	At-Risk	Observations/Comments
Current & accurate Pre-Task Planning/Briefing (Project safety plan, STAC, JHA, PTSP, tailgate briefing, etc., as needed)			**Positive Observations/Safe Work Practices:**
Properly trained/qualified/experienced			
Tools/equipment available and adequate			
Proper use of tools			**Questionable Activity/Unsafe Condition Observed:**
Barricades/work zone control			
Housekeeping			
Communication			
Work Approach/Habits			
Attitude			
Focus/attentiveness			**Observer's Corrective Actions/Comments:**
Pace			
Uncomfortable/unsafe position			
Inconvenient/unsafe location			
Position/Line of fire			
Apparel (hair, loose clothing, jewelry)			
Repetitive motion			**Observed Worker's Corrective Actions/Comments:**
Other…			

Root Cause Analysis Form

Root Cause Analysis (RCA)

Root Cause Categories (RCC): Select the RCC numbered below that applies for the root cause (RC) and/or contributing factor (CF) in the first column, then describe the specific root cause and corrective actions in each column.

1. **Lack of skill or knowledge**
2. **Lack of or inadequate operational procedures or work standards**
3. **Inadequate communication of expectations regarding procedures or work standards**
4. **Inadequate tools or equipment**
5. **Correct way takes more time and/or requires more effort**
6. **Short cutting standard procedures is positively reinforced or tolerated**
7. **Person thinks there is no personal benefit to always doing the job according to standards**

RCC #	Root Cause(s)	Corrective Actions	RC[1]	CF[2]	Due Date	Completion Date	Date Verified

[1] RC = Root Cause; [2] CF = Contributing Factors (check which applies)

Investigation Team Members

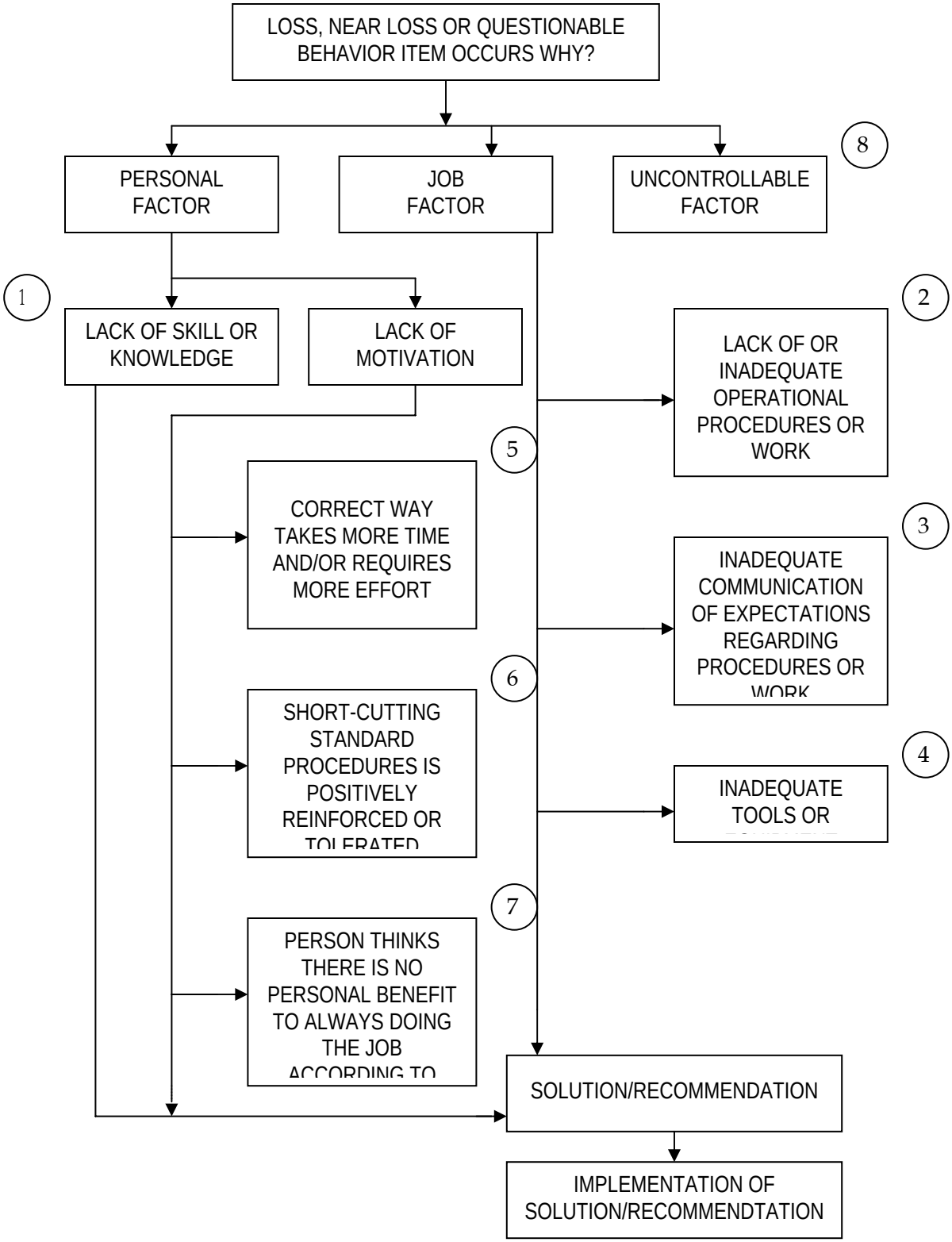
Name	Job Title	Date

Results of Solution Verification and Validation

Reviewed By

Name	Job Title	Date

Root Cause Analysis
Flow Chart



Attachment 6
Self-Assessment Checklist

CH2MHILL

HS&E Self-Assessment Checklist - DRILLING

This checklist shall be used by CH2M HILL personnel **only** and shall be completed at the frequency specified in the project's written safety plan.

This checklist is to be used at locations where: 1) CH2M HILL employees are potentially exposed to drilling hazards, 2) CH2M HILL staff are providing support function related to drilling activities, and/or 3) CH2M HILL oversight of a drilling subcontractor is required.

Safety Coordinator may consult with drilling subcontractors when completing this checklist, but shall not direct the means and methods of drilling operations nor direct the details of corrective actions. Drilling subcontractors shall determine how to correct deficiencies and we must carefully rely on their expertise. Items considered to be imminently dangerous (possibility of serious injury or death) shall be corrected immediately, or all exposed personnel shall be removed from the hazard until corrected.

Project Name: _____ Project No.: _____

Location: _____ PM: _____

Auditor: _____ Title: _____ Date: _____

This specific checklist has been completed to:

☐ Evaluate CH2M HILL employee exposures to drilling hazards (complete Section 1).
☐ Evaluate CH2M HILL support functions related to drilling activities (complete Section 2)
☐ Evaluate a CH2M HILL subcontractor's compliance with drilling safety requirements (complete entire checklist).
Subcontractors Name: _____

- Check "Yes" if an assessment item is complete/correct.
- Check "No" if an item is incomplete/deficient. Deficiencies shall be brought to the immediate attention of the drilling subcontractor. Section 3 must be completed for all items checked "No."
- Check "N/A" if an item is not applicable.
- Check "N/O" if an item is applicable but was not observed during the assessment.

Numbers in parentheses indicate where a description of this assessment item can be found in SOP HSE-204.

SECTION 1 - SAFE WORK PRACTICES (4.1)

	Yes	No	N/A	N/O
1. Personnel cleared during rig startup	☐	☐	☐	☐
2. Personnel clear of rotating parts	☐	☐	☐	☐
3. Personnel not positioned under hoisted loads	☐	☐	☐	☐
4. Loose clothing and jewelry removed	☐	☐	☐	☐
5. Smoking is prohibited around drilling operation	☐	☐	☐	☐
6. Personnel wearing appropriate personal protective equipment (PPE), per written plan	☐	☐	☐	☐
7. Personnel instructed not to approach equipment that has become electrically energized	☐	☐	☐	☐

SECTION 2 - SUPPORT FUNCTIONS (4.2)

FORMS/PERMITS (4.2.1)

8. Driller license/certification obtained	☐	☐	☐	☐
9. Well development/abandonment notifications and logs submitted and in project files	☐	☐	☐	☐
10. Water withdrawal permit obtained, where required	☐	☐	☐	☐
11. Dig permit obtained, where required	☐	☐	☐	☐

UTILITY LOCATING (4.2.2)

12. Location of underground utilities and structures identified	☐	☐	☐	☐

We will only maintain controlled copies online. Printed versions of this document are uncontrolled copies. To ensure you have the current version, use the copy found at: http://www.int.ch2m.com/safety_counts/HS_SOP_Manual/Manual.html

SECTION 2 (Continued)

		Yes	No	N/A	N/O
WASTE MANAGEMENT (4.2.3)					
13.	Drill cuttings and purge water managed and disposed properly	☐	☐	☐	☐
DRILLING AT HAZARDOUS WASTE SITES (4.2.4)					
14.	Waste disposed of according to project's written safety plan	☐	☐	☐	☐
15.	Appropriate decontamination procedures being followed, per project's written safety plan ☐		☐	☐	☐
DRILLING AT MUNITIONS RESPONSE (4.2.5)					
16.	MEC plan prepared and approved	☐	☐	☐	☐
17.	MEC avoidance provided, routes and boundaries cleared and marked	☐	☐	☐	☐
18.	Initial pilot hole established by UXO technician with hand auger	☐	☐	☐	☐
19.	Personnel remain inside cleared areas	☐	☐	☐	☐
SECTION 3 - DRILLING SAFETY REQUIREMENTS (4.3)					
GENERAL (4.3.1)					
20.	Only authorized personnel operating drill rigs	☐	☐	☐	☐
21.	Daily safety briefing/meeting conducted with crew	☐	☐	☐	☐
22.	Daily inspection of drill rig and equipment conducted before use	☐	☐	☐	☐
DRILL RIG PLACEMENT (4.3.2)					
23.	Location of underground utilities and structures identified	☐	☐	☐	☐
24.	Safe clearance distance maintained from overhead power lines	☐	☐	☐	☐
25.	Drilling pad established, when necessary	☐	☐	☐	☐
26.	Drill rig leveled and stabilized	☐	☐	☐	☐
27.	Additional precautions taken when drilling in confined areas	☐	☐	☐	☐
DRILL RIG TRAVEL (4.3.3)					
28.	Rig shut down and mast lowered and secured prior to rig movement	☐	☐	☐	☐
29.	Tools and equipment secured prior to rig movement	☐	☐	☐	☐
30.	Only personnel seated in cab are riding on rig during movement	☐	☐	☐	☐
31.	Safe clearance distance maintained while traveling under overhead power lines	☐	☐	☐	☐
32.	Backup alarm or spotter used when backing rig	☐	☐	☐	☐
DRILL RIG OPERATION (4.3.4)					
33.	Kill switch clearly identified and operational	☐	☐	☐	☐
34.	All machine guards are in place	☐	☐	☐	☐
35.	Rig ropes not wrapped around body parts	☐	☐	☐	☐
36.	Pressurized lines and hoses secured from whipping hazards	☐	☐	☐	☐
37.	Drill operation stopped during inclement weather	☐	☐	☐	☐
38.	Air monitoring conducted per written safety plan for hazardous atmospheres	☐	☐	☐	☐
39.	Rig placed in neutral when operator not at controls	☐	☐	☐	☐
DRILL RIG SITE CLOSURE (4.3.5)					
40.	Ground openings/holes filled or barricaded	☐	☐	☐	☐
41.	Equipment and tools properly stored	☐	☐	☐	☐
42.	All vehicles locked and keys removed	☐	☐	☐	☐
DRILL RIG MAINTENANCE (4.3.6)					
28.	Defective components repaired immediately	☐	☐	☐	☐
29.	Lockout/tagout procedures used prior to maintenance	☐	☐	☐	☐
30.	Cathead in clean, sound condition	☐	☐	☐	☐
31.	Drill rig ropes in clean, sound condition	☐	☐	☐	☐
32.	Fall protection used for fall exposures of 6 feet (U.S.) 1.5 meters (Australia) or greater	☐	☐	☐	☐
33.	Rig in neutral and augers stopped rotating before cleaning	☐	☐	☐	☐
34.	Good housekeeping maintained on and around rig	☐	☐	☐	☐

SECTION 4

Complete this section for all items checked “No” in previous sections. Deficient items must be corrected in a timely manner.

Item #	Corrective Action Planned/Taken	Date Corrected

Auditor: ___________________________ Project Manager: ______________________________________

We will only maintain controlled copies online. Printed versions of this document are uncontrolled copies. To ensure you have the current version, use the copy found at: http://www.int.ch2m.com/safety_counts/HS_SOP_Manual/Manual.html

Attachment 7
Spill Notification Form (USACE)

OIL & HAZARDOUS SUBSTANCES SPILL NOTIFICATION

SPILL #	**FILE #**		**LC**
SPILL NAME, IF ANY	**PERSON REPORTING:**		**PHONE NUMBER**
DATE/ TIME OF SPILL	**DATE/TIME REPORTED**: **DATE/TIME DISCOVERED**:		**REPORTED HOW? (Phone, fax, etc.)**
LOCATION			**SUBSTANCE SPILLED**
QUANTITY SPILLED	**QUANTITY CONTAINED**	**QUANTITY RECOVERED**	**QUANTITY DISPOSED**
POTENTIAL RESPONSIBLE PARTY		**OTHER POTENTIAL RESPONSIBLE PARTIES, IF ANY**	
SOURCE OF SPILL			
CAUSE OF SPILL			
CLEANUP ACTIONS			
DISPOSAL METHODS AND LOCATION			
ENVIRONMENTAL DAMAGE (circle one) YES NO	**SURFACE AREA AFFECTED (in square feet)**		**SURFACE TYPE (describe area affected)**
COMMENTS. Spill Report FWA 04-XXX			
TYPE OF DEC RESPONSE (phone, field visit, took report)	**NAMES OF DEC STAFF RESPONDING**		**CASE STATUS (open, closed, trans. to cont. sites)**

U.S. Army, Alaska

Prepared for

U.S. Army Corps of Engineers
Alaska District

FINAL

Areawide Community Involvement Plan Fort Wainwright, Alaska

January 2003

Document No. 9000-249-008

Prepared by

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PREFACE

This Areawide Community Involvement Plan* is a guide for the U.S. Army, Alaska and state and federal agencies to emphasize two-way communication with the public about the cleanup of contamination at Fort Wainwright, Alaska. This plan replaces the revised Areawide Community Relations Plan written in October 1997 by updating source area descriptions, describing the status of investigations and cleanup activities, and incorporating the current level of community interest in decisions on what community involvement activities are appropriate.

The Fort Wainwright military reservation was identified for cleanup because of the discovery of soil and groundwater contamination. More details about Fort Wainwright and the contamination at the post are presented in Section 2 and Appendix B of this plan.

The cleanup activities at Fort Wainwright comply with state and federal laws, which encourage public input into the development of proposed cleanup activities. The introduction of this Community Involvement Plan briefly describes the laws, programs, and requirements that must be fulfilled. More detailed definitions of these laws and other technical terms are presented in the Glossary of Terms in Appendix A. Readers may refer to the List of Acronyms and Abbreviations on page iv for definitions of acronyms and abbreviations contained in this document.

* Previous community plans were called "Community Relations Plans" per U.S. Environmental Protection Agency (EPA) guidance; however, the EPA has recently revised guidance to call these plans "Community Involvement Plans," hence the name change of this document compared to the previous two versions.

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LIST OF ACRONYMS AND ABBREVIATIONS

ADEC	Alaska Department of Environmental Conservation
Army	U.S. Army
bgs	Below ground surface
CERCLA	Comprehensive Environmental Response, Compensation, and Liability Act
CIP	Community Involvement Plan
CRP	Community Relations Plan
DERA	Defense Environmental Restoration Account
DoD	U.S. Department of Defense
E&E	Ecology and Environment, Inc.
EPA	Environmental Protection Agency (U.S.)
ESD	Explanation of Significant Differences
FFA	Federal Facility Agreement
IRP	Installation Restoration Program
LAAF	Ladd Army Airfield
LAFB	Ladd Air Force Base
NFA	No further action
NPL	National Priorities List
OU	Operable Unit
POL	Petroleum, oil, and lubricants
PSE	Preliminary Source Evaluation
RA	Remedial action
RAB	Restoration Advisory Board
RCRA	Resource Conservation and Recovery Act
RD	Remedial design
RI	Remedial investigation
RI/FS	Remedial Investigation/Feasibility Study
ROD	Record of Decision
RPM	Remedial Project Manager
SARA	Superfund Amendments and Reauthorization Act
TAPP	Technical Assistance for Public Participation
TPA	Two-Party Agreement
TRC	Technical Review Committee
USAED-AK	U.S. Army Engineer District – Alaska
USARAK	U.S. Army, Alaska
UST	Underground storage tank

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1.0 INTRODUCTION

This Community Involvement Plan (CIP) was prepared for known and suspected hazardous waste sites identified under the Comprehensive Environmental Response, Compensation, and Liability Act[1] (CERCLA) at Fort Wainwright, Alaska (see Figures 1-1 and 1-2). Fort Wainwright was listed on the U.S. Environmental Protection Agency's (EPA's) National Priorities List (NPL) on August 30, 1990, because of confirmed hazardous soil and groundwater contamination. CERCLA requires preparation of a CIP for each NPL site.

This CIP informs the adjacent communities of Fort Wainwright, Fairbanks, and North Pole regarding contamination at Fort Wainwright. It includes plans for community involvement activities to be conducted by the U.S. Army, Alaska (USARAK) in consultation with the EPA and the Alaska Department of Environmental Conservation (ADEC) during ongoing environmental investigation and cleanup activities at Fort Wainwright.

1.1 The Remedial Process

Congress enacted CERCLA, more commonly known as Superfund, in 1980. CERCLA established a nationwide process to determine which sites pose the greatest risk to public health and the environment. CERCLA also established a process for cleaning up hazardous waste disposal and spill sites. In 1986, Congress passed the Superfund Amendments and Reauthorization Act (SARA), which amended and reauthorized CERCLA.

Since it began operations, Fort Wainwright has generated and disposed of various hazardous wastes. The post was added to the EPA's NPL in 1990 to address soil and groundwater contamination and to initiate the Installation Restoration Program (IRP) and CERCLA process. The NPL is EPA's prioritized list of sites that require action under CERCLA. Sites are prioritized according to EPA's Hazard Ranking System, a scoring system that evaluates potential risks to public health and the environment from releases or threatened releases of hazardous substances. The score is based on the actual or potential release of hazardous substances from a site through air, soil, surface water, or groundwater. This score is the main factor used to include a site on the NPL. Once a site is included on the NPL, it becomes eligible for investigation and cleanup. Because Fort Wainwright is a U.S. Department of Defense (DoD) site, all investigations and cleanup activities are conducted and funded through the Defense Environmental Restoration Account (DERA). DERA is the fund that DoD uses to comply with the investigation and cleanup requirements established by CERCLA.

---

[1] More detailed explanations of CERCLA and other terms are presented in the Glossary of Terms in Appendix A.

Regardless of the funding mechanism, all federal facilities, including Fort Wainwright, are subject to the same hazardous substances guidelines, rules, regulations, and criteria that apply to any nonfederal facility. Section 211 of SARA describes an environmental restoration program, specifically named an *Installation Restoration Program*, for DoD facilities such as Fort Wainwright. Specific goals of the IRP include the following:

- Identification, investigation, and cleanup of contamination from hazardous substances, pollutants, and contaminants;
- Correction of other environmental damage that may create an imminent and substantial threat to public health or welfare or to the environment; and
- Demolition and removal of unsafe buildings and structures, including buildings and structures at sites formerly used by DoD or under the jurisdiction of the Secretary of Defense.

Within the IRP and CERCLA, suspect sites underwent a routine series of activities to determine appropriate actions, beginning with Preliminary Source Evaluations (PSEs). Based on results and information collected during the PSE, a PSE report (which contains the findings of the investigation) was submitted by the USARAK to the ADEC and EPA for review and comment. At that time, a decision was made that either the findings warranted additional investigation of the potential source or that no further action (NFA) was necessary. A decision of NFA at a potential source was agreed on by project managers from the USARAK, ADEC, and EPA; all parties then signed a No Further Action Decision Document. If further action was warranted, efforts at the source area continued with the steps outlined below:

1. PSE 1: This activity involved collecting and reviewing all information associated with a suspect site to determine the site's location, past operations, and whether further study is needed.

2. PSE 2: If information that indicated the past operations and locations of the potential source existed, then the PSE 2 consisted of a site visit or collection of limited field data, or both.

3. Remedial Investigation/Feasibility Study (RI/FS): The RI/FS focused on determining the type and extent of contamination at the site and identifying possible cleanup alternatives. A Risk Assessment, which identified potential environmental and human health risks related to contamination detected on site, was prepared during the RI/FS.

4. Proposed Plan: This plan proposed a preferred remedy for the site after a detailed analysis of the possible cleanup alternatives was conducted. The Army solicited and received public input on the preferred remedies identified for each operable unit (OU).

5. Record of Decision (ROD): This document explained the remedial alternative selected for the site. The ROD is based on information and technical analysis generated during the RI/FS and included consideration of public comments and community concerns.

6. Remedial Design (RD): This activity, which followed the ROD, involved developing the engineering specifications for the actual remediation.

7. Remedial Action (RA): The actual construction or implementation phase that followed RD of the selected cleanup alternative.

8. Operation and Maintenance (O&M): The operation and maintenance of remedial systems placed on site during Remedial Action construction.

9. Long-term Monitoring (LTM): The monitoring of contaminated media, in most cases on Fort Wainwright the contaminated media is groundwater, to ensure that remedial systems are operating effectively. The goal of LTM is to show a decrease in contaminant levels over time. Depending on the remedial system and the contaminant concern, monitoring is conducted quarterly, biannually, or annually.

10. Response Complete (RC): The remedy is in place and remedial action operations are completed.

Five years following the signature of the installation's first ROD, a Five-Year Review is required. At Fort Wainwright, the first ROD was signed for OU3 in March 1996. The Five-Year Review is a document that reviewed activities on post to ensure that RAs selected in the RODs are being implemented and that they continue to be protective of human health and the environment. The first Five-Year Review for Fort Wainwright was completed September 2001. A copy of the document is located in the Administrative Record and in the information repositories. Subsequent reviews will occur every 5 years if RAs result in hazardous substances, pollutants, or contaminants remaining at the site above levels that allow for unlimited use and unrestricted exposure. It is anticipated there will be at least one more Five-Year Review for Fort Wainwright scheduled for 2006.

Community involvement activities have accompanied each step in the IRP and CERCLA process at Fort Wainwright.

1.2 Federal Facility Agreement

A Federal Facility Agreement (FFA) is an agreement signed by respective agencies to manage site cleanup.[2] An FFA for Fort Wainwright was signed by EPA, Region 10; ADEC; and the U.S.

[2] A copy of the FFA can be found in the Administrative Record and at the information repository locations listed in Appendix D of this plan.

Army (Army) in March 1992. The FFA ensures that environmental impacts associated with past practices at Fort Wainwright are investigated and RAs are completed to protect human health and the environment. This agreement sets deadlines, objectives, responsibilities, and procedural framework for implementing the IRP at Fort Wainwright.

The FFA established and described the CERCLA process as it applied to Fort Wainwright. It was in the FFA that the use of PSEs was established to better define the scope of the RI/FS activities. The PSE approach, which is an accepted part of CERCLA investigation, was adopted to facilitate the use of information previously collected under the USARAK's IRP. The information was used to identify additional areas of concern, to expedite interim RAs, and to screen the numerous sites of potential concern and to identify those sites that warranted remedial investigations (RIs). This PSE approach saves money by eliminating sties that do not warrant action through the RI/FS process. PSE reports were used as lead-in documents to the OUs and the RI/FS process.

An additional goal of the FFA was to integrate the USARAK's CERCLA response obligations and Resource Conservation and Recovery Act (RCRA) corrective action obligations at this site. The FFA states that RAs implemented under this agreement will be protective of human health and the environment such that remediation of releases shall result in the need for no further corrective actions under RCRA.

Each of the three parties (i.e., the USARAK, ADEC, and EPA) to the Fort Wainwright FFA is represented by a Remedial Project Manager (RPM)[3]. These three RPMs meet quarterly, at a minimum, to discuss the USARAK's progress regarding RAs selected in the RODs and to address related issues as they arise during the course of the RAs. The RPMs meet more frequently than quarterly when needed and routinely make themselves available to each other to meet the purposes of Fort Wainwright remediation activities (e.g., conducting technical reviews and modifying monitoring programs) and to meet the intent and commitments of the FFA.

1.3 Two-Party Agreement

Fort Wainwright also negotiated a Two-Party Agreement (TPA) with ADEC in 1992. This Agreement sets the framework to cooperatively address petroleum, oil and lubricants (POL) contamination caused primarily by leaking underground storage tanks (USTs) and surface spills at the post.

The TPA acknowledged that all parties to the FFA (which was being negotiated at the time the TPA was signed) agreed to allow the USARAK to initially address the cleanup of these areas of

[3] "The RPMs" is used in this report to refer to these three representatives.

POL contamination in accordance with the state's statutes, regulations, and Interim Guidance, with a review by the RPMs at the time of the OU5 ROD to ensure that POL sites were being adequately addressed.

Appendix D to the OU5 ROD[4] contains the January 1998 "Recommended Action, Fort Wainwright Petroleum Strategy," signed by the parties to the FFA. This document verified the strategies developed by the USARAK and ADEC to address the known POL-contaminated source areas on Fort Wainwright.

Appendix C to this document contains a list of the TPA sites.

1.4 Community Involvement Program Overview

The EPA developed the CERCLA Community Involvement Program to ensure the opportunity for public involvement in all environmental cleanup actions. The USARAK, as the lead agency at Fort Wainwright, provided the public with opportunities to participate in all site-related decisions. The EPA and ADEC are also involved with the Community Involvement Program as oversight agencies to ensure that the public's concerns are addressed. The first step in the Community Involvement Program is the development of the CIP.

The activities in this CIP are designed to inform interested citizens and local officials about the progress of remedial activities and to provide the public with opportunities for offering input during the planning and implementation of RAs at Fort Wainwright.

This CIP revises the original Areawide Community Relations Plan (CRP) written in April 1993 and the revised CRP published in October 1997. The original CRP was based on anecdotal stories from interviews with representatives from the City of Fairbanks, Fairbanks-area residents, community groups, past and present workers, military personnel, and post residents. Information from the EPA's and the USARAK's files was also incorporated in that document. The revised CRP updated source area descriptions and discussed the status of investigation and cleanup activities at Fort Wainwright based on remedial work conducted through May 1997. The revised CRP also incorporated responses to a May 1996 questionnaire, distributed by the USARAK, regarding the then-called community relations program at Fort Wainwright (see Section 4.2 of this CIP). This version of the CIP reviews community involvement activities appropriate for the site during its late stage in the CERCLA process and provides brief updates on the status of OUs. (Appendix B contains detailed status information about the OUs.)

This CIP is organized into five sections:

---

[4] Copies of the OU5 ROD can be found in the Administrative Record and at the information repository locations listed in Appendix D of this CIP.

- Section 1 contains an introduction and general discussion of CERCLA,
- Section 2 provides information about Fort Wainwright's history and a description of the post,
- Section 3 describes the Fairbanks and Fort Wainwright communities and their concerns related to environmental cleanup at Fort Wainwright,
- Section 4 describes the community involvement activities which make up the Community Involvement Program and provides a schedule of remedial activities on the post, and
- Section 5 provides a bibliography of source documents used in developing this CIP.

Tables and illustrations are at the end of their respective sections. The following appendices are included:

Appendix A – Glossary of Terms,

Appendix B – Description of Operable Units,

Appendix C – Two-Party Agreement Sites,

Appendix D – Administrative Record and Information Repository Locations,

Appendix E – List of Contacts and Interested Parties,

Appendix F – Newsletter Example,

Appendix G – Public Meeting Locations,

Appendix H – Technical Assistance for Public Participation, and

Appendix I – Technical Assistance Grant Program Information.

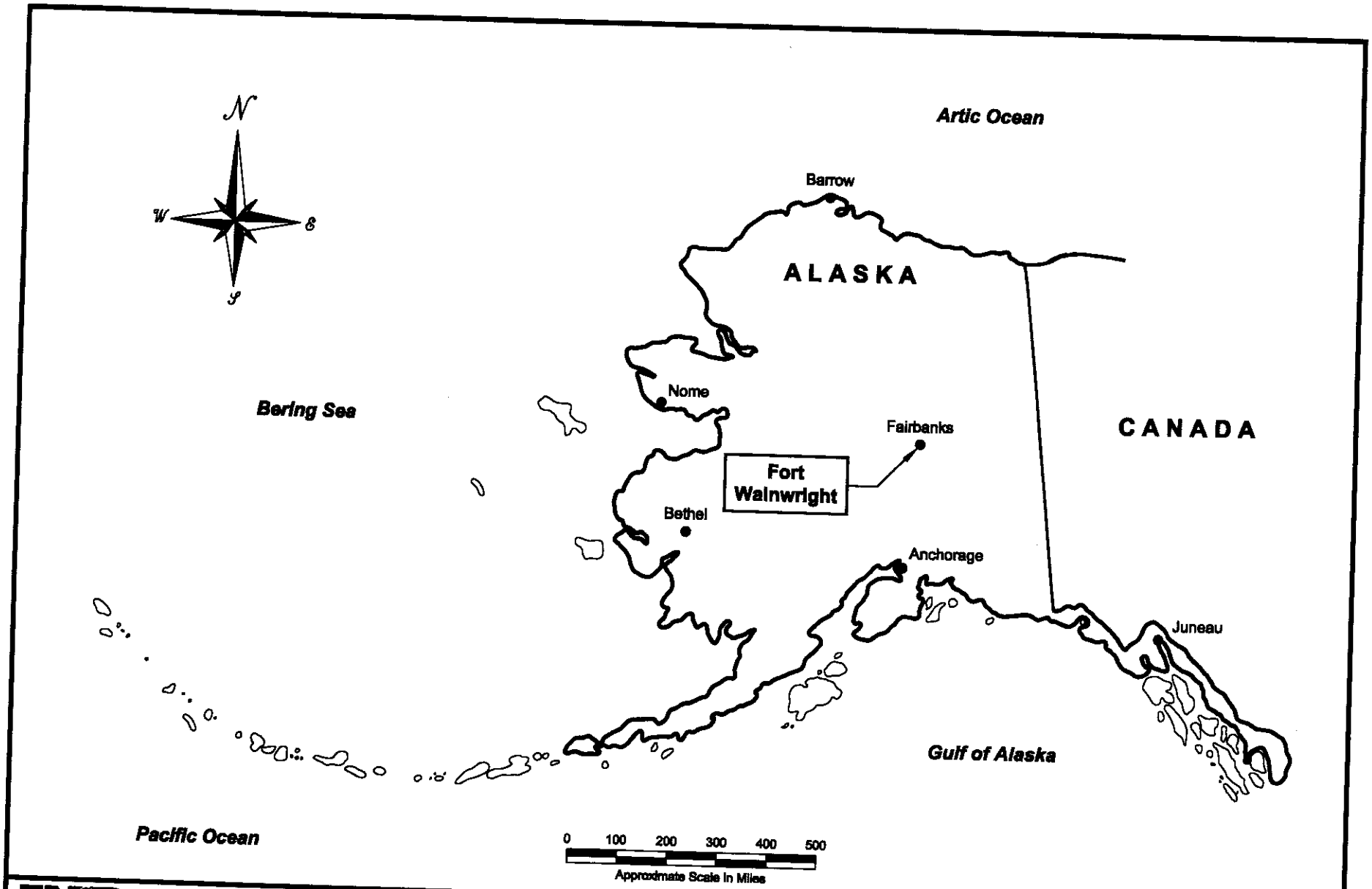

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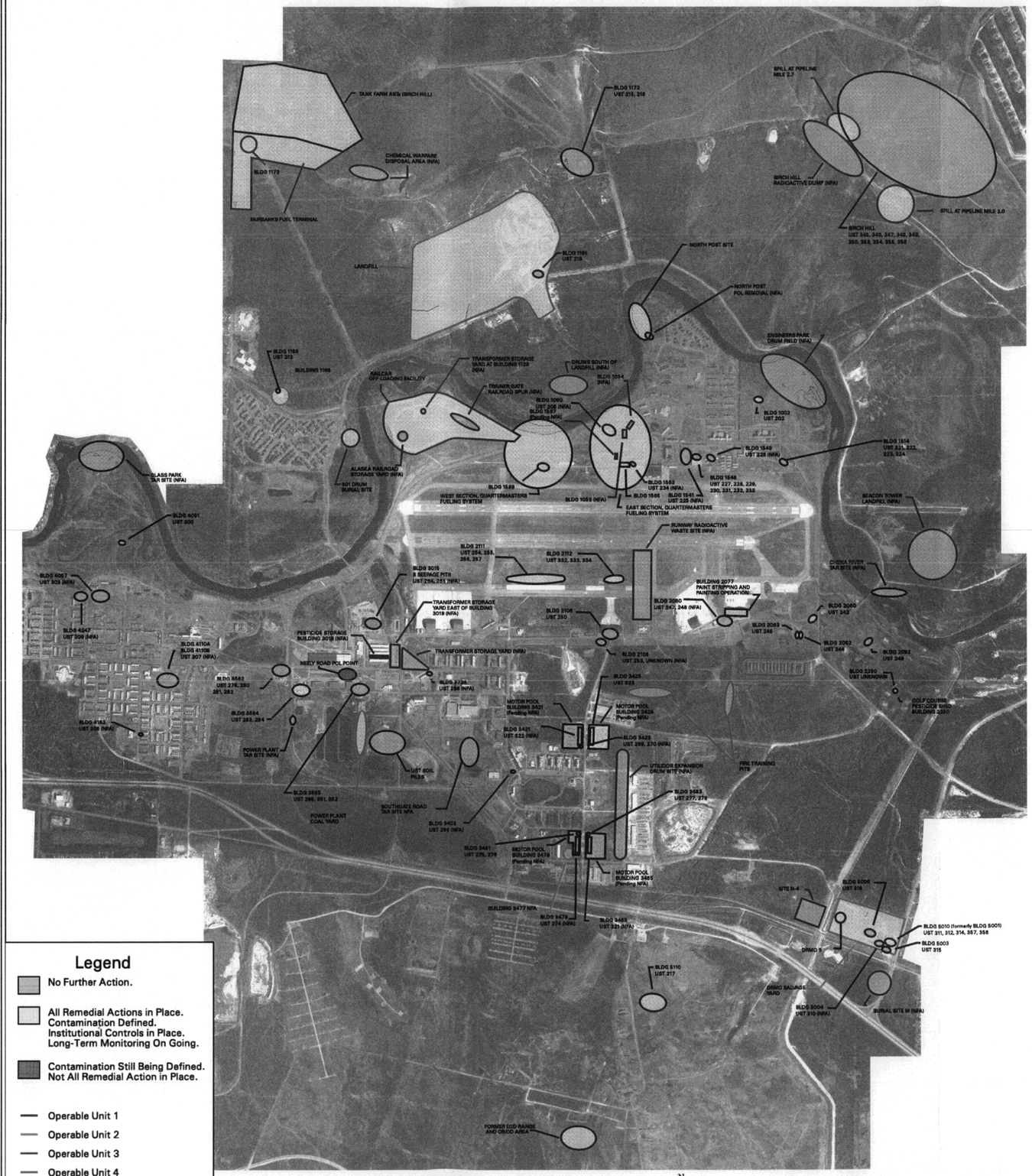
FIGURE 1-1

FORT WAINWRIGHT LOCATION MAP

U.S ARMY CORPS OF ENGINEERS
FORT WAINWRIGHT, ALASKA

PROJECT: 09000-249-008

Figure 1-2
Status of Operable Unit Remediation, March 2002
Fort Wainwright, Alaska



Legend

- No Further Action.
- All Remedial Actions in Place. Contamination Defined. Institutional Controls in Place. Long-Term Monitoring On Going.
- Contamination Still Being Defined. Not All Remedial Action in Place.
- Operable Unit 1
- Operable Unit 2
- Operable Unit 3
- Operable Unit 4
- Operable Unit 5

March 04, 2002

0 500 1000 1500 2000 Meters

0 1000 2000 3000 4000 5000 6000 Feet

N W E S

For further information on Environmental Restoration at Fort Wainwright, please contact: Therese Deardorff by phone: (907) 384-2716 or email:deardort@richardson-emh2.army.mil

For further information on this map or the U.S. Army Alaska Geographic Information System, please contact: Dr. Daniel Lawson by phone: (907) 384-0510 or email:dlawson@crrel.usace.army.mil

NO FURTHER ACTION

OPERABLE UNIT 1
Alaska Railroad Storage Yard
Alpha Impact Area (not on map)
Beacon Tower Landfill
Birch Hill Radioactive Dump
Blair Lakes (not on map)
Blair Lakes Drum Site (not on map)
Building 1053
Building 1054
Building 1128 Transformer Storage Yard
Building 3019 Pesticide Storage
Burial Site M
Chemical Warfare Disposal Area
Drum Site South of the Landfill
Engineers Park Drum Site
Former Building 1567
Runway Radioactive Waste Site
Site N-4
Trainer Gate Railroad Spur
Transformer Storage Yard
Utilidor Expansion Drum Site

OPERABLE UNIT 2
Building 3477

OPERABLE UNIT 3
Fairbanks-Eielson Pipeline Spill at Milepost 15.75 (not on map)

OPERABLE UNIT 4
Fire Training Pits

OPERABLE UNIT 5
Motor Pool Building 3421
Motor Pool Building 3479
Motor Pool Building 3485
Open burn/Open Detonation Site (not on map)

TWO-PARTY SITES
Birch Hill USTs 345-350, 353-356, 381
Building 1172 USTs 215 216 (LTM&IC)
Building 1191 UST 219
Building 1514 UST 221-224
Building 1541 UST 225
Building 1543 UST 226
Building 1546 USTs 227-233 (includes IC)
Building 1563 UST 234
Building 2080 UST 247, 248
Building 2092 (pending) UST 249
Building 2106 UST 250
Building 2108 UST 253
Building 3015 and Seepage Pits UST 264, 265
Building 3403 UST 266
Building 3421 UST 322
Building 3423 UST 269, 270
Building 3479 UST 274
Building 3485 UST 321
Building 3562 USTs 279-282 (LTM & IC)
Building 3595 USTs 295, 351, 352 (includes IC)
Building 3724 UST 298
Building 4051 UST 300
Building 4057 UST 303
Building 4110A
Building 4110B UST 307
Building 4162 UST 308
Building 4247 UST 309
Building 5003 UST 315 (includes IC)
Building 5004 UST 310 (includes IC)
Building 5006 UST 316 (includes IC)
Chena River Tar Site
Glass Park Tar Site
Nike Sites B&C (not on map)
North Post POL Removal
Power Plant Tar Site
Southgate Road Tar Site
UST Soil Piles

ALL REMEDIAL ACTIONS IN PLACE. CONTAMINATION DEFINED. INSTITUTIONAL CONTROLS IN PLACE. LONG-TERM MONITORING ONGOING.

OPERABLE UNIT 1
801 Drum Burial Site (includes IC)

OPERABLE UNIT 2
DRMO Salvage Yard (includes IC)
Former Building 1168 (includes IC)

OPERABLE UNIT 3
Railcar Off-loading Facility
Fairbanks-Eielson Pipeline Spills (Mileposts 2.7 and 3.0)
Tank Farm Facility (including Bldg 1173)

OPERABLE UNIT 4
Coal Storage Yard at Power Plant (includes IC)
Landfill (includes IC)

OPERABLE UNIT 5
East and West Quartermasters Fueling System (includes Bldgs 1060 and 1565 groundwater)
Former EOD Range and OB/OD Area
Tank Farm Facility Above-Ground Storage Tanks (Birch Hill)

TWO PARTY SITES
Building 1002 UST 202 (includes IC)
Building 1599 (IC only)
Building 2060 UST 242 (NA/IR & IC)
Building 2062 UST 244 (NA/IR & IC)
Building 2063 UST 245 (NA/IR & IC)
Building 2077 Paint Stripping and Painting (includes IC)
Building 2250 Golf Course Pesticide Shed (includes IC)
Building 3564 USTs 283, 284 (includes IC)
Building 5010 USTs 311, 312, 314, 357, 358 (includes IC) (formerly Building 5001)
Building 5110 UST 317 (includes IC)
DRMO 5
Former Building 1168 UST 213 (includes IC)
Former Building 2111 USTs 254-257 (includes IC)
Former Building 2112 USTs 332-334 (includes IC)
Former Building 3481 USTs 275, 276 (LTM & IC)
Former Building 3483 USTs 277, 278 (includes IC)
Motor Pool Building (UST 323)
North Post Site (includes IC)

NOT ALL REMEDIAL ACTION IN PLACE/INVESTIGATION IN PROGRESS

TWO PARTY SITES
Neely Road POL Point

US Army Corps of Engineers® Cold Regions Research & Engineering Laboratory

U.S. Army Alaska Directorate of Public Works
U.S. Army Cold Regions Research and Engineering Laboratory

2.0 FORT WAINWRIGHT SITE BACKGROUND

This section is an overview of the postwide Fort Wainwright NPL site. Information on the individual OUs is presented in Appendix B – Description of Operable Units.

2.1 Post History

Fort Wainwright has been used by the DoD for military operations continuously since 1938. Originally known as Ladd Army Airfield (LAAF), the post was established for cold weather experimentation. During World War II, LAAF served as a transfer point in the lend-lease program. Between 1942 and 1945, almost 8,000 combat and transport aircraft were transferred to Soviet aircrews at LAAF. In 1947, the newly formed U.S. Air Force assumed control of LAAF, which was redesignated as Ladd Air Force Base (LAFB). LAFB served as a resupply and maintenance base for the remote Distant Early Warning sites and experimental ice stations in the Arctic Ocean. During the Korean conflict, LAFB served as part of the defense network and was the site of the first Nike Hercules Missile launch from a tactical missile site in December 1959.

On January 1, 1961, the Army resumed control over LAFB. The Army renamed the installation Fort Wainwright, after General Jonathan M. Wainwright, the commander of the forces defending the Bataan Peninsula in the Philippines at the beginning of World War II.

Fort Wainwright became the home of the 171st Infantry Brigade in 1963 and has housed various Army brigades and divisions over the years. In July 2001, as part of its transformation to a more strategic and responsive force, the Army announced its intent to make the 172nd Infantry Brigade, located at Forts Wainwright and Richardson, into one of the next four Stryker brigade combat teams.

2.2 CERCLA History

Fort Wainwright was proposed for placement on the CERCLA NPL in July 1989, due to releases of hazardous substances, pollutants, and contaminants into the environment. The USARAK's investigation of contaminated sites at Fort Wainwright under the IRP began in 1989, and the post was added to the CERCLA NPL in 1990. The EPA, Region 10, and the ADEC began working closely with the USARAK to better understand the nature and extent of contamination at Fort Wainwright and its threat to human health and the environment. The three parties negotiated the Fort Wainwright NPL site FFA, which was signed in 1992, and, that same year, the USARAK and ADEC entered into a TPA to address POL sites at the post.

Attachment I of the FFA describes the investigation and restoration approach for Fort Wainwright agreed upon by the USARAK, EPA, and ADEC. The FFA addressed 95 areas, as described below. As of the FFA signing:

- Forty-one potential contaminant source areas were identified as warranting inclusion into OUs.
- Fifty-seven POL sources were identified through previous studies, reports, and interviews.
- NFA was planned for 27 potential source areas[5] based on the screening criteria outlined by the RPMs.[6]

The history of contamination and remediation of source areas are summarized in Appendix B of this CIP. Sites were identified by the RPMs using the RCRA Facility Assessment, Westin Facility Assessment, Environmental Assessment, 172nd Brigade, numerous interviews, and the Federal Facility Compliance Agreement. Formal preliminary assessments were not conducted at Fort Wainwright.

Of the 78 Fort Wainwright contaminant "source areas" initially identified for further investigation, 10 are in various stages of remediation under the five CERCLA OUs, including 3 that are being addressed by the CERCLA Explanation of Significant Differences (ESD) process.[7] Twelve are being managed under the TPA and the remaining 56 have been found to require NFA.

Fort Wainwright has reached another significant milestone in environmental cleanup with the completion of all construction activities associated with the planned CERCLA treatment system on post. The milestone, known as "construction complete," is achieved when all physical construction of the treatment or monitoring systems is done, pre-final inspections have been conducted, and the treatment systems are operational and functional. In order to document this nationally recognized milestone, the EPA, in cooperation with the Army, is completing a Preliminary Closeout Report, or PCOR, for Fort Wainwright. This report documents that all major construction activities are completed for the site consistent with the ROD. The PCOR includes information on the status of each treatment system in the five OUs, construction costs,

---

[5] Source areas are specific locations where contamination has been verified to exist in concentrations that prevent unrestricted use of land or water or that make these areas ongoing sources of pollution to the surrounding environment.

[6] Decisions to recommend NFA at source areas were based on the following: 1) the physical location could not be identified or located in the investigation, 2) no visible sign of contamination was observed during the source area inspection, 3) the site was referred to the TPA, or 4) environmental sampling results showed that contamination was present at levels below the protective human-health-based levels.

[7] An ESD documents new information received or generated after signature of the ROD that could affect implementation of the original remedy selected. For example, an ESD is being prepared for OU3 to document increased volume and areal extent of contamination, increase in remedial cost, discovery of additional source areas, and changes in some components of the selected remedy. This does not fundamentally alter the overall remedial approach.

and anticipated future operation and maintenance costs, as well as identifies any remaining tasks or reports that will need to be completed.

2.3 Land and Resource Use

Fort Wainwright is located in the Fairbanks North Star Borough in interior Alaska and occupies 915,000 acres on the east side of Fairbanks. Fort Wainwright consists of a main post area, which is 2 miles east of Fairbanks on the Chena and Tanana rivers and has a cantonment area; a small arms range complex; and a closed-in range complex. The main post was originally established as a cold-weather testing station. The Tanana Flats Training Area is across the Tanana River from the main post, and the Yukon Training Area is 16 miles east-southeast of Fairbanks, adjacent to Eielson Air Force Base.

Primary missions at Fort Wainwright include training infantry soldiers in the arctic environment, testing equipment in arctic conditions, and preparing troops for defense of the Pacific Rim and rapid deployment worldwide. On-site industrial activities include operation, maintenance, and repair of fixed-wing aircraft, helicopters, and tactical and nontactical vehicles. On-site utilities include drinking-water production, power generation, and steam-heat production.

Groundwater is the only source of drinking water used at Fort Wainwright and in the Fairbanks area. Approximately 95 percent of Fort Wainwright's drinking water is supplied through a single distribution system fed by two large-capacity wells located in Building 3559, near the Post Power Plant. These wells are completed at a depth of approximately 80 feet below ground surface (bgs) and provide between 1.5 million and 2.5 million gallons of water per day to the Post Water Treatment Plant for processing and distribution. In addition to the main drinking water supply wells, there are five emergency standby supply wells located around the cantonment area. These wells have been completed between 80 feet and 120 feet bgs and are capable of pumping approximately 250,000 gallons per day per well.

Golden Heart Utilities has four developed wells located 1¼ miles downgradient of the post's boundaries, on the banks of the Chena River. College Utilities has four developed wells (two of which are active) located approximately 3½ miles downgradient of the post's boundaries. These wells serve as the main drinking water supply for most of the City of Fairbanks.

2.4 History of Contamination

Beginning in 1938, fuels, waste solvents, and pesticides were disposed of on the ground. Spills associated with fuel management, storage, transportation, and handling were common. In addition, waste oils, solvents, and contaminated fuels were incinerated at the Post Power Plant and fire training areas, a practice which was discontinued in 1993. Waste oils were used for dust control and fire-pit training exercises. USTs for waste oil, fuel, lubricants, and solvents were installed at most maintenance facilities. A majority of these tanks eventually leaked and

released contaminants into the soil and groundwater. All existing USTs were removed or replaced, or both, with double-walled, cathodically protected tanks with leak detection systems.

Pesticides (insecticides, herbicides, fungicides, avicides, and rodenticides) have been used over the years to maintain grounds and structures and to prevent pest-related health problems. Pesticides were reported to have been mixed or stored in ways that allowed releases to the soil.

Current USARAK practices no longer include uncontrolled or unpermitted releases of pollutants to the environment.

3.0 COMMUNITY BACKGROUND

3.1 Community Profile

Fairbanks is located in the heart of interior Alaska at the northern end of the Parks and Richardson highways. By air, Fairbanks is 4 hours from Seattle and 45 minutes from Anchorage. The population of the Fairbanks North Star Borough is 82,840 with 23,000 within the Fairbanks city limits (Davison 2002).

Fort Wainwright, located on the east side of the City of Fairbanks, has an on-post population of 7,383 (USCB 2000). Four housing areas are located on Fort Wainwright, and one housing area is segregated completely from the installation. Each area has a post mayor who is a liaison between residents and the Fort Wainwright command structure to resolve problems in an effective and timely manner.

Today, the economy of Fairbanks relies on government operations, which include the City and Borough of Fairbanks and Fort Wainwright, as its main source of employment. Fort Wainwright and Eielson Air Force Base contribute significantly to the economy of Fairbanks. Services and trade comprise the next largest source of employment. The University of Alaska Fairbanks and tourism also play important economic roles.

The City of North Pole is also located near Fort Wainwright. The population of North Pole is approximately 1,570. Many North Pole residents commute to Fairbanks for work. One of North Pole's main employers is an oil refinery that produces heating oil, diesel, gasoline, jet petroleum fuel, and other petroleum products.

3.2 History of Community Involvement

Based on information gathered during community interviews conducted by the USARAK and a contractor (Ecology and Environment, Inc. [E&E]) in July 1992, a limited but positive relationship appears to exist between Fort Wainwright and Fairbanks.

Contact with the community related to the Fort Wainwright CERCLA site began in 1991 when contractors to the U.S. Army Engineer District – Alaska (USAED-AK) conducted a records search. The records search was initiated to identify physical locations and potential sources of contamination at various source areas on Fort Wainwright. The records search included a 30-day public request for information printed in the *Fairbanks Daily News-Miner* and was broadcast over three Fairbanks radio stations. The advertisement in the newspaper was published from November 8 through December 6, 1991. The radio advertisement was broadcast twice per day on radio stations KIAK, KRAR, and KWLF from November 8 through December 7, 1991. Both advertisements included an address for written responses and a toll-free telephone number. One written response was received, and seven people called the toll-free number to relay

information about Fort Wainwright to the contractors. Personnel identified as having been involved with hazardous waste generation, management, and disposal at Fort Wainwright also were interviewed by these contractors.

Little other contact regarding potential contamination sources at Fort Wainwright occurred among the USARAK, ADEC, EPA, and on- and off-post residents before the community interviews conducted in July 1992. Before the community interviews, the USARAK had contact with the public on three separate occasions regarding the potential source areas. Contractors to the USARAK previously interviewed an individual regarding possible contaminant source locations at Fort Wainwright (this contact was part of the aforementioned effort in 1991); in November 1991, ADEC contacted representatives of two churches bordering the west side of the post near the tank farm regarding contamination detected in the representatives' groundwater wells; and one civilian resident living near Fort Wainwright reportedly contacted ADEC regarding oil spills from the Fairbanks-Eielson Pipeline onto his property.

To develop the original CRP, published in April 1993, several community members in the Fort Wainwright/Fairbanks area were interviewed during the summer of 1992. Only one interviewee had been involved with activities under way to remedy contamination at Fort Wainwright.

The revised CRP that was published in 1997 included information gathered from a questionnaire that was included in the March 1996 issue of the *Environmental Restoration News*[8] newsletter, as described in Section 3.3.

Limited direct communication occurs between Fort Wainwright and the neighboring cities of Fairbanks and North Pole, other than through newspaper articles. The mayors of both cities have some contact with Fort Wainwright representatives, specifically during ceremonial activities on post. Post officials participate in Fairbanks Chamber of Commerce meetings regularly to discuss local business issues.

3.3 Historical Community Interview Program

Community interviews were conducted by the USARAK and its contractors between July 27 and July 30, 1992. The purpose of the community interviews was to identify community perceptions and concerns associated with the environmental studies being performed at Fort Wainwright. Twenty-five interviews were conducted with post residents; community members; community groups; and representatives of federal, state, and local governments. A telephone interview was conducted with a member of a local environmental organization on August 20, 1992. The questionnaire provided to the public via the March 1996 *Environmental Restoration News* was

[8] *Environmental Restoration News* is a newsletter that is published quarterly and that summarizes the status of Fort Wainwright's environmental cleanup program. The newsletter is sent to all interested individuals and organizations on the mailing list (see Section 4.3.4).

sent to over 100 interested individuals who were included on the mailing list. Eleven questionnaires were returned. The following is a summary of the community interview and questionnaire results.

3.3.1 General Perceptions

Most individuals recalled newspaper articles about environmental problems associated with Fort Wainwright but could not remember details. Generally, those interviewed perceived that contamination problems at Fort Wainwright were minimal and did not pose an immediate health threat or danger.

3.3.1.1 Government Creditability

Interviews with several community members indicated that although there is a general distrust of the federal government, Fort Wainwright officials are entrusted to handle contamination problems promptly and effectively. Many interviewees mentioned the Alaska Battery Enterprises NPL site located in Fairbanks near Fort Wainwright. Actions associated with the EPA at the Alaska Battery Enterprises NPL site in the late 1980s and early 1990s have resulted in some distrust of the EPA.

3.3.1.2 Post Operations

Fort Wainwright residents interviewed had a limited understanding of the post's operational history but a fairly good understanding of current operations on post. In contrast, residents of Fairbanks had only a fair understanding of the post history, and few knew about the post's current activities.

3.3.1.3 Media Coverage

Although most people interviewed read the local newspaper and believed that it was effective in reporting local news, several people indicated that the newspaper was not a consistently credible source of information.

Public meetings are a communication method commonly used in Fairbanks. Almost all of the interviewees had attended public meetings in the past and believed that public meetings are used too commonly and have low attendance. Newsletters are used frequently in Fairbanks, and caution was expressed that too much information about Fort Wainwright through direct mail would be ineffective.

Radio and television were recommended as effective media for communicating with the citizens of Fairbanks. Most citizens regularly listen to radio talk shows and programs on the public radio station. Television was a method of communication suggested by most interviewees as reaching the greatest number of citizens.

3.3.1.4 Community Involvement

Other suggestions for community outreach included presentations to groups that may be interested in the Fort Wainwright cleanup, such as the Fairbanks Chamber of Commerce and the city councils of Fairbanks and the North Pole. Several interviewees also expressed an interest in a tour of potential source area locations on Fort Wainwright.

At the time of the interviews, only one environmental organization, the Northern Alaska Environmental Center, expressed interest in cleanup activities at Fort Wainwright.

3.3.2 Key Community Concerns and Issues

Several community concerns and issues were identified thorough the community interviews and are presented below. Because the CIP promotes two-way communication between the USARAK and the public, personal contact with community members will continue throughout the CERCLA process. Concerns other than those mentioned in the following paragraphs may be identified in the future.

3.3.2.1 Water Supply

The main concern expressed by residents of Fort Wainwright and Fairbanks was possible contamination of drinking water. Groundwater in the Fairbanks area is the only source of drinking water.

3.3.2.2 Health Concerns

In addition to concern about groundwater contamination, many interviewees expressed general concern about public health. A concern of equal importance was the need for open and honest communication between USARAK officials at Fort Wainwright and the public.

3.3.2.3 Financial and Economic Considerations

Because of the public's perception that the contamination on post is minimal, concern was expressed that the taxpayers' money should be spent conservatively. The analysis and selection of remedial activities should consider the environmental benefit of the cleanup as well as comparative costs.

Concerns about USARAK's hiring practices at Fort Wainwright were expressed in several of the interviews. Five people interviewed stated that local hiring practices are an important issue to them. These interviewees were concerned that contractors from the lower 48 states would be used instead of members of the local work force. It is important to note that USAED-AK, the largest agency involved in contracting work for the USARAK, has a requirement that 95 percent of new hires must be Alaskan. The only exception to this requirement is in the case of an emergency response.

3.3.2.4 Other Issues of Concern

Other issues mentioned included the sewer line between Fort Wainwright and the City of Fairbanks, activities at Fort Greely, surface water and air contamination, and household hazardous waste disposal in the Post Landfill.

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4.0 COMMUNITY INVOLVEMENT PROGRAM

4.1 Goals and Objectives

The goals of this Community Involvement Program are to do the following:

- Inform interested citizens and local officials about the progress of investigations and remedial activities;
- Encourage two-way communication between the USARAK at Fort Wainwright and the community; and
- Provide opportunities for the public to participate in the planning and execution of RAs at Fort Wainwright.

Community concerns may change as the remedial process proceeds. The community involvement activities described below are designed to meet the aforementioned goals. Promoting two-way communication with the public during the investigations and cleanup is especially important so that community concerns are addressed effectively.

4.2 Community Relations Questionnaire

To update the original CRP, the USARAK distributed a questionnaire, soliciting feedback on the Fort Wainwright community relations program, as an insert in the May 1996 issue of the *Environmental Restoration News* newsletter. Eleven questionnaires were returned.

All respondents reported that they were either very familiar or somewhat familiar with environmental activities at Fort Wainwright, and the medium they found most helpful in learning at the post was direct mailing of the newsletters. Respondents reported favorably on Fort Wainwright's newsletter, *Environmental Restoration News*; public notices published in the *Fairbanks Daily News-Miner*; the Noel Wien Information Repository; and the overall community relations program associated with environmental restoration activities. More details regarding the results of the questionnaire are reported in the following sections.

4.3 Community Involvement Activities

To meet the outlined CIP goals and objectives, the USARAK at Fort Wainwright will undertake specific community involvement activities. These will include activities required by CERCLA and additional activities to ensure that the community remains well informed and has the opportunity to express its concerns. These activities are described below. Table 4-1 outlines a recommended schedule of community involvement activities.

For the Fort Wainwright CIP to be effective, efficient communication must be maintained. The communication tools discussed in the remainder of Section 4 will be employed to disseminate

information among agencies; civilian and military personnel; the general public; the media; and the communities of Fairbanks, Fort Wainwright, and North Pole.

4.3.1 Technical Review Committee and Restoration Advisory Board

4.3.1.1 Technical Review Committee

A Technical Review Committee (TRC) is a group consisting of agency and interested public representatives to review and comment on the USARAK's actions at an installation with respect to releases or threatened releases of hazardous substances. The TRC focuses mainly on reviewing technical aspects of work conducted at an installation. TRC members also exchange information and organizational viewpoints regarding events occurring at an installation, recommend cleanup requirements, attempt to solve problems, and schedule site activities.

The USARAK established a TRC for Fort Wainwright after publication of the Areawide CRP in 1993. This TRC conducted its first meeting with nine attendees in February 1994. Most of the attendees represented local, state, and federal agencies.

Since the first Fort Wainwright TRC meeting, the DoD recommended that the USARAK attempt to expand existing TRCs at installations into Restoration Advisory Boards (RABs), if there is sufficient and sustained community interest.

The USARAK included questions about the TRC and RAB concepts in its March 1996 community relations program questionnaire to determine whether enough community interest existed to continue a TRC or to expand the TRC into a RAB. Most of the individuals completing the questionnaire expressed interest in the establishment of a RAB or a combination group. In addition, seven of ten people indicated an interest in belonging to the group.

The USARAK expanded the TRC into a RAB and invited more community members to participate. The USARAK began formal RAB meetings in October 1997 and has continued them quarterly until 2002; however, interest in the RAB has been declining with decreasing attendance for several years. The Army responded to the decline by decreasing meeting frequency from quarterly to semi-annually and is now on an annual schedule.

4.3.1.2 Restoration Advisory Board

A RAB is a group comprising community and government representatives to provide government decision makers with advice about environmental restoration activities at USARAK installations. The RAB is a means of information exchange between the installation and the community. The RAB is intended to bring together members who reflect the diverse interests within the community and to allow for a two-way flow of information, concerns, priorities, and needs between the affected community and the installation.

RAB members are asked to meet regularly to review and comment on technical documents and plans related to the ongoing environmental studies and restoration activities at the installation. Members are also asked to provide advice as individuals, not as a group consensus, and are expected to be available to meet with other community members and groups. Technical support staff are available to provide information and explanations to RAB members as needed.

4.3.1.3 Technical Assistance for Public Participation

In addition, the DoD has a program called "Technical Assistance for Public Participation" (TAPP) to assist community members of TRCs or RABs in understanding the technical aspects of environmental restoration at DoD installations. More information on the TAPP has been included in Appendix H. All RAB meetings are open to the public. Community members are expected to serve on the RAB as volunteers without monetary compensation for time or expenses.

4.3.1.4 Differences Between TRC and RAB

Although the TRC and RAB have similar goals and objectives, there are some differences. The TRC mainly comprises agency representatives with one or two community members, while the RAB is based on agency representatives with full community membership. The TRC focuses on reviewing the technical aspects of cleanup at an installation, and the RAB provides technical and nontechnical information to its members so they can share the information with other community members. For example, TRC members may be expected to read a technical document and comment on it whereas a RAB member may be expected to read the same document or an executive summary and provide a summary to other community members.

4.3.1.5 RAB Interest Decline

Interest in the RAB has declined significantly in the past 2 years. It is not clear why participation has decreased; however, there seems to be a correlation of a decrease in investigative work associated with OUs and the decline. An explanation may be that since the OUs are in the cleanup stage, public perception may be that the need for community involvement within the RAB is not as critical.

Due to this decrease in attendance, the USARAK has proposed decreasing the frequency of RAB meetings to one meeting per year and possibly disbanding the group if interest does not increase.

4.3.2 Contact Person

A contact person associated with the USARAK is responsible for addressing citizens' concerns, answering individual questions, and responding to inquiries from the media. The current point of contact for CERCLA activities related to Fort Wainwright is Ms. Linda Douglass, Media Relations Officer, (907) 353-6701.

4.3.3 Administrative Record and Information Repositories

The Administrative Record is the legal file of documents upon which the lead agency bases the selection of a response action for the site. This record, including all public comments, is available for public review at the Directorate of Public Works, Environmental Resources Division Office, in Building 3023, Fort Wainwright.

Information repositories and the Administrative Record are similar in content. Information repositories typically are established in public buildings conveniently located for local residents and contain current information, technical reports, and reference documents related to IRP and CERCLA sites. The Fort Wainwright information repositories contain an index of documents in the Administrative Record. The Army is responsible for maintaining the information repositories and Administrative Record. The Army updates the repositories and the record annually.

The USARAK has established two information repositories for Fort Wainwright (one on post at the Post Library and one off post at the Noel Wien Library) to provide interested parties with general information about the remediation program. Documents and information contained in the repositories include the CRP, a copy of the TPA, a copy of the FFA, documentation of sampling results, RI/FS work plans, draft and final RI/FS reports, responsiveness summaries, signed RODs, an Administrative Order of Consent or Consent Decrees, RD work plans, the Five-Year Review, and other relevant materials.

Although the Administrative Record can be closed following Agency signature of the ROD, the Army has continued to place documents in the Administrative Record. This practice is expected to stop when the RAB is disbanded. At that time the Administrative Record will be closed; however, the public will still have access to any new documents for review if interested by contacting Army representatives. The current Administrative Record will remain in place until Fort Wainwright is removed from the EPA's National Priorities List.

Appendix D lists the locations of the Administrative Record and information repositories, including their hours of operation.

4.3.4 List of Contacts and Interested Parties

The USARAK has established a list of individuals, organizations, and businesses interested in the cleanup at Fort Wainwright to ensure that all who wish to receive information about the investigation and remedial activities will be informed. This list is updated regularly to include people who contact the EPA, ADEC, or Fort Wainwright or who return the mailing list coupons included in the newsletters. The list similarly is updated upon notification by any individual, organization, or business that wishes to be removed from the list or that has moved recently.

Appendix E presents the current list of contacts and interested parties for Fort Wainwright; however, individuals and businesses have been excluded from the appendix list to protect their privacy.

4.3.5 Public Notices

The USARAK places public notices in the *Fairbanks Daily News-Miner* and the post newspaper to announce milestones in the investigation and remediation process at Fort Wainwright. This ensures that a wider audience is made aware of significant events occurring at the site.

During the community interview program, several interviewees indicated that the local Fairbanks newspaper was not a consistently credible source of information. Therefore, paid advertisements (public notices) containing appropriate information were used to inform the public. Most respondents to the community relations program questionnaire reported seeing the public notices in the *Fairbanks Daily News-Miner* and believed that such notices have been the best way to inform the community about upcoming public meetings and other public involvement opportunities.

Public notices were published at the following milestones:

- When the Administrative Record file and information repositories were established;
- When the RI/FS and Proposed Plans became available for each OU;
- When a public comment period and public meeting for the RI/FS and Proposed Plan was scheduled for each OU;
- When the response action was selected and the RODs were signed;
- When an Explanation of Significant Differences (ESD) was documented due to the discovery that the final remedial plan differed significantly from the remedial plan documented in the OU3 ROD; and
- When the Five-Year Review was completed.

A public notice will be published when the notice of intent to delete Fort Wainwright from the NPL becomes available.

Public notices also should announce public comment periods and public meetings.

4.3.6 Small Group Presentations

Based on suggestions made during the community interviews, it may be appropriate for the USARAK to be prepared to conduct small presentations that address the concerns of specific groups. Suggested groups include the Fairbanks Chamber of Commerce, the city councils of Fairbanks and North Pole, and interested parties in potentially affected neighborhoods. To date, small group presentations have not been conducted at Fort Wainwright.

The purposes of small group presentations are to inform citizens and local officials of site activities, to answer questions, and to resolve any misconceptions or misunderstandings. To date, the USARAK, ADEC, and EPA representatives have met with the Fairbanks North Star Borough Council, the mayor of Fairbanks, the mayors of all post housing areas, and the Fairbanks Emergency Responses staff, as well as with individual citizens. The USARAK believes that this communication tool could increase agency awareness of citizens' concerns and maintain a positive working relationship with residents.

4.3.7 Newsletters

The USARAK prepares newsletters about environmental restoration activities at Fort Wainwright on a quarterly basis. Entitled *Environmental Restoration News*, the newsletters are published primarily to summarize the status of work being conducted as part of Fort Wainwright's environmental cleanup program. Most respondents to the community relations program questionnaire believed that the newsletters were the most helpful medium for communicating environmental information about Fort Wainwright.

Based on favorable feedback from the public, the USARAK will continue to prepare quarterly newsletters in understandable, nontechnical language to summarize progress at Fort Wainwright and to highlight upcoming events.

Future newsletters will inform the public of the status of the IRP and CERCLA program at Fort Wainwright and will encourage two-way communication between the community and USARAK representatives. Topics in which questionnaire respondents indicated an interest included updates on OU investigations, progress reports on how selected remedies are reducing contamination, public involvement opportunities, selected remedies for cleanup, and construction and operation schedules. In addition, the public will be informed when documents are completed and available in the Administrative Record or information repositories. The newsletters will also be the method the Army uses to inform the public of any changes in site conditions.

Appendix F includes a copy of the most recent newsletter prepared for Fort Wainwright. Future editions of the newsletters will be sent to all those on the list of contacts and interested parties list, including individuals, organizations, and businesses, and will be made available in the information repositories, Administrative Record, and at RAB meetings.

4.3.8 Public Meetings

The USARAK conducted CERCLA-required public meetings during the 30-day public comment period associated with the publication of the Proposed Plan for each OU. Public meetings provided an opportunity for the interested members of the public to receive information regarding proposed cleanup plans, to ask questions and listen to answers to those questions, and to submit comments. The public meetings were conducted during the public comment

period for each OU. Court reporters transcribed oral comments received by the public. Copies of the transcripts became part of the Administrative Record for the site. Copies of the transcripts were also placed in the information repositories.

A total of five public meetings have been conducted in support of the environmental program at Fort Wainwright. An informational public meeting, during which presentations on all OUs were made, was conducted on July 22, 1993. In addition, meetings during public comment periods for each OU and for one interim removal action were conducted:

- On April 25, 1995, a public meeting addressed the Proposed Plans for the Chemical Agent Dump Site Interim Removal Action and for OU3;
- On October 17, 1995, a public meeting addressed the Proposed Plan for OU4;
- On May 8, 1996, a public meeting addressed the Proposed Plan for OU2;
- On March 11, 1997, a public meeting was conducted to address the OU1 Proposed Plan and to provide information about the formation of the RAB; and
- On June 25, 1998, a public meeting addressed the Proposed Plan for OU5.

Proposed Plan public meetings were conducted in easily accessible and convenient locations (see Appendix G). The USARAK has used the Noel Wien Library and the Carlson Center to date; both locations have been well suited to the USARAK's and the public's needs.

Once the aforementioned CERCLA-required meetings had been conducted, the USARAK continued providing a public meeting forum via the quarterly RAB meetings.

While RAB public meetings are not designed to take the place of informational or Proposed Plan meetings, they offer an opportunity for the public to participate on a regular basis with the USARAK. For example, the Army used RAB meetings as the means to inform and discuss the OU3 Explanation of Significant Differences and CERCLA 5-Year Review with the public.

RAB meetings have historically been held in an on-post conference room at the Fort Wainwright headquarters building; however, in the past year, RAB meetings have been conducted in one of the conference rooms at the Noel Wien Library.

4.3.9 Proposed Plans

The Proposed Plan is a document that summarizes the preferred cleanup strategy rationale for the preferences and alternatives presented in the detailed analysis of the RI/FS. This document must solicit public review and comment on all alternatives under consideration. The Proposed Plan must include information regarding how the public may comment on the Proposed Plan, RI/FS, and any risk assessments that have been prepared for the site.

Proposed Plans are written after the completion of the RI/FS. Copies are placed in the Administrative Record and information repositories and are distributed to the entire list of contacts and interested parties.

Proposed Plans have been completed for OU1, Chemical Agent Dump Site Interim Removal Action (April 1995), OU3 (April 1995), OU4 (October 1995), OU2 (April 1996), OU1 (February 1997), and OU5 (June 1998). These Proposed Plans are all those expected for Fort Wainwright.

4.3.10 Public Comment Periods

The USARAK scheduled a 30-day public comment period upon release of Proposed Plans for each OU at Fort Wainwright. Under the EPA's community involvement guidance, the comment period can be extended an additional 30 days if the request is made in a timely manner. The public was able to comment on the Proposed Plan, RI/FS, or any other document in the Administrative Record. The public was encouraged to submit comments to the USARAK in writing, via a toll-free telephone line, or at the public meeting.

Four public comment periods were scheduled. The public was invited to comment on the USARAK's Proposed Plan for OU3 and on the Proposed Plan for the Chemical Agent Dump Site Interim Removal Action between April 19 through May 19, 1995. From October 11 to November 10, 1995, public comments on the Proposed Plan were requested for OU4, and between May 1 and May 31, 1996, public comment on the Proposed Plan was solicited for OU2. A 30-day public comment period on the OU1 Proposed Plan was conducted from March 4 to April 3, 1997, and the OU5 public comment period was conducted from June 17 to July 17, 1998. During each comment period, the public was invited to mail written comments, provide oral and/or written comments at a public meeting, and record comments on a toll-free telephone number answering service.

4.3.11 Records of Decision/Responsiveness Summaries

RODs were prepared for each OU. A ROD is the formal documentation step that identifies the remedial options chosen by the USARAK, with input from the ADEC and EPA and in consideration of public input received in the Proposed Plan.

The USARAK prepared a Responsiveness Summary, which listed all comments received during each comment period and responses to the comments, for each OU at Fort Wainwright. The Responsiveness Summary is issued as an appendix of the ROD for each OU and made available in the information repositories and Administrative Record.

Five RODS have been issued to date as a result of the IRP and CERCLA program at Fort Wainwright. A ROD announcing the selected remedy for the OU1 Chemical Agent Dump Site was signed in August 1996. The ROD for cleanup activities at OU3 was signed in April 1996,

the ROD for cleanup activities at OU4 was signed in September 1996, the OU2 ROD was signed in March 1997, the OU1 ROD was signed in June 1997, and the OU5 ROD was signed in May 1999. All five RODs included responsiveness summaries addressing the comments received during the comment periods on their respective Proposed Plans.

4.3.12 Explanation of Significant Differences

An Explanation of Significant Differences (ESD) was prepared to explain differences between the final remedy selected in the 1986 ROD and the final remedy to be implemented at the site. The ESD documents an increase in extent and volume of contamination, increase in remedial cost, discovery of additional contaminants and remedial areas, and changes in some components of the selected remedy described in the 1996 OU3 ROD. However, the overall remedial approach has not been fundamentally altered.

The ESD was finalized in September 2002 and is available for review in the Administrative Record and information repositories.

The public was kept informed about the status of the ESD through articles in quarterly newsletters and updates at RAB meetings.

4.3.13 Community Involvement Plan Revision

This CIP revision is the second revision since the publication of the original CRP in 1993. The 1993 CRP was based on interviews with community members and some agency personnel. The first revision in 1997 incorporated responses from a questionnaire. This revision primarily serves to update the status of the Community Involvement Program, specifically regarding the RAB, and provides an update of the status of the OUs.

For this revised CIP, community interviews were not conducted. Feedback from RAB meetings were used to revise the 1997 CRP into this CIP.

4.4 Technical Assistance Grant Program

In addition to the assistance offered by the Army through the TAPP program (see Section 4.3.13 and Appendix H), EPA offers grants of up to $50,000 to community groups to hire technical advisers to help citizens understand and interpret site-related technical information. Such advisors allow groups to comment on available documents more competently and to convey their preferences about specific activities. Information regarding applying for a Technical Assistant Grant (TAG) from EPA will be available in the information repositories, and more detailed information is included in Appendix I. The EPA, Region X, TAG coordinator will assist groups interested in completing an application.

Community Activity Involvement	Completion of RI/FS Management Plan	Completion of RI	Completion of FS	Record of Decision	Remedial Design	Begin Remedial Action	First Five-Year Review
Technical Review Committee / Restoration Advisory Board	Meets regularly throughout the process						
Contact Persons	Established at beginning of process and provided throughout						
Administrative Record and Information Repositories	Established at beginning of process and provided throughout						
List of Contacts and Interested Parties	Continuously updated throughout CERCLA process for each OU						
News Releases and Conferences	Provided as needed						
Small Group Presentations	Provided upon request						
Fact Sheet / Updates	Published throughout CERCLA process						
Public Meetings			*		*		
Proposed Plan			*				
Public Notices			*	*		*	*
Public Comment Period			30 Days				
Responsiveness Summary				*			
CIP Revision					*		

KEY:
- RI/FS – Remedial Investigation / Feasibility Study
- CERCLA – Comprehensive Environmental Response, Conpensation, and Liability Act
- OU – Operable Unit
- * – Milestones (Mandatory)
- CIP – Community Involvement Plan

Table 4-1 COMMUNITY RELATIONS ACTIVITIES SCHEDULE, FORT WAINWRIGHT, ALASKA

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APPENDIX A

GLOSSARY OF TERMS

Glossary of Terms

Administrative Record: A file maintained by and containing all information used by the lead agency to make its decision regarding the selection of a response action under the **Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA)**. This file is to be available for public review and a copy maintained at or near the site, usually at one of the **Information repositories**. A duplicate file is held in a central location, such as a Regional Office of State.

Aquifer: An underground rock formation composed of materials, such as sand, soil, or gravel, that can supply **groundwater** to wells and springs.

Cleanup: Actions taken to deal with a release or threatened release of **hazardous substances** that could affect public health or the environment. The term often is used broadly to describe various response actions or phases of remedial responses, such as the **Remedial Investigation/Feasibility Study (RI/FS).**

Comment Period: A time period for the public to review and comment on various documents and U.S. Environmental Protection Agency (EPA) actions. For example, a minimum 30-day comment period is conducted to allow community members to review and comment on a draft **RI/FS** and **Proposed Plan**; it must be extended an additional 30 days upon timely request. A comment period is required to amend the **Record of Decision (ROD)**.

Community Relations/Community Involvement: EPA's program to inform and involve the public in the cleanup process and respond to community concerns.

Community Relations/Involvement Plan: A formal plan for EPA-mandated community relations/involvement activities. The plan is designed to assure citizens of opportunities for public involvement at the site, to determine activities that will provide for such involvement, and to allow citizens the opportunity to learn about the site.

Comprehensive Environmental Response, Compensation, and Liability Act: A federal law passed in 1980 and modified in 1986 by the **Superfund Amendments and Reauthorization Act**. The act created a special tax providing revenues for a **Trust Fund**, commonly known as **Superfund**, to investigate and clean up abandoned or uncontrolled hazardous waste sites. Under the program, EPA either can:

- Pay for site **cleanup** when parties responsible for the contamination cannot be located or are unwilling or unable to perform the work; or
- Take legal action to force parties responsible for site contamination to clean up or repay the federal government for the cost of the cleanup.

Feasibility Study: See **RI/FS**.

Groundwater: Water that is found beneath the earth's surface and that fills pores between materials such as sand, soil, or gravel. In **aquifers**, groundwater occurs in sufficient quantities that it can be used for drinking water, irrigation, and other purposes.

Hazard Ranking System (HRS): A scoring system used to evaluate potential risks to public health and the environment from releases or threatened release **of hazardous substances**. EPA and state agencies use the HRS to calculate a site score (0 to 100) based on the actual or potential release of hazardous substances from a site through air, **surface water**, or **groundwater**. This score is the main factor used to decide whether a hazardous waste site should be placed on the **National Priorities List (NPL)**.

Hazardous Substance: Any material that poses a threat to public health and/or the environment. Typical hazardous substances are materials that are toxic, corrosive, ignitable, explosive, or chemically reactive.

Hydrology: The science dealing with the properties, movement, and effects of water found on the earth's surface, in the soil and rocks below, and in the atmosphere.

Incineration: Burning of certain types of solid, liquid, or gaseous materials under controlled conditions to destroy hazardous wastes.

Information Repository: A file containing current information, technical reports, reference documents, and **Technical Assistance Grant** application information regarding a **Superfund** site. The information repository usually is located in a public building that is convenient for local residents, such as a public school, city hall, or library.

Monitoring Wells: Special wells drilled at specific locations on or off a hazardous waste site, where **groundwater** can be sampled at selected depths and studied to determine the direction of **groundwater** flow and the types of contaminants present.

National Oil and Hazardous Substances Pollution Contingency Plan (NCP): The federal regulation that guides the **Superfund** program. The NCP was revised in February 1990.

National Priorities List: EPA's list of the most serious uncontrolled or abandoned hazardous waste sites identified for possible long-term remedial response using money from the **Trust Fund**. The list is based mainly on the score a site receives on the **HRS**. EPA is required to update the NPL at least once a year.

Operable Unit (OU): The cleanup of a site can be divided into a number of OUs, depending on the complexity of the problems associated with the site. OUs may address geographical portions of the site, specific site problems, or an initial phase of an action, or may consist of any set of actions performed over time or any actions that are concurrent but located in various parts of a site.

parts per billion (ppb)/ parts per million (ppm): Units commonly used to express low concentrations of contaminants. For example, 1 ounce of trichloroethylene in 1 million ounces of water is 1 ppm; 1 ounce in 1 billion ounces of water is 1 ppb. If one drop is mixed in a competition-sized swimming pool, the water will contain about 1 ppb.

Potentially Responsible Party (PRP): An individual or company (such as owners, operators, transporters, or generators of hazardous waste) potentially responsible for, or contributing to, the contamination problems at a **Superfund** site. Whenever possible, EPA requires PRPs, through administrative and legal actions, to clean up hazardous waste sites they have contaminated.

Preliminary Source Evaluation (PSE): A process of and resulting documentation for evaluating releases or threatened releases of **hazardous substances**, pollutants, or contaminants from source areas with the potential to constitute a threat to public health, welfare, or the environment. A PSE may consist of two phases: an existing data evaluation (PSE 1) and/or a limited field investigation (PSE 2).

Proposed Plan: A public participation requirement of **CERCLA** in which EPA summarizes for the public the preferred cleanup strategy, rationale for the preference, alternatives presented in the detailed analysis of the **RI/FS**, and waivers to cleanup standards that may be proposed. This may be prepared either as a newsletter or a separate document. In either case, it must actively solicit public review and comment on all alternatives under consideration.

Record of Decision: A public document that explains which cleanup alternative will be used at **NPL** sites. The ROD is based on information and technical analysis generated during the **RI/FS** and consideration of public comments and community concerns.

Remedial Action (RA): The actual construction and implementation phase that follows the **remedial design** of the selected cleanup alternative at a site on the **NPL**.

Remedial Design: An engineering phase that follows the **ROD** when technical drawings and specifications are developed for the subsequent **RA** at a site on the **NPL**.

Remedial Investigation/Feasibility Study: Investigative and analytical studies usually performed at the same time in an interactive, iterative process, and together referred to as the ***RI/FS***. They are intended to:

- Gather the data necessary to determine the type and extent of contamination at a **Superfund** site;
- Establish criteria for cleaning up the site;
- Identify and screen **cleanup** alternatives for **RA**; and
- Analyze in detail the technology and costs of the alternatives.

Remedial Project Manager:	The EPA or state official responsible for overseeing remedial response activities.
Superfund:	The common name used for **CERCLA**; also referred to as the ***Trust Fund***.
Superfund Amendments and Reauthorization Act:	**CERCLA** modifications enacted on October 17, 1986.
Surface Water:	Bodies of water that are above ground, such as rivers, lakes, and streams.
Technical Assistance Grant Program:	A grand program that provides funds for qualified citizens' groups to hire independent technical advisers to help them understand and comment on technical decisions relating to **Superfund cleanup** actions.
Trust Fund:	A fund set up under **CERCLA** to help pay for **cleanup** of hazardous waste sites and to take legal action to force those responsible for the sites to clean them up.

APPENDIX B

DESCRIPTION OF OPERABLE UNITS*

* The information contained in this appendix was obtained exclusively from the U.S. Army's Five-Year Review Report, First Five-Year Review Report for Fort Wainwright, Alaska, September 2001, prepared by Wood Canyon Group.

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LIST OF ACRONYMS AND ABBREVIATIONS

AAC	Alaska Administrative Code
ADEC	Alaska Department of Environmental Conservation
ARAR	Applicable or Relevant and Appropriate Requirements
Army	United States Army
AS	Air sparging
AS/SVE	Air sparging and soil vapor extraction
AST	Aboveground storage tank
AWQS	Alaska Water Quality Standards
bgs	below ground surface
BTEX	Benzene, toluene, ethylbenzene, and total xylenes
CANOL	Canadian Oil Line
CERCLA	Comprehensive Environmental Response, Compensation, and Liability Act
CIP	Community Involvement Plan
COC	Contaminant of concern
CSY	Coal Storage Yard
DCA	Dichloroethane
DCE	Dichloroethene
DPW	Directorate of Public Works
DRMO	Defense Reutilization and Marketing Office
DRO	Diesel range organic
EDB	1,2-dibromoethane
EOD	Explosive Ordnance Disposal
EPA	United States Environmental Protection Agency
ESD	Explanation of Significant Differences
EQFS	East Quartermaster's Fueling System
FAA	Federal Aviation Administration
FFA	Federal Facility Agreement
FS	Feasibility Study
FTP	Fire Training Pit
GIS	Geographic Information System
GRO	Gasoline range organics
IC	Institutional controls
IRP	Installation Restoration Program
IRA	Interim Remedial Action
JP-4	Jet petroleum fuel
MCL	Maximum concentration limits
MCLG	Maximum contaminant level goal
µg/L	Micrograms per liter
mg/kg	Milligrams per kilogram

mg/L	Milligrams per liter
NFA	No further action
NPL	National Priorities List
OB/OD	Open Burning/Open Detonation
OM&M	Operations, Maintenance and Monitoring Manual
ORC	Oxygen releasing compound
OU	Operable Unit
PAH	Polycyclic aromatic hydrocarbon
PDRAR	Preliminary Draft Remedial Action Report, Operable Unit 5
PCB	Polychlorinated biphenyl
PCE	Perchloroethylene
POL	Petroleum, oil, and lubricant
PSE	Preliminary Source Evaluation
QFS	Quartermaster's Fueling System
RAO	Remedial Action Objective
RAR	Remedial Action Report
RBC	Risk-Based Concentration
RCRA	Resource Conservation and Recovery Act
RI	Remedial investigation
RI/FS	Remedial Investigation/Feasibility Study
ROD	Record of Decision
ROLF	Railcar Off-loading Facility
RPM	Remedial Project Manager
SOP	Standard operating procedure
SVE	Soil vapor extraction
SVOC	Semivolatile organic compounds
TAH	Total aromatic hydrocarbon
TAqH	Total aqueous hydrocarbon
TCA	Trichloroethane
TCE	Trichloroethene
TFS	Truck Fill Stand
TMB	Trimethylbenzene
TPA	Two-Party Agreement
USARAK	United States Army, Alaska
UST	Underground storage tank
VOC	volatile organic compound
WQFS	West Quartermaster's Fueling System

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1.0 OPERABLE UNIT 1

1.1 Operable Unit 1 Background

Operable Unit (OU) 1 originally consisted of 22 potential source areas, of which only four were carried through remedial investigation (RI): the 801 Drum Burial Site, Site N-4, Building 1599, and Building 2077. Subsequent Installation Restoration Program (IRP) management of these source areas was based on the results of the RI, as follows:

- Buildings 1599 and 2077 were referred to the Two-Party Agreement (TPA), since the only contaminants of concern (COCs) at these two locations consisted of petroleum hydrocarbons.
- Site N-4 was found to require no further action.
- The 801 Drum Burial Site is the only source area recommended for further action under the OU1 Record of Decision (ROD), based on potential risk to human health and the environment.

A no further action decision was made for the following source areas based on 1) the physical location could not be identified, 2) no visible sign of contamination was observed during inspections, or 3) environmental sampling results showed that contamination was below the protective human health based levels. Based on these criteria, the Remedial Project Managers (RPMs) recommended the following sources areas as requiring no further action under this ROD: the Utilidor Expansion Drum Site, the Beacon Tower Drum Site, the Blair Lakes Drum Site, Building 3015, Burial Site M, Building 1128, Transformer Yard Drum Site, Trainor Gate Railroad Spur, the Runway Radioactive Waste Site, the Birch Hill Radioactive Waste Site, Building 1567, Site N-4, Transformer Storage Yard East of 3019, the Alaska Railroad Storage Yard, Building 2250, the Drum Site South of the Landfill, the Engineer Park Drum Site. A description of these no further action decisions can be found in the OU1 ROD and the administrative record.

An interim ROD was signed in 1995 for the Chemical Agent Dump Site. The Interim Remedial Action (IRA) indicated that chemical warfare materials were not present at this site and a no further action decision was recommended under this ROD. Information on this source can be found in the IRA ROD Chemical Agent Dump Site and the administrative record.

Periods of use and dates related to the history of the 801 Drum Burial source area contamination and remediation are summarized in Table 1-1.[1]

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[1] Information obtained from the OU1 Interim Action Plan, OU1 Operations, Maintenance and Monitoring Manual, and the Five-Year Review Report Document Log.

Table 1-1. 801 Drum Burial Source Area History.

EVENT	DATE
Drum storage and disposal activities.	1950s & 1960s
Buried drums discovered during construction of storm sewer. Geophysical survey conducted and two anomalies discovered.	1987
Fort Wainwright added to the National Priorities List (NPL).	August 1990
Preliminary Source Evaluation (PSE) conducted and 801 Drum Burial Site assigned to OU2 for Remedial Investigation/Feasibility Study (RI/FS).	1991
Federal Facility Agreement (FFA) signed.	1992
TPA signed.	1992
PSE2 conducted followed by excavation and removal of 92 drums from site, 18 containing some amount of product. Drilling, installation, and sampling of 6 groundwater monitoring wells and 18 microwells performed.	1992 & 1993
801 Drum Burial Site transferred from OU2 to OU1 and 3 additional monitoring wells installed. Geophysical survey conducted and four additional areas located for further investigation.	1994
Management Plan, OU1, RI/FS issued.	August 1995
26 drums (8 containing some amount of product) removed during RI activities. Two additional monitoring wells installed and sampled.	1995
Additional geophysical surveys conducted and 118 drums were subsequently removed, 46 containing some amount of product. 850 cubic yards of pesticide-contaminated soil removed during excavation and stockpiled on site in two lined containment cells for later management. Six additional monitoring wells installed and the first quarterly groundwater sampling performed.	September 1996
Proposed Plan for Remediation for OU1 issued.	February 1997
Stockpiled soils removed from site for final disposition.	1997
OU1 ROD signed.	June 1997
Additional excavations performed based on previous geophysical surveys but no additional drums discovered.	October 1997
Final Operations, Maintenance and Monitoring Manual (OM&M) for 801 Drum Burial Site issued.	December 2000
IRA Report issued.	May 2001

1.2 801 Drum Burial Site

1.2.1 Overview

The 801 Drum Burial Site (Figure 1-1) is located between the west bank of the Chena River and Fegree Road and south of the Alaska railroad bridge. It covers an area of approximately 20 acres. The site was discovered during construction of a storm sewer in the summer of 1992, as part of the 801 contract housing construction project. Numerous drums were reportedly removed from the area during initial construction. In the fall of 1992 and in 1995 excavation and drum removal activities were undertaken. Sampling results showed elevated levels of petroleum, oil, and lubricant (POL), pesticides and solvents in soil and groundwater at this location. Additional drums were found and removed during the 1995 remedial investigation and 1996 follow up investigation. The ROD was signed June, 1997. Monitoring wells to determine potential contaminant migration were installed; sampling is conducted currently on a yearly basis; every third year a comprehensive event conducted, the other two years only a small monitoring event takes place. Long-term monitoring at the site will continue. Institutional controls (ICs) are in place, and an informational sign was installed at this source area in 2001 to inform the public of restricted activities at this site. The United States Environmental Protection Agency (EPA) determined this remedy to be operational and functional as of May 30, 2001. The OM&M has been written, and the IRA Report was received in April 2001.

1.2.2 Background

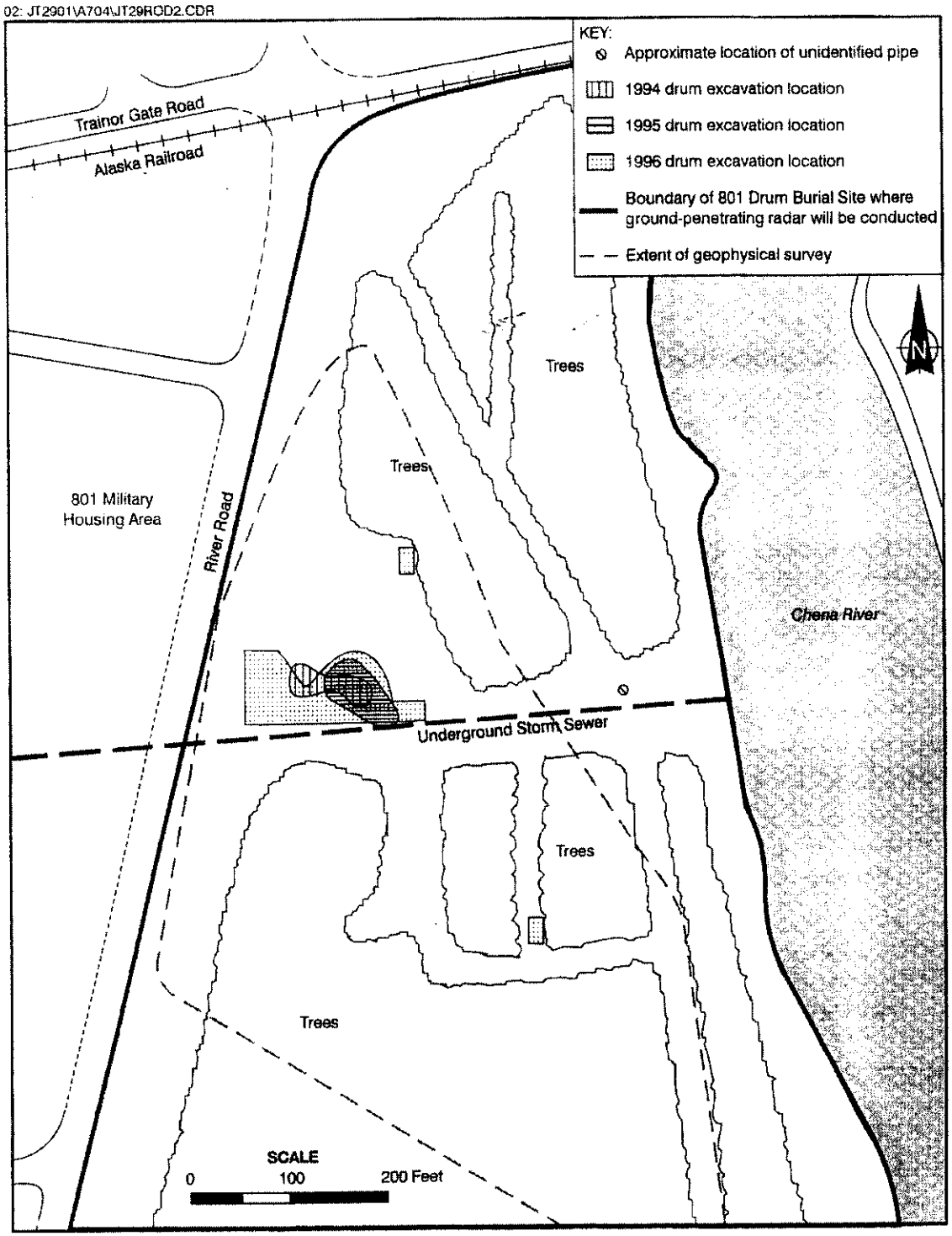
Physical Characteristics

The 801 Drum Burial Site is approximately 0.13 miles east of the 801 Military Housing Area on the east side of River Road and near the west bank of the Chena River. The area is in a small depression between River Road and the Chena River and is currently undeveloped and vegetated with grass, brush and trees. Groundwater in the area of the Drum Burial Site is shallow, varying from about 5 feet to 15 feet below ground surface (bgs) across the site. Groundwater level monitoring has shown groundwater flow direction to be generally consistent with the regionally west-northwesterly flow direction. However, the groundwater flow direction and gradient fluctuate seasonally and with the water level and flow of the Chena River. During periods of high water and flow in the Chena River, the groundwater flow direction on site is generally to the west, away from the river. During low water and flow, usually in the winter and early spring, the groundwater flow direction is eastward, toward the river.

History of Contamination

The 801 Drum Burial Site was formerly used as a drum storage area and disposal area. Drums stored at this source area reportedly contained diesel fuel, gasoline, jet fuel, solvents, asphalt, pesticides, and lubricants. Aerial photographs from the 1950s and 1960s indicate that a pit was in the southwest corner of the storage area. Subsequent aerial photographs show that the pit

Figure 1-1. OU1 801 Drum Burial Site.



was filled. During summer 1992, buried drums were found during construction of a storm sewer that runs west-east through the source area and outfalls in the Chena River. Numerous drums were removed during these construction activities.

Land and Resource Use

The 801 Drum Burial Site is across River Road from a military housing area and between the housing area and the Chena River. The ROD described land use at this source area as recreational. The land use is expected to remain recreational due to its location and the access it provides to the Chena River. River Road is elevated at this location, providing a physical barrier that prevents typical surface water runoff from reaching the housing area. The road directs local surface water runoff to the Chena River, which is directly adjacent to the source area.

Some nonmilitary residents north of the Chena River obtain drinking water from the College Utilities well located approximately 1.25 mile west of the post on the southern bank of the Chena River. Downgradient of the 801 Drum Burial Site, there are residential and commercial wells that provide residential and bottled drinking water respectively. Residents of the 801 Military Housing Area obtain their drinking water from the Golden Heart Utilities water system. Groundwater use is considered residential because water supply wells for the City of Fairbanks are located in the same unconfined aquifer as groundwater contamination downgradient of the source area.

Pre-ROD Response

As part of the PSE process at the 801 Drum Removal Site in 1991, numerous geophysical surveys were conducted, and over 126 drums were removed from this area during 1992-93. Drum contents were sampled and found to contain aqueous liquid, organic solids, flammable organic liquid, and chlorinated organic liquid. During these removal actions, over 150 cubic feet of soil was removed and taken to a landfarming facility located south of the landfill. The excavation was lined with visqueen and backfilled in imported sandy silt. The area was graded to match the original slope and excavation.

Based on the findings of geophysical surveys, another removal action was conducted in 1996 and an additional 118 drums (some of which were found to contain fuels, solvents, pesticides, and lubricants) were removed. Approximately 850 cubic yards of pesticide and diesel range organics (DRO) contaminated soil was removed and stockpiled pending a treatability study and determination of ultimate disposition.

1.2.3 Remedy Selection

Nature of Contamination

Sampling conducted prior to and during the remedial investigation detected petroleum hydrocarbons, volatile organic compounds (VOCs), pesticides, and heavy metals in surface soil, subsurface soil, and groundwater; heavy metals in Chena River water samples; and VOCs, pesticides, and heavy metals in Chena River sediments. Of these, two organic compounds, two pesticides, and diesel range POL were reported in concentrations requiring remediation.

Preliminary data suggested that contaminant plumes in the groundwater were migrating from the known source areas; however, migration rates were undetermined due to complexity of groundwater movement in the area. The results of the remedial investigation also suggested a high potential for the contaminants to migrate to the Chena River and affect downgradient groundwater users if not controlled.

Remedial Action Objectives

A baseline risk assessment indicated the need for remedial action at the 801 Drum Burial Site, and the following remedial action objectives (RAOs) were established:

Groundwater

- Ensure that groundwater use at the 801 Drum Burial Site meets federal and state standards.
- Minimize potential migration of contaminated groundwater to the Chena River and downgradient drinking water wells.
- Establish and maintain ICs to ensure that the groundwater will not be used until federal and state maximum concentration limits (MCLs) are attained, except for activities undertaken to initiate the selected remedies.

Soil

- Prevent further leaching of contaminants from soil to groundwater.
- Reduce risks associated with exposure to contaminated soil and drums.
- Prevent migration of soil contaminants to groundwater which could result in groundwater contamination and exceedances of federal MCLs and Alaska Water Quality Standards (AWQS) (18 Alaska Administrative Code [AAC] 70).

Selected Remedy

The remedy selected for the 801 Drum Burial Site consisted of:

- Locating potential buried drums and, if found, removing and disposing of drums and contaminated soils, while restricting access to the source area during this work.
- Establishing and maintaining ICs to ensure that the groundwater will not be used until federal and state MCLs are attained, except for activities undertaken to initiate the selected remedies. ICs include restrictions governing site access, construction and well development or placement as long as hazardous substances remain on site that preclude unrestricted use.
- Natural attenuation of groundwater with long-term groundwater monitoring
- A groundwater contingent remedy which includes an air sparging and soil vapor extraction (AS/SVE) system to specifically treat VOCs. This remedy will be implemented if the plume shows an increasing trend over any three consecutive sampling events, or if designated monitoring points indicate the plume is migrating.

1.2.4 Status of Remediation

Drum and Soil Removal

Three separate removal actions for drums and soil were conducted in 1992 and 1996. These actions were conducted under the United States Army, Alaska's (USARAK's) removal authority and were documented in Decision Documents, which have been placed in the Administrative Record. Based on geophysical surveys conducted at this source area, it is believed that all drums were removed during these efforts. Contaminated soil was excavated and treated.

Groundwater Monitoring

Groundwater monitoring at this source area began after the signing of the ROD in September 1997 and is ongoing. Monitoring is accomplished by means of sixteen wells across the water table and varying in depth from 20 to 40 feet bgs. Beginning in March 1998, the RPMs agreed that the groundwater monitoring frequency could be reduced from quarterly to annual sampling based on results that demonstrated no new migration of contaminants and little or no change in contaminant concentrations at the wells.

In 1999, the monitoring program was modified to sample for pesticides in two of the wells in odd numbered years and to sample all wells for pesticides and VOCs in even numbered years. In 2000, the monitoring program was reevaluated by the RPMs and the monitoring regime modified to that in place as of the publication date of this document:

- Two wells will be sampled for pesticides in Spring 2001 and 2002.
- All wells will be sampled for pesticides, gasoline range organics (GRO), DRO, and metals in 2003. Eleven (11) of the wells will be sampled for VOCs.

- This sequence of sampling (2 wells for 2 years followed by all wells the third year) will be continued pending future review of monitoring results.

Results of the 2000 annual sampling indicate little or no change in the analytes tested since the December 1996 sampling event, with the exception that cis-1,2-dichloroethene was detected above MCLs. Contaminant concentrations at perimeter wells along the eastern, southern and western margins of the site either remained constant or were non-detect, indicating that contaminant migration is under control. Results from the 2001 sampling event further corroborated this finding, as no exceedances were reported and none of the analytes were detected in the two sentinel wells sampled.

Passive remediation is the selected remedy at this source area, and as a result, there is no system operations and maintenance per se. Monitoring wells are maintained as necessary, as is access to the wells. EPA determined the remedy at the 801 Drum Burial Site to be operational and functional. An OM&M for the 801 Drum Burial Site, dated December 2000, provides specific procedures and protocol for ongoing maintenance and monitoring for the source area. The RPMs review the results of groundwater sampling and analysis as the data become available, and review the groundwater monitoring program for this OU on an annual basis.

Institutional Controls

ICs at the 801 source area have been implemented. An informational sign describing these ICs was posted at the source area in 2001, and Fort Wainwright has established a post-wide IC policy for all known or suspected contaminated sites.[2] This policy will be updated in December 2001.

This policy ensures that:

- No unauthorized intrusive actions take place at this source area,
- No potable water wells are installed on this source area, and
- No soil excavation can take place without prior briefings on potential concerns at the source area, knowledge of the procedures for handling contaminated soils on Fort Wainwright, and possession of a valid site-specific Fort Wainwright Excavation Permit.

[2] Further details of USARAK/Fort Wainwright IC policy can be found in the OU5 ROD, the U.S. Army, Alaska Institutional Controls Standard Operating Procedures [APVR-RPW (200-1)], and a September 1999 Memorandum on Institutional Controls [APVR-RPW-EV-(200-1c)] from Major General Dean W. Cash, Fort Richardson, Alaska.

USARAK Directorate of Public Works (DPW) maintains a Geographic Information System (GIS) database with information on all of the contaminated sites on post. The DPW is responsible for ensuring ICs are in place on Fort Wainwright. ICs will remain in place as long as hazardous substances remain on site at levels that preclude unrestricted use. Excavation and groundwater intrusion at this source area is restricted subject to approval by DPW Environmental. There have been no unauthorized activities at this site, and the ICs are accomplishing the intended purpose.

Since there is no ongoing surface contamination at the 801 Drum Burial Site, access to the area for non-intrusive activities is unrestricted.

Site Inspection

The 801 Drum Burial Site was inspected on April 27, 2001. All wells appeared to be in good condition at that time, and no unusual conditions were observed.

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2.0 OPERABLE UNIT 2

2.1 Operable Unit 2 Background

OU 2 originally consisted of the following eight source areas: the North Post Site, the 801 Drum Burial Site, the Engineers Park Drum Site, the Drum Site South of the Landfill, Building 3477, four Tar Sites, the Defense Reutilization and Marketing Office (DRMO) Yard, and the Building 1168 Leach Well. All OU2 source areas underwent PSEs, which included historical record reviews and, as necessary, limited field investigations. Subsequent IRP management of these source areas was based on the results of the RI as follows:

- The 801 Drum Burial Site, Engineers Park Drum Site, and the Drum Site South of the Landfill were all moved to the OU1 ROD.
- North Post Site was addressed under the TPA.
- Building 3477 and the Tar Sites were moved to no further action (NFA) status.
- Building 1168 Leach Well and the DRMO are the only two source areas recommended for further action under OU2, based on potential risk to human health and the environment.

2.2 Building 1168 Leach Well

2.2.1 Overview

Building 1168 (Figure 2-1) was constructed in 1950 as a lubricant oil and vehicle storage facility and was converted to a POL laboratory around 1962. It is located near the western boundary of Fort Wainwright, adjacent to Trainor Gate Road. The contamination covers an area of approximately 50 feet from the leach well with a thickness of approximately 5 feet. The primary source of contamination was from a former leach well connected to an oil/water separator system. Contaminants found at this site included POL, solvents and heavy metals. The decision to treat this source was influenced by its proximity to the post boundary (500 feet) and a public school (1,000 feet). Remedial action was undertaken for in-situ treatment of contamination. Installation of the AS/SVE system was completed in November 1994,[3] and active AS/SVE continued through 1998. The system was turned off after RAOs for non-POL contaminants were achieved, but groundwater monitoring has continued through 2001 to ensure that contaminant concentrations are stable before the system is decommissioned. The AS/SVE system is slated for removal from Building 1168 in 2001, making system components available

[3] USARAK has designated construction of this remedial action as complete for project tracking and accounting purposes.

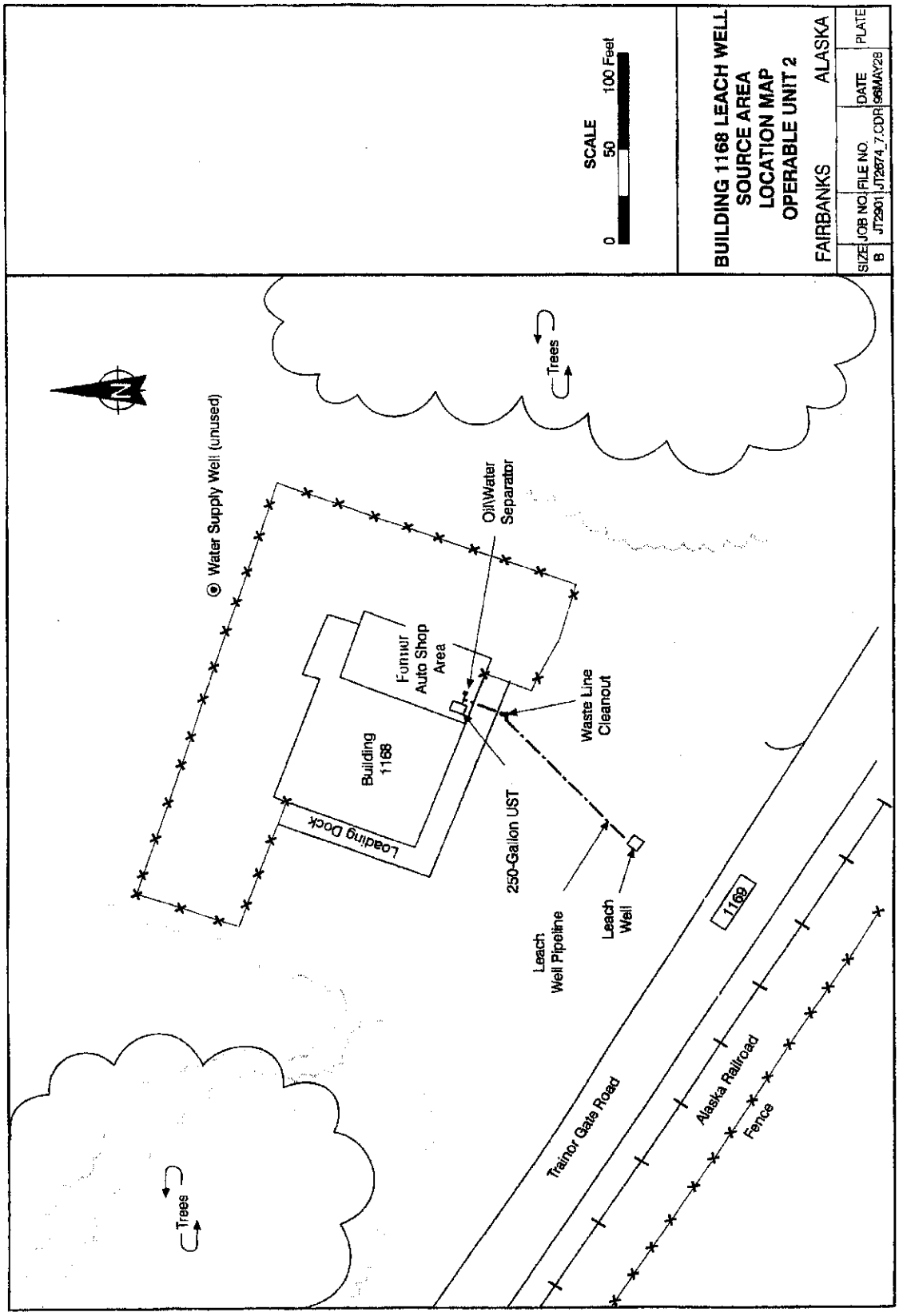

Figure 2-1. OU2 Building 1168 Leach Well Location as Depicted in May 1996 ROD.

for use at other IRP sites on Fort Wainwright. A long-term monitoring plan has been agreed to by EPA, the Alaska Department of Environmental Conservation (ADEC), and USARAK. This plan will be reviewed and updated at least yearly. The OM&M and IRA reports for this source area are complete.

2.2.2 Background

Periods of use and dates related to the history of Building 1168 contamination and remediation are shown in Table 2-1.[4]

Table 2-1. Building 1168 Contamination and Remediation History.

EVENT	DATE
Lube oil and vehicle storage facility operations.	1949 to 1962
Converted into a petroleum test laboratory.	1962
Groundwater survey conducted and EPA recommends further investigation.	1990
Fort Wainwright NPL listed.	August 1990
FFA signed.	1992
TPA signed.	1992
PSE conducted.	1992 and 1993
RI conducted.	1994
Source area pilot-scale AS/SVE remediation system installed.	November 1994
Feasibility Study (FS) completed.	1996
ROD signed.	January 1997
Building 1168 demolished.	1997
Active AS/SVE treatment completed.	1998
Remedial Action Report (RAR) completed.	May 1999
Final OM&M issued.	December 2000

[4] Information obtained from the OU2 ROD, Building 1168 RAR, Building 1168 OM&M, and the Five-Year Review Report Document Log.

Physical Characteristics

The Building 1168 source area is within the main post confines and located north of Trainor Gate Road, adjacent to the Trainor gate entrance. The site is bounded by undeveloped land on three sides (north, east, and west) and Trainor Gate Road (south). A Fairbanks public school is located within 1,000 feet northwest of this site, and the 801 military housing area is approximately 300 feet south of the site. The nearest surface water body, the Chena River, is approximately 1,800 feet to the east.

Subsurface soil at this site consists of unconsolidated lenses of interlayered silt, silty sand and poorly graded sand and gravel. Predominant groundwater flow is generally to the west-northwest following the trend of the Tanana River Valley; however, seasonal changes in flow direction may occur due to the influences of water level changes in the Chena River located approximately 1,800 feet to the east.

Land and Resource Use

Building 1168 was demolished during the summer of 1997, and the former building site is now a flat, graded gravel lot. The current land use designation is "industrial", which it is expected to remain for the foreseeable future. Groundwater use is considered residential because water supply wells for the City of Fairbanks are located in the same unconfined aquifer as groundwater contamination downgradient of the source area.

History of Contamination

Contamination at Building 1168 originated from a leach well that received liquids collected in floor drains within Building 1168. From the 1950s to 1997, Building 1168 was used as a lubrication oil and vehicle storage/shop facility, and a POL laboratory. Floor drains in the building formerly discharged into an oil/water separator designed to allow POL to flow into a storage tank and wastewater to flow through a 4-inch diameter buried waste line to a leach well approximately 100 feet southwest of the former building. The oil/water separator system was decommissioned in 1993. Because of system malfunctions during the 40 years of service, some products entering the oil/water separator were inadvertently conveyed directly to the leach well, subsurface soil, and groundwater. Products suspected to have entered the leach well include oil from engines and transmissions, gasoline, diesel, jet fuel, and solvents.

Pre-ROD Response

The initial response to contamination identification at Building 1168 Leach Well was to install a treatability study AS/SVE system in 1994.

2.2.3 Remedy Selection

Nature of Contamination

Contaminated soils associated with the leach well appears to be the source of contamination detected in the groundwater which is located approximately 12 feet to 17 feet bgs. Initial site investigations discovered a zone of hydrocarbon contamination approximately four to five feet thick in subsurface soils near the groundwater interface and extending approximately 50 feet radially from the leach well. Contamination from these subsurface soils created a commingling benzene and trichloroethene (TCE) plume in the groundwater 20 feet to 50 feet bgs. Initial chemicals of concern for remediation at this site included the following:

Groundwater

RI results confirmed the presence of the VOCs benzene, trichloroethene, vinyl chloride, 1,1-dichlorethene (DCE), and 1,2-DCE in groundwater above MCLs.

Soil

Subsurface soils were found to contain DRO, GRO and benzene, toluene, ethylbenzene, and total xylenes (BTEX). The release mechanism precluded significant surface contamination at this site.

Remedial Action Objectives

RAOs for the Building 1168 Leach Well source area and the DRMO Yard are identical and were based on federal and state Applicable or Relevant and Appropriate Requirements (ARAR). All groundwater RAOs were based on state and federal MCLs. Soil RAOs were based on State of Alaska cleanup levels for non-underground storage tank (UST) petroleum contamination.

The RAOs for groundwater at all OU2 source areas are:

- Restore groundwater to its beneficial use of drinking water quality within a reasonable time frame through source control.
- Reduce or prevent further migration of contaminated groundwater from the source areas.
- Prevent use of groundwater containing contaminants at levels above Safe Drinking Water Act and State of Alaska Drinking Water Standard MCLs and AWQS.
- Use natural attenuation to attain AWQS (18 AAC 70) after reaching state and federal MCLs.

The RAO for soil at all OU2 source areas is:

- Prevent migration of soil contaminants to groundwater, which could result in groundwater contamination and exceedances of state and federal MCLs and AWQS (18 AAC 70).

Selected Remedy

The goal of this remedial action is to restore groundwater to its beneficial use as a drinking water aquifer and to remediate soil to State of Alaska cleanup levels for non-UST petroleum-contaminated soil. To achieve the OU2 ROD objectives, the remedial action components specified for the Building 1168 Leach Well Source Area included:

Soil Vapor Extraction and Air Sparging

- In situ treatment of groundwater via air sparging (AS) to remove volatile organic compounds, thereby attaining state and federal drinking water standards.
- In situ treatment of soil via soil vapor extraction (SVE) to prevent contaminated soil from acting as an ongoing source of contamination to groundwater.
- Treatment system evaluation and modification as necessary to optimize effectiveness.
- Periodic monitoring and evaluation of air emissions from the AS/SVE treatment system to meet emission requirements.
- Periodic groundwater monitoring and off-gas measurements to determine attainment of RAOs.

Natural Attenuation and Groundwater Monitoring

- Achieve AWQS through natural attenuation after active treatment attains state and federal maximum contaminant levels.

Institutional Controls

- Maintain ICs, including restricted access and well development restrictions, as long as hazardous substances remain on site at levels that preclude unrestricted use.

2.2.4 Status of Remediation

Leach Well

In 1994, a pilot scale remediation system was installed around the leach well to determine whether an in situ treatment system was technically feasible in source area soil and groundwater. The system was modified and expanded in 1996 and 1997 to optimize the effectiveness based on monitoring data evaluation. The treatment system was designed to operate in the summer months (May through October) only, and operated seasonally until

December 1998 when the system was shut down following achievement of the remedial action objectives. A small rebound in benzene to just above the MCL was identified in May 2000, but subsequent sampling in September 2000 and May 2001 show the benzene concentration has dropped below the MCL.

Groundwater Monitoring

Groundwater monitoring frequency was decreased from quarterly to annually following attainment of MCLs and system shut down in 1998. However, some minor rebound in concentrations of contaminants has occurred since the treatment system was shut down, and, following review by the RPMs, groundwater monitoring frequency was increased to a semiannual basis subject to reconsideration after the May 2002 sampling event.

In general, sample results indicate that groundwater contamination at the site has decreased since 1994. This has been attributed mainly to the operation of the treatment system from 1994 to 1998. GRO has not exceeded the groundwater cleanup levels since June 1998, and TCE has not exceeded the MCL since October of 1997. Benzene has also been below the MCL since September of 1998 except for a single spike of 6.5 micrograms per liter (µg/L) in well AP-6809 during the May 2000 sampling event. A subsequent benzene concentration of 3.58 µg/L was detected in this well during the September 2000 sampling event. DRO levels dropped significantly in wells GP1 and GP2 at the onset of treatment, while PS23 exhibited a slight trend toward decreasing concentrations. Concentrations at all three locations were below ADEC Groundwater Cleanup Standards at the January 1998 sampling event. Following discontinuation of active treatment, DRO levels have remained constant in PS23, while GP1 and AP-6809 and HC1 (both installed in June 1998) have exhibited a rebound above the ADEC cleanup level of 1.5 µg/L.

The Building 1168 site is located near the western boundary of Fort Wainwright and is monitored by picket wells along the boundary line. No contamination has been detected in any of these wells above the MCLs. Trichlorofluoromethane was the only contaminant detected in the picket wells during 2000 sampling activities, but the detected concentrations were well below the determined Risk-Based Concentrations (RBCs). The source of the trichlorofluoromethane has not been established but is assumed to not be associated with the Building 1168 Leach Well.

Institutional Controls

Fort Wainwright has established a post-wide IC policy for all known or suspected contaminated sites.[5]

This policy ensures that:

- No unauthorized intrusive actions take place at this source area,
- No potable water wells are installed on this source area, and
- No soil excavation can take place without prior briefings on potential concerns at the source area, knowledge of the procedures for handling contaminated soils on Fort Wainwright, and possession of a valid site-specific Fort Wainwright Excavation Permit.

USARAK DPW maintains a GIS database with information on all of the contaminated sites on post. The DPW is responsible for ensuring ICs on Fort Wainwright. ICs will remain in place as long as hazardous substances remain on site at levels that preclude unrestricted use. Excavation and groundwater intrusion at this source area is restricted subject to approval by DPW Environmental.

Site Inspection

A site inspection was conducted on April 27, 2001 and included inspecting the condition of the monitoring wells and treatment system container. All wells appeared to be in good condition. The system was in place but not operating as discussed above.

2.3 DRMO Yard

2.3.1 Overview

Contamination was originally identified at six subareas at the DRMO yard (Figure 2-2). Two subareas with petroleum and solvent contamination are part of OU2, and the others are addressed in the TPA or were identified in the ROD as requiring NFA. Contaminants found at the DRMO Yard were solvents and petroleum in the soil and groundwater. The site is located along Badger Road, northwest of the intersection of Badger Road and the Old Richardson Highway, on the eastern boundary of Fort Wainwright. The salvage yard is a fenced compound covering approximately 25 acres. Spills occurred routinely at the DRMO Yard in the past. The

[5] Further details of the USARAK/Fort Wainwright IC policy can be found in the OU5 ROD, the U.S. Army Alaska Institutional Controls Standard Operating Procedures [APVR-RPW (200-1)], and a September 1999 Memorandum on Institutional Controls [APVR-RPW-EV-(200-1c)] from Major General Dean W. Cash, Fort Richardson, Alaska.

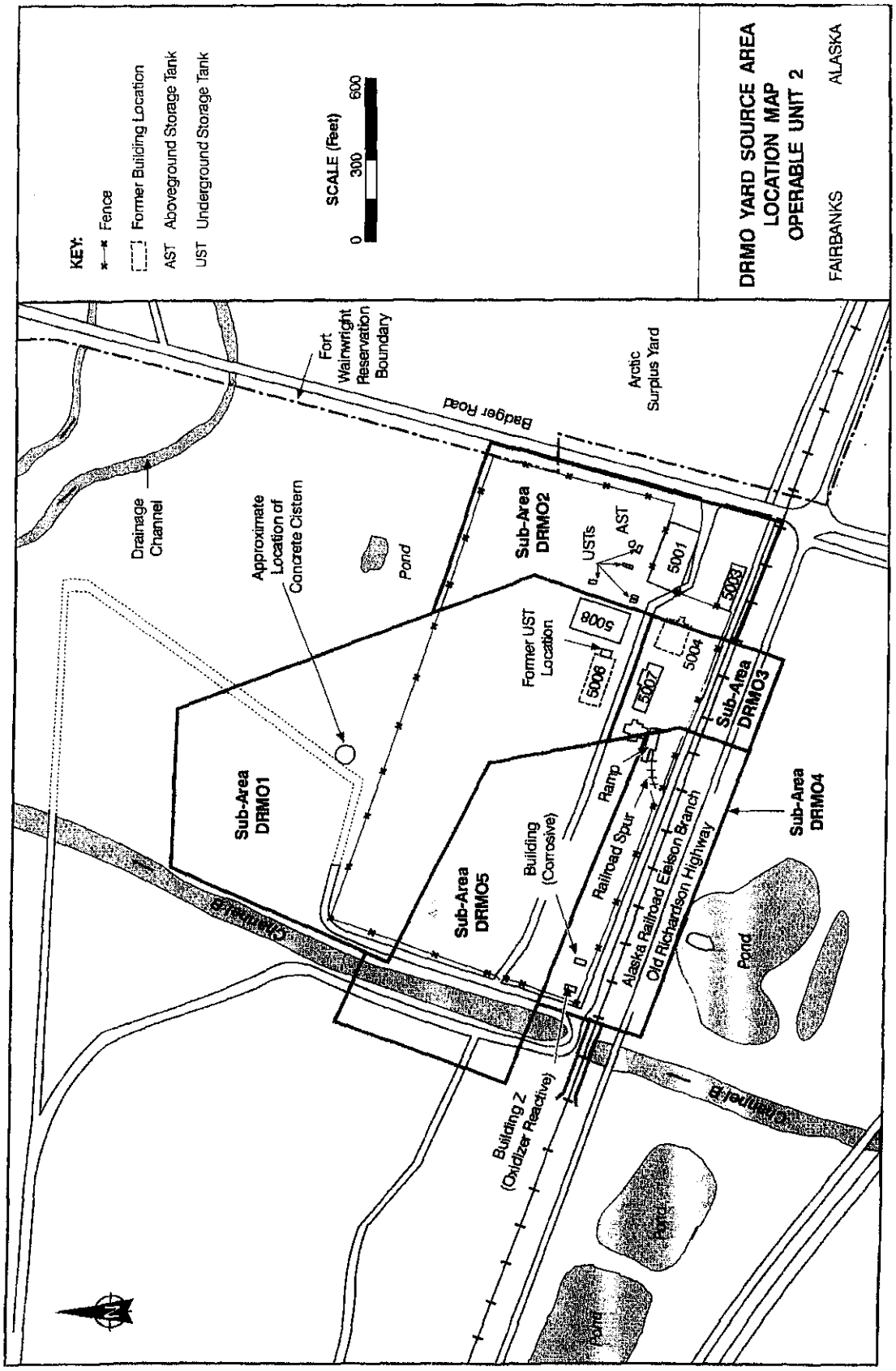

Figure 2-2. OU2 DRMO Yard as Depicted in January 1997 ROD.

RI/FS was completed in October 1994. The ROD was signed in April 1997, with the chosen alternative being AS/SVE with groundwater monitoring. The AS/SVE system was installed during the summer of 1997, and new groundwater monitoring wells were installed outside the northwest fence line, at the DRMO water supply well, at Building 5010, and inside the south fence line. The monitoring wells outside the northwest fence line are picket wells to provide information related to off-site migration of contaminants from this source area towards Channel B, a man made trench constructed as part of the Chena River flood control project.

2.3.2 Background

The DRMO Yard source area was divided into six sub-areas for remedial investigation purposes. Of these six subareas, three (DRMO2, DRMO3, and DRMO5) were found to have petroleum-related contamination without commingling with other COCs. These sites are addressed under the TPA. Contamination in another of the subareas (DRMO6) was determined to warrant no further action. Two of the subareas (DRMO1 and DRMO4) were carried through to remedial action under the Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA) of 1980. DRMO1 and DRMO5 design study treatment systems for petroleum contamination are being operated under the TPA and will not be discussed further in this section.

There are currently three active remediation systems in place at the DRMO Yard: 1) the DRMO1 design study treatment system, 2) the DRMO5 design study treatment system, and 3) the OU2 ROD design study treatment system. The OU2 ROD treatment system located in DRMO1, is being operated under CERCLA; DRMO1 and DRMO5 treatment is being conducted under the TPA.

Periods of use and dates related to the history of DRMO yard contamination and remediation are shown in Table 2-2:[6]

Physical Characteristics

The DRMO Yard is an approximately 25-acre, fenced compound located near the eastern end of the post on the west side of Badger Road. The yard is bordered by the Alaska Railroad tracks on the south and a channel of the Chena River Flood Control Project on the west. Groundwater flow is generally toward the west following the regional flow of the Tanana River Valley. At the western boundary there may be some minor short term influences due to water

[6] Information obtained from OU2 ROD; August 1999 OU2 RAR; 1999 Monitoring Report, North Post, DRMO1, and DRMO5 Sites; Draft Comprehensive Annual Monitoring Report (February 2000); and the Five-Year Review Report Document Log.

level fluctuations in the man made channel (Channel B) located on the western boundary of the DRMO Yard.

Table 2-2. DRMO Yard Contamination and Remediation History.

EVENT	DATE
Vehicle storage and vehicle maintenance shop activities.	1945 to 1961
Site converted to salvage yard and drum storage.	1961
Diesel spill near Building 5001.	Early 80s
Removal of eight USTs (cleanup of associated soils are being addressed under the TPA).	1988 to 1996
FFA signed.	1992
TPA signed.	1992
Installation and semiannual sampling of 14 monitoring wells at the DRMO yard as part of the Arctic Surplus site investigation.	1990 to 1993
Fort Wainwright NPL listed.	August 1990
Soil and groundwater contamination discovered north of Building 5001 during investigation for construction of a building foundation.	July 1992
PSE2, Phase 2, conducted at DRMO yard to assess extent of soil contamination.	September 1992
Proposed Plan for Remediation made available to public.	April 1996
OU2 RI and FS issued.	1996
AS/SVE systems installed at sub-areas DRMO1 and DRMO5 as part of a petroleum hydrocarbon treatability study (performed under the TPA).	Summer of 1996
OU2 ROD signed.	January 1997
ROD Design Study System in sub-area DRMO1 is commissioned.	July 1997
OU2 RAR completed.	August 1999
Final DRMO OM&M issued.	December 2000
Final OU2 Design Study System OM&M issued.	June 2001

Land and Resource Use

The DRMO Yard's function is to store obsolete, surplus, unserviceable equipment and supplies for transfer to another authorized user, for public auctions, or for destruction and disposal. The

yard contains numerous aisles of surplus appliances, tires, transformers, and wire. Additionally, it serves as the hazardous material transfer point for Fort Wainwright, Fort Greely, and Eielson Air Force Base and operates as a storage facility in accordance with the Fort Wainwright Resource Conservation and Recovery Act (RCRA) Part B Permit. The land use is currently designated "industrial" and is expected to retain that designation for the foreseeable future.

Three residential areas are nearby the DRMO Yard. The first is approximately 1,400 feet to the north, the second is approximately 1,000 feet to the northeast, and the third is approximately 400 feet to the southwest. All three subdivisions use groundwater as their drinking water source and their wells are located in the same unconfined aquifer as that associated with the DRMO Yard groundwater contamination. Groundwater in the area generally flows west to northwest, away from these residential areas; however, fluctuations in flow direction occur.

A Class C public drinking water well and fire suppression system exist on site, but their use has been restricted by ICs enacted under a State of Alaska Plan Approval to Construct. The ROD specified that, with the exception of emergencies, the fire suppression water tank not be refilled from the DRMO Yard water supply well until after MCLs are met. Groundwater use is considered to be residential.

History of Contamination

From 1945 to 1961, the DRMO Yard was used for vehicle storage and contained a vehicle maintenance shop. In 1961 the source area was converted into a salvage yard and was used to store drums of waste oil; pesticides; solvents; vehicle fluids such as antifreeze and hydraulic fluid; asphalt; and electrical transformers, some of which may have contained polychlorinated biphenyls (PCBs). Many drums reportedly leaked. Items such as mattresses, wood furniture and possibly plastics were incinerated routinely in a burn pit and it is likely that the drummed fluids were also disposed of by burning. Waste oil, which historically contained heavy metals, solvents, PCBs, and other contaminants, was used to control dust on roads in the DRMO Yard during the 1970s and early 1980s. During the early 1980s, an estimated 3,000 gallons to 8,000 gallons of No. 1 diesel fuel were spilled near the former location of Building 5001. Cleanup activities of that spill included spreading the contaminated soil throughout the yard. Storage and destruction records were maintained by DRMO Yard personnel for three years and then were destroyed; therefore, complete records of DRMO Yard activities are unavailable.

Pre-ROD Response

From 1988 to 1996, eight leaking underground petroleum storage tanks, ranging in size from 500 gallons to 10,000 gallons, were removed from the DRMO Yard. Cleanup of the associated petroleum-contaminated soil and groundwater is being conducted under the TPA.

2.3.3 Remedy Selection

Nature of Contamination

DRMO1 (OU2 Treatment System)

The DRMO1 subarea was the site of waste oil drum and transformer storage, but no discrete source was identified for perchloroethylene (PCE), TCE, DRO, and GRO contamination at this location. A defined plume of groundwater contaminated with PCE and TCE was delineated at DRMO1 during 1995 RI activities.

In addition to the aforementioned contaminants, 1,1-DCE and 1,2-DCE are known breakdown products of PCE and TCE. Although not detected during the RI, these compounds were considered to be contaminants of potential concern in formulating the RAOs for the DRMO Yard. The location of the PCE or TCE release has been determined to be in the active treatment zone.

DRMO4

Benzene and PCE contamination at the DRMO4 source area appears to have resulted from miscellaneous releases associated with activities occurring along a railroad spur, resulting in a smaller groundwater contamination plume and lower contaminant concentrations than was evidenced in DRMO1.

Remedial Action Objectives

RAOs for the DRMO Yard and the Building 1168 Leach Well source area are identical and were described in Section 2.2.3.

Selected Remedy

The goal of this remedial action is to restore groundwater to its beneficial use as a drinking water aquifer and to remediate soil to State of Alaska cleanup levels for non-UST petroleum-contaminated soil. To achieve the OU2 ROD objectives, the remedial action components specified for the DRMO source area included:

DRMO Yard

- In situ treatment of groundwater via AS to remove volatile organic compounds, thereby attaining RAOs.
- In situ treatment of soil via SVE to prevent contaminated soil from acting as an ongoing source of contamination to groundwater.
- Treatment system evaluation and modification as necessary to optimize effectiveness.

Fort Wainwright has established a post-wide IC policy for all known or suspected contaminated sites.[7]

This policy ensures that:

- No unauthorized intrusive actions take place at this source area,
- No new potable water wells will be installed on this source area, and
- No soil excavation can take place without prior briefings on potential concerns at the source area, knowledge of the procedures for handling contaminated soils on Fort Wainwright, and possession of a valid site-specific Fort Wainwright Excavation Permit.

USARAK DPW maintains a GIS database with information on all of the contaminated sites on post. The DPW is responsible for ensuring ICs on Fort Wainwright. ICs will remain in place as long as hazardous substances remain on site at levels that preclude unrestricted use. Excavation and groundwater intrusion at this source area is restricted subject to approval by DPW Environmental.

Site Inspection

A site inspection was conducted on April 27, 2001. Inspection activities included checking the condition of the monitoring wells and the completeness of the remediation equipment. The AS/SVE equipment is not equipped to operate during the winter and was idle at the time of the visit. The feasibility of operating the AS portion of the treatment system year round is being evaluated at this time.

[7] Further details of the USARAK/Fort Wainwright IC policy can be found in the OU5 ROD, the U.S. Army Alaska Institutional Controls Standard Operating Procedures [APVR-RPW (200-1)], and a September 1999 Memorandum on Institutional Controls [APVR-RPW-EV-(200-1c)] from Major General Dean W. Cash, Fort Richardson, Alaska.

3.0 OPERABLE UNIT 3

3.1 Operable Unit 3 Background

OU3 was the first Fort Wainwright OU to reach a final-action ROD. That ROD was signed in January 1996 and initially addressed four source areas:

- Remedial Area 1a: Lead-contaminated soils near aboveground storage tanks (ASTs) within Birch Hill Tank Farm.
- Remedial Area 1b: Area below Birch Hill Tank Farm and around the Truck Fill Stand (TFS).
- Remedial Area 2: Valve Pit A, Valve Pit B, Valve Pit C, and the Railcar Off-loading Facility (ROLF).
- Remedial Area 3: Mileposts 2.7, 3.0, and 15.75 of the Fairbanks-Eielson Pipeline.

Remedial Area 1a was transferred to OU5. The RPMs agreed to defer selection of a final remedy because additional time was required to select an appropriate cleanup level and remediation goal for lead in soils.

3.2 Remedial Area 1b – Below Birch Hill Tank Farm and Truck Fill Stand

3.2.1 Overview

Remedial Area 1b (Figure 3-1) was divided into the following sub-areas based on geographic location and differing physical characteristics:

- Lazelle Road Sub-Area,
- Building 1173 Sub-Area,
- TFS Sub-Area,
- Shannon Park Subdivision Sub-Area,
- Canadian Oil Line (CANOL) Road Sub-Area, and
- Birch Hill Tank Farm Product Recovery System.

The Birch Hill Tank Farm dates back to the early 1940s. Sampling and monitoring at this source area, also referred to as the "Fairbanks Fuel Terminal," covers an area approximately 250 acres in the northwest corner of Fort Wainwright. Post-ROD studies indicate a substantial increase in the areal extent of contamination at the site to include free product within bedrock on Birch Hill. Results of FY98 field season sampling events indicated elevated concentrations of 1,2-dibromoethane (EDB) and 1,2-dichloroethane (DCA) in the groundwater in the fractured

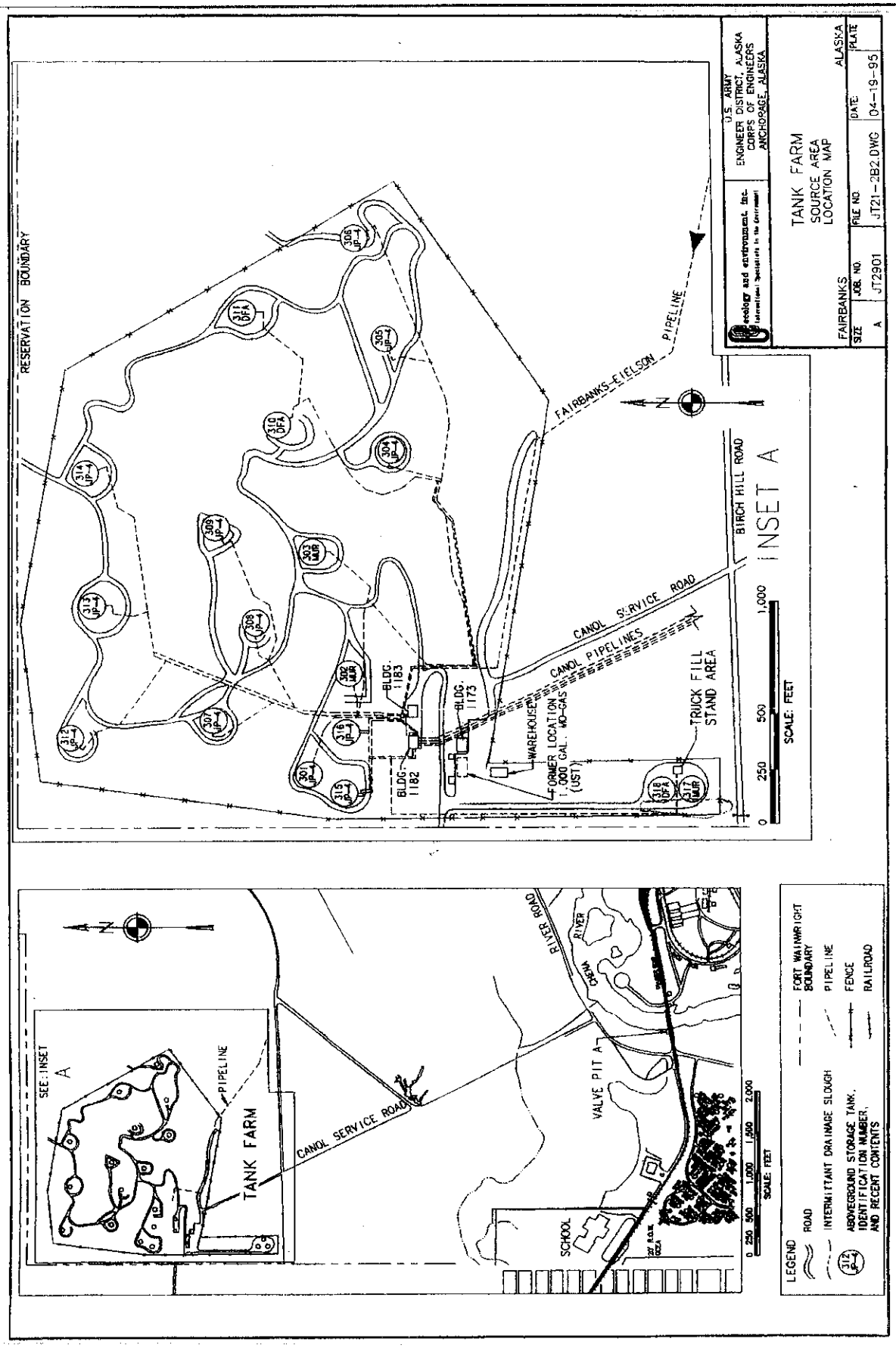

Figure 3-1. OU3 Tank Farm Source Area.

bedrock on Birch Hill. Further investigation during 1999-2000 indicate that groundwater contaminants measured off-post are likely migrating from the free product identified in the fractured bedrock aquifer on the hill directly under the Tank Farm. The Explanation of Significant Differences (ESD) will address product recovery implementation in the bedrock aquifer and increased costs for remediating this site. The ESD is anticipated to be completed in FY02. A product recovery system was installed on Birch Hill in 2000 and modified in 2001 to capture product. Draft OM&M reports have been completed for adoption for all systems at OU3. Bottled water has been provided to bordering churches since 1995; contamination still remains in their wells at levels below the MCL. Wells were monitored semiannually until 2000, when the Right of Entry expired. A memorandum of agreement is being developed to continue monitoring.

3.2.2 Background

Contamination was initially discovered at this site during a soil-gas survey conducted in 1988. Five monitoring wells were installed along the western boundary of the post as part of the post-wide groundwater monitoring program. Initial sampling events found BTEX and petroleum hydrocarbons at levels above MCLs. Monitoring wells were installed in 1992 near the TFS and in the area between the Tank Farm and the Chena River along the post boundary. These wells, served a down gradient monitoring wells and were part of the original FFA. These wells were known as "picket wells" and were monitored twice annually until 1995 when they became part of the closest OU.

Periods of use and dates related to the history of the Birch Hill Tank Farm contamination and remediation are shown in Table 3-1.[8]

Physical Characteristics

Remedial Area 1b extends south from the base of Birch Hill to the TFS and extends west toward Lazelle Road and east toward the CANOL service road. This area is located in the Chena River floodplain and is characterized by flat topography that gently slopes southward. The subsurface is typified by discontinuous permafrost and poorly drained soils covered by thick organic mats. Surface water ponding is common throughout the area from spring breakup until early to mid-summer. Wetlands are scattered throughout the area and shrub and forested wetlands border the southern portion. The Tank Farm Source Area has two distinct hydrogeologic areas: 1) the Birch Creek schist bedrock aquifer located from the top of the hill to the base of the hill, which includes the area beneath the ASTs on Birch Hill; and the alluvial aquifer with discontinuous

[8] Information obtained from the OU3 ROD; Groundwater Extraction and Treatment Effectiveness Review (Oct. 2000); OU3, 1999 Monitoring Report; and the OU3 Draft ESD.

permafrost located south and west of the TFS, which includes private property, the Bentley Trust Property and Church property.

Table 3-1. Birch Hill Tank Farm Contamination and Remediation History.

EVENT	DATE
Soil-gas survey conducted.	1988
Fort Wainwright NPL listed.	August 1990
FFA signed.	1992
TPA signed.	1992
Picket wells installed.	1992
RI fieldwork conducted.	September and October 1994
RI and Risk Assessment Reports submitted to EPA.	October 1994
FS submitted to EPA.	April 1995
ROD signed.	January 1996
AS/SVE systems installed at Building 1173 and Lazelle Road.	1996
Lazelle Road system relocated to the TFS and the Building 1173 system expanded to cover Lazelle Road source area.	1997
Product recovery treatability studies initiated at the Birch Hill Tank Farm.	1998
Thaw Channel treatment system installed.	1999
ESD submitted to document installation and operation of existing AS/SVE treatment systems; operation of the dual phase product recovery system on Birch Hill; continuation of groundwater modeling; and concomitant changes in remedial costs.	September 2001

Birch Hill consists of loess overlaying Birch Creek schist and other bedrock units. Groundwater flow in the bedrock aquifer at the Tank Farm is expected to occur mainly in fractures and to flow to the southwest.

The presence, location, and extent of permafrost from the base of Birch Hill southward to the Chena River significantly affect the groundwater flow direction in this part of the Tank Farm source area. Groundwater occurs in two zones above and below the permafrost in the alluvial aquifer. The suprapermafrost groundwater zone is the saturated zone above permafrost. The subpermafrost groundwater zone is the saturated zone beneath the permafrost. Groundwater occurs at approximately 20 to 22 feet bgs in the TFS area at the base of Birch Hill in the

suprapermafrost groundwater zone. Groundwater in this area flows to the west. Shallow discontinuous permafrost in this area may channel groundwater into thawed corridors that occur in meander scars, and a hydraulic connection may exist between the suprapermafrost groundwater zone in the thawed areas and the subpermafrost groundwater zone.

The closest drinking water wells to the Tank Farm Source Area are located at the Shannon Park Baptist Church and Mormon Chapel on Lazelle Road approximately 0.25 miles west of the Tank Farm.

Land and Resource Use

The current land use is considered light industrial in the immediate remedial area and light industrial, recreational, and residential in the surrounding areas. The groundwater below Remedial Area 1b is not currently a source of drinking water. For purposes of planning remedial action, future land use is considered to be industrial, recreational, and residential, and future groundwater use is considered to be residential.

History of Contamination

The Tank Farm and associated TFS was originally constructed as part of the 1943 CANOL Project. The CANOL Project was the construction of a 3-inch pipeline from Whitehorse to Fairbanks. The Tank Farm originally consisted of fourteen 10,000-barrel-capacity, bolted-steel aboveground fuel tanks on top of Birch Hill which contained jet petroleum fuel (JP-4), motor vehicle gasoline, and diesel fuels. The 14 tanks were connected by an 8-inch pipeline connected to the Railroad Offloading Facility and the East Birch Hill UST Tank Farm. A post-ROD historical search indicated that a pump house with a slop tank was located at the base of Birch Hill. This is believed to be the major source associated with the Building 1173 sub-area. The pump house was used until 1955 when the Haines to Fairbanks pipeline was built.

In 1955, as part of the new Haines Pipeline, two 25,000-barrel tanks, the TFS, and a new pump house and manifold building were built. These new facilities were installed on Birch Hill on Birch Creek Schist, with the exception of the TFS that is located in the alluvial area.

A majority of the contamination within the bedrock is from receiving fuels from the Haines Fuel Terminal, cleaning and dewatering of ASTs and operational spills. At the TFS, the majority of contamination was due to spills during truck filling activities and operational spills. USTs located at the base of the hill are thought to be a source of petroleum contamination through spills and overfilling or leaking.

The RI for Remedial Area 1b focused mainly on the base of Birch Hill; thus all monitoring wells were installed in alluvial material. At the time of the RI, no wells or deep borings were installed on Birch Hill, thus missing free product within the bedrock aquifer. Post-ROD activities, which

identified the free product, have led to the addition of a sub-area known as the Birch Hill Product Recovery System. This will be documented in the ESD.

Two of the sub-areas investigated during the RI/FS indicated no remedial action was required. The Shannon Park Subdivision sub-area and the CANOL Road sub-area were both recommended for no further action in the OU3 ROD.

3.2.3 Remedy Selection

Nature of Contamination

The primary sources of contamination at Remedial Area 1b are associated with fuel and fuel additives storage, transfer, and handling activities and the Fairbanks Fuel Terminal and the TFS.

Investigations prior to and during the RI characterized contamination associated with Remedial Area 1b as follows:

Groundwater

Benzene, toluene, ethylbenzene, EDB, 1,2-DCA, 1,2,4-trimethylbenzene, and 1,3,5-trimethylbenzene were detected in groundwater at the base of Birch Hill and in the downgradient west transport pathway in concentrations exceeding federal drinking water MCLs and EPA RBCs used for screening potential COCs.

Petroleum hydrocarbons in soil are found at Building 1173 and the TFS.

Remedial Action Objectives

The remedial action objectives are generic for all source areas in OU3.

Groundwater

- Restore groundwater to drinking water quality within a reasonable time frame.
- Reduce further migration of contaminated groundwater.
- Prevent use of groundwater with contaminants at levels above Safe Drinking Water Act levels.

Soil

- For petroleum-contaminated soil, prevent migration of contaminants from soil into groundwater that would result in groundwater contamination and exceedance of Safe Drinking Water Act standards.

Selected Remedy

Appropriate technologies were identified and screened for site conditions. The chosen technologies for OU3 were combined into media-specific site wide alternatives. For Remedial Area 1b the remedial area is specifically petroleum-contaminated soil and groundwater found at the area that extends south from the base of Birch Hill to the TFS at the southwest corner of the Tank Farm Source Area and that extends west toward Lazelle Road.

The selected remedy for Remedial Area 1b includes:

AS/SVE

- SVE of petroleum-contaminated soil;
- AS of petroleum-contaminated groundwater in permafrost-free areas to achieve Safe Drinking Water Act levels; and
- Natural attenuation to meet AWQS.

The OU3 ROD specified that due to different site conditions, site-specific design information will be collected in a pilot study. In addition, during implementation or operations of systems, if the remedy is not effective or contaminant levels cease to decline, then the system performance and/or the remedy may be re-evaluated.

Institutional Controls

- Maintain ICs and restrict access to and development at the site as long as hazardous substances remain onsite at levels that precluded unrestricted use.

3.2.4 Status of Remediation

Status of Selected Remedy by Subarea

Lazelle Road Sub-Area

An AS/SVE treatment system was installed in 1996 to remove VOCs and to prevent contaminated soils from acting as an ongoing source of contamination to groundwater. AS wells were placed in areas of highest contamination (hot spots). The Lazelle Road treatment system was removed in 1997 and the site was incorporated into the 1173 Sub-area system.

Building 1173 Sub-Area

In 1996 at Building 1173 Sub-Area, an AS/VE treatment system was installed to remove VOCs and to prevent contaminated soils from acting as an ongoing source of contamination to groundwater. In 1997 this system was expanded in size to treat additional contaminated areas,

including the Lazelle Road Sub-area. In addition, oxidizers were installed to reduce atmospheric emissions. To date the treatment system has removed 72,693 pounds of VOC.

Truck Fill Stand Sub-Area

In 1997 an AS/VE system was installed in the area of the truck fill stand for the removal of VOCs in groundwater and to prevent contaminated soils from acting as an ongoing source of contamination to groundwater. To date the treatment system has removed 4,776 pounds of VOC.

In 1999, an AS treatment system was installed as part of a treatability study to reduce contaminants migrating off-post through a permafrost thaw channel. This system has been effective and was retained as part of the remedy for this subarea.

Birch Hill Tank Farm Product Recovery System

Floating product was discovered in large amounts during the 1997 field season on Birch Hill. In 1998 active and passive skimmers were installed in various wells located on the hill. In 1999 a pilot scale recovery system was installed in newly installed wells. During the summer and fall of 2000 a product recovery system was installed on Birch Hill. The system is currently actively recovering free-product. This sub-area was not a part of the OU3 ROD but will be established as part of the ESD.

Institutional Controls

A restricted access boundary for the Birch Hill Tank Farm has been determined.

Groundwater Monitoring

Building 1173

Dissolved contaminant concentrations have also decreased overall since initial system start-up in 1996. Benzene and 1,2-DCA were not detected above remediation goals in downgradient probes during the 2000 field season.

The following summarizes the results of groundwater analytical sampling at the Former Building 1173 treatment system:

- Zone 1 – Benzene and 1,2,4- and 1,3,5-trimethylbenzene (TMB) were above remediation goals during the June and August sampling events. 1,2,4- and 1,3,5-TMB were the only COCs detected during the March sampling event. EDB, detected in LAZ-Milepost 2 in 1999, was not detected in this zone in 2000.

- Zone 2 – A slight rebound in benzene concentrations were seen in GWP1173-Milepost 4 in March; however, benzene was below remediation goals in this probe during the August sampling event.
- Zone 3 – Benzene, EDB, 1,2-DCA and 1,2,4-TMB and 1,3,5-TMB concentrations are above the ROD cleanup level in GWP1173-Milepost 1, and concentrations did not exhibit a decrease during the 2000 field season. Benzene and 1,2,4-TMB and 1,3,5-TMB were above remediation goals in AP-7597 during the June sampling event but fell below remediation goals in August.
- Zone 4 – Monitoring Well AP-5271, the only point included in the groundwater-monitoring program in Zone 4, did not contain COCs above the ROD cleanup levels. COCs have not been detected above ROD cleanup levels in this well since 1998; however, results of soil samples collected from a boring drilled in this zone in 2000 indicate soil contamination remains in the western portion of this zone. AP-5271, located in the eastern portion of this zone may not be influenced by groundwater impacted by the soil contamination.
- Downgradient – Dissolved contaminant concentrations in downgradient monitoring locations were below remediation goals with the exception of 1,2,4-TMB and 1,3,5-TMB in AP-6583 and GWP45. 1,2-DCA fell below the ROD cleanup goal for the first time since system start-up at AP-6056. Groundwater results provide strong evidence that contaminants are being intrinsically remediate downgradient of the AS/SVE treatment system.

Truck Fill Stand

There has been a steady decrease in dissolved contaminant concentration at the TFS.

The following summarizes the results of groundwater analytical sampling during 2000 at the TFS treatment system:

- Zone 2, GWP145 – Benzene concentrations decreased to below the remediation goal during the March sampling event and remained below the remediation goal throughout the year. EDB was detected at concentrations above the ROD cleanup level during the June and August monitoring events for the first time since system start-up.
- Zone 1, GWP100 – Benzene concentrations were above the remediation goal throughout the year, ranging from 5.43 mg/L to 9.79 mg/L. COCs were not detected in AP-7362, a deep monitoring well (screened from 50 to 60 feet bgs) located adjacent to GWP100.
- Zone 3, GWP121 – No COC was detected during the 2000 field season. COCs have not been detected in Zone 3 since March 1999.

- Concentrations of 1,2,4-TMB and 1,3,5-TMB were not observed above ROD cleanup levels at any monitoring location.

3.3 Remedial Area 2 – Valve Pits and Railcar Off-Loading Facility

3.3.1 Overview

Remedial Area 2, which includes the ROLF and three valve pits, is located south of the Tank Farm Facility across the Chena River and north of Gaffney Road. Remedial Area 2 was subdivided into sub-areas based on geographic location and differing physical characteristics. The areas shown on Figure 3-2 are Valve Pit A, Valve Pit C, the Central Header, Former Building 1144, and the Eight Car Header. Pipes connect the Tank Farm and the ROLF. The facility covers an area of approximately 40 acres. The facility dates back to 1939. The areas associated with this source area include the off-loading headers and associated USTs, six valve pits and underground pipelines. Floating product was measured in numerous monitoring wells during the summer of 1996. The findings indicated subsurface contamination in hot spots throughout the area especially along the pipeline system. Petroleum contamination was found in subsurface soils and groundwater surrounding Valve Pits A, B and C, along Front Street, and surface and subsurface soils and groundwater in the center of the Central ROLF area.

The AS/SVE systems were installed during the summer of 1996. These studies indicated a larger area of contamination than originally defined. Expansion of the systems was determined necessary. ICs are in place, and informational signs have been installed to inform the public of restrictions and activities in this area. Off-gas vapors are being treated in order to meet compliance with Title V Permit.

3.3.2 Background

A soil-gas survey was conducted at the ROLF and associated valve pits in 1988. Samples collected revealed a contaminant plume centered on the railroad spur containing the 16-tank-car unloading header (Central Header) and the former USTs. A monitoring well at Valve Pit C was installed in 1989 and contained free-floating product in most of the sampling events until commencement of RA activities.

Periods of use and dates related to the history of the Remedial Area 2 contamination and remediation are shown in Table 3-2.[9]

[9] Information obtained from the OU3 ROD; Groundwater Extraction and Treatment Effectiveness Review (Oct. 2000); OU3, 1999 Monitoring Report; and the OU3 Draft ESD.

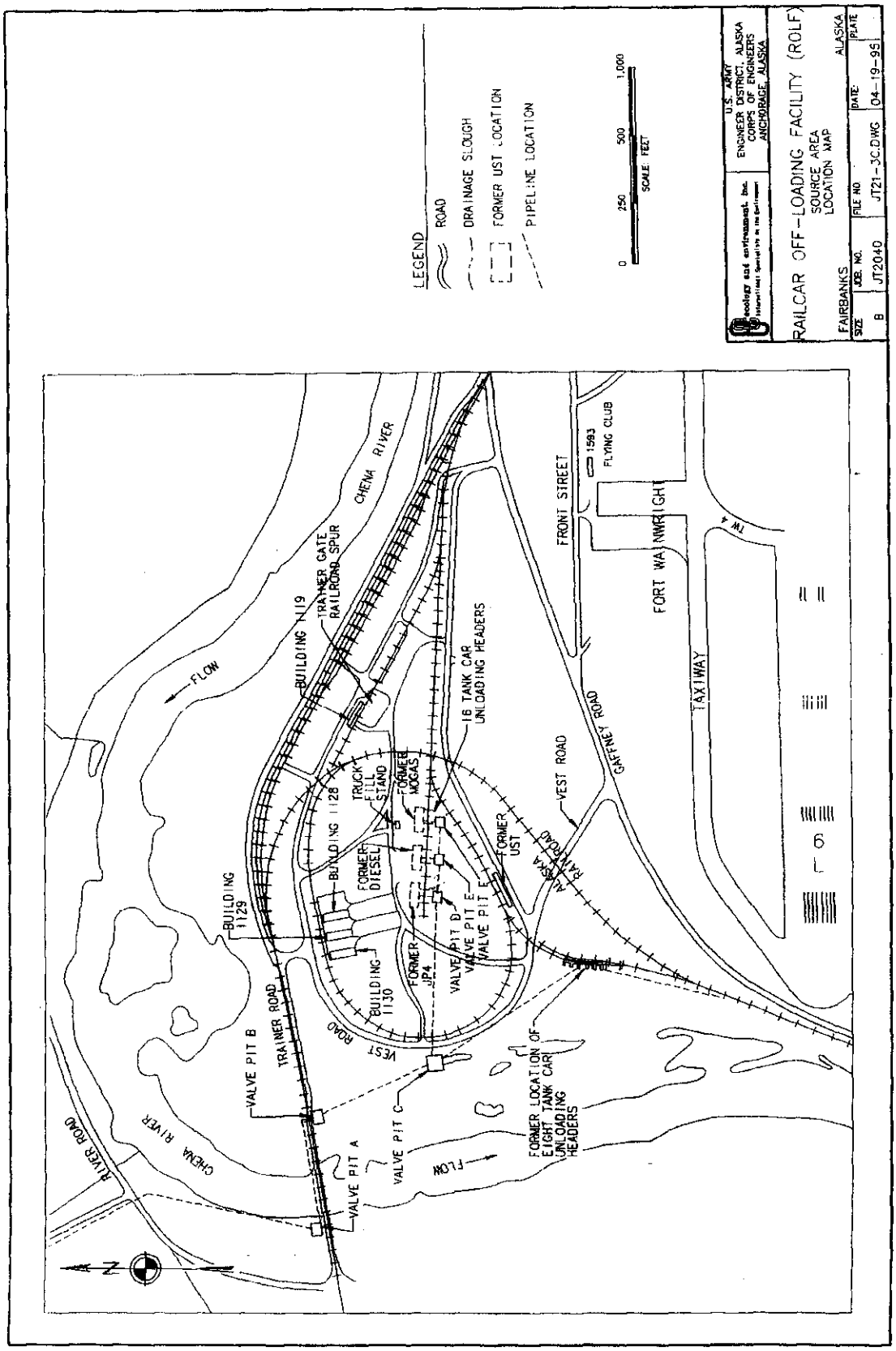

Figure 3-2. OU3 ROLF Source Area, including Valve Pits, as Depicted in January 1996 ROD.

Table 3-2. Remedial Area 2 Contamination and Remediation History.

EVENT	DATE
Soil-gas survey conducted.	1988
Monitoring wells installed.	1989
Fort Wainwright NPL listed.	August 1990
FFA signed.	1992
TPA signed.	1992
RI fieldwork conducted.	September and October 1994
RI and Risk Assessment Reports submitted to EPA.	October 1994
FS submitted to EPA.	April 1995
ROD signed.	January 1996
AS/SVE treatments installed at Valve Pits A, B, & C; Central Header; and Former Building 1144 source areas.	July and August 1996
AS/SVE systems expanded.	1997
AS/SVE system installed at the Eight Car Header sub-source area. Central Header and Former Building 1144 further expanded.	1998
ESD submitted to expand AS/SVE treatment areas to cover the lateral extent of contamination as identified in post-ROD investigations. Concomitant increase in remedial costs also documented.	September 2001

Physical Characteristics

Valve Pit A and portions of the ROLF are located directly on the banks of the Chena River. Valve Pit A is approximately 0.25 mile east of 801 Housing Subdivision on the north bank of the Chena River. Groundwater near Valve Pit A generally flows away from 801 Housing Subdivision and toward the Chena River.

The main area of the ROLF is within the Chena River floodplain. The ROLF is located immediately north of the Fort Wainwright airstrip and is bounded on its north and west sides by the Chena River and Gaffney Road to the south. A scrub-shrub wetland borders the northeast edge of the ROLF. No endangered or threatened species reside in the area.

Groundwater in the shallow aquifer zone generally flows west towards the Chena River. Flow direction and gradient is subject to seasonal variations. Depth to groundwater in the vicinity of the ROLF is approximately 10 to 20 feet.

Land and Resource Use

The area around Remedial Area 2 is used heavily by residents and nonresidents involved in recreational sport fishing, boating and hiking. Groundwater use is residential. Numerous residential wells are located on the north bank of the Chena River, less than 0.5 mile downstream. The Golden Heart Utilities and College Utilities wells are located approximately three and five and a half miles from the source area respectively. Four Fort Wainwright drinking water supply wells and the Pioneer Class A drinking water wells for the Hamilton Subdivision are located approximately one mile from the ROLF. Future land and groundwater use is considered to be residential and recreational.

History of Contamination

The ROLF was built in 1939 to receive fuel from tanks on railcars and to distribute the fuels to the airfield refueling points, quartermaster fuel system, the Birch Hill AST Tank Farm, and East Birch Hill UST Tank Farm. As part of this distribution system, there were three valve pits, Valve Pit A on the west side of the Chena River, Valve Pit B and C located on the east side of the Chena River. A pipeline connects the ROLF to the East Birch Hill UST Tank Farm. Fuel was stored in USTs at this facility until they were removed in 1990. Available records indicate that one 20-gallon spill of fuel occurred at the ROLF between 1970 and 1987. However, it is known that the tank car headers were prone to minor leaks, and at least one major spill of JP-4 occurred at one of the headers. Additionally, the USTs formerly at the ROLF reportedly were overfilled on numerous occasions. In 1991, a pipeline from Valve Pit C to the airfield failed a hydrostatic pressure test and was taken out of service. Valve pits on both sides of the Chena River and at the ROLF had leaks.

Pre-ROD Response

There were no pre-ROD responses for the Remedial Area 2 source area.

3.3.3 Remedy Selection

Nature of Contamination

The primary sources of contamination at Remedial Area 2 are associated with fuel and fuel additives storage, transfer, and handling activities at Valve Pit A, Valve Pit C, Central Header, 8-Car Header, and Former Building 1144 at the ROLF.

Investigations prior to and during the RI characterized contamination associated with Remedial Area 2 as follows:

Eight Car Header

Air Sparging and Soil Vapor Extraction

The AS/SVE system was initially installed in 1997 and expanded to its current size in 1998. The treatment system operates year round. Off-gas emissions are controlled by the use of a thermal oxidizer. To date the treatment system has removed 106,688 pounds of VOC.

Former Building 1144

Air Sparging and Soil Vapor Extraction

The AS/SVE system was initially installed in 1996 and expanded to its current size in 1997. The treatment system operates year round. Off-gas emissions are controlled by the use of a thermal oxidizer. To date the treatment system has removed 214,398 pounds of VOC.

Groundwater Monitoring

The concentrations of contaminants in Remedial Area 2 in the identified groundwater plume have decreased since implementation of the AS/SVE systems. The groundwater monitoring results show that the remedy is working. There has been no identified migration of the plume within the site or off of the site. Groundwater has not been sampled for lead since the signing of the ROD.

Valve Pit A

Of the nine locations sampled during the August 2000 sampling event, three (VPA-Milepost 4, AP-6064, and GWP72S) were below ROD cleanup levels for all COCs. Six locations plus monitoring point VPA-Milepost 1 (last sampled in May 2000) exceeded ROD cleanup levels. Since 1996, concentrations of COCs have decreased significantly (for some contaminants up to three orders of magnitude) in all but two of the ten groundwater monitoring locations (GWP22 and GWP24). 1,2-DCA and EDB are non-detectable at all groundwater monitoring locations.

Valve Pit B

As of the August 2000 sampling event, four of the nine groundwater sample locations were below ROD cleanup levels for all COCs sampled. All groundwater sample locations have seen significant decreases in COC levels since installation of the AS/SVE system in 1996. In particular, VPB-Milepost 3 has had three COC concentrations decrease by four orders of magnitude. 1,2-DCA and EDB are non-detectable at all monitoring points within this source area.

Valve Pit C

All eight of the monitoring locations sampled during 2000 were below ROD cleanup levels for all source area COCs. Three monitoring locations last sampled during 1999 were also below ROD cleanup levels for all source area COCs. All groundwater sample locations have seen significant to moderate decreases in contaminant levels since installation of the AS/SVE treatment system in 1996. Contaminant rebound was evident during the last monitoring event of 1998 and the first three monitoring events of 1999. However, during the last monitoring event of 1999, all COCs were below the ROD cleanup levels at those locations sampled. Three groundwater sample locations experienced benzene rebound in the first sampling event of 2000; however, all COCs were below ROD cleanup levels as of the last monitoring event. Neither 1,2-DCA nor EDB were detected in any of the groundwater sample locations.

Central Header

Decreasing trends are observed in all Central Header Zones except Zone 5. Contaminant levels at groundwater probe, GWP48 and GWP150, have fluctuated since installation in 1996 and 1999, respectively. All other zones as well as two upgradient and two downgradient groundwater sample locations have seen moderate to significant decreases in levels of COCs. Benzene and toluene levels have decreased at some locations by four orders of magnitude since installation of the AS/SVE treatment system in 1996.

Free-phase product was not observed during the 1999 sampling season either within or immediately downgradient of the Central Header treatment area for the first time since the treatment system began operating in 1996. As of the August 2000 sampling event, COC levels at two groundwater probe and one monitoring well locations were below ROD cleanup levels for all COCs. Eight other locations sampled in 2000 (upgradient, within, and downgradient of the Central Header treatment area) were above ROD cleanup levels. EDB was above ROD cleanup levels at two of these locations, GWP80 and CH-Milepost 2, as of the August 2000 sampling event. Groundwater monitoring probe GWP79 was last sampled in 1998 and was also above ROD cleanup levels at that time. Two other monitoring probes were last sampled in 1999 and at that time were below ROD cleanup levels for all COCs.

Eight Car Header

ROD COC concentrations have generally decreased at all monitoring locations associated with the Eight Car Header since sampling began in 1996. In 1999 no free-phase product was observed at the Eight Car Header subarea for the first time since installation of the treatment system in 1996. During the August 2000 sampling event five of nine monitoring locations were below ROD cleanup levels for all COCs. 1,2,4-TMB and 1,3,5-TMB were still above ROD cleanup levels at four sample locations, while benzene exceeded ROD cleanup levels at two of those locations. Neither 1,2-DCA nor EDB was detected in any of the groundwater sample locations.

Building 1144

Groundwater COC levels have generally decreased within the Building 1144 source area. Two groundwater monitoring probes, GWP109 and GWP147, have seen increasing concentrations since installation in 1998 and 1999, respectively. In 1999 free-phase product was not observed for the first time since installation of the treatment system. Three of the ten monitoring locations sampled in 2000 were below ROD cleanup levels for all COCs. 1,2,4-TMB and 1,3,5-TMB were found in seven while three of those contained benzene above ROD cleanup levels. Groundwater probe GWP83 was last sampled for 1,2,4-TMB, 1,3,5-TMB, benzene, toluene, and EBZ in October of 1999 and was below ROD cleanup levels for all analytes.

Institutional Controls

ICs for Remedial Area 2 are in effect and policies to limit excavation or well installation in potentially contaminated sites.

Fort Wainwright has established a post-wide IC policy for all known or suspected contaminated sites.[10] There have been no violations of the IC policy to date.

This policy ensures that:

- No unauthorized intrusive actions take place at this source area,
- No potable water wells are installed on this source area, and
- No soil excavation can take place without prior briefings on potential concerns at the source area, knowledge of the procedures for handling contaminated soils on Fort Wainwright, and possession of a valid site-specific Fort Wainwright Excavation Permit.

USARAK DPW maintains a GIS database with information on all of the contaminated sites on post. The DPW is responsible for ensuring ICs on Fort Wainwright. ICs will remain in place as long as hazardous substances remain on site at levels that preclude unrestricted use. Excavation and groundwater intrusion at this source area is restricted subject to approval by DPW Environmental.

[10] Further details of USARAK/Fort Wainwright IC policy can be found in the OU5 ROD, the U.S. Army, Alaska Institutional Controls Standard Operating Procedures [APVR-RPW (200-1)], and a September 1999 Memorandum on Institutional Controls [APVR-RPW-EV-(200-1c)] from Major General Dean W. Cash, Fort Richardson, Alaska.

3.4 Remedial Area 3 – Mileposts 2.7, 3.0, and 15.75

3.4.1 Overview

The Fairbanks to Haines Pipeline was put into service in 1955. Three source areas have been identified along the pipeline. The source areas Mileposts 2.7 and 3.0 (Figure 3-3) were discovered as part of a 1989 soil gas survey. Sampling locations were spaced ¼ mile apart, and the investigation spanned 27 miles from the Fairbanks Terminal to Eielson Air Force Base. Elevated levels of BTEX were noted at Milepost 2.6 and Milepost 15.75. At the time of the RI and ROD, it was unknown the exact cause of the contamination at Mileposts 2.7 and 3.0. The Proposed Plan and ROD listed potential sources as potentially from pipeline breaks of the Haines Pipeline, and truck fill stands, water separator pits, valve pits, and pipelines associated with the abandoned East Birch Hill Underground Tank Facility.

A record search to document the source of contamination is being conducted and will be documented in the ESD. The contamination at source area Milepost 15.75 (the intersection of Laurance Road and Robyn Drive) was the result of a spill that occurred in August 1989, when a portion of the Fairbanks-Eielson Pipeline was ruptured during road construction. An AS/SVE system was installed and operated, and has accomplished remediation of this site. This system was removed and relocated to Remedial Area 1b. Long-term monitoring continues at Milepost 15.75.

3.4.2 Background

Remedial Area 3 consists of three locations along the Fairbanks-Eielson Pipeline: Milepost 2.7, Milepost 3.0, and Milepost 15.75. A treatability study initiated at Mileposts 2.7 and 3.0, which included AS/SVE and oxygen releasing compounds, was not effective due to low permeability of the soils in the area. A new treatability study was completed to determine the effectiveness of aboveground AS/SVE with soils removed from the Mileposts. This treatment has been highly effective, and soils at the Mileposts have been removed for *ex situ* treatment. *In situ* long-term monitoring continues at the actual milepost sites. The OU3 ESD will document changes in treatment for petroleum contaminated soil and associated increased costs.

Physical Characteristics

Milepost 2.7 and Milepost 3.0 Source Areas are similar in physical characteristics. Both have a moderate to steep south-facing slope to the north and a shallow, south-facing slope to the south. They are located downgradient of East Birch Hill UST facility. Soils are poorly drained and ponded surface water is common from spring breakup until mid-summer. Discontinuous permafrost is typical in the areas' subsurface soil. A black spruce-scrub-shrub wetland borders the south side of the source areas while the rest of the surrounding area is densely vegetated. Groundwater is encountered at depths from 3 to 12 feet bgs and groundwater flows to the southwest.

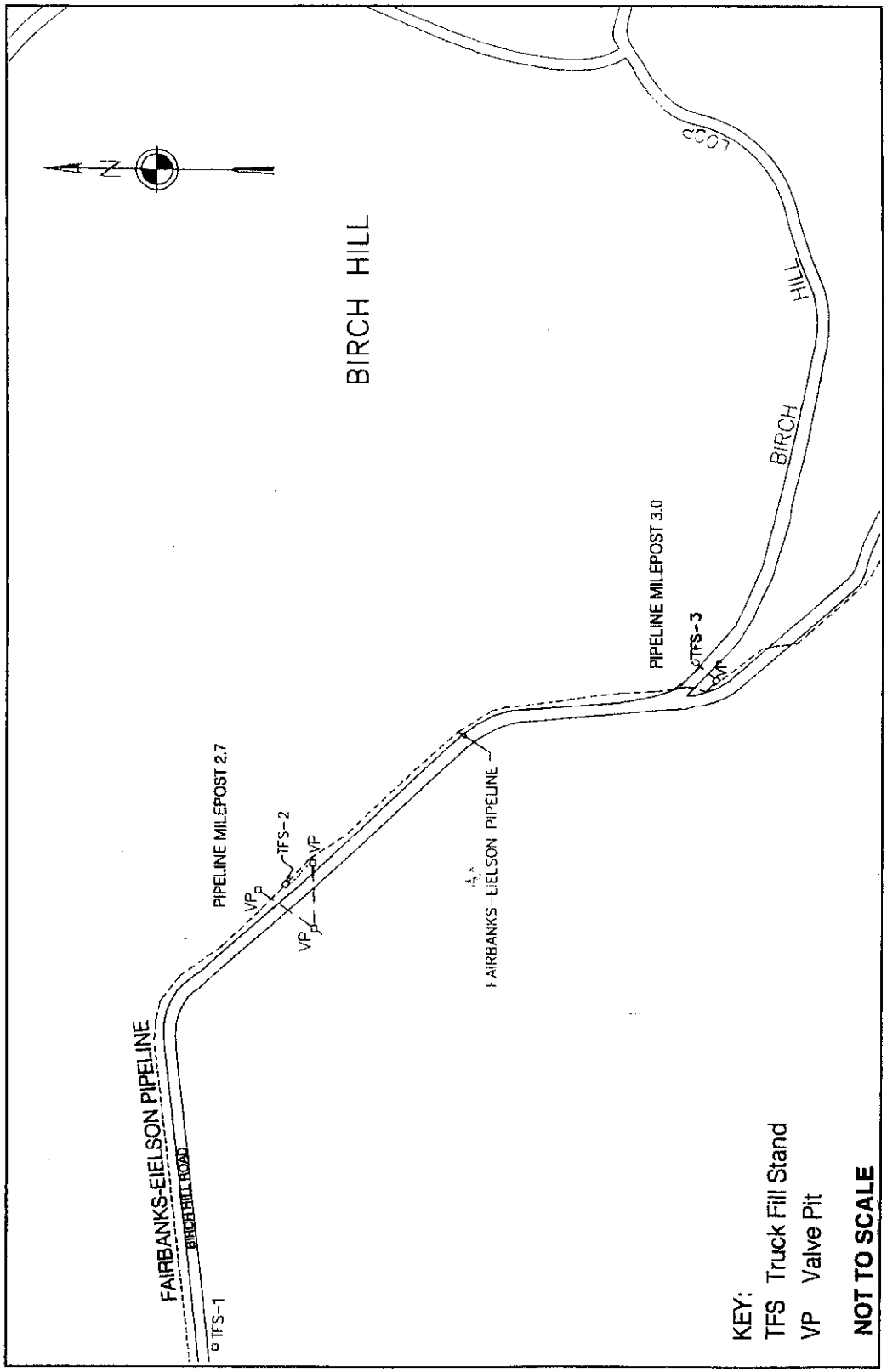

Figure 3-3. OU3 Milepost 2.7 and 3.0 Source Areas as Depicted in January 1996 ROD.

The Milepost 15.75 Source Area is located on an off-post military fuel pipeline right-of-way within a residential area approximately 1 mile south of North Pole. The Chena River is to the north and east and the Tanana River is to the west. The site is flat except for drainage ditches that parallel Laurance Road. The drainage ditch on the south side of Laurance Road usually contains water. Soils in the area are sandy with little gravel and generally are moderately well-drained. The surrounding area is forested with trees and shrubs. Groundwater is encountered at depths from 3 to 7 feet bgs and groundwater flows to the north.

Land and Resource Use

The Milepost 2.7 and 3.0 Source Areas are located within a military training area across the Chena River and approximately one mile from the nearest residential development. Both areas are used recreationally. The nearest well to both source areas is located approximately one mile away at the Birch Hill Ski area. The well is not hydraulically connected to the alluvial aquifer below both source areas. The Milepost 15.75 source area is located within a residential area and wetlands occur within 0.25 miles. Future land and groundwater use at all three source areas are residential and recreational.

History of Contamination

The Haines Pipeline was put into service in 1955 to transport fuel from Haines to Fairbanks. The section of the pipeline between Fort Wainwright and the Mapco refinery in the city of North Pole, was decommissioned in 1992. Mileposts 2.7 and 3.0 are located downgradient of the former East Birch Hill UST Facility. This facility was built as part of the CANOL pipeline and stored high-octane aviation fuel and aviation fuel in 34 50,000-gallon tanks. There were three truck fill stands associated with this tank farm, two adjacent to the contamination at Mileposts 2.7 and 3.0. Numerous investigations were conducted to close out the USTs under the State of Alaska UST regulations. The State of Alaska closed the USTs, but due to severe groundwater contamination associated with this operation, the groundwater was added to OU3. The RI listed potential sources for Mileposts 2.7 and 3.0 as the Fairbanks Eielson Pipeline, and leaks that could have originated from the former East Birch Hill USTs, associated piping, valve pits and truck fill stands. A record search is being conducted to determine the source of contamination. The former USTs were located topographically upslope of the reported pipeline spill locations.

In August 1989, the Fairbanks-Eielson pipeline was ruptured while a contractor was upgrading Laurance road and establishing a subgrade level for Robyn Drive, near Milepost 15.75. The pipeline was closed at nearby valves and an earthen berm was constructed to contain the spill. Approximately 2,400 gallons of an estimated 4,200 gallons of spilled fuel was recovered. Contaminated soils were removed from the spill area immediately following the recovery of liquid fuel. Elevated benzene concentrations were detected at this source area in 1992 and subsequent installation of a monitoring wells revealed elevated levels of petroleum products at this area.

3.4.3 Remedy Selection

Nature of Contamination

The primary sources of contamination at Remedial Area 3 are associated with fuel storage, transfer, and handling activities at the East Birch Hill Underground Storage Tank Facility and the Fairbanks-Eielson Pipeline.

Investigations prior to and during the RI and post-ROD sampling characterized contamination associated with Remedial Area 3 as follows:

Groundwater

Benzene, toluene, ethylbenzene, EDB, 1,2-DCA, 1,2,4-trimethylbenzene, and 1,3,5-trimethylbenzene were detected in groundwater exceeding federal drinking water MCLs and EPA RBCs used for screening potential COCs.

Soil

GRO, DRO, and benzene are the contaminants in soil found at the Remedial Area 3 source areas.

Remedial Action Objectives

The remedial action objectives are the same for all source areas in OU3.

Groundwater

- Restore groundwater to drinking water quality within a reasonable time frame;
- Reduce further migration of contaminated groundwater; and
- Prevent use of groundwater with contaminants at levels above Safe Drinking Water Act levels.

Soil

- For petroleum-contaminated soil, prevent migration of contaminants from soil into groundwater that would result in groundwater contamination and exceedance of Safe Drinking Water Act standards.

Selected Remedy

Appropriate technologies were identified and screened for site conditions. The chosen technologies for OU3 were combined into media-specific site wide alternatives. For Remedial Area 3 the remedial area is specifically petroleum-contaminated soil and groundwater found at

Mileposts 2.7 and 3.0, including TFS-1 and TFS-2, and Milepost 15.75 along the Fairbanks-Eielson Pipeline.

The selected remedy for Remedial Area 3 includes:

AS/SVE

- SVE of petroleum-contaminated soil;
- AS of petroleum-contaminated groundwater in permafrost-free areas to achieve Safe Drinking Water Act levels;
- Natural attenuation to meet AWQS; and
- The OU3 ROD specified that due to different site conditions, site-specific design information will be collected in a pilot study. In addition, during implementation or operations of systems, if the remedy is not effective, then the performance standards and/or the remedy will be re-evaluated.

Institutional Controls

- Maintain ICs and restrict access to and development at the site as long as hazardous substances remain onsite at levels that precluded unrestricted use.

3.4.4 Status of Remediation

Milepost 2.7

An AS treatability study was conducted at Milepost 2.7 in 1996. The same year, a study involving oxygen-releasing compounds injected into the groundwater was evaluated. Both of these in situ technologies were considered not viable for the site due to low soil permeability and lack of electrical power. A treatability study was performed during 1998 to evaluate the feasibility of excavation and ex situ soil treatment.[11] The RPMs agreed that removing the soil would assist in achieving the RAOs. This involved the excavation of approximately 1,500 cubic yards of contaminated soil. These soils were placed in a treatment cell constructed adjacent to the TFS at Remedial Area 1b. The TFS AS/SVE blowers were utilized to treat the petroleum contaminated soil ex-situ. This system is still operational and the results of the 2000 field season indicate that only DRO remain. This action and its basis will be documented in an ESD.

Groundwater monitoring at Milepost 2.7 has been conducted bi-annually to evaluate the progress towards achieving RAOs. The 2000 monitoring events indicate that there has been no

[11] Source: Hart Crowser 1999 OU3 Monitoring Report.

change in benzene concentrations. All other COCs remain below RAOs with the exception of 1,2-DCA. 1,2-DCA was detected in one well in September 2000.

Milepost 3.0

A pilot study was conducted at Milepost 3.0 in 1996 involving the use of an oxygen-releasing compound injected as a slurry below the water table. Analytical results of groundwater samples indicated injection of the oxygen-releasing compound slurry was not effective.

Since the soils at Milepost 3.0 are similar to Milepost 2.7, ex-situ treatment of the soils was determined feasible. Excavation and ex-situ soil treatment was performed at Milepost 3.0 in April 2000. This involved the excavation of approximately 6,000 cubic yards of petroleum-contaminated soil. These soils were placed in a treatment cell constructed at the base of Birch Hill. This action and its basis will be documented in an ESD. The 1173 Treatment System AS/SVE blowers are utilized to treat the petroleum contaminated soil ex-situ. This system has operated one field season, with the main contaminants being DRO, GRO, and benzene.

Groundwater monitoring has been conducted bi-annually to evaluate the progress towards achieving RAOs. The 2000 monitoring events indicate that there has been little change in benzene, EDB, GRO and DRO concentrations. All other COCs remain below RAOs.

Milepost 15.75

An AS/SVE treatment system was installed at Milepost 15.75 site in November 1996. This site is located in a residential area in North Pole, Alaska. The treatment system operated continuously until May 1997, after initial cleanup goals had been achieved. During July 1997, the EPA and ADEC agreed to discontinue treatment and remove aboveground portions of the treatment system.

During August 1997, the treatment system connex was moved back to Fort Wainwright to allow for use at another OU3 site and the underground piping and treatment system probes were removed in October 2000. Quarterly groundwater sampling was conducted until 1998, when an annual groundwater sampling program was implemented. Results of the 1998 and 1999 groundwater sampling have shown contaminant concentrations below ROD objectives indicating a lack of significant contaminant rebound. During the October 2000 sampling event, benzene was detected in one groundwater sample. No other COCs were detected above ROD cleanup levels during the October sampling event.

Groundwater Monitoring

No significant changes in contaminant concentration at the monitoring wells associated with Mileposts 2.7 and 3.0 have been observed to date. All groundwater wells at Milepost 2.7 are above ROD cleanup levels as of 2000. 1,3,5-TMB has increased in two wells AP-5651 and AP-6034 between the March and September of that year. 1,2,4-TMB rebound in AP-6035 during

this same period and increased in two others. Benzene levels have also increased in AP-6034 during the last four sampling events. In addition, one well detected 1,2-DCA in the September 2000 monitoring event.

At Milepost 3.0, eight of the nine monitoring wells have COCs above the ROD cleanup levels as of the 2000 sampling events. EDB increased in five wells. Ethylbenzene has increased in three wells with exceedances above ROD cleanup levels in two of those between 1999 and 2000.

The concentrations of contaminants in the identified plume at Milepost 15.75 are generally stable with rebound of benzene in one monitoring well. There has been no identified migration of the plume within the site or off of the site.

Institutional Controls

ICs for the Mileposts 2.7 and 3.0 are in effect at Remedial Area 2 and include policies to limit excavation or well installation in potentially contaminated sites. There have been no violations of the ICs as of September 2001 (publication of the Five-Year Review document).

Fort Wainwright has established a post-wide IC policy for all known or suspected contaminated sites.[12]

This policy ensures that:

- No unauthorized intrusive actions take place at this source area,
- No potable water wells are installed on this source area, and
- No soil excavation can take place without prior briefings on potential concerns at the source area, knowledge of the procedures for handling contaminated soils on Fort Wainwright, and possession of a valid site-specific Fort Wainwright Excavation Permit.

USARAK DPW maintains a GIS database with information on all of the contaminated sites on post. The DPW is responsible for ensuring ICs on Fort Wainwright. ICs will remain in place as long as hazardous substances remain on site at levels that preclude unrestricted use. Excavation and groundwater intrusion at this source area is restricted subject to approval by DPW Environmental.

[12] Further details of the USARAK/Fort Wainwright IC policy can be found in the OU5 ROD, the U.S. Army Alaska Institutional Controls Standard Operating Procedures [APVR-RPW (200-1)], and a September 1999 Memorandum on Institutional Controls [APVR-RPW-EV-(200-1c)] from Major General Dean W. Cash, Fort Richardson, Alaska.

Site Inspection

This site was inspected on April 28, 2001.

3.5 Operable Unit 3 Explanation of Significant Differences

An ESD for the ROD for OU3 is being prepared. This ESD is being prepared in accordance with Section 117(c) of CERCLA and 40 Code of Federal Regulations 300.435(c)(2)(I), and documents significant differences to the selected remedies in the ROD. This ESD will document, increase in extent and volume of contamination, increase in remedial cost, discovery of additional contaminants and remedial areas, and changes in some components of the selected remedy described in the OU3 ROD. This does not fundamentally alter the overall remedial approach.

Remedial activities have been operational at all areas described in the ROD.

Extensive historical research about the source areas has lead to a greater understanding of the source areas. In many cases, the understanding of the source of contamination, movement of groundwater, type of contamination and geology has changed or altered the remedial option selected. The aerial extent of contamination was estimated in the ROD from a limited number of wells installed, not actual extent. The volume was an underestimate of the total contamination due to the fact that limited wells were installed as part of the original RI/FS. A more accurate assessment of the contamination was developed during post-ROD remedial investigations and activities. This ESD will document the installation of systems and their changes and additions to the remedial actions that were described in the ROD.

4.0 OPERABLE UNIT 4

4.1 Operable Unit 4 Background

OU4 was the second Fort Wainwright OU to reach a final-action ROD. That ROD was signed in August 1996 and initially addressed three source areas: the Landfill, the Coal Storage Yard (CSY) and the Fire Training Pits (FTPs). The ROD specified remedial actions subject to Five-Year Review at two of these areas: the Landfill and the CSY.

4.2 Fire Training Pits

The OU4 ROD found that removal of contaminated soils at the FTPs would adequately protect human health and the environment from potential risk associated with those source areas. Contamination of concern at the FTPs was limited to localized petroleum hydrocarbon hot spots in surface and shallow subsurface soils, and there was no reported contamination above action levels in groundwater at the FTPs. The ROD anticipated that the soil removal action would constitute final action for the FTPs. As such, no analysis of remedial alternatives was included in the OU4 ROD, and no additional remedial actions were indicated. The USARAK decision document for soil removal at the FTPs was included in the ROD as Appendix A and stated "Because this remedy will not result in hazardous substances remaining on-site above levels that allow for unlimited use and unrestricted exposure, the Five-Year Review will not apply to this action."

The USARAK completed soil removal at the FTPs in September 1996.[13]

4.3 Landfill

4.3.1 Overview

The Landfill source area covers approximately 14 acres and is located immediately to the south of Fort Wainwright's active landfill, north of River Road (Figure 4-1). Gravel excavation began in this area as early as 1944, and landfill operations reportedly began in the 1950s.[14] Unsegregated waste was disposed in the gravel pits and then burned. After the pits were filled with burned debris, they were covered. The OU4 ROD, signed in September 1996, specified a phased approach to remediation of the Landfill source area: 1) capping the inactive portion of the Landfill–completed in September 1997–along with natural attenuation, monitoring of

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[13] Site Assessment Report, Remove Soil at Burn Pits, Fort Wainwright, Alaska, Rockwell Environmental Services, January 21, 1997.

[14] There are no historical records documenting the starting date of landfill operations.

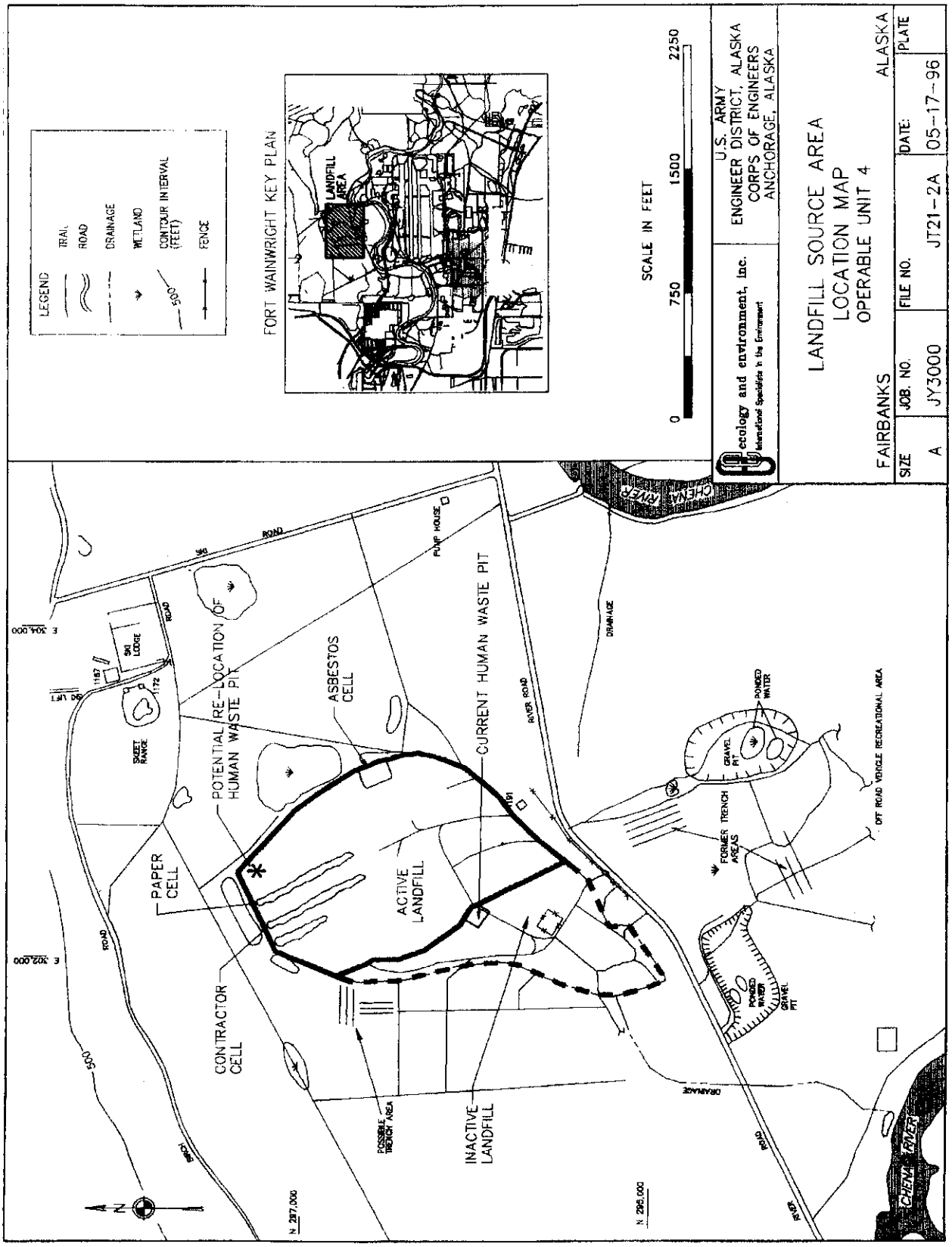

Figure 4-1. OU4 Landfill Source Area as Depicted in August 1996 ROD.

groundwater, and ICs; and 2) evaluation of potential groundwater treatment, if levels of contamination in groundwater were found to increase (which has not been shown to date). The landfill cap in inspected for integrity at least once a year.

4.3.2 Background

Early site investigations confirmed groundwater contamination at the Landfill, which was one of two contaminated sites that resulted in Fort Wainwright being placed on the NPL.

Periods of use and dates related to the history of the Landfill contamination and remediation are shown in Table 4-1.[15]

Table 4-1. Landfill Contamination and Remediation History.

EVENT	DATE
Soil and groundwater study conducted.	1990
Fort Wainwright NPL listed.	August 1990
Groundwater monitoring performed.	1991 and 1992
FFA signed.	1992
TPA signed.	1992
RI conducted.	1993 and 1994
ROD signed.	August 1996
Landfill Project Site Plan completed.	July 1997
Landfill cap constructed.	1997
RAR finalized.	March 1999
OM&M issued.	January 2001

Physical Characteristics

The Landfill is located north of the Chena River at the base of Birch Hill. It encompasses 60 acres, approximately 40 acres north of River Road and a 20-acre area immediately south of River Road (the former trench area). Wetlands border the Landfill to the north and east, and black spruce forest borders the remainder of the source area except in areas cleared for access

[15] Information compiled from the OU4 ROD, OU4 Landfill OM&M, and the Five-Year Review Report Document Log.

to the Landfill along River Road. The source area is in a 500-year floodplain. No endangered or threatened species reside in the area.

The Landfill is surrounded by discontinuous permafrost and is a part of a complex hydraulic regime. In the vicinity of the Landfill, groundwater in the shallow aquifer zone generally flows southwest towards the Chena River, while groundwater in the deep aquifer zone generally flows in the north-northwesterly direction of the regional gradient. However, flow direction and gradient is subject to seasonal variations and may be interrupted or redirected by permafrost in some locations. Depth to groundwater in the vicinity of the landfill is approximately 15 to 20 feet.

The Landfill itself is believed to be in a permafrost-free "thaw bulb," with thaw channels that have been identified as important pathways for contaminant transport from the Landfill towards the Chena River. Post-RI monitoring data supports the premise that the southwest thaw channel is the primary contaminant migration route from the Landfill to downgradient groundwater.

Land and Resource Use

The older southwest portion of the Landfill and the former trench area are inactive. The remaining portion in the cleared area north of River Road is currently an active inert waste landfill, accepting construction and demolition debris. The previous landfill permit allowed the disposal of domestic and commercial refuse, ash, asbestos, incinerator residue, bagged human waste, and construction or demolition waste. A permit application for the current landfill operation has been submitted to ADEC.

It is anticipated that the active portion of the Landfill will be closed within the next five years. This may be accomplished in stages with additional areas closed and capped in a manner similar to the portion capped as part of the OU4 ROD.

At the time of the ROD signature, there was concern that groundwater contaminated by the landfill could enter the Chena River or threaten downgradient users, including residents of the City of Fairbanks. However, sampling to date does not indicate off site migration of groundwater contaminants from the landfill source area has occurred. Future land use is industrial. Groundwater use is considered residential because water supply wells for the City of Fairbanks are located in the same unconfined aquifer as groundwater contamination downgradient of the source area.

History of Contamination

Landfill activities began in the early 1950s. Based on historical aerial photographs, waste was initially dumped into gravel pits, burned, and covered. The Landfill began receiving most wastes generated at the post in the 1950s. In the early 1960s, trenching and burning ceased and

wastes were spread, compacted by bulldozer, and covered with coal ash generated from the Fort Wainwright power plant. Wastes that may have been disposed of at the Landfill in the 1950s include human waste; household refuse; waste POLs; hazardous waste; solvents; pesticides; asbestos; construction debris; and inert munitions. Historically, the quantity and type of waste disposed of at the Landfill are not documented.

Previous investigations have identified other suspected wastes as: dry-cleaning waste and filters (reportedly redistilled prior to disposal to remove PCE); vehicular paint; asbestos; small arms and explosives disposal; triple-rinsed punctured and crushed pesticide cans, rags and soil from small pesticide spills of less than one gallon; empty drums; and paint debris.

Pre-ROD Response

A well-defined area of petroleum hydrocarbon and lead contaminated surface soil in the inactive portion of the Landfill was permanently covered prior to the OU4 ROD.

4.3.3 Remedy Selection

Nature of Contamination

The primary sources of contamination at the Landfill are wastes that were placed in the Landfill and coal ash from the power plant that was used as a cover material at the landfill. Initial investigations confirmed that transport of Landfill contaminants, including coal ash, through surface runoff from the Landfill to downgradient surface water was insignificant. Creation of leachate, through percolation and infiltration of surface water (i.e., rainwater or snowmelt) through Landfill waste, is believed to have caused groundwater contamination.

Investigations prior to and during the RI characterized contamination associated with the Landfill.

Groundwater

Volatile and semivolatile organic compounds (SVOCs) were detected in groundwater under the Landfill and in the downgradient southwest transport pathway in concentrations exceeding federal drinking water MCLs and EPA RBCs used for screening potential COCs.

Concentrations of two metals (lead and chromium) exceeded MCLs or RBCs but were less than background levels. Concentrations of two other metals exceeded MCLs or RBCs and background levels for the site but were judged to fall within the range of naturally occurring concentrations for the area.

4.4 OU4 – Coal Storage Yard

4.4.1 Overview

The CSY is located south of the Fort Wainwright power plant and east of the power plant cooling pond (Figure 4-2). The area of concern is located within an area approximately 800 ft by 300 ft between the cooling pond and an embankment. Historically, coal was stored directly on the ground without a liner, and waste petroleum products and solvents were sprayed over the coal pile to increase the heat content (British thermal units) and energy output of the plant, a practice which has been discontinued. Two 10,000-gallon USTs were installed in the 1980s to contain waste oil for the practice of spraying to increase British thermal units. Before these tanks were installed, waste oil was placed in drums adjacent to the coal pile. Two 10,000-gallon USTs were removed in July of 1995. The chosen alternative in the ROD, signed September 1996, was *in situ* treatment of soils and groundwater by enhanced AS/SVE. The treatment system was installed and began operation summer 1997. Air vapors are being treated through a vapor phase activated carbon absorption system. Additional sampling has been conducted to ensure contaminants are not migrating, and no expansion of the system is required. Results from calendar year 2000 are being evaluated to determine future operation and cost efficiencies.

4.4.2 Background

Periods of use and dates related to the history of CSY contamination and remediation include those presented in Table 4-2.[17]

Physical Characteristics

The areas north and east of the CSY are industrial areas, while the areas to the south and west have mixed hardwood forests. A man-made unlined cooling pond is located immediately to the west and is used solely for industrial purposes to cool circulated water from the power plant. The source area is in a 500-year floodplain. No endangered or threatened species reside in the area.

Land and Resource Use

The CSY is used to stockpile supplies of coal prior to burning at Fort Wainwright's coal-fired cogeneration power plant. This power plant is the sole source of heat and electricity for Fort Wainwright. The coal is transported to the CSY via rail and off-loaded through a hopper system

[17] Information compiled from the OU4 ROD, Final 1999 CSY System Monitoring Report, OU4 CSY OM&M, and the Five-Year Review Report Document Log.

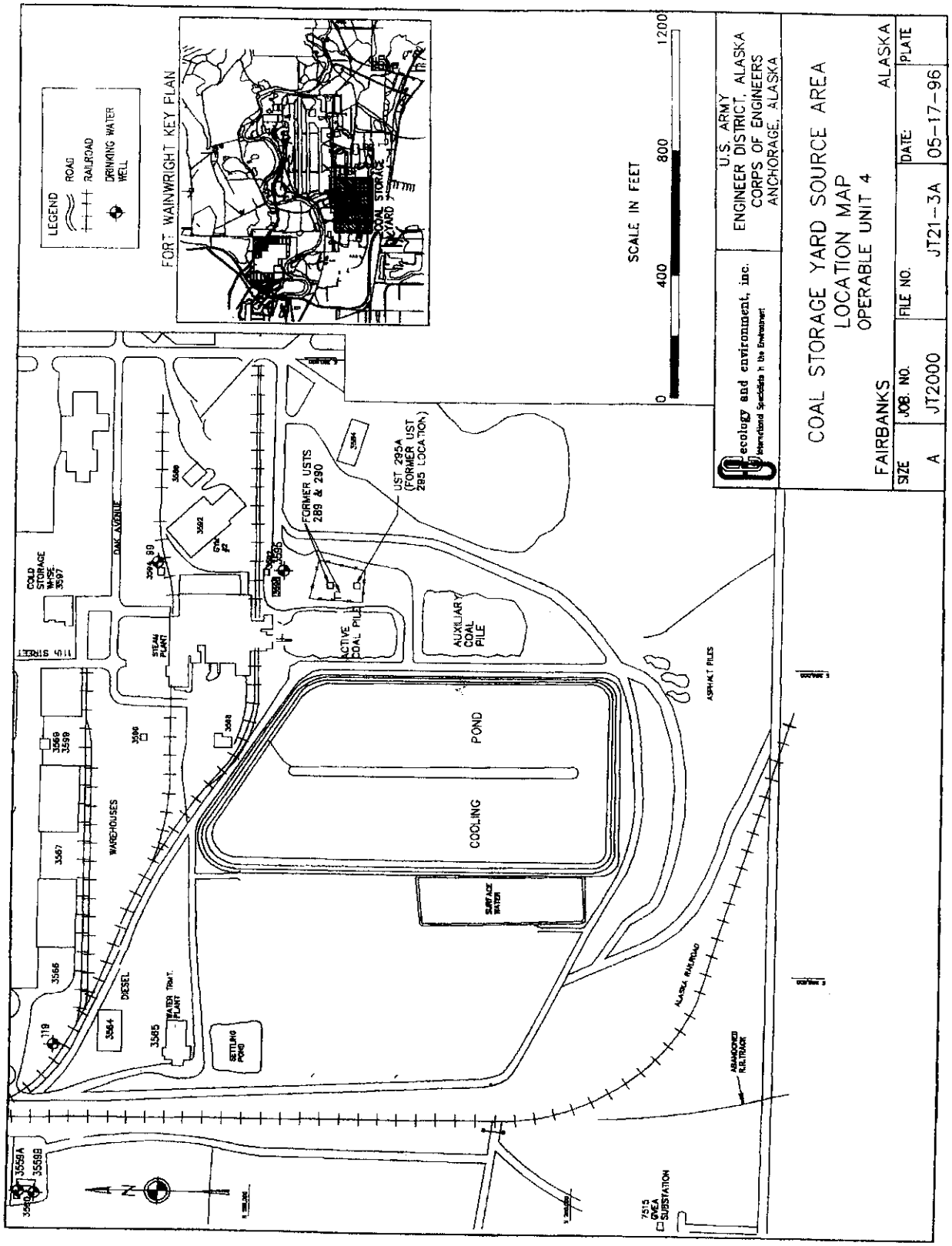

Figure 4-2. OU4 Coal Storage Yard as Depicted in August 1996 ROD.

Table 4-2. CSY Contamination and Remediation History.

EVENT	DATE
Active coal pile sprayed with waste petroleum fuel products.	1950s to 1993
Soil borings and installation of 9 monitoring wells.	1986
Fort Wainwright NPL listed.	August 1990
Re-sampling of monitoring wells. Soil sampling conducted at the active coal pile and along road adjacent to cooling pond.	1991
FFA signed.	1992
TPA signed.	1992
Release investigation conducted at location of UST 295 (formerly located with the fenced area) and groundwater survey conducted beneath the active coal pile.	1993
OU 4 RI conducted.	1993
Two USTs removed from fenced storage area adjacent to CSY.	1995
ROD signed.	August 1996
AS/SVE treatment system and nested groundwater monitoring wells installed.	Summer 1997
RAR finalized.	April 1999
OM&M available to public.	January 2001

and along a conveyor which deposits the coal on the south side of the power plant. Coal is stored in the yard directly on the ground without the use of a liner.

Water supply wells for Fort Wainwright are located downgradient of the CSY source area and are approximately 900 feet northwest of the active coal pile. Flow velocities based on measured gradients were estimated to range widely from 243 ft/year to 2,917 ft/year. The cooling pond is hydrologically connected to the groundwater aquifer and may affect groundwater flow locally. Groundwater flows generally north to northwest and varies due to water supply well pumping patterns.

Groundwater use is considered residential because water supply wells for the City of Fairbanks are located in the same unconfined aquifer as groundwater contamination downgradient of the source area.

History of Contamination

Activities at the CSY began in the 1950s with the industrial operation of the post power plant. Based on historical documents, the CSY's active coal pile was sprayed with waste petroleum fuel products to increase the British thermal unit content of the coal. This practice was discontinued in 1993. As the active coal pile was consumed, the active pile area was graded to include the top layer of soil and intermixed coal, and then burned in the power plant. New coal supplies were then added to the storage yard.

A fenced area existed within the CSY and contained a staging or storage area for drums. Surface spills of materials were common and associated leakage or spillage of material from the drums may be another source of contamination.

Pre-ROD Response

Application of POLs and solvents to the coal pile was discontinued in 1993.

4.4.3 Remedy Selection

Nature of Contamination

Original contaminant sources at the CSY include diesel, fuel oil, solvents, and lubricants sprayed on the active coal pile and waste oil spills and leaks from tanks and drums. VOCs and petroleum contaminated subsurface soils were identified during RI activities in 1994. Soils contaminated with these chemicals were considered sources of groundwater contamination at the CSY. Contaminants have been transported by overland flow of surface water (i.e., rain or snowmelt), vertical migration through soils to the groundwater aquifer, and volatilization. VOC contamination at the groundwater interface and at depth was found to be limited laterally to the area under the active coal pile and fenced storage yard.

Chemicals of concern identified in the ROD for the CSY source area include benzene, bis(2-ethylhexyl)phthalate, TCE, and toluene in the groundwater.

Remedial Action Objectives

Groundwater

- Restore groundwater to its beneficial use of drinking water quality within a reasonable time frame.
- Reduce further migration of contaminated groundwater from the source areas.
- Prevent use of groundwater containing contaminants at levels above federal MCLs and AWQS (18 AAC 70).
- Use natural attenuation to attain AWQS (18 AAC 70).

Soil

- Prevent migration of soil contaminants to groundwater that could result in groundwater contamination and exceedances of federal MCLs and AWQS (18 AAC 70).

Selected Remedy

Air Sparging and Soil Vapor Extraction

To achieve the RAOs for the CSY, *in situ* treatment of groundwater by AS was selected to remove VOCs and to prevent contaminated soils from acting as an ongoing source of contamination to groundwater. AS wells were placed in areas of highest contamination. *In situ* treatment of soils by SVE was also recommended, with extraction wells placed in areas of highest contamination and operated until groundwater MCLs were achieved. The treatment system was to be evaluated and modified as necessary to optimize effectiveness in achieving RAOs. Nine years of operation of the AS/SVE system was estimated to achieve soil and groundwater RAOs and remediate groundwater to federal MCLs and soil to ADEC goals for petroleum contamination.

Natural Attenuation with Groundwater Monitoring

After active treatment achieved MCLs, natural attenuation would be relied on to achieve AWQS. Monitoring of the nested downgradient wells was also recommended to ensure protection of post drinking water supply wells during remedial action. ICs, including restricted access and well development restrictions, were to be adopted as long as hazardous substances remained on site at levels that precluded unrestricted use. Restrictions on groundwater were also implemented until contaminant levels fell below federal MCLs and AWQS.

4.4.4 Status of Remediation

In the summer of 1997, an AS/SVE treatment system was installed. The system consists of 27 air sparge points and 14 SVE wells. Due to steam plant operational considerations, the system does not cover the entire area suspected to be contributing to groundwater contamination above remedial action objectives. The treatment system is designed to operate only during summer months (May through October).

CSY Groundwater Monitoring

Groundwater monitoring is performed on a semiannual basis. The concentrations of contaminants in the identified plume have decreased and are generally stable with some minor variation over the monitoring period with the exception of bis(2-ethylhexyl)phthalate. Bis(2-ethylhexyl)phthalate concentrations appear to fluctuate widely and it is not understood whether the source of bis(2-ethylhexyl)phthalate is a sampling or analytical laboratory artifact or an

actual groundwater contaminant. Results of groundwater sampling in April 2001 indicated no contaminant levels exceeding cleanup goals for this source area.

Institutional Controls

ICs are in effect at the CSY.

Fort Wainwright has established a post-wide IC policy for all known or suspected contaminated sites[18].

This policy ensures that:

- No unauthorized intrusive actions take place at this source area,
- No potable water wells are installed on this source area, and
- No soil excavation can take place without prior briefings on potential concerns at the source area, knowledge of the procedures for handling contaminated soils on Fort Wainwright, and possession of a valid site-specific Fort Wainwright Excavation Permit.

USARAK DPW maintains a GIS database with information on all of the contaminated sites on post. The DPW is responsible for ensuring ICs on Fort Wainwright. ICs will remain in place as long as hazardous substances remain on site at levels that preclude unrestricted use. Excavation and groundwater intrusion at this source area is restricted subject to approval by DPW Environmental.

Site Inspection

The CSY was inspected on April 27, 2001. No variances were observed.

[18] Further details of USARAK/Fort Wainwright IC policy can be found in the OU5 ROD, the U.S. Army, Alaska Institutional Controls Standard Operating Procedures [APVR-RPW (200-1)], and a September 1999 Memorandum on Institutional Controls [APVR-RPW-EV-(200-1c)] from Major General Dean W. Cash, Fort Richardson, Alaska.

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5.0 OPERABLE UNIT 5

5.1 Operable Unit 5 Background

OU5 is identified as the final operable unit in the FFA and includes three source areas deferred from previously investigated operable units as well as three source areas identified for inclusion in OU5 (Figure 5-1). Four source areas were identified for action: (1) three subareas of the West Quartermaster's Fueling System (WQFS); (2) East Quartermaster's Fueling System (EQFS); (3) Remedial Area 1a (also called the Birch Hill Tank Farm Product Recovery System); (4) Open Burning/Open Detonation (OB/OD) area. Two source areas were recommended for no further action under CERCLA: (1) Former Explosive Ordnance Disposal (EOD) Range and (2) Motor Pool Buildings. In addition, several petroleum-contaminated sites, including one WQFS subarea, have been and are being addressed in accordance with an agreement between the USARAK and the State of Alaska.

The OB/OD area and former EOD range were determined to require no further action under CERCLA. The OB/OD RCRA closure plan has been submitted to EPA for review. Upon agreement of this language, a closure plan for the former EOD range will be drafted as well.

The ROD addresses remediation of WQFS areas 1 through 3, the EQFS, and Remedial Area 1a (Figure 5-2). In addition, the OU5 ROD describes the USARAK's commitments to the Chena River Aquatic Assessment Program and to ICs at all five OUs and commits to an IC program that includes a Standard Operating Procedure (SOP) for ensuring compliance with the ICs. This OU5 section is thus organized into the following sections: WQFS, EQFS, Remedial Area 1a, Chena River, and ICs.

5.2 West Quartermaster's Fueling System

5.2.1 Overview

The WQFS area covers approximately 50 acres. The WQFS was divided into four subareas for soil: WQFS1, WQFS2, WQFS3, and WQFS4 (Figure 5-2). Soils within WQFS4 are being addressed under the TPA so were not included in remedial actions under OU5, however the groundwater beneath WQFS4 is being addressed in OU5.

The WQFS is located between Front Street and Gaffney Road. The area runs from near the southeast boundary of the taxiway to the Chena River on the north boundary. Groundwater samples collected indicate diesel range organic, gasoline range organic, solvents and benzene contamination. Soil investigations in 1994 identified several fuels and solvents. An RI was completed in 1995.

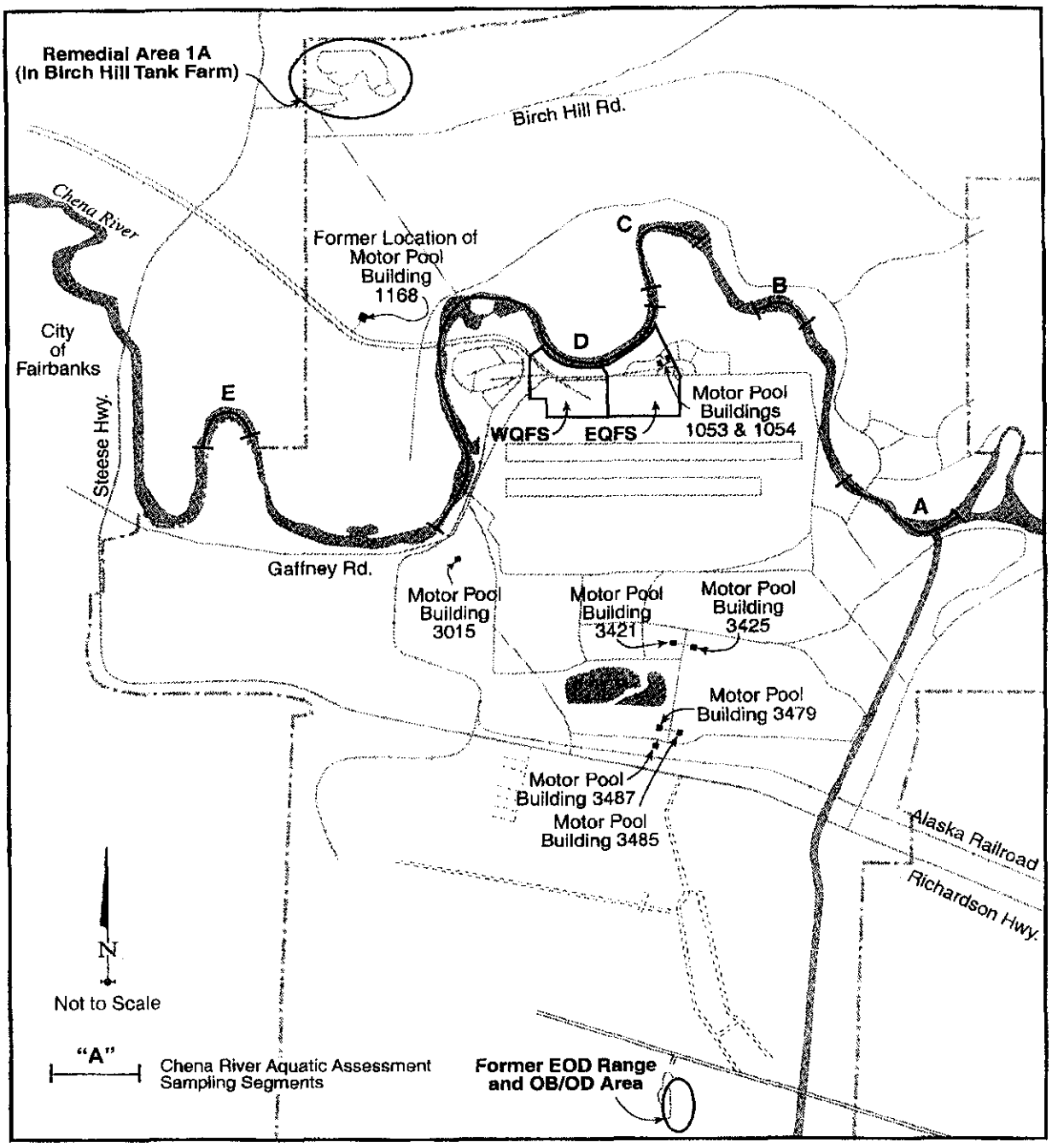

Figure 5-1. OU5 Source Area Location Map as Depicted in March 1999 ROD.

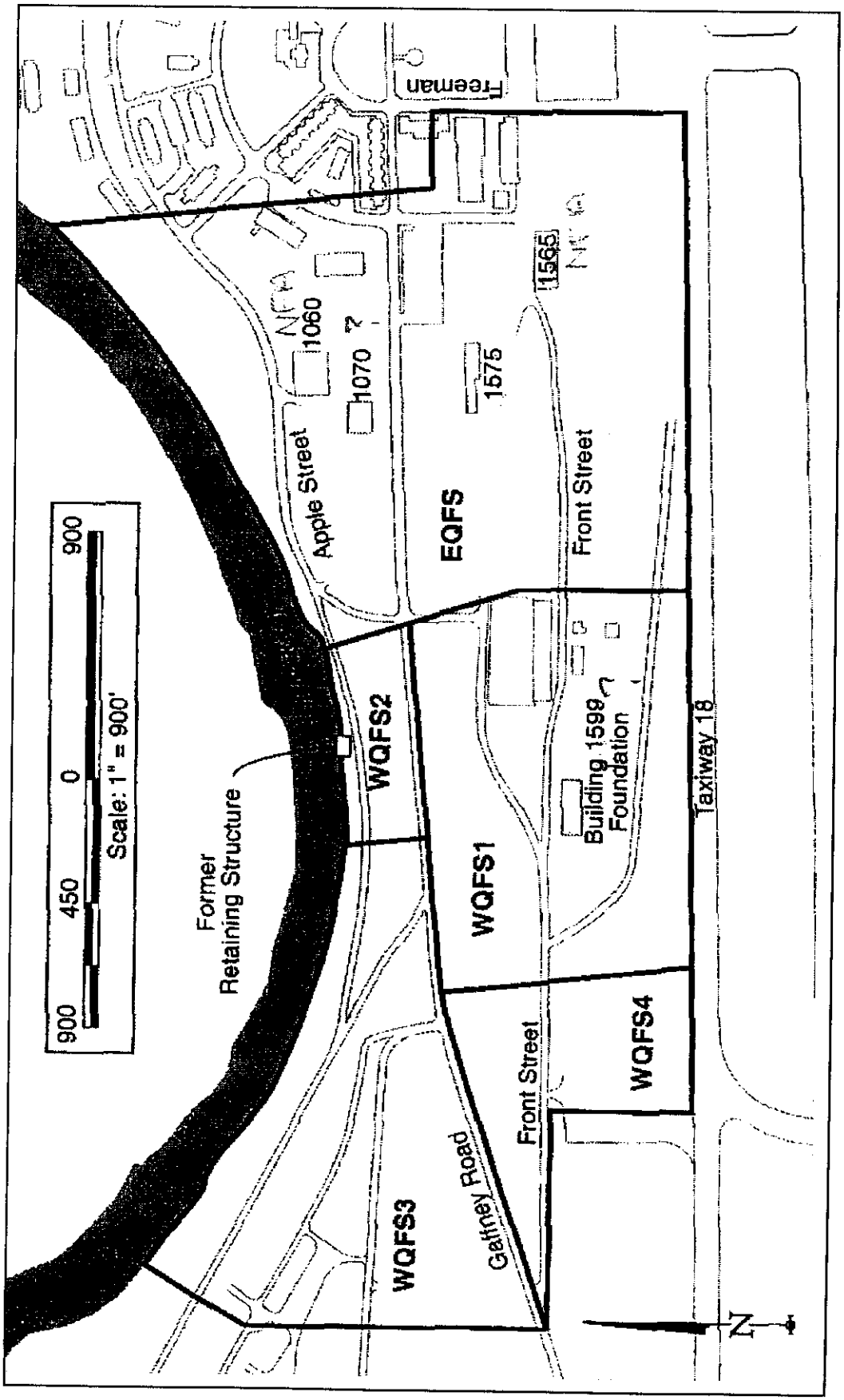

Figure 5-2. OU5 QFS Source Areas as Depicted in March 1999 ROD.

At the WQFS, a treatability study conducted from 1996 to 1998 attempted to use oxygen-releasing compounds to enhance the rate of reduction of VOCs, but had limited success. An additional treatability study, using radio frequency and six-phase soil heating and enhanced biodegradation and volatilization has been completed with mixed successes. Bench scale tracer and biodegradation studies were conducted to better understand the persistence of the contamination. Removal of the retaining structure in the WQFS2 was completed in 1998 prior to installation of the AS curtain.

On-going active remediation at the WQFS includes horizontal AS/SVE wells; source strength AS/SVE, and an AS/SVE curtain to protect the Chena River. Groundwater modeling is on-going to determine groundwater movement and contaminant transport and remedial action effects on the Chena River. Augmentation of the existing AS/SVE system and source strength system was constructed in 2001 to better protect the Chena River and attack the hot spots. A small scale system was installed in the WQFS3 to treat contamination close to the Chena River; this system was integrated into the curtain system.

The OU5 ROD, signed in April 1999, identified the remedial actions for the WQFS as AS/SVE, potential in situ soil heating of hot spots, potential operation of a downgradient AS trench, groundwater monitoring, monitored natural attenuation, and long-term monitoring.

ICs are in place in the entire Quartermaster's Fueling System (QFS); an informational sign has been installed to inform the public of activities in this area. OM&Ms are being drafted. It is anticipated that all components of the remedy will be operational and function by the end of 2002. The long-term monitoring plan and exit strategy, as well as the interim Remedial Action Report, will be completed at that time. Off-gas vapors are currently being treated through oxidizers.

5.2.2 Background

Periods of use and dates related to the history of WQFS contamination and remediation are shown in Table 5-1.[19]

Physical Characteristics

The WQFS is bordered to the north by a south trending meander of the Chena River, to the west by the ROLF and to the south by Taxiway 18. The terrain is open tussock flats as the buildings have all been removed from the site. The WQFS is located within the 500 year floodplain of the Chena River.

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[19] Information compiled from the OU5 ROD; Preliminary Draft Remedial Action Report, Operable Unit 5; and the Five-Year Review Report Document Log.

Table 5-1. WQFS Contamination and Remediation History.

EVENT	DATE
Industrial use including maintenance activities involving the use of solvents, POLs, pesticides, and other hazardous materials.	1930s to 1960s
Leak of approximately 30, 000 gallons of diesel fuel.	1971
16,000 gallons of gasoline spilled.	1971
Fuel leak of unknown origin into the Chena River.	1980
Fort Wainwright NPL listed.	August 1990
FFA signed.	1992
TPA signed.	1992
North Airfield groundwater investigation.	1994
RI completed.	1996
Initiation of WQFS1 Horizontal Well AS/SVE with Treatability Study.	Spring 1997
FS completed.	1998
Proposed Plan for Remedial Action at OU 5 finalized.	June 1998
OU 5 bench-scale column study initiated.	January 1998
Initiation of soil heating AS/SVE Treatability Study at WQFS1.	Spring 1998
Initiation of WQFS2 AS Curtain Treatability Study.	Summer 1998
Initiation of WQFS1 source area AS/SVE Treatability Study.	Aug and Sept 1998
WQFS2 AS curtain Treatability Study initiated.	August 1998
WQFS3 AS/SVE Treatability Study initiated.	August 2000
Draft 2000 *Preliminary Draft Remedial Action Report, Operable Unit 5*[20] (PDRAR) finalized.	April 2001

[20] CH2M Hill, April 2001.

History of Contamination

Activities within the WQFS included vehicle and aircraft maintenance operations and the associated use and disposal of solvents and other cleaning and maintenance compounds. The WQFS also included underground and aboveground storage tanks, a pump house and fueling islands. Drains within the WQFS were connected to a wooden pipe that drained to the river. The underground fuel pipelines and a network of aboveground and buried fuel piping were abandoned in place. Cleaning, pumping and capping of the underground piping is an ongoing project. The primary sources of contaminants in groundwater at WQFS are from surface disposals of solvents, petroleum spills and leaks, and other past disposal practices.

Nature of Contamination

Groundwater

Groundwater contamination extends approximately 70 feet bgs or 60 feet below the water table and the approximate extent of groundwater contamination is 43 acres. Initial investigations conducted at the WQFS revealed four groundwater plumes. Two free-product plumes (mostly jet fuel and diesel fuel) exist within the source area. The larger plume extends about 4½ acres and encompasses the area where the predominance of fuel pumps, dispenser islands, and storage tanks were located. The smaller free-product plume extends about 600 feet southwest of Building 1599 and coincides with a bermed area around a possible fuel containment structure. A benzene plume covers about 25 acres and with dissolved contaminants to 25 feet thick. A plume of 1,2-DCA extends from the north of Front Street to the Chena River, overlapping the free-product and benzene plumes and extends to a depth of approximately 20 feet. DRO and GRO were also detected but their extent was not defined. Groundwater contaminants originating in the WQFS source area have been detected in the Chena River.

Free liquid products exist on the water table in the area influenced by releases from the WQFS. Contaminants reported in the groundwater at the WQFS contain benzene, 1,2-DCA, toluene, and TCE in concentrations exceeding MCLs, and total aromatic hydrocarbon (TAH) and total aqueous hydrocarbon (TAqH) in concentrations exceeding AWQS.

EDB has recently been detected in concentrations exceeding RAOs in groundwater samples from two locations in WQFS-1. EDB had not been reported in the WQFS at the time of the ROD.

Soil

COCs at WQFS affect approximately 150,600 cubic yards of soil. Soil contamination in WQFS subareas is thought to be due to the following historical practices: in WQFS1 vehicle maintenance at former Building 1599 and leaks from former fuel storage and handling; in WQFS2 former ASTs and an 8-inch fuel pipeline that parallels Gaffney Road; and in WQFS3 a

6-inch wood-stave pipe through which diesel and gasoline were channeled during fuel releases in 1971 as well as possible drum storage or road-maintenance activities.

Soils in the WQFS contain BTEX, SVOCs, and petroleum hydrocarbons in concentrations greater than ADEC cleanup guidelines.

Land and Resource Use

Current land use for the WQFS is light industrial; current and future groundwater use is considered residential because water supply wells for the City of Fairbanks are located in the same unconfined aquifer as groundwater contamination downgradient of the WQFS. The closest residences to WQFS are about one mile west. Each residential area includes a school. Currently access to WQFS is unrestricted, and the area is used for recreational purposes and includes a bicycle trail. Access to the Chena River is unrestricted.

5.2.3 Remedy Selection

Remedial Action Objectives

The ROD identified the following objectives for remediation of OU5:

Groundwater

- Restore groundwater to its beneficial uses within a reasonable time frame. Reduce or prevent further migration of contaminated groundwater from the source areas to the downgradient aquifer or surface water bodies that are closely hydrologically connected by achieving MCLs (where there are no nonzero maximum contaminant level goals [MCLGs]) and AWQS. For groundwater that is hydrologically connected to surface water, AWQS will apply for the following Fresh Water Uses: (I)(A) Water Supply; (I)(B) Water Recreation; and (I)(C) Growth and Propagation of Fish, Shellfish, Other Aquatic Life, and Wildlife.
- Ensure there is no risk to aquatic receptors through control of contaminant movement through the groundwater into the Chena River.
- Remove free liquid product to the extent practicable to eliminate film or sheen from groundwater.
- Prevent use of groundwater containing contaminants at levels above Safe Drinking Water Act MCLs, nonzero MCLGs, or the following AWQS for Fresh Water Uses: (I)(A) Water Supply; (I)(B) Water Recreation; and (I)(C) Growth and Propagation of Fish, Shellfish, Other Aquatic Life, and Wildlife.

Soil

- Prevent the migration to groundwater of soil contaminants that could result in groundwater contamination and exceedances of federal MCLs and nonzero MCLGs and to groundwater that is closely hydrogeologically connected to surface water (such as the Chena River) that could result in exceedances of AWQS in surface water (EQFS and WQFS).

Chena River Sediments

- Reduce sources of contaminant releases to the Chena River.

Chena River Surface Water

- Meet AWQS for the following Fresh Water Uses: (1)(A) Water Supply; (1)(B) Water Recreation; and (1)(C) Growth and Propagation of Fish, Shellfish, Other Aquatic Life, and Wildlife.
- Continue aquatic assessment.

Selected Remedy

The ROD identified different remedial actions for the different subareas of the WQFS as described below.

WQFS1

- Operating an AS/SVE system to address solvent and petroleum contamination in the source-area soil and groundwater and the floating-product contamination. The source area AS/SVE system can be tailored to strip VOCs from groundwater and soil and to enhance biological degradation of contaminants in saturated- and vadose-zone soils while minimizing vadose-zone desiccation. An existing system, used for a treatability study, will be expanded to address the source area. The SVE system will include offgas treatment. Before operation of the AS/SVE system begins, abandoned buried fuel pipelines within the subarea will be purged of residual fuel to eliminate the potential for the lines to act as ongoing contaminant sources.
- Potential in situ heating at hot spots is proposed as a method to increase the rate of remediation in comparison to source-area treatment without heating. In the event that AS is ineffective in achieving progressive reduction of the VOC and petroleum hydrocarbon concentrations in soils, in situ soil heating is proposed as a means to increase the movement of VOCs and make them easier to extract. Treatability studies involving radio-frequency soil heating and six-phase soil heating have been initiated in WQFS1 to evaluate the potential to enhance performance of AS and SVE.

- Potentially supplementing the AS and SVE with the operation of a downgradient groundwater AS trench, if necessary, to intercept and treat dissolved contaminants migrating from source areas downgradient toward the Chena River.
- Establishing and maintaining ICs to ensure that until federal and state MCLs are attained, the groundwater will not be used as a potable water source. ICs include restrictions governing site access, onsite construction, and well development or placement. They will be necessary as long as hazardous substances remain onsite at levels that preclude unrestricted use. Current and future land use is industrial; current and future groundwater use is designated for residential use. Groundwater- and land-use restrictions will be incorporated into the Fort Wainwright master plan.
- Monitoring of the natural attenuation of COCs in groundwater to track decreases in concentrations to below ARARs and achievement of RAOs. The possible rebound of contaminant concentrations after operation of remediation technologies has ceased also will be monitored.
- Monitoring the performance of remedial treatment systems, as described above, to optimize treatment system effectiveness and efficiency through system modifications and/or enhancements as appropriate.
- Monitoring and evaluation of the selected remedy, including natural attenuation, to determine achievement of RAOs.
- Monitored natural attenuation for deep groundwater and areas not being actively treated within WQFS1.

WQFS2

- Installing an AS/SVE system to address solvent- and petroleum-contaminated hot spots in the soil and groundwater and floating-product contamination. The hot-spot AS/SVE system can be tailored to strip VOCs from groundwater and soil and to enhance biological degradation of contaminants in saturated- and vadose-zone soils. The SVE system will include offgas treatment. Before operation of the AS and SVE system begins, abandoned buried fuel pipelines within the subarea will be purged of residual fuel to eliminate the potential for the lines to act as ongoing contaminant sources.
- Continuing to operate a downgradient AS curtain to intercept and remove dissolved-phase contaminants from the groundwater, thus minimizing potential impacts to the Chena River.
- Conducting groundwater monitoring to determine whether cleanup levels are achieved and maintained downgradient of the AS curtain.
- Establishing and maintaining ICs to ensure that until federal and state MCLs are attained, the groundwater will not be used, except for activities undertaken to initiate

the selected remedies detailed in this ROD. ICs include restrictions governing site access, onsite construction, and well development or placement. They will be necessary as long as hazardous substances remain onsite at levels that preclude unrestricted use. Current and future land use is industrial; current and future groundwater use is designated for residential use. Groundwater- and land-use restrictions will be incorporated into the Fort Wainwright master plan.

- Monitoring of the natural attenuation of COCs in groundwater to track decreases in concentrations to below ARARs and achievement of RAOs. The possible rebound of contaminant concentrations after operation of remediation technologies has ceased also will be monitored.
- Monitoring performance of remedial treatment systems, as described above, to optimize treatment system effectiveness and efficiency through system modifications and/or enhancements as appropriate.
- Monitoring and evaluation of the selected remedy, including natural attenuation, to determine achievement of RAOs.
- Monitored natural attenuation for deep groundwater and areas not being actively treated within WQFS2.

WQFS3

- Installing AS and SVE wells to address solvent- and petroleum-contaminated hot spots in the soil and groundwater and floating-product contamination. The hot-spot AS/SVE system can be tailored to strip VOCs from groundwater and soil and to enhance biological degradation of contaminants in saturated- and vadose-zone soils. The SVE system will include offgas treatment. AS and SVE wells are located in the contaminant hot spot. Before operation of the AS/SVE system begins, abandoned buried fuel pipelines within the subarea will be purged of residual fuel to eliminate the potential for the lines to act as ongoing contaminant sources.
- Establishing and maintaining ICs to ensure that until federal and state MCLs are attained, the groundwater will not be used, except for activities undertaken to initiate the selected remedies detailed in this ROD. ICs include restrictions governing site access, onsite construction, and well development or placement. They will be necessary as long as hazardous substances remain onsite at levels that preclude unrestricted use. Current and future land use is industrial; current and future groundwater use is designated for residential use. Groundwater- and land-use restrictions will be incorporated into the Fort Wainwright master plan.
- Monitoring of the natural attenuation of COCs in groundwater to track decreases in concentrations to below ARARs and achievement of RAOs. The possible rebound of contaminant concentrations after operation of remediation technologies has ceased also will be monitored.

- Monitoring the performance of remedial treatment systems as described above, to optimize treatment system effectiveness and efficiency through system modifications and/or enhancements as appropriate.
- Monitoring and evaluation of the selected remedy, including natural attenuation, to determine achievement of RAOs.
- Monitored natural attenuation for deep groundwater and areas not being actively treated within WQFS3.

5.2.4 Status of Remediation

The following description of the status of the WQFS remediation systems is primarily based on the draft PDRAR, which is the most recent report of the status of remediation systems at the EQFS and WQFS.

All WQFS Subareas

These requirements are applicable to all WQFS sub areas:

Purge Abandoned Fuel Lines

Abandoned buried fuel lines in the WQFS were pigged and capped in 2000.

Natural Attenuation and Groundwater Monitoring

Groundwater modeling has been applied to the WQFS and has been used to compare the effects of treatment to what would be projected from natural attenuation and to estimate contaminant loading to the Chena River. This modeling has assisted in development of a Time to Cleanup Estimate and in placement and sizing of hot spot treatment systems.

Institutional Controls

Land and water use restrictions are in place for the WQFS. This boundary appears to adequately encompass the areas of soil and groundwater contamination that could pose risk of exposure to personnel during intrusive operations in WQFS subareas. No IC violations have occurred at these source areas to date.

WQFS1

Horizontal well AS/SVE System – The horizontal well AS/SVE system, including a thermal/catalytic heater for off-gas treatment, was installed in the spring of 1997 as a treatability study and was expanded by installing vertical AS probes and SVE probes in the summer of 1998. This treatability study was chosen as the remedy for this source area and has operated from the time of installation. This system removed over 227, 000 pounds of VOCs in 2000, with

an oxidizer efficiency of 99.5 percent. Groundwater sampling indicates a decreasing trend in concentrations.

Source area AS/SVE – The source area treatability AS/SVE was selected as a remedial action. The treatment system has removed 43, 000 pounds of VOC in the first two years of operation. Groundwater contaminant concentrations in the treatment zone indicate a decreasing trend. This system is being augmented during the 2001 construction season to improve system performance and expand the area of treatment. Soil heating to enhance AS/SVE was evaluated in 1999 and found not to be cost-effective for relatively volatile contaminants such as those subject to OU5 cleanup goals. At the time of this review, USARAK does not intend to heat soil as part of AS/SVE treatment at any of the Fort Wainwright OUs.

Site Inspection – This source area was inspected in April 2001. Photographs taken at the time of the site inspection are presented in the appendices section of this report.

WQFS2

The AS curtain system was installed in June 1998 and became operational that Fall. This curtain intercepts and treats groundwater contaminants prior to migration into the Chena River. A harbor boom was installed in 1998 downgradient of the AS curtain to control contaminant releases into the Chena. This boom will be maintained until RAOs are met. It was chosen as a component for this remedial action for this sub-area. The AS curtain system operated continuously since startup in 2000, with some minor down times for system maintenance. This system is being augmented during the 2001 construction season to improve system performance and expand the area of treatment. Two rebound evaluations were performed in 1999 to determine the best mode of system operation. It was found that without treatment benzene rebounded to greater than RAOs, indicating that the WQFS2 area is a long term source of contamination to groundwater and requires active treatment. Oxygen releasing compound (ORC) treatability study was evaluated and determined not to be effective for this source area. The ORC wells are scheduled to be decommissioned in 2001.

WQFS3

An AS/SVE system was installed at WQFS3 in the latter half of 2000 and operation begun in January 2001. The wells were connected to the WQFS2 blowers and off-gas treatment system, which was modified to operate in the catalytic mode prior to WQFS3 system start-up.

As of October 2000, benzene was the only COC present in concentrations greater than the RAO.

5.3 East Quartermaster's Fueling System

5.3.1 Overview

The east section of the former EQFS is located between Front Street and Gaffney Road (Figure 5-2). A benzene plume covers approximately 40 acres and may have extended under the Chena River in the past. The fueling system was supplied by the 8-inch pipeline that connected the Birch Hill Tank Farm and the ROLF. During an UST Release Investigation, gasoline and diesel groundwater contamination were encountered. Monitoring wells and microwells were installed surrounding this plume. In 1989 and in 1992, an investigation showed both petroleum and solvent contamination in the soil and groundwater. In 1994, a comprehensive evaluation of the EQFS was conducted, which included installing groundwater probes, soil borings, and monitoring wells. The groundwater data identified several plumes (fuels and solvents), and the soil data identified solvent contamination, believed to have originated from surface disposal and undocumented spills. The remedial investigation was conducted in 1995 and issued in 1996. An AS/SVE system was installed and operated at East Building 1060. This system, shut down since contaminant concentrations achieved cleanup goals, has been refurbished and has been relocated to the west side of Building 1060 to reduce solvent contamination in that area. It will become operational at Building 1060 West upon installation of an electrical oxidizer. Natural attenuation and intrinsic remediation treatability studies are on-going at the EQFS. Chosen alternatives for remedial action at the EQFS include continued operation of the AS/SVE at Building 1060, groundwater monitoring, and monitored natural attenuation. As stated for the WQFS, ICs are in place in the entire QFS. OM&Ms are being drafted, construction complete is anticipated at the end of 2001 (replace as done in WQFS), and the long-term monitoring plan and exit strategy, as well as the interim Remedial Action Report, will be completed at that time.

5.3.2 Background

Periods of use and dates related to the history of EQFS contamination and remediation are shown in Table 5-2.[21]

Physical Characteristics

The EQFS area covers approximately 40 acres between Taxiway 18 and the Chena River, and between Building 1579 to the southwest and Building 1054 to the northwest. The terrain is open tussock flats as the buildings have all been removed from the site. The EQFS is located within the 500-year floodplain of the Chena River.

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[21] Information compiled from the OU5 ROD; Preliminary Draft Remedial Action Report, Operable Unit 5; and the Five-Year Review Report Document Log.

Table 5-2. EQFS Contamination and Remediation History.

EVENT	DATE
Area used for vehicle storage and maintenance, dry cleaning, fuels testing, refueling, pesticide storage and mixing, and waste storage.	
FFA signed.	1992
TPA signed.	1992
Building 1054 referred from OU1 to EQFS area of OU5.	June 1994
Natural attenuation Treatability Study initiated.	September 1997
AS/SVE Treatability Study initiated at Building 1060.	June 1994
AS/SVE Treatability Study at Building 1060 completed.	September 2000
AS/SVE system installed at Building 1060 West site.	August to December 2000
Final Intrinsic Remediation Evaluation report submitted.	November 2000
Draft 2000 PDRAR finalized.	April 2001

History of Contamination

The EQFS has been used for vehicle storage and maintenance, dry cleaning, fuels testing, refueling, pesticide storage and mixing, and waste storage (for example, PCB transformers, chemicals, paints, oils, brake fluid, and solvents). The EQFS included USTs, ASTs, a pump house, fueling islands, and an 8-inch diameter fuel pipeline which is abandoned, but still in place. In addition, drains were connected to a wooden pipe that drained to the river. Solvents, pesticides, and petroleum contamination were found in groundwater beneath EQFS. Suspected sources include spills and leaks from pipelines, fueling stations and undocumented spills.

5.3.3 Remedy Selection

Nature of Contamination

Groundwater

The remedial investigation identified two groundwater contaminant plumes, one upgradient and one downgradient of Building 1565 containing benzene, EDB, 1,1,1-trichloroethane (TCA), and TCE in concentrations exceeding MCLs; TAH and TAqH in concentrations exceeding AWQS; and bis(2-chloroethyl)ether in concentrations exceeding the concentration limit corresponding to 10^{-6} risk for residential use.

Floating petroleum hydrocarbon product was been observed on the water table in the area influenced by releases from the EQFS.

Soil

Soil contamination in this area has extended to the groundwater table and GRO is found in a localized area of smear zone soil. Free product, likely to be weathered gasoline, is also found in EQFS south of Building 1060.

Remedial investigations found DRO, GRO, and xylenes exceeding ADEC cleanup guidelines in soils in the EQFS.

Land and Resource Use

Current land use for EQFS is light industrial and the groundwater use is considered residential because water supply wells for the City of Fairbanks are located in the same unconfined aquifer as groundwater contamination downgradient of the WQFS. The closest residences to EQFS are approximately ¼-mile northeast. Each residential area includes a school. Currently access to EQFS is unrestricted, and the area is used for recreational purposes and includes a bicycle trail. Access to the Chena River is unrestricted.

Remedial Action Objectives

The ROD identified the following objectives for remediation of OU5:

Groundwater

- Restore groundwater to its beneficial uses within a reasonable time frame. Reduce or prevent further migration of contaminated groundwater from the source areas to the downgradient aquifer or surface water bodies that are closely hydrologically connected by achieving MCLs (where there are no nonzero MCLGs) and AWQS. For groundwater that is hydrologically connected to surface water, AWQS will apply for the following Fresh Water Uses: (I)(A) Water Supply; (I)(B) Water Recreation; and (I)(C) Growth and Propagation of Fish, Shellfish, Other Aquatic Life, and Wildlife.
- Ensure there is no risk to aquatic receptors through control of contaminant movement through the groundwater into the Chena River.
- Remove free liquid product to the extent practicable to eliminate film or sheen from groundwater.
- Prevent use of groundwater containing contaminants at levels above Safe Drinking Water Act MCLs, nonzero MCLGs, or the following AWQS for Fresh Water Uses: (I)(A) Water Supply; (I)(B) Water Recreation; and (I)(C) Growth and Propagation of Fish, Shellfish, Other Aquatic Life, and Wildlife.

Soil

- Prevent the migration to groundwater of soil contaminants that could result in groundwater contamination and exceedances of federal MCLs and nonzero MCLGs and to groundwater that is closely hydrogeologically connected to surface water (such as the Chena River) that could result in exceedances of AWQS in surface water (EQFS and WQFS).

Chena River Sediments

- Reduce sources of contaminant releases to the Chena River.

Chena River Surface Water

- Meet AWQS (18 AAC 70.020) for the following Fresh Water Uses: (1)(A) Water Supply; (1)(B) Water Recreation; and (1)(C) Growth and Propagation of Fish, Shellfish, Other Aquatic Life, and Wildlife.
- Continue aquatic assessment.

Pre-ROD Response

Two treatability studies were initiated at the EQFS prior to the signing of the ROD for OU5, with the intent that effective technologies would be considered for incorporation into remedial actions:

- SVE and AS at Building 1060.
- Natural Attenuation Study.

Selected Remedy

- Continuing to operate the AS and SVE wells of the Building 1060 AS/SVE treatability study system to address solvent- and petroleum-contaminated hot spots in the soil and groundwater and floating-product contamination. The SVE system includes offgas treatment.
- Establishing and maintaining ICs to ensure that until federal and state MCLs are attained, the groundwater will not be used, except for activities undertaken to initiate the selected remedies detailed in this ROD. ICs include restrictions governing site access, onsite construction, and well development or placement. They will be necessary as long as hazardous substances remain onsite at levels that preclude unrestricted use. Current and future land use is industrial; current and future groundwater use is designated for residential use. Land-use restrictions include limiting future land use to operations currently being conducted at the source area. Groundwater and land-use restrictions will be incorporated into the Fort Wainwright Master Plan.

- Monitoring of the natural attenuation of COCs in groundwater to track decreases in concentrations to below ARARs and achievement of RAOs. The possible rebound of contaminant concentrations after operation of remediation technologies has ceased also will be monitored.
- Monitoring the performance of remedial treatment systems, as described above, to optimize treatment system effectiveness and efficiency through system modifications and/or enhancements as appropriate.
- Monitoring and evaluation of the selected remedy, including natural attenuation, to determine achievement of RAOs.
- Monitored natural attenuation for deep groundwater and areas not being actively treated within EQFS.

5.3.4 Status of Remediation

A natural attenuation treatability study for remediation of hot spots began in September 1997. Sample results found groundwater contaminant concentrations to be below RAOs at the Building 1565 fueling operations hot spot and the TCA spill area west of Building 1565, and greater than RAOs at the Avgas Pipeline hot spot.

An AS/SVE system operated on the east side of Building 1060 from 1994 to 1999, and groundwater RAOs have been achieved.

A small TCE hot spot at the northeast corner of Building 1060 was treated by AS/SVE during the same time frame, also achieving RAOs.

AS/SVE was discontinued at the east side of Building 1060 as of September 2000.

Groundwater contamination on the west side of Building 1060 was initially treated by natural attenuation. An AS/SVE system with a granular activated carbon off-gas treatment was installed to treat this source area from August through December 2000; system operation began in December 2000. Contaminant concentrations exceed RAOs for benzene, EDB, GRO, and DRO in groundwater at this source area.

Two monitoring wells have been installed to monitor groundwater contamination at the Apple Street source area. Groundwater in this area exceeds the RAO for DRO.

Institutional Controls

The IC use restriction boundary appears to adequately encompass the areas of soil and groundwater contamination that could pose risk of exposure to personnel during intrusive operations in the EQFS.

5.4 Remedial Area 1a—Birch Hill Above Ground Storage Tanks

5.4.1 Overview

This source area, referred to as Remedial Area 1a, is located on Birch Hill in the northwest corner of Fort Wainwright (Figure 5-1). Lead-contaminated soil surrounding the ASTs at the Birch Hill Tank Farm was deferred from OU3 to OU5, while petroleum hydrocarbon contamination is being managed under the TPA. Remedial Area 1a covers an area of approximately 110 acres. There are sixteen ASTs on Birch Hill and the associated underground pipeline system. The chosen alternative in the ROD, signed in April 1999, consists of ICs. The entire area is fenced, and signs are in place; the fence is inspected annually to ensure its integrity.

5.4.2 Background

Contamination was initially discovered at the Tank Farm site during a soil-gas survey conducted in 1988. Five monitoring wells were installed along the western boundary of the post as part of the post-wide groundwater monitoring program. Initial sampling events found BTEX and petroleum hydrocarbons at levels above MCLs. Additional monitoring wells were installed in 1992 near the TFS and in the area between the Tank Farm and the Chena River. These "picket wells" were monitored twice annually.

Periods of use and dates related to the history of the Birch Hill Tank Farm contamination and remediation are shown in Table 5-3.[22]

The Tank Farm and associated TFS are part of the Fairbanks Fuel Terminal, which was constructed in 1943 beginning with the installation of the fourteen 10,000-barrel capacity, bolted-steel tanks on Birch Hill. The mission of the Fairbanks Fuel Terminal was to provide backup fuel support for Eielson Air Force Base. Fuel was transported via the CANOL pipeline and the Haines-Fairbanks pipeline. At Fort Wainwright, the CANOL pipeline connected the Birch Hill UST facility to the ROLF and ran west to the Tank Farm. The portion of the pipeline between the ROLF and the Tank Farm remains in place. The Haines- Fairbanks pipeline was constructed from 1954 to 1955. The only active portion of this pipeline, now called the Fairbanks-Eielson Pipeline, runs between Eielson Air Force Base and the Mapco refinery in North Pole.

[22] Information obtained from the OU3 ROD; Groundwater Extraction and Treatment Effectiveness Review (Oct. 2000); OU3, 1999 Monitoring Report; and the OU3 draft ESD.

Table 5-3. Birch Hill Tank Farm Contamination and Remediation History.

EVENT	DATE
Soil-gas survey conducted.	1988
Fort Wainwright NPL listed.	August 1990
FFA signed.	1992
TPA signed.	1992
Picket wells installed.	1992
RI fieldwork conducted.	September and October 1994
RI and RARs submitted to EPA.	October 1994
FS submitted to EPA.	April 1995
ROD signed.	January 1996
AS/SVE systems installed at Building 1173 and Lazelle Road.	1996
Lazelle Road system relocated to the TFS and the Building 1173 system expanded to cover Lazelle Road source area.	1997
Product recovery treatability studies initiated at the Birch Hill Tank Farm.	1998
Thaw Channel treatment system installed.	1999
ESD submitted to document installation and operation of existing AS/SVE treatment systems; operation of the dual phase product recovery system on Birch Hill; continuation of groundwater modeling; and concomitant changes in remedial costs.	September 2001

The Tank Farm consisted of fourteen 10,000-barrel capacity, bolted-steel fuel tanks on top of Birch Hill; the tanks contained arctic grade diesel fuel, aviation-grade leaded gasoline, aircraft turbine and JP-4, leaded vehicle motor gasoline, and unleaded and regular motor fuel. All tanks have been emptied and cleaned.

Physical Characteristics

Remedial Area 1a is roughly defined by the area of the tank farm located on Birch Hill, north of the main cantonment area. The elevation of Birch Hill ranges from 441 feet to 748 feet above mean sea level. No permanent surface water bodies are located on Birch Hill, but snow and ice melt water accumulate in the depressions and in the diked areas around the ASTs.

History of Contamination

Surface soil lead contamination may be the result of several historical tank maintenance activities. These activities included tank bolt removal and replacement, cleaning sludge from tank bottoms, and tank painting and stripping. Historically, bolts removed from the tanks during routine maintenance were cleaned with solvent to remove red lead pipe dope. The solvent, which contained lead from the threaded bolt pipe dope, was spread on the ground in the areas surrounding the tanks. Because these tanks were built as bolted (rather than welded) tanks, a very large number of bolts are present on each tank.

Spills occurred around the tanks throughout the fuel terminal's history as the bolted-steel tanks were subject to minor leaks. Sludge removed from the bottoms of the fuel tanks was buried or spread in the areas surrounding the tanks and may have contributed lead to surface area soil. In addition, releases of lead-containing fuels may have contributed to the elevated lead concentrations near the ASTs. Surface and subsurface soils at the Fairbanks Fuel Terminal also are contaminated with petroleum.

Nature of Contamination

Soil

Remedial investigations in this area found petroleum hydrocarbons in surface and subsurface soils, with the most significant levels within the bermed areas around the ASTs, decreasing with depth and distance from the tanks. At the ASTs with less than 15 feet of underlying silt, soil contamination was generally highest at the interface between silt and schist bedrock. Petroleum hydrocarbons (quantified as Jet A fuel) were detected in surface and subsurface soil at a maximum concentration of 5,500 milligrams per kilogram (mg/kg). Low levels of VOCs also were detected. The maximum total lead concentration reported in surface soil samples was 7,840 mg/kg, while the maximum leachable lead (toxicity characteristic leaching procedure [EPA Method 1311]) concentration was 5.4 mg/L.

Lead contamination of surface soil was found to be most significant directly adjacent to each tank, with lead levels decreasing with lateral distance from each AST. In addition, lead concentrations in subsurface soils were found to decrease to background levels at depths of one to two feet. Lead was the only inorganic analyte above screening levels and was determined to be the only COC for Remedial Area 1a under OU5.

Land and Resource Use

Land use at Remedial Area 1a is light industrial. The site is fenced to prevent entry and subsequent exposure to soils within the source area. Groundwater use is considered residential because water supply wells for the City of Fairbanks are located in the same unconfined aquifer as groundwater contamination downgradient of the source area.

Remedial Action Objectives

The RAOs for Remedial Area 1a are the same as those for the WQFS plus an additional objective for soil:

- Limit human health and terrestrial receptor exposure to lead-contaminated soil.

Selected Remedy

Institutional Controls

Land use restrictions, signage, and maintaining the existing fence.

5.4.3 Status of Remediation

ICs are in place and there have been no violations to date. Annual inspections have been completed since 1999.

5.5 Other Operable Unit 5 ROD Requirements

5.5.1 Open Burn/Open Detonation Evaluation

The ROD specified that no less often than during the CERCLA Five-Year Reviews, USARAK will evaluate the OB/OD area. This evaluation will include review of the active range and any unexploded ordnance (UXO) within the OB/OD area and range, to determine whether ICs to restrict land use and protect human health and the environment are sufficient. USARAK also will evaluate the status of RCRA rules and regulations for military munitions ranges and UXO to determine whether additional RCRA requirements must be met.

USARAK's evaluation indicates that ICs for the OB/OD area remain protective. No new RCRA or munition rules have been promulgated specific to post-closure procedures for former OB/OD areas. USARAK has evaluated whether delay of closure affects the OB/OD area and has determined it has not, because the range has not been closed and Fort Wainwright remains an active installation. Therefore the selected remedy remains protective.

5.5.2 Chena River Surface Water and Sediments

The Chena River Aquatic Assessment is a component of the selected remedies for Operable Unit 5 source areas, and is not considered a source area in and of itself. As such, general response actions were not included in the OU 5 ROD for Chena River sediment or surface water. Through the source area remedial investigation process, the Chena River was identified as the area most likely to be affected by multiple source area releases at Fort Wainwright, with the greatest potential for impact from the WQFS and EQFS.

The Chena River Aquatic Assessment was established to determine if impacts to the river had occurred from Fort Wainwright releases and to measure anticipated improvements in water and sediment quality over time, based on the effectiveness of selected remedies for the QFS areas. This program also provides information for optimizing treatment system design and operation. The program to date has consisted of sampling and analysis of surface water, sediments, and detritus; benthic macroinvertebrate toxicological studies and bioassays; and calculating reductions in contaminant load into the Chena River.

Major components of the assessment program were described as:

- Spring and fall collection of water, sediment, and detritus (organic leaf litter) samples and analysis for COCs and water chemistry.
- Benthic macroinvertebrate study, including bioassay and toxicological analysis.
- Baseline data collection (water quality, contaminant concentrations, contaminant loading and ecological conditions) and study of changes in aquatic organisms as a function of reduction in contaminant load into the river.

During the first full-term Five-Year Review from the signature date of the OU5 ROD, if the data or other information not considered in the development of this ROD indicates significant impacts to the Chena River, other remedial alternatives or assessment measures will be evaluated by USARAK and presented to the regulatory agencies through a technical memorandum generated within 6 months of the Five-Year Review date.

- Consider possible remedial actions if further evaluation of impacts to the river shows unacceptable risks to aquatic organisms.

5.5.3 Status of the Chena River Aquatic Assessment Program

Pre-ROD

To determine whether actual impacts had occurred, assess their significance, and measure changes over time, the Chena River Aquatic Assessment Program was initiated in 1998. The assessment included collecting water, sediment, and detritus (organic leaf litter) samples during the spring and fall and analyzing them for COCs and water chemistry. A second year of study was completed, with results reported during the first quarter of 1999. The ROD, signed in May 1999, noted ongoing aquatic assessment efforts and committed to continuation of the assessment, including benthic macroinvertebrate studies.

Post-ROD

The ROD included commitments to a post-wide sampling program and the Chena River Aquatic Assessment Program. The Chena River Aquatic Assessment Program found evidence that contamination from the Fort Wainwright source areas was potentially adversely influencing

biotic health in the Chena River ecosystem but did not prove that sediment toxicities caused changes in the benthic invertebrate communities of the Chena River.

Observations of sheens on the river or in sediment and detritus samples identified one of the seep areas (Seep Area in Segment D) as being "the most conspicuous" contaminant outfall to the Chena River in the study area. Other, less conspicuous, sheens were observed downstream of the primary seep in the same study segment.

During summer 2000, polycyclic aromatic hydrocarbon (PAH) studies were conducted along the Chena River adjacent to the QFS in the vicinity of the AS curtain and former retaining structure. These studies confirmed the presence of PAHs in the seeps.

5.6 Institutional Controls

ICs are a component of the selected remedy for WQFS, EQFS, and Remedial Area 1a. In addition, the OU5 ROD established a comprehensive site wide approach to ICs at the Fort Wainwright NPL site for all source areas where the respective RODs specified ICs as an element of remediation.

5.6.1 Institutional Control Commitments in Operable Unit 5 ROD

Major OU5 commitments to a site wide IC program included the following:

- Develop SOPs to identify the objectives to be met by the restrictions, to identify all land areas under restriction, and to specify the particular restrictions, controls, and mechanisms to be used.
- Create and maintain a database and tracking mechanism to identify restricted land areas, objectives to be met by the restrictions, and the specific restrictions, controls, and mechanisms.
- Monitoring of SOP compliance annually (or some other monitoring frequency to be agreed upon by EPA, ADEC, and the USARAK).
- As part of the OM&M report for each OU, assess the condition of areas at Fort Wainwright subject to ICs. These inspections will determine the effectiveness and protectiveness of all ICs and designated land uses, and will ascertain whether the current land and groundwater uses in the area are consistent with the ICs and all RAOs outlined in the relevant decision document governing that site or OU. Results of any field inspection will be documented in the annual OM&M report submitted for the OU pursuant to the remedial action report.
- USARAK will notify the EPA and ADEC immediately on discovery of any unauthorized activity that is inconsistent with the IC SOPs. The USARAK will issue a stop work or stop activity notice on discovery of any unauthorized work. The stop

work or stop activity notice will remain effective until the EPA, ADEC, and USARAK determine a plan of action to resolve the unauthorized change.

- USARAK will notify the EPA and ADEC at least 6 months in advance about any transfer, by sale or lease, of areas of Fort Wainwright that are subject to ICs, to ensure adoption of such additional measures as may be needed to assure continued compliance with ICs on such transferred property. Before actual transfer of land management responsibilities to the Bureau of Land Management or another federal agency or department or to a private party, the USARAK will provide such transferee a written copy of installation master-planning documentation that identifies all ICs remaining in force.
- SOPs will be a component of the Five-Year Review process.

5.6.2 Status of Institutional Control Program

The USARAK has established an SOP and a GIS-based tracking system to ensure the land and use restrictions are enforced. The IC system has been incorporated into the Post-Wide Master Plan, and compliance with ICs is reported in the Annual Monitoring Reports for each OU. The IC policy applies to all USARAK units and activities, Military and Civilian Support Activities, Tenants Organizations and agencies and Government and Civilian Contractors. In the fall of 2001, the IC Memorandum signed by Major General Cash dated February 1999, will be updated to require a Work Authorization Permit for all groundwater and soils on USARAK lands. This revised memorandum, signed by the Commanding General, will include a section on areas with IC mandated by a ROD and a section on areas where contamination is not suspected. Currently, all contracts that include intrusive activities require a Work Authorization Permit. The Permit will be updated to clearly alert the user on procedures to follow when potential contamination is encountered. The SOP for IC will include a more detailed section on the procedures and responsibilities for incidents where potential contamination is found.

During the past few years, there have been numerous instances confirming the effectiveness of the IC policy at Fort Wainwright. One example is the Post Signal Battalion's project to install fiber optic lines throughout the installation (project name: OSCAR). Since the project's inception in 1998, Signal personnel have coordinated their locates with Fort Wainwright environmental personnel. Environmental personnel have walked the proposed lines with the OSCAR personnel and negotiated relocation of the lines away from areas of highest contamination and/or active treatment systems. Environmental project work was coordinated with OSCAR work schedules to minimize disruptions to either project. Environmental staff met on a weekly basis during the highest periods of OSCAR activities to expedite the dig permit signing processes and to ensure all parties understood what action would be taken if contamination was encountered.

Other examples demonstrating that the IC program is working include:

- DPW Environmental has been included as part of the planning team for the pre-construction and pre-design of housing units in the Fort Wainwright North Post area to ensure that potential areas of contamination be avoided to the extent possible. Planning stage discussion has also resulted in agreement on the handling of contamination while continuing construction.
- The Federal Aviation Administration (FAA) is planning to construct a radar tower on Fort Wainwright, and chose the N4 site, a "No Further Action" site, as its desired location. Even though the site has been identified as needing no further action, the potential to encounter contamination still exists. FAA has met with the Environmental personnel and has been provided copies of the as-builts of former activities in the area and all known information on the N4 site. FAA will therefore be able to include provisions in the construction contract related to the potential to encounter contamination and steps to be taken by the contractor.
- When siting the new hospital to be built on Fort Wainwright, the original preferred site was listed in the environmental GIS data base as requiring no further action, but indicated that construction debris tar remained in fairly large concentrations in this area. Rather than reopening the issue and attempting to build around the tar, another site was selected.
- Other requests for use of areas under ICs include the Birch Hill Tank Farm (OU3) and the inactive, fenced portion of the landfill (OU4). Requested uses have ranged from a horse stable to a skeet range. Review of each of these requests identified the pertinent IC restrictions and resulted in relocating the proposed activities to other sites while still in the planning stages.

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APPENDIX C

TWO-PARTY AGREEMENT SITES*

* The information in this appendix was obtained from Figure 1-2, Status of Operable Unit Remediation, March 2002, Fort Wainwright, Alaska, from *Areawide Community Involvment Plan, Fort Wainwright, Alaska*, prepard by ENSR for U.S. Army Corps of Engineers, Alaska District, January 2003.

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LIST OF ACRONYMS

IC	Institutional controls
IR	Intrinsic remediation
LTM	Long-term monitoring
NA	Natural attenuation
POL	Petroleum, oil, and lubricants
UST	Underground storage tank

TWO-PARTY AGREEMENT SITES

No Further Action

Birch Hill USTs 345-350, 353-356, 381
Building 1172 USTs 215 216 (LTM & IC)
Building 1191 UST 219
Building 1514 UST 221-224
Building 1541 UST 225
Building 1543 UST 226
Building 1546 USTs 227-233 (includes IC)
Building 1563 UST 234
Building 2080 UST 247, 248
Building 2092 (pending) UST 249
Building 2106 UST 250
Building 2108 UST 253
Building 3015 and Seepage Pits UST 264, 265
Building 3403 UST 266
Building 3421 UST 322
Building 3423 UST 269, 270
Building 3479 UST 274
Building 3485 UST 321
Building 3562 USTs 279-282 (LTM & IC)
Building 3595 USTs 295, 351, 352 (includes IC)
Building 3724 UST 298
Building 4051 UST 300
Building 4057 UST 303
Building 4110A
Building 4110B UST 307
Building 4162 UST 308
Building 4247 UST 309
Building 5003 UST 315 (includes IC)
Building 5004 UST 310 (includes IC)
Building 5006 UST 316 (includes IC)
Chena River Tar Site
Glass Park Tar Site
Nike Sites B&C
North Post POL Removal
Power Plant Tar Site
Southgate Road Tar Site
UST Soil Piles

All Remedial Actions in Place. Contamination Defined. Institutional Controls in Place. Long-Term Monitoring Ongoing.

Building 1002 UST 202 (includes IC)
Building 1599 (IC only)
Building 2060 UST 242 (NA/IR & IC)
Building 2062 UST 244 (NA/IR & IC)
Building 2063 UST 245 (NA/IR & IC)
Building 2077 Paint Stripping and Painting (includes IC)
Building 2250 Golf Course Pesticide Shed (includes IC)
Building 3564 USTs 283, 284 (includes IC)
Building 5010 USTs 311, 312, 314, 357, 358 (includes IC)
(formerly Building 5001)
Building 5110 UST 317 (includes IC)
DRMO 5
Former Building 1168 UST 213 (includes IC)
Former Building 2111 USTs 254-257 (includes IC)
Former Building 2112 USTs 332-334 (includes IC)
Former Building 3481 USTs 275, 276 (LTM & IC)
Former Building 3483 USTs 277, 278 (includes IC)
Motor Pool Building (UST 323) Building 3425
North Post Site (includes IC)

Contamination Still Being Defined. Not All Remedial Action in Place.

Neely Road POL Point (Remedial Investigation began September 2002)

APPENDIX D

ADMINISTRATIVE RECORD
AND
INFORMATION REPOSITORY LOCATIONS

Administrative Record/Information Repository Locations

Hours of Operation Information as of July 2002

Fort Wainwright
Environmental Resources Division Office
Building 3023
Fort Wainwright, Alaska 99703
(907) 353-9686
Hours: Monday through Friday, 8:00 a.m. to 4:30 p.m. (closed holidays)

Noel Wien Library
1215 Cowles Street Fairbanks, Alaska 99701
(907) 459-1020
Hours:
Monday, Tuesday, Wednesday & Thursday - 10:00 a.m. to 9:00 p.m.
Friday - 10:00 a.m. to 6:00 p.m.
Saturday - 10:00 a.m. to 5:00 p.m.
Sunday - Closed in June, July, and August; call for Sunday hours.

Fort Wainwright Post Library
Building 3700
Fort Wainwright, Alaska 99703
(907) 353-2642
Hours:
Saturday & Sunday - 12:00 (noon) to 8:00 p.m.
Monday, Tuesday, and Wednesday - 11:00 a.m. to 7:00 p.m.
Thursday, Friday & Holidays - Closed

Fort Richardson Environmental Office
Building 724, Quartermaster Road
Door #5
Fort Richardson, Alaska
(907) 384-2716
Hours: Monday through Friday, 8:00 a.m. to 4:30 p.m. (closed holidays)

APPENDIX E

LIST OF CONTACTS AND INTERESTED PARTIES

Federal Elected/Appointed Officials (as of December 2002)

Senator Lisa Murkowski
United States Senate
101 12th Avenue, Box 7
Fairbanks, Alaska 99701

Senator Ted Stevens
United States Senate
101 12th Avenue, Room 206
Fairbanks, Alaska 99701

Congressman Don Young
United States Congress
101 12th Avenue
Fairbanks, Alaska 99701

State Elected Officials (as of December 2002)

Interior House Delegation:

John Coghill, Jr.
Alaska State Representative
119 N. Cushman Street, Suite 211
Fairbanks, Alaska 99701

John Davies
Alaska State Representative
119 N. Cushman Street, Suite 207
Fairbanks, Alaska 99701

Hugh Fate
Alaska State Representative
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Fairbanks, Alaska 99701

Joe L. Hayes
Alaska State Representative
119 N. Cushman Street, Suite 205
Fairbanks, Alaska 99701

Jeanette James
Alaska State Representative
PO Box 56622
North Pole, Alaska 99705

Carl M. Morgan
Alaska State Representative
State Capitol
Juneau, Alaska 99801-1182

Jim Whitaker
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119 N. Cushman St., Suite 213
Fairbanks, Alaska 99701

Interior Senate Delegation:

Pete Kelly
Alaska Senator
119 N. Cushman Street, Suite 201
Fairbanks, Alaska 99701

Georgianna Lincoln
Alaska Senator
State Capitol
Juneau, Alaska 99801-1182

Gene Therriault
Alaska Senator
119 N. Cushman Street, Suite 101
Fairbanks, Alaska 99701

Gary Wilken
Alaska Senator
119 N. Cushman Street, Suite 203
Fairbanks, Alaska 99701

Fairbanks North Star Borough Assembly Members (as of December 2002)

Hank Bartos
Assembly Member, Seat H
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Fairbanks, Alaska 99707-1267

Rhonda Boyles
Borough Mayor
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Fairbanks, Alaska 99707-1267

Eileen Cummings
Assembly Member, Seat I
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Fairbanks, Alaska 99707-1267

Victoria M. Foote
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Fairbanks North Star Borough
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Fairbanks, Alaska 99707-1267

Randy Frank
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Fairbanks North Star Borough
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Tim Beck
Assembly Member, Seat B
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Fairbanks North Star Borough Representatives

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Fairbanks North Star Borough
809 Pioneer Road
Fairbanks, Alaska 99707

Director of Public Works
Fairbanks North Star Borough
809 Pioneer Road
Fairbanks, Alaska 99707

Director, Department of Land Management
Fairbanks North Star Borough
PO Box 71267
Fairbanks, Alaska 99707-1267

Planning Director
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Fairbanks, Alaska 99707

Local Elected Officials (as of December 2002)

Steve Thompson, Mayor
City of Fairbanks
800 Cushman Street
Fairbanks, Alaska 99701

Jeff Jacobson, Mayor
City of North Pole
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North Pole, Alaska 99705-7708

Chamber of Commerce

President, Greater Fairbanks
Fairbanks Chamber of Commerce
250 Cushman Street
Fairbanks, Alaska 99701

EPA, Region X Contacts

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Remedial Project Manager
U.S. Environmental Protection Agency
1200 6th Avenue ECL-115
Seattle, Washington 98101

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U.S. EPA/AK Operations Office, Rm 537
222 W. 7th Avenue, #19
Anchorage, Alaska 99513

Community and Outreach Unit Manager
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State Agency Contacts

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610 University Avenue
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Fairbanks, Alaska 99709

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610 University Avenue
Fairbanks, Alaska 99709

Kent Monroe
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610 University Avenue
Fairbanks, Alaska 99709

U.S. Army Representatives

Commander, Pacific Ocean Division
Attn: Corps of Engineers
CEPOD-PP-P
Fort Shafter, Hawaii 96858-5440

Commanding General
Attn: APVR-CG
U.S. Army Alaska
Fort Richardson, Alaska 99505-6500

Commanding General
U.S. Army Pacific
Fort Shafter, Hawaii 96858-5100

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Deputy Commander
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Fort Wainwright, Alaska 99703

Directorate of Public Works
U.S. Army Alaska
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730 Quartermaster Road #6500
Fort Richardson, Alaska 99505-6500

Douglas W. Johnson
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Fort Wainwright, Alaska 99703

Linda Douglass
Public Affairs Officer
U.S. Army Alaska
Attn: APVR-FW-PO
Fort Wainwright, Alaska 99703

Family Life Chaplain
Main Post Chapel
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Fort Wainwright, Alaska 99703

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U.S. Army Alaska/Attn: APVR-RPW-ENV
730 Quartermaster Road #6500
Fort Richardson, Alaska 99505-6500

Garrison Commander
U.S. Army Alaska
Attn: APVR-GC
Fort Richardson, Alaska 99505

HQDA (SAILE-ESOH)
110 Pentagon
Washington, DC 20310-0110

Matt McAtee (CHPPM)
Attn: MCHB-DE-HR
U.S. Army Center for Health Promotion & Preventive Medicine
Aberdeen Proving Ground, Maryland 21010-5422

U.S. Army Representatives (Continued)

Gene Kubecka
HQ
United States Army Pacific
Attn: APEN-EV
Fort Shafter, Hawaii 96858-5100

Post Commander
U.S. Army Alaska
Attn: APVR-FW-PC
Fort Wainwright, Alaska 99703

Attn: SFIM-AEC-RPM
U.S. Army Environmental Center
Aberdeen Proving Ground, Maryland 21010-5401

U.S. Army Corps of Engineers, Alaska District

Environmental Program Manager
U.S. Army Corps of Engineers
20 Massachusetts Avenue, NW
Washington, DC 20314

Fort Wainwright Project Manager
CEPOA-PM-M-A
U.S. Army Corps of Engineers, Alaska District
PO Box 6898
Elmendorf AFB, Alaska 99506-6898

Affected Area Churches

Church of Latter Day Saints Steese Chapel
858 Lancaster Drive
Fairbanks, Alaska 99709

Shannon Park Baptist Church
PO Box 74518
Fairbanks, Alaska 99707-4518

Media

Radio:

KFAR/KWLF Radio
PO Box 70910
Fairbanks, Alaska 99707-0910

KUAC
Theater Building
University of Alaska Fairbanks
Fairbanks, Alaska 99775-1420

John McWhorter, Reporter
APRN
c/o KUAC UAF
Fairbanks, Alaska 99775-1420

Newspaper:

Alaska Star
Public Affairs Office
U.S. Army Alaska
USAG-AK
Fort Wainwright, Alaska 99703

Fairbanks Daily News-Miner
200 North Cushman
Fairbanks, Alaska 99707

Media (Continued)

Television:

KATN TV Channel 2
516 2nd Avenue, Suite 400
Fairbanks, Alaska 99701

KTVF TV Channel 11
3530 International Street
Fairbanks, Alaska 99701

Other Interested Agencies and Organizations

Alaska Health Project
218 East 4th Avenue
Anchorage, Alaska 99501

Arctic Audubon
PO Box 82098
Fairbanks, Alaska 99708

ATSDR
Federal Facilities Assessment Branch
Mail Stop E-56, 1600 Clifton Road NE
Atlanta, Georgia 30333

Bureau of Land Management
1150 University Avenue
Fairbanks, Alaska 99709

BLM Alaska Fire Service
PO Box 35005
Fort Wainwright, Alaska 99703-0005

Common Ground
PO Box 43
Ester, Alaska 99725

Director, Environmental Quality Engineering
University of Alaska Fairbanks
Fairbanks, Alaska 99775

Green Star
3504 Industrial Avenue
Fairbanks, Alaska 99701

Laborers Local 942
2117 Kiana Street
Fairbanks, Alaska 99709-5249

Northern Alaska Environmental Center
218 Driveway
Fairbanks, Alaska 99701

Resource Solutions
UAA
707 A Street
Anchorage, Alaska 99501

School of Engineering
University of Alaska Fairbanks
Fairbanks, Alaska 99775-5900

Sierra Club
201 Barrow Street, Suite 101
Anchorage, Alaska 99501-2429

Tanana Chiefs Conference
Real Estate Service
Tribal Environmental Restoration Program
122 First Avenue, Suite 600
Fairbanks, Alaska 99701

The Alaska Freedom Council
PO Box 71693
Fairbanks, Alaska 99707

APPENDIX F

NEWSLETTER EXAMPLE

FORT WAINWRIGHT

ENVIRONMENTAL RESTORATION NEWS

U.S. Army, Alaska | DECEMBER 2002 | Volume 10, Number 4

Restoration Advisory Board Update

Due to decreasing public interest, it was decided at the July 2002 Fort Wainwright Restoration Advisory Board (RAB) meeting that the Army would host one more official RAB meeting during the summer of 2003. The RAB would then be disbanded if no additional interest were shown by that time. This schedule is subject to change if the Army receives requests for public meetings in the future or if the need to resume the RAB becomes necessary to make environmental restoration decisions with public input. The date of the next RAB meeting has not been set.

ACRONYMS

ADEC
Alaska Department of Environmental Conservation

EPA
U.S. Environmental Protection Agency

OU
Operable Unit

RAB
Restoration Advisory Board

Postwide Issues

Federal Facilities Agreement meetings were held in Fairbanks on October 23 and 24 to cover issues associated with Operable Units (OUs) 1, 2, 4, and 5. A meeting to cover issues associated with Operable Unit 3 was held in Seattle from November 18 to 21. The status of the Two-Party Agreement sites will be discussed at a later date.

Two-Party Agreement Sites Update

There are 14 Two-Party Agreement sites on Fort Wainwright. These sites are being addressed through a separate State of Alaska "Two Party Agreement" because the only contaminant of concern at these sites is petroleum, which is not monitored by the U.S. Environmental Protection Agency (EPA). The Army has worked closely with the Alaska Department of Environmental Conservation (ADEC) to develop a plan to address these sites.

Three of the two-party sites have active treatment systems in place: Building 2250 (at the golf course), Buildings 2111 and 2112 (located on the runway), and Building 2077. The Building 2077 and Building 2250 treatment systems continue to operate without incident.

Work has begun to evaluate the treatment system at Buildings 2111/2112 to identify ways to improve its performance. The system was operated for brief periods to perform the evaluation.

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What We Do Between RAB ...

The evaluation report with recommended system changes is currently being reviewed by the Army.

Fall groundwater monitoring activities have been completed. New monitoring wells have been installed at Buildings 2062, 2063, and 1022. Additionally, all of the wells at each site were land surveyed and inspected. Soil borings were drilled and sampled at Building 2077 in order to determine the extent of the hot spot. Review of the analytical results from the Building 2077 investigation may prompt a modification to the site treatment strategy. Action may be directed toward soil removal.

Operable Unit Updates

Construction Complete Status

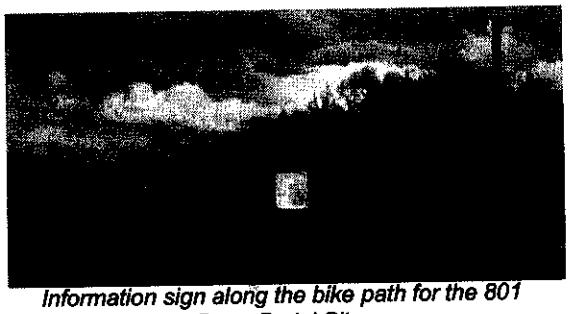
Fort Wainwright has achieved the construction complete milestone for all OUs. This means that all remedial actions for the entire post are constructed, operational, and functional. (Remediation at Fort Wainwright is in the form of treatment systems, natural attenuation, or operational controls.)

> ***"Actions at this site [Fort Wainwright] can truly be considered a national success story."***
>
> *— L. John Iani, EPA*

In an October 2, 2002, letter, the EPA congratulated Fort Wainwright staff for "accomplishing a very significant milestone in the ongoing cleanup efforts...."

L. John Iani, Regional Administrator for EPA, Region 10, wrote, "EPA staff and management want to express our appreciation ... for your conscientious, diligent, and cooperative management of this site."

Operable Unit 1



Information sign along the bike path for the 801 Drum Burial Site.

Operable Unit 1 (OU1) includes the phytoremediation soil that is being stored across the street from the Fort Wainwright landfill and the 801 Drum Burial Site.

The work plan is being drafted and will be submitted to the ADEC for review. The Army plans to move the soils generated during the phytoremediation project to a cell at the Fort Wainwright landfill. The Army is currently negotiating with ADEC on a permit modification to allow disposal of polluted soils at the landfill. The final work plan will be completed once ADEC approves the modified lined-cell design. The removal is planned for summer 2003.

Groundwater sampling at the 801 Drum Burial site is planned for March 2003. This round of sampling, per the long-term monitoring plan at the site, will include sampling the full suite of wells at the site. The full suite of wells consists of 14 groundwater monitoring wells located on the site and downgradient, toward the Chena River. The full suite of wells is scheduled to be sampled every third year, with limited wells sampled annually, until the

Remedial Project Managers negotiate other terms.

Operable Unit 2

The Defense Reutilization Marketing Office Yard.

Operable Unit 2 (OU2) includes groundwater beneath the Defense Reutilization Marketing Office (DRMO) Yard.

The Army is evaluating whether the expansion of two of the on-site treatment systems at the DRMO Yard, the DRMO-1 and DRMO-5 treatment systems, is necessary. Analytical results indicated that the treatment systems currently in place have not been adequately addressing the diesel range organic contamination. The systems appear to be too small. If the expansion occurs, the treatment area would double in size.

All of the treatment systems were operating during the summer of 2002.

During the past quarter, additional soil borings were drilled and sampled near DRMO-4 and near the suspected truck fuel stand southwest of Channel B. The fall soil, groundwater, and vapor samples were collected. The results, as well as a comprehensive report of fiscal year 2002 sampling activities, are expected next quarter. This information will be shared in future newsletters.

ACRONYMS

ADEC
Alaska Department of Environmental Conservation

DRMO
Defense Reutilization Marketing Office

EPA
U.S. Environmental Protection Agency

OU
Operable Unit

ROLF
Railcar off-loading facility

Future work at OU2 includes the semiannual sampling activities in the spring and fall, as well as routine system maintenance operations.

Operable Unit 3

Public information signs along the bike path in front of the ROLF.

Operable Unit 3 (OU3) consists of three sites – (1) mileposts (MP) 2.75 and 3.0, (2) the railcar off-loading facility (ROLF), and (3) the Birch Hill Tank Farm – which currently have a total of five treatment systems.

Fall groundwater samples were collected across the site. Soil samples were collected at the demolished ROLF buildings. The results of these sampling efforts will be shared in an upcoming newsletter, after the analytical results become available.

A technical memorandum was prepared to summarize the July 2002 pilot study of air sparge probes rehabilitation in which a hydroshock tool was used to remove iron precipitation and silt encrustation that were clogging monitoring wells. The study shows that shock treatment had the following successes:

- Restoring air flow in almost 90 percent of the probes where shock treatment was applied;
- Increasing dissolved oxygen concentrations in groundwater at seven of the eight treatment systems

where shock treatment was applied; and
- Increasing volatile organic compound concentration in soil vapor extraction probes located in the vicinity of the shocked sparge probes.

The report includes recommendations for further air sparge rehabilitation at other locations on Fort Wainwright.

Upcoming fieldwork planned for OU3 during the summer of 2003 includes the following:
- Installation of soil gas probes at ROLF sites, with special interest in the Eight-Car Header area;
- Soil sampling at MP 2.7; and
- Installation of replacement extraction wells at Birch Hill.

To gather data to update the computer model of groundwater flow in the Birch Hill area, several studies and tests have been performed. In conjunction with the routine groundwater sampling, samples were also collected as part of a dye-tracer study at Birch Hill. Aquifer pump tests and geophysical (seismic) tests were performed at Birch Hill. Results of these tests, as well as groundwater model updates, are expected this quarter (fall 2002).

All of the treatment systems are currently operating, with the exception of the Valve Pit C and Eight-Car Header systems, which are shut down for rebound studies. At the Product Recovery System, a 3,000-gallon holding tank was replaced with a 1,000-gallon holding tank, and the used carbon was replaced and disposed. The Product Recovery System is currently producing about 8 gallons of product per day.

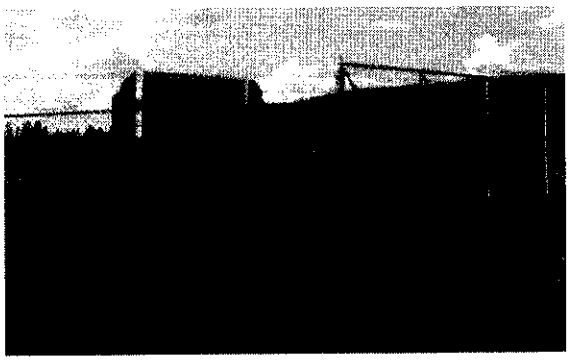
The treatment systems at the following site will be suspended for the winter due to operational concerns: the Birch Hill Tank Farm former Building 1173, the Truck Fill Stand, and the ROLF Valve Pits A, B, and C. In addition, the system treating contaminated soils from MP 2.7 and 3.0 will be suspended during the winter. The Army expects to resume operating these systems in the spring of 2003.

The Eight-Car Header system has been suspended for a rebound study and a Cleanup Operation Systems Site Exit Strategy (CLOSES) evaluation. The CLOSES evaluation will be performed to support moving the site from treatment to monitoring, to identify data gaps, to potentially reduce monitoring requirements, and to eventually move to closure status.

In September, the Army submitted the Interim Remedial Action Report to the EPA and ADEC. This report describes what remediation steps are being taken, the progress to date, and the exit strategy.

The Army finalized the final Explanation of Significant Differences (ESD) associated with the Birch Hill Tank Farm in September. The ESD describes to the public the nature of and reasons for changes to the remedy that occur after the Record of Decision has been signed. The ESD is now available at the Information Repositories.

Operable Unit 4



Public information sign in front of the inactive landfill.

Operable Unit 4 (OU4) includes the former post landfill and the coal storage yard located behind the power plant, where, historically, coal was sprayed with used oil to increase the British thermal units of the coal.

The Army is required to sample groundwater associated with the Fort Wainwright landfill twice per year. All of the wells were sampled in September, with the exception of one, which was sampled after it was de-iced. When the data from the spring and fall sampling activities are available, the results will be shared in a newsletter.

In order to ensure protection of a supply well downgradient of the coal storage yard, semiannual soil and groundwater samples are collected. The results from the spring soil sampling at the coal storage yard will be included in the annual report and shared in a future newsletter. Soil and groundwater samples were also collected during the fall of 2002. When the results from the fall sampling activity are available, they will be shared in a newsletter.

The Army will be conducting a CLOSES evaluation for the coal storage yard to determine whether (1) any data gaps exist, (2) additional monitoring wells are needed, or (3) the frequency of monitoring groundwater can be decreased.

Operable Unit 5

Equipment from a treatability study at OU5 is visible from Gaffney Road.

Operable Unit 5 (OU5) consists of two sites: the Birch Hill Tank Farm site and the Former East Quartermaster's and West Quartermaster's Fueling System sites.

The following treatment systems have continued to operate and be monitored: an air-sparge curtain, a source area treatment system, a horizontal well/vertical probes treatment system, and the Building 1060 treatment system with an electric oxidizer.

During extremely cold weather, the oxidizers used in the treatment systems have been plugging up, causing the treatment system to shut down. The blower system was also affected by freezing weather. To rectify these issues, the Army has prepared a Technical Memorandum recommending treatment system oxidizer insulation repairs and blower replacement. These upgrades and repairs are planned to be implemented this summer.

The neutron probes at the West Quartermaster's Fueling System site were decommissioned, as were 37 monitoring wells across Fort Wainwright.

Monthly samples were collected for volatile organic compound analysis from each of the treatment systems. Groundwater samples were collected at the East Quartermaster's Fueling System site to monitor natural attenuation of contaminants. The remainder of the OU5 fall groundwater monitoring was completed in October. A total of 18 soil borings were drilled and sampled at the West Quartermaster's Fueling System site in September. When the laboratory data from these monitoring activities are available, the results will be shared in a newsletter.

Indoor air quality monitoring was performed in Building 1060 in July to determine whether any vapors were being forced into Building 1060, a currently occupied building. The results indicate that no further air monitoring is required.

ACRONYMS

ADEC
Alaska Department of Environmental Conservation

CLOSES
Cleanup Operation Systems Site Exit Strategy

EPA
U.S. Environmental Protection Agency

ESD
Explanation of Significant Differences

MP
Milepost

OU
Operable Unit

ROLF
Railcar off-loading facility

The Army completed the Chena River Aquatic Assessment Program sampling to determine whether any detrimental effects have occurred to the river from contamination that has migrated from off-post areas. The goal of the program is to show that the integrity of the river in the OU5 area is improving due to the presence of the remediation systems. Sediment and water samples were collected in the area of the air sparge curtain.

The Army is reviewing the Final Interim Remedial Action Plan prepared by a consultant.

The Superfund Process

The Superfund process timetable shown below reflects the advancement of the different Operable Units through the Comprehensive Environmental Restoration, Comprehension, and Liability Act (CERCLA) activities within the Fort Wainwright Environmental Restoration Program. Activities leading up to the Record of Decision (ROD) activities for each Operable Unit have been completed and have moved beyond the ROD milestone within the Remedial Design (RD) and Remedial Action (RA) phases, with the exception of Operable Unit 3, which was amended after the ROD was signed. Therefore, the compressed, shaded milestones indicate the pre-ROD activities and the RD/RA phases of the process are expanded.

OU	NPL	RI	FS	PP	Public Comment	ROD	RD Detailed applications will be developed for the selected remedy.	RA A qualified contractor will be selected to begin the cleanup according to applications.	RA – Construction The final remedy is being put in place, and construction and testing are complete.	RA – Operations The remedy is in place and operating to achieve cleanup objectives identified in the ROD.	RC The remedy is in place and RA – Operations are completed.
1											
2											
3											
4											
5											

Notes:

Community relations activities take place throughout the CERCLA process, and cleanup actions take place when necessary.

Indicates status of OU within the Superfund or CERCLA process.

Key:

FS = Feasibility Study
OU = Operable Unit
RA = Remedial Action
RD = Remedial Design
ROD = Record of Decision
NPL = National Priority List
PP = Proposed Plan
RC = Response Complete
RI = Remedial Investigation

FOR MORE INFORMATION

Copies of site documents, fact sheets, and other supporting reports are available for public review at the following locations:

Noel Wien Library
1215 Cowles Street
Fairbanks, AK 99701
(907) 459-1020

Fort Wainwright Post Library
Building 3700
Fort Wainwright, AK 99703
(907) 353-2642

Directorate of Public Works
Building 3023
Fort Wainwright, AK 99703
(907) 353-9686

What We Do Between RAB Meetings

Happy New (Fiscal) Year! Once again we found ourselves on September 30 working feverishly to make sure fiscal year funds were fully expended; I do believe that, once again, we were successful!

While preparing for our year end, we were also diligently updating our Defense Sites Environmental Restoration Tracking Systems database and estimating funding requirements for fiscal year 2003 (which started October 1). Fort Wainwright is projected to receive approximately $4,500,000 this year. This amount allows us to continue full operation and monitoring of all sites and allows for some repairs and upgrades of systems and monitoring wells.

The Army also "transformed" as of October 1, seemingly a transparent change. As with most large businesses, the Army has changed to be come more effective and efficient in both defense and operating procedures. You might be wondering how this affects the restoration program. . . we are still learning. Our method of receiving funds has changed somewhat, and we are still in the process of learning the procedures and meeting the new individuals on our team beyond the Alaska borders.

During the past quarter, we also completed the Chena River Aquatic Assessment Program sampling (see Operable Unit 5 Update on page 5), which included for yours truly a visit to the river during the sediment sampling. Such site visits are always interesting and informative.

We also continued reviewing reports, gathering data, negotiating with regulators, and assembling data to better understand our progress toward Fort Wainwright cleanup goals. We also (finally) completed the Operable Unit 3 Explanation of Significant Differences, which will be made available at the information repositories during the next month.

The biggest accomplishment of the quarter was Fort Wainwright achieving "Construction Complete," installation-wide, by the Environmental Protection Agency. This nationally significant milestone puts Fort Wainwright as a front-runner in the Army. We certainly appreciate everyone who helped us achieve this goal!

See you next quarter. As always, please call or e-mail if you have any questions or concerns.

Thanks!

Therese Deardorff

MAILING LIST COUPON

If you received this newsletter by mail, you are already on the mailing list and may use this coupon to remove your name from the mailing list or change your name or address if the mailing label is incorrect. If you did not receive this newsletter by mail, you may use this coupon to add your name to the mailing list. Please mail a completed coupon to:

Therese Deardorff
Fort Wainwright Project Manager
U.S. Army, Alaska
Attention: APVR-RPW-EV
730 Quartermaster Road #6500
Fort Richardson, Alaska 99505

Name: _____

Organization: _____

Address: _____

City: _____

Telephone Number: _____

Please Check One:

___Please correct my address ___Add my name to the mailing list ___Remove my name from the mailing list

You can also e-mail your request to: therese.deardorff@richardson.army.mil

U.S. Army Alaska
Attn: APVR-WPW-EV
1060 Gaffney Blvd. #6505
Fort Wainwright, Alaska 99603-6506
Attn: Therese Deardorff

APPENDIX G

PUBLIC MEETING LOCATIONS

PUBLIC MEETING LOCATIONS

Informational and Proposed Plan Meetings were held at:

Carlson Center
2010 Second Avenue
Fairbanks, Alaska 99701
(907) 451-7800
Contact: Angie Spear, Marketing Coordinator

Notes: The North Star Room holds 100; the Pioneer Room holds 100-200; the Prow Room holds 50-100. Access to the North Star Room requires walking through the Pioneer Room. There is a room fee and deposit required. Lots of parking.

Noel Wien Library
1215 Cowles Street
Fairbanks, Alaska 99701
(907) 459-1020
Contact: Varies

Notes: The conference room holds 30; the auditorium holds 100. No charge for room use. Schedule room as far in advance as possible, as rooms are popular. If meetings run past library closing time, responsible for security guard hire.

Restoration Advisory Board Meetings have been held at the Noel Wien Library and in on-post conference rooms.

APPENDIX H

TECHNICAL ASSISTANCE FOR PUBLIC PARTICIPATION

Technical Assistance for Public Participation

DoD Environmental Restoration Program

A Department of Defense Program to provide technical support to community members of Restoration Advisory Boards and Technical Review Committees.

RAB/TRC Community Member Responsibilities Under the TAPP Program

Below is a simple overview of the process by which the community members of the RAB or TRC may obtain technical assistance. The DoD RAB and TRC members are available to assist community members in applying for TAPP.

Define a proposed project
Evaluate alternative sources of assistance
Prepare and submit TAPP request
Evaluate DoD's proposed provider
Obtain assistance via DoD purchase order
Prepare and submit closeout report

The Basics of the Technical Assistance for Public Participation Program

The Department of Defense (DoD) established the Technical Assistance for Public Participation (TAPP) program to assist

Who qualifies for technical assistance?

Community members of RABs and TRCs are eligible to apply for technical assistance under the TAPP program. A minimum of three community members must sit on the RAB or TRC to qualify. A majority of members in good standing must agree on the type of assistance that would most enhance their ability to participate effectively in the restoration program.

How much funding is available for TAPP?

Communities may obtain up to $25,000 per year or one percent of the total cost of completing environmental restoration at the installation, whichever is less. There is a limit of $100,000 per installation.

How does the TAPP process begin?

The process begins with the community members of the RAB

community members of Restoration Advisory Boards (RABs) and Technical Review Committees (TRCs) in participating more fully in the cleanup process affecting DoD installations and formerly used defense sites (FUDS). TAPP allows community members to obtain objective, independent scientific and engineering support concerning the restoration process through the issuance of government purchase orders to small businesses.

RABs and TRCs are forums for representatives of the installation, regulatory agencies, and community to discuss and exchange information.

What kinds of projects qualify for technical assistance?

TAPP procurements are intended to increase the ability of RAB or TRC community members to participate more effectively in the restoration program by enhancing their understanding of technical details. Typical projects might encompass:

- Review of restoration documents
- Review of proposed remedial technologies
- Interpreting health and environmental effects
- Participating in relative risk evaluations
- Certain types of technical training

Are there projects that are not eligible for funding?

Certain projects do not qualify for funding under the TAPP program. Examples include:

- The generation of new primary data
- Litigation or underwriting legal actions
- Reopening final DoD decisions
- Political activity or lobbying
- Epidemiological or health studies
- Community Outreach efforts

or TRC reaching an agreement on a TAPP project. The DoD RAB Co-Chair will be available to assist the community members should the need arise. The steps for requesting TAPP are:

1. Complete the application. Specify the type of assistance required, identify potential provider(s) and certify that alternative sources do not exist.

2. Submit the application to the DoD Co-Chair who will forward it to the Installation Commander for review and approval. The application will then be sent to the contract office to initiate a purchase order.

3. Respond to contracting office inquiries should they identify an assistance provider different from the one suggested by the community.

For more information and an application form, contact your installation RAB Co-Chair.

Technical Assistance for Public Participation

Technical Assistance for Public Participation is a new Department of Defense (DoD) program that provides a mechanism for community members of Restoration Advisory Boards (RABs) and Technical Review Committees (TRCs) to obtain technical assistance to help them understand and provide input into DoD's environmental restoration program.

The Department of Defense provides Technical Assistance to help TRCs and RABs better understand the scientific and engineering issues underlying an installation's environmental restoration activities.

Status

A final rule was published on February 2, 1998. During 1997, in preparation for the rule's publication, DoD trained over 100 of its employees from around the country in the TAPP process. RABs may now request this TAPP training through their DoD RAB Co-Chair.

How Does TAPP Work?

The community members of RABs or TRCs decide on a task that will help them participate more effectively in the environmental restoration program at an installation and apply for assistance through the DoD Co-Chair.

DoD takes care of the administrative end -- preparing a Statement of Work and procuring a technical assistance provider.

TAPP at a Glance

- Community members design project and aide in selection of provider.
- Government purchase orders procure technical assistance.
- Maximum of $25,000/year, or 1% of the total restoration cost, whichever is less. There is a limit, over the life of the restoration efforts, of $100,000.

The community members of the RAB or TRC may be called upon to support the procurement process by reviewing and providing comment on potential providers should more than one meet the established criteria. Because the TAPP program takes advantage of an accelerated procurement procedure using purchase orders, support should be available within a very short time of establishing the need.

What TAPP is...	What TAPP is not...
A way for the government to obtain alternative support for those RABs and TRCs that desire technical assistance. A means for RABs and TRCs to better understand the installation's environmental cleanup process. A government program using purchase orders to obtain support for community members of RABs or TRCs.	A requirement for RABs or TRCs to abandon existing working relationships or methods of obtaining meaningful technical support. A grant to RABs or TRCs, nor a blank check to use at their discretion. A means for RABs or TRCs to perform sampling or other functions which should be carried out by the installation.

Eligible Projects	Ineligible Projects
• Review of restoration documents • Review of proposed remedial technologies • Interpreting health & environmental effects • Participating in relative risk evaluations • Certain types of technical training	• Generation of new primary data • Reopening final DoD decisions • Epidemiological or health studies, such as blood or urine tests • Litigation or underwriting legal actions • Community outreach efforts • Political activity or lobbying

How Can You Get Involved in a RAB?

Most installations that have cleanup programs also have established RABs. This is especially true at closing installations. For more information about forming or participating in a RAB, please contact the Public Affairs Office at your local installation or consult the Directory of Restoration Advisory Boards, available on the World Wide Web at:

Policies and Documents

APPENDIX I

TECHNICAL ASSISTANCE GRANT PROGRAM INFORMATION

Superfund Technical Assistance Grants

Quick Reference Fact Sheet

What is the Technical Assistance Grant Program?

Background of the Program: In 1980, the Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA)—otherwise known as "Superfund"—established a trust fund for the cleanup of hazardous waste sites in the United States. CERCLA was modified and extended when Congress passed the Superfund Amendments and Reauthorization Act of 1986 (SARA). The Environmental Protection Agency (EPA) is responsible for administering the Superfund Program.

An important aspect of the Superfund program is citizen involvement at the local level in decision-making that relates to site-specific cleanup actions. For this reason, community outreach activities are underway at each of the approximately 1,200 sites that are presently on the National Priorities List (NPL). The NPL is EPA's published list of the most serious hazardous waste sites nationwide that have been identified as potential threats to the environment.

Recognizing the importance of community involvement and the need for citizens living near NPL sites to be well informed, Congress included provisions in SARA to establish a Technical Assistance Grant (TAG) Program, intended to promote public involvement in decisions on site-specific cleanup strategies under Superfund.

Decisions concerning cleanup activities at NPL sites should be based on a range of technical considerations. These might include:

- Studies of site conditions.
- The nature of the wastes involved.
- The technologies available for performing the necessary cleanup actions.

The TAG Program provides funds for qualified citizen's groups affected by a Superfund site to hire independent technical advisors to help them understand and comment on site-related information, and thus participate in cleanup decisions.

Since the first TAG was awarded in 1988, more than $6 million has been awarded directly to grassroots groups.

Basic Provisions of the TAG Program:

- Grants of up to $50,000 are available to community groups for the purpose of hiring a technical advisor to interpret site-related technical information. Additional funding may be available for unusually large or complex sites.
- The group is required to contribute matching funds, whether in cash or donated services or supplies, equal to 20 percent of the total project costs.
- The group must state what it intends to do with TAG funds.

- Only one TAG is available for each NPL site.

Uses of Technical Assistance Grants

Citizen groups may use grant funds to hire technical advisors to help them understand existing information about the site or information developed during the Superfund cleanup process.

You can use TAG funds to pay a technical advisor to:

- Review site-related documents, whether produced by EPA or others.
- Meet with the TAG group to explain technical information.
- Provide assistance in communicating the group's site-related concerns.
- Interpret technical information for the community.
- Participate in site visits, when possible, to gain a better understanding of cleanup activities.
- Travel to meetings and hearings related to the situation at the site.

You can also use TAG funds to hire someone to administer the grant (See "Managing Your Grant").

You **cannot** use TAG funds to develop new information (for example, to conduct additional sampling) or to support legal actions in any way, including the preparation of testimony or the hiring of expert witnesses.

Who May Apply For A Grant?

Eligible groups are made up of people whose health, economic well-being, or enjoyment of the environment are potentially threatened.

Any group applying for a TAG must be nonprofit and incorporated (formed a legal corporation) or working toward incorporation under applicable state laws. Applications are encouraged from:

- Groups that have a genuine interest in learning more about the technical aspects of a nearby Superfund site.
- Groups committed to sharing site information with the entire affected community.

For example, such groups could be:

- Community groups formed to address site-related issues.
- Existing citizens' associations.
- Environmental or health advocacy groups that have been active at the site.
- Coalitions of such groups formed to deal with community concerns about the Superfund site and its impact on the surrounding area.

Groups that are **not** eligible for grant funds are:

- Potentially responsible parties—individuals, municipalities, or companies (such as facility owners or operators, or transporters or generators of hazardous waste) potentially responsible for, or contributing to, the contamination problems at a Superfund site.
- Academic institutions.
- Political subdivisions.
- Groups, such as counties or cities, established or supported by government.

How To Apply For A Grant

Requirements and Evaluation Criteria: When applying for a TAG, your group must provide information to EPA (or to your state, if it is administering the TAG Program) to determine if your group meets specific administrative and management requirements. As part of the standard application, your group also must include a description of its history, goals, and plans for the technical assistance funds.

In general, your group must demonstrate that it is aware of the time commitment, resources, and dedication needed to successfully manage a TAG. Factors particularly important in evaluating an application include:

- Your ability to manage the grant in compliance with EPA rules.
- The degree to which the members' health, economic well-being, and enjoyment of the environment are potentially threatened by a hazardous waste site.
- Your commitment and ability to share the information provided by the technical advisor with others in the community.
- The degree to which your group represents individuals in the community.

The Application Process: EPA may award only one TAG per Superfund site. To make sure that all eligible groups have an equal opportunity to compete for a single TAG, EPA has an application process that includes the following steps:

- Send EPA a letter stating your desire to apply and naming the site(s) involved. If work at the site is underway or scheduled to begin, EPA will send you the *Superfund TAG Handbook: Applying for a Grant* and the *Superfund TAG Handbook: The Application Forms with Instructions* and inform others in the community that a group is interested in applying for a TAG.
- Other interested parties then have 30 days to contact the original applicant to form a coalition and submit one application.
- If groups are unable to form a coalition, EPA will accept separate applications from all groups for an additional 30-day period.
- EPA then may award a grant to the group that best meets the evaluation criteria.

At unusually large or complex sites, more than $50,000 in funding may be necessary to enable citizens to participate effectively in decisions related to site activities. In such cases, TAG recipients may request additional funding.

Choosing A Technical Advisor

When choosing a technical advisor after a TAG is awarded, you should consider the kind of technical advice your group needs most and whether a prospective advisor has the variety of skills necessary to provide all of the advice needed. A technical advisor must have:

- Knowledge of hazardous or toxic waste issues and experience working on hazardous or toxic waste problems.
- Academic training in relevant scientific and technical fields.
- The ability to translate technical information into terms understandable to lay persons.
- Experience in making technical presentations and working with community groups.
- Good communication skills.

You may use your TAG funds to hire more than one technical advisor if your group wants a combination of skills at a particular site. For example, a group may be unable to find a single advisor experienced in both hydrology and epidemiology, two of the skills most needed at its site. Another approach would be to hire a consulting firm that has experience in all needed areas. The*Superfund TAG Handbook: Procurement—Using TAG Funds* details the process of hiring a technical advisor and identifies related issues that citizens' groups may wish to consider.

Managing Your Grant

You must routinely keep track of how you spend TAG funds. In general, you must:

- Establish an accounting system and keep appropriate records.
- Submit reimbursement forms to EPA for the money to pay the technical advisor (each form must show that the group met the required 20 percent contribution).
- Prepare and submit quarterly progress reports to EPA.

TAG funds may be used to hire someone with the appropriate skills to administer the grant. However, to ensure that TAG funds are used primarily for the interpretation and communication of site-related technical data, these costs may not exceed 20 percent of the total TAG project costs.

Additional Information

Your EPA Regional Office is ready to answer any questions that you may have. For further information, please contact your EPA Regional Office. Copies of the four booklets that together make up the *Superfund Technical Assistance Grant Handbook* are available free of charge by contacting the EPA Regional Office for your state. The volume entitled *Superfund Technical Assistance Grant (TAG) Handbook: The Application Forms With Instructions* contains sample forms and instructions to assist you in preparing a TAG application.

EPA Superfund Offices

EPA Headquarters
Office of Emergency and Remedial Response (5203G)
401 M Street, SW
Washington, DC 20460

EPA Region 1
One Congress Street
Boston, MA 02114-2023
(617) 918-1200

Connecticut, Maine, Massachusetts, New Hampshire, Rhode Island, Vermont

EPA Region 2
290 Broadway
New York, NY 10007-1866
(212) 637-4392

New Jersey, New York, Puerto Rico, Virgin Islands

EPA Region 3
1650 Arch Street
Philadelphia, PA 19103-2029
(215) 814-5522

Delaware, District of Columbia, Maryland, Pennsylvania, Virginia, West Virginia

EPA Region 4
61 Forsyth Street
Atlanta, GA 30303
(404) 562-8651

Alabama, Florida, Georgia, Kentucky, Mississippi, North Carolina, South Carolina, Tennessee

EPA Region 6
1445 Ross Avenue, Suite 1200
Dallas, TX 75202-2733
(214) 665-6701

Arkansas, Louisiana, New Mexico, Oklahoma, Texas

EPA Region 7
901 N. Fifth Street
Kansas City, KS 66101
(913) 551-7003

Iowa, Kansas, Missouri, Nebraska

EPA Region 8
999 18th Street, Suite 500
Denver, CO 80202
1-800-227-8917

Colorado, Montana, North Dakota, South Dakota, Utah, Wyoming

EPA Region 9
75 Hawthorne Street
San Francisco, CA 94105
(415) 744-1730

Arizona, California, Guam, Hawaii, Nevada, American Samoa

EPA Region 10
1200 Sixth Avenue
Seattle, WA 98101
(206) 553-1261

Idaho, Oregon, Washington, Alaska

EPA Region 5
77 West Jackson Boulevard
Chicago, IL 60604-3507
1-800-621-8431

Illinois, Indiana, Michigan, Minnesota, Ohio, Wisconsin

Superfund/RCRA Hotline
1-800-424-9346
or (703) 920-9810 in the Washington, DC, metropolitan area (for information on programs)

National Response Center
1-800-424-8802 (to report releases of oil and hazardous substances

Contacts

For more information on the TAG program, contact the TAG coordinator for your region.

Region 1
Mike McGagh
U.S. EPA Region 1
One Congress Street
Boston, MA 02114-2023
617-918-1428

Region 2
Carol Hemington
U.S. EPA Region 2
290 Broadway
New York, NY 10007-1866
212-637-3420

Region 3
Amelia Libertz
U. S. EPA Region 3
1650 Arch Street
Philadelphia, PA 19103-2029
215-814-5522

Region 4
Rosemary Patton, Sharon Chandler, Rhonda Newberry, Denise Bland
U.S. EPA Region 4
Atlanta Federal Center
61 Forsyth Street
Atlanta, GA 30303
404-562-8866 (Rosemary)
404-562-8888 (Sharon)
404-562-8867 (Rhonda)
404-562-8880 (Denise)
Dorothy Dimsdale (Grants)
404-562-8398

Region 7
Hattie Thomas
U.S. EPA Region 7
901 North Fifth Street
Kansas City, KS 66101
913-551-7762

Region 8
Linda Armer, Peggy Crandall
U.S. EPA Region 8
999 18th Street, Suite 500
Denver, CO 80202-2466
303-312-6696 (Linda) 303-312-6699 (Peggy)

Region 8
Pam Hillery
U.S. EPA Montana Operations Office
301 South Park, Drawer 10096
Helena, MT 59626-0096
406-441-1159

Region 9
David Cooper
U.S. EPA Region IX
75 Hawthorne Street
San Francisco, CA 94105
415-744-2179

Region 5
Susan Pastor, Suzanne Coll, Denise Gawlinski
U.S. EPA Region 5
Metcalfe Federal Bldg
77 W. Jackson Blvd
Chicago, IL 60604
312-353-1325 (Susan)
312-886-6044 (Suzanne)
312-886-9859 (Denise)

Region 6
Beverly Negri, Zana Halliday
U.S. EPA Region 6
Tower at Fountain Place
1445 Ross Ave., Suite 1200
Dallas, TX 75202
214-665-8157 (Beverly)
214-665-8363 (Zana)

Region 10
Jeanne O'Dell
U.S. EPA Region 10
1200 6th Ave.
Seattle, WA 98101
206-553-6919
Debbie Larsen (Grants)
206-553-6701

Headquarters
Lois Gartner
National TAG Coordinator
U.S. EPA OERR
401 M Street, SW. Washington, DC 20460
703-603-8889

EPA United States Environmental Protection Agency

TAG Superfund

Frequently Asked Questions

What is a Technical Assistance Grant?

A Technical Assistance Grant (TAG) provides money for activities that help your community participate in decision making at eligible Superfund sites. An initial grant up to $50,000 is available for any Superfund site that is on the EPA's National Priorities List (NPL), proposed for listing on the NPL and a response action has begun. EPA's NPL is a list of the most hazardous waste sites nationwide.

Who is Eligible?

Q. Is my group eligible for a TAG?

A. You are eligible if (1) you live near one of the 1,200 sites on the National Priorities List (NPL); (2) you may be affected by a release or threatened release at any facility listed on the NPL, or proposed for listing on the NPL; (3) the response action at the site is underway; and (4) your group demonstrates you have or will have reliable procedures for record keeping and financial accountability relating to managing your TAG.

Q. What types of groups aren't eligible?

A. You are not eligible if (1) your group is a potentially responsible party (PRP) or receives money or services from a PRP or represents a PRP; (2) your group is not incorporated for the specific purpose of representing affected people; (3) your group is an academic institution; and (4) your group is a political subdivision (example: township or municipality).

How Many TAGs are Awarded at a Site?

Only one TAG may be awarded for any site. However, when the grant recipient changes (for example, EPA terminates the original TAG for non-performance, fraud or conflict of interest or the recipient terminates the original TAG), the process for applying for a TAG starts over with interested applicants writing a Letter of Intent to the Agency expressing interest in a TAG.

What Can TAGs Pay For?

Q. How can we spend TAG money?

A. The bulk of the TAG funds are used to hire an independent technical advisor (TA) to help you interpret and comment on site-related decisions. Examples of how a technical advisor can help your

group include (1) reviewing preliminary site assessment/site investigation data; (2) participating in public meetings to help clarify information about site conditions; and (3) visiting the site vicinity periodically during cleanup to observe progress and provide technical updates to your group.

The group can also use a TAG to hire a grant administrator to help you manage and administer the grant. TAG funds can also be used to purchase or rent office supplies and to print newsletters or fact sheets to disseminate information about your site. The goals of these and other eligible TAG activities is to help improve your community's understanding of environmental conditions and cleanup activities at Superfund sites.

Q. Are there things we cannot spend TAG money for?

A. Your TAG funds cannot be used for: (1) lawsuits or other legal actions such as paying for attorney fees for advice tied to any kind of legal action; (2) political activity and lobbying; (3) activities such as amusement, social activities, ceremonials and costs associated with these activities such as meals, lodging, rentals, transportation and tips; (4) group members' tuition and travel; (5) generation of new primary data such as well drilling and testing, and sampling; (5) reopening final EPA decisions such as the record of Decision; (6) resolving disputes with EPA; (7) epidemiological or health studies, such as urine or blood testing.

How Do We Get the Money?

Q. Do we get a lump sum up front?

A. EPA pays your group by reimbursing you for costs that are grant related or identified in your budget as needed to meet the overall objectives of your project. You will be reimbursed up to the amount of the TAG.

Q. Can we incur any costs prior to the award of our grant?

A. Your group may incur costs associated with incorporation prior to your grant's award. However, if the Agency does not award your group with a grant, your group will not be reimbursed for the costs of incorporation.

How To Apply for a TAG

Q. What is the first step for getting a TAG?

A. The first step for getting a TAG is to let EPA know of your group's interest in getting a TAG. Your group should first submit a Letter of Intent (LOI) to the EPA Regional Office within your area. The Letter of Intent should clearly state your group intends to apply for a TAG, and should identify the name of your group, the Superfund site for which your group would like to apply and provide the name of a

contact person in the group and his/her phone number.

Q. What does EPA do once it receives our Letter of Intent?

A. If your site is on the NPL, proposed for the NPL and a response action is underway, EPA will post a public notice notifying other interested parties that a TAG for the site may soon be awarded. An ad in a local newspaper announcing that EPA has received a LOI is usually how the Agency makes public notice of grant availability.

Q. What if more than one group wants to apply for a TAG?

A. If your group is the first to send EPA a LOI, other interested groups will have 30 days to contact your group to form a coalition. If the groups cannot form a coalition, EPA will accept separate grant applications from all interested groups for an additional 30 day period.

Q. What do we do next?

A. The next step is to determine whether your state requires review of your grant application so that your Governor can stay informed about he kinds of grants awarded within the state. The EPA Regional Office can provide the group with the contact for your state's intergovernmental review process.

Q. What has to be submitted?

A. The last step is to prepare your TAG application (Application for Federal Assistance) which includes: (1) a budget, which must clearly show how you will spend the money; and (2) a scope of work, which must clearly explain how your group will organize, will share information with affected community, will explain your project's milestone and and a schedule for meeting those milestones, and how the Board of Directors, technical advisor(s) and project manager will interact with each other.

Managing Your TAG

Q. What types of reports are required?

There are several types of reports the group will need to complete during the life of the grant: (a) Minority Owned Business Enterprise/Women Owned Business Enterprise (MBE/WBE) utilization, (b) progress reports, (c) financial status reports and (d) a final report.

Reimbursement checks will be made out to the group; therefore, the group should open a bank account in the name of the group.

(a) Quarterly, even if no contracts have been assigned, groups will need to provide information on WBE/MBE utilization. If contracts were made, the value of the contract and the percentage of project dollars on MBE/WBE will need to be reported.

(b) Progress reports are required to provide a description of the progress your group made in relation to the approved schedule, the TAG project milestones and special problems your group may have encountered.

(c) Financial Status reports are required to provide a status of project funds through identification of project transactions.

(d) Final report will include a description of project goals and objectives, activities undertaken to achieve goals and objectives, difficulties encountered, technical advisor's work products and funds spent.

Q. Are there other financial or record-keeping requirements?

In additional to the report requirements, you must keep TAG records for ten years from the date of the final Financial Status report. After ten years, you may dispose of your TAG records if you get written approval from EPA. You must send EPA a copy of each final written product your technical advisor prepares for you as part of your TAG.

Procuring a Technical Advisor

Q. What should we look for in a technical advisor?

The group must provide an opportunity for all qualified contractors to compete for the work. Before considering any technical advisor (TA), the group must make sure the advisor is not on the "list of parties excluded from Federal procurement". The EPA Regional Office can help the group make this determination.

Procure a TA that has (1) knowledge of hazardous or toxic waste issues, (2) academic training in a relevant field (e.g., biochemistry, toxicology, environmental sciences, engineering), (3) ability to translate technical information into terms the group and community can understand and (4) experience working on hazardous or toxic waste programs and communicating those problems to the public.