Final

Feasibility Study
Former Communications Site
Fort Wainwright, Alaska

Prepared for

U.S. Army Garrison,
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Acronyms and Abbreviations

µg/L	microgram(s) per liter
µg/m^3	microgram(s) per cubic meter
AAC	Alaska Administrative Code
ADEC	Alaska Department of Environmental Conservation
ARAR	applicable or relevant and appropriate requirement
Army	U.S. Army
ASTM	American Society for Testing and Materials
ATSDR	Agency for Toxic Substances and Disease Registry
bgs	below ground surface
CERCLA	Comprehensive Environmental Response, Compensation, and Liability Act of 1980
CFR	Code of Federal Regulations
cm/s	centimeter(s) per second
COC	contaminant of concern
COI	contaminant of interest
COPEC	contaminant of potential ecological concern
DCE	dichloroethene
DDD	dichlorodiphenyldichloroethane
DDE	dichlorodiphenyldichloroethene
DDT	dichlorodiphenyltrichloroethane
DMM	discarded military munitions
DNAPL	dense nonaqueous phase liquid
DOD	U.S. Department of Defense
DPW	Directorate of Public Works
DRO	diesel-range organics
ELCR	excess lifetime cancer risk
EOD	explosive ordnance disposal

EPA	U.S. Environmental Protection Agency
ERA	ecological risk assessment
EZ	exclusion zone
FCS	Former Communications Site
FFA	Federal Facilities Agreement
FNSB	Fairbanks North Star Borough
FS	feasibility study
ft^2	square feet
GAC	granular activated carbon
gpm	gallon(s) per minute
GRO	gasoline-range organics
GW	groundwater
HHRA	human health risk assessment
HI	hazard index
IDW	investigation-derived waste
ISCO	in situ chemical oxidation
MD	munitions debris
MDL	method detection limit
mg/kg	milligram(s) per kilogram
MNA	monitored natural attenuation
mV	millivolt(s)
NCP	National Contingency Plan
O&M	operations and maintenance
Oasis	Oasis Environmental, Inc.
ORP	oxidation-reduction potential
PAH	polycyclic aromatic hydrocarbon
PCA	tetrachloroethane
PCB	polychlorinated biphenyl
PCE	tetrachloroethene
PCG	preliminary cleanup goal

PID	photoionization detector
POL	petroleum, oil, and lubricants
ppm	part(s) per million
PRB	permeable reactive barrier
PSE	Preliminary Source Evaluation
PSL	project screening level
PV_{30}	present value (30 years)
RAO	remedial action objective
RCRA	Resource Conservation and Recovery Act of 1976
RDX	hexahydro-1,3,5-trinitro-1,3,5-triazine
RI	remedial investigation
ROD	record of decision
RRO	residual-range organics
RSL	regional screening level
SARA	Superfund Amendments and Reauthorization Act of 1986
SAS	School Aged Services
SG	soil gas
SVE	soil vapor extraction
SVOC	semivolatile organic compound
TBC	to be considered requirement
TCA	trichloroethane
TCE	trichloroethene
TDS	total dissolved solids
TPH	total petroleum hydrocarbon
TSCA	Toxic Substances Control Act
USACE	U.S. Army Corps of Engineers
VIP	vapor intrusion pathway
VOC	volatile organic compound
yd^3	cubic yard(s)

SECTION 1

Introduction

This Feasibility Study (FS) report has been prepared to support the pending Record of Decision (ROD) for the Fort Wainwright 102 Former Communications Site (FCS), also known as the Taku Gardens family housing development, on Fort Wainwright, Alaska. This FS report was prepared by CH2M HILL for the U.S. Army Garrison, Fort Wainwright, Alaska, under contract to the Alaska District of the U.S. Army Corps of Engineers (USACE) (Task Order 13 of Contract No. W911KB-05-D-0010). The U.S. Army (Army) is conducting this FS under the authority of the Comprehensive Environmental Response, Compensation, and Liability Act of 1980 (CERCLA), as amended by the Superfund Amendments and Reauthorization Act of 1986 (SARA).

Fort Wainwright is within the Fairbanks North Star Borough (FNSB) in central Alaska and covers approximately 918,000 acres on the eastern and southern sides of the City of Fairbanks (Figure 1-1). Fort Wainwright is a federally owned facility managed by the U.S. Army Garrison, Fort Wainwright, an installation-level command overseen by its higher headquarters, the U.S. Army Installation Management Command-Pacific. The FCS is located in the western-central portion of Fort Wainwright (Figure 1-2) and has a history of mixed uses, including barracks and company headquarters, communication and radar systems, salvage/reclamation yard activities, debris disposal, garden plots, possible ammunition storage, and firefighter training.[1] The FCS currently consists of the nearly completed Taku Gardens family housing development, which covers approximately 54 acres (Figure 1-2). Environmental contamination and buried debris containing munitions-related items discovered during the course of Taku Gardens family housing construction have impacted soil and groundwater at the site. The 110 housing units (55 buildings)[2] have been constructed, but will not be released for occupancy until the Army, Alaska Department of Environmental Conservation (ADEC), and U.S. Environmental Protection Agency (EPA) agree that the area is safe for residential occupation.

In December 2010, the Army issued the *Final Remedial Investigation, FWA 102 Former Communications Site, Fort Wainwright, Alaska* (Remedial Investigation [RI] report) (CH2M HILL, 2010), which documented the results of data collection efforts conducted to characterize site conditions, determine the nature and extent of contamination, and support informed risk-management decisions regarding potential risks to human health and the environment. The RI report and this FS report were developed according to the EPA guidance document, *Guidance for Conducting Remedial Investigations and Feasibility Studies Under CERCLA* (EPA, 1988).

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[1] A limited number of 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 military operations concurrent with similar missions conducted at other locations.

[2] This consists of Buildings 1-49 and Buildings 60-64; Buildings 50-59 were not built and are not planned to be built in the future.

The human health risk assessment (HHRA) that accompanied the RI report evaluated two exposure cases: (1) the **reasonably anticipated future use (residential) scenario** considers restrictions that preclude digging onsite and prevent use of shallow groundwater from areas outside the existing Fort Wainwright water supply wells; and (2) the **hypothetical unrestricted exposure scenario** uses conservative default assumptions regarding domestic use of shallow groundwater and direct contact with soil to 15 feet below ground surface (bgs) anywhere across the site, regardless of the existence of current or future measures precluding exposure to these media. The HHRA also included evaluation of potential exposure to recreational/site visitors, maintenance workers, and excavation workers who may use the site in the future.

The results of the HHRA under the reasonably anticipated future use scenario indicate that even if cumulative exposure occurs to the highest levels at any surface soil and subslab soil gas locations, and is combined with exposure from domestic use of Fort Wainwright-supplied water, the resulting risk estimates do not exceed the EPA and ADEC risk threshold values. The results of the HHRA under the unrestricted use scenario indicate that resulting risk estimates exceed the ADEC risk threshold. Therefore, this FS report is being prepared to conservatively evaluate alternatives for the hypothetical, unrestricted use scenario.

1.1 Purpose

The purpose of the FS is to develop and evaluate remedial alternatives that are protective of human health and the environment and comply with CERCLA. The FS is supported by information gathered during the RI and is designed to develop and evaluate remedial alternatives for soil potentially contaminated with volatile organic compounds (VOCs), semivolatile organic compounds (SVOCs), diesel-range organics (DRO), and residual-range organics (RRO), and groundwater contaminated with VOCs and DRO.

The development of the FS report and evaluation of remedial alternatives are based on the guidelines set forth in the *Guidance for Conducting Remedial Investigations and Feasibility Studies Under CERCLA* (EPA, 1988). The CERCLA Compliance Policy specifies that Superfund remedial actions must meet any federal standards, requirements, criteria, or limitations that are determined to be applicable or relevant and appropriate requirements (ARARs). State ARARs must be met as well if they are more stringent than federal requirements.

This FS report also provides information to support risk management decisions and the future selection of the most appropriate remedy. The final selection and documentation of the remedies will be presented in the ROD, currently scheduled for completion in 2012.

1.2 Report Organization

The content and format of this FS report are derived from EPA guidance (EPA, 1988). This document is organized into the following sections and appendixes:

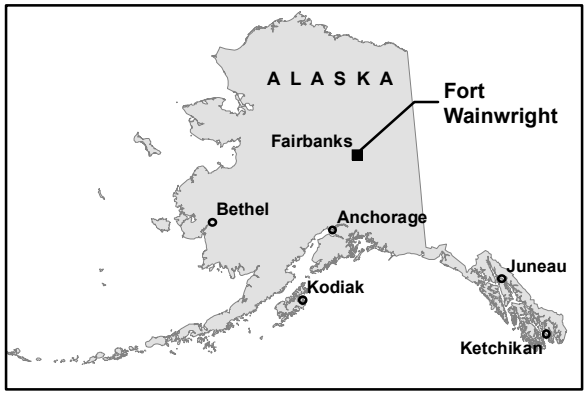
- **Section 1: Introduction.** Provides a summary of the FS process and the report organization.
- **Section 2: Site Description.** Provides historical background information for the FCS, investigation results and removal actions, the nature and extent of contaminated media,

risks to human health and the environment, and the rationale for the selected media of concern.

- **Section 3: Remedial Action Objectives and Preliminary Cleanup Goals.** Presents remedial action objectives (RAOs) and cleanup goals.
- **Section 4: Identification and Screening of Remedial Technologies.** Identifies general response actions, remedial technologies, and process options; and screens the remedial technologies and process options for effectiveness, implementability, and cost.
- **Section 5: Assembly and Screening of Alternatives.** Develops the remedial alternatives by combining remedial technologies and process options.
- **Section 6: Detailed Analysis of Alternatives.** Provides a detailed analysis of remedial alternatives based on seven of EPA's nine criteria: overall protectiveness of human health and the environment; compliance with ARARs; long-term effectiveness and permanence; reduction in toxicity, mobility, and volume through treatment; short-term effectiveness; implementability; and cost. Compliance with the remaining two criteria, community acceptance and state acceptance, will be determined following the issuance of the final FS and a public comment period on the Proposed Plan.
- **Section 7: Comparative Analysis of Remedial Alternatives.** Provides a comparison of the relative performance of each alternative evaluated against the performance of the other alternatives for each of the seven CERCLA criteria described above. The comparative analysis identifies advantages and disadvantages of each alternative to assist in the later decision making. It also points out the similarities and differences among alternatives.
- **Section 8: Works Cited.** Lists the documents referenced in this FS report.
- **Appendix A: Analysis of Potential Applicable or Relevant and Appropriate Requirements.** Presents the analysis of ARARs.
- **Appendix B: Garrison Policy.** Contains specific information on the institutional controls to be implemented at the FCS.
- **Appendix C: Cost Estimates for Alternatives.** Describes the assumptions and calculations for the cost estimates.
- **Appendix D: Subslab Sampling Program.** Contains a preliminary version of the proposed subslab sampling program.

LEGEND

- Project Location
- Installation Boundary for Fort Wainwright
- River
- Railroad



Notes:
1. Imagery U.S. Army Corps of Engineers, May 2005.

0 0.75
Miles

N

FIGURE 1-1
Former Communications Site Location Map
Feasibility Study
Former Communications Site, Fort Wainwright, Alaska

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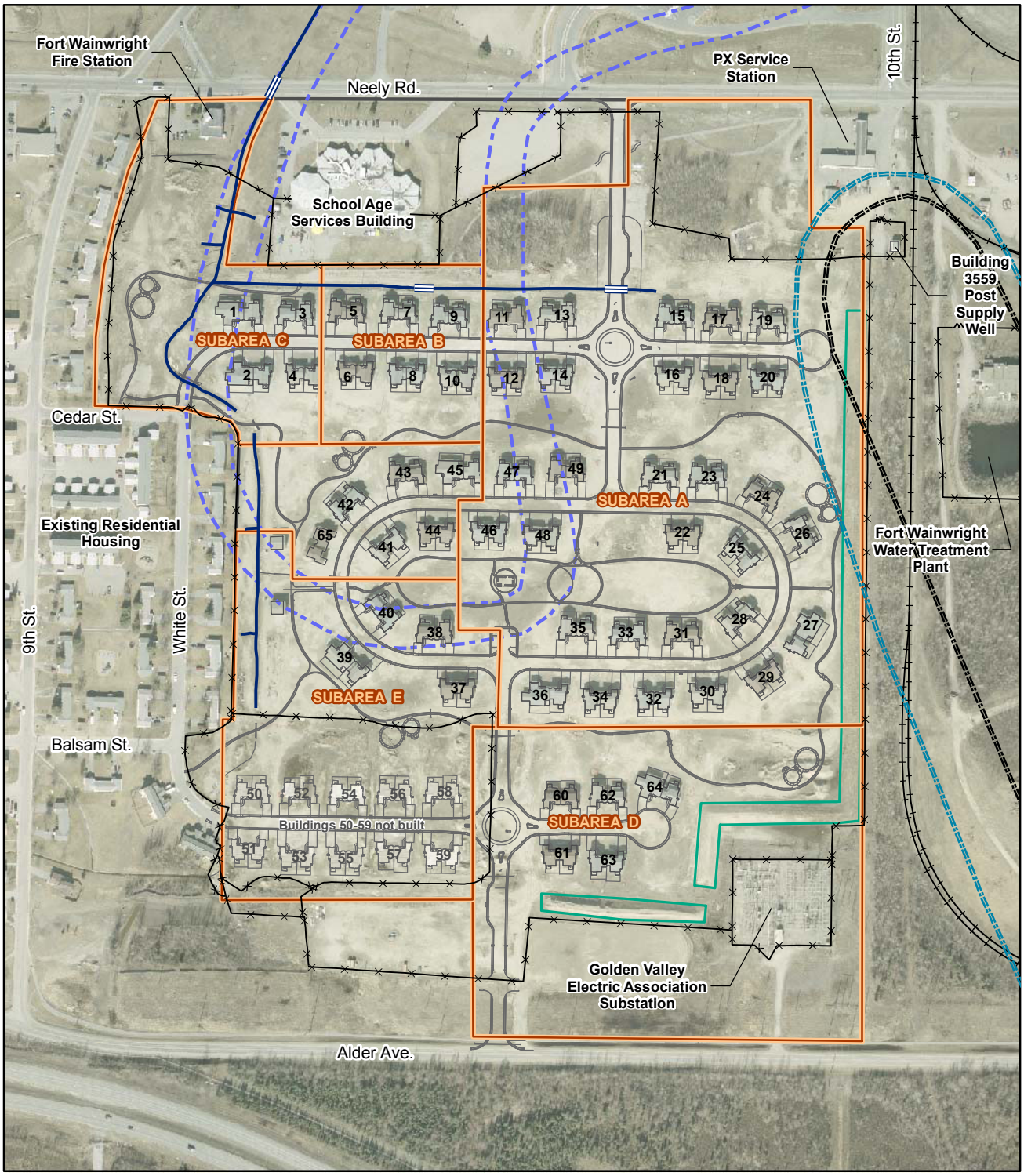
\\SIMBA\PROJ\USARMYCORPSOFENGINEE\357465TAKUGARDENS\GIS\MAPFILES\RI_2009\FIG1-1_SITELOCATION.MXD DMORIN1 4/28/2009
ES090110064115SAC Figure_1-1.ai 12.14.2010 tdaus



LEGEND

- Subarea Boundary
- Former Hoppe's Slough
- Sound Berm
- Drainage Swale
- Drainage Swale Culvert
- 1,000 gpm Pumping Rate Water Supply Capture Zone
- 1,700 gpm Pumping Rate Water Supply Capture Zone
- Security Fence
- Railroad
- Infrastructure for Taku Gardens

0 400
Feet

N

FIGURE 1-2
Taku Gardens Subdivision
Feasibility Study
Former Communications Site, Fort Wainwright, Alaska

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\\SIMBA\PROJ\USARMYCORPSOFENGINEE\357465TAKUGARDENS\GIS\MAPFILES\RI_2009\FIG1-2_TAKUGARDENS_SUBDIVISION.MXD DMORIN1 4/29/2009
ES090110064115SAC Figure_1-2.ai 04.14.2011 tdaus

SECTION 2

Site Description

This section provides a description and a brief history of Fort Wainwright and the FCS. It also includes a summary of investigations performed prior to the RI. Further details of the information contained in this section are provided in the RI report (CH2M HILL, 2010).

2.1 Site Background

2.1.1 Fort Wainwright Description and History

Fort Wainwright is within the FNSB in central Alaska and originally included 918,000 acres on the eastern and southern sides of the City of Fairbanks. Fort Wainwright has been used continuously by the U.S. Department of Defense (DOD) for military operations since 1938. Originally known as Ladd Army Airfield, the post was established for cold weather experimentation. During decades of military use at Fort Wainwright, routine operations and storage practices resulted in accidental releases of chemicals to the ground and underlying groundwater or nearby surface water. Former disposal practices were also responsible for releases to the environment. Beginning in the late 1950s, most non-hazardous waste was disposed of in the sanitary landfill located in the northern-central portion of Fort Wainwright. Naturally occurring surface depressions (such as former slough channels) were also used for disposal of construction debris and were covered with fill. Other disposal practices at Fort Wainwright included using used oil for dust control on unpaved roads and for firefighting drills; spreading coal ash on icy roads; burning used oil and other used flammable liquids for energy recovery in the power plant; and discharging or dispersing used oils, solvents, or fuel spills into floor drains in buildings across the installation (Agency for Toxic Substances and Disease Registry [ATSDR], 2003). Fort Wainwright generated hazardous waste materials in the past, including pesticides; polychlorinated biphenyls (PCBs); petroleum, oil, and lubricants (POL); and battery fluids. Such chemicals were largely associated with spent solvents and ignitable wastes from aircraft and vehicle maintenance shops, contaminated motor vehicle and aviation fuels, paint, coal fly ash, and spent non-recyclable vehicle batteries. Fort Wainwright also generated small quantities of radioactive tritium waste and low-level radioactive materials (such as radium dials) (ATSDR, 2003).

In August 1990, Fort Wainwright was placed on the CERCLA National Priorities List. Current environmental assessment and remediation activities at Fort Wainwright comply with CERCLA requirements, as amended by SARA. Activities also comply with a March 1992 Federal Facilities Agreement (FFA) among EPA, DOD, and ADEC (Army, 1992). The FFA identifies the authorities and responsibilities of the parties, and integrates CERCLA requirements with other relevant federal and state remedial programs, such as the Resource Conservation and Recovery Act of 1976 (RCRA).

2.1.2 Former Communications Site Description and History

The FCS is located in the central-western portion of Fort Wainwright. The FCS is located between Alder and Neely roads, east of White Street and west of the Fort Wainwright Power Plant. The Taku Gardens family housing development covers 54 acres of the FCS and

includes 110 new housing units (in 55 buildings). The buildings are intended for use as family housing for Fort Wainwright military personnel and their families, but are currently unoccupied. The FCS is characterized by relatively flat terrain, as is typical of the topographic area of Fort Wainwright. Topographic relief at the FCS is primarily related to the former Hoppe's Slough and several man-made features, including sound berms and drainage swales.

Hoppe's Slough, a former meander channel, or oxbow, of the Chena River, used to curve through what is now the middle of the FCS. As shown by the blue lines on Figure 1-2, the now-filled meander entered the northern portion of the FCS and continued south, approximately 1,500 feet, where it curved around along the western edge of the FCS and exited again at the north. The footprint of the slough and a second meander south of the slough were identified in historical aerial photographs from 1948 and were partially visible in the late 1960s (Oasis Environmental, Inc. [Oasis], 2007). Historical photographs document the filling of the former meander channels as the area was developed. A geophysical survey performed in May 2004 indicated that the material used to fill the slough included metallic objects (Oasis, 2007).

A sound berm was constructed as part of the original housing development plan to reduce the noise from passing trains along the eastern and southern sides of the housing area. The berm was constructed from soil generated during site-clearing and construction activities. Soil samples were collected from the berm in 2007, 2008, and 2009 to determine if contamination was present in the soil used to construct the berm. The results indicated that additional investigation was not warranted because all concentrations of contaminants from discrete samples were less than screening levels. A man-made drainage swale lies along much of the western and northern edges of the FCS. The swale carries stormwater and meltwater beyond the FCS boundary during heavy runoff periods. The sound berms and drainage swale can be seen on Figure 1-2.

The area historically defined as the FCS has a history of mixed uses, including the following:

- Barracks and company headquarters, extending into the northwestern corner of the site
- Equipment salvage and reclamation
- Debris and salvage material disposal in the Chena River oxbow that extends through the site, in trenches in the salvage yard area, and possibly in other local depressions
- Garden plots
- Concrete batch plant and railroad spur
- Communications and radar system installations
- Possible ammunition storage

Only a limited number of written records describing specific activities 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 military operations concurrent with similar missions conducted at other locations.

As shown in historical photography included in Appendix C of the RI report (CH2M HILL, 2010), a salvage yard was active in the northeastern portion of the FCS from the 1940s to 1960s. During this time, the eastern portions of Hoppe's Slough were filled, possibly with debris from the salvage yard, and accumulations of drums and debris were visible near the current locations of Buildings 11 through 19, 21 through 29, 31 through 33, 35, 47, 48, and 49 (see Figures C-1 and C-2 in the RI report [CH2M HILL, 2010]). Photographs from 1960 show stockpiles of drums, fire-training burn areas, and the remains of a wrecked U.S. Air Force aircraft in the area between the current locations of Buildings 16, 21, and 49 (see Figure C-3 in the RI report [CH2M HILL, 2010]).

During the 1950s and 1960s, a concrete batch plant and railroad spur were active in the northeastern corner of the FCS in the area between the current locations of Buildings 15, 17, and 19 and the post exchange service station (gas station) (see Figure C-2 in the RI report [CH2M HILL, 2010]). Some former salvage yard stockpiling activities also occurred in this area.

By 1956, a large, white structure was constructed and the ground surface was cleared near the planned locations for Buildings 50 through 52 for operation of communication and radar systems (Figure C-2 in the RI report [CH2M HILL, 2010]). During site investigation activities near planned Buildings 50 and 52, PCB contamination was discovered within and adjacent to the general area of past communication and radar system activities and infrastructure. Also by 1956, Company Headquarters and barracks buildings were present in the northwestern portion of the FCS. These facilities were demolished by 1960. Operations and decommissioning activities of these former buildings may explain many of the smaller buried debris and contaminant sources discovered near Buildings 1 through 4, 7, 9, 11, 12, and 45 (see Figure C-3 in the RI report [CH2M HILL, 2010]).

DRO-affected soil of unknown origin was encountered in 2005 during foundation construction activities in the vicinity of Buildings 7 through 12. The DRO was later attributed to a steel pipeline that was encountered in the area and along the western drainage swale.

In 1960, the entire eastern and southern portions of Hoppe's Slough appear to have been filled. The drum and debris investigations conducted near Building 48 during 2007 and 2008 were focused on the southeastern bend of the former slough channel, which was filled during this timeframe. By 1967, the entire FCS was clear of structures, except for the School Aged Services (SAS) building (see Figure C-4 in the RI report [CH2M HILL, 2010]), which was built in 1965 and opened in 1966.

A detailed review and discussion of the available historical aerial photographs are provided in the first phase of the Preliminary Source Evaluation (PSE I) (Oasis, 2007). PSE I divided the FCS into five subareas (Subareas A through E) based on the historical use, a review of historical aerial photographs and maps, and the types of contamination and debris encountered. Overall, the former locations of the salvage yard and Hoppe's Slough channel correlate well with the occurrence of buried debris at the FCS. However, with the exception of PCB contamination in Subarea E and munitions-related items intermixed with debris in Subarea A, the initial subarea designations do not correlate well with distinct sources or zones of contamination and are useful only as general geographic references.

The FCS 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 completed during this time indicated areas of buried and surface debris near the former

salvage yard. Excavations for building foundations, utilities, and other infrastructure began on the Taku Gardens Family Housing development in April 2005. During construction in July 2005, equipment operators uncovered soil contaminated with PCBs and petroleum. They also unearthed an extensive array of buried debris, including crushed drums, scrapped equipment, and munitions-related items used for troop support and training in the 1940s and 1950s. The 110 housing units in the 55 completed buildings have been completely finished, with the exception of the installation of major appliances. The contractor has winterized the units by activating the electrical systems, steam mains, and glycol heat exchangers. There are currently no plans to complete the 20 remaining housing units (in 10 buildings) that were originally planned for the southwestern portion of the FCS (Buildings 50 through 59); their partially installed foundations were removed in 2009 after extensive sampling and analysis had confirmed that the residual contamination would not pose unacceptable risk to site workers. The general chronology of development and investigation beginning with development of the FCS as a future housing project and continuing through completion of the RI is depicted on Figure 2-1.

The FCS is zoned and planned for future residential uses for Army families that will be stationed at the Post. The families typically reside in the housing units for approximately 3 years. The FCS is currently vacant and fenced, preventing current use. In addition to the specific yard areas near the residential buildings, other common areas and open space that could be used by all residents or other site visitors are indicated on the construction design. These include recreational areas such as playgrounds, a sledding hill, and ice skating rink.

The following structures are adjacent to the FCS (Figure 1-2):

- Residential housing along the western side
- Other structures, including Fire Station 2, the SAS building (with playground), and a gas station immediately north of the northwestern corner of the fenced source area
- The Fort Wainwright water treatment building and water supply wells at Building 3559 near the northeastern corner
- Railroad tracks running parallel to the eastern edge
- A Golden Valley Electric Association electrical substation directly south of the southeastern corner of the FCS

Soil borings drilled during the RI and previous investigations indicate that soil at the FCS consists generally of sandy silt nearest the surface changing to sand and sand with silt and gravel at around 8 to 10 feet bgs. Permafrost and corresponding low subsurface temperatures have only been reported in borings advanced in the southeastern portion of the FCS.

Groundwater is the only source of potable water used at Fort Wainwright and in the Fairbanks area. Approximately 95 percent of the potable water on Fort Wainwright is currently supplied through a single distribution system fed by two large-capacity wells in Building 3559 (Figure 1-2). These wells are completed at a depth of approximately 80 feet bgs and provide between 1.6 million and 2.4 million gallons of water per day to the Fort Wainwright water treatment plant for processing and distribution. The estimated capture zone for these wells is also depicted on Figure 1-2 and on Figure C-1 in Appendix C.

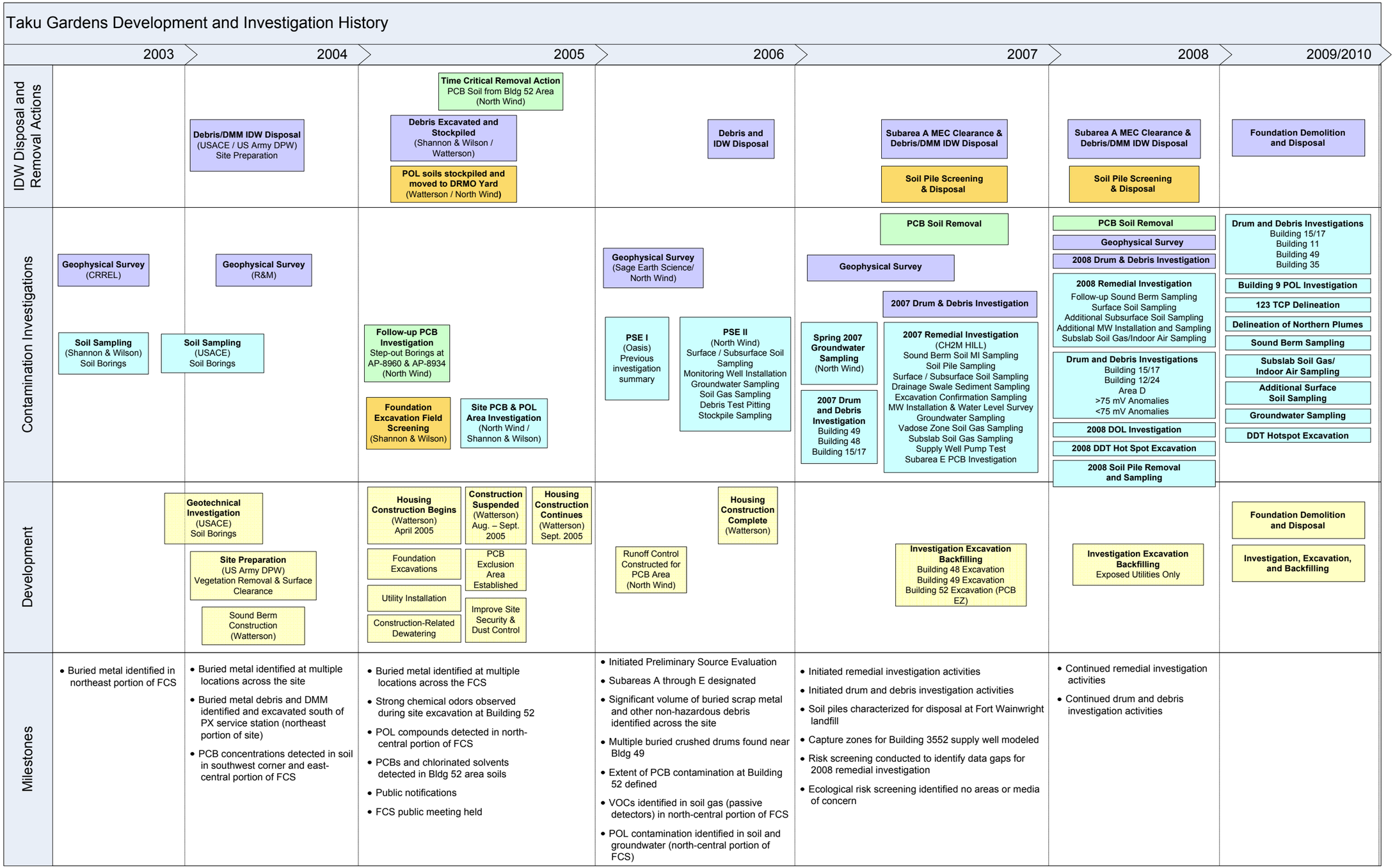


FIGURE 2-1
FCS Development and Investigation Chronology
Feasibility Study
Former Communications Site, Fort Wainwright, Alaska

CH2MHILL

394395.C1.10.02_ES032410133757SEA . Fig. 2-3 Development & Investigation Chronology.ai . 3/23/10
ES090110064115SAC Figure_2-1.ai 12.14.2010 tdaus

A detailed discussion regarding the climate, geology, hydrology, and ecological setting can be found in the RI report (CH2M HILL, 2010).

2.2 Source Characteristics

This subsection describes the nature of the debris, munitions-related items, and other possible sources of contamination at the FCS and includes a qualitative assessment of historical contaminant sources at the FCS, as determined through RI excavations and waste characterization activities.

Note that this description of possible sources is not to be confused with the nature and extent of contamination, which focuses on residual contamination left at the FCS following the PCB excavations, drum and debris investigations, and hot-spot delineation efforts described in this subsection.

2.2.1 Buried Debris

A variety of buried metal and debris, including empty drums, some drums with contents, and munitions-related items were found in the subsurface at the FCS. It must be noted that although munitions-related items were found in various places across the site, discarded military munitions (DMM) were only found in the former Subarea A. In fact, the only verified DMM found onsite were two 3.5-inch training rounds containing some propellant residue in the rocket motors, but without warheads. Based on evidence collected during the investigative effort at the FCS, the Army determined that, regarding the issue of explosives safety, the Taku Gardens family housing development is safe for residential use. It is extremely unlikely that any explosive ordnance is present at the site; furthermore, the probability of encounter by residents with any buried munitions that might be present is unlikely.

The buried debris, along with associated contaminated soil, tended to be concentrated in former low-lying areas (e.g., the former channel of Hoppe's Slough) and in pits that were filled and covered before the FCS was developed. These source areas appear to be related to historical uses of the area for salvage, troop billets, and offices. Materials and chemicals placed in these former disposal areas are assumed to be the primary sources of contaminated soil, soil gas, and groundwater at the FCS.

Approximately 1,058 drums (1,050 of which were either empty or crushed with no discernible residue) and approximately 4,814 cubic yards (yd^3) of debris, munitions-related items, and contaminated soil were removed from the surface and subsurface at the FCS during 2007, 2008, and 2009. Similar metal debris and soil were also removed during the course of site clearing and grubbing in 2004 and housing construction activities in 2005. Although some debris may remain beneath buildings, a majority of potential contaminant source materials have been removed from the FCS. Moreover, as evidenced by the predominantly empty and crushed drums, and limited volume of contaminated soil recovered from areas where partially filled drums were encountered, the presence of buried metal and drums does not directly correlate with chemical contamination. In addition, numerous test pits and exploratory excavations at the FCS encountered buried metal; however, soil, soil gas, and groundwater contamination primarily coincided only with extensive and concentrated deposits of debris in the former Subarea A.

Significant efforts have been made to investigate buried debris and associated contaminated soil at the FCS. All large and/or dense geophysical anomalies (greater than 75 millivolt [mV]) that were thought to be indicative of large volumes of buried debris and/or drums[3] and, thus, possible contaminant sources, have been investigated. In addition, a number of smaller anomalies were also investigated and cleared during the course of the RI. Clearance of the large and smaller anomalies is evidenced by comparing the 2007 and 2009 RI geophysical maps (see Figure 2-2).

However, based on observations from nearby RI excavations, past uses, or subdivision construction notes, some residual debris likely remains near and possibly underneath several buildings. Investigation of potential residual debris beneath buildings was limited because of concerns about the structural stability of the buildings, the hazards posed to workers and equipment during excavation activities, and because only limited chemical contamination had been found in conjunction with buried debris at the FCS, as evidenced by the expanded and highly engineered excavation to remove drums beneath the Building 49 foundation in 2009. Debris that was not removed appears to continue beneath the foundations of Buildings 15, 17, 22, 24, and 48, as shown on Figure 2-3. The presence of buried metal does not always correlate with the presence of intact drums of chemicals or contaminated soil; it is only a suggestion that such conditions are possible.

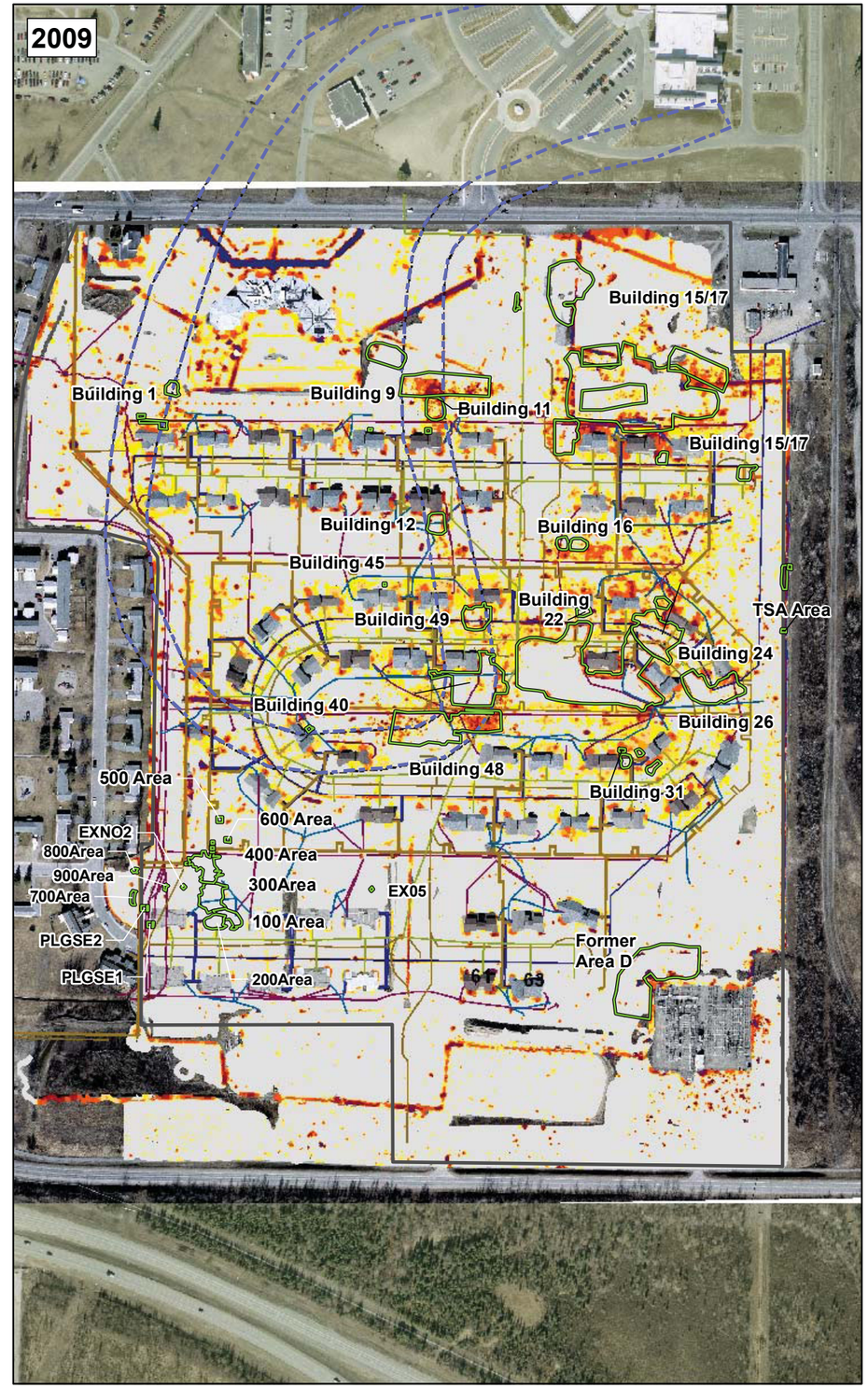
2.2.2 Contaminated Soil

The RI included efforts to investigate and delineate the extent of contaminated soil at the FCS, beginning with the PCB removal action in 2005 and continuing through investigation of the dichlorodiphenyltrichloroethane (DDT) hot spot in the northeastern portion of the FCS in 2010. The sizes of the removal actions (PCB hot spots) and investigation excavations (to delineate the extent of contamination), as well as volumes of soil recovered and disposed of during the RI, are listed in Table 2-1. The excavation boundaries are shown on Figure 2-3.

2.2.2.1 PCB-contaminated Soil

Field screening in the northern, southern, and eastern sections of the Building 52 excavation identified PCB contamination at concentrations between 1 and 10 milligrams per kilogram (mg/kg), and the central area contained PCB contamination greater than 10 mg/kg. The Army, EPA, and ADEC agreed that interim removal of PCB-contaminated soil in this area was necessary and initiated the removal in 2007. Excavation began to the north and continued in a southerly direction. The final depth of the main excavation varied between 3 and 14 feet bgs. The total area of the excavation in Subarea E in 2007 was 12,527 square feet (ft^2). Backfilling activities occurred only in portions of the excavation where confirmation results indicated that the area was below the 1-mg/kg action level for PCBs. Excavated soil with concentrations of PCBs greater than 10 mg/kg was placed into intermodal bulk containers and shipped to Chemical Waste Management Northwest, in Arlington, Oregon, for disposal. Excavated soils with PCB concentrations between 1 and 10 mg/kg were stockpiled onsite. Three separate stockpiles were created in the PCB exclusion zone (EZ). These stockpiles were disposed of at the Fort Wainwright Landfill.

[3] It was not within the scope of the RI to investigate and remove every geophysical anomaly greater than 75 mV identified at the FCS; professional judgment was used to guide the exploratory excavations to areas where large volumes of debris may have been buried based on proximity to historical operations or topographic features.



LEGEND

- Site Boundary
- Former Hoppe's Slough
- Excavation Boundary

EM61 Response mV

- 0
- 30
- 50
- 75
- 100
- 200
- 300
- 500
- 1000
- 2000

0 275
Feet

N

FIGURE 2-2
Comparison of 2007 and 2009 Geophysical Anomaly Maps
Feasibility Study
Former Communications Site, Fort Wainwright, Alaska

LEGEND

- Site Boundary
- Former Hoppe's Slough
- PCB and Exploratory Excavation Area
- Building with Observed Debris Beneath Foundation
- Building with Possible Debris Beneath Foundation

0 275 Feet

N

FIGURE 2-3
Buildings with Possible Debris Beneath Foundation
Final Feasibility Study Report
Former Communications Site, Fort Wainwright, Alaska

357465 TAKU_BuildingDebris_01.ai 07/20/2011 cts

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TABLE 2-1
Summary of Investigative Excavation Activities
Feasibility Study, Former Communications Site, Fort Wainwright, Alaska

Excavation	Area of Excavation (ft^2)	Drums	Contaminated Soil (yd^3)	MD	DMM
2007					
Building 49	4,500	186	24	0	0
Building 48	32,000	159	150	20	0
Building 15/17	9,400	75	3	257	5[a]
Buildings 22, 24	--	--	0	540	0
PCB removal	12,527	--	972.5[b]	--	--
			575[c]	--	--
Totals	**58,427**	**420**	**1,724.5**	**817**	**5[a]**
2008					
Building 1	6,161	1	--	--	--
Building 11	4,449	10	15	--	--
Building 12	3,563	4	24	--	--
PCB Area	970	--	1,720[d,e]	--	--
Building 15/17	75,579	115	238	538	1
Between Buildings 16 and 21	5,262	--	--	--	--
Buildings 22, 24	66,190	39	34	1,552	--
Building 26	5,587	1	7	--	--
Buildings 28 and 31	1,497	--	60	6	--
Area D	25,876	415	2	3	--
Building 40	170	--	60	--	--
Building 45	60	--	3	--	--
Building 9	60	--	3	--	--
Building 43	1,401	--	--	--	1
Building 29	3,236	--	--	--	--
Building 38	1,488	--	96	--	--
Totals	**201,549**	**585**	**2,166**	**2,099**	**2**
2009					
Building 9	4,905	--	920	--	--
Building 11	10,575	8	--	--	--
Building 35	432	--	--	--	--
Area E foundation demolition	30,000	--	--	--	--
Building 15/17	22,050	--	--	--	--
Building 49	2,500	45	3	--	--
Totals	**70,462**	**53**	**923**	**--**	--

[a]EOD detonated these items with excessive donor charges and reported them as high explosive filled.
[b]Concentration of PCBs greater than or equal to 50 mg/kg (TSCA).
[c]Concentration of PCBs greater than or equal to 10 mg/kg and less than 50 mg/kg (Non-TSCA).
[d]Concentration of PCBs greater than or equal to 1 mg/kg and less than 10 mg/kg (Non-TSCA).
[e]Stockpiled in 2007; removed in 2008.

Notes:

EOD = explosive ordnance disposal
MD = munitions debris
TSCA = Toxic Substances Control Act
yd^3 = cubic yard(s)

In 2007, five additional areas of PCB contamination were identified outside of the main investigation area (Building 52) within Subarea E: two immediately north of the EZ, one to the west of the main excavation, and two within the playground area. Several small (100 to 395 ft^2) excavations were dug to depths of 2 to 6 feet to remove the PCB-contaminated soil. Following confirmation sampling, the area was backfilled and compacted, and the soil was transported to the Fort Wainwright Landfill for disposal.

Outside Subarea E, two PCB hot spots in the Transformer Service Area that were greater than 1 mg/kg but less than 10 mg/kg were excavated in 2007. The total area of excavation was 1,116 ft^2, with a maximum depth of 2 feet bgs. A total of 116 yd^3 of PCB-contaminated soil was removed from this area and disposed of at the Fort Wainwright Landfill. The area was backfilled and compacted after sampling and laboratory analysis confirmed that residual PCB concentrations of the excavation floor and sidewalls were less than 1 mg/kg.

2.2.2.2 POL-contaminated Soil

Small heating-oil spills discovered in front of approximately 40 houses during construction activities at the FCS were reported in 2005. However, no survey data to identify the exact locations of these hot spots were produced; therefore, in 2008, an inspection was conducted to identify stained soil and zones of elevated photoionization detector (PID) readings. Of the 40 areas where spills had potentially occurred, stained soil with elevated PID readings was encountered only at Buildings 9, 40, and 45. The stained soil was removed, confirmation samples were collected, and the excavations were backfilled. The soil was stockpiled for eventual thermal treatment at Organic Incineration Technologies in North Pole, Alaska.

On July 7, 2009, field personnel reported fuel odors during grading activities north of Buildings 9 and 11. This area coincided with the location of a diesel fuel pipeline that was removed in 2008. The lateral extent of POL contamination was determined through test pitting, and it was determined that contamination had migrated approximately 40 feet northwest of the apparent source. On August 4, 2009, the Army initiated an excavation to delineate the extent of the contaminated soil. The excavation was guided by PID readings; soil with PID readings exceeding 20 parts per million (ppm) was excavated and transported directly to IDW stockpiles for future disposal. Materials encountered in the excavation included a variety of abandoned pipes. The final excavation footprint covered an area of approximately 109 by 45 feet. The eastern half of the excavation extended to 6 feet bgs where PID readings were below 20 ppm, and the western half extended to 15 feet bgs where groundwater was encountered. Approximately 920 yd^3 of soil were removed from the excavation and stockpiled for eventual thermal treatment at Organic Incineration Technologies in North Pole, Alaska.

2.2.2.3 DDT-contaminated Soil

An evaluation of historical sample results was undertaken as part of planning for 2008 RI activities. This evaluation identified one historical surface soil sample location near Building 11 with a DDT concentration that exceeded the screening criterion by more than 10 times. The Building 11 DDT hot spot was excavated in 2008 to determine the extent of contamination, with a total of 15 yd^3 of DDT-contaminated soil being removed and stored in Super Sacks for transport and disposal at Chemical Waste Management Northwest in Arlington, Oregon.

An evaluation of confirmation sample results from 2009 was undertaken as part of the nature and extent and risk assessment evaluations. This evaluation identified a surface soil sample from the eastern portion of the Building 15/17 backfilled excavation near Building 19 with a DDT concentration greater than default cleanup levels. The 2009 DDT hot spot was investigated further in April 2010, with a total of 51 yd^3 of DDT-contaminated soil being removed and placed in Super Sacks and transported to the long-term stockpile cell on the southern end of the FCS for later disposal.

2.3 Nature and Extent of Contamination

This subsection summarizes the nature and extent of contamination associated with the FCS, and the three primary media potentially impacted by the FCS contamination: soil, soil gas, and groundwater. Soil, soil gas, and groundwater have been thoroughly sampled and sufficient data of appropriate quality exist to characterize the nature and extent of contamination remaining at the FCS, and to evaluate remedial alternatives for residual contamination in this FS.

2.3.1 Sources

A variety of buried metal and debris, including empty drums, some drums with contents, and munitions-related items, was found at the surface and in the subsurface at the FCS. The debris, along with associated contaminated soil, tended to be concentrated in former low-lying areas (such as the former channel of Hoppe's Slough) and in pits that were filled and covered before the FCS was developed. These source areas appear to be related to historical uses of the area for barracks, motor pools, offices, and salvage operations. Materials and chemicals placed in these former disposal areas and chemicals released at the surface (such as PCBs from transformers) are assumed to be the primary sources of contaminated soil, soil gas, and groundwater at the FCS. The possible firefighter-training area in the northern portion of the salvage yard near Buildings 21 and 23 did not appear to be a source of contaminants, since only limited evidence of burning was found in nearby excavations, and soil and groundwater beneath the area were not affected by petroleum, solvents, or other chemicals typically associated with firefighter-training areas.

All significant potential disposal and contaminant source areas that are reasonably accessible at the FCS have been investigated. The buried debris, munitions-related items, and contaminated soil encountered in these areas were removed and appropriately disposed of during the course of the RI and the PCB removal action. Minor amounts of metal debris remain beneath several buildings at the FCS. However, the presence of such materials is not a direct indication that chemical contamination is present.

2.3.2 Project Screening Levels

The project screening levels (PSLs) used for the nature and extent evaluations of soil and groundwater during the RI were based primarily on the 2009 ADEC Method 2 Cleanup Levels, as listed in 18 AAC 75 Tables B1/B2 for soil and Table C for groundwater and

adjusted to account for possible cumulative exposure from multiple chemicals.[4] For soil, the PSL consists of the lowest of the adjusted under-40-inch zone-direct contact value and the adjusted under-40-inch zone outdoor inhalation value or background if it is higher than the lowest Method 2-based value. For groundwater, the PSL consists of the adjusted Table C value for drinking water, or background if higher. The residential and tap-water regional screening levels (RSLs) listed in the *Regional Screening Levels (RSLs) for Chemical Contaminants at Superfund Sites* (EPA, 2009a) were used for analytes without ADEC values.[5] The ADEC values were used preferentially over the RSLs because the ADEC values were calculated using exposure assumptions that are more realistic for the region and its inclement weather. For example, ADEC assumes 270 days of exposure per year, whereas the RSLs assume 350 days of exposure per year.

For soil gas, the PSLs were one-tenth of the target levels for shallow or subslab soil gas listed in Appendix E of *the Draft Vapor Intrusion Guidance for Contaminated Sites* (ADEC, 2009).

2.3.3 Soil

Thirteen contaminants in surface soil were detected at concentrations exceeding the PSLs (see Table 2-2). The magnitudes of exceedance for the surface soil contaminants of interest (COIs) were low (less than 10 times their respective PSLs). Samples with exceedances occurred primarily along the sidewalls of excavations, indicating that while there may have been surface sources present in the area in the past, only residual, low levels of contamination remain. No previously unidentified sources of surface contamination were identified.

Nineteen contaminants were detected in subsurface samples at concentrations exceeding the PSLs (see Table 2-2). The higher-level exceedances tend to be concentrated beneath and around portions of the FCS where contaminated soil and debris were removed during pre-RI or RI field activities, indicating that only residual contamination beneath these areas remains.

Soil contamination at concentrations greater than PSLs at the FCS is limited to three localized subsurface soil hot spots beneath and around portions of the FCS where contaminated soil and debris were removed during pre-RI or RI field activities. These subsurface hot spots consist of two DRO exceedances in the vicinity of Buildings 7 and 8 at depths of 12 and 16 feet and one 1,2,3-trichloropropane exceedance at a depth of 4 feet between Buildings 22 and 24.

The broad distribution of metal exceedances, the low magnitude of exceedances, and the statistical similarity of arsenic levels in the FCS soil to those in the background data set, coupled with the absence of any evidence of widespread use of metal-containing chemicals at the FCS, indicate that metals found in soil at the FCS are not the result of FCS operations or releases. Consequently, metals are not considered COIs for soil in the RI.

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[4] The ADEC Method 2 cleanup levels are based on an excess lifetime cancer risk (ELCR) of 1×10^{-5} and a hazard index (HI) of 1; consequently, the ADEC values for direct contact and outdoor inhalation listed in Tables B1/B2 and for groundwater ingestion in Table C were divided by 10 prior to selection of the lowest applicable value.

[5] The residential RSLs for noncarcinogenic chemicals are based on an HI of 1. Therefore, to account for possible cumulative risk associated with multiple chemical exposures, the listed RSLs for noncarcinogens were divided by 10.

TABLE 2-2
Contaminants with Concentrations Greater than PSLs
Feasibility Study, Former Communications Site, Fort Wainwright, Alaska

Matrix	Analytical Group	CAS Number	Analyte	Units	Number of Detects	Number of Samples	Frequency of Detection (%)	Minimum MDL	Maximum MDL	Minimum Detected Value	Maximum Detected Value	PSL	PSL Source	Number of Detects > PSL	Number of Nondetects > PSL
Surface Soil	VOCs	120-82-1	1,2,4-Trichlorobenzene	mg/kg	1	180	1	0.00022	0.029	6.2	6.2	4.1	1/10th ADEC Outdoor Inhl	1	--
		79-01-6	TCE	mg/kg	10	175	6	0.00013	0.015	0.00029	0.081	0.057	1/10th ADEC Outdoor Inhl	3	--
	TPH	PHCG	GRO	mg/kg	5	183	3	0.772	5.3	0.61	850	140	1/10th ADEC – Ingestion	1	--
	PAH	50-32-8	Benzo(a)pyrene	mg/kg	154	220	70	0.00022	0.68	0.00024	0.091	0.049	1/10th ADEC – Direct Contact	3	3
	Metals	7429-90-5	Aluminum	mg/kg	181	181	100	--	--	4,500	41,100	7,700	1/10th Res RSL	153	--
		7440-36-0	Antimony	mg/kg	79	181	44	0.03	0.22	0.0734	7.42	4.1	1/10th ADEC – Direct Contact	1	--
		7440-38-2	Arsenic	mg/kg	186	186	100	--	--	2.73	25.5	8.46	FTW Background	79	--
		7440-47-3	Chromium	mg/kg	181	181	100	--	--	8.13	102	30	1/10th ADEC – Direct Contact	3	--
		7440-48-4	Cobalt	mg/kg	181	181	100	--	--	4.09	16.7	2.3	1/10th Res RSL	181	--
		7440-50-8	Copper	mg/kg	181	181	100	--	--	9.43	541	410	1/10th ADEC – Direct Contact	1	--
		7439-89-6	Iron	mg/kg	181	181	100	--	--	8,840	39,100	5,500	1/10th Res RSL	181	--
		7439-92-1	Lead	mg/kg	179	181	99	0.05	0.06	3.17	254	40	1/10th ADEC – Direct Contact	12	--
		7439-96-5	Manganese	mg/kg	181	181	100	--	--	159	880	180	1/10th Res RSL	178	--
Subsurface Soil	VOCs	96-18-4	1,2,3-Trichloropropane	mg/kg	2	624	<1	0.00027	0.23	0.0013	0.5	0.017	1/10th ADEC Outdoor Inhl	1	176
		67-66-3	Chloroform	mg/kg	154	624	25	0.000048	0.0214	0.00017	0.75	0.32	1/10th ADEC Outdoor Inhl	5	--
		79-01-6	TCE	mg/kg	55	624	9	0.00013	0.026	0.00022	0.33	0.057	1/10th ADEC Outdoor Inhl	11	--
	TPH	PHCD	DRO	mg/kg	371	557	67	0.3	7.85	0.36	15,000	1,025	1/10th ADEC – Ingestion	7	--
		PHCG	GRO	mg/kg	37	512	7	0.18	11	0.37	630	140	1/10th ADEC – Ingestion	2	--
		TPH-Oil	RRO	mg/kg	403	527	76	1.6	170	1.7	3,500	1,000	1/10th ADEC – Ingestion	1	--
	SVOCs	62-75-9	n-Nitrosodimethylamine	mg/kg	1	536	<1	0.0061	4.4	0.061	0.061	0.016	1/10th ADEC – Direct Contact	1	422
		621-64-7	n-Nitrosodi-n-propylamine	mg/kg	4	553	1	0.0021	2.1	0.04	0.28	0.052	1/10th ADEC – Direct Contact	3	61
	Pesticides	50-29-3	4,4'-DDT	mg/kg	369	566	65	0.000071	0.14	0.00011	2.2	2.1	1/10th ADEC – Direct Contact	2	--
	PAH	50-32-8	Benzo(a)pyrene	mg/kg	145	610	24	0.00022	2.3	0.00023	0.17	0.049	1/10th ADEC – Direct Contact	3	15
		53-70-3	Dibenzo(a,h)anthracene	mg/kg	87	610	14	0.00018	2	0.00021	0.099	0.049	1/10th ADEC – Direct Contact	2	15
	Metals	7429-90-5	Aluminum	mg/kg	557	557	100	--	--	2,510	664,000	7,700	1/10th Res RSL	308	--
		7440-38-2	Arsenic	mg/kg	589	590	100	0.2	0.2	0.58	37.1	8.46	FTW Background	168	--
		7440-47-3	Chromium	mg/kg	590	590	100	--	--	2.1	93.9	30	1/10th ADEC – Direct Contact	9	--
		7440-48-4	Cobalt	mg/kg	559	559	100	--	--	0.97	18.3	2.3	1/10th Res RSL	557	--
		7440-50-8	Copper	mg/kg	559	559	100	--	--	2.3	36,300	410	1/10th ADEC – Direct Contact	1	--
		7439-89-6	Iron	mg/kg	557	557	100	--	--	4,720	37,500	5,500	1/10th Res RSL	556	--
		7439-92-1	Lead	mg/kg	593	593	100	--	--	0.75	289	40	1/10th ADEC – Direct Contact	9	--
		7439-96-5	Manganese	mg/kg	559	559	100	--	--	40	4,360	180	1/10th Res RSL	436	--
Groundwater	VOCs	79-34-5	1,1,2,2-Tetrachloroethane	µg/L	26	228	11	0.008	0.37	0.011	9.8	0.43	1/10th ADEC CUL	8	--
		79-00-5	1,1,2-TCA	µg/L	4	228	2	0.076	3.1	0.45	0.89	0.5	1/10th ADEC CUL	2	1
		75-35-4	1,1-Dichloroethene	µg/L	15	228	7	0.098	1.4	0.15	3.8	0.7	1/10th ADEC CUL	5	1
		96-18-4	1,2,3-Trichloropropane	µg/L	21	228	9	0.014	0.31	0.016	1.2	0.012	1/10th ADEC CUL	21	207
		71-43-2	Benzene	µg/L	5	228	2	0.1	1.3	0.12	2.6	0.5	1/10th ADEC CUL	1	1
		156-59-2	cis-1,2-Dichloroethene	µg/L	26	228	11	0.079	1	0.097	8.32	7	1/10th ADEC CUL	2	--
		127-18-4	PCE	µg/L	5	228	2	0.088	1	0.13	1	0.5	1/10th ADEC CUL	1	1

TABLE 2-2
Contaminants with Concentrations Greater than PSLs
Feasibility Study, Former Communications Site, Fort Wainwright, Alaska

Matrix	Analytical Group	CAS Number	Analyte	Units	Number of Detects	Number of Samples	Frequency of Detection %	Minimum MDL	Maximum MDL	Minimum Detected Value	Maximum Detected Value	PSL	PSL Source	Number of Detects > PSL	Number of Nondetects > PSL
Groundwater (continued)	VOCs	79-01-6	TCE	µg/L	68	228	30	0.014	0.31	0.015	14	0.5	1/10th ADEC CUL	29	--
		75-01-4	Vinyl chloride	µg/L	57	228	25	0.0097	0.31	0.011	0.84	0.2	1/10th ADEC CUL	5	10
	TPH	PHCD	DRO	µg/L	141	222	64	16	281	17	29,000	150	1/10th ADEC CUL	38	66
		TPH-Oil	RRO	µg/L	51	202	25	84	4,200	33	1,490	110	1/10th ADEC CUL	24	71
	SVOCs	117-81-7	bis-(2-Ethylhexyl)phthalate	µg/L	6	201	3	0.95	67.4	2.4	2.7	0.6	1/10th ADEC CUL	6	195
	Pesticides	60-57-1	Dieldrin	µg/L	1	202	0	0.0048	1.1	0.063	0.063	0.0053	1/10th ADEC CUL	1	105
		58-89-9	gamma-BHC (Lindane)	µg/L	1	202	0	0.0047	1.1	0.03	0.03	0.02	1/10th ADEC CUL	1	9
		76-44-8	Heptachlor	µg/L	7	202	3	0.003	0.7	0.0051	0.3	0.04	1/10th ADEC CUL	3	3
	PAH	50-32-8	Benzo(a)pyrene	µg/L	3	207	1	0.0042	3.32	0.02	0.0385	0.02	1/10th ADEC CUL	2	22
		53-70-3	Dibenzo(a,h)anthracene	µg/L	3	207	1	0.014	3.32	0.028	0.0787	0.012	1/10th ADEC CUL	3	204
	Metals	7440-36-0	Antimony	µg/L	14	202	7	0.31	2	0.321	3.8	0.6	1/10th ADEC CUL	10	121
		7440-38-2	Arsenic	µg/L	142	202	70	1	1.5	0.95	36.4	36.24	FTW Background (total)	1	--
		7440-48-4	Cobalt	µg/L	152	202	75	0.31	1	0.311	23.4	1.1	1/10th RSL	114	--
		7439-89-6	Iron	µg/L	179	202	89	16	310	17	38,700	16,938	EAFB Background (total)	11	--
		7440-02-0	Nickel	µg/L	170	202	84	0.62	1	0.644	98.6	10	1/10th ADEC CUL	22	--
		7782-49-2	Selenium	µg/L	62	202	31	0.62	1	0.639	25.2	5	1/10th ADEC CUL	11	--
		7440-28-0	Thallium	µg/L	2	202	1	0.36	0.78	0.58	0.6	0.2	1/10th ADEC CUL	2	200
	Explosives	121-82-4	RDX	µg/L	13	171	8	0.02	0.025	0.061	2.6	0.77	1/10th ADEC CUL	3	--
Soil Gas	VOCs	75-35-4	1,1-Dichloroethene	µg/m^3	167	220	76	0.023	66	0.028	200	0.49	1/10th ADEC Shallow SG Target Level	66	31
		96-18-4	1,2,3-Trichloropropane	µg/m^3	1	218	0	0.24	100	1	1	0.012	1/10th ADEC Shallow SG Target Level	1	217
		120-82-1	1,2,4-Trichlorobenzene	µg/m^3	4	218	2	0.2	300	1.3	7.5	4.2	1/10th ADEC Shallow SG Target Level	1	49
		95-63-6	1,2,4-Trimethylbenzene	µg/m^3	48	219	22	0.065	110	0.073	160	7.3	1/10th ADEC Shallow SG Target Level	2	12
		107-06-2	1,2-Dichloroethane	µg/m^3	31	219	14	0.0058	66	0.015	1.1	0.94	1/10th ADEC Shallow SG Target Level	1	49
		78-87-5	1,2-Dichloropropane	µg/m^3	4	218	2	0.17	110	0.56	8.8	1.3	1/10th ADEC Shallow SG Target Level	2	49
		108-67-8	1,3,5-Trimethylbenzene	µg/m^3	15	218	7	0.076	90	0.12	56	7.3	1/10th ADEC Shallow SG Target Level	1	12
		74-83-9	Bromomethane	µg/m^3	70	218	32	0.19	130	0.23	34	5.2	1/10th ADEC Shallow SG Target Level	7	42
		56-23-5	Carbon tetrachloride	µg/m^3	171	220	78	6.3	100	0.026	38	1.6	1/10th ADEC Shallow SG Target Level	4	49
		67-66-3	Chloroform	µg/m^3	184	220	84	4.9	81	0.068	280	1.1	1/10th ADEC Shallow SG Target Level	171	36
		100-41-4	Ethylbenzene	µg/m^3	138	220	63	0.012	71	0.013	130	22	1/10th ADEC Shallow SG Target Level	2	1
		87-68-3	Hexachlorobutadiene	µg/m^3	4	219	2	0.076	230	0.25	2.3	1.11	1/10th ADEC Shallow SG Target Level	1	49
		127-18-4	PCE	µg/m^3	172	220	78	6.8	110	0.13	110	4.1	1/10th ADEC Shallow SG Target Level	23	48
		79-01-6	TCE	µg/m^3	117	220	53	0.014	90	0.016	110	0.22	1/10th ADEC Shallow SG Target Level	43	48
		1330-20-7	Xylenes, Total	µg/m^3	3	49	6	4.3	71	11	600	100	1/10th ADEC Shallow SG Target Level	2	--
	VOCs/PAH	91-20-3	Naphthalene	µg/m^3	13	219	6	0.078	270	0.098	12	0.72	1/10th ADEC Shallow SG Target Level	11	105

Notes:

µg/L = microgram(s) per liter
µg/m^3 = microgram(s) per cubic meter
GRO = gasoline-range organics
MDL = method detection limit
PAH = polycyclic aromatic hydrocarbons
PCE = tetrachloroethene
RDX = hexahydro-1,3,5-trinitro-1,3,5-triazine
RSL = regional screening level
SG = soil gas
TCA = trichloroethane
TCE = trichloroethene
TPH = total petroleum hydrocarbon

2.3.4 Soil Gas

The soil gas data set consists of two types of samples collected from the FCS, soil gas samples obtained from boreholes advanced in open areas and subslab soil gas samples obtained from portals drilled through the foundations of the residences in the garages of each building. Both types of soil gas samples were analyzed for VOCs using EPA Method TO 15.

Sixteen VOCs were detected at concentrations exceeding PSLs (see Table 2-2). The COIs identified in the RI for soil gas are similar to those found in soil and groundwater samples.

A few scattered exceedances of the PSLs for naphthalene co-occur with the petroleum-affected soil and groundwater, but for the most part, soil gas PSL exceedances for petroleum-related VOCs are isolated and unrelated to conditions in soil and groundwater.

The predominant VOC with exceedances in soil gas was chloroform, with exceedances occurring throughout the FCS. The chloroform exceedances do not coincide with any areas of contaminated soil or groundwater at the FCS. The distribution of the chlorinated VOC exceedances in soil gas also appears to be random, with higher-magnitude exceedances occurring in open areas and beneath buildings well away from the chlorinated VOC-affected soil and groundwater in the northern part of the FCS. The single 1,2,3-trichloropropane exceedance in soil gas does not coincide with the 1,2,3-trichloropropane-affected soil and groundwater in the vicinity of Buildings 22 and 24 in the eastern part of the site.

2.3.5 Groundwater

Twenty-six contaminants were detected at concentrations exceeding PSLs for groundwater (see Table 2-2). The nature and extent of COIs in groundwater are consistent with the locations and types of contaminant sources found and removed at the FCS:

- **Petroleum.** The primary area of petroleum-affected groundwater extends along the direction of groundwater flow from an area between Buildings 7 and 9, where petroleum-contaminated soils were removed, northward beneath the SAS building and to Neely Road. The petroleum-affected zones are not located within the capture zone for the Fort Wainwright water supply wells.
- **Chlorinated VOCs.** A long, somewhat narrow zone of TCE- and PCE-affected groundwater appears to originate just north of Building 48 and extends northward to the FCS boundary with Neely Road. Other chlorinated organic compounds, which may be degradation products for TCE and PCE, are also present in the plume. The plume is not located within the capture zone for the Fort Wainwright water supply wells.
- **1,2,3-Trichloropropane.** 1,2,3-Trichloropropane was detected at concentrations above the PSL in several monitoring wells located adjacent to the capture zones for the drinking water supply wells. The extent of the 1,2,3-trichloropropane-affected groundwater has been determined, and elevated concentrations of the chemical were not detected in wells installed between the exceedance locations and the Fort Wainwright water supply wells.

2.4 Fate and Transport Considerations

This subsection provides a brief review of the fate and transport considerations for possible chemicals in residual buried debris beneath buildings and for COIs in soil and groundwater at the FCS.

2.4.1 Residual Buried Debris

Pockets of buried debris appear to extend beneath five buildings at the FCS and cannot be easily removed. Concerns have been raised about whether the inaccessible debris might contain intact drums of volatile chemicals that, if released, could pose a potential for exposure to future building residents through the indoor-air pathway. The possibility of such an occurrence is remote, given that 13 excavations targeting large and dense geophysical anomalies have been conducted at the FCS, with the following relevant observations:

- Almost all drums found in adjacent excavations were either empty, or contained man-made holes and were crushed.
- Of the 1,058 drums found in excavations, only 8 (less than 0.5 percent) contained sufficient liquid contents to allow for sampling and analysis. The remainder of the drums with contents contained tar, asphalt, and other non-hazardous solid and semi-solid materials.
- Liquids in the eight drums were characterized primarily as fuel and water mixtures, with few VOCs. None of the eight drums contained chlorinated solvents, which tend to be of more concern in terms of migration and toxicity.

An extensive effort was conducted in 2009 to investigate and recover buried drums that extended beneath Building 49. A total of 45 crushed drums were removed beneath the foundation; 42 of the drums were empty, the other three drums contained water with POL sheen.

Based on these results, it is expected that other inaccessible material beneath buildings overlying buried debris would be similar to the inventory of items buried nearby. Consequently, the likelihood that the inaccessible debris beneath the buildings contains intact drums is low (less than 0.5 percent). Even if such drums are present, any liquid contained in them would most likely be petroleum based, and petroleum compounds tend to have higher degradation rates and lower toxicity than do halogenated solvents. The residual buried material at the FCS is not expected to become emergent in the future because of the presence of concrete slab foundations.

2.4.2 Petroleum-related Chemicals

Petroleum-related chemicals, including DRO, GRO, RRO, and PAHs were detected in soil, soil gas, and groundwater at the FCS. For the most part, the number of sample results with exceedances of the PSLs is limited, and concentrations are below the Method 2 cleanup levels. However, subsurface soil and groundwater in the vicinity of Buildings 7 through 9 and at MW77 are contaminated by DRO, naphthalene, and other PAHs. No evidence of a floating liquid-phase hydrocarbon layer has been observed in any monitoring wells at

the FCS. Because most petroleum-contaminated soil encountered during construction and investigation activities has been removed from the FCS, it is unlikely that the dissolved plume would expand or that concentrations would increase.

Through time, DRO and petroleum-related constituents will naturally degrade through microbial activity and will ultimately produce nontoxic end products (e.g., carbon dioxide and water); however, a residue consisting of heavier petroleum hydrocarbons of relatively low solubility and volatility will typically be left behind in the original source (spill) area (American Society of Testing and Materials [ASTM], 1998). On the basis of the apparent age of the release and the absence of the more volatile components (such as benzene) downgradient of the apparent source, it appears that the source has been depleted of its more mobile and soluble components.

Because weathered diesel fuel contains relatively few volatile compounds, there is little possibility of impacts to indoor air.

2.4.3 Chlorinated Solvents

Chlorinated solvents such as TCE and PCE were detected in soil, groundwater, and soil gas at the FCS. Breakdown products of chlorinated solvents, most notably vinyl chloride, were also detected in groundwater. The concentration gradients indicate that TCE- and PCE-contaminated groundwater appears to originate just north of Building 48 and extends northward to the FCS boundary. Although TCE and PCE are volatile, there appears to be limited correlation between the presence of TCE and PCE exceedances in groundwater and exceedances in soil gas, suggesting that the groundwater concentrations may not be sufficient to generate significant vapors in the soil gas.

The source of the TCE- and PCE-affected groundwater plume is unknown. A number of potential sources of solvents, including metals salvage operations, took place in the area historically, and buried drums were found in the former slough channel near Building 48.

The relatively low concentrations of TCE and PCE are not suggestive of an extensive release, and neither chemical was detected above its PSL in a deep well located in the apparent source area. Therefore, ongoing releases from a separate dense nonaqueous phase liquid (DNAPL) layer of solvent within the aquifer are not suspected.

PCE biodegrades in the environment under anaerobic conditions. TCE biodegrades under both anaerobic and aerobic conditions; however, anaerobic processes are the more typical pathway for degradation. Under anaerobic conditions, chlorine atoms are sequentially removed to form less-chlorinated organic compounds by reductive dechlorination, eventually resulting in ethylene and ethane. Chemicals formed along the reductive dechlorination pathway include vinyl chloride and cis-1,2-dichloroethene (DCE) (Ellis and Anderson, 2006), both of which have been detected in groundwater at the FCS. The presence of these chemicals suggests that conditions in groundwater at the FCS are conducive to anaerobic biodegradation.

2.4.4 Chloroform

Chloroform concentrations in excess of the soil and soil gas PSLs were found in soil and soil gas samples obtained throughout much of the FCS. The source of the chloroform is

unknown. Chloroform evaporates easily into the air, does not sorb to soil very well, and can travel through soil to groundwater, where it can easily dissolve (ATSDR, 1997). However, chloroform has only been detected in one groundwater sample collected at the FCS, albeit at a lower concentration than the PSL.

2.4.5 1,2,3-Trichloropropane

A zone of 1,2,3-trichloropropane-affected groundwater was identified in the eastern portion of the FCS, near the 1,700-gallon-per-minute (gpm) capture zone for the Fort Wainwright water supply wells (located in Building 3559). Based on passive soil gas sample data and groundwater data for wells installed between the 1,2,3-trichloropropane plume and the water supply wells, there is no indication of plume movement toward the water supply wells. 1,2,3-trichloropropane is a synthetic chemical and is mainly used to make other chemicals. However, it is also used as an industrial solvent, paint and varnish remover, and cleaning and degreasing agent. Presumably it was used as a cleaning and degreasing agent sometime in the history of operations at the FCS. The chemical evaporates from surface water and surface soil, but can leach from deeper soil into groundwater where it slowly breaks down (ATSDR, 1995).

2.4.6 Pesticides

Localized zones of DDT-affected soil and heptachlor- and dieldrin-affected groundwater were identified at the FCS. DDT is a persistent contaminant, sorbs strongly to soil, and is broken down slowly by microorganisms to dichlorodiphenyldichloroethene (DDE) and dichlorodiphenyldichloroethane (DDD). DDT and especially DDE build up in plants and in the fatty tissues of fish, birds, and other animals (ATSDR, 2002a). These pesticides do not dissolve easily in water, and elevated concentrations of the chemicals have not been detected in groundwater at the FCS. Dieldrin and heptachlor also sorb strongly to soil and do not easily dissolve in water (ATSDR, 2002b, 2007). However, the only occurrences of these chemicals are in groundwater near the northern-central portion of the FCS, where DRO and other petroleum-related constituents are present.

2.5 Human Health Risk Assessment Summary

The HHRA was conducted in accordance with EPA and ADEC risk assessment guidance and is included in the RI report (CH2M HILL, 2010). Risks were estimated for the most plausible pathways of human exposure, based on reasonably anticipated land and water uses at the FCS. The exposure scenarios evaluated included reasonably anticipated future residential, recreational/site visitor, maintenance worker, and excavation worker receptor groups. In addition, a hypothetical unrestricted exposure scenario was included to evaluate the no-action scenario and includes conservative default assumptions regarding domestic use of shallow groundwater and direct contact with soil to 15 feet bgs, anywhere across the site, regardless of the existence of current or future measures precluding exposure to these media. The following discussion summarizes the results of the HHRA; for more details, see the RI report (CH2M HILL, 2010).

For the future recreational/site visitor, maintenance worker, and future excavation worker exposure scenarios, a conservative screening approach was used to select exposure

concentrations, by assuming exposure occurs to the maximum detected chemical concentrations across the entire FCS. This screening approach is conservative because it assumes that concomitant exposure to maximum levels occurs even though maximum levels are not necessarily collocated. Because of the results seen with use of this screening approach, areal averaging of data was not considered necessary. The HHRA results for these three exposure scenarios indicate that the hazard indexes (HIs) for noncarcinogenic chemicals in soil are below the EPA and ADEC threshold value of 1. The excess lifetime cancer risk (ELCR) estimates are within or below the EPA target risk range of 1×10^{-6} to 1×10^{-4} and below the ADEC risk threshold of 1×10^{-5}. Therefore, no unacceptable risk is identified for these scenarios (see Table 2-3).

Residents living at the FCS under reasonably anticipated future land use conditions were evaluated for potential exposure to chemicals detected in the following three exposure media:

- Surface soil (0 to 2 feet bgs)
- Soil gas potentially migrating to indoor air
- Fort Wainwright drinking water supply groundwater currently used for domestic purposes

TABLE 2-3
Summary of Risk and Hazard Estimates for Non-residential Exposure Scenarios
Feasibility Study, Former Communications Site, Fort Wainwright, Alaska

Exposure Scenario	Exposure Route	ELCR	Noncancer HI	Primary Contributors*
Future Maintenance Worker— Direct Contact with Soil (0 to 2 feet bgs)	Ingestion	3×10^{-6}	0.4	None identified
	Dermal	6×10^{-7}	0.06	
	Inhalation	2×10^{-7}	0.05	
	Total	**3×10^{-6}**	**0.5**	
Future Excavation Worker— Direct Contact with Soil (0 to 15 feet bgs)	Ingestion	1×10^{-6}	0.7	None identified
	Dermal	2×10^{-7}	0.05	
	Inhalation	5×10^{-8}	0.008	
	Total	**2×10^{-6}**	**0.7**	
Future Recreational/Site Visitor— Direct Contact with Soil (0 to 2 feet bgs)	Ingestion	2×10^{-6}	0.2	None identified
	Dermal	2×10^{-7}	0.01	
	Inhalation	9×10^{-8}	0.02	
	Total	**2×10^{-6}**	**0.2**	

*Primary contributors to the total risk are listed when ELCR > 10^{-5} or HI > 1.0.

The multimedia HI for combined exposure under the future residential exposure scenario by direct contact with surface soil, inhalation of indoor air originating from subslab soil gas, and domestic use of Fort Wainwright water supply well groundwater is below the EPA and ADEC threshold value of 1. The multimedia ELCR for combined exposure to these media does not exceed the EPA target risk range of 1×10^{-6} to 1×10^{-4} or the ADEC risk threshold of 1×10^{-5}. The results of the future residential scenario indicate that even if cumulative exposure occurs to the highest levels at any surface soil and subslab soil gas locations, and is combined with exposure from domestic use of Fort Wainwright-supplied water, HI and ELCR estimates do not exceed the EPA and ADEC risk threshold values. Therefore, no unacceptable risk is identified for the residential exposure scenario under reasonably anticipated future land use conditions (see Table 2-4).

TABLE 2-4
Summary of Multimedia Risk and Hazard Estimates for the Reasonably Anticipated Future Land Use (Residential Exposure) Scenario
Feasibility Study, Former Communications Site, Fort Wainwright, Alaska

Exposure Scenario and Medium	Exposure Route	ELCR	Noncancer HI
Future Resident (maximum location)— Direct Contact with Soil (0 to 2 feet bgs)	Ingestion	5×10^{-6}	0.5
	Dermal	2×10^{-6}	0.0004
	Inhalation	1×10^{-7}	0.01
	Total	**8×10^{-6}[a]**	**0.5[a]**
Future Resident (maximum location)— Vapor Intrusion to Indoor Air	Inhalation	6×10^{-6}[b]	0.05[b]
Future Resident— Domestic Use of Post Supply Water	Ingestion	--	0.001
	Dermal	--	0.00001
	Inhalation	5×10^{-7}	0.003
	Total	**5×10^{-7}[c]**	**0.005[c]**
Cumulative Multimedia Risk and Hazard		**1×10^{-5}**	**0.5**

[a]Surface soil direct contact values represent the maximum risk and hazard estimates from any single sample across the entire FCS.

[b]Vapor intrusion values represent the maximum risk and hazard estimates from any single subslab sample across the entire FCS.

[c]Groundwater use values represent the risk and hazard estimates from the Post supply well at Building 3559.

For groundwater monitoring wells located within the 1,700-gpm capture zone, the ELCR from all carcinogenic chemicals in shallow groundwater samples exceeds the EPA target risk range of 1×10^{-6} to 1×10^{-4}, and the ADEC risk threshold of 1×10^{-5} in wells MW08, MW47, and MW79 (the ELCR at MW39 exceeds the ADEC risk threshold only) (see the RI report [CH2M HILL, 2010] for more details). This ELCR is primarily a result of the presence of 1,2,3-trichloropropane at low levels (less than 2 µg/L) in these wells; however, 1,2,3-trichloropropane has neither been detected within other groundwater monitoring (sentry) wells located closer to the supply well, nor has it been detected in the supply well itself. Furthermore, solute transport calculations (Appendix B of the RI report [CH2M HILL, 2010]) suggest that the concentrations of 1,2,3-trichloropropane in monitoring wells MW08, MW47, and MW79 are not strong enough to adversely affect groundwater quality at the supply wells.

The results of the hypothetical unrestricted exposure scenario indicate that, under the conservative default assumptions regarding direct contact with soil down to 15 feet bgs, anywhere across the site, a small number (3 out of a total of 1,501) of sample-specific risk estimates are above the ADEC target risk thresholds (see Table 2-5). These sample-specific risk estimates are based primarily on direct contact with contaminants detected in the three sample locations (see Table 7-11 in the RI report [CH2M HILL, 2010]). However, these three sample locations are not contiguous, but are randomly distributed across the site and represent small isolated areas of limited subsurface contamination. Given the conservative sample-specific risk assessment methodology used and the distribution of these sample locations, the overall sitewide risk associated with areally integrated exposure to soil at the FCS is expected to be significantly less than EPA and ADEC target risk thresholds.

An important component of the HHRA was the vapor intrusion evaluation to address potential indoor exposures to future residents. The approach for evaluating vapor intrusion of volatile compounds into indoor air at the FCS is consistent with the tiered process

recommended in ADEC Vapor Intrusion Guidance (2009), and included an evaluation of multiple lines of evidence. Based on the available monitoring data generated during the RI, all lines of evidence corroborate to support the conclusion that the vapor intrusion pathway (VIP) does not represent unacceptable risk at the FCS.

TABLE 2-5
Summary of Multimedia Risk and Hazard Estimates for the Hypothetical Future Unrestricted Exposure Scenario
Feasibility Study, Former Communications Site, Fort Wainwright, Alaska

Exposure Scenario and Medium	Exposure Route	ELCR	Noncancer HI
Hypothetical Unrestricted Use (maximum location)—Direct Contact with Soil (0 to 15 feet bgs)	Ingestion	8×10^{-5}	5
	Dermal	5×10^{-8}	0.0003
	Inhalation	1×10^{-7}	0.1
	Total	8×10^{-5}[a]	5[a]
Hypothetical Unrestricted Use (maximum location)—Vapor Intrusion to Indoor Air	Inhalation	6×10^{-6}[b]	0.05[b]
Hypothetical Unrestricted Use—Domestic Use of Groundwater	Ingestion	2×10^{-3}	14
	Dermal	1×10^{-5}	0.004
	Inhalation	4×10^{-7}	0.04
	Total	2×10^{-3}[c]	14[c]
Cumulative Multimedia Risk and Hazard		**2×10^{-3}**	**19**

[a] Subsurface soil direct contact values represent the maximum risk and hazard estimates from any single sample across the entire FCS.

[b] Vapor intrusion values represent the maximum risk and hazard estimates from any single subslab sample across the entire FCS.

[c] Groundwater use values represent the maximum risk and hazard estimates from any monitoring well across the entire FCS.

2.5.1 Potential Exposure to POL

In accordance with the ADEC publication *Oil and Other Hazardous Substances Pollution Control* (2008), maximum surface and subsurface soil concentrations for petroleum hydrocarbons were compared with Method 2 petroleum cleanup levels (Table B2 of ADEC, 2008). In surface soil samples, maximum concentrations of GRO, DRO, and RRO were below the Method 2 soil cleanup levels for ingestion and/or inhalation. In subsurface soil samples, maximum concentrations of GRO and RRO were also less than Method 2 soil cleanup levels for ingestion. The maximum DRO concentration of 13,000 mg/kg in subsurface soil slightly exceeded the Method 2 soil cleanup level for ingestion of 10,250 mg/kg. Only 1 of 374 samples analyzed for DRO exceeded the Method 2 soil cleanup level for ingestion. Of the remaining 373 samples, none contained a DRO concentration greater than 5,000 mg/kg.

The one exceedance occurred at a depth of 12 feet bgs, where the only plausible exposure would be to an excavation worker during a short-term digging event. The source of the DRO contamination has been identified (former fuel lines), and the extent of the DRO contamination has been fully delineated. As a result, risk from exposure to detected petroleum mixtures at the FCS is considered within the acceptable regulatory levels. For more details, see the RI report (CH2M HILL, 2010).

2.6 Ecological Risk Assessment Summary

The ecological risk assessment (ERA) was conducted in accordance with ADEC and EPA guidance, focusing on contaminants of potential ecological concern (COPECs), receptors, and areas where the greatest potential for ecological exposure might be expected. The risk to offsite terrestrial wildlife and offsite aquatic resources potentially exposed to the COPECs occurring in the drainage swale and groundwater is considered to be low. This conclusion was drawn in consideration of (1) likely infrequent use of small drainage swales, (2) their ephemeral nature, (3) the relatively low magnitudes by which COPEC concentrations exceed conservative screening levels, and (4) the expected amount of spatial attenuation, indicating that unacceptable risk to ecological populations is unlikely. Given these findings, no COPECs or areas were identified that would require additional sampling and evaluation from the drainage swale or perimeter well points to protect ecological resources potentially using the FCS.

2.7 Media of Concern

Although three soil samples contained contaminant concentrations that resulted in risk estimates above the ADEC target risk thresholds under the hypothetical unrestricted exposure scenario, these three sample locations are randomly distributed across the site and represent small isolated areas of limited subsurface contamination. No surface soil exceedance of risk thresholds was identified, and the subsurface contamination in those three samples was identified at depths where residential exposure would not be anticipated (greater than 2 feet bgs). Considering the inherent conservatism associated with the sample-specific methodology used for the risk assessment (i.e., risks were calculated on a sample-by-sample basis rather than on an areally integrated basis) and the fact that these soil samples are generally inaccessible to residents and not at contiguous locations, the sitewide risk to human health associated with areally integrated exposure to soil at the FCS is expected to be significantly less than EPA and ADEC target risk thresholds. Therefore, soil is not considered to pose a significant risk to human health and is not evaluated in this FS for risks to human health at the FCS. However, some contaminants of concern (COCs) have concentrations in soil that exceed the most stringent cleanup levels (primarily ADEC migration to groundwater and EPA groundwater protection RSLs). This residual contamination does not appear to represent a significant threat to onsite groundwater because contaminants in soil with exceedances of the ADEC and EPA groundwater protection cleanup levels do not resemble the list of contaminants actually detected in groundwater above screening levels during extensive groundwater sampling at the FCS. However, ADEC SPAR 2002-1 guidance (ADEC, 2003) requires that any soil exhumed from the FCS containing residual contamination at concentrations exceeding ADEC Method 2 cleanup levels cannot be placed in a wetland or other environmentally sensitive location or within 100 feet of water wells, surface waters, and/or drainage ditches. Therefore, the soil media will be evaluated further in this FS for alternatives to address the potential threat to human health and the environment should the contaminated soil be exhumed.

Based on extensive soil gas sampling data (including subslab soil gas data from beneath the residential units), no unacceptable risk was identified for potential exposure to soil gas for the residential exposure scenario. While the RI did indicate that soil gas would be carried

forward as a medium of concern in the FS to address any remaining uncertainty, remedial project managers representing the Army, ADEC, and EPA agreed in a meeting on February 10, 2011, that it would be more appropriate for the Army to plan for and implement a post-construction 5-year subslab soil gas monitoring program to address the remaining uncertainty outside the FS process because no unacceptable risk was identified. Therefore, soil gas is not retained as a medium of concern in this FS and is not carried forward for the evaluation of remedial alternatives. However, to verify that current soil gas conditions remain consistent and ensure that no significant changes in soil gas conditions arise in the near future because of changes in site conditions, including the remaining construction activities (e.g., road, driveway, and landscaping installations), the Army will continue to perform subslab soil gas sampling at the FCS. After initial baseline sampling following final site construction activities, sampling will take place quarterly at a selected number of buildings, and transition to annual sampling, leading up to the five-year review. At that point, assuming that the sampling results remain stable and continue to indicate that there is no unacceptable human health risk from subslab vapor, no further sampling will be conducted. Further specific details of the sampling effort will be determined by the Army with input from the EPA and ADEC, and will be documented in the Proposed Plan and ROD to be prepared for the FCS. A preliminary version of the proposed sampling plan is included in Appendix D.

Several small, isolated plumes are present in groundwater where contaminant concentrations result in risk estimates that exceed EPA and ADEC target risk thresholds under the hypothetical unrestricted exposure scenario. Therefore, groundwater is also retained as a medium of concern in this FS and is carried forward for the evaluation of remedial alternatives.

SECTION 3

Remedial Action Objectives and Preliminary Cleanup Goals

This section describes RAOs and how they are translated to the preliminary cleanup goals (PCGs) that will be used in developing and evaluating the remedial alternatives.
This section also describes the sources of PCGs for soil and groundwater, including ARARs and risk-based factors.

3.1 Remedial Action Objectives

RAOs define the extent to which the site will require cleanup to meet the objectives of protecting human health and the environment. These RAOs reflect the COCs, exposure routes and receptors, and acceptable contaminant concentrations or range of concentrations for contaminants in soil and/or groundwater. Specific RAOs developed for the FCS are as follows:

- Minimize or eliminate the potential threat posed by residual concentrations of contaminants in soil that is exhumed from the FCS. This RAO will be achieved if soil containing COCs at concentrations exceeding PCGs (Table 3-1) that is exhumed from the FCS is managed through administrative processes.
- Protect against exposure to COCs in groundwater (see Table 3-2). This RAO will be attained if the exposure pathway to human receptors is limited or eliminated, or if COC concentrations in groundwater are reduced to meet cleanup goals.

3.2 Applicable or Relevant and Appropriate Requirements

Section 121(d) of CERCLA states that remedial actions on CERCLA sites must attain (or justify the waiver of) federal or more stringent state environmental standards, requirements, criteria, or limitations that are determined to be ARARs. Applicable requirements are those cleanup standards, criteria, or limitations promulgated under federal or state law that specifically address the situation at a CERCLA site. Relevant and appropriate requirements are those cleanup standards, standards of control, and other substantive environmental protection requirements, criteria, or limitations promulgated under federal or state law that, while not applicable, address problems or situations sufficiently similar to the circumstances of the proposed response action and are well suited to the conditions of the site. A third type of requirement, while not an ARAR, consists of non-promulgated advisories of guidance issued by the federal or state governments. These are "to be considered" requirements (TBCs). TBCs are not legally binding, but may be used to establish cleanup goals in the absence of ARARs.

TABLE 3-1
Identification of COCs and Preliminary Cleanup Goals for Soil
Feasibility Study, Former Communications Site, Fort Wainwright, Alaska

COCs	Analytical Group	PCG (mg/kg)	Source*
1,1,2-TCA	VOC	0.018	ADEC Migration to Groundwater
1,2,4-Trichlorobenzene	VOC	0.85	ADEC Migration to Groundwater
1,2-DCA	VOC	0.016	ADEC Migration to Groundwater
1,2,3-Trichloropropane	VOC	0.00053	ADEC Migration to Groundwater
1,2-Dichloropropane	VOC	0.018	ADEC Migration to Groundwater
1,2-Dibromomethane	VOC	0.00016	ADEC Migration to Groundwater
Benzene	VOC	0.025	ADEC Migration to Groundwater
Chloroform	VOC	0.46	ADEC Migration to Groundwater
Dibromochloromethane	VOC	0.032	ADEC Migration to Groundwater
Methylene chloride	VOC	0.016	ADEC Migration to Groundwater
PCE	VOC	0.024	ADEC Migration to Groundwater
TCE	VOC	0.02	ADEC Migration to Groundwater
Vinyl chloride	VOC	0.0085	ADEC Migration to Groundwater
2-Hexanone	VOC	0.011	EPA Groundwater Protection RSL
GRO	TPH	300	ADEC Migration to Groundwater*
DRO	TPH	250	ADEC Migration to Groundwater
4-Chloroaniline	SVOC	0.057	ADEC Migration to Groundwater
4-Nitroaniline	SVOC	0.0014	EPA Groundwater Protection RSL
2,4-Dinitrotoluene	SVOC	0.0093	ADEC Migration to Groundwater
2,6-Dinitrotoluene	SVOC	0.0094	ADEC Migration to Groundwater
Hexachlorobenzene	SVOC	0.047	ADEC Migration to Groundwater
n-Nitrosodimethylamine	SVOC	0.000053	ADEC Migration to Groundwater
n-Nitroso-di-n-propylamine	SVOC	0.0011	ADEC Migration to Groundwater
Pentachlorophenol	SVOC	0.047	ADEC Migration to Groundwater
Bis-(2-Chloroethoxy)methane	SVOC	0.025	EPA Groundwater Protection RSL
Bis-(2-Chloroethyl)ether	SVOC	0.0022	ADEC Migration to Groundwater
Bis-(2-Chloroisopropyl)ether	SVOC	0.00012	EPA Groundwater Protection RSL
Beta-BHC	Pesticide	0.022	ADEC Migration to Groundwater
Gamma-BHC	Pesticide	0.0095	ADEC Migration to Groundwater
2,4,5-T	Herbicide	0.15	EPA Groundwater Protection RSL
Aroclor 1260	PCB	0.024	EPA Groundwater Protection RSL
Arsenic	Metal	8.46	FWW Background
Aluminum	Metal	77,000	EPA Residential RSL
Copper	Metal	4,100	ADEC Direct Contact
Manganese	Metal	1,800	EPA Residential RSL

*See Section 3.3 for more details regarding the sources used in the RI report (CH2M HILL, 2010).

TABLE 3-2
Identification of COCs and Preliminary Cleanup Goals for Groundwater
Feasibility Study, Former Communications Site, Fort Wainwright, Alaska

COCs	Analytical Group	PCG (µg/L)	Source*
DRO	TPH	1,500	ADEC
RRO	TPH	1,100	ADEC
1,1,2,2-PCA	VOC	4.3	ADEC
1,2,3-Trichloropropane	VOC	0.12	ADEC
TCE	VOC	5	ADEC
Arsenic	Metal	36.24	FTW Background
Cobalt	Metal	11	EPA Tapwater RSL
Iron	Metal	16,938	EAFB Background

*See Section 3.3 for more details regarding the sources used in the RI report (CH2M HILL, 2010).

Pursuant to EPA guidance, ARARs generally are classified into the following three categories:

- **Chemical-specific ARARs** include those laws and requirements that regulate the release to the environment of materials possessing certain chemical or physical characteristics or containing specified chemical compounds. These requirements generally set health- or risk-based concentration limits or discharge limitations for specific hazardous substances.
- **Location-specific ARARs** relate to the geographical or physical position of the site, rather than the nature of the contaminants or the proposed site remedial actions.
- **Action-specific ARARs** define acceptable handling, treatment, and disposal procedures for hazardous substances.

A complete discussion of chemical-, location-, and action-specific ARARs is presented in Appendix A.

3.3 Preliminary Cleanup Goals

PCGs are based primarily on the most stringent 2009 ADEC Method 2 cleanup levels in 18 AAC 75—Tables B1/B2 and C, respectively—for soil and groundwater. For those substances that do not have Method 2 cleanup levels, the most stringent EPA RSL is utilized. Background metals concentrations are utilized as PCGs for metals that have background concentrations higher than the ADEC and EPA risk-based cleanup levels.

3.4 Contaminants of Concern

Contaminants in soil and groundwater at concentrations exceeding PCGs were identified as COCs. The COCs for soil and groundwater are presented in Tables 3-1 and 3-2, respectively.

To identify COCs for groundwater, contaminants in groundwater that posed a risk for the hypothetical unrestricted scenario greater than the carcinogenic ADEC risk threshold of

1×10^{-5} or an HI greater than 1 were identified. These contaminants were then screened against the PCGs. The contaminants with concentrations exceeding the PCGs were identified as COCs in groundwater. It should be noted that dieldrin also exceeded the ADEC risk threshold and the PCG for groundwater; however, it was only detected in 1 groundwater sample out of 202 samples evaluated during the RI. In addition, dieldrin was detected in a sample from MW12 during the fall 2008 sampling event, but was not detected during more recent sampling events (spring and fall 2009). The dieldrin detection above the ADEC threshold appears to be a solitary, isolated occurrence and was therefore not identified as a COC in groundwater. The COCs for groundwater are presented in Table 3-2. Figure C-1 in Appendix C presents the distribution of COCs in groundwater.

SECTION 4

Identification and Screening of Technologies

This section describes the identification and screening of remedial technologies to satisfy the RAOs defined for the FCS site addressed in this FS. The approach taken is consistent with the *Guidance for Conducting Remedial Investigations and Feasibility Studies Under CERCLA* (EPA, 1988). General response actions describe those actions that can potentially achieve the RAOs established in Section 3. These actions are intended to (1) mitigate potential exposure to, (2) control the migration of, and/or (3) remediate COCs. General response actions may include treatment, containment, excavation, extraction, disposal, institutional actions, or a combination of these. A No Action general response action is included as a baseline for comparison.

Except for the No Action alternative, each general response action can be achieved by several remedial technologies. Remedial technologies are defined as the general categories of remedies under a general response action. For example, capping is one of the remedial technologies under the general response action of containment. Process options are specific categories of remedies within each remedial technology. The process options are used to implement each remedial technology. For example, the remedial technology of capping could be implemented using one of several types of capping options (e.g., soil cap or multi-layer cap).

This section identifies the general response actions and associated remedial technologies and process options deemed applicable for addressing contamination in groundwater and potential future contamination in soil gas at the FCS. The technologies and process options are further screened primarily for effectiveness, as well as implementability and relative cost.

The applicability of specific process options was evaluated by considering the following factors:

- The ability of a process option to address identified COCs and media of concern
- How reliable and proven the process is with respect to the types of contamination and site conditions that will be encountered

The implementability of a technology or process option was further investigated with consideration of the administrative or institutional aspects of using a technology or process. Factors such as the ability to obtain necessary permits; the availability and capacity of treatment, storage, and disposal services; and the availability of the equipment and workers to implement the technology were considered under this criterion.

Cost also plays a role in the screening of process options. Relative capital plus operations and maintenance (O&M) costs were used rather than detailed estimates. The costs for each process option were evaluated on the basis of engineering judgment relative to the other process options in the same technology type. This information assists in the selection of cost-effective process options, or it can be used to screen out process options that, based on industry or site-specific knowledge, have very high costs relative to other suitable options.

When process options were considered equivalent, a representative process option was chosen to be used in the development and analysis of remediation alternatives. Retained technologies and process options will be combined into media-specific remedial alternatives (e.g., GW-2 for groundwater).

4.1 General Response Actions

General response actions for remediating contaminated soil gas and groundwater at the FCS are as follows:

- **No Action –** No remedial measures are implemented. The No Action general response action is required for consideration by the National Contingency Plan (NCP), and it provides a baseline for comparison.
- **Institutional Controls –** Institutional actions taken to control exposure to contaminated soil and/or groundwater.
- **Monitoring –** Groundwater samples are collected and analyzed to evaluate contaminant concentrations. The data can be used to evaluate the extent of contaminant migration or degradation.
- **Engineered Controls –** Physical methods or actions are taken to control contaminated soil and/or groundwater at a site, thereby minimizing or eliminating the migration of contaminants, preventing direct exposure to contamination, and restricting access to the contaminated site. These actions would be necessary for most cleanup alternatives before and during construction and operation phases. If contaminated media are left at a site, long-term engineered controls might be required.
- **Containment –** Physical methods or actions are taken to contain contaminants or contaminated material, thereby minimizing or eliminating the migration of contaminants and preventing direct exposure to contamination.
- **Removal –** Expedites site cleanup and restoration when combined with either disposal or treatment. Actions are taken to physically remove contaminated soil or groundwater from a site.
- **Treatment –** Reduces the toxicity, mobility, and/or volume of contaminated media. In situ or ex situ actions are taken to treat soil or groundwater using thermal, physical, chemical, and/or biological processes.
- **Disposal –** Actions are taken to dispose of treated or untreated soil or groundwater at an offsite facility or reuse treated, clean soil, or groundwater onsite.

4.2 Screening of Remedial Technologies and Process Options

Following the development of the general response actions, potential remedial technologies and process options for implementing the general response actions are identified and screened for applicability as described in the following subsections.

4.2.1 Identification of Remedial Technologies and Process Options

Except for the No Action general response action, each general response action can be achieved by several remedial technologies and associated process options. In this context, the following definitions apply:

- **Remedial Technologies –** The general categories of remedies under a general response action. For example, in situ chemical treatment is one of the remedial technologies under the treatment general response action.
- **Process Options –** Specific categories of remedies within each remedial technology. The process options are used to implement each remedial technology. For example, the remedial technology of in situ chemical treatment could be implemented using chemical oxidation, one of several process options under this technology.

Many technology types and process options are available to implement the general response actions. Potentially applicable technologies and process options under each general response action are provided in Table 4-1. The technologies and process options listed in Table 4-1 come from various sources, including references developed specifically for application to CERCLA sites or military installations, Internet searches, information supplied by vendors, standard engineering texts, input from state and federal regulatory agencies, and other sources. Identifying a comprehensive list of technologies and process options ensures that a potentially viable remedy is not overlooked early in the FS process.

4.2.2 Applicability Screening

After potentially applicable technologies and process options are identified, the options are screened for applicability. Applicability refers to the ability of the remedial technology or process option to address identified COCs and media of concern. This initial screening eliminates those technologies and process options that are clearly not applicable or not workable for the contaminants and/or site characteristics found at the FCS and addressed by this FS.

The applicability screening of potential remediation technologies and process options is shown in Table 4-1. This table provides brief descriptions of the technologies and process options associated with the general response actions. The table also provides the rationale for either retaining or screening out a particular option. Technologies and process options that are screened out are shaded in Table 4-1.

4.3 Evaluation of Process Options

Following the applicability screening, the retained technologies and process options are evaluated in greater detail using the criteria of effectiveness, implementability, and relative cost. For this evaluation, the implementability criterion focuses on administrative and institutional issues instead of technical issues. The evaluation of process options is provided in Table 4-2. Technologies and process options that are retained based on effectiveness, implementability, and/or cost are shown in boldface in Table 4-2.

Additional descriptions of each evaluation criterion are provided in the following subsections.

4.3.1 Effectiveness

Specific process options are evaluated for effectiveness by considering the following factors:

- The ability of a process option to address the estimated areas or volumes of contaminated media and meet the goals identified in the RAOs (i.e., meet established cleanup levels).
- The potential impacts to human health and the environment during the construction and implementation phases.

4.3.2 Implementability

For the evaluation of process options, implementability focuses on the administrative or institutional aspects of using a technology or process, as opposed to the technical implementability screening described in Section 4.2.2. Factors considered under this criterion include the ability to obtain necessary permits; the availability and capacity of treatment, storage, and disposal services; and the availability of the equipment and workers to implement the technology. Because of the FCS's future residential use as Taku Gardens, an additional consideration included in this FS is how a technology or process option may affect or restrict future residential land use.

4.3.3 Relative Cost

Cost plays a role in the screening of process options. Relative capital plus O&M costs are used rather than detailed estimates. The costs for each process option are evaluated according to engineering judgment as high, medium, or low relative to the other process options in the same technology type. This information assists in the selection of cost-effective process options. Cost can also be used to screen out process options that, based on industry or site-specific knowledge, have very high costs relative to other suitable options.

4.4 Selection of Representative Process Options

Following evaluations for the criteria of effectiveness, implementability, and relative cost, process options are chosen to represent the range of process options under a remedial technology. These representative process options are selected by considering those process options that are the best established, proven, and reliable over a range of potential site conditions. Implementation of some process options, in isolation, may not completely satisfy RAOs. Therefore, representative process options are generally used in conjunction with other process options to fully achieve RAOs. Representative process options for soil gas and groundwater remediation are shown in Table 4-2 (in boldface).

Only one or two representative process options are typically selected for each remedial technology type to simplify the subsequent development and evaluation of remedial alternatives. Some general response actions and associated remedial technologies may have more than one representative process option, and some may not have any representative process option selected. More than one process option may be selected if the processes are sufficiently different in their performance where one process would not adequately represent the other.

TABLE 4-1
Applicability Screening of Remediation Technologies and Process Options
Feasibility Study, Former Communications Site, Fort Wainwright, Alaska

General Response Action	Remedial Technology	Process Option	Media	Description	Screening Comments
No Action	None	None	Soil and groundwater	No action is taken.	Required for consideration by NCP.
Institutional Controls	Governmental controls	Garrison Policy	Soil and groundwater	A Garrison Policy would be used to prohibit installation of dewatering wells, monitoring wells, or potable water wells without prior approval from the Fort Wainwright DPW.	Potentially applicable.
Monitoring	Monitoring	Groundwater monitoring	Groundwater	Groundwater samples are collected and analyzed to evaluate contaminant levels and migration.	Potentially applicable if used in conjunction with other technologies to satisfy RAOs.
		MNA	Groundwater	Monitoring of hydrocarbon contaminants in groundwater to evaluate natural degradation rates and residual contaminant levels.	Potentially applicable to hydrocarbon-contaminated areas.
Containment	Physical/impermeable barrier	Slurry wall, sheet piling, vibrating barrier wall	Groundwater	Physical barriers that prevent contaminated groundwater from flowing downgradient.	Potentially applicable when used in conjunction with other technologies. Effective for short-term applications. Does not reduce toxicity or volume of contaminants.
	Hydraulic barrier	Extraction wells	Groundwater	Vertical and horizontal extraction wells are installed and groundwater is pumped. A hydraulic barrier is established that prevents contaminant migration.	Potentially applicable. May be used in conjunction with other technologies. Does not reduce toxicity or volume of contaminants. Requires treatment and/or disposal of contaminated groundwater.
		Extraction and injection wells	Groundwater	Wells are installed and groundwater is pumped to establish a hydraulic barrier that prevents contaminant migration. Uncontaminated water is injected to create a hydraulic barrier and to increase flow to extraction wells.	Potentially applicable. May be used in conjunction with other technologies. Does not reduce toxicity or volume of contaminants. Requires treatment and/or disposal of contaminated groundwater.
Removal	Excavation	Soil excavation	Soil	Contaminated soil is excavated from where it is known or suspected to exist.	Potentially applicable, but likely to be incompatible with intended residential reuse and cost prohibitive.
	Groundwater extraction	Groundwater is pumped from extraction wells	Groundwater	The groundwater extraction wells are used to remove contaminated groundwater.	Potentially applicable when used in conjunction with other technologies. Requires treatment and/or disposal of contaminated groundwater.
Treatment	Ex situ physical treatment	GAC	Groundwater	Contaminated water is passed through adsorbent media, such as GAC. The GAC is replaced and/or regenerated on a regular basis.	Potentially applicable when used in conjunction with other technologies (e.g., groundwater extraction). May not be feasible for SVOCs.
		Air stripping	Groundwater	Large volume of air is forced through water in a packed column or by diffused bubble aeration to promote transfer of non-polar VOCs to the air phase.	Potentially applicable for VOCs when used in conjunction with other technologies (e.g., groundwater extraction). Process is not feasible for semi-volatile and non-volatile contaminants. Treatment of vapor phase may be required.
	Ex situ chemical treatment	Advanced oxidation	Groundwater	Ultraviolet light in combination with a strong oxidizer (ozone or hydrogen peroxide) is used to promote the oxidation of VOCs/SVOCs.	Potentially applicable when used in conjunction with other technologies (e.g., groundwater extraction). May be feasible for groundwater contaminated with 1,2,3-trichloropropane.
	In situ chemical treatment	PRB	Groundwater	A trench is dug and backfilled with reactive material such as iron filings, activated carbon, or peat, which absorb and/or degrade the contaminant as water from the aquifer passes through the barrier. This technology may involve physical, chemical, and/or biological treatment depending on the barrier filling.	Potentially applicable for VOCs and hydrocarbons. May be feasible for 1,2,3-trichloropropane.
		Chemical oxidation	Groundwater	Chemical oxidants such as persulfate are injected into groundwater. The oxidants chemically transform VOCs and SVOCs, including fuels, fuel constituents, and chlorinated compounds.	Potentially applicable. May be feasible for 1,2,3-trichloropropane.
		Chemical reduction	Groundwater	Chemical reductants such as zero valent iron or zinc are injected into groundwater. The reductant chemically transforms VOCs and SVOCs, including chlorinated compounds.	Potentially applicable. May be feasible for 1,2,3-trichloropropane.

TABLE 4-1
Applicability Screening of Remediation Technologies and Process Options
Feasibility Study, Former Communications Site, Fort Wainwright, Alaska

General Response Action	Remedial Technology	Process Option	Media	Description	Screening Comments
Treatment (continued)	In situ biological treatment	Aerobic biodegradation	Groundwater	Organics are biologically assimilated and transformed by aerobic microorganisms. Addition of oxygen and nutrients may be required. Oxygen-releasing compounds may also be used to enhance the biological degradation.	Potentially applicable for organic compounds.
		Enhanced reductive dechlorination (anaerobic biodegradation)	Groundwater	Electron donors and nutrients are injected into groundwater to enhance the natural degradation of chlorinated hydrocarbons.	Potentially applicable. May be feasible for 1,2,3-trichloropropane.
		Biosparging	Groundwater	Air is injected into groundwater to stimulate aerobic biological activity. Organics are transformed.	Potentially applicable for some VOCs.
	In situ thermal treatment	Steam stripping	Soil	Steam is forced through contaminated subsurface soil by injection wells. Steam carrying stripped volatiles is collected at the surface by extraction wells.	Not applicable. Applicable for VOCs only, but not feasible for FCS soil that contains a wide range of non-VOC contaminants.
Disposal	Offsite disposal	Offsite landfill	Soil	Offsite disposal of soil at an appropriate disposal facility. This may include disposal at a Class I or Class III facility depending on the characteristics of the soil and types and concentrations of residual contaminants in the soil.	Potentially applicable, but may be costly if Class I disposal is required.
	Treated water reuse	Irrigation/land application	Groundwater	Application of treated water to land for potential beneficial reuse such as agricultural production/irrigation.	Not applicable; public perception is likely to preclude this option.
		Wetland	Groundwater	Engineered wetlands to enhance evaporation and create habitat.	Not applicable; not consistent with future residential use.
		Discharge to Municipal Water District	Groundwater	Treated water would be blended with water from municipal production wells for delivery to residents. Treated water would meet drinking water standards.	Not applicable; public perception is likely to preclude this option.
		Discharge to sanitary sewer	Groundwater	Discharge of treated water to local sanitary sewer system.	Potentially applicable depending on the sewer capacity.
		Discharge to local receiving water body	Groundwater	Discharge of treated water to local creek, stream, or water course.	Potentially applicable if water is pumped to the drainage swale west of the site that carries water to the Chena River.
		Aquifer reinjection	Groundwater	Injection of treated groundwater into subsurface using wells, infiltration galleries, or recharge ponds.	Not applicable. May be cost prohibitive.

Notes:
Shading indicates that the process option was screened out on the basis of applicability.
GAC = granular activated carbon
MNA = monitored natural attenuation
PRB = permeable reactive barrier
DPW = Directorate of Public Works

TABLE 4-2
Evaluation of Remediation Technologies and Process Options
Feasibility Study, Former Communications Site, Fort Wainwright, Alaska

Soil General Response Action	Remedial Technology	Process Option	Effectiveness	Institutional Implementability	Relative Cost
No Action	**None**	**None**	Low effectiveness. Contaminant loss from natural processes only (e.g., radioactive decay).	May be implemented at sites with regulatory agency acceptance.	None. No actions are implemented.
Institutional Controls	**Governmental controls**	**Garrison Policy**	Effective at eliminating or minimizing exposure to contamination. Legal mechanisms and processes are already in place.	Implementable.	Low capital, low maintenance.
Monitoring	**Monitoring**	**Groundwater monitoring**	Effective for assessing contaminant concentrations, but does not remediate contamination by itself.	Implementable.	Low capital, low maintenance.
		MNA	Effective for assessing contaminant concentrations and degradation rates, but does not remediate contamination by itself.	Implementable.	Low capital, low maintenance.
Containment	Physical/ impermeable barrier	Slurry wall, sheet piling, vibrating barrier wall	Effective method to prevent migration of small contaminated groundwater plumes. Not applicable for deep groundwater (deeper than 60 feet bgs). Does not reduce the intrinsic toxicity or volume of contamination.	Not readily implementable. Different plumes are located throughout the FCS, requiring a larger area to be contained.	Moderate to high capital, low to moderate maintenance.
	Hydraulic barrier	Extraction wells	Effective method of groundwater extraction to prevent further migration of groundwater contamination. Extracted groundwater may require treatment prior to disposal.	Implementable. Groundwater monitoring wells are already installed at the FCS. Conversion to extraction well is required and may be limited because of the future residential use at the FCS. Additional wells may be needed to contain the contaminated groundwater. Different plumes are located throughout FCS, requiring a larger area to be contained.	Moderate capital, moderate maintenance.
		Extraction and injection wells	Effective method of groundwater extraction and hydraulic control. Design must take into account local hydrogeologic conditions.	Implementable with regulatory agency acceptance. May require groundwater treatment prior to injection.	Moderate to high capital, moderate maintenance.
Removal	Excavation	Soil excavation	Not effective. Residual concentrations of contamination in soil do not appear to represent a significant threat to onsite groundwater if left in place. Only if the soil is exhumed from the site and disposed of offsite does it appear to pose a possible threat to groundwater, surface water, or human health. Therefore, excavation of soil is not an effective process option for soil at the FCS.	Implementable.	High capital, low maintenance.
	Groundwater extraction	Extraction wells	Effective method for dissolved contaminant removal. Also effective in controlling the lateral and vertical migration of a contaminant plume and is a proven and reliable technology. Requires groundwater sampling and analysis to verify effectiveness.	Implementable. Qualified personnel are readily available. Groundwater monitoring wells are already installed at the FCS. Conversion to extraction well is required. Extracted groundwater will need to be transported to a treatment, disposal, or consolidation facility located onbase or offbase. Implementability is limited because of the FCS future residential use.	Moderate to high capital, low to moderate maintenance.
Treatment	Ex situ physical treatment	GAC	Highly effective; adsorbate removal efficiencies greater than 90 percent are typical for organic compounds.	Potentially implementable only in conjunction with other technologies (e.g., SVE, air stripping/vacuum extraction).	Low capital, moderate to high maintenance.
		Air stripping	Highly effective. Most COCs (except for 1,2,3-trichloropropane) in groundwater at the FCS are readily strippable at ambient temperatures and have high removal efficiencies (up to 99 percent). Additional emission controls are necessary to remove contaminants from the air stream.	Air stripping for VOCs is an industry standard. Equipment, materials, and qualified personnel for the implementation of this process option are readily available. Would require a treatment area onsite that may not be compatible with residential use.	Moderate capital, moderate to high maintenance.
	Ex situ chemical treatment	Advanced oxidation	Highly effective at degrading VOCs to non-hazardous compounds. Potentially effective to remove 1,2,3-trichloropropane. The effectiveness depends on the oxidant and the stream turbidity.	Potentially implementable only in conjunction with other technologies (e.g., SVE and air stripping/vacuum extraction).	Moderate to high cost, high maintenance cost.

TABLE 4-2
Evaluation of Remediation Technologies and Process Options
Feasibility Study, Former Communications Site, Fort Wainwright, Alaska

Soil General Response Action	Remedial Technology	Process Option	Effectiveness	Institutional Implementability	Relative Cost
Treatment (continued)	**In situ chemical treatment**	**PRB**	Effectiveness depends on the reactive materials. Laboratory and pilot testing may be necessary for the selection of reactive material.	Implementability may be reduced by the intrusiveness of the technology, considering the future residential use at the FCS.	Moderate to high capital, low to moderate maintenance.
		Chemical oxidation	Potentially effective for achieving oxidation of fuels, fuel constituents, and chlorinated hydrocarbons. Emergent contaminants such as 1,2,3-trichloropropane may be chemically oxidized by persulfate.	Potentially implementable treatment process for VOCs (including 1,2,3-trichloropropane) at the FCS.	Moderate capital, low maintenance.
		Chemical reduction	Potentially effective for achieving reduction of chlorinated hydrocarbons. Not likely to be effective for fuels and fuel constituents. Emergent contaminants such as 1,2,3-trichloropropane may be chemically reduced by zero valent iron or zinc.	Potentially implementable at the FCS.	Moderate capital, low maintenance.
	In situ biological treatment	Aerobic biodegradation	Aerobic biological processes do not effectively degrade chlorinated VOCs. Potentially effective for petroleum hydrocarbons.	Implementable with regulatory acceptance of nutrient injection.	Moderate capital, low maintenance.
		Enhanced reductive dechlorination (anaerobic biodegradation)	Reduction dechlorination is an anaerobic biodegradation process and has been shown to be effectively enhanced for chlorinated solvents such as TCE and PCE. In addition, may be effective at dechlorination of 1,2,3-trichloropropane.	Implementable for some contaminant types but will depend on site and waste characteristics and volume. Vendor availability may be limited. Regulatory agencies acceptance of the electron donor and nutrient injection is required.	Moderate capital, low maintenance.
		Biosparging	Aerobic biological processes do not effectively degrade chlorinated VOCs. Potentially effective for petroleum hydrocarbons.	Implementability may be reduced by the intrusiveness of the technology, considering the future residential use at the FCS. A large amount of injection wells and a conveyance system are likely required. May enhance the VIP.	Moderate capital and maintenance.
Disposal	Offsite disposal	Offsite landfill	Effective for disposal of soil. If Class I disposal is required, the soil may need to be transported a significant distance.	Implementable. May be very costly because of transportation and disposal fees.	Moderate to high capital and maintenance.
	Treated water reuse	Discharge to sanitary sewer	Effective for disposal of treated water, provided that water meets discharge requirements.	Requires permit with sanitation district. Also depends on cooperation of local government. Groundwater extraction and ex situ treatment are not representative remedial technologies or process options at the FCS.	Low to moderate capital and maintenance.
		Discharge to local receiving water body	Effective for disposal of treated water; however, requires high level of treatment to meet discharge requirements and protect ecological receptors.	Implementable. Groundwater extraction and ex situ treatment are not representative remedial technologies or process options at the FCS.	High capital and maintenance.

Notes:

Boldface indicates a representative technology or process option.
Shading indicates that the process option was screened out on the basis of effectiveness, implementability, and relative cost.

SVE = soil vapor extraction

The final remedy eventually selected for a site is not limited to the representative process options identified in the FS. The selection of representative process options merely provides for flexibility when the final remedial action is selected and designed. The specific process that will be used at a particular site may not be identified until the remedial design phase.

4.5 Descriptions of Representative Process Options

This subsection provides summary descriptions of the selected representative process options.

4.5.1 No Action

The No Action general response action is required by the *Guidance for Conducting Remedial Investigations and Feasibility Studies Under CERCLA* (EPA, 1988) as a baseline for comparison with other remedial alternatives. The No Action option does not include active remediation or monitoring.

4.5.2 Institutional Controls

18 AAC 75.325(i) requires ADEC approval for the transport of soil exceeding the most stringent cleanup levels. Institutional controls would be used to control the transportation and disposition of exhumed soil and to prohibit installation of dewatering wells, monitoring wells, or potable water wells for whatever reason without prior approval from the Fort Wainwright DPW. The institutional controls may be implemented by the Army through a Garrison Policy such as the policy provided in Appendix B.

4.5.3 Monitoring

Under monitoring, the representative process options are groundwater monitoring and MNA.

Groundwater monitoring consists of the collection and analysis of groundwater samples and may be implemented in conjunction with remediation techniques.

MNA consists of the collection and analysis of soil gas and/or groundwater samples to verify that contaminants are degrading naturally. MNA also assesses the degradation rate. The analysis of the samples typically includes the target COCs (e.g., VOCs, DRO, and GRO) and general water quality parameters such as dissolved oxygen and oxidation-reduction potential (ORP).

4.5.4 Containment

No remedial technologies under the containment general response action were retained as representative process options.

4.5.5 Removal

No remedial technologies under the removal general response action were retained as representative process options.

Excavation of soil containing COC concentrations in excess of PCGs was considered. However, residual concentrations of contamination in soil do not appear to represent a significant threat to onsite groundwater if left in place. Only if the soil is exhumed from the site

and disposed of offsite does it appear to pose a threat to surface water. Therefore, excavation is not considered to be an appropriate process option for the FCS.

4.5.6 Treatment

Two in situ treatment technologies were selected as representative process options under treatment. In situ treatment involves modifying media to reduce COC mass or mobility without collecting and removing the media. Biological, chemical, or physical characteristics of the media are modified to obtain desired fate and transport mechanisms. Desired mechanisms enhance native mechanisms to facilitate achievement of RAOs. The in situ treatment technologies and representative process options that were retained are as follows:

- In situ chemical treatment – PRB
- In situ biological treatment – in situ chemical oxidation (ISCO)

Summary descriptions of the representative process options for in situ treatment are provided in the following subsections.

4.5.6.1 Permeable Reactive Barrier

A PRB is essentially an emplacement of reactive materials into the subsurface. A PRB may also be described as an in situ reactor system placed at the downgradient edge of a groundwater plume. As the contaminated groundwater flows into the permeable barrier, physical, chemical, or biological processes (i.e., adsorption, chemical redox, or biodegradation) will remove contaminants from groundwater or transform them to more desirable (less toxic, more readily biodegradable) compounds. In addition, PRBs may be used to contain groundwater and prevent exposure of humans to contaminated groundwater. PRBs can include zero valent iron to reductively degrade chlorinated hydrocarbons, activated carbon to adsorb contaminants, or a line of air sparging wells coupled with vapor extraction to strip the contaminants in situ.

Field studies have demonstrated that zero valent iron will promote the abiotic reductive dehalogenation of chlorinated compounds dissolved in groundwater, including 1,2,3-trichloropropane. As groundwater passes through the reactive barrier, the chlorine atoms of the contaminants are replaced with hydrogen. Although details of the reaction chemistry are currently unknown, it is believed that the iron serves both to lower the redox potential of the groundwater and act as the electron source in the VOC degradation reaction. Complete degradation of VOCs to nontoxic byproducts is controlled by the residence time of the contaminated groundwater within the PRB. Residence time is dictated by the groundwater flow velocity and thickness of the barrier as measured in the direction of the flow.

PRBs may be constructed as a single element or in conjunction with vertical barriers in a funnel-and-gate configuration. Vertical barriers perpendicular to the groundwater flow direction are generally effective in containing and directing (funneling) contaminants to the PRB (gate). The precise configuration of a PRB for any given application depends on hydrogeology, plume geometry, and other site-specific conditions. Groundwater flow direction at the FCS is currently to the northwest. The 1,2,3-trichloropropane-impacted groundwater is currently located crossgradient (not downgradient) of the operating Fort Wainwright water supply wells (located in Building 3559) and is not likely migrating toward the supply well capture zone. The operation of this well does not appear to be

impacting groundwater flow direction in the vicinity of the 1,2,3-trichloropropane plume. However, if pumping of the wells resulted in a cone of depression that altered natural groundwater flow to the east (toward the Fort Wainwright water supply wells), the PRB would treat the contaminated groundwater prior to impacting the supply well capture zone and therefore prevent the completion of the human exposure pathway.

Advantages of PRBs are as follows:

- No disposal requirements or disposal costs for treated wastes.
- Plumes are not increased by size.
- Passive remediation; therefore, no ongoing energy input and limited monitoring after installation. Maintenance costs are typically low.
- Effective on a diverse group of contaminants, including fuels, fuel constituents, and chlorinated compounds (e.g., 1,2,3-trichloropropane).

Disadvantages of PRBs are as follows:

- PRBs are passive systems; treatment only occurs for groundwater that flows through the barrier.
- Restricted to shallow plumes, typically less than 50 feet bgs; however, groundwater at the FCS is at approximately 20 feet bgs.
- Reactions are nonselective. As such, the reactive media will not only react with the target contaminants, but also with substances found in the soil that can be readily oxidized and/or reduced.
- Reactive media may create and introduce unwanted byproducts (e.g., metals) into groundwater during treatment of site contaminants.
- Capital costs (reactive media and installation) are typically high to very high.

4.5.6.2 In Situ Chemical Oxidation

ISCO consists of injecting chemical oxidants into subsurface source zones and the associated downgradient plumes. Typically, vertical or horizontal injection wells (the wells can be temporary or permanent) are used to deliver the chemical reagents. Upon contact with the oxidant, organic contaminants (including fuels, fuel constituents, and chlorinated compounds) are broken down into inert materials, such as carbon dioxide, hydrogen, chloride, and water (EPA, 2001). ISCO also causes some secondary effects, such as increases in total dissolved solids (TDS) and oxidation and mobilization of redox-sensitive metals (e.g., chromium, manganese, and selenium).

ISCO is moderately difficult to implement compared with other in situ technologies. ISCO is commercially available; however, matching the oxidant and delivery system to the site-specific contaminants and the site conditions is the key to successful implementation. Although other oxidants exist, the most common oxidants used for ISCO include permanganate, hydrogen peroxide, persulfate, and ozone. Permanganate is less sensitive to pH effects and easier to implement in the field compared with hydrogen peroxide, persulfate, or ozone. Chlorinated ethenes, such as TCE and cis-1,2-DCE, are the most

common groundwater contaminants treated by permanganate oxidation. Hydrogen peroxide–based and persulfate-based ISCO requires injecting activators and/or conditioning agents (making it more difficult to implement in the field), but they are capable of targeting a wider range of organics (including DRO, RRO, and 1,2,3-trichloropropane) than permanganate. Ozone-based ISCO most commonly involves injecting ozone gas, and that may be further activated with hydrogen peroxide.

ISCO is effective in source areas and high concentration zones. It is capable of achieving high treatment efficiencies with very fast reaction rates. The degree of effectiveness is dependent on achieving a complete and even delivery of the oxidant through the treatment area. The oxidant dissolution rate can be limited by low permeability of soils and aquifer heterogeneity. Because permafrost has only been reported in the southeastern portion of the FCS, outside the injection area, permafrost and corresponding low subsurface temperatures are not expected to affect ISCO injection or performance. A pilot scale test would be required to refine design parameters. If DNAPL is present in competent sandstone providing a continuing source of contaminants to the dissolved plume, effectiveness will be limited. Only dissolved contaminants at the time of injection would be treated, and rebound is likely. There is no indication of DNAPL at the FCS.

ISCO requires injecting water into the subsurface, which may mobilize and increase the size of the dissolved plume. Using strong oxidizers may also mobilize some metals, especially hexavalent chromium, and decrease the pH. Consistent and frequent monitoring of reductions in contaminant mass, concentrations, mobility, amendments, and byproducts is required. Byproducts would likely attenuate and become immobile soon after the oxidant has been consumed. Because the FCS is planned to be used as a residential area, storing and using large quantities of oxidizing chemicals may require additional planning and coordination. Costs are moderately high to high depending on the injection system and treatment timeframe. ISCO requires more frequent groundwater monitoring than other in situ technologies, but is generally compatible with future residential use at the FCS.

Advantages of ISCO processes are as follows:

- Rapid treatment time and the ability to treat contaminants present at high concentrations.
- Effective on a diverse group of contaminants, including fuels, fuel constituents, and chlorinated compounds (e.g., TCE and 1,2,3-trichloropropane).

Disadvantages of ISCO process are as follows:

- Oxidation reactions are nonselective. As such, the oxidant will not only react with the target contaminants, but also with substances found in the soil that can be readily oxidized and/or reduced.
- Control of pH, temperature, and contact time is important to ensure the desired extent of chemical oxidation.
- Capital and operational costs are typically moderately high to high.

4.5.7 Disposal

No remedial technologies under the disposal general response action were retained as representative process options.

SECTION 5

Assembly and Screening of Alternatives

In this section, the representative process options identified in Section 4 are assembled into remedial alternatives to address contamination and uncertainties at the FCS that require remediation. The assembled alternatives are then evaluated against the criteria of effectiveness, implementability, and cost. Alternatives with the most favorable composite evaluation of all criteria are retained for more detailed evaluation against additional CERCLA criteria, as described in Section 6. This process of alternative development is depicted on Figure 5-1.

5.1 Assembly of Alternatives

Remedial alternatives have been developed in accordance with the *Guidance for Conducting Remedial Investigations and Feasibility Studies Under CERCLA* (EPA, 1988). Remedial alternatives have been developed for each of the impacted media:

- Soil
- Groundwater

The assembly of process options into remediation alternatives is shown in Table 5-1. For the purposes of this FS, the alternatives have been separated into soil and groundwater alternatives. This approach will better facilitate the evaluation of alternatives for each media, and the proper selection of alternatives to be further evaluated. The assembled alternatives consist of the following:

- Alternative 1 – No Action
- Alternative S2 – Institutional Controls to Control the Disposition of Exhumed Soil
- Alternative GW2 – MNA, and Institutional Controls to Prohibit Groundwater Use
- Alternative GW3 – ISCO, and Institutional Controls to Prohibit Groundwater Use
- Alternative GW4 – PRB, MNA, and Institutional Controls to Prohibit Groundwater Use

5.1.1 Alternative 1 – No Action

The No Action Alternative provides a baseline for comparing other alternatives. No remedial activities for soil gas or groundwater are implemented under this alternative. Evaluation of the No Action Alternative is required by the NCP to serve as a baseline for comparison with other alternatives and is evaluated for all media. No cost is associated with this alternative.

TABLE 5-1
Remedial Alternatives from Selected Representative Process Options
Feasibility Study, Former Communications Site, Fort Wainwright, Alaska

General Response Action	Remedial Technology	Representative Process Option	Alternative				
			1	S2	GW2	GW3	GW4
No Action	None	None	●				
Institutional Controls	Governmental controls	Garrison Policy		●	●	○	●
Monitoring	Monitoring	Groundwater monitoring				○	
		MNA			○		○
Treatment	In situ chemical treatment	PRB					●
		Chemical oxidation/reduction				○	

Notes:

The rationale for the selection of representative process options is described in Section 4.4, and the selected representative process options are described in Section 4.5.

Alternative 1 = No Action
Alternative S2 = Institutional Controls to Control the Disposition of Exhumed Soil
Alternative GW2 = MNA, and Institutional Controls to Prohibit Groundwater Use
Alternative GW3 = ISCO, and Institutional Controls to Prohibit Groundwater Use
Alternative GW4 = PRB, MNA, and Institutional Controls to Prohibit Groundwater Use

○ = Process option can be discontinued when remedial action is complete and PCGs are met. The remedial action includes any post-remediation sample collection and/or monitoring required to demonstrate that RAOs and PCGs have been met.
● = Process option to continue into the foreseeable future.

5.1.2 Alternative S2 – Institutional Controls to Control the Disposition of Exhumed Soil

Under Alternative S2, institutional controls would be used to control the disposition of any soil exhumed from the FCS containing contaminants at concentrations exceeding PCGs and that may pose a potential threat if disposed of offsite.

5.1.2.1 Institutional Controls

Institutional controls would be implemented under this alternative into the foreseeable future to control the transportation and disposition of any soil exhumed from the FCS. Management of any soil exhumed from the FCS through institutional controls would ensure that the exhumed soil is handled properly and that its final disposition would be in a location approved by ADEC and EPA. The specifics of the institutional controls to be implemented would be provided in a Garrison Policy; an example is provided in Appendix B.

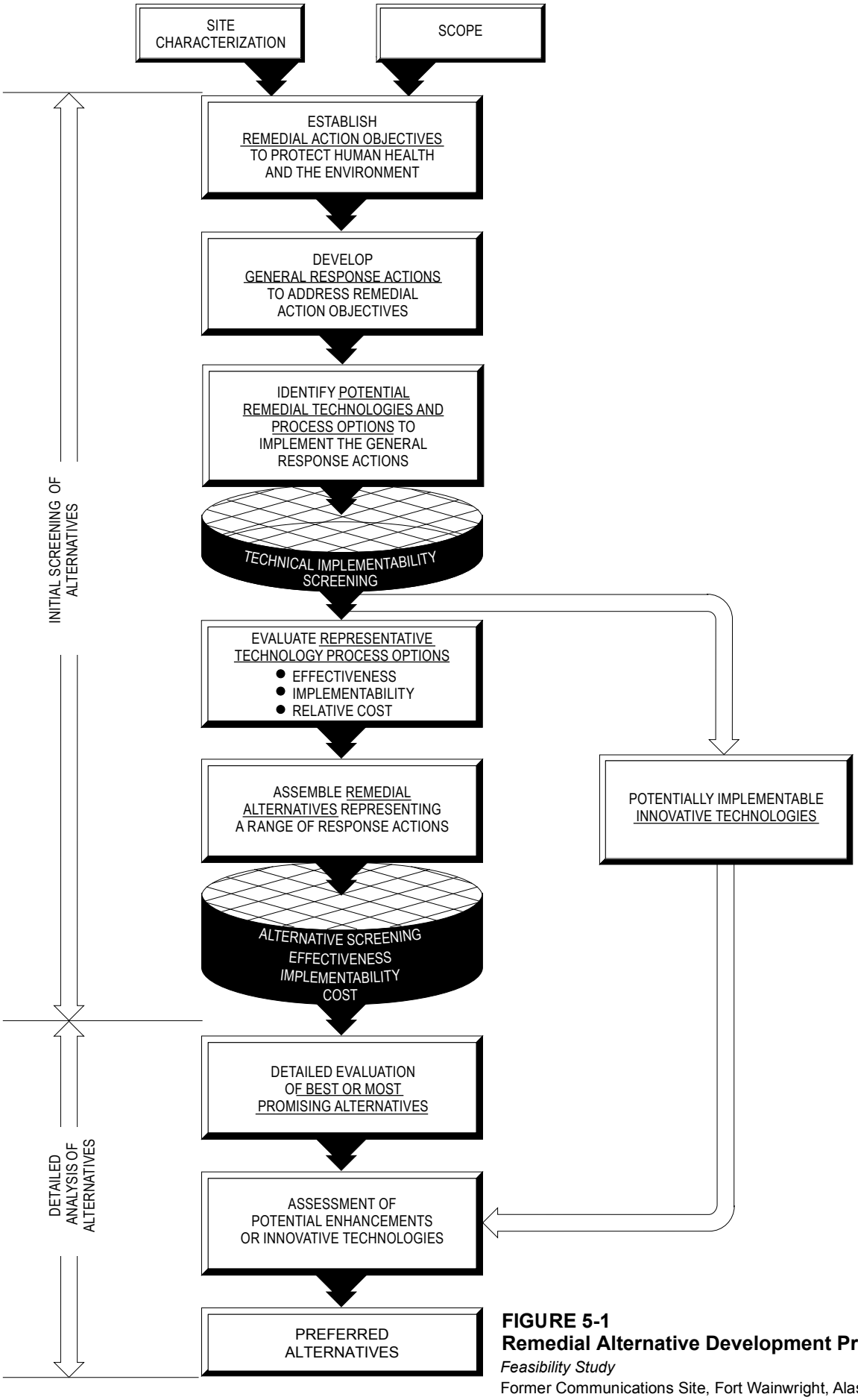

FIGURE 5-1
Remedial Alternative Development Process
Feasibility Study
Former Communications Site, Fort Wainwright, Alaska

5.1.3 Alternative GW2 – MNA, and Institutional Controls to Prohibit Groundwater Use

Under Alternative GW2, institutional controls would be used to eliminate or limit exposure pathways for COCs in groundwater to human receptors and the environment. In addition, groundwater monitoring and data evaluation would be performed periodically to assess the effectiveness of the natural attenuation and degradation processes to reduce contaminant concentrations, as well as to track the extent of contaminant migration.

5.1.3.1 Institutional Controls

Institutional controls would be implemented under this alternative into the foreseeable future to eliminate or limit unacceptable exposure pathways for COCs in groundwater to human receptors and the environment using non-engineered methods. Institutional controls implemented by the Army through a Garrison Policy would prohibit installation of dewatering wells, monitoring wells, or potable water wells without prior approval from the Fort Wainwright DPW. The specifics of the institutional controls to be implemented are provided in Garrison Policy (Appendix B).

5.1.3.2 Monitored Natural Attenuation

To the extent practicable, an MNA program would be conducted using the existing groundwater monitoring wells at the FCS. Upgradient wells would be used to provide information about the background groundwater quality. Downgradient wells would be used to assess attenuation and degradation rates, and potential contaminant migration.

MNA would target groundwater COCs (e.g., TCE, 1,2,3-trichloropropane, 1,1,2,2-tetrachlorothane [PCA], RRO, and DRO), potential degradation products (e.g., cis-1,2-DCE and trans-1,2-DCE), and general water quality parameters (e.g., dissolved oxygen and ORP) that would assist in the assessment of natural degradation processes. Sample collection, analysis, and data evaluation would continue until contaminant concentrations reach cleanup goals, or it can be demonstrated that groundwater plumes are stable and diminishing and no longer present an unacceptable risk to human health or the environment. The frequency of monitoring would be defined specifically during the Remedial Design phase. For cost estimation purposes, it is assumed that groundwater monitoring would be conducted during the entire period of evaluation (30 years). The monitoring frequency is assumed to be semiannually during the first 2 years and annually thereafter. Assumptions used for cost estimation can be found in Section C.2.4 (Appendix C).

5.1.4 Alternative GW3 – ISCO, and Institutional Controls to Prohibit Groundwater Use

Under Alternative GW3, ISCO would be used to decrease concentrations of COCs below cleanup goals and therefore restore groundwater use at the FCS. Institutional controls would be implemented until cleanup goals are met to eliminate or limit exposure pathways for COCs in groundwater to human receptors and the environment.

5.1.4.1 Institutional Controls

Institutional controls would be implemented as described in Section 5.1.3.1. However, under Alternative GW3, the implementation of institutional controls would cease when cleanup

goals are met. For cost estimation purposes, it is assumed that cleanup goals would be met after 2 years.

5.1.4.2 In Situ Chemical Oxidation

Peroxide-activated persulfate was selected as the oxidant for the ISCO remediation system at the FCS because of the wide variety of contaminants it targets, including fuel-related hydrocarbons and chlorinated VOCs. Persulfate ion ($S_2O_8^{-2}$) is a strong oxidant capable of oxidizing a wide range of organic compounds to carbon dioxide, hydrogen, chloride, and water. Persulfate would be activated by either sodium peroxide or hydrogen peroxide. The decomposition of these peroxides in the subsurface would generate localized heating, which could increase contaminant solubility in groundwater and desorption rates from soil surfaces. In addition, there is evidence suggesting that peroxide-activated persulfate generates a superoxide radical, which is able to enhance the oxidation of more recalcitrant compounds. Persulfate would remain in the subsurface for a longer period than other oxidants. Secondary effects, such as increases in TDS, and oxidation and mobilization of redox sensitive metals (arsenic, chromium, and manganese) may also occur and would require monitoring.

ISCO would treat groundwater by injecting peroxide-activated persulfate within the source area portion of the plumes. There are three groundwater plumes beneath the FCS: (1) a fuel-related (DRO and RRO) plume located in the northern-central portion of the FCS between Buildings 7 and 8, extending northwest beyond the FCS boundaries; (2) a VOC (TCE and 1,1,2,2-PCA) plume located in the central portion of the FCS between Buildings 14 and 49; and (3) a 1,2,3-trichloropropane plume located in the eastern-northeastern portion of the FCS. The distribution of COCs in groundwater is presented on Figure C-1 of Appendix C. For cost estimation purposes, it is assumed that temporary injection points would be required to deliver the activated persulfate to the subsurface. No long-term injection wells or aboveground storage or pumping facilities would be required for the ISCO system. The assumed ISCO injection points and target areas are presented on Figure C-2 of Appendix C. A small-scale pilot test would be conducted to evaluate the radius of influence of injection wells and injection effectiveness, determine the success and benefit of the technology, and assist with final design.

5.1.4.3 Monitoring

Groundwater monitoring would be conducted to determine the effectiveness of the remedy. The performance monitoring would target the COCs, potential degradation products, and byproducts such as sodium, sulfate, and metals. Performance monitoring, including sample collection, analysis, and data evaluation, would continue until sufficient data regarding the effectiveness of the remedy are gathered and cleanup goals have been met. In addition, following the attainment of cleanup goals, monitoring would continue as post-remedy monitoring to ensure that there was no rebound of contaminant concentrations. The frequency of performance and post-remedy monitoring would be defined specifically during the Remedial Design phase. For cost estimation purposes, it was assumed that groundwater performance and post-remedy monitoring would be conducted quarterly for an overall period of 2 years.

5.1.5 Alternative GW4 – PRB, MNA, and Institutional Controls to Prohibit Groundwater Use

Under Alternative GW4, a PRB would be used to prevent 1,2,3-trichloropropane migration eastward to the water supply well capture zone at concentrations that represent a risk to human health. An MNA program would be implemented to address COCs and source areas not treated by the PRB. Institutional controls would be implemented into the foreseeable future or until cleanup goals are met to eliminate or limit exposure pathways for COCs in groundwater to human receptors and the environment.

5.1.5.1 Institutional Controls

Institutional controls would be implemented as described in Section 5.1.4.1. Because fuel-related contaminants and VOCs would be left in place under this alternative, institutional controls would be implemented into the foreseeable future or until MNA confirms that cleanup goals are met. For cost estimation purposes, it is assumed that institutional controls would be implemented during the entire period of evaluation (30 years).

5.1.5.2 Permeable Reactive Barrier

PRBs represent an innovative in situ treatment technology for remediating chlorinated VOCs in groundwater. This is a passive remedial technology in which a wall of a permeable reactive media (e.g., iron fillings or an iron/sand mixture) is installed across the flow path of the groundwater plume. No aboveground treatment facility is required.

Of the COCs in groundwater, the presence of 1,2,3-trichloropropane in groundwater near the Fort Wainwright water supply wells (the two supply wells are located in Building 3559 northeast of the FCS) represents the highest human health risk associated with groundwater contamination. 1,2,3-trichloropropane could potentially migrate and be captured by these primary potable water supply wells, completing the exposure pathway to human receptors. Although the general groundwater flow is southeast to northwest and groundwater contamination beneath the FCS is not expected to impact the supply well capture zone, a PRB would be installed within the shallow aquifer between the 1,2,3-trichloropropane groundwater plume and the supply well capture zone. The PRB would remediate 1,2,3-trichloropropane potentially migrating eastward because of the pumping of the Fort Wainwright water supply wells. The objectives of the PRB would be to reduce contaminant concentrations and prevent the 1,2,3-trichloropropane groundwater plume from migrating to the Fort Wainwright water supply wells; hence, preventing human exposure to contaminated groundwater. Because of the location of the PRB and natural groundwater flow direction, fuel-related and VOC (i.e., TCE and 1,1,2,2-PCA) plumes are not expected to be treated and/or contained by the PRB under Alternative GW4.

5.1.5.3 Monitoring

Because fuel-related contaminants and VOCs would be left in place under Alternative GW4, an MNA program would be implemented until cleanup goals are met. Groundwater monitoring under Alternative GW4 would include an appropriate monitoring well network to assess the PRB performance as well as the natural degradation processes. For cost estimation purposes, it is assumed that groundwater monitoring would be conducted

during the entire period of evaluation (30 years). MNA would be implemented as described in Section 5.1.4.3.

5.2 Screening of Alternatives

In this subsection, the assembled remedial alternatives are screened against the criteria of effectiveness, implementability, and cost. Following are summary descriptions of the three criteria:

- **Effectiveness –** Refers to the effectiveness of each alternative at protecting human health and the environment. Each alternative is evaluated in its effectiveness at providing protection and reducing toxicity, mobility, or volume. Short- and long-term effectiveness are evaluated. In this context, short term refers to the construction and implementation period for the alternative. Long term refers to the period after remedial action is completed.
- **Implementability –** Implementability is evaluated in terms of the technical and administrative feasibility of constructing, operating, and maintaining a remedial alternative.
  - Technical feasibility refers to the ability to construct, reliably operate, and comply with regulatory requirements during implementation of an alternative. Technical feasibility also refers to the future operation, maintenance, and monitoring of an alternative after the remedial action has been completed.
  - Administrative feasibility refers to the ability to obtain approvals and permits from regulatory agencies; the availability and capacity of treatment, storage, and disposal services; and the requirements for and availability of specialized equipment and technicians.
- **Cost –** The cost screening criterion permits comparative estimates between alternatives. Cost information is presented in Appendix C. Although these estimates do not present cradle-to-grave costs, they were used in screening the alternatives as a measure of relative costs between different process options. In accordance with EPA guidelines, the cost estimates for each alternative are order-of-magnitude estimates. Estimates of this type are generally accurate within plus 50 percent to minus 30 percent.

At this stage, the screening process focuses on effectiveness factors, with less effort directed at the implementability and cost evaluation. The screening of remedial alternatives is presented in Table 5-2. With the exception of Alternative GW4 (PRB, MNA, and Institutional Controls to Prohibit Groundwater Use), all of the alternatives were retained for detailed evaluation. Alternative GW4 was not retained for further evaluation because a PRB is not considered to be effective. Although the PRB is capable of treating 1,2,3-trichloropropane, hydraulic conductivity of the formation (10^{-1} centimeters per second [cm/s]) is about an order of magnitude higher than typical PRB materials (10^{-2} cm/s); therefore, there is likely to be no flow through the barrier, rendering it ineffective. In addition, because of the depth to which the PRB would need to be installed (greater than 20 feet bgs), installation of the PRB would be highly disruptive and costly.

TABLE 5-2
Initial Screening of Remedial Alternatives
Feasibility Study, Former Communications Site, Fort Wainwright, Alaska

Remedial Alternative		Effectiveness	Implementability	Cost	Comments
1	No Action	Potentially effective for soil gas because the VIP does not represent an unacceptable risk to human health based on current data. Ineffective for groundwater. Would not be protective of human health and the environment. Would not implement any actions to reduce the toxicity, mobility, and volume of contamination. Would not reduce residual risk. Would not meet the RAOs of protecting human health and the environment by reducing exposure or risks. Would not use permanent solutions, consider innovative technologies, nor remediate soils. Would not expedite site cleanup. Natural attenuation of contaminants might result in reduced concentrations.	Implementable.	Capital: none O&M: none	Alternative 1 is retained for detailed analysis as required by the NCP.
S2	Institutional Controls to Control the Disposition of Exhumed Soil	Effective. Institutional controls would provide both short- and long-term protection of surface water resources by controlling the disposition of any soil containing residual contamination at concentrations in excess of PCGs exhumed from the FCS. Institutional controls would ensure that this contaminated soil was placed in a location approved by ADEC and EPA.	Implementable. Institutional controls could be implemented and enforced by the Army.	Capital: low O&M: low	Alternative S2 is retained for more detailed evaluation.
GW2	MNA, and Institutional Controls to Prohibit Groundwater Use	Effective. Institutional controls would provide both short- and long-term protection of human health by eliminating or minimizing exposure to contaminated groundwater. MNA would assess natural attenuation and degradation of contaminants in groundwater. MNA would not directly treat contaminants; however, natural processes would reduce the volume and toxicity of contaminants over time.	Implementable. Institutional controls could be implemented and enforced by the Army. Groundwater monitoring wells are spatially located throughout the FCS. Should additional monitoring wells be necessary, construction contractors and equipment would be readily available.	Capital: low to moderate O&M: low to moderate	Alternative GW2 is retained for more detailed evaluation.

TABLE 5-2
Initial Screening of Remedial Alternatives
Feasibility Study, Former Communications Site, Fort Wainwright, Alaska

Remedial Alternative		Effectiveness	Implementability	Cost	Comments
GW3	ISCO, and Institutional Controls to Prohibit Groundwater Use	Effective. Institutional controls would provide both short- and long-term protection of human health by eliminating or minimizing exposure to contaminated groundwater. ISCO would quickly reduce contaminant levels in the aquifer and the migration of contaminants. ISCO is expected to permanently meet RAOs and would eliminate the toxicity, mobility, and volume of groundwater contaminants at the site.	Implementable. Institutional controls could be implemented and enforced by the Army and state. ISCO has demonstrated effectiveness with similar contaminants in groundwater. Construction contractors and equipment would be readily available.	Capital: moderate to high O&M: low	Alternative GW3 is retained for more detailed evaluation.
GW4	PRB, MNA, and Institutional Controls to Prohibit Groundwater Use	Not effective. A PRB only treats groundwater that flows through the barrier. Although the PRB would be effective at treating 1,2,3-trichloropropane, hydraulic conductivity of the formation (10^{-1} cm/s) is about an order of magnitude higher than typical PRB materials (10^{-2} cm/s); therefore, there is likely to be no flow through the barrier, rendering it ineffective.	Implementability is questionable. The PRB would likely need to be installed to a depth in excess of 20 feet bgs. Installation would be highly intrusive and expensive.	Capital: very high O&M: moderate	Alternative GW4 is not retained for detailed evaluation.

SECTION 6

Detailed Analysis of Alternatives

In this section, the remedial alternatives retained in Section 5 are subjected to detailed analysis. These alternatives are as follows:

- Alternative 1 – No Action
- Alternative S2 – Institutional Controls to Control the Disposition of Exhumed Soil
- Alternative GW2 – MNA, and Institutional Controls to Prohibit Groundwater Use
- Alternative GW3 – ISCO, and Institutional Controls to Prohibit Groundwater Use

The detailed analysis provides sufficient information to allow for comparisons among the different alternatives based on the criteria specified in the *Guidance for Conducting Remedial Investigations and Feasibility Studies Under CERCLA* (EPA, 1988).

The nine CERCLA evaluation criteria are as follows:

1. Overall Protection of Human Health and the Environment
2. Compliance with ARARs
3. Long-term Effectiveness and Permanence
4. Reduction of Toxicity, Mobility, or Volume through Treatment
5. Short-term Effectiveness
6. Implementability
7. Cost
8. State Acceptance
9. Community Acceptance

The NCP (40 Code of Federal Regulations [CFR] Section 300.430(e)(9)(iii)) categorizes these nine criteria into the following three groups:

- **Threshold criteria** are requirements that each alternative must meet to be eligible for selection as the preferred alternative, and include overall protection of human health and the environment and compliance with ARARs (unless a waiver is obtained).

- **Primary balancing criteria** are used to weigh effectiveness and cost tradeoffs among alternatives. The primary balancing criteria include long-term effectiveness and permanence; reduction of toxicity, mobility, or volume through treatment; short-term effectiveness; implementability; and cost. The primary balancing criteria represent the main technical criteria that the alternative evaluation is based on.

- **Modifying criteria** include state acceptance and community acceptance, and could be used to modify aspects of the preferred alternative when preparing the ROD. Modifying criteria are generally evaluated after public comment on the Proposed Plan.

Each criterion has its own weight when it is evaluated. Accordingly, only the seven threshold and primary balancing criteria are in the detailed analysis phase. The following subsections provide descriptions of the first seven evaluation criteria.

6.1 Description of Evaluation Criteria

6.1.1 Criterion 1 – Overall Protection of Human Health and the Environment

This evaluation criterion assesses how each alternative provides and maintains adequate protection of human health and the environment. The alternatives are assessed to determine whether they can adequately protect human health and the environment from unacceptable risks posed by contaminants present at the site, in both the short and long term. This criterion is also used to evaluate how risks would be eliminated, reduced, or controlled through treatment, engineering, institutional controls, or other remedial activities. The considerations evaluated during the analysis of each alternative for overall protection of human health and the environment are presented in Table 6-1.

6.1.2 Criterion 2 – Compliance with ARARs

This evaluation criterion is used to determine whether each alternative would attain federal and state ARARs, or whether invoking waivers to specific ARARs is adequately justified. Other information, such as advisories, criteria, or guidance, is considered where appropriate during the ARARs analysis. The considerations evaluated during the analysis of the ARARs applicable to each alternative are presented in Table 6-2. ARARs for the alternatives presented in this FS report are identified in Appendix A.

6.1.3 Criterion 3 – Long-term Effectiveness and Permanence

This evaluation criterion addresses the long-term effectiveness and permanence of maintaining the protection of human health and the environment after implementing the remedial action imposed by the alternative. The primary components of this criterion are the magnitude of residual risk remaining at the site after remedial objectives have been met and the extent and effectiveness of controls that might be required to manage the risk posed by treatment residuals and/or untreated wastes. The considerations evaluated during the analysis of each alternative for long-term effectiveness and permanence are presented in Table 6-3. The components addressed for each alternative are described in more detail in the following subsections.

6.1.3.1 Magnitude of Residual Risk

The magnitude of residual risk at the end of remedial activities is measured by numerical standards such as cancer risk levels or the volume or concentration of contaminants remaining onsite. The characteristics of the residuals remaining onsite are also evaluated, considering their volume, toxicity, mobility, and propensity to bioaccumulate.

6.1.3.2 Adequacy and Reliability of Controls

The adequacy and reliability of controls that are used to manage treatment residuals or untreated materials that remain at the site after attaining PCGs are evaluated. This criterion includes an assessment of containment systems and institutional controls to evaluate the degree of confidence in their ability to adequately handle potential problems and provide sufficient protection. The criterion also addresses long-term reliability, need for long-term management and monitoring of the site, and potential need to replace technical components of the alternative.

TABLE 6-1
Criterion 1 – Overall Protection of Human Health and the Environment
Feasibility Study, Former Communications Site, Fort Wainwright, Alaska

Analysis Factor	Considerations
Human health protection	• Likelihood that the alternative would reduce risk to human health through exposure to contaminants in soil gas or groundwater by direct contact, ingestion, or inhalation
Environmental protection	• Likelihood that the alternative would reduce the threat to unaffected soil, soil gas, or groundwater by minimizing migration of contaminants • Likelihood that the alternative would reduce risk to ecological receptors

TABLE 6-2
Criterion 2 – Compliance with ARARs
Feasibility Study, Former Communications Site, Fort Wainwright, Alaska

Analysis Factor	Considerations
Chemical-specific ARARs	• Likelihood that the alternative would achieve compliance with chemical-specific ARARs within a reasonable period of time • Evaluation of whether a waiver is appropriate if the chemical-specific ARAR cannot be met
Location-specific ARARs	• Determination of whether any location-specific ARARs (e.g., preservation of wetlands) would apply to the alternative • Likelihood that the alternative would achieve compliance with the location-specific ARAR • Evaluation of whether a waiver would be appropriate if the location-specific ARAR cannot be met
Action-specific ARARs	• Likelihood that the alternative would achieve compliance with action-specific ARARs (e.g., hazardous waste treatment regulations) • Evaluation of whether a waiver would be appropriate if the action-specific ARAR cannot be met
Other criteria and guidance	• Likelihood that the alternative would achieve compliance with other criteria such as risk-based criteria

TABLE 6-3
Criterion 3 – Long-term Effectiveness and Permanence
Feasibility Study, Former Communications Site, Fort Wainwright, Alaska

Analysis Factor	Considerations
Magnitude of residual risks	• Identity of remaining risks (from treatment residuals), including risks from untreated residual contamination • Magnitude of the remaining risks
Adequacy and reliability of controls	• Likelihood that the technologies would meet required process efficiencies or performance specifications • Type and degree of long-term management that would be required • Long-term monitoring requirements • O&M functions that would need to be performed • Difficulties and uncertainties that would be associated with long-term O&M functions • Potential need to replace technical components • Magnitude of threats or risks should the remedial action need replacement • Degree of confidence that controls could adequately handle potential problems • Uncertainties associated with land disposal of residuals and untreated wastes

6.1.4 Criterion 4 – Reduction of Toxicity, Mobility, or Volume through Treatment

This evaluation criterion addresses the anticipated performance of the alternative's treatment technologies in permanently and significantly reducing toxicity, mobility, and/or volume of hazardous materials at the site. The NCP prefers remedial actions where treatment is used to reduce the principal threats at a site through destruction of toxic contaminants, irreversible reduction in contaminant mobility, or reduction of total volume of contaminated media. The considerations evaluated during the analysis of each alternative for reduction of toxicity, mobility, or volume of contaminants present at a given site are presented in Table 6-4.

6.1.5 Criterion 5 – Short-term Effectiveness

This evaluation criterion considers the effect of each alternative on the protection of human health and the environment during the construction and implementation process. The short-term effectiveness evaluation only addresses protection before meeting the RAO. The considerations evaluated during the analysis of each alternative for short-term effectiveness are presented in Table 6-5. This criterion includes consideration of the time required to reach the RAOs.

6.1.6 Criterion 6 – Implementability

This criterion evaluates the technical and administrative feasibility (i.e., the ease or difficulty) of implementing each alternative. This includes the availability of required services and materials during its implementation; ability to obtain approvals and permits from regulatory agencies; availability and capacity of treatment, storage, and disposal services; and requirements for and availability of specialized equipment and technicians. Additionally, a primary consideration for implementation of remedial alternatives at the FCS sites is the restrictions that would be placed on future land use if an alternative is implemented and the alternative's compatibility with existing and planned land use. The considerations evaluated during the analysis of each alternative for implementability are presented in Table 6-6. Compatibility with other potential remedial actions is also considered under this criterion.

6.1.7 Criterion 7 – Cost

This criterion evaluates the cost of implementing each alternative. The cost of an alternative encompasses all engineering, construction administrative, and O&M costs incurred over the life of the project. The assessment against this criterion is based on the estimated present worth of these costs for each alternative. Present worth is used to estimate expenditures, such as construction and O&M, that occur over different lengths of time. This allows costs for remedial alternatives to be compared by discounting all costs to the year that the alternative is implemented.

TABLE 6-4
Criterion 4 – Reduction of Toxicity, Mobility, or Volume through Treatment
Feasibility Study, Former Communications Site, Fort Wainwright, Alaska

Analysis Factor	Considerations
Treatment process and remedy	• Likelihood that the treatment process would address the principal threat • Special requirements for the treatment process
Amount of hazardous material destroyed or treated	• Portion (mass) of contaminant that would be destroyed • Portion (mass) of contaminant that would be treated
Reduction in toxicity, mobility, or volume	• Extent that the total mass of contaminants would be reduced • Extent that the mobility of contaminants would be reduced • Extent that the volume of contaminants would be reduced
Irreversibility of treatment	• Extent that the effects of the treatment would be irreversible
Type and quantity of treatment residual	• Residuals that would remain • Quantities and characteristics of the residuals • Risk posed by the treatment residuals
Statutory preference for treatment as the principal element	• Extent to which the scope of the action would cover the principal threats • Extent to which the scope of the action would reduce the inherent hazards posed by the principal threats at the site

TABLE 6-5
Criterion 5 – Short-term Effectiveness
Feasibility Study, Former Communications Site, Fort Wainwright, Alaska

Analysis Factors	Considerations
Protection of the community during the remedial action	• Risks to the community that would need to be addressed • How the risks would be addressed and mitigated • Remaining risks that could not be readily controlled
Protection of workers during remedial actions	• Risks to the workers that would need to be addressed • How the risks would be addressed and mitigated • Remaining risks that could not be readily controlled
Environmental impacts	• Environmental impacts that would be expected with the construction and implementation of the alternative • Mitigation measures that would be available and their reliability to minimize potential impacts • Impacts that could not be avoided, should the alternative be implemented
Time until RAOs are achieved	• Time to achieve protection against the threats being addressed • Time until any remaining threats would be addressed • Time until RAOs would be achieved

TABLE 6-6
Criterion 6 – Implementability
Feasibility Study, Former Communications Site, Fort Wainwright, Alaska

Analysis Factors	Considerations
Technical Feasibility	
Ability to construct and operate the technology	• Difficulties that would be associated with the construction • Uncertainties that would be associated with the construction
Reliability of the technology	• Likelihood that technical problems would lead to schedule delays
Ease of undertaking additional remedial action	• Likely future remedial actions that might be anticipated • Difficulty implementing additional remedial actions
Monitoring considerations	• Migration or exposure pathways that could not be monitored adequately • Risks of exposure, should the monitoring be insufficient to detect failure
Administrative Feasibility	
Need for land use restrictions	• Requirement for institutional controls and implementation of land use restrictions
Coordination with other agencies	• Steps that would be required to coordinate with regulatory agencies • Steps that would be required to establish long-term or future coordination among agencies • Ease of obtaining permits for offsite activities, if required
Availability of Services and Materials	
Availability of treatment, storage capacity, and disposal services	• Availability of adequate treatment, storage capacity, and disposal services • Additional capacity that would be necessary • Whether lack of capacity would prevent implementation • Additional provisions that would be required to ensure that additional capacity would be available
Availability of necessary equipment and specialists	• Availability of adequate equipment and specialists • Additional equipment or specialists that would be required • Whether there would be a lack of equipment or specialists • Additional provisions that would be required to ensure that equipment and specialists would be available
Availability of prospective technologies	• Whether technologies under consideration would be generally available and sufficiently demonstrated • Further field applications that would be needed to demonstrate that the technologies might be used full-scale to treat the waste at the site • When technology should be available for full-scale use • Whether more than one vendor would be available to provide a competitive bid

6.2 CERCLA Criteria Evaluation

In this subsection, the soil gas and groundwater remedial alternatives are evaluated against the seven CERCLA criteria. The previously developed alternatives consist of the following:

- Alternative 1 – No Action
- Alternative S2 – Institutional Controls to Control the Disposition of Exhumed Soil
- Alternative GW2 – MNA, and Institutional Controls to Prohibit Groundwater Use
- Alternative GW3 – ISCO, and Institutional Controls to Prohibit Groundwater Use

6.2.1 Alternative 1 – No Action

The No Action Alternative provides a baseline for comparing other alternatives. No remedial activities for soil or groundwater are implemented under this alternative. Evaluation of the No Action Alternative is required by the NCP to serve as a baseline for comparison with other alternatives. No cost is associated with this alternative. Alternative 1 would comply with ARARs if soil at the FCS remained in place; however, if soil is exhumed from the FCS, Alternative 1 would not comply with ARARs related to the transportation and disposition of exhumed soil containing residual contamination. Alternative 1 may not comply with ARARs requiring cleanup of contamination that poses a risk to human health and the environment. For groundwater, the cleanup criteria may be met eventually under Alternative 1 given the natural attenuation of contaminants; however, this alternative does not comply with ARARs because there would be no monitoring to confirm that cleanup criteria have been met.

6.2.1.1 Overall Protection of Human Health and the Environment

Under Alternative 1, there would be no reduction in risk to human health because exposure to contaminants in groundwater through direct contact, ingestion, and/or inhalation would be possible. Alternative 1 would be protective if no soil was exhumed from the FCS. However, there would be no management of soil containing residual contamination at concentrations above PCGs that is exhumed from the FCS. There would be unlimited access to the site, and future activities (such as residential use and groundwater use) would not be monitored or restricted.

6.2.1.2 Compliance with ARARs

Alternative 1 would comply with ARARs if soil at the FCS remained in place; however, if soil is exhumed from the FCS, Alternative 1 may not comply with ARARs related to the transportation and disposition of exhumed soil containing residual contamination. Alternative 1 may not comply with ARARs requiring cleanup of contamination that poses a risk to human health and the environment. Cleanup criteria may eventually be met under Alternative 1 given the natural attenuation of contaminants; however, this alternative does not comply with ARARs because there would be no monitoring to confirm that cleanup criteria have been met.

6.2.1.3 Long-term Effectiveness and Permanence

All current and future risks would remain under Alternative 1, except that some organics would attenuate naturally through volatilization, diffusion, and biological degradation, which would provide some degree of long-term reduction in risk at the site. No controls would be implemented to manage residual contamination that remains at the site or that is exhumed and disposed of offsite.

6.2.1.4 Reduction of Toxicity, Mobility, or Volume through Treatment

There would be no reduction of toxicity, mobility, or volume through treatment because no treatment technologies would be employed. No treatment residuals would be generated. Permanent or significant reduction in toxicity and volume would occur only gradually as natural biological, chemical, or physical degradation occurs. These processes would be inherently irreversible.

6.2.1.5 Short-term Effectiveness

No remedial action would be taken under Alternative 1. Therefore, there would be no short-term risks to the community or to workers resulting from the implementation of Alternative 1. Similarly, there would be no environmental impacts from remediation activities.

6.2.1.6 Implementability

No technology factors are evaluated (i.e., ability to construct or operate the technology, availability and reliability of the technology or specialists) under Alternative 1. There would be no impediments to implementing future remedial actions.

6.2.1.7 Cost

No costs are associated with Alternative 1.

6.2.2 Alternative S2 – Institutional Controls to Control the Disposition of Exhumed Soil

Under Alternative S2, institutional controls would be used to control the transportation and disposition of any soil exhumed from the FCS containing contaminants at concentrations exceeding PCGs.

6.2.2.1 Overall Protection of Human Health and the Environment

Residual concentrations of contaminants in soil do not pose a significant risk to human health or to onsite groundwater. Management of any soil exhumed from the FCS through institutional controls would ensure that the exhumed soil is transported and handled properly and that its final disposition would be in a location approved by ADCE and EPA. A Garrison Policy could be used to implement the institutional controls.

6.2.2.2 Compliance with ARARs

Institutional controls to control the disposition of exhumed soil would comply with ARARs for soil management.

6.2.2.3 Long-term Effectiveness and Permanence

Institutional controls would provide continued protection of the environment (i.e., surface water resources) as long as the institutional controls to control the disposition of exhumed soil are monitored and enforced. Potential threats associated with residual soil contamination are expected to gradually decrease as contaminant concentrations decrease over time through volatilization, diffusion, and biological degradation.

6.2.2.4 Reduction of Toxicity, Mobility, or Volume through Treatment

This alternative would result in no reduction in the intrinsic toxicity, mobility, or volume of contamination through treatment. Permanent or significant reduction in toxicity and volume would occur only gradually as natural biological, chemical, or physical degradation occurs. These processes would be inherently irreversible.

6.2.2.5 Short-term Effectiveness

The RAOs for protection of surface water would be achieved in the short term because institutional controls can quickly and readily be implemented through the established Garrison Policy.

6.2.2.6 Implementability

Institutional controls are readily implementable. The legal mechanisms (e.g., a Garrison Policy) and processes (e.g., DPW work orders, service orders, and checklists) necessary to implement the alternative are available. Because the Army owns the property, it would have unrestricted access to the property to monitor and enforce the institutional controls.

6.2.2.7 Cost

At 30 years, the estimated present-worth cost for implementation of Alternative S2 is $41,600. Details regarding the cost estimates can be found in Appendix C.

6.2.3 Alternative GW2 – MNA, and Institutional Controls to Prohibit Groundwater Use

Under Alternative GW2, institutional controls would be used to eliminate or limit exposure pathways for COCs in groundwater to human receptors. In addition, MNA (i.e., groundwater monitoring and data evaluation) would be performed periodically to obtain information regarding the effectiveness of the natural attenuation process in remediating the contamination, as well as to track the extent of contaminant migration from the source area.

6.2.3.1 Overall Protection of Human Health and the Environment

Protection of human health would be achieved and maintained under Alternative GW2 by preventing exposure to contaminants. A Garrison Policy would be used to restrict the installation of potable water wells and prevent site-derived groundwater use by site residents. Assuming that no breach would occur, exposure pathways would be incomplete, and no human health risks would be posed. Institutional controls alone would provide environmental protections above those that would be provided by the No Action Alternative. Under this alternative, contamination would be left in place; however, organic contaminants in groundwater would attenuate naturally through volatilization and diffusion, and degrade as a result of natural biological processes, which would provide some additional degree of protection of human health and the environment. Groundwater monitoring would provide data regarding the natural attenuation of contaminants and the migration of contaminants toward water bodies around the FCS and/or the Fort Wainwright water supply wells northeast of the FCS.

6.2.3.2 Compliance with ARARs

Institutional controls would comply with ARARs for protection of human health.

6.2.3.3 Long-term Effectiveness and Permanence

Institutional controls would provide continued protection of human health and the environment as long as the institutional controls to prohibit groundwater use are monitored

and enforced. Risks posed by contaminants in groundwater are expected to gradually decrease as contaminant concentrations decrease over time through volatilization, diffusion, and biological degradation. Because the groundwater contamination remains in place, the drinking water pathway would become complete if there is a violation of the institutional controls or if contaminant migration reaches the drinking water supply. Groundwater monitoring would provide data to demonstrate the long-term effectiveness of the natural attenuation and degradation processes and potential migration of contaminants toward the Fort Wainwright water supply wells.

6.2.3.4 Reduction of Toxicity, Mobility, or Volume through Treatment

This alternative would result in no reduction in the intrinsic toxicity, mobility, or volume of contamination through treatment. Permanent or significant reduction in toxicity and volume would occur only gradually as natural biological, chemical, or physical degradation occurs. These processes would be inherently irreversible.

6.2.3.5 Short-term Effectiveness

The RAOs for protection of human health and the environment would be achieved in the short term because contaminants would not be disturbed (restriction to groundwater use) under this alternative. If a breach of the institutional controls occurs and contaminated groundwater is used, a receptor could be exposed to contaminants.

Implementing and monitoring institutional controls would pose only minor exposure risk to workers. Because a well developed groundwater monitoring well system is already in place at the FCS, installation of new wells is not expected; therefore, risks to the community or to workers as a result of implementing the action would not occur. The institutional controls would be implemented before or upon residential use. Upon implementation of the institutional controls, the RAOs for protection of human health would be achieved.

RAOs to restore groundwater use will eventually be met. Contaminant concentrations will decrease because of natural attenuation and degradation.

6.2.3.6 Implementability

Institutional controls are readily implementable. The legal mechanisms (e.g., a Garrison Policy) and processes (e.g., DPW work orders, service orders, and checklists) necessary to implement the alternative are available. Because the Army owns the property, it would have unrestricted access to the property to monitor and enforce the institutional controls. Downgradient and upgradient groundwater monitoring wells are spatially located throughout the FCS. Should additional monitoring wells be necessary, construction contractors and equipment would be readily available. Implementing a groundwater monitoring plan may interfere with future residential activities at the FCS.

6.2.3.7 Cost

At 30 years, the estimated present-worth cost for implementation of Alternative GW2 is $456,000. This includes costs for labor, materials, laboratory analysis, and reporting. Details regarding the cost estimates can be found in Appendix C.

6.2.4 Alternative GW3 – ISCO, and Institutional Controls to Prohibit Groundwater Use

Under Alternative GW3, ISCO would be used to decrease concentrations of COCs below cleanup goals and therefore restore groundwater use at the FCS. Institutional controls would be implemented until cleanup goals are met to eliminate or limit exposure pathways for COCs in groundwater to human receptors.

6.2.4.1 Overall Protection of Human Health and the Environment

Alternative GW3 involves the injection of a strong oxidizer to destroy organic contaminants in situ. Alternative GW3 would be protective of human health and the environment as it would reduce contaminant levels within the aquifer.

Institutional controls preventing site groundwater use would effectively prevent exposure to contaminated groundwater until cleanup goals are met. Assuming that no breach would occur, exposure pathways would be incomplete, and no human health risks would be posed. Performance monitoring would verify the overall performance of the remedy.

6.2.4.2 Compliance with ARARs

The application of ISCO under Alternative GW3 would comply with chemical-specific ARARs by reducing concentrations of contaminants to below cleanup levels. Prior to and during ISCO implementation, compliance with ARARs associated with the protection of human health would be achieved using institutional controls. Groundwater monitoring would assess compliance with chemical-specific ARARs as the result of treatment.

6.2.4.3 Long-term Effectiveness and Permanence

Alternative GW3 is intended to remediate the VOC plumes by reducing contaminant concentrations in shallow groundwater to achieve cleanup goals. These processes would be inherently irreversible. ISCO would be an effective long-term and permanent remedy that is protective of human health and the environment. To maintain oxidizing conditions, one reinjection event is assumed to occur approximately 1 year after the initial injection event. Groundwater monitoring would provide data to prove the long-term effectiveness of the treatment technology (no rebound concentrations), and the potential migration of contaminants toward the Fort Wainwright water supply wells. It should be noted that there is currently no indication that groundwater contaminants are migrating toward the Fort Wainwright water supply wells.

6.2.4.4 Reduction of Toxicity, Mobility, or Volume through Treatment

Under Alternative GW3, ISCO would reduce the toxicity, mobility, and volume of contaminants in groundwater at the FCS, which meets the statutory preference for treatment. The degree of effectiveness is dependent on achieving a complete and even delivery of the oxidant through the treatment area. These processes would be inherently irreversible.

6.2.4.5 Short-term Effectiveness

Implementation of Alternative GW3 would entail remediation activities (drilling of temporary injection points, chemical oxidant mixing and injection systems) at the FCS, with the potential to affect the current housing development through noise, dust, and traffic.

Driving the temporary injection points would pose some risks to remediation workers from exposure to contaminated soils and/or groundwater. Remediation workers would also be potentially exposed to the chemical oxidants. A rigorous health and safety plan would have to be developed and implemented to minimize risks to workers and the community.

Oxidation (i.e., destruction) of contaminants would occur relatively rapidly. Cleanup goals are anticipated to be met within 2 years. Prior to the implementation of the ISCO, institutional controls to prohibit groundwater use would be implemented until groundwater cleanup goals are met throughout the FCS and groundwater use is restored. Upon implementation of the institutional controls, the RAOs for protection of human health would be achieved.

6.2.4.6 Implementability

Alternative GW3 is readily implementable. Contractors required for installing temporary injection points, mixing, and injecting the chemical oxidants are readily available. Chemical oxidant vendors are also readily available.

6.2.4.7 Cost

At 30 years, the estimated present-worth cost for implementation of Alternative GW3 is $1,265,400. The major capital cost elements of Alternative GW3 include the temporary injection points and the chemical oxidant mixing and injection systems. Costs for a pilot test, performance monitoring, and reporting are also included. Details regarding the cost estimates can be found in Appendix C.

SECTION 7

Comparative Analysis of Alternatives

This section provides a comparative analysis of the relative performance of each alternative in relation to the seven CERCLA evaluation criteria. The alternatives have been segregated into soil (S) and groundwater (GW) alternatives. This approach will better facilitate the evaluation of alternatives for each media of concern.

The comparative analysis identifies advantages and disadvantages of the alternatives relative to one another based on seven of the nine CERCLA evaluation criteria described in Section 6.1.

7.1 Soil Alternatives

The alternatives compared for soil are as follows:

- Alternative 1 – No Action
- Alternative S2 – Institutional Controls to Control the Disposition of Exhumed Soil

7.1.1 Overall Protection of Human Health and the Environment

Residual concentrations of contaminants in soil do not pose a significant risk to human health or to onsite groundwater. However, if exhumed from the FCS, soil containing contaminants at concentrations exceeding PCGs may pose a potential threat to surface water if disposed of offsite. Alternative 1 would not reduce the potential threat to surface water. Alternative S2 would ensure that the exhumed soil is handled properly and that its final disposition would be in a location that ensures protection of surface water. Therefore, Alternative S2 would be more protective of the environment.

7.1.2 Compliance with ARARs

Alternative 1 would be compliant with ARARs if soil at the FCS remained in place; however, if soil is exhumed from the FCS, Alternative 1 may not be compliant with ARARs related to the disposition of exhumed soil containing residual contamination. Alternative S2 is compliant with ARARs for protection of surface water.

7.1.3 Long-term Effectiveness and Permanence

There are no controls implemented to manage residual soil contamination under Alternative 1. If soil remained in place at the FCS, Alternative 1 would meet the criterion for long-term effectiveness and permanence. However, if any soil was exhumed from the FCS, Alternative 1 would no longer meet the criterion. Alternative S2 would ensure that the exhumed soil is handled properly and that its final disposition would be in a location that ensures protection of surface water. Institutional controls to control the disposition of exhumed soil under Alternative S2 would provide continued protection of the environment as long as they are monitored and enforced. Thus, Alternative S2 would meet the criterion for long-term effectiveness and permanence. Alternative S2 better meets the long-term effectiveness and permanence criterion for the FCS.

7.1.4 Reduction of Toxicity, Mobility, or Volume through Treatment

Alternatives 1 and S2 would not reduce toxicity, mobility, and volume of contaminants present at the site through treatment because no treatment technologies would be employed. However, some toxicity, mobility, and volume reductions would occur through natural physical, chemical, and biological processes. In addition, through implementation of institutional controls under Alternative S2, the mobility of contaminants may additionally be controlled by proper handling and disposition of any exhumed soil.

7.1.5 Short-term Effectiveness

No remedial action will be taken under Alternative 1; therefore, there is no short-term effectiveness associated with this alternative. Therefore, no environmental impacts will occur, and no short-term risks to the community or to workers as a result of implementing Alternative 1 will occur. Implementation of the institutional controls under Alternative S2 would not pose any additional risk to human health and/or the environment. Alternative S2 would provide for immediate control over the disposition of exhumed soil and would provide immediate protection for offsite surface water.

Alternative S2 is ranked highest with regard to short-term effectiveness.

7.1.6 Implementability

There are no actions associated with Alternative 1. Therefore, there are no technical impediments to implementing Alternative 1. Alternative S2 is readily implementable through the established Garrison Policy.

7.1.7 Cost

The estimated costs for implementing the soil alternatives evaluated in this FS report are presented in Table 7-1. Detailed cost calculations are presented in Appendix C. Note that if both Alternative S2 and Alternative GW2 are selected, the institutional control costs are duplicative (i.e., the cost for implementing institutional controls would be the same whether Alternative S2 was selected or both Alternatives S2 and GW2 were selected).

TABLE 7-1
Summary of Costs for Remedial Alternatives (PV_{30})
Feasibility Study, Former Communications Site, Fort Wainwright, Alaska

Remedial Alternative	Costs (PV_{30})
Alternative 1	$0
Alternative S2	$41,600
Alternative GW2	$456,000
Alternative GW3	$1,265,400

Notes:

Alternative 1 = No Action
Alternative S2 = Institutional Controls to Control the Disposition of Exhumed Soil
Alternative GW2 = MNA, and Institutional Controls to Prohibit Groundwater Use
Alternative GW3 = ISCO, and Institutional Controls to Prohibit Groundwater Use

PV_{30} = present value (30 years)

No costs are associated with Alternative 1. Alternative S2 ($41,600) is more expensive than Alternative 1.

7.2 Groundwater Alternatives

The alternatives compared for groundwater are as follows:

- Alternative 1 – No Action
- Alternative GW2 – MNA, and Institutional Controls to Prohibit Groundwater Use
- Alternative GW3 – ISCO, and Institutional Controls to Prohibit Groundwater Use

7.2.1 Overall Protection of Human Health and the Environment

Alternative 1 would not reduce the risk to human health because exposure to contaminants in groundwater would still be possible. Alternative GW2 would protect human health by preventing exposure to contaminants through the implementation of institutional controls that prohibit onsite groundwater use.

Alternative GW3 would protect human health and the environment by the implementation of in situ treatment (ISCO), which would reduce concentrations of contaminants in groundwater. Institutional controls would be implemented under Alternative GW3 to prohibit exposure to groundwater (such as in Alternative GW2) until cleanup goals are met.

7.2.2 Compliance with ARARs

Alternative 1 does not comply with potentially applicable ARARs. The No Action alternative does not meet EPA's national program goal identified in the NCP (40 CFR 300.430(a)(1)(i)) for the remedy selection process, which is to "select remedies that are protective of human health and the environment, that maintain protection over time, and that minimize untreated waste." Some organics would attenuate naturally through volatilization, diffusion, and biological degradation, which would provide some degree of contaminant concentration reduction; however, Alternative 1 does not provide a means to assess the natural attenuation.

Alternative GW2 would comply with ARARs for the protection of human health and the environment by implementing institutional controls to prohibit groundwater use. In addition, Alternative GW2 would assess natural attenuation through continued monitoring.

Alternative GW3 would comply with chemical-specific ARARs by reducing concentrations of contaminants below PCGs. Institutional controls prohibiting groundwater use would protect human health until cleanup goals are met. Alternative GW3 would comply with action-specific ARARs as long as proper disposal of excavated soil and/or waste is conducted.

7.2.3 Long-term Effectiveness and Permanence

There are no controls implemented to manage untreated wastes and risks that remain at the sites for Alternative 1. Therefore, under Alternative 1, the criterion for long-term effectiveness and permanence is not met except to the extent that organic compounds would attenuate naturally through volatilization, diffusion, and biological degradation, which would provide some degree of long-term reduction in risk at the site; however, Alternative 1 does not provide a means to assess the effectiveness of natural attenuation.

Institutional controls to prohibit groundwater under Alternative GW2 would provide continued protection of human health and the environment as long as they are monitored and enforced. Groundwater monitoring would provide data to demonstrate the long-term effectiveness of the natural attenuation processes and the migration of contaminants toward drinking water supply wells.

Alternative GW3 would remediate the contaminant plumes by reducing contaminant concentrations in shallow groundwater to achieve site cleanup goals. Alternative GW3 would effectively and permanently prevent 1,2,3-trichloropropane from entering the supply well capture zone so that the human exposure pathway is not completed. Alternative GW3 would be an effective long-term and permanent remedy that is protective of human health and the environment. Groundwater monitoring would provide data to demonstrate the long-term effectiveness of the treatment technology, the natural attenuation processes, and the potential migration of contaminants toward the drinking water supply east of the FCS.

Alternative GW3 is ranked the highest with regard to long-term effectiveness and permanence, followed by Alternative GW2. Alternative 1 is ranked the lowest.

7.2.4 Reduction of Toxicity, Mobility, or Volume through Treatment

Alternatives 1 and GW2 would not reduce toxicity, mobility, and volume of contaminants present at the site through treatment because no treatment technologies would be employed. However, some toxicity, mobility, and volume reductions would occur through natural physical, chemical, and biological processes; however, Alternative 1 does not provide a means to assess the reduction of toxicity, mobility, or volume resulting from natural attenuation. Under Alternative GW2, the mobility and reduction of toxicity and volume of contaminants would be assessed through groundwater monitoring.

Alternative GW3 would significantly reduce the toxicity, mobility, and volume of contaminants in groundwater at the FCS.

Alternative GW3 is ranked the highest with regard to reduction of toxicity, mobility, or volume, followed by Alternative GW2. Alternative 1 is ranked the lowest.

7.2.5 Short-term Effectiveness

No remedial action will be taken under Alternative 1. Therefore, no environmental impacts will occur, and no short-term risks to the community or to workers as a result of implementing Alternative 1 will occur. Contaminants would be left in place and potential impacts to human health and the environment may occur.

Under Alternative GW2, contaminants would be left in place and institutional controls implemented, maintained, monitored, and enforced to prevent exposures to human receptors. Protection of human health and the environment would be effective upon implementation of institutional controls. These actions, by themselves, would entail no significant adverse risks to the environment or health of the community and workers.

Under Alternative GW3, institutional controls to prohibit groundwater use would be implemented prior to residential use and the implementation of the ISCO treatment. Protection of human health and the environment would be effective upon implementation of institutional controls. Implementation of the in situ treatments would entail construction activities at the FCS with the potential to affect the current housing development through

noise, dust, and traffic. A rigorous health and safety plan would have to be developed and enforced to minimize risks to workers and the community during implementation of remedy. Implementation of Alternative GW3 may increase total suspended solids in groundwater and therefore reduce the groundwater quality.

Alternative GW2 is ranked the highest with regard to short-term effectiveness, followed by Alternative GW3. Alternative 1 is ranked the lowest.

7.2.6 Implementability

There are no actions associated with Alternative 1. Therefore, there are no technical impediments to implementing Alternative 1.

Institutional controls and monitoring under Alternative GW2 are readily implementable. Groundwater monitoring wells are currently installed at the FCS. Vendors and contractors are readily available should installation of additional groundwater monitoring wells be considered necessary.

The ISCO system under Alternative GW3 is technically implementable; however, injection of the oxidant could be difficult to control. Temporary oxidant storage facilities are likely to be in place near the injection zones. ISCO is commercially available and does not generate a waste stream that requires treatment or disposal. Current site surface features may interfere with the construction activities considering the importance of the location of injection points.

Alternative 1 is ranked the highest with regard to implementability, followed by Alternative GW2. Alternative GW3 is ranked the lowest.

7.2.7 Cost

The estimated costs for implementing the groundwater alternatives evaluated in this FS report are presented in Table 7-1. Detailed cost calculations are presented in Appendix C. Note that if both Alternative S2 and Alternative GW2 are selected, the institutional control costs are duplicative.

No costs are associated with Alternative 1. Alternative GW2 ($456,000) is less expensive than Alternative GW3 ($1,265,400).

7.3 Ranking of Alternatives

Based on the comparative analysis above, the alternatives for each media of concern were ranked relative to one another based on seven of the nine CERCLA evaluation criteria (see Table 7-2). The first two criteria (overall protection of human health and compliance with ARARs) are threshold criteria and were not ranked numerically, rather each alternative was determined to either meet or not meet these criteria. Alternative 1 for soil and groundwater was determined not to meet one of the threshold criteria. For each of the remaining five criteria, each alternative was assigned a value between 1 and 3, with 1 representing the highest ranking alternative for that criterion. The values for each alternative were then summed determine an overall ranking of alternatives. As shown in Table 7-2, Alternative S2 is the highest ranking alternative for soil and Alternative GW2 is the highest ranking alternative for groundwater. It should be noted that this ranking of alternatives is subjective and gives equal weight to each of the criteria.

TABLE 7-2
Ranking of Alternatives
Feasibility Study, Former Communications Site, Fort Wainwright, Alaska

	Soil Alternatives		Groundwater Alternatives		
Criterion	**1**	**S2**	**1**	**GW2**	**GW3**
Overall protection of human health and environment[a]	Yes	Yes	Yes	Yes	Yes
Compliance with ARARs[a]	No	Yes	No	Yes	Yes
Long-term effectiveness and permanence	3	2	3	2	1
Reduction of toxicity, mobility, or volume through treatment	3	2	3	2	1
Short-term effectiveness	3	1	3	1	2
Implementability	1	2	1	2	3
Cost	1	2	1	2	3
Total[b]	**11**	**9**	**11**	**9**	**10**

[a] The first two criteria are threshold criteria and were not ranked numerically. Each alternative is determined to meet or not meet these criteria.

[b] The lowest total indicates the highest ranking among each set of alternatives.

SECTION 8

Works Cited

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Appendix A
Analysis of Potential Applicable or Relevant and Appropriate Requirements

APPENDIX A

Analysis of Potential Applicable or Relevant and Appropriate Requirements

A.1 Introduction

Section 121(d) of the Comprehensive Environmental Response, Compensation, and Liability Act of 1980 (CERCLA) states that remedial actions on CERCLA sites must attain (or justify the waiver of) any federal or more stringent state environmental standards, requirements, criteria, or limitations that are determined to be applicable or relevant and appropriate requirements (ARARs). Applicable requirements are those cleanup standards, criteria, or limitations promulgated under federal or state law that specifically extend to the situation at a CERCLA site. A requirement is applicable if the jurisdictional prerequisites of the environmental standard show a direct correspondence when objectively compared with the conditions at the site.

If a requirement is not applicable, the requirement may be relevant and appropriate. Relevant and appropriate requirements are those cleanup standards, standards of control, and other substantive environmental protection requirements, criteria, or limitations promulgated under federal or state law that, while not applicable, address problems or situations sufficiently similar to the circumstances of the proposed response action and are well suited to the conditions of the site. The criteria for determining relevance and appropriateness are listed in Title 40, Code of Federal Regulations (CFR), Section 300.400(g)(2).

ARARs are concerned only with substantive, not administrative, requirements of a statute or regulation. The substantive portions of the regulation are those requirements that pertain directly to actions or conditions in the environment. Examples of substantive requirements include quantitative health- or risk-based restrictions upon exposure to types of hazardous substances. Administrative requirements are the mechanisms that facilitate implementation of the substantive requirements. Administrative requirements include issuance of permits, documentation, reporting, recordkeeping, and enforcement. Thus, in determining the extent to which onsite CERCLA response actions must comply with environmental laws, a distinction should be made between substantive requirements, which may be ARARs, and administrative requirements, which are not.

Furthermore, the ARARs provision in CERCLA applies to onsite actions. “Onsite” is defined as the areal extent of contamination and areas in proximity to it necessary for the implementation of the remedy. According to CERCLA Section 121(e), a remedial response action that takes place entirely onsite is exempt from administrative portions of ARARs and may proceed without the obtaining of permits. This permit exemption applies to all administrative requirements, as well as to permits. Actions taken offsite must comply with all applicable laws and regulations. Thus, actions such as offsite disposal of waste will

comply with all laws and regulations applicable to the actions, but the laws and regulations governing offsite activities are not ARARs for the purpose of this feasibility study (FS).

Pursuant to U.S. Environmental Protection Agency (EPA) guidance, ARARs generally are classified into three categories: chemical-specific, location-specific, and action-specific requirements. These three categories of ARARs are defined below:

- **Chemical-specific ARARs** include those laws and requirements that regulate the release to the environment of materials possessing certain chemical or physical characteristics or containing specified chemical compounds. These requirements generally set health- or risk-based concentration limits or discharge limitations for specific hazardous substances. If, in a specific situation, a chemical is subject to more than one discharge or exposure limit, the more stringent of the requirements should generally be applied.
- **Location-specific ARARs** are those requirements that relate to the geographical or physical position of the site, rather than the nature of the contaminants or the proposed site remedial actions. These requirements may limit the placement of remedial action, and may impose additional constraints on the cleanup action.
- **Action-specific ARARs** are requirements that define acceptable handling, treatment, and disposal procedures for hazardous substances. These ARARs generally set performance, design, or other similar action-specific controls or restrictions on particular kinds of activities related to management of hazardous substances or pollutants. These requirements are triggered by the particular remedial activities that are selected to accomplish a remedy. Because a remedial site usually involves several alternative actions, very different action-specific requirements can apply.

A requirement may not meet the definition of ARAR as defined above, but may still be useful in determining whether or how to take action at a site or to what degree action is necessary. This can be particularly true when there are no ARARs for a site, action, or contaminant. Such requirements are called to-be-considered (TBC) criteria. TBC materials are advisories or guidance issued by federal or state government that are not legally binding, but that may provide useful information or recommended procedures for remedial action. Although TBCs do not have the status of ARARs, they may be considered together with ARARs to establish the cleanup levels or processes for protection of human health or the environment. The critical difference between a TBC criterion and an ARAR is that one is not required to comply with or meet a TBC criterion when deciding on a remedial action.

A.2 ARARs Analysis Process

ARARs and TBCs are identified at various points throughout the EPA Superfund process. These criteria are identified on a site-specific basis, and therefore, as additional information is developed about the site, including special features of the site location, the specific chemicals at the site, and the actions that are being considered as remedies, more ARARs may be identified, and the list of potential ARARs further refined. Potential ARARs are usually identified in the FS. After consultation with the state, the lead agency (in this case, the Army) makes the formal determination of ARARs for a remedial action in the Record of Decision (ROD) selecting that action.

Each requirement was evaluated to determine if it was applicable or relevant and appropriate to the circumstances at the site. Potential ARARs were selected after evaluating where the state and federal programs and regulations overlapped, then selecting the most stringent requirement. The ARARs presented in this analysis are considered potential ARARs. Upon selection of a remedy for media, the ROD will provide a final listing of the ARARs.

A.3 Waivers

CERCLA Section 121 provides that, under certain circumstances, an otherwise applicable or relevant and appropriate requirement may be waived in the ROD. These waivers apply only to the attainment of the ARAR; other statutory requirements, such as that remedies must be protective of human health and the environment cannot be waived. If a waiver is proposed, the Proposed Plan would include a statement that identifies the ARAR to be waived and the basis for that waiver. The waivers provided by CERCLA Section 121(d)(4) are listed below:

1. **Interim Remedy –** The remedial action selected is only part of a total remedial action that will attain such a level or standard of control when completed.
2. **Greater Risk to Human Health or the Environment –** Compliance with the requirement at the site will result in greater risk to human health and the environment than alternative options.
3. **Technical Impracticability –** Compliance with the requirement is technically impracticable from an engineering perspective.
4. **Equivalent Standard of Performance –** The remedial action selected will attain a standard of performance that is equivalent to that required under the otherwise applicable standard, requirement, criteria, or limitation through use of another method or approach.
5. **Inconsistent Application of State Requirements –** With respect to a state standard, requirement, criterion, or limitation, the state has not consistently applied (or demonstrated the intention to consistently apply) the standard, requirement, criterion, or limitation in similar circumstances at other remedial actions.
6. **Fund Balancing –** The Fund Balancing waiver does not apply to Department of Defense sites.

A.4 Chemical-specific ARARs

Chemical-specific ARARs are summarized in Table A-1.

A.5 Location-specific ARARs

Location-specific ARARs may affect implementation of the remedial action because of the physical or geographical position of the specific location to be remediated. No location-specific ARARs have been identified.

A.6 Action-specific ARARs

The potential federal and state action-specific ARARs for the alternatives discussed in this FS report are summarized in Table A-2. These ARARs generally set performance, design, or other similar action-specific controls or restrictions on certain activities related to management of hazardous substances or pollutants.

Tables

TABLE A-1
Potential Chemical-specific ARARs
Feasibility Study, Former Communications Site, Fort Wainwright, Alaska

Source	Standard, Requirement, Criterion, or Limitation	ARAR Status	Description	Comment
Alaska Water Quality Standards	18 AAC 70	Applicable	These standards apply to groundwater and surface water and establish criteria for protected classes of water use. In addition, Alaska has adopted a non-degradation policy for waters of quality that is higher than quality in the criteria. For water that is used for more than one purpose, ADEC regulations state that the most stringent water-quality criteria ARARs should be used. For toxic and other deleterious organic and inorganic substances, the ADEC water-quality criteria reference EPA ambient water-quality criteria or Alaska drinking water standards. For petroleum hydrocarbons, oil, and grease, the ADEC water-quality criteria include a maximum of 15 µg/L for TAqH and a maximum of 10 µg/L for TAH. In addition, levels of those contaminants may not cause a visible sheen or discoloration to surface waters and adjoining shorelines.	Remedial alternatives evaluated must consider attainment of these standards for water quality.
Alaska Oil and Hazardous Substances Pollution Control	18 AAC 75.300 to 75.396	Applicable	The Alaska Contaminated Sites Program addresses releases (past and present) of oil and hazardous substances. This article addresses discharge reporting, cleanup, and disposal of oil and other hazardous substances. It contains cleanup levels for soil, groundwater, and surface water.	Remedial alternatives evaluated must consider attainment of these standards for soil, groundwater, and surface water.
Alaska Drinking Water Regulations	18 AAC 80.300 to 80.375	Applicable	These regulations establish MCCs for organic and inorganic contaminants in public water systems. These concentrations are equivalent to, or more stringent than, the MCLs of the SDWA.	Remedial alternatives evaluated must consider attainment of these standards for drinking water.
Alaska Spill Prevention and Response	SPAR Guidance 2002-1	TBC	This guidance states the requirements for offsite transport and disposal of contaminated soil per elements of 18 AAC 75 and 18 AAC 78.	Any offsite disposal of contaminated soil must consider this guidance.

Notes:

µg/L = microgram(s) per liter
AAC = Alaska Administrative Code
ADEC = Alaska Department of Environmental Conservation
MCC = maximum contaminant concentration
MCL = maximum contaminant limit
SDWA = Safe Drinking Water Act
TAH = total aromatic hydrocarbon
TAqH = total aqueous hydrocarbon
TBC = to be considered

TABLE A-2
Potential Federal and State Action-specific ARARs
Feasibility Study, Former Communications Site, Fort Wainwright, Alaska

Action	Standard, Requirement, Criterion, or Limitation	ARAR Status	Description	Comment
Cleanup of releases to the environment	18 AAC 75.300 to 75.396	Applicable	The Alaska Contaminated Sites Program addresses releases (past and present) of oil and hazardous substances. The site cleanup rules establish 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.	Applicable to site cleanup activities.
Remediation of contaminated media	40 CFR 63 Subpart G	Relevant and Appropriate	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.
UST release response	18 AAC 78	Applicable	Establishes corrective action requirements for petroleum releases from leaking USTs and for removal of USTs.	Applicable if petroleum contamination is associated with USTs; relevant and appropriate if petroleum contamination is found that is not associated with USTs.
Managing contaminated soil	18 AAC 60	Applicable	These regulations set requirements for the management of solid waste, including hazardous waste. Waste must be managed to prevent violation of the Alaska water quality standards (18 AAC 70). The solid waste regulations also include requirements for certain management and disposal options for “polluted soil,” including transporting, landfilling, and landspreading.	Applicable if soils generated during remediation are disposed of offsite.
Management and identification of wastes	40 CFR Part 261	Applicable to RCRA waste	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 focus on whether the generated waste could be classified as toxicity characteristic waste as defined by the contaminant concentrations. The toxicity characteristic is determined by running a TCLP test on the waste.	

TABLE A-2
Potential Federal and State Action-specific ARARs
Feasibility Study, Former Communications Site, Fort Wainwright, Alaska

Action	Standard, Requirement, Criterion, or Limitation	ARAR Status	Description	Comment
Offsite disposal of contaminated waste	40 CFR 268	Applicable to RCRA waste	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.	
Transportation of hazardous waste	49 CFR 171-177	Applicable to RCRA waste	Establishes standards for packaging, labeling, and transportation of hazardous materials.	Applicable if RCRA wastes are sent offsite for disposal.
Planning and implementing offsite response actions	40 CFR 300.440	Applicable	Offsite transfer of CERCLA remediation waste for disposal must be to an EPA-approved facility.	This requirement applies to offsite disposal.
Corrective Action (Staging Piles)	40 CFR 264.554	Applicable to RCRA waste	During corrective action, remediation waste can be placed in piles without triggering LDRs or MTRs. Must not operate piles for more than 2 years.	This provision would allow for temporary storage of remediation wastes characterized as hazardous before offsite disposal.
Occupational safety and health standards	8 AAC 61	Applicable	Alaska has a delegated occupational safety and health program. This program sets standards for safety in the work environment.	

Notes:

AAC = Alaska Administrative Code
CERCLA = Comprehensive Environmental Response, Compensation, and Liability Act of 1980
CFR = Code of Federal Regulations
EPA = U.S. Environmental Protection Agency
LDR = land disposal restriction
MTR = minimum technological requirement
RCRA = Resource Conservation and Recovery Act
TCLP = toxicity characteristic leaching procedure
UST = underground storage tank

Appendix B
Garrison Policy

DEPARTMENT OF THE ARMY
INSTALLATION MANAGEMENT COMMAND
HEADQUARTERS, U.S. ARMY GARRISON FORT WAINWRIGHT
1060 GAFFNEY ROAD #6000
FORT WAINWRIGHT, ALASKA 99703-6000

REPLY TO
ATTENTION OF:

IMPC-FWA-PWE

MEMORANDUM FOR SEE DISTRIBUTION

SUBJECT: Land Use Controls/ Institutional Controls (Garrison Policy)

1. References:

a. AR 600-20, 27 April 2010, *Army Command Policy*

b. AR 200-1,13 December 2007, *Environmental Quality; Environmental Protection and Enhancement*

c. USAG FWA, Garrison Policy #22, *Spill Reporting Requirements for All Units/Organizations and Activities on Fort Wainwright*.

d. Memorandum: DUSD (ES/CL) 17 January 2001; *Policy on Land Use Controls Associated with Environmental Restoration Activities*

e. Executive Order 12580, *Implementation of Superfund*, 23 January 1987, as amended by Executive Order 13308, 20 June 2003, *Further Amendment to Executive Order 12580, as Amended, Superfund Implementation*

f. 40 CFR 300, *National Oil and Hazardous Substances Pollution Contingency Plan*.

g. 42 USC 9601 et seq. *Comprehensive Environmental Response, Compensation, and Liability Act of 1980, as Amended by the Superfund Amendment and Reauthorization Act of 1986.*

h. 10 USC 2710(b) Military Munitions Response Program, Inventory of UXO, DMM, and MC Defense Sites other than operational ranges.

i. USAG FWA, Federal Facility Agreement as amended under CERCLA Section 120, Administrative Docket Number: 1092-04-10-120 April 2007.

2. Purpose: To update and disseminate the Land Use Controls/ Institutional Controls (LUC/IC) Policy for USAG FWA.

3. Applicability:

a. This policy applies to all individuals, units, Directorates, activities, organizations, partners and tenants which includes the U.S Army Corps of Engineers in its entirety, all Prime and Sub-Contractors, and Consultants; all personnel working for contractor owned, contractor operated facilities and operations; Government Owned, Contractor Operated facilities and operations; and personnel living, working, or conducting other authorized activities on USAG FWA

controlled lands and are therefore responsible for complying with all established LUC/ICs identified in this document.

b. These LUC/ICs cover all contiguous and non-contiguous properties under the control of USAG FWA.

c. Specific land use restrictions cited in this policy as well as those established in Comprehensive Environmental Response Compensation and Liability Act Record of Decisions shall be incorporated into all lease agreements, Memoranda of Agreement, and contract documents, as necessary to reduce the potential for exposure to environmental hazards.

d. In addition to these LUC/ICs, all units or personnel entering US Army Garrison Fort Wainwright Alaska Ranges and Training Areas shall also comply with the directives of the Range Control Officer and Range Control Standard Operating Procedures.

e. Penalties for violating this policy include the full range of statutory and regulatory sanctions for military and civilian personnel according to the following citations:

1. For military personnel, the Uniform Code of Military Justice (UCMJ) Article 92(1), violation of a lawful general regulation, and service-specific regulations.

2. For civilian personnel, Army Regulation (AR) 690-700, Chapter 751; and the Code of Federal Regulation, Title 5, Chapter 1, Part 752. Commanders should contact their servicing civilian personnel activity for assistance concerning punitive actions for civilian personnel.

4. Procedures: The Directorate of Public Works (DPW) shall ensure that the following procedures are in place to comply with this policy:

a. All construction, maintenance, repairs, and authorized training activities conducted anywhere within active ranges and training areas that involve soil disturbing activities impacting soils six inches or more below the ground surface in known contaminated areas, shall comply with LUC/ICs requirements in addition to Range Control directives, and Range Control standard operating procedures.

b. All soil disturbing activities impacting soils six inches or more below the ground surface anywhere on the installation must have a DPW approved DA Form 4283 (Work Order) or DPW approved Service Order, a signed and approved Excavation Clearance Request (ECR) from DPW Customer Service Desk and a completed and signed Project Checklist for Environmental Concerns. During this process, DPW Environmental personnel will identify applicable LUC/ ICs, identify known or suspected contamination, and other pertinent information and requirements. This process shall be followed for the listed activities which include but are not limited to the following:

1. Installation, maintenance, and removal of facilities, infrastructure, landscaping, and private fence/gates in North Haven Communities and Army Family Housing.

2. Installation, maintenance, and repair of facilities, infrastructure or utilities by DPW workers, service contractors, privatized utility or privatized housing partners, organizations, tenants, soldiers, units and Family Housing Residents.

3. Military Construction Army (MCA) contracts for facilities, utilities, ranges or other infrastructure.

4. Landscaping, erosion control, Storm Water Pollution Prevention mitigations or similar activities anywhere on the installation.

5. Installation of investigative test pits, soil borings, remediation systems, dewatering wells, monitoring wells, or potable water wells for whatever reason. Submission of the request for installation and justification for dewatering or potable water wells shall be coordinated through the DPW Environmental Office not less than 365 days prior to installation of the wells.

c. If any of the above listed activities occurs in an area of known or suspected contamination, the Work Order shall be accompanied by a US Army, EPA and ADEC approved Work Plan that addresses the following:

1. The nature of the contaminants of concern.

2. How the construction workers will deal with the contaminated media.

3. Protection of existing ground water monitoring wells.

4. Decommissioning of existing ground water monitoring wells that must be removed to facilitate the construction of new facilities or infrastructure.

5. Installation of new or replacement ground water monitoring wells

6. Construction and maintenance requirements for long-term contaminated soil stockpiles.

7. Final disposition of the exhumed contaminated material.

8. How the remaining/residual contaminated media will be mitigated to prevent future accidental exposure to contaminants of concern.

d. The discovery of readily identified or potentially hazardous waste, buried waste containers, discarded military munitions, unexploded ordnance, munitions debris, “unusual debris” or other forms of contamination in surface soil, sub-surface soil, ground water, or indoor/outdoor air within the cantonment area shall comply with the following process:

1. Immediately cease all work or training, move away from the area and notify the DPW Environmental Division at 361-9686 and await further guidance before proceeding with any other soil disturbing activity.

2. If DPW cannot be reached, call the emergency responders (911 on Post) or 353-9170 if calling from a cell phone or Family Housing Area.

3. If these items are found within an active training area or range, immediately move away from the area and notify Range Control via radio or call 353-1244.

4. Tenants or contractor's signature on an ECR acknowledges their understanding of Army Reporting Requirements regarding new contaminant finds. Failure to report this contamination constitutes a violation of US Code and Army Regulations.

e. Newly identified contaminated areas shall be added to the LUC/ IC list within 90 calendar days of final report on the contamination being received and approved by the Army, the EPA, and the ADEC.

f. DPW shall maintain an electronic map of all Installation Restoration Program sites and Military Munitions Response Program Sites. The map shall be updated as soon as practicable but, not more than 90 calendar days from confirmation of the nature and extent of site contamination.

g. Groundwater restrictions prohibit the drilling of water wells for potable water, fire suppression, irrigation or other purposes anywhere on the installation without written consent of the Garrison Commander or approved representative. Coordination for these activities must begin not less than 365 calendar days prior to the date required. DPW ENV will provide the necessary coordination with the EPA and ADEC.

h. DPW shall sample and analyze ground water monitoring wells up-gradient from the Installation Drinking Water Supply wells to ensure no contaminants of concern are migrating towards these wells from adjacent contaminated sites. DPW shall ensure that the analytical test methods used are capable of detecting the contaminants of concern at levels that are protective of human health.

i. Construction on known or potentially contaminated areas will not proceed until the site has been properly evaluated for its intended use as follows:

1. If Family Housing is planned for an area, investigative results will compare soil and groundwater results against unrestricted use scenarios. Occupants will be protected against exposure to hazardous levels of contaminants.

2. If new or upgraded infrastructure or unoccupied industrial facilities are planned, engineering controls will be incorporated into the design to ensure construction workers are not exposed to contaminant levels exceeding the OSHA PEL.

3. If volatile organic compounds or other hazardous materials are left in the soil or ground water under occupied building foundations, facility designs shall incorporate protective measures to prevent vapor intrusion into the breathing zone of the facility and prevent exposure to hazardous levels of sub-slab contaminants by occupants during normal activities.

j. DPW shall monitor sub-slab soil gas for all buildings in the Taku Gardens Family Housing area at each change of occupancy, but not less than every three years or until the US Army, EPA and ADEC agree the monitoring is no longer required.

k. DPW shall ensure the disposal of contaminated soil or groundwater approved for removal from the work site must be containerized and disposed of per IAW USARAK Pamphlet 200-1, *Hazardous Materials and Regulated Waste Management*.

l. Implementation details shall be updated in the USAG FWA Land Use Controls/Institutional Controls Standard Operating Procedures.

5. Modification or Revocation: Future modifications or revocation of this policy shall be conducted in consultation with the US Environmental Protection Agency (Region 10) and the Alaska Department of Environmental Conservation (Military Contaminated Sites Program).

6. Point of Contact: The Point of Contact for this policy is Mr. Clifford A. Seibel, Directorate of Public Works, Environmental Division Chief at 361-6220 or email clifford.a.seibel@us.army.mil.

2 Encls
1. List of Known Contaminated Sites
2. LUC /IC SOP

TIMOTHY A. JONES
COL, AV
Commanding

DISTRIBUTION:
A
FWA Safety Office
FWA DOL
FWA DMWR
FWA Public Affairs
FWA SJA
FWA DPW
Preventive Medicine
1/25 SBCT
TF49 Aviation
USAG-AK DPTMS

CF: (w/encls)
FWA Garrison S3

STAFF SUMMARY

DATE	9 December 2010

TO Garrison Commander	**FROM** DPW Environmental	
SUBJECT Land Use Controls/Institutional Controls Policy Memorandum	**ACTION OFFICER (SIGNATURE)** **TYPED NAME, RANK & PHONE** Joseph S. Malen, RPM 361-4512	SUSPENSE

Reason for Action: Obtain Garrison Commander's Signature on Institutional Control Memorandum

FACTS/DISCUSSION

The purpose of this Memorandum is to insure that all operations, units, tenants, and contractors are familiar with the policy and procedures for digging on US Army Garrison, Alaska land. This Memorandum and attachments apply to all activities where soil is disturbed to a depth of 6 inches or greater, anywhere on Garrison Lands, especially in known or suspected contaminated sites where contamination has been left in place. This Memorandum updates the current Institutional Controls Memorandum signed by MG Lovelace in 2003. The contents of this Institutional Controls Memorandum include source areas that have been negotiated and agreed to by the Army, EPA and ADEC and are a component of the selected remedies for all Record of Decisions (ROD) for US Army Garrison, Alaska. In addition, this update is required as part of the CERCLA 5-year review process.

RECOMMENDATIONS: Sign attached Permit Application

COORDINATION

OFFICE	SIGNATURE	CONCUR	NONCONCUR
Chief, Environmental Division			
DPW Director			
SJA			

ENCLOSURES	**APPROVED (SIGNATURE)**	**DISAPPROVED (SIGNATURE)**
	TYPED NAME & RANK **TIMOTHY A. JONES** **COL, AV** **Commanding**	**TYPED NAME & RANK** **TIMOTHY A. JONES** **COL, AV** **Commanding**

USARAK Form 407
1 Nov 94

COORDINATION CONTINUED

OFFICE	SIGNATURE	CONCUR	NONCONCUR

USARAK Form 407
1 Nov 94

Appendix C
Cost Estimates for Alternatives

APPENDIX C

Cost Estimates for Alternatives

C.1 Introduction

The alternatives evaluated in the Feasibility Study (FS) for the Fort Wainwright (FWA) 102 Former Communications Site (FCS) (also known as the Taku Gardens family housing development) have been segregated into soil (S) and groundwater (GW) alternatives. This approach will better facilitate the evaluation of alternatives to separately address contamination in each media. Costs for Alternatives S2, GW2, and GW3 are presented in this appendix. Alternative 1 has no associated costs. The costs include both capital and operation and maintenance (O&M) costs.

In accordance with U.S. Environmental Protection Agency (EPA) guidelines, the cost estimates for each alternative are order-of-magnitude estimates. Estimates of this type are generally accurate within plus 50 percent to minus 30 percent. The extent of this range implies that there is a high probability the final projected cost will fall within this range. However, the accuracy of the estimates is subject to substantial variation because details of the specific design will not be known until the remedy is implemented. For example, the actual site conditions, project scope and schedule, design details, competitive market conditions, changes during construction, labor and equipment rates, and other variables are not known. Even with these uncertainties, U.S. Army Corps of Engineers (USACE) is confident that the final costs for the remedial action will be within the required range (plus 50 percent to minus 30 percent).

Furthermore, the selection of technologies or process options to estimate costs is not intended to limit flexibility during remedial design. Remedial design efforts might reveal possible cost savings as a result of value engineering studies and reduce the cost of implementing the remedy.

Costs were estimated in accordance with EPA guidelines (2000). According to the guidelines, the discount rate used for the calculations was 2.7 percent and was taken from Appendix C of the Office of Management and Budget Circular A-94 (January 2008) for real discount rates over a 30-year period.

The formula used to calculate the present value is as follows:

$$PV_{30} = F(1 / (1 + i)^n) + A[((1 + i)^n - 1) / (i(1 + i)^n)]$$

Where:

- i = The discount rate
- n = The number of years from 2011
- F = A future cost
- A = An annual cost

The methodology and information used to develop the cost estimates and the costs for each alternative by site are presented in the subsections that follow. Section C.2 presents the unit costs and assumptions for each cost component (e.g., institutional controls).

C.2 Components of Costs

The alternatives evaluated in Section 6 of the FS report comprise a mix of several components: institutional controls, monitoring, gas collection, and treatment. For example, institutional controls are a component of Alternatives GW2 and GW3, and treatment is a component of Alternative GW3. These components were priced for the FCS, and the component costs are assembled into the cost estimates for each alternative.

Cost estimates for the various components described in this subsection are presented in Tables C-1 through C-5. Table C-6 presents a summary of the costs by alternative. All tables are located at the end of this appendix.

C.2.1 Institutional Controls

Costs for maintaining, monitoring, and enforcing land use restrictions and other institutional controls are included in the costs to implement Alternatives S2, GW2, and GW3. Institutional control costs for each alternative are presented in Tables C-2, C-3, and C-5, respectively.

C.2.1.1 Army Institutional Controls Costs

Annual costs associated with institutional controls would be incurred into the foreseeable future under Alternatives S2 and GW2. Under Alternative GW3, institutional controls would only be implemented until the remedial action is complete. It is assumed that approximately 1 hour per month would be required to facilitate the permit process and 8 hours would be required per year to complete inspections.

C.2.2 Monitoring

C.2.2.1 Monitored Natural Attenuation

Unit costs for the components of monitored natural attenuation (MNA) are provided in Table C-1. Alternative GW2 includes the implementation of MNA.

For the purpose of cost estimation, it is assumed that the MNA program will consist of two sampling events per year (semiannually) for the first 2 years to establish a baseline trend, and one sampling event per year (annually) thereafter. It is assumed that 15 monitoring wells would be sampled. The monitoring well network would be selected during the remedial design phase. It is assumed that installation of new groundwater monitoring wells would not be required. Groundwater samples would be collected and analyzed for diesel-range organics (DRO)/residual-range organics (RRO) by Method AK102/AK103 and VOCs by EPA Method 8260B. The target analytes were selected based on the contaminants of concern (COCs) identified for groundwater. Figure C-1 presents the concentrations of COCs exceeding cleanup goals (all figures are located at the end of this appendix). Groundwater quality parameters (e.g., dissolved oxygen and oxidation-reduction potential [ORP]) would also be measured.

Labor and reporting costs are also included. It is estimated that sampling one groundwater monitoring well would require 2 hours by a two-person team. Assuming an hourly rate of $60, the labor costs for the natural attenuation monitoring are estimated to be $3,600 per event. Costs for materials required for groundwater sampling (e.g., sample containers, shipping supplies, and miscellaneous supplies) are estimated to be $20 per monitoring well.

A report would be written after each sampling event and is estimated to require 40 hours at an hourly rate of $100. In addition, it is estimated that materials and supplies (e.g., paper and binders) would cost approximately $500 per report. Costs for MNA under Alternative GW2 are presented in Table C-3.

C.2.2.2 Groundwater Performance and Post-remedy Monitoring

Unit costs for the components of groundwater performance and post-remedy monitoring are provided in Table C-1. Alternative GW3 includes the implementation of groundwater performance and post-remedy monitoring.

The purpose of the groundwater performance monitoring is to establish a baseline, evaluate the continued effectiveness of the in situ chemical oxidation (ISCO) treatment, and assess the generation of degradation products and byproducts such as sodium, sulfate, and metals. The assumed groundwater monitoring network consists of several locations within each plume/treatment zone and several locations downgradient of each plume/treatment zone. Given this approach, the assumed monitoring network for ISCO performance and post-remedy monitoring consists of the following 15 wells:

- Six monitoring wells associated with zone of TCE-affected groundwater
- Six monitoring wells associated with zone of DRO-affected groundwater
- Three monitoring wells associated with the area of TCP-affected groundwater

A baseline sampling event would be conducted prior to oxidant injection. Performance monitoring would occur monthly during the first quarter of operation, and would continue on a quarterly basis until cleanup goals had been met. Once cleanup goals had been met, monitoring would continue on a quarterly basis as post-remedy monitoring to ensure that contaminant rebound has not occurred. The overall performance and remedy monitoring period is assumed to be 2 years. Monitoring points would be selected from the current network of monitoring wells at the FCS, and no additional wells are assumed to be required. Groundwater samples would be collected and analyzed for DRO/RRO by Method AK102/AK103; VOCs by EPA Method 8260B; metals (including sodium) by Methods SW6010, SW6020, and SW7470A; sulfate by Method 300; and alkalinity by Method SM2320B. Groundwater quality parameters (e.g., pH, conductivity, turbidity, and ORP) would also be measured. The assumed analyses and number of wells analyzed for the performing monitoring program are presented in Table C-4.

Labor and reporting costs are also included. It is estimated that sampling one groundwater monitoring well would require 2 hours by a two-person team. Measurement of groundwater parameters only (i.e., no samples collected for laboratory analysis) is estimated to require 0.5 hour per well by a two-person team. Assuming an hourly rate of $60, the labor costs for the performance monitoring are estimated to be $29,100. Costs for materials required for groundwater sampling (e.g., sample containers, shipping supplies, and miscellaneous supplies) are estimated to be $20 per monitoring well. Semiannual reporting is assumed for the 2-year monitoring period. Each report is estimated to require 24 hours at an hourly rate of $100. In addition, it is estimated that materials and supplies (e.g., paper and binders) would cost approximately $500 per report. Costs for groundwater performance monitoring under Alternative GW3 are presented in Table C-5.

C.2.3 In Situ Chemical Oxidation

The proposed ISCO conceptual design includes direct-push injection of persulfate activated with hydrogen peroxide in areas where COCs exceed cleanup goals (see Figure C-1). Based on the FCS Remedial Investigation (CH2M HILL, 2010), the following parameters were used to conceptually design the ISCO system:

- Hydraulic conductivity (K_H) = 1,400 feet per day (ft/day)
- Hydraulic gradient (i) = 0.0007 feet per foot (ft/ft)
- Groundwater velocity (v) = 3.92 ft/day
- Depth to water = 10 to 15 feet below ground surface (bgs)

In addition, the following parameters were assumed to be representative of site conditions in lieu of site-specific data:

- Persulfate soil oxidant demand (SOD) = 1 gram per kilogram (site soil samples would be analyzed for SOD to evaluate actual site conditions)
- Porosity (n) = 0.25
- Soil bulk density = 3,000 pounds per yd^3

The injected oxidant solution is assumed to be 20 percent by weight of FMC Environmental Solution (FMC) Klozur® solid persulfate. The activator (hydrogen peroxide) solution that would be injected is assumed to be 8 percent by volume to minimize the generation of heat and gas during injection. It was estimated that approximately 200,000 pounds of persulfate and 90,000 gallons of hydrogen peroxide (17.5 percent stock solution) would be required. Approximately 200,000 gallons of water would be required to prepare the persulfate solution and dilute the hydrogen peroxide stock solution. It is assumed that a water source is available onsite; therefore, no costs were included for the required water. Based on these design assumptions, the total injection volume of persulfate/peroxide mixture was estimated to be approximately 300,000 gallons. Unit prices (including freight to Fairbanks, Alaska) for Klozur® persulfate and hydrogen peroxide stock solution are presented in Table C-1.

An inject-and-drift approach is assumed for the ISCO injection. Multiple rows of injection points spaced along the direction of groundwater flow would be installed using direct-push methods at each treatment area. The design parameters used to estimate the number of injection points required include an assumed radius of influence (ROI) of 15 feet, a conservative oxidant persistence of 30 days (FMC indicates that persulfate persistence is between 5 weeks and 3 months), and a groundwater velocity of approximately 4 ft/day. Based on these design assumptions, it was estimated that approximately 311 injection points (spaced approximately 20 to 25 feet apart, with rows spaced approximately 120 feet apart) would be needed to treat the source areas within the FCS.

The oxidant/activator mixture is assumed to be injected at a rate of 5 gallons per minute (gpm) (recommended by Vironex). It is assumed that five injection points would be manifolded together and two direct-push technology (DPT) drill rigs would operate simultaneously. The injection team would be composed of three people, and the time assumed to complete the drilling and injection is 33 days (based on a quote from GeoTek Alaska). The daily rate for the ISCO implementation, including per diem (meals and lodging) and consumables (i.e., pumps, tools, tanks, and miscellaneous), is $7,200 (see

Table C-1). Permits for drilling and/or injecting are assumed to have no cost, which is typical at Alaska Department of Environmental Conservation (ADEC) contaminated sites. The target areas and proposed injection points are presented on Figure C-2. Costs for mobilization, demobilization, engineering design, and construction oversight, as well as a 15 percent contingency, are also included in the capital cost estimates.

A small-scale pilot test would be conducted prior to remedial design to evaluate the ROI of injection wells and injection effectiveness, determine the success and benefit of the technology, and assist with final design. It was assumed that the pilot test would consist of the injection of persulfate activated with hydrogen peroxide in 15 points between the DRO/RRO plume and chlorinated VOC plume (see Figure C-1). Based on this assumption, it is estimated that the pilot test injection would take approximately 10 percent of the time estimated for the full-scale system. It is also estimated that the pilot test would require 5 percent of the materials (persulfate and hydrogen peroxide) and would include one groundwater monitoring event. The cost for groundwater performance monitoring associated with the pilot test is assumed to be 10 percent of the cost for the full-scale groundwater performance monitoring.

Costs for ISCO under Alternative GW3 are presented in Table C-5. Factors that affect the time to reach the cleanup goals through ISCO include the contaminants present (i.e., DRO, RRO, VOCs, or combinations), the initial concentrations, and hydrogeology. Therefore, institutional controls would continue to be implemented until performance and post-remedy monitoring confirms cleanup goals have been met and are maintained. For cost estimation purposes, it was assumed that performance and post-remedy monitoring would be completed within 2 years.

C.2.5 Reports

Unit costs for preparation of a Remedial Action Work Plan (RAWP) and Remedial Action Completion Report (RACR) are presented in Table C-1. A RAWP is required for the implementation of all alternatives except for Alternative 1 (No Action). Although it is uncertain that concentrations of COCs would fall below cleanup goals as a result of natural attenuation processes under Alternative GW2, a RACR is conservatively assumed to be necessary. A RACR is also required after the cleanup levels are met as a result of the ISCO implementation under Alternative GW3. The costs for a RAWP and a RACR are estimated to be $50,000 each.

C.3 Works Cited

CH2M HILL. 2010. *Remedial Investigation, FWA 102 Former Communications Site, Fort Wainwright, Alaska*. Draft Final. April.

U.S. Environmental Protection Agency (EPA). 2000. *A Guide to Developing and Documenting Cost Estimates During the Feasibility Study*. Office of Solid Waste and Emergency Response. 9355.0-75. July.

Tables

TABLE C-1
Unit Costs and Assumptions
Feasibility Study, Former Communications Site, Fort Wainwright, Alaska

Task	Quantity	Unit Cost	Unit	Estimated Cost	Assumptions
Component: Institutional Controls					
Permit Process	12	$100	hour	$1.200	Assumes 1 hour per month to facilitate permit process.
Inspections	8	$100	hour	$800	Assumes 8 hours per year for inspections.
Total Annual Institutional Controls Cost	-	-	-	**$2.000**	Annual cost.
Component: Monitoring					
Monitored Natural Attenuation					
DRO/RRO Analysis	15	$92	sample	$1.381	Quote from TestAmerica (December 2008) - escalated to 2011
VOC Analysis	15	$146	sample	$2.193	Quote from TestAmerica (December 2008) - escalated to 2011
Low-level VOC Analysis	15	$146	sample	$2.193	Quote from TestAmerica (December 2008) - escalated to 2011
Labor and Materials	1	$3.900	event	$3.900	Assumes one groundwater well every 2 hours by a two-person team (three 10-hour days for 15 wells) and $20 in materials per monitoring point.
Reporting	1	$4.500	event	$4.500	Assumes 40 hours at $100 per hour and $500 in materials per report
Total MNA Costs per Event	-	-	-	**$14.168**	15 wells per event; samples analyzed for DRO/RRO, VOCs, and low-level VOCs
Groundwater Performance and Post-remedy Monitoring					
Soil Oxidant Demand	6	$600	sample	$3.600	Verbal quote from FMC (September 2010)
Oxidant (Field Colorimeter Kit)	99	$11	sample	$1.089	Verbal quote from FMC (September 2010)
Alkalinity	42	$20	sample	$840	Verbal quote from Test America (September 2010)
Sulfate	117	$20	sample	$2.340	Verbal quote from Test America (September 2010)
Sodium	42	$25	sample	$1.050	Verbal quote from Test America (September 2010)
DRO/RRO Analysis	70	$92	sample	$6.445	Quote from TestAmerica (December 2008) - escalated to 2011
VOC Analysis	70	$146	sample	$10.236	Quote from TestAmerica (December 2008) - escalated to 2011
Low-level VOC analysis	70	$146	sample	$10.236	Quote from TestAmerica (December 2008) - escalated to 2011
Metals Analysis	101	$130	sample	$13.128	Quote from TestAmerica (December 2008) - escalated to 2011
Labor and Materials	1	$31.340	lump sum	$31.340	Assumes one groundwater monitoring well every 2 hours by a two-person team and $20 in materials per sampling point; for groundwater quality parameters only, assumes one groundwater monitoring well every 0.5 hour by a two-person team; see Table C-5
Reporting	1	$11.600	lump sum	$11.600	Semiannual reporting for the 2-year monitoring period; assumes 24 hours at $100 per hour and $500 for materials per report

TABLE C-1
Unit Costs and Assumptions
Feasibility Study, Former Communications Site, Fort Wainwright, Alaska

Task	Quantity	Unit Cost	Unit	Estimated Cost	Assumptions
Component: In Situ Chemical Oxidation					
Klozur® Persulfate (Oxidant)	200.000	$1,89	pound	$377.200	Quote from FMC (September 2010) of $1.34 per pound of material and $0.546 per pound for shipping and delivery
Hydrogen Peroxide (17.5% Stock Solution)	90.000	$3,36	gallon	$302.670	Quote from FMC (September 2010) of $1.64 per pound of material and $1.723 per pound for shipping and delivery
Drilling and Injection Labor & Materials	33	$7.200	day	$237.600	Quote from GeoTek Alaska (September 2010); assumes two rigs working simultaneously; includes consumables and per diem rates
Engineering/Construction Oversight	1	$35.640	lump sum	$35.640	Apply to 15% of the total construction cost
Contingency	1	$35.640	lump sum	$35.640	Apply to 15% of the total construction cost
Mobilization and Demobilization	1	$5.000	lump sum	$5.000	Quote from GeoTek Alaska (September 2010)
ISCO Pilot Test	1	$74.072	lump sum	$74.072	Assumes 5% of the material and 10% of the time for the full-scale injection; includes 10% of the groundwater performance monitoring cost
Total ISCO Cost				**$1.067.822**	Assumptions provided in Appendix C, Components of Cost subsection
Component: Reports					
Work Plan	1	$50.000	lump sum	$50.000	Assumptions provided in Appendix C, Components of Cost subsection
Remedial Action Completion Report	1	$50.000	lump sum	$50.000	Assumptions provided in Appendix C, Components of Cost subsection

TABLE C-2
Costs under Alternative S2 (Institutional Controls to Control the Disposition of Exhumed Soil)
Feasibility Study, Former Communications Site, Fort Wainwright, Alaska

Component	Start	End	Cost	Total Cost	PV_{30}	Assumptions
Institutional Controls – Annual Cost	2011	2041	$2,000	$62,000	$41,600	Includes facilitation of permit process and inspections
Total				**$62,000**	**$41,600**	

TABLE C-3
Costs under Alternative GW2 (Institutional Controls to Prohibit Groundwater Use and MNA)
Feasibility Study, Former Communications Site, Fort Wainwright, Alaska

Component	Start	End	Cost	Total Cost	PV_{30}	Assumptions
Institutional Controls – Annual Cost	2011	2041	$2,000	$62,000	$41,600	Includes facilitation of permit process and inspections
MNA – Annual Cost	2011	2041	$15,100	$468,100	$314,400	Semiannual events during the first 2 years; annual events after the first 2 years
Reports – Capital Cost	2011	2041	$100,000	$100,000	$100,000	Includes a RAWP and a RACR
Total				**$630,100**	**$456,000**	

TABLE C-4
Groundwater Monitoring Program for ISCO under Alternative GW-3
Feasibility Study, Former Communications Site, Fort Wainwright, Alaska

		Year 1						Year 2				
		Q1										
Analysis	**Baseline**	**Month 1**	**Month 2**	**Month 3**	**Q2**	**Q3**	**Q4**	**Q1**	**Q2**	**Q3**	**Q4**	**Total**
SOD	6	–	–	–	–	–	–	–	–	–	–	**6**
Oxidant	11	11	11	11	11	11	11	–	11	–	11	**99**
pH, temp, ORP, specific conductivity	20	11	11	11	20	20	20	11	11	11	11	**157**
Alkalinity	20	11	–	11	–	–	–	–	–	–	–	**42**
Sulfate	20	11	–	11	15	15	15	–	15	–	15	**117**
Sodium	20	11	–	11	–	–	–	–	–	–	–	**42**
VOCs	10	–	–	10	10	10	10	–	10	–	10	**70**
DRO	10	–	–	10	10	10	10	–	10	–	10	**70**
Metals	15	6	–	15	15	15	15	–	10	–	10	**101**

Notes:

11 sampling points refer to all treatment zone wells (see Monitoring subsection on page C-2).

15 sampling points refer to all downgradient wells plus two wells per source area (see Monitoring subsection on page C-2).

20 sampling points refer to all wells (see Monitoring subsection on page C-2).

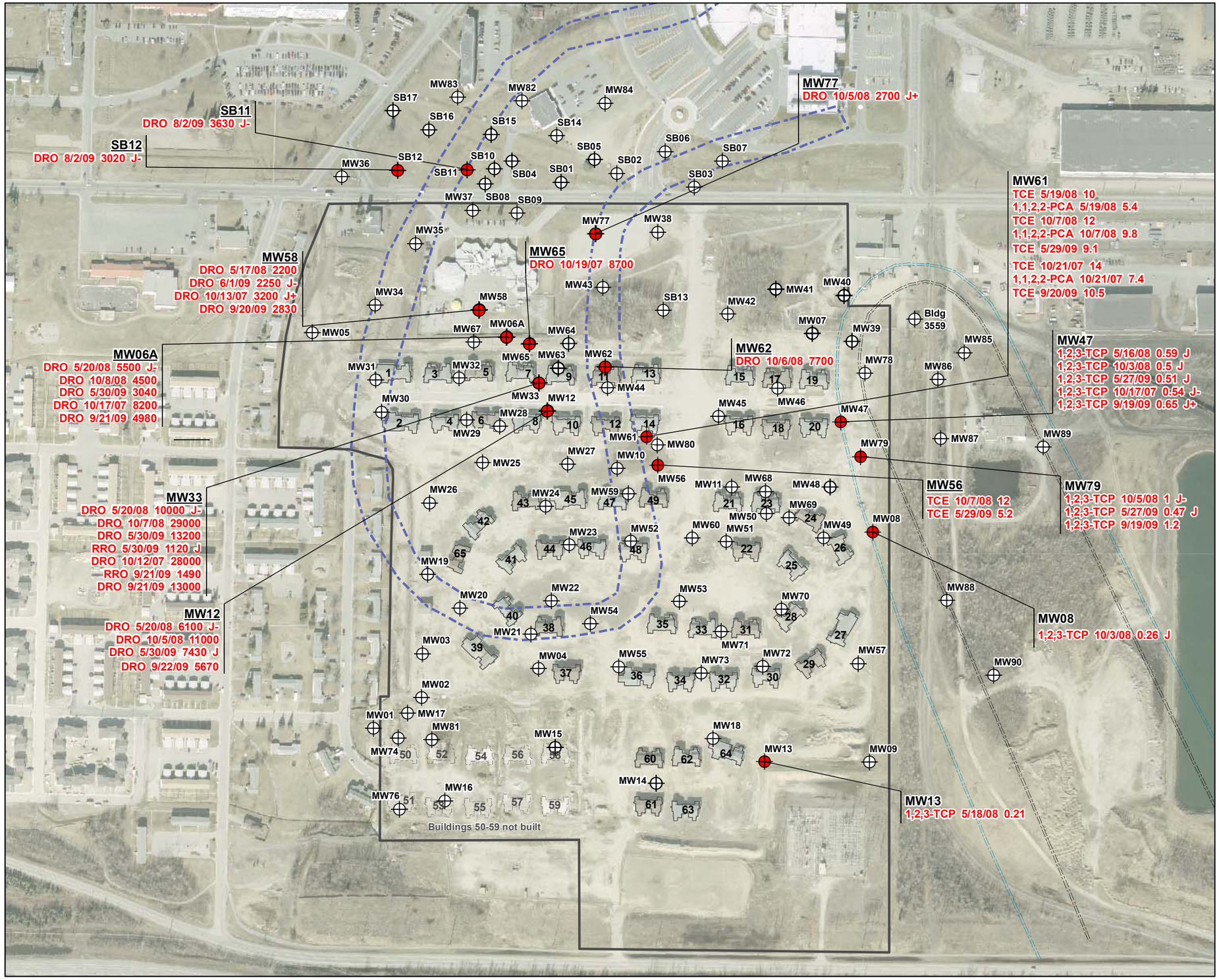
TABLE C-5
Costs under Alternative GW3 (In Situ Chemical Oxidation and Institutional Controls to Prohibit Groundwater Use)
Feasibility Study, Former Communications Site, Fort Wainwright, Alaska

Component	Start	End	Cost	Total Cost	PV_{30}	Assumptions
Institutional Controls – Annual Cost	2011	2013	$2,000	$6,000	$5,700	Includes facilitation of permit process and inspections.
ISCO – Capital Cost	2011	2011	$1,067,800	$1,067,800	$1,067,800	See In Situ Chemical Oxidation subsection on page C-5 for assumptions.
Groundwater Performance Monitoring – Capital Cost	2011	2012	$91,900	$91,900	$91,900	See Groundwater Performance Monitoring subsection on page C-3 for assumptions.
Reports – Capital Cost	2011	2013	$100,000	$100,000	$100,000	Includes a RAWP and a RACR.
Total				**$1,265,700**	**$1,265,400**	

TABLE C-6
Summary of Costs for 30-year Period
Feasibility Study, Former Communications Site, Fort Wainwright, Alaska

Alternative	Total Cost (30 years)	PV_{30}
Alternative 1	$0	$0
Alternative S2	$62,000	$41,600
Alternative GW2	$630,100	$456,000
Alternative GW3	$1,265,700	$1,265,400

Figures



LEGEND

- Site Boundary
- Former Hoppe's Slough
- 1,000 gpm Pumping Rate Water Supply Capture Zone
- 1,700 gpm Pumping Rate Water Supply Capture Zone

Explanation of Results

- No detected exceedances of COCs (3 sample events)
- One or more exceedance of PCG

Explanation of Label

Location ID
Analyte Sample Date Result (µg/L) Qualifier

Analyte	PCG
DRO	1,500 µg/l
RRO	1,100 µg/l
TCE	5 µg/l
1,1,2,2-PCA	4.3 µg/l
1,2,3-TCP	0.12 µg/l

NOTE:
5 groundwater sampling events have occurred

0 275
Feet

N

FIGURE C-1
Distribution of COCs in Groundwater
Feasibility Study
Former Communications Site, Fort Wainwright, Alaska

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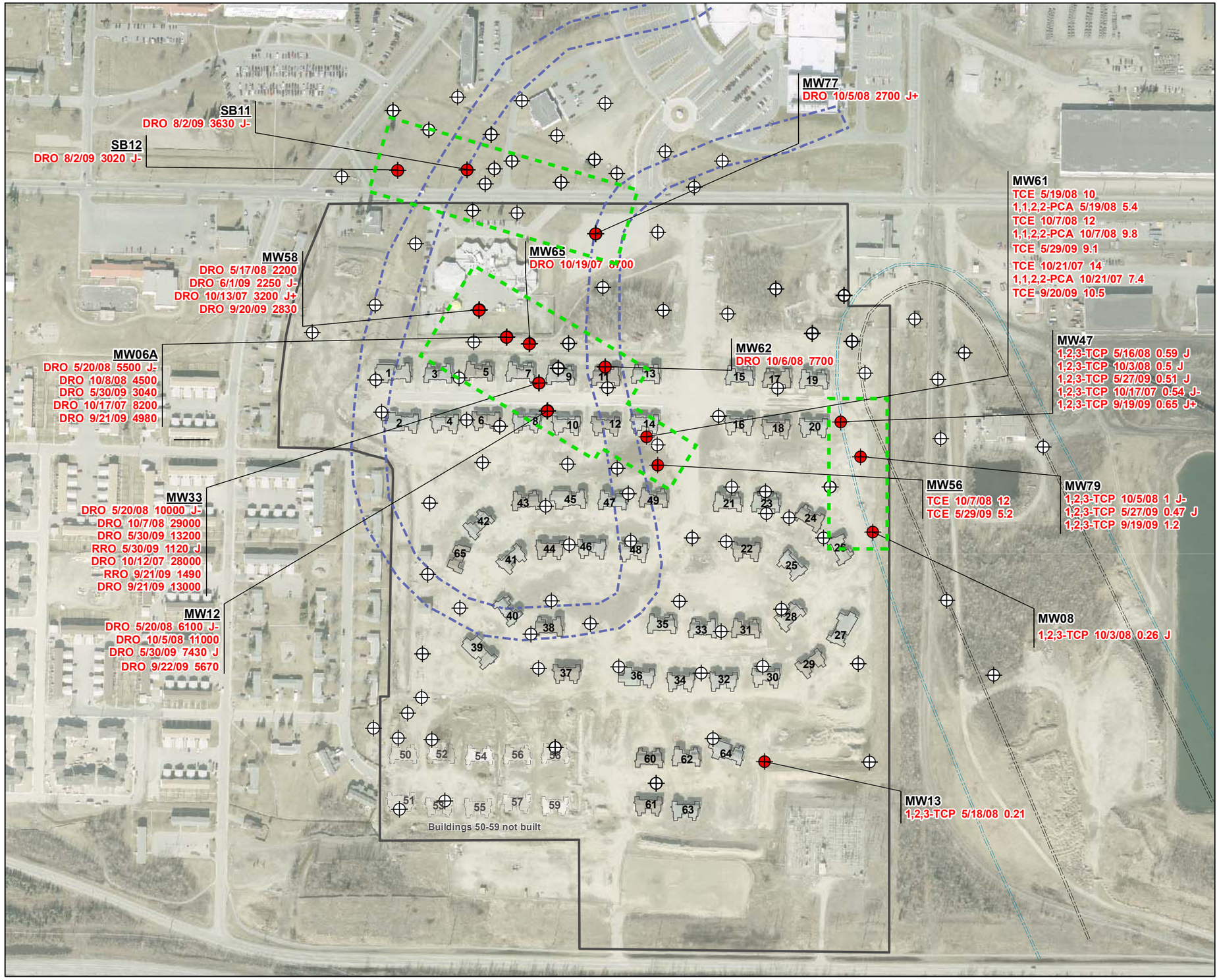
ES090110064115SAC Figure C-1.ai 12.14.2010 tdaus



LEGEND

- Site Boundary
- Former Hoppe's Slough
- 1,000 gpm Pumping Rate Water Supply Capture Zone
- 1,700 gpm Pumping Rate Water Supply Capture Zone

Explanation of Results

- No detected exceedances of COCs (3 sample events)
- One or more exceedance of PCG
- Approximate ISCO Treatment Area

Explanation of Label

Location ID
Analyte Sample Date Result (µg/L) Qualifier

Analyte	PCG
DRO	1,500 µg/l
RRO	1,100 µg/l
TCE	5 µg/l
1,1,2,2-PCA	4.3 µg/l
1,2,3-TCP	0.12 µg/l

NOTE:
5 groundwater sampling events have occurred

0 275
Feet

N

FIGURE C-2
Potential ISCO Treatment Areas
Alternative GW3
Feasibility Study
Former Communications Site, Fort Wainwright, Alaska

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ES090110064115SAC Figure C-2.ai 12.14.2010 tdaus

Appendix D
Subslab Sampling Program

Proposed Post-construction Subslab Soil Gas Monitoring Program for the Former Communications Site (Taku Gardens) at Fort Wainwright, Alaska

PREPARED FOR:	U.S. Army, Directorate of Public Works, Fort Wainwright, Alaska
PREPARED BY:	CH2M HILL
COPIES:	U.S. Army Corps of Engineers, Alaska District
DATE:	June 29, 2011
CONTRACT NUMBER:	W911KB-05-D-0010, Task Order 13

1 Purpose

This memorandum describes the proposed 5-year post-construction subslab soil gas monitoring program for the Former Communications Site (FCS), also known as the Taku Gardens family housing development, at Fort Wainwright, Alaska. The memorandum provides the proposed schedule of monitoring events, identifies the housing units to be monitored, discusses the rationale for the selection of monitoring locations, and describes the proposed sampling approach.

2 Background

CH2M HILL has prepared a remedial investigation (RI) report (CH2M HILL, 2010) and a feasibility study (FS) report (CH2M HILL, 2011) to support the pending record of decision (ROD) for the FCS. The U.S. Army Department of Public Works (DPW) has conducted the RI/FS under the authority of the Comprehensive Environmental Response, Compensation, and Liability Act of 1980, as amended by the Superfund Amendments and Reauthorization Act of 1986.

An important component of the human health risk assessment (HHRA) that was conducted as part of the RI was the vapor intrusion evaluation to address potential indoor exposures to future residents. In the assessment of extensive soil gas sampling data (including subslab soil gas data from samples taken beneath residential units), no unacceptable risk was identified for potential exposure to soil gas for the residential exposure scenario. Therefore, soil gas was not retained as a medium of concern in the FS. However, to verify that soil gas conditions remain consistent and ensure that no significant changes in soil gas conditions arise in the near future as a result of changes in site conditions, including the remaining construction activities (for example, road, driveway, and landscaping installations), the DPW will continue to conduct subslab soil gas sampling at the FCS.

3 Subslab Vapor Monitoring Schedule

Table 1 shows the proposed 5-year schedule for subslab vapor monitoring events at the FCS. After initial baseline sampling has been conducted at all 110 housing units following final site construction activities, sampling will take place quarterly at a selected number (12) of buildings, then transition to annual sampling, leading up to the 5-year review. At that point, assuming that the sampling results remain stable and continue to indicate that there is no unacceptable human health risk from subslab vapor, no further sampling will be conducted.

TABLE 1
Proposed Five-year Schedule for Subslab Vapor Monitoring

Sampling Year	Sampling Event	Month	Number of Units
Year 1	First quarter	February	110
	Second quarter	May	12
	Third quarter	August	12
	Fourth quarter	November	12
Year 2	First quarter	February	12
	Second quarter	May	12
	Third quarter	August	12
	Fourth quarter	November	12
Year 3	Single event	February	110
Year 4	Single event	February	12
Year 5	Single event	February	12

The strategy for this sampling schedule is to front-load the monitoring frequency (quarterly at 12 housing units) so that the variance in monitoring data can be adequately characterized early. It is anticipated that, given the consistently low source strength of the subslab volatile organic compound (VOC) concentrations observed during the RI, any variance will likely be influenced by normal sampling and analytical variability, as well as seasonal fluctuations. The eight quarterly sampling events during Years 1 and 2 are anticipated to be sufficient to characterize this variance, allowing for a distinction to be made between normal variability ("noise") and any longer-term, upward or downward trends that could hypothetically occur in subslab soil gas concentrations. After this level of variance has been characterized during Years 1 and 2, the longer-term stability can be documented during single sampling events in Years 3, 4, and 5.

4 Housing Units To Be Monitored

Table 2 lists the 12 housing units to be monitored throughout the entire 5-year program and provides the rationale for their selection. The sample locations are shown in Figure 1.

Legend

- Subslab Soil Gas Sample Location
- Outdoor Ambient Air Sample Location

FIGURE 1
June 2010 Soil Gas and Subset of Subslab Soil Gas Monitoring Locations for 5-Year Monitoring
Former Communications Site
Fort Wainwright, Alaska

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CH2MHILL

The sample locations were identified at selected units where previous subslab VOC concentrations were highest and had exceeded project screening levels to the greatest degree[1] and/or near an area of groundwater contamination. Preference was given to units for which more existing rounds of monitoring data were available, to provide for analysis of longer trends. Monitoring data from these 12 units will be obtained during a total of 11 monitoring events over the 5-year period. These results, combined with the RI data from December 2008, August 2009, and July 2010, will allow for characterization of both short-term variance and longer-term stability. These locations provide roughly even coverage across the FCS site.

TABLE 2
Rationale for Twelve Housing Units To Be Monitored

Housing Unit	Rationale
Unit 03 right	Near area of elevated petroleum hydrocarbons in groundwater
Unit 08 right	Housing unit with highest PSL exceedance for carbon tetrachloride and PSL exceedance for trichloroethylene in subslab soil gas
Unit 12 left	Housing unit with highest PSL exceedance for trichloroethylene in subslab soil gas
Unit 13 left	ADEC-requested because of indications of soil with elevated PID readings documented during construction activities in 2005.
Unit 16 left	Housing unit with PSL exceedance for trichloroethylene in subslab soil gas
Unit 20 left	Housing unit with PSL exceedance for trichloroethylene in subslab soil gas
Unit 22 left	Housing unit with PSL exceedance for trichloroethylene in subslab soil gas
Unit 29 left	Housing unit with PSL exceedance for trichloroethylene in subslab soil gas
Unit 32 right	Housing unit with PSL exceedance for trichloroethylene in subslab soil gas
Unit 34 left	Housing unit with highest PSL exceedances for 1,2,4-trimethylbenzene and naphthalene in subslab soil gas
Unit 42 left	Housing unit with PSL exceedance for chloroform in subslab soil gas
Unit 47 left	Housing unit with highest PSL exceedance for chloroform in subslab soil gas

ADEC = Alaska Department of Environmental Conservation
PID = photoionization detector
PSL = project screening level used during the RI.

Each subslab soil gas sample will be collected from subslab soil gas sample points that were installed within the garage floors of each housing unit in 2007. All subslab sampling points will be inspected and helium-leak-tested prior to sampling. Subslab soil gas field duplicate samples will be collected, representing a field duplicate frequency of 10 to 20 percent.

[1] Exceeding a screening level does not imply unacceptable risk. The HHRA conducted during the RI identified no unacceptable risk for potential exposure to soil gas for the residential exposure scenario.

5 Target Analytes

All subslab soil gas samples will be analyzed for VOCs by U.S. Environmental Protection Agency (EPA) Method TO-15, using a mass spectrometer in both low-level scan and selective ion monitoring modes. Modifications to the method may be made by using a solvent delay or other, similar techniques to help mitigate potential interference by other non-target analytes such as freon.

6 Reporting

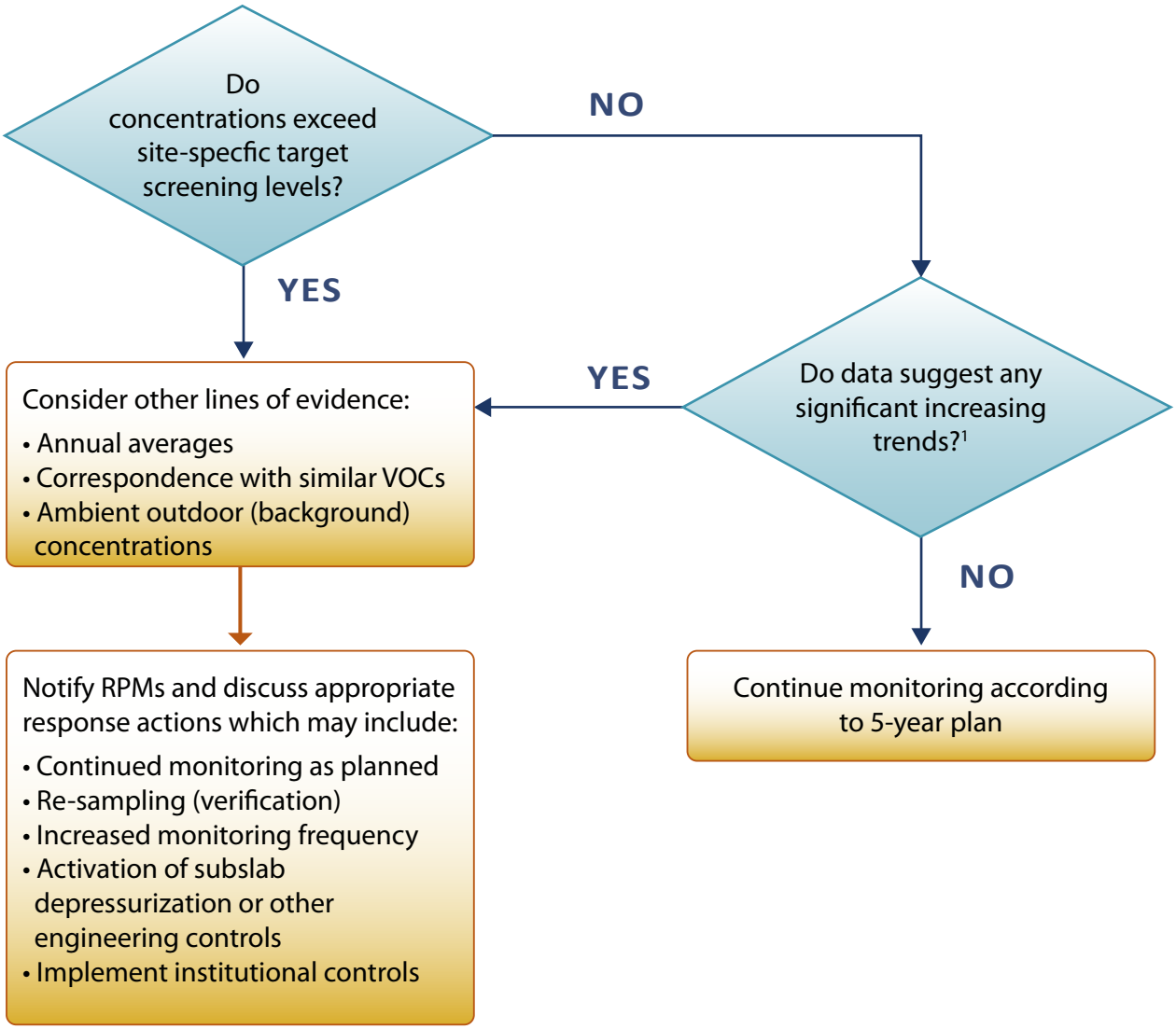
Following completion of each year of subslab vapor sampling activities, the final validated data will be evaluated and incorporated into a technical memorandum for submission to the EPA and the Alaska Department of Environmental Conservation (ADEC). If sampling results indicate that changes in monitoring (for example, frequency, location, and target analytes) are justified, the rationale for suggested changes will be provided in the annual report.

7 Evaluation of Results

After each round of monitoring, concentrations of detected VOCs will be compared with site-specific target levels for identifying results that could pose unacceptable risk. These site-specific target levels will be computed by dividing the ADEC residential target levels for indoor air listed in Appendix D of the draft ADEC (2009) vapor intrusion guidance (or future updates) by the site-specific subslab soil gas-to-indoor air attenuation factor (AF) identified during the RI (AF = 0.0022).

Consistent with the approach used during the RI, the annual average concentration will be considered most representative of chronic exposure, commensurate with the toxicity factors used for risk assessment. Interpretation of individual quarterly excursions above site-specific target levels, if any, will consider the longer-term (annual) averages and other lines of evidence (including correspondence with similar VOCs) that a significant change may be occurring. A decision diagram is included as Figure 2, which may be helpful in evaluating the results of each monitoring event.

The front-loaded monitoring frequency (quarterly at 12 housing units) is intended to allow for a distinction to be made between normal variability ("noise") and any longer-term upward or downward trends that could hypothetically occur in subslab soil gas concentrations. Concentration trends will be evaluated and then depicted graphically using suitable statistical approaches, depending on the results. As an example, cumulative sum control charts providing the cumulative average, upper confidence limit, and lower confidence limit of VOC concentrations may be useful visualization tools. Analysis of these charts has been shown to be efficient in detecting relatively small shifts in the mean of a process (National Institute of Standards and Technology [NIST], 2006). This sequential analysis technique charts a statistic that incorporates both current and previous data values; the inclusion of more samples in the cumulative sum results in greater sensitivity for detecting shifts or trends.



Notes:

[1]After first year of quarterly monitoring

FIGURE 2
Decision Diagram for Evaluation of Monitoring Results
Former Communications Site
Fort Wainwright, Alaska

Based on the results from the RI, it is anticipated that VOC concentrations in subslab soil gas will remain relatively stable or decreasing. During the 5-year review process for the FCS, assuming that the sampling results remain stable and continue to indicate that there is no unacceptable human health risk from subslab vapor, no further sampling will be conducted. If, at that point, the results of the 5-year subslab soil gas monitoring program indicate that a significant change could occur, any response action will be determined by the DPW with input from the EPA and ADEC.

8 References

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