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EPA Superfund
Record of Decision:

FORT WAINWRIGHT
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OU 05
FORT WAINWRIGHT, AK
03/31/1999

RECORD OF DECISION
for
OPERABLE UNIT 5
FORT WAINWRIGHT
FAIRBANKS, ALASKA

May 1999

DECLARATION STATEMENT
for
RECORD OF DECISION
FORT WAINWRIGHT
FAIRBANKS, ALASKA
OPERABLE UNIT 5

SITE NAME AND LOCATION

Operable Unit 5
Fort Wainwright
Fairbanks, Alaska

STATEMENT OF BASIS AND PURPOSE

This Record of Decision (ROD) presents the selected remedial actions for Operable Unit 5 (OU5) at Fort Wainwright near Fairbanks, Alaska. OU5 is identified as the final operable unit in the Federal Facilities Agreement. OU5 includes three source areas deferred from previously investigated operable units, as well as three source areas identified for inclusion in OU5. Four source areas are identified for action: (1) three subareas of the West Quartermaster's Fueling System (WQFS); (2) East Quartermaster's Fueling System (EQFS); (3) Remedial Area 1A (also called the Birch Hill Aboveground Storage Tanks); (4) Open Burning/Open Detonation (OB/OD) area. Two source areas are recommended for no further action under the Comprehensive Environmental Response, Compensation, and Liability Act of 1980 (CERCLA): (1) Former Explosive Ordnance Disposal (EOD) Range and (2) Motor Pool Buildings. In addition, several petroleum-contaminated sites, including one WQFS subarea, have been and are being addressed in accordance with an agreement between the U.S. Army (Army) and the State of Alaska.

The ROD was developed in accordance with CERCLA, as amended by the Superfund Amendments and Reauthorization Act of 1986 (42 *United States Code*, Section 9601 *et seq.*), and to the extent practicable, in accordance with the National Oil and Hazardous Substances Pollution Contingency Plan (40 *Code of Federal Regulations* 300 *et seq.*). These decisions are based on the Administrative Record for this operable unit.

The Army, the U.S. Environmental Protection Agency, and the State of Alaska, through the Alaska Department of Environmental Conservation, concur with the selected remedies.

ASSESSMENT OF THE SITE

Actual or threatened releases of hazardous substances from the WQFS, EQFS, and Remedial Area 1A source areas, if not addressed by implementing the response actions selected in this ROD, may present an imminent and substantial endangerment to public health, welfare, or the environment. Specific hazardous substances are bis(2-chloroethyl)ether, 1,2-dichloroethane, 1,2-ethylene dibromide, 1,1,1-trichloroethane, trichloroethene, benzene, ethylbenzene, toluene, xylenes, lead, total aromatic hydrocarbons, and total aqueous hydrocarbons.

DESCRIPTION OF SELECTED REMEDIES

This is the fifth and final operable unit to reach a final-action ROD at the Fort Wainwright National Priorities List site. This ROD addresses soil and groundwater contamination at OU5.

The remedies were selected to reduce or prevent risks to human health and the environment associated with potential current or future exposure to the contaminants. The remedial action objectives (RAOs) of this ROD are designed to perform the following:

- Prevent migration of WQFS and EQFS soil contaminants to groundwater
- Restore groundwater beneath the WQFS and EQFS to beneficial use of drinking water within a reasonable time frame
- Reduce cancer and noncancer risks from exposure to volatile compounds and petroleum in soil and groundwater of the WQFS and EQFS
- Minimize potential migration of WQFS contamination to the Chena River and downgradient drinking water wells
- Remove WQFS floating product from the smear zone to the extent practicable
- Protect aquatic resources by reducing WQFS contaminant releases to the Chena River
- Prevent use of groundwater beneath the WQFS and EQFS that contains contaminants at levels that exceed Safe Drinking Water Act levels
- Reduce risk to human health and terrestrial receptors from exposure to lead-contaminated soil in Remedial Area 1A.

The following are major components of the remedy selected for Subarea 1 of the WQFS (WQFS1):

- In situ source-area treatment with air sparging and soil vapor extraction to attain state and federal standards for drinking water
- Potential in-place soil heating at hot spots, pending results of a treatability study to increase contaminant removal
- Potential operation of a downgradient air-sparging trench to prevent migration of contaminants to the Chena River and potential downgradient receptors

The following are major components of the remedy selected for Subarea 2 of the WQFS (WQFS2):

- Source-area treatment with air sparging and soil vapor extraction to attain state and federal standards for drinking water
- Continued operation of the downgradient air-sparging curtain to prevent migration of contaminants to the Chena River
- Groundwater monitoring to determine downgradient concentrations

The following is the major component of the remedy selected for Subarea 3 of the WQFS (WQFS3):

- Source-area treatment with air sparging and soil vapor extraction to attain state and federal standards for drinking water

The following is the major component of the remedy selected for EQFS:

- Continued operation of the air sparging and soil vapor extraction system at Building 1060 to attain state and federal drinking water standards

All selected remedies for the EQFS and WQFS areas include the following:

- Institutional controls to restrict access, water use, and land use
- Monitored and evaluated natural attenuation
- Monitoring to determine achievement of RAOs

The major component of the remedy selected for Remedial Area 1A is as follows:

- Institutional controls to restrict access and land use

Other areas addressed under this ROD are the Chena River and the former OB/OD Area.

The Chena River Aquatic Assessment Program has been designed to determine whether actual impacts to the Chena River have occurred, assess their significance, and measure changes over time. Components of the program include the following:

- Collecting and analyzing water, sediment, and detritus
- Collecting and analyzing benthic macroinvertebrates
- Determining reductions of contaminant load into the Chena River

In addition, no further action is selected for the former OB/OD area for hazardous chemicals. Because of concerns about potential human exposure to unexploded ordnance, the Army has institutional controls that provide monitoring and control of access to the site. These controls are required to remain in place. No analysis of remedial alternatives was conducted for the OB/OD area. A discussion of the OB/OD area is provided in Section 9 of this ROD.

STATUTORY DETERMINATION

The selected remedial actions are protective of human health and the environment, comply with federal and state requirements that are legally applicable or relevant and appropriate to the remedial actions, and are cost-effective.

The WQFS and EQFS remedies use permanent solutions and alternative treatment technologies to the maximum extent practicable. They also satisfy the statutory preference for remedies that employ treatments that reduce toxicity, mobility, and volume as a principal element. Treatment of the principal threats of Remedial Area 1A use was not found to be practicable; the remedy for Remedial Area 1A does not satisfy the statutory preference for treatment as a principal element. The remedy is protective under existing land-use scenarios and restricts exposure to human health and the environment.

Because these remedies will result in hazardous substances above health-based levels remaining at these source areas, a review will be conducted within 5 years after commencement of remedial actions to ensure that the remedies continue to provide adequate protection of human health and the environment.

SIGNATURE

Signature sheet for the foregoing Operable Unit 5, Fort Wainwright, Record of Decision between the U.S. Army and the Environmental Protection Agency, Region 10, with concurrence by the Alaska Department of Environmental Conservation.

R.L. Van Antwerp
Major General, USA
Assistant Chief of Staff for
Installation Management
U.S. Army

26 March 1999
Date

SIGNATURE

Signature sheet for the foregoing Operable Unit 5, Fort Wainwright, Record of Decision between the U.S. Army and the U.S. Environmental Protection Agency, Region 10, with concurrence by the Alaska Department of Environmental Conservation.

Chuck Clarke

Chuck Clarke
Regional Administrator, Region X
United States Environmental Protection Agency

3/31/99
Date

SIGNATURE

Signature sheet for the foregoing Operable Unit 5, Fort Wainwright, Record of Decision between the U.S. Army and the U.S. Environmental Protection Agency, Region 10, with concurrence by the Alaska Department of Environmental Conservation.

Lynn J. Tomich Kent — 4/6/99

Lynn Tomich Kent
Contaminated Sites Program Manager
Division of Spill Prevention and Response
Alaska Department of Environmental Conservation

Date

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Abbreviations

AAC	*Alaska Administrative Code*
ADEC	Alaska Department of Environmental Conservation
AEHA	U.S. Army Environmental Hygiene Agency
ARAR	applicable or relevant and appropriate requirement
AS	air sparging
AST	aboveground storage tank
BTEX	benzene, toluene, ethylbenzene, and xylenes
CERCLA	Comprehensive Environmental Response, Compensation, and Liability Act
CFR	*Code of Federal Regulations*
COC	contaminant of concern
COPC	contaminant of potential concern
DCA	dichloroethane
DCE	dichloroethene
DDD	dichlorodiphenyldichloroethane
DDE	dichlorodiphenyldichloroethene
DDT	dichlorodiphenyltrichloroethane
DRO	diesel-range organic
EOD	Explosive Ordnance Disposal
EPA	U.S. Environmental Protection Agency
EQFS	East Quartermaster's Fueling System
FFA	Federal Facility Agreement
FFCA	Federal Facility Compliance Agreement
FS	feasibility study
GRO	gasoline-range organic
MCL	maximum contaminant level
MCLG	maximum contaminant level goal
µg/L	micrograms per liter
mg/kg	milligrams per kilogram
mg/L	milligrams per liter
NCP	National Oil and Hazardous Substances Pollution Contingency Plan
NFA	no further action
NPL	National Priorities List
O&M	operation and maintenance
OB/OD	Open Burning / Open Detonation

ORC	oxygen release compound
OU	operable unit
OSWER	Office of Solid Waste and Emergency Response
PAH	polynuclear aromatic hydrocarbon
PCB	polychlorinated biphenyl
POL	petroleum, oil, and lubricants
ppm	parts per million
PSD	prevention of significant deterioration
QA	quality assurance
QFS	Quartermaster's Fueling System
RAO	remedial action objective
RBC	risk-based concentration
RCRA	Resource Conservation and Recovery Act
RFA	RCRA Facility Assessment
RfD	reference dose
RI	remedial investigation
ROD	record of decision
RPM	remedial project manager
SARA	Superfund Amendments and Reauthorization Act of 1986
SOP	standard operating procedure
SVE	soil vapor extraction
SVOC	semivolatile organic compound
TAH	total aromatic hydrocarbon
TAqH	total aqueous hydrocarbon
TBC	to be considered
TCA	trichloroethane
TCE	trichloroethene
TCLP	toxicity-characteristic leaching procedure
TS	treatability study
USAF	U.S. Air Force
USARAK	U.S. Army Alaska
UST	underground storage tank
UXO	unexploded ordnance
VOC	volatile organic compound
WQFS	West Quartermaster's Fueling System
WQFS1	WQFS Subarea 1

WQFS2	WQFS Subarea 2
WQFS3	WQFS Subarea 3
WQFS4	WQFS Subarea 4

DECISION SUMMARY

RECORD OF DECISION
for
OPERABLE UNIT 5
FORT WAINWRIGHT
FAIRBANKS, ALASKA

This Decision Summary provides an overview of the problems posed by the contamination at the Fort Wainwright Operable Unit 5 (OU5) source areas. This summary describes the physical features of the site, the contaminants present, and the associated risks to human health and the environment. The summary also describes the remedial alternatives considered at OU5 source areas, provides the rationale for the remedial actions selected, and states how the remedial actions satisfy the Comprehensive Environmental Response, Compensation, and Liability Act of 1980 statutory requirements.

The United States Army completed a Remedial Investigation (RI) at OU5 to provide information regarding the nature and extent of contamination in the soils and groundwater. A baseline Human Health Risk Assessment and Ecological Risk Assessment were developed and used in conjunction with the RI to determine the need for remedial action and to aid in the selection of remedies. A Feasibility Study was completed to evaluate remedial options.

SECTION 1

Site Description

1.1 Site Location and Description

Fort Wainwright is in the Fairbanks North Star Borough in central Alaska and covers about 918,000 acres on the east side of the City of Fairbanks (Figure 1). Fort Wainwright includes the main post area, a range complex, and two maneuver areas. Fort Wainwright originally was established in 1938 as a cold-weather testing station. During World War II, it served as a crew and supply transfer point for the U.S. Lend-Lease program to the Soviet Union. After the war, it became a resupply and maintenance base for the remote Distant Early Warning sites, an experimental station in the Arctic Ocean, and the Nike Hercules missile sites in Interior Alaska. In 1961, all operations were transferred to the U.S. Army.

Primary missions at Fort Wainwright include training infantry soldiers in the arctic environment, testing of equipment in arctic conditions, preparation of troops for defense of the Pacific Rim, and rapid deployment of troops worldwide. Onsite industrial activities include the operation, maintenance, and repair of fixed-wing aircraft, helicopters, tactical and nontactical vehicles, weapon systems, as well as general support activities. The activities also include power generation; steam heat production; drinking water production, treatment, and distribution; and standby power and water production.

The Fort Wainwright cantonment area is 4,473 acres east of downtown Fairbanks, partly within the city limits. The rest of Fort Wainwright consists of ranges and military maneuver areas. The Chena River flows through Fort Wainwright and the City of Fairbanks into the Tanana River. All source areas, except Remedial Area 1A, are in a 500-year floodplain. Remedial Area 1A, is 500 to 750 feet above mean sea level on the side of Birch Hill. No threatened or endangered species reside in the OU5 area. The Ladd Field National Historic/Landmark District is within the EQFS.

A number of sites associated with known or suspected releases of hazardous chemicals have been identified across Fort Wainwright. Depending on the nature and extent of contamination identified during preliminary site assessment activities, these sites have been addressed as follows:

- Incorporated into one of the five operable units (OUs) on Fort Wainwright
- Identified as sites with petroleum, oil, and lubricants (POLs) for disposition under the Two-Party Agreement between the Alaska Department of Environmental Conservation (ADEC) and the Army
- Identified as no further action (NFA) sites under the Comprehensive Environmental Restoration, Compensation, and Liability Act (CERCLA)

OU5 is the final OU to be investigated at Fort Wainwright; consequently, this ROD integrates the remaining evaluations at the post. Consideration of OU5 includes potential cumulative human health or ecological risks that may become evident from the aggregate of

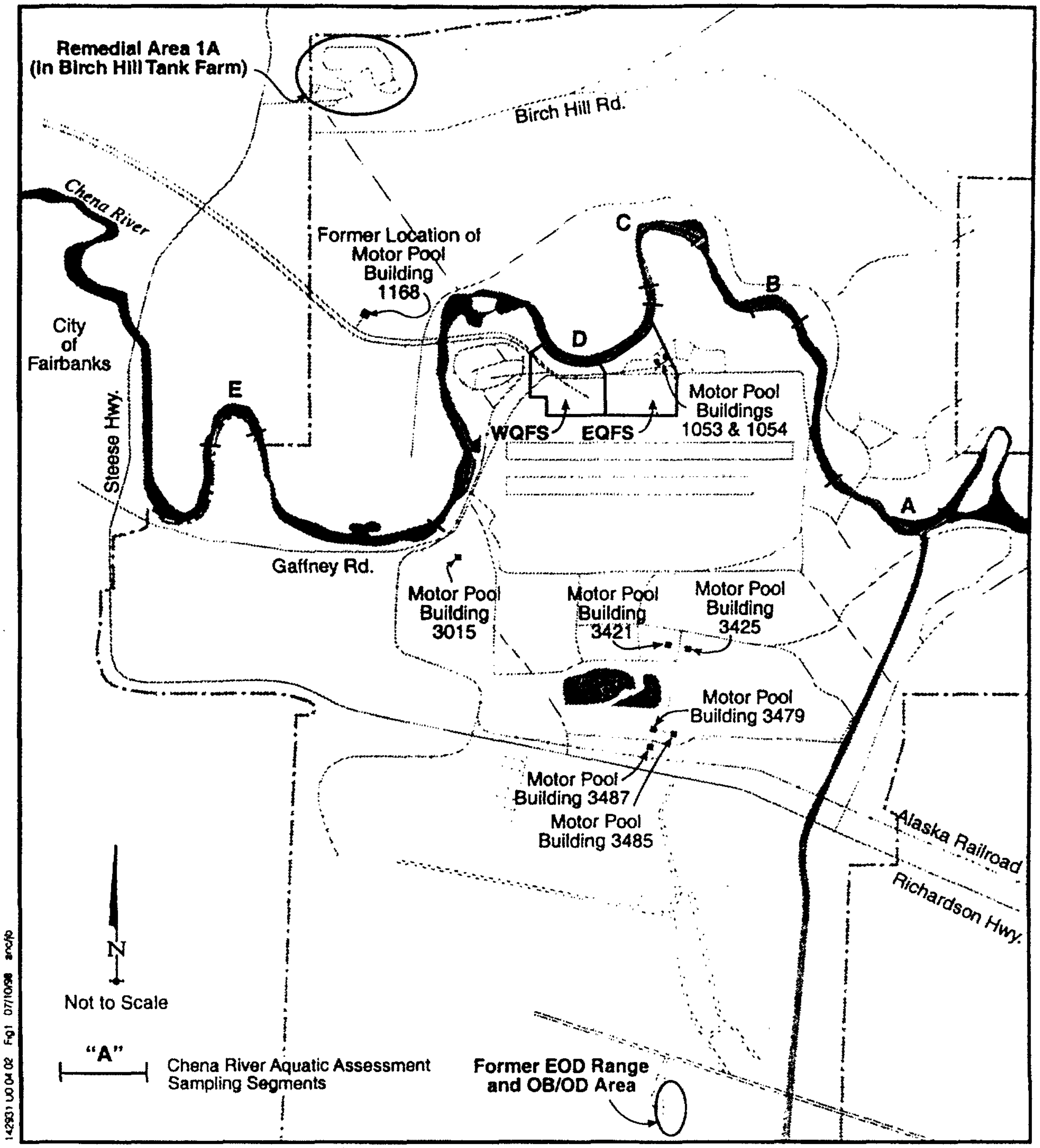

Figure 1. Fort Wainwright Site Map with OU5 Areas

source areas and areas not otherwise resolved in previous OUs. OU5 also has been used to integrate all the remaining sites not addressed under one of the records of decision (RODs) for OUs 1 through 4. OU5 includes three source areas deferred from previous investigations and three source areas originally identified in OU5:

- West Section, Former Quartermaster rs Fueling System (WQFS)
- East Section Former Quartermaster rs Fueling System (EQFS)
- Remedial Area 1A
- Open Burning/Open Detonation (OB/OD) Area
- Former Explosive Ordnance Disposal (EOD) Range (Blair Lakes Alpha Impact Area)
- Motor Pool Buildings

The locations of the WQFS, EQFS, Motor Pool buildings, Remedial Area 1A, and OB/OD areas are shown in relation to the entire installation and the Chena River in Figure 1. This ROD describes alternatives for remedial action for four of the six source areas: three subareas in WQFS, EQFS, Remedial Area 1A, and the OB/OD Area. The other two source areas have been identified as NFA sites under CERCLA.

1.1.1 WQFS Area

The WQFS, (Figure 2) area covers approximately 50 acres between Taxiway 18 and the Chena River.

Activities within this historical vehicle and aircraft maintenance operations area included the use and disposal of solvents and other cleaning and maintenance compounds. Several compounds of the Quartermaster's Fueling System (QFS) were located within the source area. The WQS, included underground storage tanks (USTs), aboveground storage tanks

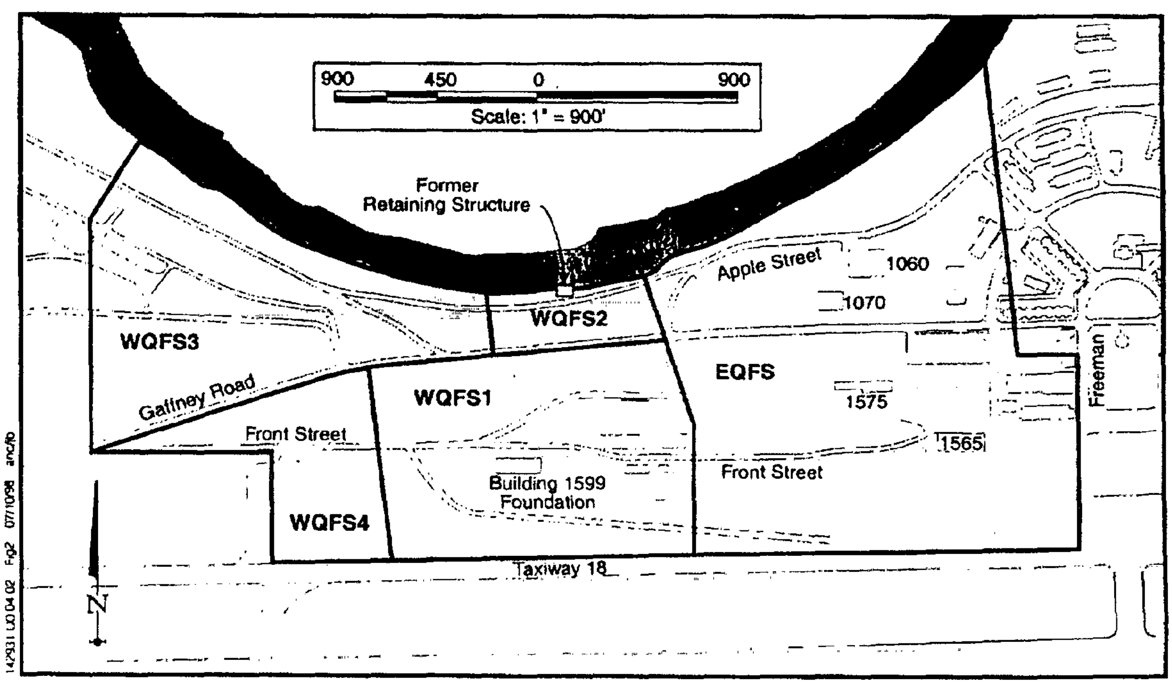

Figure 2. WQFS Subareas and EQFS Location Map

(ASTs), a pump house and fueling islands, which have been removed. In addition, drains were connected to a wooden pipe that drained to the river. The underground fuel pipelines and a network of aboveground and buried fuel piping were abandoned in place, and the status of the other buried piping, whether removed or abandoned, is unknown.

As shown in Figure 2, the WQFS area was divided into four subareas: WQFS1, WQFS2, WQFS3, and WQFS4. The alternatives selected for WQFS1, WQFS2, and WQFS3 are described in this ROD; WQFS4 is being addressed under the separate Two-Party Agreement between the Army and the ADEC (Appendix D).

1.1.2 EQFS Area

The EQFS area covers approximately 40 acres between Taxiway 18 and the Chena River, and between Building 1579 to the southwest and Building 1054 to the northeast (Figure 2).

The EQFS has been used for vehicle storage and maintenance, dry cleaning, fuels testing, refueling, pesticide storage and mixing, and waste storage. In addition, drains were connected to a wooden pipe that drained to the river. Solvents, pesticides, and petroleum contamination were found in EQFS groundwater. Suspected sources include spills and leaks from pipelines, fueling stations, and undocumented spills. The fuel pipeline has been abandoned in place, and the status of the other buried piping, whether removed or abandoned, is unknown.

The EQFS included USTs, ASTs, a pump house, and fueling islands, which have been removed. The 8-inch-diameter fuel pipeline is abandoned, but is still in place; it is unknown whether the other identified buried piping has been abandoned or removed.

1.1.3 Remedial Area 1A

Remedial Area 1A, the Birch Hill Tank Farm, is in the northwest corner of the main cantonment area. It was constructed in 1943 and stored fuel for military use. In 1993, the tanks were emptied and cleaned. The ground is almost entirely covered with vegetation.

Fuel stored in the tanks included arctic-grade diesel fuel, aircraft turbine and jet engine fuel (JP-4), vehicle motor gasoline, and unleaded regular motor fuel. Tank maintenance activities included cleaning sludge out of tank bottoms, the use of red lead pipe dope on bolts as a thread lubricant, and tank painting.

1.1.4 OB/OD Area

The OB/OD area is within the active small-arms impact area, approximately 1,000 feet north of the Tanana River and 1,500 feet south of the flood control dike. The site is along the east side of a gravel borrow pit filled with water.

The OB/OD area reportedly was used by the Army and the U.S. Air Force (USAF) for disposing of unexploded ordnance (UXO), unused propellants (black powder), rocket motors, small-arms ammunition, and other hazardous materials. The site was used as an OB/OD area from the mid-1960s through 1986.

1.1.5 Former EOD Range (Blair Lakes Alpha Impact Area)

The Former EOD Range is south of the other OU5 sites and reportedly lies somewhere within the active firing range (see Figure 1). The physical description of this site matches the location of the OB/OD area, and they are likely one and the same. This site formerly was known as the Blair Lakes Alpha Impact Area. The Army and USAF reportedly used the Former EOD Range as an open burning/open detonation site for disposing of UXO, unused explosives, and motors that propel weapons, and ammunition for small firearms. The site was active from the 1950s through 1974

1.1.6 Motor Pool Buildings

The Motor Pools are vehicle-maintenance facilities located at building 1053,1054,1168, 3015, 3421, 3425, 3479, 3485, and 3487. Buildings 3421, 3425, 3479, and 3485 each contain two motor pools. With the exception of Building 1168, these buildings still operate as motor pools. Minimal amounts of POL were stored at the Motor Pool Buildings. The motor pools have been addressed as one source area to allow for a comprehensive motor pool investigation.

1.2 Soils and Geology

Most of Fort Wainwright lies in the lowlands of the basin surrounding the Tanana and Chena rivers, which has a surficial layer of fine-grained soil over deeper alluvial deposits.

The surface soil is generally less than 5 feet thick. The alluvial floodplain deposits under the surface soil have varying proportions of sand and gravel, which are commonly layered, The alluvium layers contain up to 10 percent silt. The area has discontinuous permafrost of generally low ice content in mineral soil. The south-facing slopes of Birch Hill are free of permafrost. North of the Chena River, the permafrost is pervasive, with large areas frozen beneath a shallow active layer of 10 feet or less in the unconsolidated deposits. Thaw channels are associated with old river meanders, and in some areas (primarily cleared areas), the permafrost has receded to more than 20 feet below ground surface. Much of the native vegetation has been removed near the military facilities south of the Chena River, and the land surface has been extensively reshaped. Permafrost has degraded here to the extent that no significant amount remains in WQFS or EQFS.

1.3 Hydrogeology and Groundwater Use

The main aquifer at Fort Wainwright is the Tanana basin alluvium. The aquifer ranges from a few feet thick at the base of Birch Hill to at least 300 feet thick under the cantonment, and may reach 700 feet thick in the Tanana River valley. The aquifer is unconfined in permafrost-free areas. The water table is generally within 10 to 15 feet below ground surface and generally flows west-northwest on the south side of the Chena River. Although information on groundwater flow on the north side of the Chena River is limited, the flow appears to be to the west-southwest, and is highly influenced by permafrost. The groundwater at OUS flows into the Chena River either in OU5 or downriver. The Chena River flows through Fort Wainwright and the City of Fairbanks, into the Tanana River. The Tanana River flows south of the containment area of Fort Wainwright.

Groundwater levels and flow near the Chena River fluctuate greatly with changes in the river stage and interactions with the Tanana River. Typically, groundwater levels are highest during spring breakup and late summer runoff, when the river flow is greatest and river water enters the river banks. The groundwater flow also may be affected by high-volume pumping at off-post gravel pits for dewatering activities.

Potable water at Fort Wainwright and Fairbanks is supplied only by groundwater. A single distribution system supplies about 95 percent of potable water at Fort Wainwright. The post is fed by two large-capacity wells in Building 3559, near the power plant. These wells were completed at a depth of about 80 feet and provide between 1.5 million and 2.5 million gallons of water per day to the water treatment plant for treatment and distribution. Five emergency standby supply wells are located around the cantonment. These wells are between 80 and 120 feet deep, and can provide 250,000 gallons per day per well. These wells can supply minimally treated water to Fort Wainwright system for potable water supply.

The City of Fairbanks uses the same aquifer and has four developed wells in its Fairbanks Municipal Utility System wells 1 mile downgradient of the post boundaries, on the banks of the Chena River. These wells are the main drinking water supply for the city.

The Chena River is a clear-water (nonglacial) stream characterized in its lower reaches by slough-like conditions, relatively slow-moving water, and a single, well-defined channel. The river forms the boundary of Fort Wainwright for about 1.25 miles along WQFS and EQFS. Approximately 2.5 miles downstream of OU5, the Chena River leaves military lands, running through the City of Fairbanks to it confluence with the Tanana River, which is about 11 miles downstream.

River engineering projects have significantly affected the hydrology and ecology of the lower Chena River. Before 1941, the lower Chena River was a slough of the Tanana River called the Chena Slough. In 1941, a dike was constructed across the upstream end of Chena. Slough to prevent floodwaters of the Tanana from causing flood damage to Fairbanks. The Chena River is now the main source of flow through Fort Wainwright and Fairbanks. The ecology of the lower Chena River has changed considerably since the exclusion of the glacial meltwater of the Tanana River with its high load of suspended sediments. The flood control program was expanded from 1975 to 1981.

Upstream of Fort Wainwright, the Chena River is fed by small streams from adjacent hills. In Fort Wainwright, drainage from the main cantonment area drains into the south side of the Chena River. In contrast, drainage north of the river on post is undeveloped, forested, and contains a few gravel roads.

1.4 Land Use

Current land use for OU5 is light industrial; there are no residences in the OU. The nearest residences, within 1 mile northeast of EQFS, are site housing on North Post. Another residential area exists about 1 mile west of WQFS and 1.5 miles south of Remedial Area 1A. Each residential area includes a school. Access to WQFS and EQFS is unrestricted. Recreation in the area is encouraged currently with a bike trail as well as unlimited access to the Chena River.

Groundwater in the aquifer that extends under the source areas is the sole source of drinking water for Fort Wainwright and the City of Fairbanks. Wildlife use of the OU5 is limited by loss of habitat resulting from facility activities.

SECTION 2

Site Description

2.1 Site History

2.1.1 WQFS Area

Before the early 1970s, spills were not reported. The WQFS was the major industrial area for the installation between the late 1930s and the late 1960s. Historical air photographs indicate that numerous maintenance and industrial facilities existed in this area; all building have been removed. Historical routine maintenance practices involved the use of solvents and other hazardous materials. Disposal practiced included pouring the materials down dry wells, into leach fields, and onto the ground.

The 1996 *Operable Unit 5 Remedial Investigation Report, Fort Wainwright, Alaska,* lists recorded spills from vehicle and aircraft maintenance operations and leaks, including a 1971 leak of about 30,000 gallons of diesel fuel. The fuel reportedly ran into the abandoned wooden sewer line that had an outfalll at the Chena River. An estimated 1,600 gallons were recovered; about 7,500 gallons were burned; and the rest was lost. Another 1971 spill of about 16,000 gallons of gasoline occurred during fuel transfer activities. The fuel leaked into the Chena River through the same wooden sewer line. In 1980, a fuel leak into the Chena River occurred near WQFS. The source was unknown, but the 8-inch pipeline along the north side of Gaffney Road was suspected. The Army dug a trench between Apple Road and the river to capture the spill, and installed a sheet-metal retaining structure to prevent fuel migration to the river. However, sheens had been observed in the river below the retaining structure. In spring 1998, about 7oo cubic yards of contaminated soil and the retaining structure were removed. The removal action is discussed further in Section 5.4.3.

Building 1599, the facilities engineer maintenance shop, was built in 1942. It was burned in a training exercise in 1994, leaving the concrete foundation . A 3-inch pipe extended from the floor drain i the vehicle wash rack led to a manhole in the lubrication and service room, where it passed through a grease trap and then out of the building into a septic tank. Building 1599 also was used to store and mix pesticides before 1973. The building was adjacent to a sewer terminating at an outfall into the Chena River. The end of the 6-inch wooden pipe in still visible from the bank of the river. It is unknown if the building was connected to this sewer line. However, sampling of the Chena River was conducted to determine if any waste releases had occurred.

Several 55-gallon steel drums containing a black, sticky, tar-like substance were exposed along the south bank of the Chena River within WQFS during the 1994 North Airfield groundwater investigation. These drums were corroded, at least partially crushed, and leaking into the soil, sediment, and surface water.

The exposed drums were removed in 1995 by the Fort Wainwright Department of Public Works. Nine nearby buried drums and approximately 3 cubic yards of waste soil were excavated and removed in 1996 during the OU5 remedial investigation (RI).

Several treatability studies have been initiated at WQFS to evaluate the implementability, effectiveness, and cost of potential remedial technologies to treat solvent and other volatile organic commingled plumes. Treatability s tudies were designed to be incorporated into final remedies if they proved to be successful. Effective technologies have been incorporated into alternatives for WQFS and EQFS, as described below.

Treatability Study of Soil Vapor Extraction (SVE) and Air Sparging (AS) with Horizontal Wells at WQFS1. This treatability study system includes the installation of a pilot-scale treatment system that uses horizontal SVE/AS wells, instead of standard vertical wells, to treat residual contamination in soil and groundwater. The primary objective of this study is to compare the cost-effectiveness and efficiency of wells drilled horizontally with vertical wells drilled by conventional drilling. Fewer horizontal wells are needed than vertical wells, which results in lower cost. The wells were installed in August 1997, and will be incorporated into the selected remedy for WEFS1. The SVE well appears to be performing as specified. Improvements to the AS well are currently being evaluated to enhance the movement of air through the soil.

AS Curtain Treatability Study with Vertical AS Wells for Removal of Contaminants from Groundwater Downgradient of WQFS2 Soil Source. This treatability study system will demonstrate the applicability and cost-effectiveness of a vertical AS well curtain for protection of the Chena River from contaminants. The AS curtain system consists of a row of AS wells perpendicular to the groundwater flow direction. Air is injected into the AS wells through piping with an air-compressor blower. The injected air displaces groundwater from the largest, interconnected pores in the soil, forming continuous air channels. The curtain was installed during the late summer of 1998 and operation started shortly after installation. The system is expected to be in operation until cleanup objectives are achieved. This study has been incorporated into Alternative 3 for WQFS2.

AS Trench Treatability Study. The objective of this study is to evaluate the effectiveness of an AS trench on a laboratory scale. A short section of a simulated trench was installed in the laboratory to evaluate backfill design and the operational properties of the trench. This information would be used to evaluate effectiveness and to provide input on trench design.

Source Strength Treatability. The objective of this study is to assess the extent to which contaminants present in floating product dissolve into groundwater. The treatability study ins being performed in WQFS1 and began in early 1998. Information will be incorporated into groundwater modeling simulations to further refine fate and transport prediction for use in design and operation of treatment system.

WQFS Natural Attenuation Treatability Study. The objective of this study is to evaluate the rate of contaminant disappearance and the mechanisms and processes for natural attenuation in groundwater emanating from the WQFS! Source. Computer modeling will be performed and soil and groundwater samples will be collected to determine the mechanism of natural attenuation. This information is used to refined time frames for achieving remedial action objectives (RAOs), to determine treatment system placement, and to better understand the potential for downgradient migration of contaminants. Monitored and evaluated natural attenuation has been incorporated into all active treatment remedies for WQFS alternatives.

Treatability Study of In Situ Soil Heating in WQFS1. This study will evaluate the extent to which soil heating increases remediation rates through increased contaminant volatility and biodegradation, which reduce the duration of treatment and decrease the level of residual soil contamination. In situ soil heating with radio frequency will be compared to heating with the six-phase technology. Both systems began operation in spring 1998. Six-phase heating operated through November 1998. The radio-frequency treatability study system was expected to be in operation until March 1999. In situ heating has been incorporated into Alternatives 4 and 5 for WQFS1.

In Situ Treatability Study with Oxygen Release Compound (ORC) for Groundwater at Subarea WQFS2. A pilot-scale ORC system was constructed and completed in 1996. A formulation of magnesium peroxide contained in filter "socks" was inserted into the groundwater wells, to allow contact with contaminated groundwater. The peroxide formula was intended to increase dissolved oxygen in groundwater to enhance biodegradation processes through more available oxygen. Performance was measured by the amount of dissolved oxygen in groundwater. Groundwater sampling and dissolved-oxygen testing were conducted quarterly. Sampling began in February 1997, and was expected to run through mid-1998. Preliminary results received indicate that levels of dissolved oxygen have not increased measurably. ORC will not be considered for expansion at OU5 because preliminary results indicate that ORC may not be effective at reducing dissolved contaminants in site groundwater. These wells are being used in conjunction with other treatability studies.

Bench-Scale Column Study of Factors Limiting the Bioremediation Rate. Soil samples have been collected throughout the OU5 source areas and will be used in this study. The study started in January 1998 and is expected to continue until December 1998. Data collected will be used to assess the bioremediation component of the selected remedial actions and to refine estimated time frames for achieving RAOs.

2.1.2 EQFS Area

According to the OU5 RI report, EQFS has been used for vehicle storage and maintenance, dry cleaning, fuels testing, refueling, pesticide storage and mixing, and waste storage (for example, polychlorinated biphenyl [PCB] transformers, chemicals, paints, oils, brake fluid, and solvents). The Motor Pool (Building 1054) had drains connected to a 6-inch pipe connected to an 8-inch wooden pipe that drained to the river. Contamination from commingled solvent and other volatile organic plumes was found in EQFS groundwater.

Historical routine maintenance practices involved the use of solvents and other hazardous materials. Disposal practices included pouring the materials down dry wells, into leach fields, and onto the ground. Soil and groundwater beneath Building 1054 were investigated during an OU1 preliminary source evaluation. On June 3,1994, the remedial project managers (RPMs) recommended NFA under CERCLA for soil at Building 1054 (*Fort Wainwright CERCLA Federal Facility Agreement Recommended Action*, *Source Area: Building 1054*). Under the same decision document, groundwater beneath Building 1054 was referred from OU1 to the EQFS area of OU5.

Ongoing treatability studies at EQFS are described below.

SVE/AS System at Building 1060. Consisting of nine SVE and eight AS wells, this system was installed at the Building 1060 site in June 1994 to evaluate the suitability of using these technologies to remediate solvent- and petroleum-contaminated groundwater and soils. The system has run almost continuously since startup. The treatability study has demonstrated that the SVE/AS system at Building 1060 is successfully removing chlorinated solvents and petroleum hydrocarbons from the soils and groundwater. This treatability study system was incorporated into Alternatives 2, 3, 4, and 5 for EQFS.

Natural Attenuation Treatability Study. In this treatability study, monitoring wells were installed around the contaminant plume. In addition, contaminant and geochemical data were collected. Contaminant concentrations were modeled to simulate the migration and attenuation of the contaminant plume through time. A simplified risk assessment of exposure to groundwater contamination through seepage to the Chena River also was conducted. The objective of this study is to evaluate the rate of contaminant disappearance and the mechanisms and processes for the natural attenuation of groundwater emanating from the EQFS source. Historical trends showed a reduction in hydrocarbon concentrations in all EQFS wells downgradient of the source, and contaminant mass calculations showed an overall decrease in total mass over time. Because natural attenuation has been successfully demonstrated in EQFS, monitored and evaluated natural attenuation has been incorporated into all alternatives for EQFS, with the exception of the no-action alternative.

2.1.3 Chena River

The Chena River was identified as the area most likely to be affected by multiple source areas. As a result, the Chena River Aquatic Assessment Program was initiated to evaluate potential impacts. A total of 81 known or suspected contaminated sites were identified for consideration in the postwide risk assessment. To assess risks to aquatic receptors in the Chena River, five segments of the river (Segments A through E) that correspond to the spatial distribution of river sediment and surface water samples were identified. These segments are also adjacent or linked to the following source areas:

- Segment A–Channel B outflow (a ditch draining contaminated areas assigned to OU1 and OU2) and the Chena River Tar Site
- Segment B–Engineer Park Drum Site
- Segment C–North Post Site (assigned to OU2) and Landfill (assigned to OU4)
- Segment D–WQFS and EQFS (assigned to OU5), Railcar Off-loading Facility (assigned to OU3), and 801 Drum Burial Site (assigned to OU1)
- Segment E–the Glass Park Tar Site

When average concentrations of chemicals in each segment were compared to the appropriate benchmark values for toxicology of surface water and sediment, a number of exceedances were noted. The following compounds exceeded benchmark levels: DDT or its metabolites, dioxins, furans, several polynuclear aromatic hydrocarbons (PAHs), pesticides, and PCBs. Surface water benchmarks were exceeded for a number of chemicals in Segment D. The impacts of these exceedances are discussed further in Section 4, Risk Assessment.

Results of groundwater sampling show that contaminated groundwater from the WQFS area meets the Chena River in Segment D. Seepage from within this area often creates a visible sheen on the river, and contaminated sediment along the shore releases a hydrocarbon sheen and odor.

The Chena River is listed as a water-quality-limited water body, according to Section 303(d) of the Clean Water Act. Tier II fists the river as a water body for which an assessment has been completed and that now requires a water-body recovery plan. Water-quality-limited water bodies are surface waters with documentation of actual or imminent persistent exceedances of water quality criteria and/or adverse impacts to designated uses. Designation of a water body as a water-quality-limited water body does not necessarily indicate that the entire water body is affected. In most cases, only a segment of the water body is affected. The Chena River was included on the list in 1994 because of turbidity, sediment, and habitat modification. However because the turbidity and sedimentation may be the result of a one-time failure of a settling pond for placer mining, which has been repaired, the Alaska Mining Division has recommended that the turbidity and sediment parameters be dropped. ADEC recommends that the Chena River be included on the list because of petroleum products.

2.1.4 Remedial Areal 1A

Remedial Area 1A was investigated in the OU3 RI. The soil contamination in the top tank area was transferred to OU5 for further evaluation in the January 1996 *Record of Decision for Operable Unit 3, Fort Wainwright, Fairbanks, Alaska*, to provide time to select an appropriate cleanup level for lead-based paint in soil. National cleanup standards specific to lead-based paint in soil have not yet been promulgated. Since the OU3 ROD was signed, new information indicating additional sources of lead in soil at Remedial Area 1A has become available. Records on historical tank farm activities indicate that the suspected origins of lead contamination in soils include sludge from the bottoms of tanks, lead-containing thread lubricant used on bolt threads for routine maintenance, and leaded paint chips from tank maintenance. Soil is contaminated with lead, petroleum, and related constituents.

Groundwater investigation on Birch Hill has been limited in scope because of the difficulty in drilling with the tanks in place, the fractured rock composition, and the slope and terrain of the tank farm. Petroleum spills have occurred in and around the tanks and the truck fill stand throughout the history of the fuel terminal. Petroleum contamination at Fort Wainwright is primarily addressed through the conditions of the Two-Party Agreement between the State of Alaska and the Army. Groundwater at the base of Birch Hill is contaminated with commingled volatile organic compounds (VOCs) and is being addressed under OU3.

2.1.5 OB/OD Area

The OB/OD area, previously referred to as the EOD area, is within the active small-arms impact range on Fort Wainwright. Open burning and open detonation of explosives on Fort Wainwright historically have been performed on this pad from the mid 1960s to some time between 1981 and 1986. No OB/OD activities have been performed on OB/OD pad since that time. The pad now contains no visible debris.

The OB/OD area, which was designated as a RCRA-regulated unit, was scheduled for closure under Title 40, part 265, of the 40 *Code of Federal Regulations* (CFR) 265, Subparts G and P. This area was included in OU5 under the FFA. The process for closing the OB/OB pad in accordance with RCRA regulations is detailed in Section 9 of this ROD.

An RI at the OB/OD area in 1996 included sampling and analysis of soil. Further details of this investigation are described in Section 9 of this ROD. The ecological and human health risk assessments completed during the RI indicate that the risks are very low. For this reason, the OB/OD area has been recommended for NFA.

Public access to the OB/OD area is restricted. Entry into this area is by a road with a locked gate. Access is controlled and monitored by the Range Control at Fort Wainwright. These restrictions are not expected to change. Because of the potential for hazard from UXO in this area, the OB/OD area is not available for future development. The OB/OD Area is discussed extensively in Section 9 of this ROD.

2.1.6 No Further Action Sites

Two source areas are recommended for NFA under CERCLA: Former EOD Range and Motor Pool Buildings. These sites are briefly discussed below. Appendix C provides an illustration of these sites and other relevant information. No costs are associated with these sites, and they are not discussed further in this ROD.

2.1.6.1 Former EOD Range

The Former EOD Range (Blair Lakes Alpha Impact Area) was referred from OU1 to OU5 on January 13,1994, in the document *No Further Action Site Summaries, OU 1 Fort Wainwright* (1994). The source area was reportedly used as an OB/OD site for disposing of UXO and dud ordnance through 1974. The extent of use and actual years of operation are unknown.

Fort Wainwright and contract personnel evaluated aerial photographs and historical information, interviewed individuals with an institutional knowledge of Fort Wainwright, conducted site visits, and reviewed analytical data. The results of these efforts failed to provide a location of this potential source area. It is believed that the former EOD Area and the OB/OD Area are the same site.

On the basis of the inability to locate the Former EOD Range, it was determined that further investigation of this source area under CERCLA was not justified. On April 10 and 25,1995, the Army, EPA, and ADEC project managers recommended NFA for this source under CERCLA. NFA recommendations become final upon signature of this ROD.

2.1.6.2 Motor Pools

The Motor Pool Buildings were referred to OU5 from OU1 in the 1996 *Fort Wainwright CERCLA Federal Facility Agreement Recommended Action, Source Area: Motorpools (13 Estimated)* to allow for a comprehensive investigation of the facilities. Table C-1 in Appendix C lists the Motor Pool Buildings and describes their facilities and current status.

The contaminants found at the Motor Pools were primarily low-level concentrations of POL and solvents. After limited investigation, all Motor Pool source areas were recommended for NFA under CERCLA. On July 27,1995, the Army, EPA, and ADEC project managers recommended NFA for this source under CERCLA. NFA recommendations become final upon signature of this ROD.

2.1.7 Two-Party Agreement Sites

Through the CERCLA investigative process, Fort Wainwright areas were evaluated to determine whether they should be referred to another federal or state program, recommended for NFA under CERCLA, or continued through the CERCLA process. Source areas limited to potential petroleum contamination were deferred to the Two-Party Agreement.

Signed by the Army and ADEC originally in 1992 and updated in 1998, the Two-Party Agreement defined the process by which the Army agrees to investigate and clean up petroleum-contaminated areas in accordance with Alaska State regulations. These areas generally are associated with USTs that have leaked or surface spills of petroleum products such as lubricating oils and grease, heating fuels, and motor fuels. For example, tanks near six of the Motor Pools have been transferred to the Two-Party Agreement. In addition, WQFS4, which has isolated, low-level petroleum contamination, will be addressed under the Two-Party Agreement.

The Two-Party Agreement is part of the FFA for Fort Wainwright, and decisions for cleanup within the Two-Party Agreement are part of this OU5 ROD. The Two-Party Agreement presents the petroleum cleanup strategy and documents all known historical petroleum sources on Fort Wainwright and their current cleanup status. It also verifies the Army's commitment to adequately address petroleum sites in a manner consistent with state regulation.

Costs associated with sites deferred to the Two-Party Agreement are not a component of this ROD. These sites are not discussed further in this ROD. The Two-Party Agreement and a figure and table identifying affected sites are provided in Appendix D.

2.2 Enforcement Activities

Fort Wainwright was placed on the National Priorities List (NPL) of CERCLA in 1990 because a number of sites associated with known or suspected releases of hazardous chemicals were identified on the post. As a result, environmental assessment and remediation activities at Fort Wainwright are being performed to comply with CERCLA, as amended by the Superfund Amendments and Reauthorization Act (SARA) of 1986 and subsequent amendments.

These activities also are being performed to comply with a 1992 Federal Facility Agreement (FFA) among the U.S. Environmental Protection Agency (EPA), the Department of the Army, and the ADEC. The FFA identifies the authorities and responsibilities of these parties, integrates CERCLA requirements with pertinent aspects of other federal and state remedial programs, and defines schedules and general requirements for investigation and/or remediation at areas suspected of being historical sources of hazardous waste.

An additional goal of the FFA was to integrate the Army's CERCLA response obligations and Resource Conservation and Recovery Act (RCRA) corrective action obligations. The

FFA enabled the Army to obtain a RCRA Part B permit for its interim status facilities. This permit was issued during spring 1992. Remedial actions implemented under this ROD will be protective of human health and the environment and will meet the substantive requirements of the National Oil and Hazardous Substances Pollution Contingency Plan (NCP).

The FFA divided Fort Wainwright into five OUs and required a risk assessment "to evaluate any ecological or human health cumulative risk effects which may become evident from the aggregate of the source areas at Fort Wainwright not addressed in prior OU remedial investigation/feasibility studies."

The Army and ADEC signed a Two-Party Agreement in 1992 to define the process by which the Army agrees to investigate and clean up petroleum-contaminated areas. These areas generally are associated with USTs that have leaked or surface spills of petroleum products such as lubricating oils/grease, heating fuels, and motor fuels. The areas identified and placed in the Two-Party Agreement are identified in Appendix D.

2.3 Highlights of Community Participation

The public was encouraged to participate in the selection of the remedies for OU5 during a public comment period from June 17 to July 17, 1998. *The Proposed Plan for Remedial Action, Operable Unit 5, Fort Wainwright, Alaska,* presents combination s of options considered by the Army, ADEC, and EPA to address contamination in soil and groundwater at WQFS1, WQFS2, WQFS3, EQFS, and Remedial Area 1A of OU5. The Proposed Plan was released to the public on June 16, 1998, and was sent to all known interested parties, which included approximately 150 concerned citizens.

Community relations activities conducted for Fort Wainwright, which includes OU5, began in 1992. A community relations plan was prepared in 1993 and updated in 1997. Fact sheets describing the environmental restoration activities at all Fort Wainwright OUs have been distributed regularly since 1993. The Restoration Advisory Board, a group that focuses on restoration and community relations activities, first met in 1997 and has met quarterly since then.

The Proposed Plan summarizes cleanup alternatives for OU5. Additional materials were placed in two information repositories: one at the Noel Wien Library in Fairbanks and the other at the Fort Wainwright Post Library. An Administrative Record, including all items placed in the information repositories and other documents used in the selection of the remedial actions, was established in Building 3023 on Fort Wainwright. The public is invited to inspect materials available in the Administrative Record and the information repositories during business hours.

Interested citizens were invited to comment on the Proposed Plan and the remedy selection process by mailing comments to the Fort Wainwright project manager, calling a toll-free telephone number to record a comment, or attending and commenting at a public meeting on June 25,1998, in Fairbanks at the Carlson Center. The public did not provide any comments on the Proposed Plan.

Display advertisements in the *Fairbanks Daily News-Miner*, published on June 19, 21, 24, and 25, 1998, also included information about the information repositories, the toll-free telephone line, and an address for submitting written comments.

The Responsiveness Summary provides a background discussion of community involvement activities conducted in association with OU5. This document is Appendix A of this ROD.

This ROD presents the selected remedial actions for OU5 chosen in accordance with CERCLA as amended by SARA and, to the extent practicable, the NCP. The decision for OU5 is based on information and documents that are in the Administrative Record.

2.4 Scope and Role of Operable Units

As with many CERCLA sites at large installations and with many source areas, the problems at Fort Wainwright are complex. The potential source areas were grouped into OUs based on the amount of existing information, the similarity of potential hazardous substance contamination, and the level of effort required to complete an RI. OU5 will be the fifth and last OU to have completed the RI/FS process and begin remedial activities. OUs 1, 2, 3, and 4 have been addressed in previous RODs; only OU5 is addressed in this ROD.

OU5 contains source units resulting from past fuel leaks, spills, waste storage, and other facility activities, and groundwater under these source units. The source sites originally were in three general areas: WQFS, EQFS, and OB/OD area. Additional CERCLA sites have been transferred into OU5 from other OUs: Remedial Area 1A (Birch Hill Underground Storage Tanks), Motor Pool Buildings, Former EOD Range, and sites deferred to the Two-Party Agreement.

The RI fieldwork was completed and reported with the risk assessment in the 1996 *Operable Unit 5 Remedial Investigation Report, Fort Wainwright, Alaska* (three volumes). The feasibility study (FS) was completed and reported in 1998 in *Operable Unit 5 Feasibility Study, Fort Wainwright, Alaska.* A risk assessment was completed for the entire Fort Wainwright area to supplement the individual risk assessments developed for each of the five OUs and other designated source areas at the site. The objective of the postwide risk assessment was to evaluate any ecological or human health cumulative risk effects that may become evident from the aggregate of the source areas and not addressed in the previous OU RI/FSs. The RI and FS defined potential risks posed by existing groundwater contamination and the potential for migration if remediation does not occur. The Chena River was identified as the area most likely to be affected by multiple source areas. As a result, the Chena River Aquatic Assessment Program was initiated to evaluate potential impacts.

This ROD presents the selected remedial actions for OU5 source areas in accordance with CERCLA as amended by SARA and, to the extent practicable, the NCP. The decision for OU5 is based on information and documents that are in the Administrative Record.

The actions identified in this ROD are intended to significantly reduce risks to human health and the environment associated with contamination resulting from past activities at Fort Wainwright. The principal threats, as defined by EPA guidance, are the highly contaminated subsurface soils, floating product layer, smear zones, and groundwater in the

WQFS source areas. Treatment has been selected as an element of the remedial action for these principal threats.

SECTION 3

Summary of Source Area Characteristics

The transport pathways, hydrogeologic conditions, and nature and extent of contamination for the WQFS, EQFS, and Remedial Area 1A source areas are summarized in the following sections.

3.1 Transport Pathways and Hydrogeologic Conditions

This section provides a brief discussion of factors affecting the migration of contaminants detected in soil, groundwater, sediment, and surface water at OU5.

3.1.1 Air Transport

Organic compounds detected in surface soil at OU5, especially aromatic hydrocarbons (benzene, toluene, ethylbenzene, and xylenes [BTEX]), may volatilize and be transported by air. Because of the significant dilution caused by the atmosphere, volatilization is expected to be a minor transport pathway. When wind speed is high enough to suspend small surface-soil particles (dust), site contaminants sorbed to the dust particles may be transported offsite. Because most contamination in OU5, with the exception of Remedial Area 1A, is subsurface, the transport of airborne particulates is relatively insignificant.

3.1.2 Surface Water Runoff

Surface water runoff at OU5 is relatively insignificant, because the majority of precipitation infiltrates directly into the porous soils, then returns to the atmosphere through evapotranspiration. When surface-water runoff occurs, surface-water migration occurs as intermittent overland flow during rainfall or snowmelt. Surface-water runoff from WQFS and EQFS eventually drains toward the Chena River. The Chena River flows through the northern portion of the cantonment area, then through Fairbanks before it joins the Tanana River approximately 8 miles west-southwest of Fort Wainwright.

3.1.3 Migration in Soil to Groundwater

Solvents and petroleum hydrocarbons are the contaminants of concern (COCs) in the OU5 source area soil. At WQFS and EQFS, dissolved chlorinated solvents are present in groundwater. No evidence of free-phase or immiscible dense free product has been found in saturated or unsaturated soil in these areas. Concentrations do not indicate a free-product source in the groundwater.

In general, the contaminants were released to the soil as nonaqueous-phase liquid (referred to as free product), most of which migrated down through the soil by gravity. Some of the hydrocarbon liquid remains held in the soil pores by capillary forces and becomes immiscible. This condition is termed residual saturation. The concentration of petroleum (in soil) at residual saturation is expected to be several thousand to tens of thousands of milligrams per kilogram of soil for the sand and gravel at the OU5 sites. Free product at or below residual saturation will not migrate downward through the soil by gravity, but may be transported down by percolating water, both as immiscible globules and in solution. Sources of percolating water at the OU5 sites include infiltrating snowmelt and rainfall. The extent of contaminant infiltration into subsurface soil depends on the ability of specific contaminants to adsorb to or react with subsurface soil particles. The majority of groundwater contamination in OU5 is a result of subsurface releases such as pipeline breaks and leaking tanks.

The principles governing downward migration of floating product through the unsaturated zone also apply to heavier-than-water free product, such as trichloroethene (TCE). Upon reaching the water table, the heavier-than-water, or dense, nonaqueous-phase liquids (referred to as dense free product) displaces the water and continues downward until reaching residual saturation and becoming immobile. Because dense free product does not float on the water table, significant lateral spreading does not occur. As a result, the contaminated soil "footprint" is relatively small and therefore more difficult to detect than floating product.

Lighter-than-water nonaqueous-phase liquids (referred to as floating product), such as gasoline or diesel, have a specific gravity of approximately 0.7 to 0.85 and, therefore, float on water. Accumulations of floating-product petroleum hydrocarbons are sometimes referred to as free-phase petroleum hydrocarbons or free product. The term floating product is used in this ROD.

When sufficient floating product reaches the water table, it tends to depress the water table. These contaminants tend to spread horizontally on the surface of the water table from the force of the buoyancy of the water and from the force of additional contaminants migrating from above. The contaminants at the water-table surface fluctuate vertically as the water table fluctuates, and as the water table drops, contaminants enter soil pores that were formerly filled with water. During high water, some floating product becomes trapped below the water table in the soil pores. The groundwater zone containing floating product between the low and high water levels is sometimes referred to as the "smear zone." At WQFS and EQFS, the smear zone is located in the interval between approximately 12 and 18 feet below ground surface. Floating product continues to move with the water table until it is transformed into residual saturation or is degraded.

Both free-phase and residual saturation are sources for contaminants dissolving into groundwater.

3.1.4 Groundwater Migration

The aquifer beneath the OU5 area consists of glacially derived sands and gravels (Chena alluvium) that have been transported and reworked by the Tanana and Chena rivers. The alluvium has been described as a heterogeneous mixture of coarser and finer soil lenses of relatively small size, a description that is consistent with logs of borings installed in the area. The aquifer ranges from a few feet thick at the base of Birch Hill to at least 300 feet thick under the cantonment, and may reach thicknesses of up to 700 feet in the Tanana River valley. The aquifer is considered unconfined in permafrost-free areas, such as OU5. The horizontal hydraulic conductivity is estimated to be 125 to 400 feet per day. The vertical hydraulic conductivity is estimated to be one-twentieth of the horizontal hydraulic conductivity. The water table generally is encountered within 10 to 15 feet below ground surface and flows generally west-northwest on the south side of the Chena River. The groundwater flow direction and gradient are influenced strongly by the Chena River.

Dissolved contaminants migrate in groundwater by advection and dispersion. Groundwater is expected to move with an average linear velocity of 1.0 to 1.5 feet per day in the OU5 area. Contaminants have been carried with the groundwater flow approximately 2,000 feet downgradient of the main source area within WQFS. The shape and location of the plume suggest that downward gradients have carried contaminants into, beneath, and north of the Chena River. Dissolved contaminants (benzene and total aromatic hydrocarbon [TAH]) were detected at concentrations greater than the federal maximum contaminant level (MCL) and Alaska Water Quality Standards at depths up to 70 feet below ground surface. Contaminants also have been detected at concentrations greater than MCLs at groundwater sampling locations north of the Chena. River.

3.1.5 Groundwater and Chena River Interaction

Shallow groundwater flows into or out of the riverbed and riverbanks depending on the elevation of the water in the river relative to the groundwater table. Seasonally, the discharge of the river fluctuates from a high during late May or early June snowmelt to a low in late April or early May, which is late winter and presnowmelt. The river stage also may rise in response to summer rainfall. The groundwater table generally rises and falls in response to these river fluctuations, but is less affected with increasing distance from the river.

High-flow events in the Chena River produce transient changes in the groundwater flow regime, temporarily reversing the groundwater flow direction and gradient. The duration of these transient events is typically several days. These transient events generally occur during two periods: the spring snowmelt and late-summer precipitation, which results in peak flows in the Chena River.

Groundwater contaminants enter the Chena River and potentially affect aquatic receptors and downgradient groundwater users, including residents of the City of Fairbanks. Modeling simulations indicate that during most of the year groundwater flows in a northwesterly direction and intersects (recharges) the Chena River. Flow lines that originate at depths of 60 feet or more are thought to flow beneath the river. The flow lines have no hydraulic connection to the river (at that point). Simulations indicate that water flowing beneath the river has an upward gradient within 1,000 feet north of the river and tends to rise toward the surface and turn in a westerly direction to join the river before the next meander. Transient high-water events in the Chena River (such as during breakup) tend to reverse the flow into and under the river. They also cause temporary flow downward and away from the river at all depths. The flow reversal propagates to distances of approximately 1,500 feet from the river.

Groundwater flow transports dissolved contaminants to the Chena River. The groundwater is quickly diluted by the river flow; therefore, only low-level contaminants have been detected in the Chena River. U.S. Geological Survey records indicate that the average discharge for the Chena River at Fairbanks in a 42-year recording period was 1,371 cubic feet per second.

3.1.6 Sediment Transport

Less volatile fractions of transported groundwater contaminants are found in sediments in the OU5 reach of the Chena River. Contaminated sediment particles are transported with river flow act as hydraulic forces on the riverbed and riverbanks. The particles produce mass transfer and reshape the river channel. The rate of contaminated sediment transport is affected by many factors, including geologic characteristics of the sediment, hydrologic cycles, geometric characteristics of the river, and hydraulic characteristics such as depth, slope, and velocity.

3.1.7 Potential Transport Pathways and Receptors

At OU5, chemicals in soil, sediment, and groundwater are potentially available to human and ecological receptors. Transport pathways considered for an evaluation of human health risks are ingestion, dermal contact, and inhalation of particulates for soil; and ingestion, dermal contact, and inhalation of VOCs (through air) for groundwater contaminants. The potential current and future receptors assessed are facility workers, construction workers, and military and nonmilitary residents. The pathways considered for ecological receptors are ingestion of soil, sediment, and surface water; ingestion of terrestrial and aquatic plants; and exposure to sediment and surface water. The risk assessments for the source areas are summarized in Section 4.

3.2 Nature and Extent of Contamination

Investigations at WQFS before the OU5 RI included surface and subsurface soil samples, shallow borings, and monitoring wells. These investigations are identified in the 1996 OU5 RI report. The 1994 North Airfield groundwater investigation (documented in the 1995 *North Airfield Groundwater Investigation, Fort Wainwright Alaska,* report) identified several groundwater plumes. Two free-product plumes are in WQFS. The larger plume extends about 4-1/2 acres and encompasses more of the area where fuel pumps, dispenser islands, and storage tanks were located. The smaller free-product plume extends about 600 feet southwest of Building 1599 and coincides with a bermed area around a possible fuel containment structure. A benzene plume covers about 25 acres, at least 25 feet thick. A plume of 1,2-dichloroethane (1,2-DCA) extends from north of Front Street to the Chena River, overlapping the free-product and benzene plumes. Estimated depth of the plume is 20 feet. Dissolved diesel-range organics (DRO) and gasoline-range organics (GRO) also were detected in WQFS, but the extents were not defined.

Soil sampling at Building 1599 showed fuel contaminants extending from the ground surface to the groundwater table near fuel facilities. The data suggested that the concentrations increased with depth between zero and 15 feet and were typically greatest near the groundwater table, where hydrocarbons had accumulated. Sampling also indicated the presence of pesticides in soils at concentrations below screening levels. However, because of high levels of hydrocarbons found in soil samples, uncertainty exists about the laboratory data for exact concentrations of pesticides. In the 1997 *Record of Decision for Operable Unit 1, Fort Wainwright, Fairbanks, Alaska,* remediation of petroleum-contaminated soils at Building 1599 was deferred to the Two-Party Agreement between the Army and ADEC. The groundwater under the site, however, is addressed in OU5.

Data from pre-RI investigations indicated that groundwater contaminant plumes were not discrete; they were commingled. To better address the complexity of these commingled plumes in a cost-effective and comprehensive manner, the project managers combined source area groundwater investigations into the Quartermaster areas identified in the RL

Contaminants detected in 1994 at the 55-gallon drum site along the Chena River included petroleum hydrocarbons and benzene. Although the contents did not impart a sheen to the river, a surface water sample collected within 10 feet of the drums contained benzene at 1.3 micrograms per liter (µg/L). Other organic contaminants were detected in the surface water at other locations. Sediment sampling at the river bank and sampling of river water during the OU5 RI showed contaminants above potential applicable or relevant and appropriate requirements (ARARs).

The COCs for OU5 are identified and assessed for potential risk in the November 1996 *Operable Unit 5 Remedial Investigation Report, Fort Wainwright, Alaska;* the November 1997 *Operable Unit 5 Feasibility Study, Fort Wainwright, Alaska;* and the April 1995 *Feasibility Study, Operable Unit 3, Fort Wainwright, Alaska* (for Remedial Area 1A).

3.2.1 WOFS Nature and Extent of Contamination

The COCs at WQFS1, WQFS2, and WQFS3 are discussed below and summarized in Table 1. Contaminants identified at WQFS include chlorinated VOCs and petroleum hydrocarbons in groundwater and petroleum hydrocarbons and PAHs in soil. The approximate extent

TABLE 1
Summary of Soil and Groundwater Sample Results for Contaminants of Concern–WQFS

Medium	Contaminant	No. of Detections/ No. of Samples	Range of Detected Concentrations
Soil	DRO	118/184	4 – 54,000
	GRO	43/184	5 – 5,300
	Benzene	9/184	0.002 – 3.7
	Ethlybenzene	21/184	0.082 – 31
	Toluene	24/184	0.002 – 91
	Xylenes	30/184	0.003 – 220
Groundwater	Benzene	16/19	0.3 – 960
	Toluene	16/19	0.1 – 2,500
	1,2-DCA	9/19	0.3 – 41
	TCE	2/19	36 – 42
	TAH	14/19	13 - 6,230
	TaqH	12/19	19 - 6,773

Notes:
1. Soil concentrations are in milligrams per kilogram. Groundwater concentrations (remediation goal and detected) are in micrograms per liter.

TAqH = Total aqueous hydrocarbon

of soil and groundwater contamination is shown in Figure 3. Contaminated soil volume estimates are presented in Table 2.

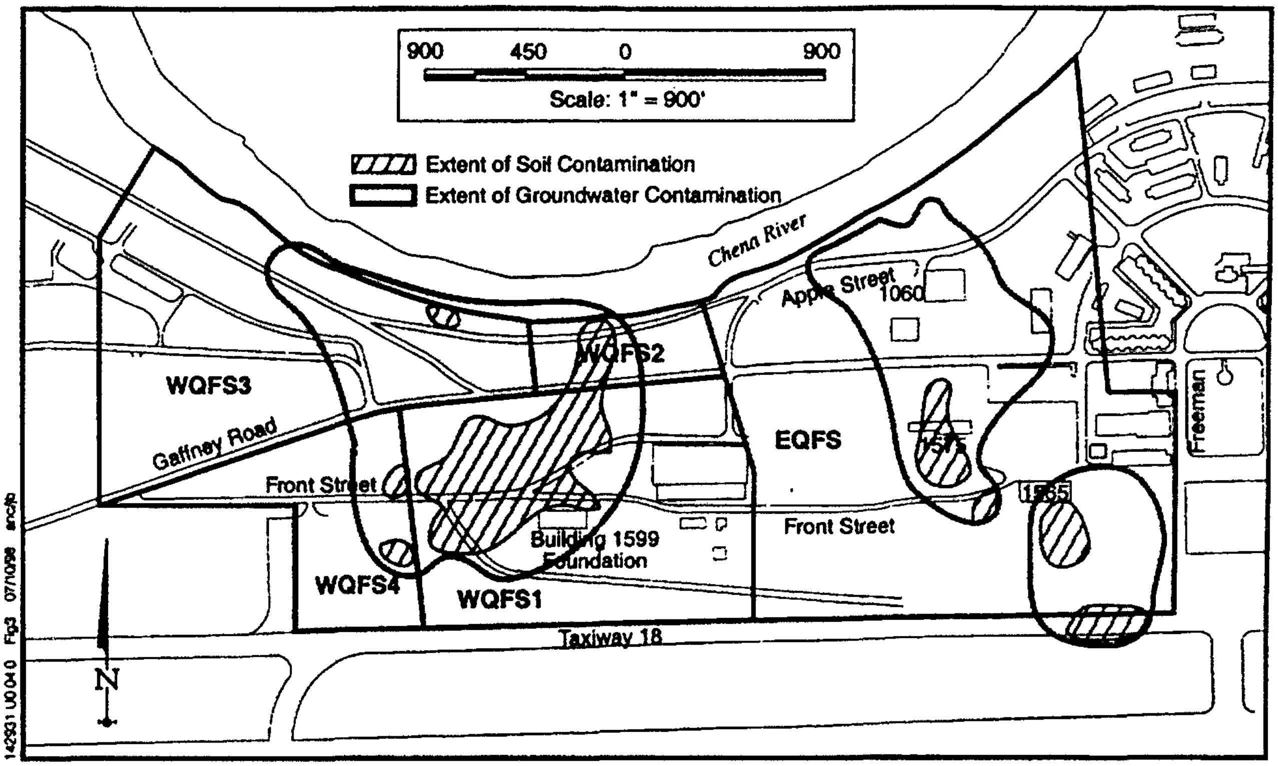

Figure 3. Extent of Groundwater and Soil Contamination at OU5

TABLE 2
Contaminated Soil Volume Estimates

Source Area	Subarea	Contaminants	Estimated Volume of Contaminated Soil (cubic yards)
WQFS	WQFS1	DRO, GRO, BTEX	139,000
	WQFS2	DRO, GRO, BTEX	8,300
	WQFS3	DRO, GRO	3,300
Total volume of affected soil at WQFS			150,600
EQFS		DRO, GRO, BTEX	73,100
Remedial Area 1A		lead	1,200

Notes:
1. Estimated volumes are based on analytical data, field observations, and professional judgement.
2. Volumes in place do not include expansion, which would occur with excavation.
3. Volumes do not include uncontaminated overburden soil or uncontaminated soil that would be removed for sloping or benching excavation.

3.2.1.1 Soil

WQFS1 Soil. Soil COCs at WQFS1 include DRO, GRO and BTEX Vehicle maintenance activities at former Building 1599 and spills and leaks from former fuel storage and handling facilities are the primary sources of petroleum hydrocarbon contaminants. The estimated volumes of contaminated soil are shown in Table 2.

WQFS2 Soil. At WQFS2 (adjacent to the Chena River), soil COCs are DRO, GRO, toluene, ethylbenzene, and xylenes. The 8-inch fuel pipeline that parallels Gaffney Road and the former ASTs are the suspected sources of petroleum hydrocarbons. The estimated volumes of contaminated soil are shown in Table 2.

WQFS3 Soil. Soil COCs at WQFS3 (adjacent to the Chena River) are DRO and GRO. The suspected sources of petroleum hydrocarbons in subsurface soil are a 6-inch wood-stave pipe, through which diesel and gasoline were channeled during fuel releases in 1971, and possible drum storage or road-maintenance activities. The estimated volumes of contaminated soil are shown in Table 2.

WQFS4 Soil. Soil at the WQFS4 is being addressed under the Two Party Agreement between the Army and the ADEC (see Appendix D.)

3.2.1.2 Groundwater

The extent of contamination in groundwater at the WQFS is not discussed by subarea because groundwater plumes from various sources combine across the subarea boundaries (Figure 3). The contaminants benzene, toluene, 1,2-DCA, TCE, TAH, and total aqueous hydrocarbon (TAqH) were detected in groundwater samples at concentrations exceeding state or federal standards, or both. These contaminants and the ranges and frequencies of detection's are summarized in Table 1. Additionally, pesticides below action levels were detected in groundwater near Building 1599. Although these concentrations do not pose an unacceptable risk, detection levels were elevated because of high levels of petroleum products.

Groundwater contaminants extend deeper than 70 feet below ground surface (more than 60 feet below the water table). The aerial extent for groundwater contamination in the EQFS and WQFS is approximately 43 acres. Groundwater contaminants from the WQFS are released into the Chena River. The primary sources of contaminants in groundwater at WQFS are from surface disposals of solvents, spills and leaks, and other past disposal practices at Building 1599. Solvents and petroleum hydrocarbons in soil and free product in the smear zone are secondary sources of contamination in groundwater at WQFS.

3.2.1.3 Free Product

Two distinct plumes of free product (mostly jet fuel and diesel fuel) floating on groundwater have been encountered in WQFS:

1. A plume south of Gaffney Road that encompasses most of the area where fuel pumps, dispenser islands, and fuel storage tanks were located

2. A plume between Gaffney Road and the former retaining structure on the Chena River

The observed thickness and extent of free product plumes vary with seasonal fluctuations in groundwater levels. Thicknesses range from a sheen to approximately 1 foot; the areal extent in the WQFS is approximately 5 acres. These plumes are generally within the boundaries of the groundwater contamination plume shown in Figure 3.

Samples of free product were collected from probes within the largest plume and were analyzed for fuel identification and quantitation, kinematic viscosity, and specific gravity. The project laboratory identified the product from each probe as kerosene or gasoline. The quality assurance (QA) laboratory identified the product as diesel fuel No.2 or JP-4 jet fuel. Historical records indicate that both diesel and gasoline were stored at the site.

3.2.2 EQFS Nature and Extent of Contamination

Figure 3 shows the approximate extent of soil and groundwater contamination in EQFS. Contaminated soil volume estimates are presented in Table 2. Before fieldwork for the OU5 RI was conducted, other investigations of the sources at EQFS were performed from 1989 to 1994. These studies collected soil and groundwater samples to identify contamination at source areas within EQFS. They are summarized in the RI report. The 1994 North Airfield groundwater investigation was the most extensive of these previous investigations. Results of this investigation showed groundwater plumes of the following:

- Free product (about 1/4 acre)
- Benzene (about 1-1/2 acres)
- 1,1,1-trichloroethane (1,1,1-TCA) (extending about 300 feet, but no plume size provided)
- TCE and cis-1,2-dichloroethene (cis-1, 2-DCE) (a degradation product of TCE, both plumes extending about 600 feet but no plume sizes provided)
- DRO (plume not defined)
- GRO (plume not defined)

3.2.2.1 Soil

Soil COCs at EQFS include DRO, GRO, and xylenes (Table 3). The suspected source of petroleum hydrocarbon contamination in the area south of Building 1565 is past and current fueling operations (storage tanks, fuel bladders, and fuel tanker trucks). Soil contamination in this area has extended to the groundwater table. Near Building 1575, GRO is found in a localized area of smear zone soil. The presumed source is a leak in the abandoned 6-inch underground fuel pipeline. Petroleum contamination also was found south of Taxiway 18.

Fuel-dispensing equipment from a former fuel station near Building 1070 and past road maintenance activities are other suspected sources of petroleum hydrocarbon contamination in surface soil. The suspected sources of petroleum hydrocarbon contamination in subsurface soil near Building 1070 are former USTs and the abandoned 8-inch and 6-inch fuel pipelines. The source of subsurface-contamination north of Apple Street near the Chena River is unknown, but may be related to fuel releases channeled through a wood-stave pipe protruding from the bank of the Chena River.

3.2.2.2 Groundwater

Groundwater COCs at EQFS that exceed state and federal MCLs are TCE, 1,1,1-TCA, 1,2-ethylene dibromide, bis(2-choroethyl)ether, TAH, TAqH, and benzene (Table 3). Two distinct groundwater plumes have been identified in EQFS: one slightly upgradient and one downgradient of Building 1565. The suspected sources are as follows:

- For petroleum hydrocarbon compounds in the groundwater plume south and east of Building 1565, an abandoned fuel pipeline near the airfield
- For petroleum contaminants near Building 1575, an abandoned 6-inch fuel pipeline
- For benzene, spills and leaks from the former fueling station southeast of Building 1070
- For 1,1,1-TCA 1,2-ethylene dibromide, and TICE, undocumented spills

1,1,1-TCA was not detected at concentrations above the MCL of 200 µg/L in the wells sampled during the OU5 RI. It was detected in one monitoring well at a concentration of 190 µg/L. In previous investigations and in a 1997 groundwater study, 1,1,1-TCA in groundwater had been identified at concentrations above the MCL. The highest concentration detected was 1,100 µg/L in 1989. Therefore, 1,1,1-TCA has been carried forward as a COC. The source of the 1,1,1-TCA may be an undocumented spill or spills west of Building 1565 and between buildings 1576 and 1578. The 1,2-DCA is believed to be associated with degradation of the 1,1,1-TCA plume. The decreasing concentration of 1,1,1-TCA and the presence of 1,2-DCA suggest that the plume may be attenuating through natural processes (anaerobic biotransformation).

TABLE 3
Summary of Soil and Groundwater Sample Results for Contaminants of Concern–EQFS

Medium	Contaminant	No. of Detections/ No. Of Samples	Range of Detected Concentrations
Soil	DRO	64/114	4 - 10,600
	GRO	21/114	4 - 5,900
	Xylenes	11/114	5 - 72
Groundwater	Benzene	12/25	0.1 - 18
	TCE	9/25	0.4 - 60
	1,1,1,-TCA	NA	1,100 (max)
	1,2-ethylene dibromide	5/25	0.02 - 0.46
	bis(2-chloroethyl)ether	1/25	0.5
	TAH	8/25	10 - 160.6
	TaqH	7/25	18.6 - 175.6

Notes:
1. Soil concentrations are in milligrams per kilogram. Groundwater concentrations (remediation goal and detected) are in micrograms per liter.
2. ADEC soil matrix concentrations will be used as guidance for in situ treatment of soils.
   NA = Not available

3.2.2.3 Free Product

A plume of free product was encountered in EQFS south of Building 1060 and east of Building 1070 during previous investigations. The free-product plume covered up to 1 acre, encompassing the area where the former fuel station, dispensers, and 25,000-gallon gasoline tank were located. During the OU5 RI, measurements in wells and probes in this area did not indicate that free product was present. To confirm the absence of free product, several probes were purged with a peristaltic pump to allow direct observation of the groundwater. The presence of a thin layer of product was noted after examining water purged from south of Building 1060 near Gaffney Road.

A sample of free product was collected for fuel identification. Analytical results from the project laboratory identify the product as kerosene; the QA laboratory identified the product as mineral spirits. On the basis of site history, the product is likely to be weathered gasoline.

3.2.3 Chena River

Free product flows into the Chena River from the WQFS through bank seeps. Numerous surface stains are visible along river banks of the WQFS. Additional contamination is transported into the river from contaminated groundwater.

Results of the OU5 RI indicate that average concentrations of the following chemicals in sediment collected from the Chena River at WQFS or EQFS areas exceed preliminary ecological screening criteria: 2-methylnaphthalene, fluorene, naphthalene, phenanthrene, 4,4'-dichlorodiphenyldichloroethane (DDD), 4,4'-dichlorodiphenyldichloroethene (DDE), 4,4'-dichlorodiphenyltrichloroethane (DDT), and lead. Maximum concentrations of a few additional chemicals such as dieldrin also exceeded the screening criteria. For some chemicals, criteria were not available. With the exception of petroleum compounds, PAHs, and dieldrin, the distribution of contaminants does not suggest a localized source. Exceedances of screening levels indicate a potential for impacts to the Chena River ecosystem.

To determine whether actual impacts have occurred, assess their significance, and measure changes over time, the Chena River Aquatic Assessment Program was initiated. The assessment includes collecting water, sediment, and detritus (organic leaf litter) samples during the spring and fall and analyzing them for COCs and water chemistry. A second year of study was completed, with results to be reported during the first quarter of 1999. Benthic macroinvertebrates such as insects and larvae also will be collected and analyzed through toxicological studies and bioassays. Additional details on the completed aquatic assessment and ongoing studies are provided in the FS.

3.2.4 Remedial Area 1A

Lead contamination was detected at various sampling locations within Remedial Area 1A. Sixteen borings were drilled and 47 surface soil samples were collected. Total lead was detected in all surface soil samples with concentrations ranging from 8.3 milligrams per kilogram (mg/kg) to 7,840 mg/kg. Nine samples had total lead concentrations above 1,000 mg/kg, the lead screening level for industrial land uses.

Surface soil lead contamination may be the result of several historical tank maintenance activities. These activities included tank bolt removal and replacement, cleaning sludge from tank bottoms, and tank painting and stripping. Historically, bolts removed from the tanks during routine maintenance were cleaned with a solvent to remove red lead pipe dope. The solvent, which contained lead from the threaded bolt pipe dope, was spread on the ground in the areas surrounding the tanks. Because these tanks were built as bolted (rather than welded) tanks, a very large number of bolts are present on each tank. Sludge removed from the bottoms of the fuel tanks was buried or spread in the areas surrounding the tanks and may have contributed to lead contamination in these areas. Paint from stripping operations also may have contributed lead to surface area soil. In addition, releases of lead-containing fuels may have contributed to the elevated lead concentrations near the ASTs.

Lead contamination of surface soil is most significant directly adjacent to each tank, with lead levels decreasing as lateral distance increases from each AST. In addition, lead concentrations in subsurface soils decrease to background levels at depths of 1 to 2 feet. A 1996 field investigation further identified five surface soil samples in Remedial Area 1A with leachable lead concentrations that exceed the EPA toxicity characteristic leaching procedure (TCLP) criterion of 5 milligrams per liter (mg/L) for hazardous waste.

An evaluation indicated that lead was the only inorganic analyte above screening levels. All VOCs and semivolatile organic compounds (SVOCs) initially identified as chemicals of potential concern (COPCs) were retained, except acetone and bis(2-ethythexyl)phthalate. These analytes were excluded because they are common laboratory contaminants and were detected frequently in blanks.

SECTION 4

Summary of Site Risks

Baseline human health and ecological risk assessments were performed for WQFS, EQFS, and Remedial Area 1A to determine the need to take action at the source areas and to indicate the exposure pathways that need to be addressed by remedial action. A more detailed presentation of the baseline risk assessments for EQFS and WQFS are contained in the 1996 *Operable Unit 5 Remedial Investigation Report, Fort Wainwright, Alaska*. The baseline risk assessment for Remedial Area 1A is contained in the 1994 *Operable Unit 3 Remedial Investigation Report, Fort Wainwright, Alaska*. The baseline risk assessments determine potential risks to humans and the environment in the absence of remedial action. Both current- and potential future-exposure scenarios were considered for WQFS, EQFS, and Remedial Area 1A. A conceptual site model was developed that identified possible exposure pathways between site chemicals and different human populations. The current population at the source areas is facility workers; potential future populations that were considered include facility workers, construction workers, and military and nonmilitary residents.

In addition to the risk assessments for WQFS, EQFS, and Remedial Area 1A, described above, postwide human health and ecological risk assessments were performed to evaluate any human health or ecological cumulative risk effects that may become evident from the aggregate of source areas at Fort Wainwright not addressed in individual OU RIs and FSs. These assessments were documented in the 1997 *Postwide Risk Assessment, Fort Wainwright, Alaska*. The postwide risk assessment was designed to consider unique exposure and risk scenarios that transcend the boundaries of individual source areas and OUs, supplementing the human health and ecological risk assessments for the five OUs and designated source areas at Fort Wainwright.

4.1 Human Health Risk Assessment

The human health risk assessment was performed by using information on toxicity of contaminants and assumptions about the extent to which people may be exposed to them. Although future residential scenarios were completed for OU5 source areas, they were determined to not be appropriate for soils because industrial use is the reasonably anticipated future use based on the Fort Wainwright master plan and historical use of both areas. It was determined that future residential risks identified in the baseline human health risk assessment are applicable to groundwater because an exposure pathway for domestic water users currently exists. The NCP requires that groundwater be returned to its beneficial uses whenever practicable. At WQFS and EQFS, the beneficial use is domestic water supply.

4.1.1 Identification of Contaminants of Concern (Screening Analysis)

Analytical sampling data were screened in a two-step process to select a list of site-related COCs that potentially contribute to human health risks at the source areas. First, the maximum concentrations of contaminants detected in onsite soil and water during the RIs were compared to health-based screening levels for soil and drinking water developed by EPA Region 3 (April 1, 1998) and Region 10 (*Supplemental Risk Assessment Guidance*, 1991). These standards reflect residential exposure assumptions of 1 x 10^{-6} and 1 x 10^{-7} risks associated with groundwater and soil, respectively, or a hazard quotient of 0.1 for all media. Chemicals detected at concentrations below the risk-based screening concentrations were eliminated from the source-area risk assessments. If risk-based screening concentrations were not available, maximum groundwater concentrations were compared to Safe Drinking Water Act MCLs.

Second, inorganic chemicals were compared to naturally occurring background levels. If maximum concentrations of inorganic chemicals were determined to be below established background levels, they were eliminated from further evaluation. Table 4 presents the COCs identified in the soil and groundwater at the WQFS, EQFS, and Remedial Area 1A.

4.1.2 Exposure Assessment

The exposure assessment estimates the type and magnitude of exposures to the COCs at the source areas. It considers the current and potential future uses of the site, characterizes the potentially exposed populations, identifies the important exposure pathways, and quantifies the intake of each COC from each medium for each population at risk. The current population at WQFS, EQFS, and Remedial Area 1A is facility workers. Potential

TABLE 4
Contaminants of Concern for Human Health Risk Assessment

	Contaminated Medium in Source Area		
Analyte	**WQFS**	**EQFS**	**Remedial Area 1A**
Benzene	Soil, GW	GW	--
bis(2-chloroethyl)ether	--	GW	--
DRO	Soil	Soil	--
1,2-Ethylene dibromide	--	GW	--
1,2-Dichloroethane	GW	--	--
Ethylbenzene	Soil	--	--
GRO	Soil	Soil	--
lead	--	--	Soil
TAH	GW	GW	--
TaqH	GW	GW	--
Toluene	Soil, GW	--	--
Trichloroethene	GW	GW	--
Xylenes	Soil	Soil	--

Notes:
-- = Not identified as a COC in environmental media at this source area
GW = Groundwater

future populations that were considered include facility workers, construction workers, and military and nonmilitary residents.

Potential exposures were evaluated for both average-exposure and reasonable-maximum-exposure scenarios. The average-exposure scenario was estimated by using average-exposure concentrations (such as average soil or groundwater concentrations) and exposure variables that represent central values or best estimates of exposure for an individual with normal activity patterns. The reasonable-maximum-exposure scenario has been estimated by using EPA risk assessment guidance. The intent of evaluating the reasonable-maximum exposure is to estimate a conservative-exposure scenario that is still within the range of possible exposures. Because of the uncertainty surrounding any estimate of exposure concentration, the EPA recommends that the 95 percent upper confidence limit of the arithmetic mean be used for the exposure point concentration of COCs in calculating risks for reasonable-maximum exposure. If the 95 percent upper confidence limit exceeded the maximum detected concentration, the maximum detected concentration was used as the concentration for evaluation of the risk of reasonable maximum exposure.

Exposure frequency for soil exposure was modified to reflect the fact that the ground at Fort Wainwright is snow covered and/or frozen for at least 6 months per year. The snow cover reduces by 6 months per year the time that any receptor could be in contact with the soil. The appropriate changes were made for the receptors (facility worker, construction worker, and military and nonmilitary residents) and pathways (ingestion and dermal contact) that were used to evaluate exposure to chemicals in the soil. This assumption was determined by the EPA and ADEC to be representative of conditions at Fort Wainwright.

In the postwide human health risk assessment, exposure assumptions for reasonable-maximum exposure and average-case exposure scenarios were developed for a hunter, fisherman, and recreational swimmer assumed to be exposed to postwide contaminants. These exposure scenarios assumed exposures anywhere on the installation and that no cleanup action had occurred. Exposure pathways evaluated included incidental ingestion of surface soil, ingestion of moose and fish meat, and incidental ingestion of surface water. The exposure point concentrations used to estimate potential risk in the postwide human health risk assessment were the maximum detected concentration for the reasonable-maximum-exposure scenario and the arithmetic mean concentration of CCCs for the average-exposure scenario.

Data about the concentration of contaminants of concern in the media of concern at the source area (the exposure point concentrations) were combined with information about the projected behaviors and characteristics of the people who potentially may be exposed to these media (exposure parameters) to estimate exposure. The calculated value of the exposure point concentration is intended to represent the distribution of the chemical within a specific medium. Separate exposure point concentrations have been calculated for each medium for WQFS, EQFS, and Remedial Area 1A.

Analytical data for soil at the source areas were divided into separate databases corresponding to surface and subsurface soil. This approach allowed a separate evaluation of potential exposures to different populations. Surface soil is defined as all surficial samples and samples collected to a depth of 0.5 foot below ground surface. Subsurface soil is defined as all soil samples from the surface to a maximum depth of 10 feet below ground surface. It is unlikely that excavation or construction activities would disturb soil deeper than 10 feet below ground surface because of the presence of permafrost throughout the Fort Wainwright area. Inclusion of the surface soil profile in the subsurface soil database is appropriate because exposure to subsurface soil through intrusive activities also will include exposure to surface soil.

4.1.2.1 EPA Region 10 Guidance on the Use of Nondetect Data Points

EPA Region 10 recommends that a value of one-half the detection limit be used for nondetected concentrations in soil and groundwater to calculate the exposure point concentration if the detection limit is equal to or less than the maximum detected concentration. For nondetected concentrations with a detection limit greater than the maximum detected concentration, but less than twice the maximum detected concentration, the nondetected data point would be replaced with a surrogate concentration equal to one-half the maximum detected concentration. For nondetected concentrations with a detection limit equal to or greater than twice the maximum detected concentration, the nondetected data point would be replaced with a surrogate concentration equal to the maximum detected concentration. This conservative approach is intended to avoid underestimating exposure point concentrations for chemicals that are potentially present but are masked by high detection limits. However, elevated detection limits were generally not an issue for the data sets for WQFS, EQFS, and Remedial Area 1A.

4.1.2.2 Exposure Parameters

The parameters used to calculate average-exposure and reasonable-maximum-exposure were obtained from the EPA Region 10 human health risk assessment guidance (*Supplemental Risk Assessment Guidancefor Superfund*, 1991). The parameters include body weight, age, contact rate, frequency of exposure, and exposure duration. Default exposure factors were modified to reflect climatological and other factors specific to Fort Wainwright. Site-specific exposure assumptions for soil contact, including soil ingestion, dermal contact, and dust inhalation, were modified based on the site being snow-covered for half the year.

4.1.2.3 Exposure Point Concentrations

Exposure point concentrations were calculated for the surface soil, subsurface soil, and groundwater for WQFS, EQFS, and Remedial Area IA. Before exposure point concentrations were calculated, the analytical data for the source areas were evaluated to assess whether any areas of significantly elevated concentrations were present. No discernible areas were identified. The exposure point concentrations for average exposure and reasonable maximum exposure are represented by the arithmetic mean and the 95 percent upper confidence limit, respectively, of the analytical data for each of the detected compounds retained as COCs. These concentrations are presented in the baseline risk assessments for WQFS and EQFS (*Operable Unit 5 Remedial Investigation Report, Fort Wainwright, Alaska*) and for Remedial Area 1A (*Operable Unit 3 Remedial Investigation Report, Fort Wainwright, Alaska*).

Because of the large number of nondetected concentrations in the analytical data for the COCs, the arithmetic mean concentration and the 95 percent upper confidence limit are generally the same value. In addition, the maximum detected concentrations for the COCs are less than two orders of magnitude greater than the arithmetic mean concentration. This finding indicates that, in general, there was not a wide variability in the distribution of chemicals in the different media. Consequently, the exposure point concentrations for average exposure and reasonable maximum exposure are the same value for most COCs.

4.1.3 Toxicity Assessment

Human health toxicity factors were identified for the COCs. Toxicity factors were identified for both carcinogens (slope factors) and noncarcinogens (reference doses [RfDs]). Only chronic toxicity criteria were used in the human health risk assessment. Oral toxicity factors were used to evaluate both oral and dermal exposures. Inhalation toxicity factors were used to evaluate inhalation exposure to volatile chemicals. Dermal absorption factors and permeability coefficients recommended by the EPA were used to assess risks from dermal contact with chemicals in soil and groundwater.

The toxicity factors were drawn from the Integrated Risk Information System or, if no Integrated Risk Information System values were available, from the Health Effects Assessment Summary Tables. For chemicals that do not have toxicity values available, other criteria, such as state and federal MCLs, were used to, assess potential hazards or to determine action levels.

4.1.4 Risk Characterization

The purpose of the risk characterization is to integrate the results of the exposure and toxicity assessments to estimate risk to humans from exposure to site contaminants. Risks were calculated for carcinogenic (cancer-causing) and noncarcinogenic (toxic) effects for both the average-exposure and reasonable-maximum-exposure scenarios (see Section 4.1.2). To estimate cancer risk, the slope factor is multiplied by the exposure expected for that chemical to provide an estimate of the excess lifetime cancer risk. This estimate is the incremental probability of an individual developing cancer over a lifetime as a result of exposure to cancer-causing chemicals at a source area. The EPA considers excess lifetime cancer risks between 1 in 1 million ($1x10^{-6}$) and 1 in 10,000 ($1x10^{-4}$) to be within the generally acceptable range; risks greater than 1 in 10,000 usually suggest the need to take action at a site.

In defining effects from noncancer-causing contaminants, the EPA considers acceptable exposure levels to be those that do not adversely affect humans over their expected lifetime, with a built-in margin of safety. Potential concern for noncarcinogenic effects of a single contaminant in a single medium is expressed as a hazard quotient, which is the ratio of the estimated exposure from a site contaminant to the RfD of that contaminant. If the hazard quotient is less than 1, adverse noncancer health effects are unlikely to occur. Hazard quotients for individual COCs are summed to yield a hazard index for a site. If the hazard index exceeds 1, the individual contributions (hazard quotients) to the sum should be evaluated for possible systemic toxic effects.

Cancer risks and noncancer health effects were characterized for each human population of interest at WQFS, EQFS, and Remedial Area 1A. Risk summaries for WQFS and EQFS are presented in Tables 5 and 6, respectively, and are discussed below.

TABLE 5
Summary of Total Cancer Risks and Noncancer Hazard Indices for Potentially Exposed Populations at WQFS

	Cancer Risks		Noncancer Hazard Indices	
Receptor/Pathway	**Average**	**RME**	**Average**	**RME**
Facility Worker				
Surface soil ingestion	5.2E-09	7.0E-08	NA	NA
Total	**5.2E-09**	**7.0E-08**		
Construction Worker				
Subsurface soil ingestion	1.1E-09	6.5E-08	NA	NA
Total	**1.1E-09**	**6.5E-08**		
Construction Worker				
Subsurface soil ingestion	1.1E-09	6.5E-08	NA	NA
Total	**1.1E-09**	**6.5E-08**		
Future Nonmilitary Resident				
Surface soil ingestion	1.3E-07	6.4E-07	NA	NA
Total	**1.3E-07**	**6.4E-07**		
Future Nonmilitary Resident				
Subsurface soil ingestion	1.3E-07	6.4E-07	NA	NA
Total	**1.3E-07**	**6.4E-07**		
Future Nonmilitary Resident				
Groundwater ingestion	7.4E-06	1.2E-04	7.0E-02	3.9E-01
Groundwater inhalation of VOCs	7.4E-06	1.2E-04	1.1E+00	5.6E+00
Groundwater dermal contact	1.5E-06	8.9E-06	4.3E-02	8.8E-02
Total	**1.6E-05**	**2.5E-04**	**1.2E+00**	**6.1E+00**
Future Military Resident				
Groundwater ingestion	1.7E-06	2.1E-05	7.0E-02	3.9E-01
Groundwater inhalation of VOCs	1.6E-06	2.0E-05	1.1E+00	5.6E+00
Groundwater dermal 3.4E-07 contact	3.4E-07	1.5E-06	4.3E-02	8.8E-02
Total	**3.6E-06**	**4.2E-05**	**1.2E+00**	**6.1E+00**

Notes:
All average and RME risks are based on the mean and 95 percent upper confidence limit concentrations, respectively.
NA = Not applicable; no noncancer chemicals were selected as COCs
RME = Reasonable maximum exposure

TABLE 6
Summary of Total Cancer Risks and Noncancer Hazard Indices for Potentially Exposed Populations at EQFS

	Cancer Risks		**Noncancer Hazard Indices**	
Receptor/Pathway	**Average**	**RME**	**Average**	**RME**
Facility Worker				
Surface soil dermal	2.5E-11	8.8E-10	6.3E-07	8.8E-06
Surface soil ingestion	9.9E-09	1.7E-07	2.1E-07	1.2E-06
Total	9.9E-09	8.8E-07	8.4E-07	1.0E-05
Construction Worker				
Surface soil dermal	3.2E-12	1.1E-10	4.0E-07	5.4E-06
Surface soil ingestion	1.9E-09	1.5E-07	2.1E-07	5.4E-06
Total	**1.9E-09**	**1.5E-07**	**6.2E-07**	**1.1E-05**
Construction Worker				
Subsurface soil dermal	1.4E-11	6.7E-10	1.9E-06	3.3E-05
Subsurface soil ingestion	2.4E-09	1.7E-07	9.7E-07	3.3E-05
Total	**2.4E-09**	**1.7E-07**	**2.8E-06**	**6.7E-05**
Future Nonmilitary Resident				
Surface soil dermal	1.1E-11	9.4E-10	2.9E-07	7.8E-06
Surface soil ingestion	2.4E-07	1.5E-06	1.7E-06	9.0E-06
Total	**2.4E-07**	**1.5E-06**	**2.0E-06**	**1.7E-05**
Future Nonmilitary Resident				
Subsurface soil dermal	4.8E-11	5.8E-09	1.3E-06	4.8E-05
Subsurface soil ingestion	2.8E-07	1.7E-06	7.7E-06	5.4E-05
Total	**2.8E-07**	**1.7E-06**	**9.1E-06**	**1.0E-04**
Future Nonmilitary Resident				
Groundwater ingestion	1.1E-05	1.7E-04	1.2E-02	5.9E-02
Groundwater inhalation of VOCs	1.0E-06	1.2E-05	2.6E-02	1.3E-01
Groundwater dermal contact	1.3E-07	8.0E-07	1.9E-04	3.4E-04
Total	**1.2E-05**	**1.9E-04**	**3.8E-02**	**1.9E-01**
Future Military Resident				
Groundwater ingestion	2.4E-06	2.9E-05	1.2E-02	5.9E-02
Groundwater inhalation of VOCs	2.2E-07	2.0E-06	2.6E-02	1.3E-01
Groundwater dermal contact	2.9E-08	1.3E-07	1.9E-04	3.4E-04
Total	**2.6E-06**	**3.1E-05**	**3.8E-02**	**1.9E-01**

TABLE 6
Summary of Total Canoer Risks and Noncancer Hazard Indices for Potentially Exposed Populations at EQFS

	Cancer Risks		Noncancer Hazard Indices	
Receptor/Pathway	**Average**	**RME**	**Average**	**RME**
Future Military Resident				
Surface soil dermal	2.3E-12	1.6E-10	2.9E-07	7.8E-06
Total	**2.3E-12**	**1.6E-10**	**2.9E-07**	**7.8E-06**
Future Military Resident				
Subsurface soil dermal	1.1E-1I	9.6E-10	1.3E-06	4.8E-05
Total	**1.1E-11**	**9.6E-10**	**1.3E-06**	**4.8E-05**

Notes:
All average and RME risks are based on the mean and 95 percent upper confidence limit concentrations, respectively.
RME = Reasonable maximum exposure
VOCs = Volatile organic compounds

4.1.4.1 WQFS Area

The total cancer risks related to surface and subsurface soil exposure at WQFS for the facility worker, construction worker, and the future resident are all less than 1 x 10^{-6}. The total cancer risks for reasonable maximum exposure related to groundwater use are 2.5 x 10^{-4} for a future nonmilitary resident and 4.3 x 10^{-5} for a future military resident. Risk is greater to future nonmilitary residents because they are assumed to have the EPA 30-year average exposure while future military residents are assumed to have a 5-year average exposure. Most of this risk (88 percent) is contributed by benzene, which was consistently detected in groundwater at concentrations exceeding the MCL. Most of the remaining risk is contributed by 1,2-DCA.

The noncancer hazard index of reasonable maximum exposure for residential groundwater use for both future military and nonmilitary resident is 6.1. Although this hazard index exceeds the EPA benchmark of 1.0, most of this value is contributed by benzene, which was evaluated by using an interim, unverified inhalation RfD for benzene. If benzene is omitted from the noncancer evaluation, the total hazard index is approximately 1.0.

4.1.4.2 EQFS Area

The total cancer risks of reasonable maximum exposure related to surface and subsurface soil exposure at EQFS for both the facility worker and the construction worker were less than 1 x 10^{-6}. The total cancer risks of reasonable maximum exposure related to surface and subsurface soil exposure for the future nonmilitary resident are less than 2 x 10^{-6} and are at the lower end of the EPA acceptable risk range of 1 x 10^{-6} to 1 x 10^{-4}. The total cancer risks of reasonable maximum exposure related to surface and subsurface soil exposure for a future military resident are less than 1 x 10^{-9}. The total cancer risks of reasonable maximum exposure related to groundwater use are 1.9 x 10^{-4} for future nonmilitary resident and 3.1 x 10^{-5} for a future military resident. Risk is greater to future nonmilitary residents because they are assumed to have the EPA 30-year average exposure while future military residents are assumed to have a 5-year average exposure.

1,2-ethylene dibromide contamination only occurs in groundwater and does not appear to be widespread. At the worst, 1,2-ethylene dibromide is very isolated in occurrence (as reported in the final human health risk assessment for OU5). The calculation that 1,2-ethylene dibromide is the major contributor to risks related to groundwater use of 1.9×10^{-4} for a future nonmilitary resident and 3.1×10^{-5} for a future military resident must be weighed against the facts that 1,2-ethylene dibromide was detected in only 4 of 22 samples and only 2 of the detections were above the MCL.

Total noncancer risks for all populations at EQFS were below a hazard index of 1.0.

4.1.4.3 Remedial Area 1A

Estimates of cancer risks and hazard indices for potential excess lifetime exposure developed for the human health risk assessment are within or below the regulatory benchmarks defined under current land-use conditions. Estimates of cancer risk below 1×10^{-6} and noncancer risk below a hazard index of 1.0 reflect the absence of complete exposure pathways by which potential receptors could contact site-related contaminant sand the relatively low concentrations of COCs detected in soils and groundwater. Potential cancer and noncancer risks in excess of regulatory guidelines were associated only with potential future domestic use of onsite groundwater.

Lead contamination was detected at various surface soil sampling locations in Remedial Area 1A. The EPA does not currently recommend numerical estimates for cancer risk from lead because human evidence of lead as a carcinogen is inadequate. Toxic effects of lead are correlated with blood-lead levels rather than exposure levels or daily intake. Lead is a poison that causes toxic effects in virtually every system in the body, and no lowest effect level of exposure or daily intake has been identified. In Remedial Area 1A, levels of lead exist in excess of EPA guidance for industrial cleanup levels for soil; however, a risk or hazard index cannot be calculated for lead exposure. Additionally, lead levels detected exceed the State of Alaska regulation of 1,000 mg/kg for total lead in Title 18, Chapter 75, of the *Alaska Administrative Code* (AAC).

Lead was not included in the quantitative risk estimates because it has no EPA-approved RfD or slope factor. Instead, lead concentrations in Remedial Area 1A soils were assessed by comparing the exposure point concentrations in soil with the concentrations generated by using the default assumptions of the uptake/biokinetic model. However, the uptake/biokinetic model does not address lead exposure to older children or adults. Therefore, the risks associated with exposures of adult residents and workers and of adolescent site visitors could not be evaluated quantitatively.

4.1.4.4 Postwide Human Health Risk Assessment

The postwide human health risk assessment determined excess lifetime cancer risks for the hunter, based on moose ingestion, to be 5×10^{-4} for the reasonable-maximum-exposure scenario and 3×10^{-6} for the average-exposure scenario. Noncancer hazard indices, based on calculated values for moose meat ingestion, were 5.2 for the reasonable-maximum-exposure scenario and 0.2 for the average-exposure scenario. The primary contributors to the excess cancer risks were dioxins/furans, PAHs, DDT, dieldrin, and arsenic. Dioxins and furans were responsible for approximately 78 percent of the moose ingestion risk for the hunter. Noncancer hazard indices were primarily from inorganic chemicals, with mercury (43 percent) and zinc (30 percent) posing the majority of the reasonable-maximum-exposure risk. For further discussion, see Section 4.1.5, Uncertainly Analysis.

The excess-lifetime cancer risks associated with fish ingestion were 1×10^{-4} for the reasonable-maximum-exposure scenario and 4×10^{-5} for the average-exposure scenario. Noncancer hazard indices based on fish ingestion were 1.6 for the reasonable-maximum-exposure scenario and 0.8 for the average-exposure scenario. The primary contributors to the excess cancer risks for the reasonable-maximum-exposure scenario were beryllium (56 percent), dieldrin (32 percent), and DDT (11 percent). Because dieldrin was detected only once in the Chena River surface water and DDT and beryllium only twice, the uncertainty associated with these risk estimates is very high. These chemicals are indicated as COCs for the Chena River in Table 7.

Surface-water-ingestion risks for the recreational swimmer in the postwide human health risk assessment ranged from 2×10^{-6} to 3×10^{-7} for the reasonable-maximum-exposure and average-exposure scenarios, respectively. Surface-water-ingestion risks were primarily from arsenic and beryllium, which were detected at concentrations consistent with background concentrations. These chemicals are indicated as COCs for the Chena River in Table 7.

4.1.5 Uncertainty Analysis

It is important to identify the primary limitations and areas of uncertainty in a risk assessment, so that risk management decisions may be informed and accurate. Many assumptions used in a human health risk assessment are conservative, to avoid underestimating the risk for anyone potentially exposed at the site. Areas of uncertainty for the WQFS, EQFS, Remedial Area 1A, and postwide human health risk assessments include the sampling and analysis program, the exposure assessment, the toxicity assessment, and the risk characterization, which are discussed below.

4.1.5.1 Sampling and Analysis

The human health risk assessment is based on soil and groundwater data specific to each source area. In general, the large numbers of samples collected are considered to be adequate for evaluation of current site conditions. Although natural attenuation and human activities may result in a decrease in concentrations over time, it was conservatively assumed that chemical concentrations would be constant in the future.

4.1.5.2 Exposure Assessment

Performance of a risk assessment requires numerous assumptions about site populations, exposure pathways, and exposure assumptions. A major uncertainty inherent in risk assessments for military bases relates to the duration of exposure. This human health risk assessment uses the EPA recommended default value of 30 years for residential exposure; however, most military assignments are for much shorter periods of time, often for only 1 to 3 years. A military resident was evaluated with an exposure duration of 5 years.

For the purposes of completing baseline risk calculations, a future residential scenario was assumed for the WQFS, EQFS, and Remedial Area 1A, with use of site groundwater for domestic purposes. Groundwater is the only source of potable water used at Fort

TABLE 7
Contaminants of Concern for the Chena River Based On Results Of the Postwide Risk Assessment

	Ecological Risk Assessment								Human Heafth Risk Assessment	
	Sediment Segment [a]					Surface Water Segment [a]			Surface Water	
	A	B	C	D	E	A	C	D	Fish Ingestion	Surface Water Ingestion
Volatile Organic Compounds										
2-Butanone[b, c, d]				X				X		
Acetone[b, d]	X			X						
Methylene chloride[d]				X						
n-Butylbenzene[b]				X						
o-Propylbenzene[b]				X						
p-isopropyttoluene[b]				X						
Semivolatile organic Compounds										
1,2,4-Trichlorobenzene[b]				X						
1,2,4-Trimethylbenzene[b]				X						
1,3,5-Trimethylbenzene[b]				X						
2-Methylnaphthalene				X						
Acenaphthene				X						
bis(2-ethylhexyl)phthalate[b, d]	X			X						
Butylbenzyl phthalate[b, d]	X			X				X		
Di-n-butyl phthalate[b, d]	X		X	X				X		
Diethylphthalate[b, c, d]				X				X		
Fluorene				X						
Naphthalene				X						
Phenanthrene				X						

TABLE 7
Contaminants of Concern for the Chena River Based on Results of the Postwide Risk Assessment

	Ecological Risk Assessment								Human Health Risk Assessment	
	Sediment Segment [a]					Surface Water segment [a]			Surface Water	
Analyte	A	B	C	D	E	A	C	D	Fish Ingestion	Surface Water Ingestion
Organochlorine Pesticides and Polychlorinated Biphenyls										
4,4'-DDD				X				X		
4.4'-DDE			X							
4,4'-DDT	X		X		X			X	X	
Aroclor 1260				X						
beta-Hexachlorocyclohexane				X						
Dieldrin				X				X	X	
gamma-Hexachlorocyclohexane				X						
DioxIns(Furans										
2,3,7,8-Trichlorodibenzo-p-dioxin toxicity equivalent[d]			X							
Metals										
Arsenic					X			X		X
Barium[c]						X	X	X		
Beryllium[e]									X	X
Iron[c]					X	X	X	X		
Lead								X		
Manganese[c]						X	X	X		
Nickel[e]			X		X					
Sodium[c, e]						X	X	X		

TABLE 7
Contaminants of Concern for the Chena River Based on Results of the Postwide Risk Assessment

Analyte	Ecological Risk Assessment								Human Health Risk Assessment	
	Sediment Segment [a]					Surface Water Segment [a]			Surface Water	
	A	B	C	D	E	A	C	D	Fish Ingestion	Surface Water Ingestion

[a] Five river segments, A-E, have been identified on Fort Wainwright. Surface water and sediment samples have been collected from these segments of the Chena River in support of previous OU-specific risk assessments. The boundaries of Segments A-E were based on spatial distribution of sample locations, which were associated with various potential contaminant sources.
b Indicated as a COC because ecological sediment criteria are not available.
c Indicated as a COC because ecological surface-water criteria are not available.
d Potential laboratory contaminant
e Maximum postwide concentration is consistent with Chena River background concentrations based on August 1995 and January 1997 background sampling results (*Postwide Risk Assessment, Fort Wainwright, Alaska,* 1997).

Notes:
X = COC based on postwide risk assessment results
Sediment screening criteda were based on guidance from the National Oceanic and Atmospheric Administration, Ontario Ministry of Environment and Energy, New York Department of Environmental Conservation, and Washington State Department of Ecology.

Wainwright and throughout the Fairbanks area. Ninety-five percent of the Fort Wainwright potable water is supplied through a single distribution system fed by two large-capacity wells near the Power Plant (building 3559). The City of Fairbanks uses the same aquifer and has four supply wells of the municipal utility 1 mile downgradient of post boundaries on the banks of the Chena River.

Chemical concentrations in soil and groundwater were assumed to remain constant over time. No consideration was given to biotic or abiotic processes that would be expected to reduce chemical concentrations in these media through time.

The postwide human health risk assessment included the following significant uncertainties, which could overestimate risk:

- The hunter is assumed to ingest meat from moose that use a home range limited to the Fort Wainwright cantonment area and that are in contact with the maximum detected concentration of all chemicals at all times. Although moose range across very large areas, the cantonment area offers some of the least desirable habitat for moose on Fort Wainwright. Additionally, hunting is not allowed in the main cantonment area. A large percentage of the calculated risks to the hunter are from background concentrations of the risk drivers.

- The fisherman's risk drivers are dieldrin, which was only detected once in Chena River water, and DDT and beryllium, which were only detected twice in Chena River water. In addition, this pathway requires partition modeling based on water concentrations to obtain fish tissue concentrations.

- The swimmer's risk drivers are arsenic and beryllium, which were detected at concentrations consistent with background concentrations.

4.1.5.3 Toxicity Assessment

The toxicity factors used in performance of human health risk assessments also are associated with a high degree of uncertainty. Several specific uncertainties in toxicity factors pertain to the risk assessments for OU5. Surrogate toxicity factors were used to evaluate the potential risk associated with structurally similar chemicals that lack EPA-verified toxicity factors. It was not possible to quantitatively assess potential risks from gasoline, diesel, and other petroleum hydrocarbons, although constituents such as benzene and toluene, which may or may not be attributable to petroleum, were quantitatively evaluated.

Because toxicity factors have not been developed for the dermal exposure route, oral toxicity factors were used to evaluate the dermal toxicity of chemicals. As a result, all risk estimates associated with the dermal exposure pathway are conservatively overestimated and should be viewed with caution.

4.1.5.4 Risk Characterization

The risk characterization combines exposure and toxicity assessment information to estimate potential risk for a site. Therefore, the uncertainties associated with the exposure and toxicity assessments are combined in the risk characterization. Concentrations of chemicals detected in the different media were assumed to remain constant for the entire duration of exposure, not considering environmental degradation from physical, chemical, or biological actions. Risks from different chemicals were assumed to be additive, which may not always be correct. Risks from multiple chemicals may be independent (through different mechanisms of action) or additive (through the same mechanism of action).

Potential risks from other exposure pathways or from chemicals other than the COCs were not considered.

4.2 Ecological Risk Assessment

An ecological risk assessment was performed to assess whether chemicals associated with site activities at WQFS, EQFS, or Remedial Area 1A may adversely affect local populations of ecological receptors. The ecological risk assessment was conducted in three steps-problem formulation, analysis, and risk characterization. The assessment was consistent with the EPA framework document for ecological risk assessment and used chemical data compiled during RI activities.

4.2.1 Ecological Problem Formulation

Ecological habitat surveys were performed at each source area, and the site-specific information obtained during these surveys was used to identify relevant receptors. A screening assessment was conducted as part of the problem formulation step to identify COPCs at each source area based on a chemical data review and a toxicity screening assessment.

Conceptual models were developed for the source areas based on the COPCs, that were identified. A conceptual model is defined as a written or pictorial representation of an environmental system and the biological, physical, and chemical processes that determine the transport of contaminants from sources through environmental media to receptors within the system. Potential exposures to various ecological receptors and trophic levels were considered in the development of the conceptual model. Potential terrestrial receptors include plants, birds, amphibians, soil invertebrates, and burrowing and non-burrowing mammals. Potential aquatic receptors include plants, birds, amphibians, benthic invertebrates, fish, and mammals. Measurement and assessment end points were selected based on the characteristics of the identified stressors (COPCs), the ecosystem and its components that may be at risk (indicator species), and the expected or observed ecological effects associated with the stressors.

Indicator species were selected to focus the ecological risk assessment on a subset of potential receptors that have adequate exposure and toxicity information in the scientific literature. Terrestrial and aquatic species with small home ranges were evaluated to assess potential risks for specific source areas. Predatory species with larger home ranges were quantitatively evaluated in the postwide ecological risk assessment. The relative contribution of WQFS, EQFS, and Remedial Area 1A source areas to the exposure of these receptors was assessed as part of the postwide ecological risk assessment.

At WQFS, EQFS, and Remedial Area 1A, chemicals in soil, sediment, and surface water are potentially available to ecological receptors. The COPCs identified for ecological receptors are shown in Table 8. Mammalian indicator species selected for WQFS and EQFS include the meadow vole (exposure pathways include ingestion of plants and ingestion of soil) and the muskrat (exposure pathways include ingestion of aquatic plants, ingestion of sediment,

TABLE 8
Contaminants of Potential Concern for the ous Ecological Risk Assessment

	Soil		Sediment		Surface Water	
Contaminant	**WQFS**	**EQFS**	**WQFS**	**EQFS**	**WQFS**	**EQFS**
Volatile Organic Compounds						
1.2,3-Trichlorobenzene	X	X				
1,2,4-Trimethylbenzene	X	X				
1,3,5-Trimethylbenzene	X	X	X			
2-Butanone						X
Acetone		X		X		
Benzene		X				
Isopropylbenzene		X				
n-Butylbenzene		X				
Semivolatile Organic Compounds						
2-Methinaphthalene			X			
Benzyl butyl phthalate			X	X		X
bis(2-ethylhexyl)phthalate			X	X		
Di-n-butyl phthalate			X	X	X	X
Diethyl phthalate			X		X	
Fluorene			X			
Naphthalene			X	X		
Phenathrene			X			
Pesticides/PCBs						
4,4'-DDD			X	X		
4,4'-DDE				X		
4,4'-DDT			X	X		
Inorganics						
Arsenic					X	
Cadmium			X		X	X
Lead			X	X	X	
Mercury				X		

Notes:
DDD = Dichlorodiphenyldichloroethane
DDE = Dichlorodiphenyldichloroethene
DDT = Dichlorodiphenyltrichloroethane
X = Indicates that this chemical was selected as a potential COC for the designated source area and media

and ingestion of surface water). Other aquatic indicators selected for WQFS and EQFS include benthic invertebrates (exposure pathways include exposure to sediment and surface water). The postwide ecological risk assessment identified the red fox as an indicator species to represent terrestrial receptors because it is omnivorous and, therefore, is more likely to bioaccumulate chemicals than herbivores whose diets consist of plants. Bioaccumulation factors for animals generally are higher than plant uptake factors for the same chemicals.

4.2.2 Ecological Risk Analysis

The analysis phase consists of two main components: (1) characterization of exposure, and (2) characterization of ecological effects. Conservative assumptions were used in estimating potential exposure and effects to the selected indicator species.

Species-specific exposure parameters and equations for complete exposure pathways were developed for mammalian indicator species. The average daily doses calculated for individual pathways were summed to obtain chemical-specific average daily doses, which were used to estimate exposure. Potential exposure pathways for the meadow vole, including plant ingestion and soil ingestion, were evaluated for WQFS and EQFS. Exposures to sediment and surface water were not evaluated because meadow voles inhabit upland areas. The average chemical concentrations from the top zero to 0.5 foot of soil were used for the quantitative assessment of risk to the meadow vole.

Potential exposure pathways for the muskrat, including plant ingestion, sediment ingestion, and surface water ingestion, were evaluated separately for WQFS and EQFS and for the combined WQFS and EQFS areas. Exposure to soil was not evaluated because muskrats are primarily present in aquatic habitats. The chemical concentrations of soil, sediment, and surface water used in the analysis and risk characterization were the average concentrations over a given source area. The sediment data and the surface water data also were averaged over WQFS and EQFS to assess potential impacts to muskrats throughout the segment of the Chena River adjacent to both of these source areas.

Chemical exposure to benthic invertebrates was evaluated separately for WQFS and EQFS by comparing average chemical concentrations in sediment and surface water for each source area to applicable sediment and surface-water quality criteria.

Ecological effects were characterized by using toxicity reference values identified in the scientific literature. Where available, published benchmark values intended to protect biota were used as toxicity reference values to qualitatively assess the potential adverse effects to benthic invertebrates from chemicals in sediment and surface water. Toxicity reference values used in the quantitative assessment of potential adverse effects to the meadow vole and muskrat were developed from published toxicity values based on toxicological studies on laboratory animals. Toxicity reference values used in the ecological risk assessments for WQFS, EQFS, and Remedial Area 1A included no observed adverse effect levels, lowest observed adverse effect levels, and taxa-specific levels from the scientific literature.

The postwide ecological risk assessment was developed and organized according to EPA and Army guidance. Terrestrial receptors evaluated in the postwide ecological risk assessment included the red fox and the northern goshawk. Aquatic receptors evaluated include benthic invertebrates and salmonids.

The postwide ecological risk assessment distinguished two home range groups for the red fox. Group 1 included source areas north of the Chena River (including Remedial Area 1A). Group 2 included a larger set of source areas (including WQFS and EQFS) south of the Chena River. Because the red fox is omnivorous, individual hazard indices were determined for small-mammal ingestion, bird ingestion, soil ingestion, and plant ingestion. Toxicity threshold limit values for the red fox were derived by using rat and mouse toxicity data, with uncertainty factors to account for different toxicological end points and different taxonomic relationships between the test organism and indicator species.

4.2.3 Ecological Risk Characterization

Risk characterization consists of two steps: (1) risk estimation and (2) risk description. Risks were characterized separately for selected indicator species at WQFS, EQFS, and Remedial Area 1A. In addition, combined risk from sediment and surface water from both WQFS and EQFS was estimated for the muskrat. Risk estimation involves integrating the exposure and toxicity information, calculating hazard indices, and summarizing the uncertainties identified, in the assessment. Sites and media with hazard indices of 1.0 or below were assumed to pose no significant risk to ecological receptors. For sites with hazard indices greater than 1.0, conclusions were made about the potential ecological significance of these risks.

Determination of hazard indices for the meadow vole, muskrat, and benthic invertebrates is discussed in the OU5 FS for Fort Wainwright.

4.2.3.1 WQFS Area

The total hazard index estimated for the meadow vole based on the average chemical concentrations in soil at WQFS is less than 0.01, well below the EPA level of concern (hazard index of 1.0). On the basis of the estimated hazard index, the meadow vole and other populations of terrestrial receptors associated with WQFS are not expected to be affected.

A total hazard index of 1.9 was estimated for the muskrat based on the average chemical concentrations in sediment and surface water collected from the Chena River adjacent to WQFS. Cadmium and PAHs are the primary contributors to the overall risk. Although potential adverse effects to individuals are indicated by the total hazard index that slightly exceeds 1.0, the potential for adverse effects at the population level is not considered significant. Given the nature of uncertainties in developing toxicity benchmarks (based on extrapolations of information from laboratory studies of mice and rats) and the use of conservative exposure parameters (assuming continuous contact with contaminated media), a hazard index of 1.9 for the muskrat is unlikely to be significant at the population level.

Average concentrations of PAHs and pesticides detected in sediment collected from the Chena River exceed sediment benchmarks, indicating potential adverse effects to benthic invertebrates. Such benchmarks include promulgated values, such as ambient water quality criteria for chemicals in water, as well as nonpromulgated criteria. Average concentrations of phthalates, arsenic, cadmium, lead, and mercury detected in surface water exceed Alaska Water Quality Standards for the protection of freshwater, aquatic organisms. These results indicate the potential for adverse effects to aquatic organisms in the segment of the Chena River adjacent to WQFS.

4.2.3.2 EQFS Area

The hazard index estimated for the meadow vole based on the average chemical concentrations in soil at EQFS is 0.01, well below the EPA level of concern (hazard index of 1.0). Acetone is the primary contributor to the overall risk. On the basis of the estimated hazard indices, the meadow vole and populations of terrestrial receptors at EQFS are not expected to be affected.

The hazard index estimated for the muskrat based on the average chemical concentrations in sediment and surface water from the Chena River adjacent to EQFS is 2.5. Although potential adverse effects to individuals are indicated by the total hazard index that exceeds 1.0, the potential for adverse effects at the population level are not considered to be significant.

Comparison of sediment COCs to sediment benchmarks did indicate the potential for adverse impacts to occur to aquatic organisms adjacent to EQFS. The aquatic risk was further evaluated in the postwide ecological risk assessment.

4.2.3.3 WQFS and EQFS Areas

The hazard index estimate for the muskrat based on the average chemical concentrations in sediment and surface water above the segment of the Chena River adjacent to both WQFS and EQFS areas is 3.1. Arsenic, lead, and cadmium contribute the greatest overall risk. Concentrations of arsenic, lead, and cadmium in sediment are statistically above background, although the results of many analyses were below background. Given the nature of uncertainties in developing toxicity benchmarks and the use of conservative exposure parameters, a hazard index of 3.1 for the muskrat is unlikely to be significant at the population level.

4.2.3.4 Remedial Area 1A

Potential risks from exposure to lead and petroleum hydrocarbons exist for all terrestrial receptors at Remedial Area 1A. However, the source area does not provide suitable habitat for any species because of the presence of existing facilities and human disturbance in the area. Potential receptors would be expected to avoid Remedial Area 1A and preferentially inhabit appropriate habitat with less disturbance. Habitat outside the source areas has not been affected. Therefore, Remedial Area 1A would be expected to constitute only a portion of the range of ecological receptors and a significant portion of their diet would be obtained from outside the source areas.

4.2.3.5 Postwide Ecological Risk Assessment

The postwide ecological risk assessment addressed potential risks posed by contaminants that accumulate in body tissue and predicted potential risks exceeding the EPA acceptable ecological hazard index of 1.0. However, the potential for adverse effects to populations is not considered to be significant because of unsuitable habitat in the areas considered and uncertainty in risk estimates resulting from necessary conservative assumptions. Ecological risks to land-based receptors were evaluated by examining the feeding habits of small mammals and birds. Hazard indices for different ingestion pathways range from 1.8 to 225 for the red fox and 0.01 to 1.3 for the northern goshawk. Dioxins and furans are the primary contributors to risk for the northern goshawk and the red fox on the south side of the Chena River. On the north side of the Chena River, lead from Remedial Area 1A is the primary contributor for risk to the red fox, with a hazard index of 225. Dioxins and furans are consistently present at levels below screening criteria throughout Fort Wainwright and are not attributable to a specific source. Dioxins are likely attributable to historical aerial pesticide applications and routine historical combustion products from the power plant.

Surface water and sediment samples were collected from the Chena River as a component of both the OU5 RI and the postwide risk assessment. For evaluation purposes, the Chena River was divided into five river segments (as presented in Figure 1). A number of contaminants exceeded surface water and sediment criteria considered protective of aquatic life. These include DDT, dioxins, dieldrin, and PAHs. Sediment samples from Segment D of the Chena River, adjacent to the OU5 sources areas, had the greatest potential to affect aquatic resources. The Chena River Aquatic Assessment Program will evaluate the portion of the Chena River next to OU5 to determine actual impacts and contaminant loading entering the river through time. The aquatic assessment includes invertebrate and chemical sampling for river sediment and surface water along the river, and is considered an action under CERCLA. The study is currently under way. Monitoring and evaluation of risk will be completed on an agreed-upon schedule, and could result in remedial actions if unacceptable risks are found to exist to aquatic organisms of the Chena River that cannot be reduced through existing remedial actions.

4.3 Risk Assessment Conclusions

The risk to human or ecological receptors at WQFS, EQFS, and Remedial Area 1A has been summarized in previous sections and described in detail in the OU3 and OU5 FSs and in the postwide risk assessment.

The human health risk assessment predicts cancer risk for potential residential groundwater use slightly in excess of the risk threshold of 1 x 10^{-4}. The noncancer hazard index of reasonable maximum exposure for residential groundwater use is less than the acceptable value of 1.0 for all chemicals except benzene, which was evaluated with an inhalation RfD that is interim and unverified. The ecological risk assessment predicts that individual receptors in sediment and surface water environments may be exposed to risks exceeding the EPA-acceptable ecological hazard index of 1.0.

The postwide human health risk assessment predicts cancer risks in excess of the risk threshold of 1 x 10^{4} and noncancer hazard indices in excess of 1.0 for the hunter and fisherman. The postwide ecological risk assessment predicts risks in excess of the EPA acceptable ecological hazard index of 1.0 for terrestrial and aquatic receptors.

WQFS and EQFS Areas:

- Total carcinogenic risks related to surface and subsurface-soil exposure for the facility worker, construction worker, and the military and nonmilitary resident are predicted to be less than 1 x 10^{6}.

- Total carcinogenic risks in WQFS related to groundwater use are 2.5 x 10^{-4} for a future nonmilitary resident and 4.3 x 10^{5} for a future military resident. Eighty-eight percent of

This risk is contributed by benzene, which was consistently detected in groundwater at concentrations exceeding the MCL.

- Total carcinogenic risks in EQFS related to groundwater use are 1.9 x 10^{-4} for a future nonmilitary resident and 3.1 x 10^{-5} for a future military resident. The majority of that risk is attributed to ethylene dibromide.

- The hazard index for potential noncarcinogenic health effects exceeds the EPA-acceptable level of 1.0 only for future residential groundwater use. The hazard index in WQFS is 6.1, mainly because of benzene.

- Exposure of terrestrial ecological receptors to chemicals in soil at WQFS and EQFS does not present a risk above the EPA-acceptable risk level of 1.0.

- Exposure of the individual muskrat to chemicals in sediment predicts a hazard index of 3.1. However, the potential for adverse effects at the population level is not considered significant.

- Exceedances of sediment criteria indicate a potential for adverse effects to occur to benthic invertebrates within the segment of the Chena River adjacent to WQFS and EQFS.

Remedial Area 1A:

- Existing contamination does not pose risks to humans in excess of regulatory guidelines under current land-use scenarios. Currently, this site is fenced and has restricted access. Although areas of contaminant concentrations in excess of soil screening levels exist, associated risk estimates are low because of the absence of plausible exposure mechanisms.

- Terrestrial ecological communities are not predicted to be affected by contamination at Remedial Area 1A, because of existing fencing. Although areas of concentrated contamination might affect individuals, the overall ecological significance of these impacts is low. Lead-contaminated surface soils present the highest potential to affect terrestrial species.

Postwide Risk Assessment:

- The postwide human health risk assessment predicts total carcinogenic risks for the hunter, based on moose ingestion, to be 5 x 10^{-4} and the noncancer hazard index to be 5.2. Total carcinogenic risks for the fisherman, based on fish ingestion, is predicted to be 1 x 10^{-4} and the noncancer hazard index to be 1.6. The uncertainty associated with these risk estimates is very high.

- The postwide ecological risk assessment concluded that contaminants in sediment and surface water in the Chena River, particularly in the river reach identified as Segment D near WQFS, are present at concentrations that may adversely affect populations of aquatic ecological receptors. The ongoing Chena River Aquatic Assessment Program will assess the potential for adverse effects to benthic invertebrates within this segment of the river during a 10-year period.

- The postwide ecological risk assessment evaluated risk to terrestrial receptors from bioaccumulative contaminants. The assessment predicts a hazard index for the northern goshawk of 1.3 from dioxin/furans and DDT and a hazard index for the red fox in the area south of the Chena River of 225, principally from dioxin. The uncertainty of these risk assessments is very high because of conservative assumptions for ingestion and bioaccumulation.

- The postwide risk assessment predicted lead at Remedial Area 1A to present a hazard index of 62 to the red fox, contributing 99 percent of the risk in the areas north of the Chena River. However, the potential for adverse effects to the red fox population is not considered to be significant because of existing fencing, unsuitable habitat in the areas considered, and uncertainty in risk estimates resulting from necessary conservative assumptions.

The results of the OU5 RI indicated that various organic contaminants, including 1,2 DCA, TCE, 1,2-ethylene dibromide, and benzene, are present in soil and groundwater at WQFS and EQFS at concentrations exceeding established regulatory cleanup guidelines, including MCLs for groundwater. Lead is present in Remedial Area 1A at concentrations exceeding EPA soil screening guidelines. Remedial actions will be performed in response to concentrations of contaminants in the soil and groundwater that exceed state and federal standards.

SECTION 5

Description of Alternatives

5.1 Need for Remedial Action

Actual or threatened releases of hazardous substances from the OU5 source areas, if not addressed by the response actions selected in this ROD may present a threat to human health, welfare, or the environment. Remedial action is necessary at the WQFS, EQFS, and Remedial Area 1A source areas to protect human health and the environment, including the Chena River.

Groundwater is the only source of potable water for Fort Wainwright. The Fort Wainwright aquifer is unconfined, except in areas of permafrost. Remedial actions in WQFS and EQFS and the Chena River Aquatic Assessment Program are recommended to protect groundwater and the Chena River. Remedial action in Remedial Area 1A is recommended to protect humans and terrestrial mammals. Contaminated soil acts as an ongoing source of contamination to the groundwater in all source areas, except Remedial Area 1A.

5.1.1 WQFS Area

The specific reasons for conducting remedial actions at WQFS are provided below. The primary emphasis is protection of groundwater and reduction of contamination entering the Chena River.

- Groundwater contains concentrations of benzene, 1,2-DCA, toluene, and TCE that exceed MCLs and TAH and TAqH exceeding Alaska Water Quality Standards.

- Soils contain BTEX and petroleum hydrocarbons that exceed ADEC cleanup guidelines and have resulted in contaminated groundwater.

- VOCs, SVOCs, and petroleum hydrocarbons pose a potential risk to downgradient groundwater users.

- Free product (floating product) has been found at the interface of the vadose zone and groundwater.

The Chena River is adjacent to WQFS and downgradient from the areas of soil and groundwater contamination. The water supply wells for the City of Fairbanks are within the same unconfined aquifer as the contamination downgradient of WQFS. Groundwater contamination from dissolved contaminants and free products within the source areas enters the Chena River and has the potential to affect the downgradient water users.

5.1.2 EQFS Area

The specific reasons for conducting remedial actions at EQFS are provided below. The areas of primary emphasis are protection of groundwater and monitoring to ensure that no contaminant migration to the Chena. River is occurring.

- Groundwater contains concentrations of benzene, 1,2-ethylene dibromide, 1,1,1-TCA, and TCE that exceed MCLs; bis(2-chloroethyl)ether that exceeds $1x10^{-6}$ risk; and TAH and TAqH that exceed Alaska Water Quality standards.

- Soils contain xylenes and petroleum products that exceed ADEC cleanup guidelines and have resulted in contaminated groundwater.

- VOCs, SVOCs, and petroleum hydrocarbons pose a potential risk to downgradient groundwater users.

- Free product (floating product) is floating on the groundwater at the interface of the vadose zone and groundwater.

The Chena River is adjacent to EQFS and downgradient from the areas of soil and groundwater contamination. The RI/FS indicated that past contamination reached the Chena River; however, data indicate that this is no longer occurring.

5.1.3 Postwide Sampling at the Chena River

A postwide sampling program, the Chena River Aquatic Assessment Program, is currently being implemented. It involves performing an aquatic assessment of the Chena River during the spring and fall. The assessment includes collecting water, sediment, and detritus (organic leaf litter) samples and analyzing them for COCs and water chemistry. In addition, benthic macroinvertebrates such as insects and larvae will be collected and analyzed through toxicological studies and bioassays.

5.1.4 Remedial Areal A

The specific reason for conducting remedial actions at Remedial Area 1A is that lead-contaminated soils within its boundaries present a potential hazard to ecological and future human receptors if use of the land changes. Lead has been detected in soils at concentrations greater than EPA Region 9 Industrial Preliminary Remedial Goals and State of Alaska soil cleanup levels.

5.2 Remedial Action Objectives

The RAOs for the WQFS, EQFS, and Remedial Area 1A source areas are described below.

5.2.1 Soil

- Prevent the migration to groundwater of soil contaminants that could result in groundwater contamination and exceedances of federal MCLs and nonzero maximum contaminant level goals (MCLGs) and to groundwater that is closely hydrologically connected to surface water (such as the Chena River) that could result in exceedances of Alaska Water Quality Standards in surface water (EQFS and WQFS)

- Limit human health and terrestrial receptor exposure to lead-contaminated soil (RA1A)

5.2.2 Groundwater (WQFS and EQFS)

- Restore groundwater to its beneficial uses within a reasonable time frame. Reduce or prevent further migration of contaminated groundwater from the source areas to the downgradient aquifer or surface water bodies that are closely hydrologically connected by achieving MCLs (where there are no nonzero MCLGs) and Alaska Water Quality Standards. For groundwater that is hydrologically connected to surface water, Alaska Water Quality Standards will apply for the following Fresh Water Uses: (1)(A) Water Supply; (1)(B) Water Recreation; and (1)(C) Growth and Propagation of Fish, Shellfish, Other Aquatic Life, and Wildlife.

- Ensure there is no risk to aquatic receptors through control of contaminant movement through the groundwater into the Chena River

- Remove floating product to the extent practicable to eliminate film or sheen from groundwater

- Prevent use of groundwater containing contaminants at levels above Safe Drinking Water Act MCLs, nonzero MCLGs, or the following Alaska Water Quality Standards for Fresh Water Uses: (1)(A) Water Supply; (1)(B) Water Recreation; and (1)(C) Growth and Propagation of Fish, Shellfish, Other Aquatic Life, and Wildlife.

5.2.3 Chena River Sediment and Surface Water

- Reduce sources of contaminant releases to the Chena River

- Meet the following Alaska Water Quality Standards for Fresh Water Uses: (1)(A) Water Supply; (1)(B) Water Recreation; and (1)(C) Growth and Propagation of Fish, Shellfish, Other Aquatic Life, and Wildlife.

- Continue aquatic assessment

For purposes of protecting the Chena River aquatic resources, cleanup goals for groundwater are expected to be achieved by treating groundwater before it enters the Chena River. Chemical-specific cleanup goals for the media of the OU5 source areas are summarized in Section 7.

5.3 Significant Applicable or Relevant and Appropriate Requirements

A full list of ARARs is provided in Section 8. The following ARARs are the most significant regulations that apply to the remedies selected for the OU5 source areas:

- Federal and state MCLs are relevant and appropriate for groundwater that is a potential drinking water source (40 CFR 141 and 18 AAC 80). These ARARs set the active remediation goals for groundwater. Alaska Water Quality Standards (18 AAC 70) are also applicable to surface water, sediment, and groundwater that is closely hydrologically connected to surface water.

- Alaska oil pollution regulations (18 AAC 75) are applicable and require the cleanup of oil or hazardous material releases.

5.4 Description of Alternatives

Many technologies were considered for use in cleaning up the soil and groundwater in the OU5 source areas. The most favorable options that passed the preliminary screening were assembled into preliminary remedial alternatives addressing the RAOs established for soil and groundwater in OU5. These alternatives were evaluated based on their effectiveness, implementability, and relative costs. Experience gained from installing and operating treatment systems in four OUs previously addressed at Fort Wainwright and from treatability study systems (discussed in Section 2) also were considered as part of this evaluation. The preliminary remedial alternatives are listed in Table 9 and described below.

With the exception of the no-action alternative, all alternatives discussed below include institutional controls and monitoring.

The Chena River Aquatic Assessment Program is an ongoing program. The information collected during this aquatic assessment program will be used to determine reductions of contaminant load into the Chena River from remedial actions and associated changes to aquatic organisms. The annual cost of this sampling program is $350,000. For cost estimating purposes, it has been assumed that the postwide sampling program will be implemented every other year for 10 years. The frequency and scope of sampling will be reviewed following the 1998 field season.

5.4.1 Development of Remedial Alternatives

Remedial alternatives are developed by subarea for contaminnant sources within WQFS. Remedial alternatives for WQFS1, WQFS2, and WQFS3 address soil containing DRO, GRO, and BTEX that exceeds the ADEC cleanup guidelines; groundwater containing TAH and TAqH that exceeds Alaska Water Quality Standards; and groundwater containing 1,2-DCA, toluene, benzene, and TCE that exceeds MCLs.

Remedial alternatives for EQFS address soil containing DRO, GRO, and xylenes that exceeds ADEC cleanup guidelines; groundwater containing TAH and TAqH that exceeds Alaska Water Quality Standards; groundwater containing ethylene dibromide, benzene, 1,1,1-TCA, and TCE that exceeds MCLs; and groundwater containing bis(2-chloroethyl)ether that exceeds a human health risk of 1×10^{-6}.

Groundwater contamination extends to depths greater than 70 feet below ground surface at WQFS and EQFS areas. Alternatives include the use of monitored and evaluated natural attenuation to address remediation of contaminants in deep groundwater (more than 30 feet below ground surface, or approximately 15 feet below the water table). The implementability of a pump-and-treat remedial option is questionable for addressing deep groundwater plumes. The relative cost is high, and it is not likely to be effective given the highly permeable aquifer conditions at the WQFS and EQFS areas. The preferred method of remediating deep groundwater contamination is natural attenuation. Consistent with the Monitored Natural Attenuation Policy from the EPA Office of Solid Waste and Emergency Response (OSWER), the fundamental components of source control and performance monitoring will be met. The term “groundwater” used throughout the remainder of this report refers to shallow (less than 15 feet below the water table) groundwater, unless noted otherwise.

TABLE 9
Remedial Alternatives for 0U5 Source Areas

Subarea WQFS1

1. No Action
2. Institutional Controls and Monitored and Evaluated Natural Attenuation
3. Source Area Treatment with Soil Vapor Extraction and Air Sparging, Institutional Controls, and Monitored and Evaluated Natural Attenuation
4. Alternative 3 with Potential In Place Soil Heating at Source Areas
5. Alternative 4 with Operation of the Potential Downgradient Air Sparging Trench

Subarea WQFS2

1. No Action
2. Institutional Controls and Monitored and Evaluated Natural Attenuation
3. Hot Spot (Source Area) Treatment with Soil Vapor Extraction and Air Sparging. Continued Operation of the Downgradlent Air Sparging Curtain, Groundwater Monitoring, Institutional Controls, and Monitored and Evaluated Natural Attenuation

Subarea WQFS3

1. No Action
2. Institutional Controls and Monitored and Evaluated Natural Attenuation
3. Hot Spot (Source Area) Treatment with Soil Vapor Extraction and Air Sparging, Institutional Controls, and Monitored and Evaluated Natural Attenuation

EQFS Area

1. No Action
2. Continued Operation of the Building 1060 SVE/AS Treatability Study System, Institutional Controls, and Monitored and Evaluated Natural Attenuation
3. Alternative 2 with Additional SVE/AS
4. Alternative 3 with Downgradient Air Sparging Trench
5. Alternative 3 with Downgradient Funnels and Gates and an Air Sparging Trench

Remedial Area 1A

1. No Action
2. Institutional Controls
3. Sampling, Soil Cover, and Revegetation with Institutional Controls
4. Excavation and Offsite Disposal of Lead-Contaminated Soil Through Defense Reutilization and Marketing Office to RCRA-Permitted Transport, Storage, and Disposal Facility

Remedial alternatives developed for the Remedial Area 1A source area address lead contaminated soil. Lead contamination in soil is predominantly located within the bermed areas surrounding the tanks. The contaminated soil contains lead at concentrations of concern to human and ecological receptors if current land-use scenarios were different and restrictions were not in place.

Descriptions of remedial alternatives for WQFS1, WQFS2, WQFS3, EQFS, and Remedial Area 1A are presented in the following sections.

5.4.2 Subarea WQFS1

The following discussion describes the remedial alternatives developed for WQFS1.

5.4.2.1 Alternative 1-No Action

Under the no-action alternative, no active remedial measures are used to address contamination. The no-action alternative does not include monitoring, site controls, or decommissioning of existing wells and probes. Additionally, off-source migration would not be monitored or controlled. Although natural attenuation would occur under this alternative, it would not be measured or evaluated, because no sampling or monitoring would be conducted.

Development of the no-action alternative is required by the NCP to provide a basis of comparison for the remaining alternatives. This alternative serves as a baseline by reflecting current conditions without any cleanup effort. The no-action alternative was evaluated consistently with NCP requirements. No present worth, capital, operation and maintenance (O&M), or groundwater monitoring costs are associated with the no-action alternative.

Capital Cost: $0
Annual O&M Cost: $0
Total Cost (30-year present worth): $0

5.4.2.2 Alternative 2-Institutional Controls and Monitored and Evaluated Natural Attenuation

This alternative includes monitoring natural attenuation of contaminants along with the use of institutional controls to restrict local groundwater and land use. A conceptual design layout of Alternative 2 is shown in Figure 4.

A long-term groundwater monitoring program would be developed and implemented until RAOs are met. For cost-estimating purposes, the program was projected to continue for 30 years. The frequency of monitoring would be decided during the development of the remedial action work plan for the QFS. On the basis of the magnitude of the source contamination, it is not likely that RAOs would be achieved for this alternative.

Natural attenuation and monitoring likely would be required beyond the 30-year period. Groundwater-use restrictions would include preventing the installation of groundwater supply wells within contaminated plumes in shallow and deep groundwater on post.

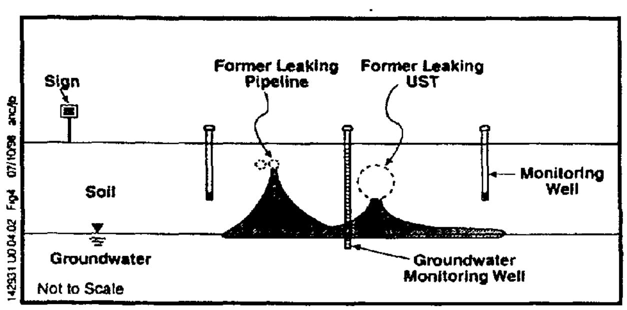

Figure 4. Alternative 2 for WQFS1, WQFS2, WQFS3, and EQFS

However, institutional controls cannot be used to control groundwater for protection of downgradient environmental receptors. Institutional controls are not effective in preventing contaminants from entering the Chena River. Land-use restrictions would include limiting future land use to operations currently being conducted at the source areas. Groundwater and land-use restrictions would be incorporated into the Fort Wainwright master plan and would be implemented and monitored through the institutional control SOPs.

Capital Cost: $88,000
Annual O&M Cost: $70,000
Total Cost (30-year present worth): $2,180,000

5.4.2.3 Alternative 3-Source Area Treatment with Soil Vapor Extraction and Air Sparging, Institutional Controls, and Monitored and Evaluated Natural Attenuation

This alternative consists of installing SVE/AS wells to address soil, groundwater, and floating-product contamination in the source area. It also includes the monitored and evaluated natural attenuation for less-contaminated areas and institutional controls described for Alternative 2. A conceptual design layout of Alternative 3 is shown in Figure 5.

The source-area SVE/AS system would strip VOCs from groundwater and soil and would increase the potential for aerobic biological degradation of contaminants in saturated- and vadose-zone soils. The SVE system would include offgas treatment. The SVE/AS wells would be located within the contaminant source area. The horizontal AS well and the horizontal SVE well that were installed as part of a treatability study system in WQFS1 would be operated as part of this alternative. This alternative also includes installation and operation of an SVE/AS system in a treatability study east of the main treatment system and just south of Gaffney Road scheduled for operation at the end of October 1998. This treatability study is needed to evaluate the effectiveness of SVE/AS treatment. If the system is effective, operation of the system will continue as part of the remedy.

Removal of VOCs from source-area soil is estimated to be complete within approximately 5 years, and the contribution of contaminants from source-area soil to groundwater would

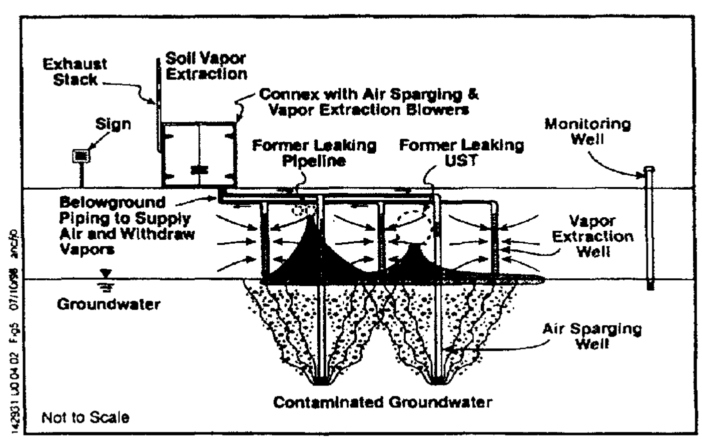

Figure 5. Alternative 3 for WQFS1, WQFS3, and EQFS

be significantly diminished after this time. This 5-year period for active treatment was based on contamination degradation modeling for this area and has been used to estimate costs. A review of Fort Wainwright SVE/AS systems in treatability studies indicated that this period is a reasonable assumption.

Residual contamination in the form of low-volatility petroleum hydrocarbons likely would remain in the source-area soil at concentrations above ADEC cleanup guidance. On the basis of groundwater modeling, it is expected that the MCL for benzene would still be exceeded at the Chena River after 10 years. Treatability studies at Building 1168 and other sites suggest that the DRO cleanup rate in soil may become asymptotic at a concentration greater than ADEC Level A. Contaminants in the soil (at concentrations exceeding ADEC guidance) and groundwater in areas outside the inferred extent of floating product would not be actively treated in this alternative. Monitored and evaluated natural attenuation would be relied on to remediate these areas.

For cost-estimating purposes, it was assumed that groundwater monitoring would be conducted in the source area during the 5 years of system operation and for an additional 3 years to monitor for contaminant rebound (8 years total). Natural attenuation monitoring would be conducted during treatment of the contaminant source area and for an additional 25 years following source-area treatment (30 years total). This monitoring duration is based on the following assumptions:

- Removal of VOCs from source soil is estimated to be complete within 5 years, and source soil would no longer continue to act as a source of groundwater contamination after this period.
- Attenuation of COCs in soil and groundwater outside the defined treatment area to concentrations below ARARs would occur after an additional 25 years.

The frequency of monitoring would be decided during the development of the remedial action work plan for the QFS.

Alternative 3 also includes restrictions on local groundwater and land use until RAOs are achieved. Groundwater-use restrictions would include preventing the installation of groundwater supply wells in the plume areas and in downgradient areas where contaminant migration might occur. However, institutional controls cannot be used to control groundwater for protection of downgradient receptors. Institutional controls do not effectively prevent contaminants from entering the Chena River. Land-use restrictions would include limiting future land use to operations currently being conducted at the source area. Groundwater- and land-use restrictions would be incorporated into the Fort Wainwright master plan and would be implemented and monitored through the institutional control SOPs.

Capital Cost: $3,371,000
Annual O&M Cost: $89,000
Total Cost (30-year present worth): $6,030,000

5.4.2.4 Alternative 4–Alternative 3 with Potential In Place Soil Heating at Source Areas

This alternative is the same as the Alternative 3 with the addition of in situ soil heating at hot spot locations. A conceptual design layout of Alternative 4 is shown in Figure 6.

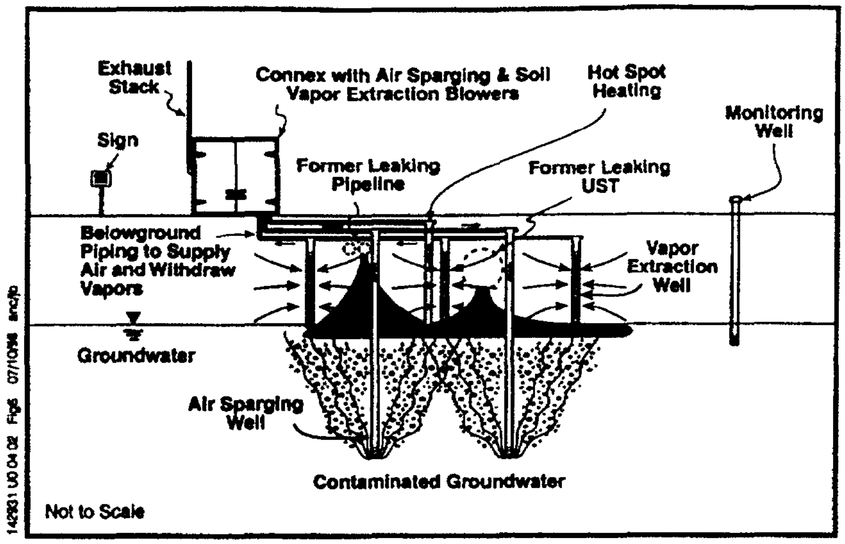

Figure 6. Alternative 4 for WQFS1

In situ soil heating is proposed as a method to increase the speed and effectiveness of remediation. In situ soil heating would be implemented in the areas containing the highest contamination, specifically within the area that would be treated with the SVE/AS system described in Alternative 3.

Two heating methods are being considered for OU5. These include radio frequency and six-phase soil heating. Treatability studies are being conducted to evaluate the effectiveness of these methods. For each of these basic methods, there are options for moderate-temperature (40˚C) and high-temperature (100˚C) heating. Current information on these technologies indicates that all four heating options (moderate- and high-temperature radio frequency and moderate- and high-temperature six-phase soil heating) would be effective for increasing the rate of contaminant removal in the WQFS1 source area. If results of the treatability studies are favorable, in situ soil heating will be used at the areas containing the highest contamination (hot spots).

Because treatability study results will not be available until 1999, one soil heating technology has been selected to be representative for cost estimating. This choice does not restrict the selection of the other options later in the remedial design when more information is available from the treatability studies.

The SVE/AS of Alternative 4 is identical to that described for Alternative 3. By supplementing source-area SVE/AS with in situ soil heating in areas with the highest contamination, contaminant volatilization and biodegradation rates would increase and RAOs would be achieved more rapidly. Residual contamination in the form of DRO likely would remain in the source-area soil at concentrations above ADEC cleanup guidance; however, adding soil heating to SVE/AS would increase the removal of DRO. A reduction in treatment time may result in reduced O&M costs. The overall cost for remediation may in turn be reduced if the savings in O&M costs are greater than the capital costs for implementing in situ soil heating. The Army is currently conducting a treatability study system of in situ soil heating at Fort Wainwright. If the system is effective, operation of the system will be continued as part of the remedy.

Preliminary information from the in situ heating treatability studies indicates that the time required for treatment can be decreased substantially by augmenting SVE/AS with soil heating. It is estimated that with moderate temperature heating (40 °C) the contaminant hot spot would be treated sufficiently in 2 years so that it would no longer act as a source of VOC contamination to groundwater. Operation of the SVE/AS treatability system on the eastern side of WQFS1 would continue to operate for 5 years because it does not include a soil heating component.

Contaminants in the soil (at concentrations exceeding ADEC guidance) and groundwater in areas outside the inferred extent of floating product would not be actively treated in this alternative. On the basis of groundwater modeling, it is expected that the MCL for benzene would still be exceeded at the Chena River after 10 years. It is expected that groundwater outside the treatment areas would remain above MCLs for a long time.

Monitored and evaluated natural attenuation would be relied on to remediate these less-contaminated areas (where contaminants in soil and groundwater are outside the inferred extent of floating product). Natural attenuation in these areas may be enhanced by residual heat in the soil heating areas.

For cost-estimating purposes, it was assumed that groundwater monitoring would be conducted in the contaminant source area during the 2 years of system operation and for an additional 3 years to monitor for contaminant rebound (5 years total). Monitoring outside the contaminant source area for natural attenuation would be conducted during source-area treatment and for an additional 28 years (30 years total). The frequency of monitoring would be decided during development of the remedial action work plan for the QFS.

Restrictions on groundwater and land use are identical to those in Alternative 3.

Capital Cost: $3,650,000
Annual O&M Cost: $115,000
Total Cost (30-year present worth): $7,100,000

5.4.2.5 Alternative 5–Alternative 4 with Operation of the Potential Downgradient Groundwater Air Sparging Trench

This alternative is the same as Alternative 4 with the possible addition of a downgradient groundwater AS trench. A conceptual design layout of Alternative 5 is shown in Figure 7.

The AS trench would be either a line of vertical AS wells to form an AS curtain or would be composed of a relatively high-permeability gravel fill about 30 feet deep with AS lines installed at the bottom. The trench would be about 1,200 feet long and would be located just south of Gaffney Road. The AS trench would be installed to intercept and treat dissolved contaminants migrating from the source area toward the Chena River.

Similarly to Alternative 4, the removal of VOCs from source-area soil is estimated to be complete within about 2 years. The contribution of contaminants from source-area soil to groundwater would be significantly diminished after this time. Because of the residual soil contamination that would be present outside the active treatment area, migration of contaminants from these areas to the groundwater would occur until these areas are remediated by natural attenuation. The AS trench would provide treatment of this groundwater until the source area is remediated. Residual contamination in the form of

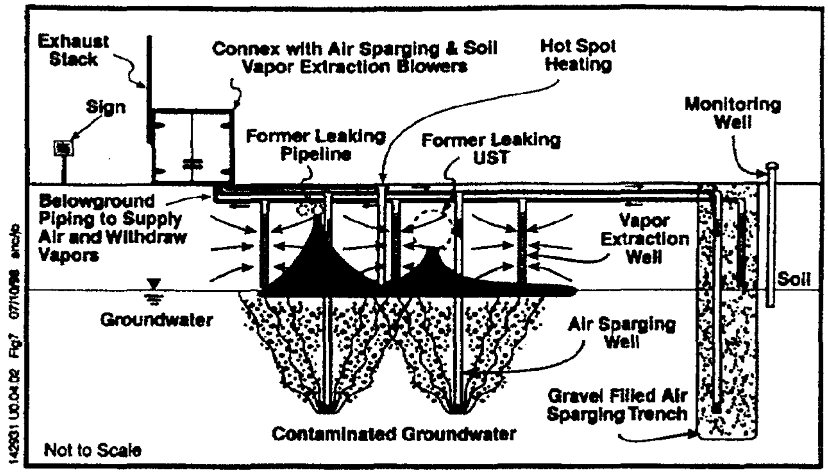

Figure 7. Alternative 5 for WQFS1

DRO likely would remain in the source-area soil at concentrations above ADEC cleanup guidance.

On the basis of groundwater modeling, it is expected that the MCL for benzene would be met at the Chena River in less than 10 years. It is expected that groundwater outside of the treatment areas and upgradient of the AS trench would remain above MCLs for a longer period of time.

For cost-estimating purposes, it was assumed that if in situ heating is implemented, source area SVE/AS would be conducted for 2 years. If in situ soil heating is not implemented, source area SVE/AS would be conducted for 5 years. Regardless of the duration of the source-area treatment, the downgradient AS trench would operate for 30 years. It also was assumed that groundwater monitoring would be conducted quarterly in the source area during system operation and semiannually for an additional 3 years to monitor for contaminant rebound. Natural attenuation monitoring of less-contaminated areas would be performed during source-area treatment, during the 3 years after treatment is completed, and during Years 10, 15, 20, 25, and 30. The frequency of monitoring would be reevaluated during development of the remedial action work plan for the QFS.

Restrictions on groundwater and land use are identical to those in Alternative 3.

Costs with heating:

Capital Cost: $3,610,000
Annual O&M Cost: $130,000
Total Cost (30-year present worth): $7,500,000

Costs without heating:

Capital Cost: $3,220,000
Annual O&M Cost: $111,000
Total Cost (30-year present worth): $6,540,000

5.4.3 Subarea WQFS2

A removal action was conducted in April 1998 after completion of the RI. The purposes of this action were excavation and treatment of petroleum-contaminated soil in WQFS2 near the Chena River retaining structure. The removal action resulted in source reduction (soil and sediment) of free-product release to the Chena River by the following:

- Removal of the retaining structure
- Excavation and treatment of about 700 cubic yards of contaminated soil and sediment
- Excavation of soil down to the groundwater level and into the saturated zone

The removal action was expected to reduce the immediate source of floating product from the bank of the Chena River. However, the removal action does not prevent floating product from migrating from the hot spot in WQFS2 and recontaminating the area where the removal occurred.

The following is a description of the remedial alternatives developed for WQFS2. These alternatives have been developed in conjunction with the retaining-structure removal action.

5.4.3.1 Alternative 1–No Action

This alternative is identical to the no-action alternative described for WQFS1.

5.4.3.2 Alternative 2–Institutional Controls and Monitored and Evaluated Natural Attenuation

This alternative includes developing and implementing a long-term groundwater monitoring program of natural attenuation. Figure 4 provides a conceptual design layout of Alternative 2.

The frequency of monitoring would be decided during the development of the remedial action work plan for the QFS. Monitoring likely would be required beyond the 30-year period. Groundwater- and land-use restrictions are identical those described in Alternative 2 for WQFS1. On the basis of the magnitude of the source-area contamination, it is not expected that Alternative 2 for WQFS2 would achieve RAOs.

Capital Cost: $60,000
Annual O&M Cost: $42,000
Total Cost (30-year present worth): $1,330,000

5.4.3.3 Alternative 3–Hot Spot (Source Area) Treatment with Soil Vapor Extraction and Air Sparging, Continued Operation of the Downgradient Groundwater Air Sparging Curtain, Groundwater Monitoring, Institutional Controls, and Monitored and Evaluated Natural Attenuation

This alternative consists of installing SVE/AS wells to address soil, groundwater, and floating-product contamination in the hot spots (source areas), supplemented with a downgradient groundwater AS curtain. The AS curtain was installed in 1998 adjacent to the Chena River as part of a treatability study and would be operated as a component of this alternative. The AS curtain primarily would address dissolved-phase contamination in the groundwater, but also would provide treatment of floating product that may migrate from

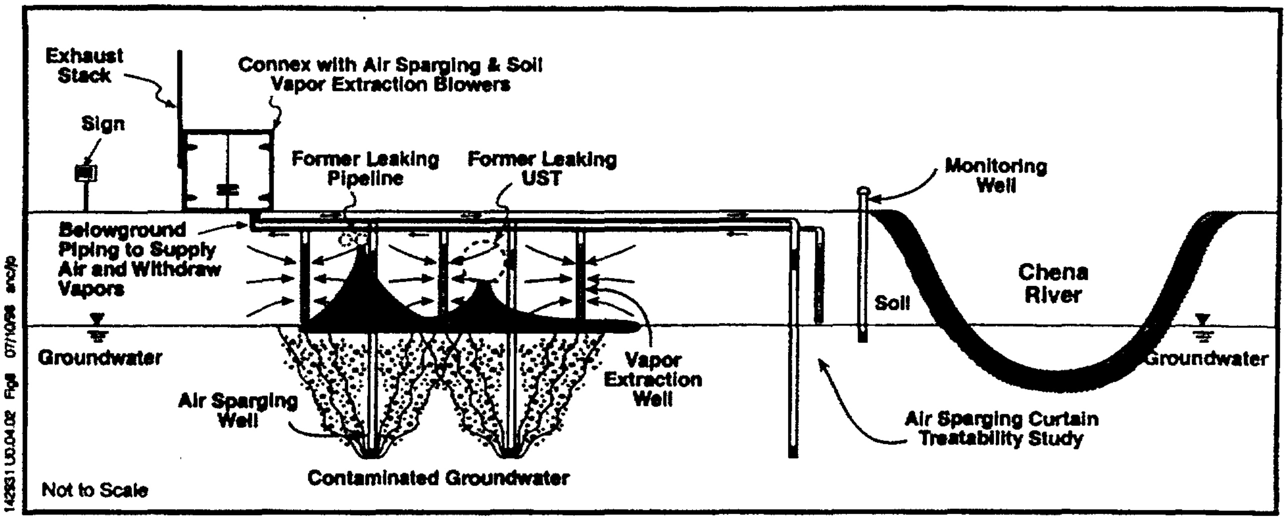

Figure 8. Alternative 3 for WQFS2

WQFS2 to the Chena River. A conceptual design layout of Alternative 3 is shown in Figure 8.

The hot-spot (source-area) SVE/AS system would strip VOCs from soil and groundwater and would increase potential for aerobic biological degradation of contaminants in saturated- and vadose-zone soils. The SVE system would include offgas treatment. SVE/AS wells would be located within the contaminant hot spot. The contaminant hot spot is defined as the approximate extent of soil containing DRO, GRO, and BTEX at concentrations that exceed the ADEC Level A cleanup concentrations. The SVE/AS system would be installed so that the northern end of the system is directly adjacent to the area of the removal action along the Chena River.

The downgradient groundwater AS curtain would consist of a series of closely spaced AS wells. The AS curtain would provide treatment for dissolved contamination that would migrate through the curtain toward the Chena River. Floating-product migration is expected to be slowed by the AS curtain. Volatile components of the floating product would be removed by the AS curtain, which would result in a reduced volume and a higher viscosity for the floating product. AS also would result in a reduction in aquifer permeability because of air being forced into previously saturated pore spaces, which would decrease floating-product mobility. The AS curtain would not remove PAHs that are contained in the floating product; however, it would slow their migration. by slowing the movement of the floating product. PAHs may be removed as a result of biodegradation, which will be enhanced through AS.

Removal of VOCs from the contaminant source area is estimated to be complete within about 5 years, and contribution of contaminants from soil to groundwater would be significantly diminished in this time. This 5-year period for active treatment was based on contamination degradation modeling for this area and has been used to estimate costs. However, residual contamination in the form of low-volatility petroleum hydrocarbons likely would remain in the soil at concentrations above ADEC cleanup guidance. The AS curtain would operate simultaneously with the source remediation (5 years). It is expected that the source-area treatment with SVE/AS and the AS curtain would also reduce the migration of floating product (and therefore PAHs) to the area where the removal action occurred. Therefore, this treatment also would reduce the migration of these components to the Chena River. The time frame for this reduction and the extent of the reduction in floating-product migration are difficult to estimate. Modeling for this area is continuing as new data become available to more precisely define treatment time frames.

On the basis of groundwater modeling, it is estimated that the MCL for benzene would be met at the Chena River in less than 10 years. The groundwater modeling assumes that essentially all hot spots in WQFS2 would be treated by SVE/AS in this alternative. Therefore, the modeling estimates that MCLs in the groundwater throughout WQFS2 would be met much more rapidly than for the nontreatment alternatives.

For cost-estimating purposes, it was assumed that hot spot treatment would be conducted for 5 years. In addition, groundwater monitoring would be conducted quarterly in the hot spot area during system operation and semiannually for an additional 3 years (8 years total) to monitor for contaminant rebound. Natural attenuation groundwater monitoring of less-contaminated areas outside the hot spots would be conducted during hot-spot treatment (Years 1 to 5), during the 3 years after treatment is completed (Years 6, 7, and 8), and in Years 10, 15, 20, 25, and 30. The frequency of monitoring would be reevaluated during development of the remedial action work plan for the QFS.

This alternative also includes restrictions on local groundwater and land use until RAOs are achieved. Groundwater-use restrictions would include preventing the installation of groundwater supply wells in the plume areas and in downgradient areas where contaminant migration might occur. However, institutional controls cannot be used to control groundwater for protection of downgradient receptors. Institutional controls do not effectively prevent contaminants from entering the Chena River. Land-use restrictions would include limiting future land use to operations currently being conducted at the source area. Groundwater- and land-use restrictions would be incorporated into the Fort Wainwright master plan and would be implemented and monitored through the institutional control SOPs.

Capital Cost: $1,070,000
Annual O&M Cost: $60,000
Total Cost (30-year present worth): $2,800,000

5.4.4 Subarea WQFS3

The following is a description of the remedial alternatives developed for WQFS3.

5.4.4.1 Alternative 1–No Action

This alternative is identical to the no-action alternative described for WQFS1 and WQFS2.

5.4.4.2 Alternative 2–Institutional Controls and Monitored and Evaluated Natural Attenuation

This alternative is similar to Alternative 2 for WQFS1 and WQFS2 and includes groundwater- and land-use restrictions. Figure 4 provides a conceptual design layout of Alternative 2.

A long-term groundwater monitoring program would be developed and implemented until RAOs are met. For cost-estimating purposes, this program was projected to continue for 30 years. The frequency of monitoring would be decided during development of the remedial action work plan for the QFS. On the basis of the extent and magnitude of soil contamination, this alternative would not likely meet RAOs.

Groundwater-use restrictions would include preventing the installation of groundwater supply wells within shallow- and deep-groundwater contaminant plume areas and in downgradient areas where contaminant migration might occur. However, institutional controls cannot be used to control groundwater for protection of downgradient environmental receptors. Institutional controls are not effective in preventing contaminants from reaching the Chena River. Land-use restrictions would include limiting future land use to operations currently being conducted at the source area. Groundwater- and land-use restrictions would be incorporated into the Fort Wainwright master plan and would be implemented and monitored through the institutional control SOPs.

Capital Cost: $71,000
Annual O&M Cost: $36,000
Total Cost (30-year present worth): $1,160,000

5.4.4.3 Alternative 3–Hot Spot (Source Area) Treatment with Soil Vapor Extraction and Air Sparging, Institutional Controls, and Monitored and Evaluated Natural Attenuation

This alternative is similar to Alternative 3 for WQFS1 and consists of installing SVE/AS wells to address soil and groundwater contamination in the source area.

The hot-spot (source-area) SVE/AS system would strip VOCs from groundwater and soil and would increase the potential for aerobic biological degradation of contaminants in saturated- and vadose-zone soils. The SVE system would include offgas treatment. SVE/AS wells would be located in the contaminant hot spot. The hot spot is defined as the approximate extent of soil containing DRO and GRO at concentrations that exceed the ADEC Level A cleanup concentrations. Figure 5 provides a conceptual design layout of Alternative 3.

Removal of VOCs from source-area soil is estimated to be complete within about 5 years. This 5-year period of active treatment was based on contamination degradation modeling for this area and has been used to estimate costs. However, residual contamination in the form of low-volatility petroleum hydrocarbons likely would remain in the soil at concentrations above ADEC cleanup guidance.

On the basis of groundwater modeling, it is estimated that the MCL for benzene would be met at the Chena River in less than 10 years. The groundwater modeling assumes that essentially all hot spots in WQFS3 would be treated by SVE/AS in this alternative. Therefore, the modeling estimates that MCLs in the groundwater throughout WQFS3 would be met much more rapidly through treatment than in the nontreatment alternatives. It is likely that some areas of soil contamination that would not be addressed by the treatment system would be addressed over the long term by monitored and evaluated natural attenuation.

For cost-estimating purposes, it was assumed that the hot-spot treatment would be conducted for 5 years. In addition, it was assumed that groundwater monitoring would be conducted quarterly in the hot spots during the 5 years of system operation and semiannually for an additional 3 years to monitor for contaminant rebound (8 years total). Natural attenuation monitoring of less-contaminated areas would be conducted during system operation (Years 1 to 5), during the 3 years after system operation is discontinued (Years 6 to 8), and in Years 10, 15, 20,25, and 30. The frequency of monitoring would be decided during development of the remedial action work plan for the QFS.

Restrictions on local groundwater and land use are identical to those in Alternative 2.

Capital Cost: $440,000
Annual O&M Cost: $30,000
Total Cost (30-year present worth): $1,390,000

5.4.5 EQFS Source Area

The following are descriptions of the remedial alternatives for the EQFS source area.

5.4.6.1 Alternative 1–No Action

This alternative is identical to the no-action alternative described for WQFS1, WQFS2, and WQFS3.

5.4.6.2 Alternative 2-Continued Operation of the Building 1060 SVE/AS Treatability Study System, Institutional Controls, and Monitored and Evaluated Natural Attenuation

This alternative includes continued operation for 2 additional years of the SVE/AS treatability study that is installed at Building 1060. It also includes monitoring natural attenuation of less-contaminated areas and restricting local groundwater and land use.

The Building 1060 SVE/AS treatability study system addresses TCE, GRO, and DRO contamination. The SVE/AS system consisting of 12 vertical SVE wells and 10 vertical AS wells, was installed in 1994 and has been effectively removing contaminants from soil and groundwater. In general, the relatively high TCE concentrations encountered in soil samples before startup were not detected in sample results after 1 and 2 years of operation. For vadose-zone samples, the results show a reduction of contaminants at all sampling locations. For saturated-zone soil samples, TCE has been reduced to low or nondetect levels. TCE concentrations in groundwater were reduced by two orders of magnitude between 1993 and 1996. September 1997 groundwater monitoring results indicate TCE reductions of 42 to 97 percent from 1993 levels. The TCE concentration in downgradient groundwater is now below the MCL of 5 Fg/L.

For cost-estimating purposes, the Building 1060 treatment system would continue to be operated for a total of 5 years from the time of startup (until the year 2000). Quarterly groundwater monitoring of the treatment area would be conducted during system operation and would continue semiannually for an additional 3 years after treatment is discontinued to monitor contaminant rebound. Data are currently being evaluated to identify the appropriate operation of the system.

On the basis of groundwater modeling, it is estimated that the MCL for benzene is currently being met at the Chena River. However, MCL exceedances do occur at other locations within EQFS. These areas would require a longer time to achieve RAOs.

A long-term groundwater monitoring program would be developed and implemented until RAOs are met. For cost-estimating purposes, this program would be conducted during system operation (Years 1 to 5), during the 3 years after the system is in place (Years 6 to 8), and in Years 10, 15, 20, 25, and 30. The frequency of monitoring would be decided during development of the remedial action work plan for the QFS. Monitoring likely would be required beyond the 30-year period until RAOs are met.

Groundwater-use restrictions also would be developed to include preventing the installation of groundwater supply wells within shallow- and deep-groundwater contaminant plume areas and in downgradient areas where contaminant migration might occur. Land-use restrictions would include limiting future land use to operations currently being conducted at the source area. Groundwater- and land-use restrictions would be incorporated into the Fort Wainwright master plan and would be implemented and monitored through the institutional control SOPs.

Activities performed under this alternative will not affect the Ladd Field National Historic Landmark District.

Capital Cost: $220,000
Annual O&M Cost: $35,000
Total Cost (30-year present worth): $ 1,290,000

5.4.5.3 Alternative 3–Alternative 2 with Additional SVE/AS

This alternative consists of installing SVE and AS wells to address source-area soil, groundwater, and floating-product contamination. Figure 5 is a conceptual design layout of Alternative 3.

The SVE/AS system would strip VOCs from groundwater and soil and would increase the potential for biological degradation of contaminants in saturated- and vadose-zone soils. The SVE system would include offgas treatment. The SVE/AS wells would be located in the areas where soil contamination exceeds ADEC Level A cleanup guidelines.

Removal of VOCs from soil is estimated to be complete within about 5 years. This 5-year period of active treatment was based on contamination degradation modeling for this area and has been used to estimate costs. The contribution of contaminants from soil to groundwater would be significantly diminished after this time. However, residual contamination in the form of low-volatility petroleum hydrocarbons likely would remain in the soil at concentrations above ADEC cleanup guidance.

For cost-estimating purposes, it was assumed that groundwater monitoring would be conducted at the treatment area during system operation and for an additional 3 years (8 years total) to monitor for contaminant rebound. Natural attenuation monitoring of less-contaminated areas would be conducted simultaneously with source-area treatment and for an additional 25 years (30 years total).

Alternative 3 also includes restrictions on local groundwater and land use until RAOs are achieved. Groundwater-use restrictions would include preventing the installation of groundwater supply wells in the plume areas and in downgradient areas where contaminant migration might occur. Land-use restrictions would include limiting future land use to operations currently being conducted at the source area. Groundwater- and land-use restrictions would be incorporated into the Fort Wainwright master plan and would be implemented and monitored through the institutional control SOPs.

Capital Cost: $5,160,000
Annual O&M Cost: $120,000
Total Cost (30-year present worth): $8,760,000

5.4.5.4 Alternative 4–Alternative 3 with Downgradient Air Sparging Trench

This alternative supplements the Alternative 3 remedial measures with a downgradient groundwater sparging trench along the south bank of the Chena River. The trench consists of a highly permeable gravel fill about 30 feet deep with AS lines installed at the bottom and SVE lines installed near the top. The AS trench is installed to intercept and treat dissolved contaminants migrating to the Chena River. A conceptual design layout of Alternative 4 is shown in Figure 9.

As described in Alternative 2, groundwater near the Chena River is currently meeting MCLs for benzene. On the basis of RI data and groundwater modeling, it is estimated that the MCL for benzene is currently being met in shallow groundwater adjacent to the Chena River and would continue to be met. The AS trench is not expected to remove a significant amount of contamination from the groundwater.

As discussed for the previous alternative, removal of VOCs from source-area soil is estimated to be complete within about 5 years. The contribution of contaminants from source-area soil to groundwater would be significantly diminished after this time. Residual contamination in the form of DRO likely would remain in the source-area soil at concentrations above ADEC cleanup guidance. The AS trench would operate simultaneously with the source-area remediation and for an additional 25 years (30 years total). Groundwater monitoring would be conducted in the source area during system operation and for an additional 3 years (8 years total) to monitor for contaminant rebound. Natural attenuation monitoring of less-contaminated areas would be implemented until RAOs are met. For cost-estimating purposes, monitoring was projected to continue for 30 years. The frequency of monitoring would be decided during development of the remedial action work plan for the QFS.

Restrictions on groundwater and land use are identical to those in Alternative 3.

Activities performed under this alternative will not affect the Ladd Field National Historic Landmark District.

Capital Cost: $5,378,000
Annual O&M Cost: $169,000
Total Cost (30-year present worth): $10,460,000

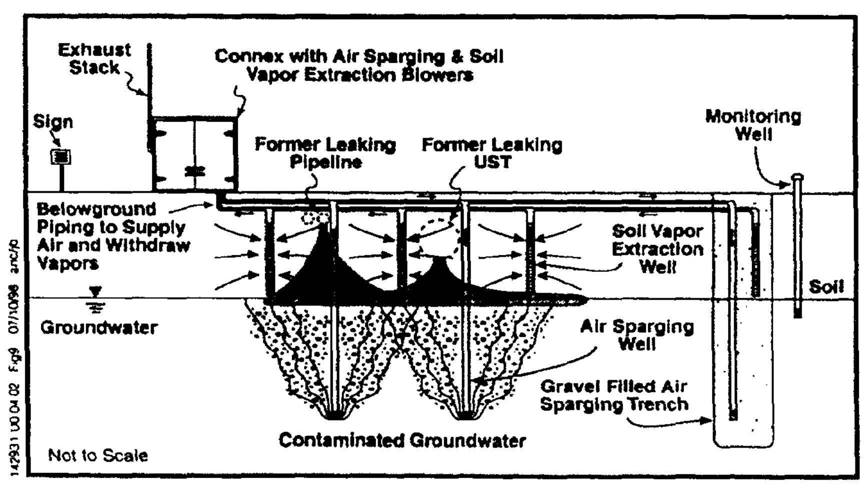

Figure 9. Alternative 4 for EQFS

5.4.5.5 Alternative 5–Alternative 3 with Downgradient Funnels and Gates and an Air Sparging Trench

This alternative supplements the Alternative 3 remedial measures with funnels and gates along the south bank of the Chena River. A conceptual design layout of Alternative 5 is shown in Figure 10.

A sheet-pile wall installed to a depth of about 30 feet would be designed to funnel contaminated groundwater through openings, or gates, in the wall. As contaminated groundwater passes through a gate, an AS trench installed in the gate area would reduce contaminant concentrations.

As discussed for Alternative 3, operation of the source-area system is expected to last 5 years. The funnel-and-gate system would operate simultaneously with source remediation and for an additional 25 years (30 years total). Groundwater monitoring of less-contaminated areas would be conducted in the source area during system operation and for an additional 3 years (8 years total) to monitor for contaminant rebound. Natural attenuation monitoring would be implemented until RAOs are met. For cost-estimating purposes, this monitoring was projected to continue for 30 years. The frequency of monitoring of less-contaminated areas would be decided during development of the remedial action work plan for the QFS.

Restrictions on groundwater and land use are identical to those in Alternative 3.

Activities performed under this alternative will not affect the Ladd Field National Historic Landmark District.

Capital Cost $5,796,000
Annual O&M Cost: $162,000
Total Cost (30-year present worth): $10,640,000

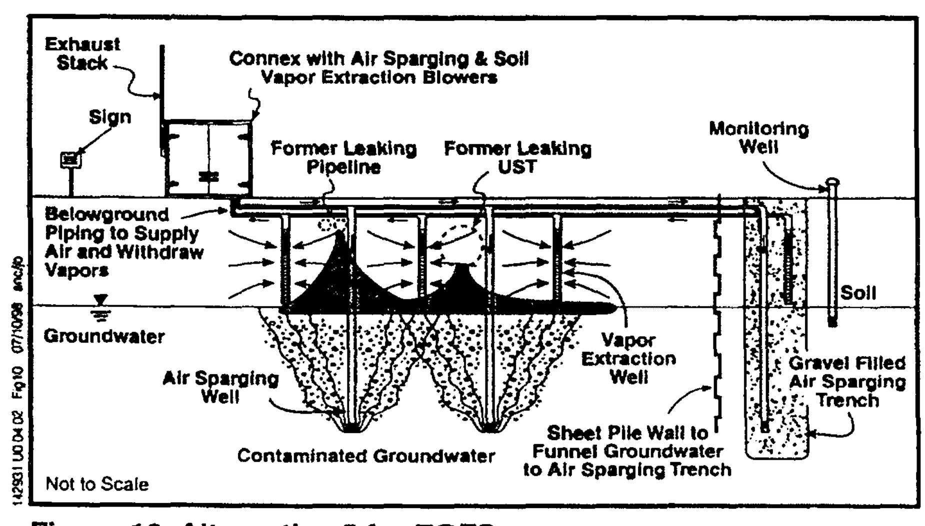

Figure 10. Alternative 5 for EQFS

5.4.6 Remedial Area 1A

The following are descriptions of the remedial alternatives for the Remedial Area 1A source area.

5.4.6.1 Alternative 1–No Action

Under the no-action alternative, no active remedial measures are used to address contamination. The no-action alternative does not include monitoring and site controls. Additionally, off-source migration would not be monitored or controlled.

Development of the no-action alternative is required by the NCP to provide a basis of comparison for the remaining alternatives. This alternative serves as a baseline by reflecting current conditions without any cleanup effort. The no-action alternative was evaluated consistently with NCP requirements. No present worth, capital, O&M, or groundwater monitoring costs are associated with the no-action alternative.

Capital Cost: $0
Annual O&M Cost: $0
Total Cost (30-year present worth): $0

5.4.6.2 Alternative 2–Institutional Controls

This alternative includes land-use and access restrictions. Soils containing petroleum and other contaminants will be cleaned up when the tanks are removed under the conditions in the Two-Party Agreement. Future land use is expected to be limited to activities associated with an inactive fuel terminal. Access restrictions would include maintaining the existing fence and posting signs. Land-use restrictions would be established and incorporated into the Fort Wainwright master plan and would be implemented and monitored through the institutional control SOPs. These restrictions are designed to limit the exposure of terrestrial wildlife and to control trespassing in the restricted area. For cost-estimating purposes, it is assumed that institutional controls would be maintained for 30 years.

Capital Cost: $8,000
Annual O&M Cost: $6,000
Total Cost (30-year present worth): $190,000

5.4.6.3 Alternative 3–Sampling, Soil Cover, and Revegetation with Institutional Controls

In this alternative, approximately four composite samples per tank and two samples at the tank outfall area would be collected. It is estimated that 600 cubic yards of topsoil would be placed on any existing lead-contaminated soils within the Remedial Area 1A area. Revegetation would reduce the exposure to lead-contaminated soil. The volume estimate was calculated assuming 10 feet around each tank area with soil cover to a depth of 6 inches. No additional sampling would be conducted after placement of the soil cover. The soil placement and revegetation could be performed in one construction season. This alternative also includes the same land-use and access restrictions as Alternative 2.

Capital Cost: $59,000
Annual O&M Cost: $6,000
Total Cost (30-year present worth): $240,000

5.4.6.4 Alternative 4–Excavation and Offsite Disposal of Lead-Contaminated Soil Through Defense Reutilization and Marketing Off ice to RCRA-Permitted Transport, Storage, and Disposal Facility

Under this alternative, about 1,200 cubic yards of lead-contaminated soil would be excavated. Most of this soil would have lead concentrations greater than 5 mg/L as measured by the TCLP, and would be transported to a RCRA-permitted facility for storage and disposal. The volume estimate was calculated assuming the soil to a distance of 10 feet from each tank would be excavated to a depth of 1 foot. Additional sampling would be performed to identify soils for removal and to refine the volume estimate before remediation. Cleanup confirmation soil samples would be collected at the completion of excavation. The remediation contractor would provide all equipment, services, and labor required to sample, excavate, transport, treat, and dispose of the soil at the offsite RCRA-permitted facility. Transport and disposal would be coordinated by the Defense Reutilization Marketing Office. This alternative could be performed in one construction season.

Capital Cost: $1,460,000
Annual O&M Cost: $0
Total Cost (30-year present worth): $1,460,000

SECTION 6

Summary of Comparative Analysis of Alternatives

In accordance with CERCLA, the alternatives for WQFS1 (five alternatives), WQFS2 (three alternatives), WQFS3 (three alternatives), EQFS (five alternatives), and Remedial Area 1A (four alternatives) were evaluated based on the nine criteria presented in the NCP. Table 10 lists the criteria. The first two criteria are known as threshold criteria and must be met by all selected remedial actions. The following five criteria are known as balancing criteria, and the final two criteria are referred to as modifying criteria.

TABLE 10
Criteria for Evaluation of Alternatives

THRESHOLD CRITERIA: Must be met by all selected alternatives.

1. **Overall protection of human health and the environment.** How well does the alternative protect human health and the environment, both during and after construction?
2. **Compliance with requirements.** Does the alternative meet all applicable or relevant and appropriate state and federal laws?

BALANCING CRITERIA: Used to compare alternatives.

3. **Long-term effectiveness and permanence.** How well does the alternative protect human health and the environment after completion of cleanup? What, if any, risks wiII remain at the site?
4. **Reduction of toxicity, mobility, and volume through treatment.** Does the alternative effectively treat the contamination to significantly reduce the toxicity, mobility, and volume of the hazardous substances?
5. **Short-term effectiveness.** Are there potential adverse effects to either human health or the environment during construction or implementation of the alternative? How long until remedial action objectives are achieved?
6. **Implementability.** Is the alternative both technically and administratively feasible? Has the technology been used successfully at similar areas?
7. **Cost.** What are the relative costs of the alternative?

MODIFYING CRITERIA: Evaluated as a result of public comments.

8. **State acceptance.** What are the state's comments or concerns about the alternatives considered and about the preferred alternative? Does the state support or oppose the preferred alternative?
9. **Community acceptance.** What are the community's comments or concerns about the alternatives considered and the preferred alternative? Does the community generally support or oppose the preferred alternative?

6.1 Subarea WQFS1

6.1.1 Threshold Criteria

6.1.1.1 Overall Protection of Human Health and the Environment

Alternative 1, the no-action alternative, would not limit exposure to contaminants or reduce contaminant levels, except through natural attenuation.

Alternative 2, institutional controls and monitored and evaluated natural attenuation, would provide controls protective of human health for on-post receptors only. It would not prevent migration of contaminants to the Chena River or provide protection for downgradient receptors. This alternative is not considered protective of the environment.

Alternative 3 would protect human health and the environment by reducing source location soil and groundwater contaminant levels to achieve remedial objectives, but would not actively address the contaminant plume in downgradient shallow groundwater.

Alternative 4 is similar to Alternative 3 in its level of protection of human health and the environment. However, Alternative 4 would treat the primary floating-product source area more rapidly than Alternative 3 would because of the potential addition of in situ soil heating. Alternative 4 would result in a faster reduction in the movement of contaminants from the source to the groundwater. Alternatives 3 and 4 would result in similar levels of protection, however.

Alternative 5 is the most protective of human health and the environment. It would provide more rapid treatment of the source areas through SVE/AS and potential enhancement of treatment through in situ soil heating. It also would provide a method to capture shallow contaminated groundwater that may result from small source areas that do not undergo source treatment. The downgradient AS trench would provide this additional protection, if necessary, for treating shallow groundwater until the smaller untreated source areas undergo natural attenuation. Consequently, Alternative 5 would provide protection to the Chena River much more quickly than the other alternatives. Deep groundwater would be addressed by source control and natural attenuation. Monitoring would determine when the RAOs are met, and institutional controls would prevent exposure of the groundwater until these objectives are achieved.

6.1.1.2 Compliance with ARARs

All alternatives, except Alternatives 1 and 2, are intended to achieve ARARs for source-area soil and groundwater and to reduce cancer risk from groundwater exposure for potential future residents. Alternatives 4 and 5 are expected to achieve source-area ARARs sooner than the other alternatives. Only Alternative 5 would address downgradient groundwater contamination outside of the source area. Residual contamination in the form of low-volatility petroleum hydrocarbons likely would remain in the source-area soil at concentrations above ADEC cleanup guidance.

6.1.2 Balancing Criteria

6.1.2.1 Long-Term Effectiveness and Permanence

Alternatives 1 and 2 would not reduce residual risk, except through natural attenuation over a long period of time. Alternatives 2 through 5 include groundwater monitoring, to evaluate contaminant movement and determine the rate of natural attenuation. Alternatives 3, 4, and 5 provide long-term effectiveness and permanence for soil and groundwater treatment of the source area. However, Alternative 5 may achieve the highest degree of effectiveness by intercepting and treating contaminant plumes in downgradient shallow groundwater. The results of the groundwater treatability studies will be evaluated to determine the effectiveness of these technologies.

6.1.2.2 Reduction of Toxicity, Mobility, and Volume Through Treatment

Alternatives 1 and 2 do not provide treatment and would not reduce toxicity, mobility, and volume in soil or groundwater. Alternative 2 does account for long-term contaminant reduction through natural attenuation.

Alternatives 3, 4, and 5 would significantly reduce the toxicity, mobility, and volume of soil and shallow-groundwater contamination in the source area. Alternative 5 is the only alternative that would reduce the toxicity, mobility, and volume of contaminant plumes in downgradient shallow groundwater through treatment. The toxicity, mobility, and volume of deep-groundwater contamination would be reduced through source control and natural attenuation.

6.1.2.3 Short-Term Effectiveness

Alternatives 1 and 2 do not provide treatment, therefore, they do not present additional adverse risks to workers or the community. Remedial objectives would be achieved through natural attenuation over a long time.

Risks to onsite workers and remedial contractors during the duration of construction for the installation and implementation of Alternatives 3, 4, and 5 would pose some short-term risk that can be minimized with appropriate controls and measures. With offgas treatment, risk to the community from these alternatives is considered to be the same as for baseline conditions. Alternative 3 is expected to achieve remedial objectives for soil in 5 years. Alternatives 4 and 5 would achieve most RAOs within 2 years because they would treat the hot spot more rapidly with in situ soil heating. Alternative 5 is expected to achieve remedial objectives for shallow groundwater outside the contaminant source area more quickly than any other alternative. In addition, Alternative 5 is most protective of the Chena River because it minimizes additional contaminant releases to the river in the short and long term

6.1.2.4 Implementability

All alternatives considered for WQFS1 are implementable. Source-area treatment technologies are considered reliable, and the equipment and trained specialists are available. In situ soil heating and the groundwater AS trench are considered new and innovative but are implementable. Alternatives 1 and 2 are considered the most implementable alternatives because of their simplicity. Alternatives 2 through 5 include groundwater monitoring, which is technically and administratively feasible. Equipment, specialists, and technology are readily available.

6.1.2.5 Cost

The total costs of the alternatives are summarized in Table 11, which is provided at the end of this section, and are based on the information available at the time the alternatives were developed. These costs are estimated for the purposes of comparison and are considered to be accurate within -30 to +50 percent. Costs are described by using the 30-year present-worth methodology with a discount rate equal to 5 percent. Costs estimates include direct, indirect capital costs, and annual O&M costs.

The cost of Alternative 1, no action, is $0. The cost of Alternative 2, institutional controls, is $2,180,000. Of the alternatives expected to significantly reduce source-area toxicity, mobility, and volume, Alternative 3, source-area treatment with SVE/AS, institutional controls, and monitored and evaluated natural attenuation, is the least expensive ($6,030,000). The cost for Alternative 4 is $7,100,000. The cost for Alternative 5, which provides reduction of toxicity, mobility, and volume in shallow downgradient groundwater, is $7,500,000 with soil heating and $6,540,000 without soil heating.

6.1.3 Modifying Criteria

6.1.3.1 State Acceptance

The State of Alaska has been involved with the development of the remedial alternatives for OU5 and concurs with the Army and the EPA in the selection of Alternative 5.

6.1.3.2 Community Acceptance

Although no official comments were received during the public comment period, community response to the preferred alternatives was generally positive.

6.2 Subarea WQFS2

6.2.1 Threshold Criteria

6.2.1.1 Overall Protection of Human Health and the Environment

Alternative 1, the no-action alternative, would not limit exposure to contaminants or reduce contaminant levels except through natural attenuation. Alternative 2, institutional controls, would provide controls protective of human health for potential on-post exposures only. It would not prevent migration of contaminants into the Chena River or protect potential downgradient users. These alternatives are not considered sufficiently protective of human health and the environment.

Alternative 3 is the most protective of human health and the environment because it addresses soil and shallow groundwater in the source area. This alternative treats the source area through SVE / AS, which would reduce the VOC migration to the groundwater and would also help to reduce floating-product migration to the Chena River. The continued operation of the downgradient AS curtain would further reduce the migration of these contaminants in the shallow groundwater to the Chena River. The level of contaminant migration to the Chena and the time to achieve remediation in the source area for this alternative would be significantly reduced compared to Alternatives 1 and 2. Monitoring would determine when the RAOs are met, and institutional controls would prevent exposure of the groundwater until these objectives are achieved.

6.2.1.2 Compliance with ARARs

Alternatives 1 and 2 would not achieve ARARs for soil and groundwater.

Alternative 3 is intended to achieve ARARs for soil and groundwater of contaminants in the source area and addresses dissolved contamination in shallow groundwater downgradient of the source area. Alternatives 2 and 3 address contamination in deep groundwater through monitored natural attenuation.

6.2.2 Balancing Criteria

6.2.2.1 Long-Term Effectiveness and Permanence

Alternatives 1 and 2 would not reduce residual risk except by natural attenuation over a long period of time. Alternatives 2 and 3 include groundwater monitoring for natural attenuation. Alternative 3 would provide long-term effectiveness and permanence by treating source-area soil and groundwater and intercepting and treating the contaminant plume in downgradient shallow groundwater. The results of the treatability study for the groundwater AS curtain in WQFS2 would be evaluated to determine the degree of effectiveness for this technology. The results of this treatability study are expected to be positive.

6.2.2.2 Reduction of Toxicity, Mobility, and Volume Through Treatment

Alternatives 1 and 2 do not provide treatment and would not reduce toxicity, mobility, and volume in soil or groundwater. Alternative 3 would significantly reduce the toxicity, mobility, and volume of soil and shallow-groundwater contamination in the source area and the contaminant plume in downgradient shallow groundwater.

6.2.2.3 Short-Term Effectiveness

Alternatives 1 and 2 would not provide treatment; therefore, they would not present additional adverse risks to workers or the community. Remedial objectives would be achieved through natural attenuation over a long time.

Risks to onsite workers and remedial contractors associated with the installation and implementation of Alternative 3 could be minimized with appropriate controls and protective measures. With offgas treatment, risk to the community for these alternatives is considered to be the same as for baseline conditions. Alternative 3 is expected to achieve RAOs for source-area contamination in 5 years. Alternative 3 is most protective of the Chena River because it minimizes additional contaminant releases to the river.

6.2.2.4 Implementability

All alternatives considered for the WQFS2 source-area treatment are implementable; the technologies are considered reliable; and the equipment and tiained specialists are available. The treatability study of the groundwater AS curtain would be evaluated to determine curtain implementability and effectiveness. Alternatives 1 and 2 are considered the most implementable alternatives because of their simplicity. Alternatives 2 and 3 include groundwater monitoring, which is technically and administratively feasible. Equipment, specialists, and technology are readily available.

6.2.2.5 Cost

The cost for Alternative 1, no action, is $0. The cost for Alternative 2, institutional controls, is $1,330,000. Alternative 3, the only alternative expected to significantly reduce the toxicity, mobility, and volume of source-area and downgradient groundwater, is estimated to cost $2,800,000.

6.2.3 Modifying Criteria

6.2.3.1 State Acceptance

The State of Alaska has been involved with the development of the remedial alternatives for OU5 and concurs with the Army and the EPA in the selection of Alternative 3.

6.2.3.2 Community Acceptance

Although no official comments were received during the public comment period, community response to the preferred alternatives was generally positive.

6.3 Subarea WQFS3

6.3.1 Threshold Criteria

6.3.1.1 Overall Protection of Human Health and the Environment

Alternative 1, the no-action alternative, would not limit exposure to contaminants or reduce contaminant levels, except through natural attenuation. Because no monitoring occurs in this alternative, the degree of protection would not be known.

Alternative 2, institutional controls, would provide controls protective of human health for potential on-post exposures only. However, Alternative 2 would not prevent migration of contaminants into the Chena River or provide protection of downgradient receptors. These alternatives are not considered sufficiently protective of human health and the environment.

Alternative 3 is the most protective to human health and the environment. It provides active treatment of the source area by SVE / AS, which is expected to immediately reduce the migration of contaminants to the groundwater and achieve RAOs in about 5 years. The level of contaminant migration to the Chena River and the time to achieve remediation in the source area for this alternative would be significantly reduced compared to Alternatives 1 and 2. There would be no active treatment of the groundwater outside the source area. However, natural attenuation is expected to lower the concentrations that reach the Chena River and eventually result in groundwater that meets RAOs throughout the source area. Monitoring would determine when the RAOs are met, and institutional controls would prevent exposure of the groundwater until these objectives are achieved.

6.3.1.2 Compliance with ARARs

Alternatives 1 and 2 would not achieve ARARs for soil and groundwater.

Alternative 3 is intended to achieve ARARs for soil and groundwater of the contaminants in the source area. It addresses dissolved contamination in downgradient groundwater through monitored and evaluated natural attenuation.

6.3.2 Balancing Criteria

6.3.2.1 Long-Term Effectiveness and Permanence

Alternatives 1 and 2 do not reduce residual risk except through natural attenuation over a long time. Alternative 2 includes groundwater monitoring for natural attenuation. Alternative 3 would provide long-term effectiveness for source-area soil and groundwater through treatment and addresses the contaminant plume in shallow groundwater outside the source area through monitored and evaluated natural attenuation.

6.3.2.2 Reduction of Toxicity, Mobility, and Volume Through Treatment

Alternatives 1 and 2 do not provide treatment and would not reduce toxicity, mobility, and volume in soil or groundwater. Alternative 2 would account for long-term contaminant reduction through natural attenuation.

Alternative 3 would significantly reduce the toxicity, mobility, and volume of soil and shallow-groundwater contamination in the source area. It addresses the toxicity, mobility, and volume of the groundwater contaminant plume outside the source area through monitored and evaluated natural attenuation.

6.3.2.3 Short-Term Effectiveness

Alternatives 1 and 2 do not provide treatment; therefore, they would not present additional adverse risks to workers or the community. Remedial objectives would be achieved through natural attenuation over a long time.

Risks to onsite workers and remedial contractors associated with the installation and implementation of Alternative 3 could be minimized with appropriate controls and protective measures. With offgas treatment, risk to the community from these alternatives is considered to be the same as for baseline conditions. Alternative 3 is expected to achieve RAOs for source-area contamination in 5 years. In addition, Alternative 3 would reduce contaminant load to the river in the interim.

6.3.2.4 Implementability

All alternatives considered for WQFS3 source-area treatment are implementable; the technologies are considered reliable; and equipment and trained specialists are available. Alternatives 1 and 2 are considered the most implementable because of their simplicity. Alternatives 2 and 3 include groundwater monitoring, which is technically and administratively feasible. Equipment, specialists, and technology are readily available.

6.3.2.5 Cost

The cost for Alternative 1, no action, is $0. The cost for Alternative 2, institutional controls and monitored and evaluated natural attenuation, is $1,160,000. The cost for Alternative 3 is $1,390,000.

6.3.3 Modifying Criteria

6.3.3.1 State Acceptance

The State of Alaska has been involved with the development of the remedial alternatives for OU5 and concurs with the Army and the EPA in the selection of Alternative 3.

6.3.3.2 Community Acceptance

Although no official comments were received during the public comment period, community response to the preferred alternatives was generally positive.

6.4 EQFS Source Area

6.4.1 Threshold Criteria

6.4.1.1 Overall Protection of Human Health and the Environment

Alternative 1, the no-action alternative, would not limit exposure to contaminants or reduce contaminant levels except through natural attenuation. Alternative 1 is not considered sufficiently protective of human health and the environment.

Alternative 2, continued operation of the Building 1060 SVE / AS treatability study system, institutional controls, and monitored and evaluated natural attenuation, is considered sufficiently protective of human health and the environment. Benzene and TCE concentrations in the shallow groundwater adjacent to the Chena River are currently below MCLs. In contrast to WQFS, EQFS presents minimal potential for contamination to move off post. Continued operation of the Building 1060 SVE / AS treatability study system would reduce the TCE concentrations in this hot spot. A longer time period would be required to achieve RAOs in other hot spots that would not be actively treated and in the deep groundwater. However, institutional controls would prevent human exposure to these areas of elevated groundwater contamination while natural attenuation is occurring. Monitoring would be conducted to determine the progress of natural attenuation and to determine the length of time that the institutional controls would need to be in place.

Alternative 3 would protect human health and the environment by reducing the levels of soil and groundwater contaminants in the source area to achieve remedial objectives, but does not actively address contaminant plumes in downgradient shallow groundwater. This alternative would achieve RAOs in the source area more rapidly than Alternative 2 would, but would not be more protective in the long term.

Alternatives 4 and 5 would achieve RAOs in the groundwater outside the source area more rapidly than other alternatives would. They would achieve RAOs within the source area more rapidly than Alternative 2 would. In the long term, however, they are not expected to be more protective of human health and the environment than Alternative 2.

6.4.1.2 Compliance with ARARs

Alternative 1, the no-action alternative, may achieve soil and groundwater ARARs over a very long time because of natural attenuation; however, it would not provide protection of human health and the environment during that time. Alternatives 2 and 3 are intended to achieve ARARs for soil and groundwater in the source area and to reduce cancer risk from groundwater exposure for potential future residents.

Alternative 2, continued operation of the Building 1060 SVE / AS treatability study system, institutional controls, and monitored and evaluated natural attenuation, would take the longest to achieve ARARs; however, groundwater-use restrictions would be sufficiently protective of human health while natural attenuation proceeded. Because the contaminant concentrations are lower in EQFS, the contaminants are not intersecting the Chena River and they appear to be biodegrading. ARARS could be met effectively with Alternative 2.

Alternatives 4 and 5 are intended to achieve ARARs for soil and groundwater in the hot spot and also to address dissolved contamination in shallow groundwater downgradient of the source. The preferred method for remediating deep groundwater is monitored and evaluated natural attenuation.

6.4.2 Balancing Criteria

6.4.2.1 Long-Term Effectiveness and Permanence

Alternative 1 would not reduce residual risk except through natural attenuation over a long time. Alternative 2 would provide long-term effectiveness and permanence for soil and groundwater of the hot spot at Building 1060 and would reduce residual risk in other source areas through natural attenuation. Alternatives 2 through 5 include groundwater monitoring for natural attenuation.

Alternatives 3, 4, and 5 would provide long-term effectiveness and permanence for treatment of source-area soil and groundwater. However, Alternatives 4 and 5 would achieve the highest degree of effectiveness by intercepting and treating contaminant plumes in downgradient shallow groundwater.

6.4.2.2 Reduction of Toxicity, Mobility, and Volume Through Treatment

Alternative 1 does not provide treatment; therefore, it would not reduce toxicity, mobility, and volume in soil or groundwater except through natural attenuation.

Alternative 2 would provide treatment in the area of the Building 1060 SVE / AS treatability study system, significantly reducing toxicity, mobility, and volume of contaminants in the soil and groundwater in that area. In addition, Alternative 2 would reduce toxicity, mobility, and volume of contaminants in soil and groundwater in other areas of EQFS through natural attenuation.

Alternatives 3, 4, and 5 would significantly reduce the toxicity, mobility, and volume of soil and shallow-groundwater contamination in the source area. Alternatives 4 and 5 would reduce the toxicity, mobility, and volume of contaminated plumes in downgradient groundwater.

6.4.2.3 Short-Term Effectiveness

Alternative 1 does not provide treatment; therefore, it would not present additional adverse risks to workers or the community. Remedial objectives would be achieved over a long time through natural attenuation.

Alternative 2 would provide continued operation of the Building 1060 SVE / AS treatability study system. This system has operated successfully, and there are no increased short-term risks from its continued operation. This alternative is expected to achieve RAOs in the Building 1060 treatment area within 5 years. At the Chena River, cleanup goals are expected to be met in less than 5 years. Outside of the active treatment area, Alternative 2 would achieve RAOs over a longer time than in Alternatives 3, 4, and 5. However, as discussed previously, short-term risks would be addressed by institutional controls and natural attenuation.

Risks to onsite workers and remedial contractors associated with the installation and implementation of Alternatives 3, 4, and 5, are essentially the same, and could be minimized with appropriate controls and protective measures. With offgas treatment, risk to the community for these alternatives is considered to be the same as for baseline conditions. Alternatives 3, 4, and 5 are expected to achieve remedial objectives for soil and shallow groundwater in the source area within 5 years.

6.4.2.4 Implementability

Alternatives 1 and 2 are considered the most implementable because of their simplicity. Because contaminant concentrations are lower and because of the extensive underground infrastructure in EQFS, construction and operation of active treatment systems would be more difficult and less effective. Source-area treatment in Alternatives 3, 4, and 5 is considered implementable and effective. The downgradient groundwater AS trench and the funnel and gate technologies in Alternatives 4 and 5 are considered new and innovative. The Army is currently conducting a laboratory treatability study of the groundwater AS trench to evaluate the effectiveness of this technology.

6.4.2.5 Cost

The cost of Alternative 1, no action, is $0. The cost of Alternative 2, continued operation of the Building 1060 SVE / AS treatability study system, institutional controls, and monitored and evaluated natural attenuation, is $1,290,000. Of the alternatives expected to significantly reduce toxicity, mobility, and volume, Alternative 3, source treatment with SVE / AS, institutional controls, and monitored and evaluated natural attenuation, is the least expensive ($8,760,000). Alternatives 4 and 5 would provide additional reduction of toxicity, mobility, and volume in downgradient shallow groundwater and cost $10,460,000 and $10,640,000, respectively.

6.4.3 Modifying Criteria

6.4.3.1 State Acceptance

The State of Alaska has been involved with the development of the remedial alternatives for OU5 and concurs with the Army and the EPA in the selection of Alternative 2.

6.4.3.2 Community Acceptance

Although no official comments were received during the public comment period, community response to the preferred alternatives was generally positive.

6.5 Remedial Area 1A

6.5.1 Threshold Criteria

6.5.1.1 Overall Protection of Human Health and the Environment

Alternative 1 would not provide protection of human health or environmental receptors. Alternative 2 and Alternative 3 would reduce the risk to human health and ecological receptors by reducing exposure to onsite contamination. These alternatives would meet the RAO of minimizing direct contact with lead-contaminated soils containing more than 1,000 mg/kg of lead. Alternative 4 would provide the greatest protection of human health and the environment by permanently eliminating the contaminants in the soil.

6.5.1.2 Compliance with ARARs

RCRA is an ARAR for all four alternatives. Alternative 1 would not meet compliance with RCRA as an ARAR. Alternatives 2 and 3 would meet compliance with ARARs to the extent that the RCRA corrective action permit for Fort Wainwright would integrate these alternatives into permit requirements.

Guidance from the EPA Region 9 suggests no direct contact with lead-contaminated soil that has concentrations grater than 1,000 mg/kg. Alternatives 2, 3, and 4 meet the criteria of this guidance. Alternative 4 would meet ARARs associated with disposal of lead-contaminated soils.

6.5.2 Balancing Criteria

6.5.2.1 Long-Term Effectiveness and Permanence

Alternative 1 does not meet the intent of this criterion. Alternatives 2 and 3 would not permanently eliminate long-term risks. However, the risk is controlled if current land-use scenarios and access restrictions are maintained for both alternatives. Alternative 4 would permanently eliminate risks related to lead-contaminated soil.

6.5.2.2 Reduction in Toxicity, Mobility, and Volume Through Treatment

Alternatives 1, 2, and 3 would not actively reduce the toxicity, mobility, and volume of contaminants at Remedial Area 1A. Alternative 4 would permanently reduce the toxicity and mobility of the contaminated soil.

6.5.2.3 Short-Term Effectiveness

Remedial activities for Alternatives 3 and 4 would create short-term impacts (dust) that would require readily available controls. There are no short-term impacts for Alternatives 1 and 2. The time required to implement Alternative 2 would be minimal. Alternative 3 would require a small amount of lead time. Alternative 4 would take the longest to implement, but could be conducted in one construction season.

6.5.2.4 Implementability

All the remedial alternatives are readily implementable.

6.5.2.5 Cost

The cost of Alternative 1, no action, is $0. The cost of Alternative 2, institutional controls is $190,000. The cost of Alternative 3, sampling, soil cover, and revegetation with institutional controls, is $240,000. Alternative 4, excavation and offsite disposal of lead-contaminated soil through Defense Reutilization and Marketing Office to RCRA-Permitted transport, storage, and disposal facility, is the most expensive alternative at $1,460,000.

6.5.3 Modifying Criteria

6.5.3.1 State Acceptance

The State of Alaska has been involved with the development of the remedial alternatives for OU5 and concurs with the Army and the EPA in the selection of Alternative 2.

6.5.3.2 Community Acceptance

Although no official comments were received during the public comment period, community response to the preferred alternatives was generally positive.

TABLE 11
WQFS, EQFS, and Remedial Area 1A Cost Comparison

	Alternative	Capital Cost ($)	Average Annual O&M Cost ($)	30-Year Present-Worth Total Cost ($)
Chena River Aquatic Assessment				
[redacted]				
Subarea WQFS1				
1	No Action	0	0	0
2	Institutional Controls and Monitored and Evaluated Natural Attenuation	88,000	70,000	2,180,000
3	Source Area Treatment with Soil Vapor Extraction and Air Sparging, Institutional Controls, and Monitored and Evaluated Natural Attenuation	3,371,000	89,000	6,030,000
4	Alternative 3 with Potential In Place Soil Heating at Source Areas	3,650,000	115,000	7,100,000
[redacted]				
5	Alternative 5 Without Soil Heating	3,220,000	111,000	6,540,000
Subarea WQFS2				
1	No Action	0	0	0
2	Institutional Controls and Monitored and Evaluated Natural Attenuation	60,000	42,000	1,330,000
[redacted]				
Subarea WQFS3				
1	No Action	0	0	0
2	Institutional Controls and Monitored and Evaluated Natural Attenuation	71,000	36,000	1,160,000
[redacted]				

TABLE 11
WQFS, EQFS, and Remedial Area 1A Cost Comparison

	Alternative	Capital Cost ($)	Average Annual O&M Cost ($)	30-Year Present-Worth Total Cost ($)
EQFS Area				
1	No Action	0	0	0
[redacted]				
3	Alternative 2 with Additional SVE/AS	5,160,000	120,000	8,760,000
4	Alternative 3 with Downgradient Air Sparging Trench	5,378,000	169,000	10,460,000
5	Alternative 3 with Downgradient Funnels and Gates and an Air Sparging Trench	5,796,000	162,000	10,640,000
Remedial Area 1A				
1	No Action	0	0	0
[redacted]				
3	Sampling, Soil Cover, and Revegetation with Institutional Controls	59,000	6,000	240,000
4	Excavation and Offsite Disposal of Lead-Contaminated Soil Through Defense Reutilization and Marketing Office to RCRA-Permitted Transport, Storage, and Disposal Facility	1,460,000	0	1,460,000
[redacted]				

Notes:
1. Costs are based on a 30-year present-worth analysis.
2. Discount rate applied is 5%.

[redacted] = Selected remedy

SECTION 7

Selected Remedy

The selected remedies for WQFS, EQFS, and Remedial Area 1A were chosen on the basis of the nine remedial alternative evaluation criteria found in the NCP as described in Section 6. The selected remedies for WQFS1, WQFS2, WQFS3; EQFS; and Remedial Area 1A are presented in this section.

Natural attenuation is a component of the selected remedies for EQFS and all WQFS source areas. These remedies also include the fundamental components of active remediation and performance monitoring combined with institutional controls to ensure protection of human health and the environment until contaminant concentrations are consistent with unrestricted land use. The use of monitored natural attenuation was evaluated with the same rigor as were other viable remedial approaches, and will result in achieving goals of source control and returning groundwater to its beneficial use.

Site-specific sampling and data analysis have been conducted to characterize the nature and rates of natural attenuation processes at these source areas. Performance monitoring will continue as long as contamination remains above required cleanup levels.

General response actions have not been developed for Chena River sediment or surface water below the water line. Because sediment excavation or other treatment technologies implemented in the river could result in significant degradation or destruction of habitat, it was agreed by the three parties identified in the FFA and through consultation with the Alaska Department of Fish and Game that active remediation of surface water and sediment below the water line will not be attempted. Instead, the approach for reducing concentration of COCs and achieving RAOs in Chena River sediment and water at OU5 will be to reduce sources of contaminant releases to the river through remedial activities at contributing source areas and to continue the Chena River Aquatic Assessment Program.

7.1 Selected Remedies

7.1.1 Chena River Aquatic Assessment

After the postwide and the OU5-specific risk assessments were completed, it was determined that an aquatic assessment should be conducted.

This postwide sampling program, called the Chena River Aquatic Assessment Program, is currently being implemented. The following are the major components of this program:

- Performing an aquatic assessment of the Chena River during the spring and fall. This assessment includes collecting water, sediment, and detritus (organic leaf litter) samples and analyzing them for contaminants of concern and water chemistry.

- Collecting benthic macroinverteb rates such as insects and larvae and analyzing them through toxicological studies and bioassays

- Determining reductions of contaminant load into the Chena River from remedial actions and associated changes to aquatic organisms

Possible remedial actions will be considered later if further evaluation of impacts to the river shows unacceptable risks to aquatic organisms.

It is assumed that contaminant load and associated impacts to the Chena River will be reduced through the selected remedial actions for the QFS areas. The aquatic assessment program is designed to establish a baseline for water quality, contaminant concentrations, and loading and ecological conditions and to measure changes in these parameters through time. The data will be evaluated to identify trends and ensure remedial objectives are being met. Results and progress will be evaluated during the 5-year review. During the first full-term 5-year review from the signature date of the OU5 ROD, if the data or other information not considered in the development of this ROD indicates significant impacts to the Chena River, other remedial alternatives or assessment measures win be evaluated by the Army and presented to the regulatory agencies through a technical memorandum generated within 6 months of the 5-year review date.

The total estimated 30-year present worth of this sampling program is $1,560,000, based on a biennial cost of $350,000 for 10 years. For cost-estimating purposes, it has been assumed that the postwide sampling program will be implemented every other year for 10 years. The frequency and scope of sampling will be reviewed following the 1998 field season.

7.1.2 Institutional Controls

Institutional controls are a component of the selected remedy for WQFS, EQFS, and Remedial Area 1A. The definition of institutional controls as specified in the NCP at 40 CFR 300.430(a)(1)(iii)(D) is incorporated by reference into this ROD.

The FFA reflects the intent to have the ROD for OU5 serve as a comprehensive sitewide document (see FFA, Attachment 1, page 6). The institutional-control actions at Fort Wainwright will apply on a sitewide basis to all areas, including those in OUs 1, 2, 3, 4 and 5. The ROD requires the U.S. Army Alaska (USARAK) to develop standard operating procedures (SOPs) to identify all land areas under restriction; identify the objectives that must be met by the restrictions; and specify the particular restrictions, controls, and mechanisms that will be used to achieve the identified objectives. These SOPs are intended to help assure that the institutional controls selected in this and other OU RODs at Fort Wainwright are carried out and remain in place until the EPA, ADEC, and USARAK determine they are no longer needed to protect the public and the environment. Upon concurrence by the EPA and ADEC, the SOPs will be incorporated by adoption as part of the OU5 ROD, to serve as a single sitewide source documenting all institutional controls being implemented at Fort Wainwright. The SOPs are a component of this ROD and must, at a minimum, include the following elements:

- USARAK has developed institutional control SOPs, with concurrence by the EPA and ADEC, that apply to each OU at Fort Wainwright that has an institutional control as a component of the selected remedy in the OU ROD. Components of the SOPs are a database with tracking mechanism that identifies all land areas under restriction (for example, use of a master base plan, master post maps, or a certified survey plat); the objectives to be met by the restrictions; and the particular restrictions, controls, and mechanisms that will be used to achieve the identified objectives.

- Activities required by the SOPs are included as a component of the operable unit remedy cost.

- USARAK will monitor compliance with the SOPs, which with concurrence of all the parties could be modified to accommodate minor substantive changes, on an annual basis throughout the time the ROD-required institutional controls are in effect, unless another monitoring frequency is specified by unanimous agreement among the EPA, ADEC, and USARAK.

- USARAK will notify both the EPA and ADEC before any change in a previously identified land-use designation or restriction or a specific required activity.

- USARAK, as part of the O&M report for each OU, will assess the condition of areas at Fort Wainwright subject to institutional controls. These inspections will determine the effectiveness and protectiveness of all institutional controls and designated land uses, and will ascertain whether the current land and groundwater uses in the area are consistent with the institutional controls and all RAOs outlined in the relevant decision document governing that site or OU. Results of any field inspection will be documented in the annual O&M report submitted for the OU pursuant to the remedial action report.

- USARAK will notify the EPA and ADEC immediately on discovery of any unauthorized activity that is inconsistent with the institutional-control SOPs. The USARAK will issue a stop work or stop activity notice on discovery of any unauthorized work. The stop work or stop activity notice will remain effective until the EPA, ADEC, and USARAK determine a plan of action to resolve the unauthorized change.

- USARAK will notify the EPA and ADEC at least 6 months in advance about any transfer, by sale or lease, of areas of Fort Wainwright that are subject to institutional controls, to ensure adoption of such additional measures as may be needed to assure continued compliance with institutional controls on such transferred property. Before actual transfer of land management responsibilities to the Bureau of Land Management or another federal agency or department or to a private party, the Army will provide such transferee a written copy of installation master-planning documentation that identifies all institutional controls remaining in force.

- SOPs will be a component of the 5-year review process.

7.1.3 Subarea WQFS1

Alternative 5 is the selected remedy for WQFS1 because it best controls risk pathways and provides protection of human health and the environment. Expansion of existing proven technology will permanently reduce VOC contaminants in soil and groundwater. In situ soil heating will increase the remediation rate. A downgradient AS trench will intercept and control contaminant migration the Chena River. Monitoring and evaluation of natural attenuation will assist in projecting remediation time frames. Institutional controls will ensure interim protection. This alternative meets ARARs and is cost-effective. Alternative 5 includes the following:

- Operating an SVE / AS system to address solvent and petroleum contamination in the source-area soil and groundwater and the floating-product contamination. The source area SVE / AS system can be tailored to strip VOCs from groundwater and soil and to enhance biological degradation of contaminants in saturated- and vadose-zone soils while minimizing vadose-zone desiccation. An existing system, used for a treatability study, will be expanded to address the source area. The SVE system will include offgas treatment. Before operation of the SVE / AS system begins, abandoned buried fuel pipelines within the subarea will be purged of residual fuel to eliminate the potential for the lines to act as ongoing contaminant sources.

- Potential in situ heating at hot spots is proposed as a method to increase the rate of remediation in comparison to source-area treatment without heating. In the event that AS is ineffective in achieving progressive reduction of the VOC and petroleum hydrocarbon concentrations in soils, in situ soil heating is proposed as a means to increase the movement of VOCs and make them easier to extract. Treatability studies involving radio-frequency soil heating and six-phase soil heating have been initiated in WQFS1 to evaluate the potential to enhance performance of AS and SVE.

- Potentially supplementing the AS and SVE with the operation of a downgradient groundwater AS trench, if necessary, to intercept and treat dissolved contaminants migrating from source areas downgradient toward the Chena River.

- Establishing and maintaining institutional controls to ensure that until federal and state MCLs are attained, the groundwater will not be used as a potable water source. Institutional controls include restrictions governing site access, onsite construction, and well development or placement. They will be necessary as long as hazardous substances remain onsite at levels that preclude unrestricted use. Current and future land use is industrial; current and future groundwater use is designated for residential use. Groundwater- and land-use restrictions will be incorporated into the Fort Wainwright master plan. Administrative components of these institutional controls are discussed further in Section 7.1.2.

- Monitoring of the natural attenuation of COCs in groundwater to track decreases in concentrations to below ARARs and achievement of RAOs. The possible rebound of contaminant concentrations after operation of remediation technologies has ceased also will be monitored.

- Monitoring the performance of remedial treatment systems, as described above, to optimize treatment system effectiveness and efficiency through system modifications and/or enhancements as appropriate

- Monitoring and evaluation of the selected remedy, including natural attenuation, to determine achievement of RAOs

- Monitored natural attenuation for deep groundwater and areas not being actively treated within WQFS1

It is estimated that Alternative 5 will meet RAOs in the source area in 2 years and at the Chena River in more than 10 years. Elimination of the source-area petroleum and VOC contamination in the soil by AS and SVE with soil heating will minimize further contamination of the groundwater. Use of the AS trench for removal of COCs from the groundwater and soil will prevent continued contamination of the Chena River.

The total estimated 30-year present worth of this alternative with soil heating is $7,500,000, including $3,610,000 for capital costs and $130,000 annually for O&M, groundwater monitoring, and final decommissioning costs.

The total estimated 30-year present worth of this alternative without heating is $6,540,000, including $3,220,00 for capital costs and $111,000 annually for O&M, groundwater monitoring, and final decommissioning costs.

7.1.4 Subarea WQFS2

Alternative 3 is the selected remedy for WQFS2 because it best controls pathways of risk to human health and the Chena River aquatic receptors. Alternative 3 treats solvent and VOC contamination with SVE / AS treatment in hot spots and continued operation of an AS curtain to enhance removal actions completed in spring 1998. Groundwater monitoring and evaluation will be used to monitor natural attenuation of dissolved-phase contaminants in groundwater. Institutional controls including groundwater and land-use restrictions will control pathways of exposure. Alternative 3 is expected to meet ARARs and is cost-effective. Alternative 3 includes the following:

- Installing an SVE / AS system to address solvent- and petroleum-contaminated hot spots in the soil and groundwater and floating-product contamination, The hot-spot SVE / AS system can be tailored to strip VOCs from groundwater and soil and to enhance biological degradation of contaminants in saturated- and vadose-zone soils. The SVE system will include offgas treatment. Before operation of the AS and SVE system begins, abandoned buried fuel pipelines within the subarea will be purged of residual fuel to eliminate the potential for the lines to act as ongoing contaminant sources.

- Continuing to operate a downgradient AS curtain to intercept and remove dissolved-phase contaminants from the groundwater, thus minimizing potential impacts to the Chena River.

- Conducting groundwater monitoring to determine whether cleanup levels are achieved and maintained downgradient of the AS curtain.

- Establishing and maintaining institutional controls to ensure that until federal and state MCLs are attained, the groundwater will not be used, except for activities undertaken to initiate the selected remedies detailed in this ROD. Institutional controls include restrictions governing site access, onsite construction, and well development or placement. They will be necessary as long as hazardous substances remain onsite at levels that preclude unrestricted use. Current and future land use is industrial; current and future groundwater use is designated for residential use. Groundwater- and land-use restrictions will be incorporated into the Fort Wainwright master plan. Administrative components of these institutional controls are discussed further in Section 7.1.2.

- Monitoring of the natural attenuation of COCs in groundwater to track decreases in concentrations to below ARARs and achievement of RAOs. The possible rebound of contaminant concentrations after operation of remediation technologies has ceased also will be monitored.

- Monitoring performance of remedial treatment systems, as described above, to optimize treatment system effectiveness and efficiency through system modifications and/or enhancements as appropriate

- Monitoring and evaluation of the selected remedy, including natural attenuation, to determine achievement of RAOs

- Monitored natural attenuation for deep groundwater and areas not being actively treated within WQFS2

Alternative 3 is expected to meet the RAOs in the treated source area in 5 years and at the Chena River in 5 to 10 years. The hot-spot SVE / AS treatment system and the downgradient groundwater AS curtain are intended to intercept and remove dissolved-phase contaminants from the groundwater, thus minimizing potential impacts to the Chena River. Groundwater monitoring will be conducted to determine whether cleanup levels are achieved and maintained by the hot-spot SVE / AS system and continued operation of the downgradient groundwater AS curtain.

The total estimated 30-year present worth of this alternative is $2,800,000, including $1,070,000 for capital and $60,000 annually for O&M, groundwater monitoring, and final decommissioning costs.

7.1.5 Subarea WQFS3

Alternative 3 is the selected remedy for WQFS3 because it best controls risk pathways, thereby protecting human health and the environment. Information already gained from treatability studies in WQFS1 will be used during removal of solvent and VOC petroleum hydrocarbons from soil and groundwater in hot spots with SVE /AS treatment. Alternative 3 is expected to meet ARARs and be implementable and cost-effective. Institutional controls will ensure protective use for site access, onsite construction, and well development or placement. Alternative 3 includes the following:

- Installing AS and SVE wells to address solvent- and petroleum-contaminated hot spots in the soil and groundwater and floating-product contamination. The hot-spot SVE / AS system can be tailored to strip VOCs from groundwater and soil and to enhance biological degradation of contaminants in saturated- and vadose-zone soils. The SVE system will include offgas treatment. AS and SVE wells are located in the contaminant hot spot. Before operation of the SVE / AS system begins, abandoned buried fuel pipelines within the subarea will be purged of residual fuel to eliminate the potential for the lines to act as ongoing contaminant sources.

- Establishing and maintaining institutional controls to ensure that until federal and state MCLs are attained, the groundwater will not be used, except for activities undertaken to initiate the selected remedies detailed in this ROD. Institutional controls include restrictions governing site access, onsite construction, and well development or placement. They will be necessary as long as hazardous substances remain onsite at levels that preclude unrestricted use. Current and future land use is industrial; current and future groundwater use is designated for residential use. Groundwater- and land-use restrictions will be incorporated into the Fort Wainwright master plan. Administrative components of these institutional controls are discussed further in Section 7.1.2.

- Monitoring of the natural attenuation of COCs in groundwater to track decreases in concentrations to below ARARs and achievement of RAOs. The possible rebound of contaminant concentrations after operation of remediation technologies has ceased also will be monitored.

- Monitoring the performance of remedial treatment systems as described above, to optimize treatment system effectiveness and efficiency through system modifications and/or enhancements as appropriate

- Monitoring and evaluation of the selected remedy, including natural attenuation, to determine achievement of RAOs

- Monitored natural attenuation for deep groundwater and areas not being actively treated within WQFS3

Alternative 3 is expected to meet RAOs in the treated source area in 5 years and at the Chena River in 5 to 10 years. Elimination of the hot spots of petroleum and VOC contamination in the soil by AS and SVE will minimize further contamination of the groundwater and prevent continued contamination of the Chena River.

The total estimated 30-year present worth of this alternative is $1,390,000, including $440,000 for capital and $30,000 annually for O&M, groundwater monitoring, and final decommissioning costs.

7.1.6 EQFS Source Area

Alternative 2 is the selected remedy for EQFS because it best controls the risk pathways for soil and groundwater through continued operation of an existing treatment system that has proven effective. In addition, monitoring for natural attenuation parameters to track decreases in dissolved-phase contaminants and the implementation of institutional controls to limit future land and groundwater use make this alternative protective, implementable, and cost-effective. Alternative 2 includes the following:

- Continuing to operate the AS and SVE wells of the Building 1060 SVE / AS treatability study system to address solvent- and petroleum-contaminated hot spots in the soil and groundwater and floating-product contamination. The SVE system includes offgas treatment.

- Establishing and maintaining institutional controls to ensure that until federal and state MCLs are attained, the groundwater will not be used, except for activities undertaken to initiate the selected remedies detailed in this ROD. Institutional controls include restrictions governing site access, onsite construction, and well development or placement. They will be necessary as long as hazardous substances remain onsite at levels that preclude unrestricted use. Current and future land use is industrial; current and future groundwater use is designated for residential use. Land-use restrictions include limiting future land use to operations currently being conducted at the source area. Groundwater- and land-use restrictions will be incorporated into the Fort Wainwright master plan. Administrative components of these institutional controls are discussed further in Section 7.1.2.

- Monitoring of the natural attenuation of COCs in groundwater to track decreases in concentrations to below ARARs and achievement of RAOs. The possible rebound of contaminant concentrations after operation of remediation technologies has ceased also will be monitored.
- Monitoring the performance of remedial treatment systems, as described above, to optimize treatment system effectiveness and efficiency through system modifications and/or enhancements as appropriate
- Monitoring and evaluation of the selected remedy, including natural attenuation, to determine achievement of RAOs
- Monitored natural attenuation for deep groundwater and areas not being actively treated within EQFS

Alternative 2 is expected to meet RAOs in the treatability study area in 5 years. Elimination of hot spots of VOC and petroleum contamination in the soil by SVE / AS treatability study at Building 1060 will minimize further contamination of the groundwater. Monitored and evaluated natural attenuation also has been proven effective in reducing contaminant concentrations.

The total estimated 30-year present worth of this alternative is $1,290,000, including $220,000 for capital and $35,000 annually for O&M, groundwater monitoring, and final decommissioning costs.

7.1.7 Remedial Area 1A

Alternative 2 is the selected remedy under current land-use scenarios for the lead-contaminated soil in Remedial Area 1A. This alternative best meets the nine CERCLA criteria by minimizing the exposure pathways with a remedy that meets ARARs and is implementable and cost-effective. The main component of Alternative 2, institutional controls, includes land-use and access restrictions that are considered protective of human health and the environment under current land use. Soils containing petroleum and other contaminants will be cleaned up when the tanks are removed under the conditions of the Two-Party Agreement.

Alternative 2 will control exposure and eliminate potential risk to human health and the environment. Onsite future uses and human access will be controlled by imposing land-use restrictions, posting warning signs, and maintaining existing fencing of contaminated areas. Fencing is sufficient to prevent access to lead-contaminated soils and potential food sources by terrestrial animals. Uptake of lead from food sources affected by lead-contaminated soils is a major component of ecological risk to the red fox on the north side of the Chena River.

In addition to the remedial actions used to treat COCs, institutional controls (see Section 7.1.2) will be used to prevent unacceptable exposure to contamination remaining at source areas at concentrations above RAOs. Institutional controls to restrict site access and control land use are designed to minimize human and ecological exposure to contaminants.

Institutional controls include restrictions governing site access and onsite construction., They will remain in effect as long as hazardous substances remain onsite at levels that preclude unrestricted use. Current and future land use is industrial. Land-use restrictions include limiting future land use to operations currently being conducted at the source area. Land-use restrictions will be incorporated into the Fort Wainwright master plan. Administrative components of these institutional controls are discussed further in Section 7.1.2.

The total estimated 30-year present worth of this alternative is $190,000, including $8,000 for capital and $6,000 annually for O&M.

7.2 Remedial Action Goals

The overall goal of a remedial action is to protect human health and the environment from contaminated media associated with the OU5 source areas. The remedial action goals will provide the most effective mechanisms to meet state and federal MCLs for drinking water. To facilitate selection of the most appropriate remedial actions, specific cleanup objectives were developed for the source areas. These objectives specify the COCs in each medium of interest, exposure pathways and receptors, and acceptable regulatory levels. Remedial goals were developed for industrial use of soils and residential use of groundwater.

The final cleanup levels for soil, groundwater, sediment, and surface water are presented in Table 12. The remediation goals presented in Table 12 were established for the specific COCs that were determined to require remedial action. These goals are intended for the areas where active remediation will occur.

The cleanup levels for COCs in soils are based on ADEC cleanup guidelines for petroleum products and EPA-recommended guidance for lead-contaminated soils. Because soils contaminated with VOCs and petroleum-related compounds are acting as a continuing source of contamination to groundwater, the remedial action goal for in situ soils is active remediation until contaminant levels in groundwater are consistently below state and federal MCLs. The State of Alaska cleanup levels for UST petroleum-contaminated soil and Tables B and B2 in 18 AAC 75 will be considered as a guideline for the treatment of in situ soils.

The cleanup levels for COCs in groundwater are federal and state MCLs for drinking water and Alaska Water Quality Standards for protection of freshwater, aquatic resources. When federal or state standards are not available, the cleanup level is based on a risk-based concentration (RBC) equivalent to an excess lifetime cancer risk of 1×10^{-6} for a residential-exposure scenario. The cleanup levels for COCs in groundwater are protective of downgradient residential, commercial, and municipal utility system well users.

Monitoring at the OU5 source areas would be conducted to ensure that RAOs are achieved. The goals of this monitoring include, but are not limited to, the following:

- To ensure that migration of contaminated groundwater from the source areas to downgradient aquifers or surface waters is reduced or prevented

TABLE 12
Remedial Action Objectives and Preliminary Remediation Goals for Operable Unit 5

Remedial Action Objective	Source Area	Chemicals of Concern	Remediation Goal	Basis
Soil				
Environmental Protection				
Prevent migration to groundwater of soil contaminants that could result in groundwater contamination and exceedances of federal MCLs and nonzero MCLGs and to groundwater that is closely hydrologically connected to surface water (such as the Chena River) that could result in exceedances of Alaska AWQS in surface water.	WQFS & EQFS WQFS & EQFS WQFS WQFS WQFS WQFS & EQFS	DRO GRO Benzene Ethylbenzene Toluene Xylenes	Active remediation of soils until contaminant levels in groundwater are consistently below state and federal MCLs.	ADEC 18 AAC 75 and 18 AAC 75
Limit human health and terrestrial receptor exposure to lead-contaminated soil.	Remedial Area 1A	Lead	No direct contact for total lead concentration greater than 1,000 mg/kg	ADEC cleanup levels and human health and ecological risk assessment and EPA Region 9 Industrial Preliminary Remediation Goal

TABLE 12
Remedial Action Objectives and Preliminary Remediation Goals for Operable Unit 5

Remedial Action Objective	Source Area	Chemicals of Concern	Remediation Goal	Basis
Groundwater				
Environmental Protection				
Restore groundwater to its beneficial uses within a reasonable time frame. Reduce or prevent further migration of contaminated groundwater from the source areas to the downgradient aquifer or surface water bodies that are closely hydrologically connected by achieving MCLs (where there are no nonzero MCLGs) and Alaska WQS.	WQFS & EQFS	RRO	1110 µg/L	18 AAC 75
	WQFS & EQFS	DRO	1500 µg/L	18 AAC 75
	WQFS	GRO	1300 µg/L	18 AAC 75
	WQFS & EQFS	1,2-DCA	5 µg/L	MCL
	WQFS	Benzene	5 µg/L	MCL
	WQFS & EQFS	Toluene	1,000 µg/L	MCL
	EQFS	Trichloroethene	5 µg/L	MCL
	EQFS	1,2-Dibromoethane	0.05 µg/L	MCL
For groundwater that is hydrologically connected to surface water, Alaska WQS will apply for the following Fresh Water Uses: (1)(A) Water Supply; (1)(B) Water Recreation; and (1)(C) Growth and Propagation of Fish, Shellfish, Other Aquatic Life, and Wildlife.	EQFS	bis),2-Chloroethyl) ether	0.0092 µg/L	1 x 10^{-6} Risk
Ensure no risk to aquatic receptors through control of contaminant movement through the groundwater into the Chena River.				
Remove floating product to the extent practicable to eliminate film or sheen from groundwater.		Floating-product petroleum hydrocarbons	Eliminate sheen	Clean Water Act, 18 AAC 75, and Alaska WQS Fresh Water Uses
Human Health				
Prevent use of groundwater containing contaminants at levels above Safe Drinking Water Act MCLs, nonzero MCLGs, or the following Alaska WQS for Fresh Water Uses: (1)(A) Water Supply; (1)(B) Water Recreation; and (1)(C) Growth and Progagation of Fish, Shellfish, Other Aquatic Life, and Wildlife.				Safe Drinking Water Act 18 AAC 75

TABLE 12
Remedial Action Objectives and Preliminary Remediation Goals for Operable Unit 5

Remedial Action Objective	Source Area	Chemicals of Concern	Remediation Goal	Basis
Chena River Sediments				
Reduce sources of contaminant releases to the Chena River.		Contaminated sediments that contain all COCs identified in the postwide risk assessment	No concentrations of toxic substances or petroleum hydrocarbons and other contaminants in bottom sediments allowed that cause deleterious effects to aquatic life	Clean Water Act and Alaska WQS for Sediments
			Benthic macroinvertebrate assessment to establish baseline and to monitor aquatic biotic integrity through time	See Note 1
Chena River Surface Water				
Meet Alaska WQS for the following Fresh Water Uses: (1)(A) Water Supply; (1)(B) Water Recreation; and (1)(C) Growth and Propagation of Fish, Shellfish, Other Aquatic Life, and Wildlife.		TAH	10 µg/L	Clean Water Act and Alaska WQS
		TAqH	15 µg/L	Clean Water Act and Alaska WQS
		Petroleum hydrocarbons	Eliminate sheen	Clean Water Act and Alaska WQS
Continue aquatic assessment.		All chemicals of concern identified in the postwide risk assessment	Benthic macro-invertebrate assessment to establish baseline and to monitor aquatic biotic integrity over time	See Not e 1
			Groundwater monitoring to assess reduction of contaminant releases to the Chena River	Alaska WQS

Note:
1. Basis is the assessment endpoint for the Chena River Aquatic Assessment, which evaluates the integrity of the biotic community in Segment D of the river.

ALASKA WQS = Alaska Water Quality Standards

- To indicate contaminant concentration and compliance with MCLs and Alaska Water Quality Standards
- To ensure that natural attenuation is occurring at the source areas
- To provide information to modify selected remedies to enhance performance, as appropriate

7.3 Five Year Review

CERCLA and NCP require that a review be conducted of all remedial actions that do not achieve cleanup levels for unrestricted use be conducted every 5 years. The first 5-year review will be in 2001, based on the statutory review trigger date for OU3, Fort Wainwright.

The 5-year reviews will be conducted in accordance with OSWER Directive 9355.7-02, May 23,1991, Structure and Components of Five Year Reviews, and supplemental guidance. This guidance requires conducting different levels of review for sources with ongoing treatment and sources where waste is left in place. This 5-year review may result in a decision that the remedies selected in this ROD are no longer protective and that additional remedial action must be taken by the Army to ensure protection of public health and the environment.

The 5-year review for all source areas, will include, but not be limited to, the following components:

- Evaluation of whether the response action remains protective of public health and the environment. Evaluation will consider the effectiveness of the technology for the specific performance levels established in the ROD.
- Evaluation of whether remedial action treatment systems remain cost-effective and technically sound
- Review of remedial action treatment systems to determine whether the remedy might be replaced by other more state-of-the-art remedies that would remain protective at less cost
- Assessment of current and reasonable future land use of the site and surrounding area to ensure that the ROD assumptions of land use are still reasonable and consistent with institutional controls specified in Section 7.1.2 of this ROD
- Evaluation of ecological exposure pathways to verify that the assumptions and ecological risk evaluations completed remain valid
- Addition of any new sampling data into the source area databases

Sites that have waste left in place are subject to additional requirements under the 5-year review. These requirements are specifically applicable to Remedial Area 1A where natural attenuation is not expected to occur. These requirements are as follows:

- Collection and evaluation of all new lead-risk information and risk-assessment approaches for evaluating lead risks recommended by the state, EPA, or Army. This new information may result in a human health risk assessment for lead exposure being conducted for Remedial Area 1A.

- Collection and evaluation of current Army, EPA, and state regulations and policies on remediation of lead in soils, keeping in mind that total lead values at Remedial Area 1A reflect commingling of releases from numerous lead sources

- Any other new information, draft or otherwise, or considerations relevant to an assessment of protectiveness for Remedial Area 1A

No less often than during the CERCLA 5-year reviews, the Army will evaluate the OB/OD area. This evaluation will include review of the active range and any UXO within the OB/OD area and range, to determine whether institutional controls to restrict land use and protect human health and the environment are sufficient. The Army also will evaluate the status of RCRA rules and regulations for military munitions ranges and UXO to determine whether additional RCRA requirements must be met.

SECTION 8
Statutory Determinations

The main responsibility of the Army, ADEC, and EPA under their legal CERCLA authority is to select remedial actions that are protective of human health and the environment. In addition, Section 121 of CERCLA, as amended by SARA, provides several statutory requirements and preferences. The selected remedy must be cost-effective and use permanent treatment technologies or resource-recovery technologies to the maximum extent practicable. The statute also contains a preference for remedies that permanently or significantly reduce the toxicity, mobility, and volume of hazardous substances through treatment. Finally, CERCLA requires that the selected remedial action for each source area must comply with ARARs established under federal and state environmental laws, unless a waiver is granted.

8.1 Protection of Human Health and the Environment

The selected alternatives for WQFS1, WQFS2, WQFS3, and EQFS will provide long-term protection of human health and the environment and satisfy the requirements of Section 121 of CERCLA. The selected alternative for Remedial Area 1A is protective of human health and the environment under current land-use scenarios.

8.1.1 WQFS1, WQFS2, WQFS3, and EQFS

The selected remedies will provide long-term protection of human health and the environment. Institutional controls will be implemented to restrict residential development and access of the source areas through standard installation security to keep risk at a minimum until RAOs are achieved. Treatment of the contamination will reduce future risk associated with exposure to contaminated soil and groundwater, and it will minimize further contamination and offsite migration of the groundwater. Natural attenuation of remaining contaminants in the groundwater and soil will continue to occur. Groundwater monitoring and evaluation will track not only the effectiveness of treatment systems but also the progress of natural attenuation. Continuation of the Chena River Aquatic Assessment Program will ensure protection of aquatic resources.

The selected remedies are consistent with the presumptive strategy for contaminated groundwater through technology phasing and the use of the OSWER Natural Attenuation Policy, which specifies natural attenuation be used as a reasonable and protective component of a broader remedial strategy.

8.1.2 Remedial Area 1A

The selected remedy, institutional controls, will provide protection of human health and the environment. Residential development and access will continue to be restricted. Engineering and safety controls, such as maintaining fences around the source-area perimeter to restrict access by humans and terrestrial animals, will be used. In addition, signs will be installed to warn the public of the contamination and restrict human access.

Land-use restrictions will be incorporated into the Fort Wainwright master plan and will be implemented and monitored through the institutional control SOPs. The effectiveness of these controls will be periodically evaluated.

8.2. Compliance with Applicable or Relevant and Appropriate Requirements and To-Be-Considered Guidance

The selected remedies for the WQFS and EQFS source areas will comply with all ARARs of federal and state environmental and public health laws, including compliance with all location-, chemical-, and action-specific ARARs listed below.

8.2.1 Applicable or Relevant and Appropriate Description

An ARAR may be either "applicable" or "relevant and appropriate." Applicable requirements are those substantive environmental protection standards, criteria, or limitations promulgated under federal or state law that specifically address a hazardous substance, remedial action, location, or other circumstance at a CERCLA site. Relevant and appropriate requirements are those substantive environmental protection requirements promulgated under federal and state law that, although not legally applicable to the circumstances at a CERCLA site, address situations sufficiently similar to those encountered at the CERCLA site so that the use of the requirements is well suited to the particular site. The three types of ARARs are described below:

- Chemical-specific ARARs are usually health- or risk-based numerical values or methodologies that establish an acceptable amount or concentration of a chemical in the ambient environment.

- Action-specific ARARs are usually technology- or activity-based requirements for remedial actions.

- Location-specific ARARs are restrictions placed on the concentration of hazardous substances or the conduct of activity solely because the ARARs occur in special locations.

The to-be-considered (TBC) requirements are nonpromulgated federal or state standards or guidance documents that are to be used as appropriate in developing cleanup standards. Because they are not promulgated or enforceable, TBCs do not have the same status as ARARs and are not considered required cleanup standards. They generally fall into three categories:

- Health effects information with a high degree of credibility

- Technical information about how to perform or evaluate site investigations or response actions

- State or federal agency policy documents

8.2.2 Chemical-Specific Applicable or Relevant and Appropriate Requirements

The following chemical-specific ARARs have been identified:

- **Federal Safe Drinking Water Act (40 CFR 141) and Alaska Drinking Water Regulations (18 AAC 80).** The MCL and nonzero MCLGs were established under the Safe Drinking Water Act and are applicable and relevant and appropriate for groundwater that is a potential drinking water source. The MCLs and MCLGs will be met through treatment and natural attenuation.

- **Alaska Water Quality Standards for Protection of Class (1)(A) Water Supply, Class (1)(B) Water Recreation, and Class (1)(C) Aquatic Life and Wildlife (18 AAC 70).** 18 AAC 70.015 specifies that actions may not degrade water that is higher in quality than the Alaska Water Quality Criteria (Alaska Water Quality Standards, 18 AAC 70-020). The Alaska Water Quality Standards require the protection of all groundwater and surface water for specific uses, including water supply, recreation, and aquiculture. These standards are considered applicable for remedial actions, conducted at the OU5 WQFS and EQFS source areas. Many constituents of groundwater regulated by Alaska Water Quality Standards have identical MCLs in drinking water regulations. Alaska Water Quality Standards also contain criteria for sediment. These regulations are applicable to surface water and sediments and apply to groundwater that is closely hydrologically connected to surface water.

- **Alaska Regulations for Underground Storage Tanks (18 AAC 78, as amended through January 22, 1999).** The State of Alaska has established cleanup requirements for petroleum contamination from leaking USTs to protect groundwater. These regulations are relevant and appropriate for the OU5 source areas.

- **Alaska Oil and Other Hazardous Substances Pollution Control Regulations (18 AAC 75, as amended through January 22, 1999).** These regulations are applicable. Under these regulations, responsible parties are required to clean up oil and hazardous substance releases in Alaska.

Recent amendments to these regulations include the following:

- The applicability of 18 AAC 70, Alaska Water Quality Standards, was changed so that these standards will apply only to surface water and associated sediments and to groundwater demonstrated to be closely hydrologically connected to nearby surface waters.

- Specific numeric cleanup levels for petroleum hydrocarbons in soil are risk based and are different from the soil cleanup levels specified in the cleanup matrix of past Alaska UST regulation (18 AAC 78)

- Updated 18 AAC 75 regulations will require the removal of free-product petroleum to the maximum extent practicable, and will include risk-based numeric cleanup levels for gasoline-range and diesel-range petroleum hydrocarbons in groundwater.

- Updated 18 AAC 75 regulations contain soil cleanup standards of 1,000 mg/kg for total lead.

8.2.3 Location-Specific Applicable or Relevant and Appropriate Requirements

The following location-specific ARARs have been identified:

- **UST Soil Stockpile Separation Distances.** In 18 AAC 78, Underground Storage Tanks, Article 3 contains cleanup standards that include separation distance requirements for soil storage and disposal (18 AAC 78.311). These requirements may apply to remedial actions selected in this ROD.

- **Air Quality Prevention of Significant Deterioration.** Air quality standards for prevention of significant deterioration (PSD) of the air basin in the Fairbanks region are location-specific relevant and appropriate requirements for treatment alternatives generating offgas, in the OU5 source areas. (See 40 CFR Parts 50 and 61, 18 AAC 15, and 18 AAC 50.)

- **National Historic Preservation Act of 1966.** Section A106, which is implemented by the Advisory Council on Historic Preservation and the Army through regulations found in 36 CFR 800 through 800.15, 16 *United States Code* 470 et seq., and Public Law 89-665, requires federal agencies to take into account the effects of the agency's undertaking on properties included in or eligible for the National Register of Historic Places and, before approval of an undertaking to afford the State Historical Preservation Office and the Advisory Council on Historic Preservation a reasonable opportunity to comment on the undertaking. This statute is relevant and appropriate to the protection of the Ladd Field National Historic Landmark/District.

8.2.4 Action-Specific Applicable or Relevant and Appropriate Requirements

The following action-specific ARARs have been identified:

- **Federal Clean Air Act (42 *United States Code* 7401).** As amended, these statutes are applicable for venting contaminated vapors.

- **Federal Air Quality Regulations.** The substantive requirements of 40 CFR 61.93, air emission monitoring and procedures, are applicable to remedial actions for the OU5 source areas. Emission resulting from the SVE/AS technology must be monitored under the Fort Wainwright facility permit.

- **Federal Clean Water Act.** Section 404 of the Clean Water Act, which is implemented by the EPA and the Army through regulations found in 40 CFR 230 and 33 CFR 320 to 330, prohibits the discharge of dredged or fill materials into waters of the United States without a permit.

- **Alaska Air Quality Control Regulations.** The substantive requirements of the ADEC air-quality control regulations (18 AAC 50) must be satisfied at Fort Wainwright. Remedial actions may produce organic vapors and fugitive dust, respectively, during system operation. Emissions resulting from remedial technologies must be considered and evaluated under the Fort Wainwright facility permit.

- **RCRA Subtitle C.** The RCRA Subtitle C (40 CFR 260-272) governs the "cradle-to-grave" management of materials that meet the definition of a hazardous waste. Hazardous wastes are either specifically listed in 40 CFR 261 Subpart D, or exhibit one of four hazardous characteristics: ignitability, corrosivity, reactivity, or toxicity as determined by the TCLP. The most significant substantive RCRA requirements for a hazardous waste generator include the following:

- 40 CFR 262.11–Applicable requirements to assess whether waste being generated is a hazardous waste by sampling and analysis or process knowledge

- 40 CFR 262.34–Requirements applicable to the short-term (less than 90-day) storage of RCRA hazardous waste (for example, excavated RCRA waste piles awaiting treatment/disposal)

  Excavated sediment (for, the WQFS2 limited removal action), water removed in SVE system flow streams, particulate filters, or other wastes associated with OU5 source-area remediation are not expected to meet the definition of a RCRA hazardous waste. However if they do, the RCRA generator standards requirements, RCRA land disposal restrictions (40 CFR 268), or RCRA treatment, storage, and disposal requirements (40 CFR 264) will apply.

- **Alaska UST Regulations for Underground Storage Tanks and Guidance (adopted by reference as amended January 22, 1999).** ADEC UST regulations in 18 AAC 78 and the *Underground Storage Tanks Procedures Manual* (December 10, 1998) are relevant and appropriate for the remediation of soil and groundwater with petroleum hydrocarbon contamination at the OU5 source areas.

- **Alaska Oil and Other Hazardous Substances Pollution Control Regulations (18 AAC 75), as amended through January 22, 1999).** These regulations are applicable and are consistent with
  requirements in Alaska UST requirements.

- **Alaska Solid Waste Management Regulations.** Substantive provisions of Alaska regulations for solid waste management (18 AAC 60) are identified as ARARs for managing solid wastes that do not meet the definition of a RCRA hazardous waste. Therefore, the following solid waste regulations may be relevant and appropriate to excavated and/or treated soil and additional investigation-derived wastes:

  - Disposal requirements for polluted soil (18 AAC 60.025)

  - Accumulation, storage, and treatment of solid waste (18 AAC 60.010) (for example, runoff and litter control and wildlife attraction control)

  - Transportation requirements (18 AAC 60.015) (for example, containment of waste and cleanup of any spills that may occur during transport)

8.2.5 To-Be-Considered Information

The following TBC information has been used in remedy selection and implementation:

- EPA Revised Interim Soil Lead Guidance for CERCLA Sites and RCRA Corrective Action Facilities, OSWER Directive 9355.4-12 (1994)

- EPA Region 9 Industrial Preliminary Remediation Goals: no direct contact with lead contaminated soil that has concentrations greater than 1,000 mg/kg

- EPA Region 3 Risk-Based Concentration Tables
- OSWER Directive 9200.4-17, Use of Monitored Natural Attenuation at Superfund, RCRA Corrective Action and Underground Storage Tank Sites

8.3 Cost Effectiveness

The Army believes that the combination of remedial actions identified as the selected remedies for OU5 will reduce or eliminate the risks to human health and the environment at an expected cost of $14.73 million. The remedies are cost-effective. They provide an overall protectiveness proportional to their costs.

By tailoring the WQFS and EQFS remedies so that AS and SVE are applied in hot spots and source areas and monitored and evaluated natural attenuation is performed in less-contaminated areas, the selected remedies cost-effectively provide an appropriate level of protection. Allowing monitored and evaluated natural attenuation to restore less-contaminated areas within a reasonable time frame avoids costly and unnecessary remedial action.

Institutional controls will be implemented at Remedial Area 1A. Land-use and access restrictions cost-effectively provide an appropriate level of protection for humans and terrestrial receptors.

8.4 Use of Permanent Solutions and Alternative Treatment Technologies or Resource Recovery Technologies to the Maximum Extent Practicable

The Army, ADEC, and EPA have determined that the selected remedies represent the maximum extent to which permanent solutions and treatment technologies can be used in a cost-effective manner at the OU5 source areas. Of those alternatives that protect human health and the environment and comply with ARARs, the Army, ADEC, and EPA have determined that the selected remedies provide the best balance of trade-offs in terms of long-term effectiveness and permanence; reduction of toxicity, mobility, and volume through treatment; short-term effectiveness; implementability; cost; and the statutory preference for treatment as a principal element in considering state and community acceptance.

8.5 Preference for Treatment as a Main Element

The selected remedies for WQFS and EQFS source areas satisfy the statutory preference for treatment for soil and groundwater. The selected remedy for Remedial Area 1A does not include active treatment as a main element. Under the current land use for this source area, the chosen alternative is best and will effectively provide protection for human health and ecological risks at the site.

SECTION 9

OB/OD Pad

9.1 Site History

The OB/OD area, formerly called the EOD area, is within the active small-arms impact range on Fort Wainwright. The physical location is approximately 1,000 feet north of the Tanana river and 1,500 feet south of the flood control dike. The bermed area measures about 150 feet by 450 feet. The OB/OD area was used by the Army from the mid 1960s to some time between 1981 and 1986. The site was reportedly used for disposing of UXO and dud ordnance, unused propellants (black powder), rocket motors, small-arms ammunition, and other hazardous materials. Operating records are no longer available for this site.

The RCRA Facility Assessment indicated that the Fort Wainwright EOD Detachment operates only occasionally and detonates less than 4,000 pounds of waste ordnance each year. It notes the maximum explosive charge used to detonate munitions is a 50-pound charge and is usually a C-4. During the winter months, the charge is reduced to 25 pounds or less because of atmospheric conditions.

After extensive record searches, review of all available historical aerial photographs and interviews with employees and past employees with an institutional knowledge of EOD-OB/OD activities at Fort Wainwright, it was determined that the OB/OD site (formerly identified as the EOD site) was the only historically active and identifiable ordnance disposal area on Fort Wainwright. After ordnance disposal activities and procedures were discussed with individuals who have local expertise, sampling was done by completing a large array of analytical tests to identify any potential contaminants from historical activities.

Field investigation and sampling were completed at the site on September 1, 1994. Eight surface soil samples (3 to 6 inches deep), one water sample, and appropriate quality assurance/quality control samples were collected. Analysis was completed on all samples for halogenated VOCs, DRO, pesticides and PCBs, chemical agents, organosulfur compounds, explosives (and associated breakdown products), thiodiglycol, and chloroacetic acid.

Additional samples were collected for metals analysis during the OU5 RI in 1996. Eight surface soil samples (3 to 6 inches deep), along with to background samples from 1,100 feet northwest of the OB/OB area, were collected from the approximate locations of the 1994 samples.

The U.S. Army Environmental Hygiene Agency (AEHA) identified this site as FA-113, Explosive Ordnance Disposal Site, in the 1990 evaluation of solid waste management units. The physical description provided in the AEHA document for the EOD site matches the description for Site D-17, OB/OD pad, in the RCRA Facility Assessment (RFA), completed in 1991. During the 1990 site investigation by AEHA, the site had several visible detonation craters but no visible debris. The description states the site was used to detonate a small amount of unserviceable munitions once a month. A visual inspection completed for the RFA confirmed that no visible debris was present.

9.2 Physical Features

The soil within the OB/OD area is a permafrost silty clay. A water-filled gravel pit is immediately adjacent to the OB/OD area. The RFA estimated contamination would be predominantly lead, barium, and various nitrogen-rich, large-molecule-residuals from C-4, large military rounds, and small-caliber munitions. It noted that the hazardous constituents would be deposited in the first 18 inches of soil or in the open impact craters.

The sampling program at the OB/OD site was conducted to determine what, if any, contamination existed at the site and at what levels. An observational approach was used to identify sampling areas. This method focused on identifying the areas with the highest potential for contamination.

Field representatives from the Army, EPA, ADEC, and U.S. Army Corps of Engineers, accompanied by two ordnance experts, completed a site visit. With the assistance of the ordnance experts, this reconnaissance team identified appropriate sampling locations. Soil samples were collected at a depth of 3 to 6 inches below ground surface on the inside lip of two detonation (impact) craters and from four areas where vegetation appeared stressed or sparse. Initially, samples were only going to be collected in detonation craters. However, during the field visit, the reconnaissance team agreed that the low vegetation areas also should be sampled. One water sample was collected from a detonation crater. This sample is considered representative of a groundwater sample, because the water level in the crater was reflective of groundwater elevation.

The sampling strategy was designed to identify the worst-case contamination at the site. If significant contamination had been found, additional sampling would have occurred.

9.3 Nature and Extent of Contamination

DRO was found in four soil samples at concentrations ranging from 5.3 to 21.0 mg/kg, well below the most stringent potential ARAR of 100 mg/kg. The organosulfur compound p-chlorophenyl methyl sulfoxide was the only other compound identified at this site. This contaminant was found in three samples, with concentration ranging from 59 µg/kg to 657 µg/kg. This compound is reported to be a degradation product of the herbicide Planevin. No ARARs or cleanup levels have been identified for this compound. No screening criterion or surrogate risk analysis is available.

DRO also was found in the water samples at a maximum concentration of 0.19 ppm. No other target analytes were identified.

Metals (arsenic, barium, cadmium, chromium, lead, mercury, selenium, silver, and vanadium) were detected in each soil sample. Arsenic, cadmium, mercury, selenium, silver, and vanadium were less than or equal to background levels. Barium, chromium, and lead exceeded background levels, but were below Region 3 RBCs of 10^{-6} for soil.

9.4 Summary of Site Risks

The sampling program for the OB/OD area was designed to identify any released contaminants from historical detonation activities. No contaminants that exceed any ARARs or TBC criteria were identified at the OB/OD area. On the basis of the low levels of DRO and the organosulfur compound (Planevin) identified, no risk assessment was completed. The OB/OD area is within an active range, where human access is extremely restrictive. The evaluation of the site indicated that there are no current complete exposure pathways for contaminants and that the contaminants exist at such low levels that they are not of concern. The low contaminant levels to not pose an unacceptable risk to human health or the environment. An evaluation of future-use scenario for the site indicates that the MOD area is likely to remain a small-arms impact range into the foreseeable future.

On the basis of the results of the RI/FS at the OB/OD area and an evaluation of data collected at this site, no further action is selected for the OB/OD area for hazardous chemicals. Because of concerns about potential human exposure to UXO, institutional controls to monitor and control access and to restrict land use will apply to the OB/OD area.

9.5 OB/OD Area Closure

The OB/OD area is being treated administratively as part of OU5 as agreed by the EPA, ADEC, and Army in the 1992 FFA. This ROD selects the final remedial action for OU5, as well as the EPA decision under RCRA hazardous waste closure of the OB/OD area at this time.

The EPA, ADEC, and Army are electing to combine actions under RCRA and CERCLA primarily because the OB/OD area is administratively subject to RCRA closure authority; however, the OB/OD area is also a specified source area in OU5, which is subject to CERCLA authority. Moreover, the OB/OD area is within the active firing range where residuals of explosives remain. By applying CERCLA authority concurrently with RCRA closure through this integrated plan, the EPA, ADEC, and Army intend to minimize response costs and maximize protectiveness.

This ROD for OU5 integrates RCRA corrective action and the CERCLA remedial action processes for describing and analyzing corrective and remedia! alternatives. To fulfill the requirements for the RCRA closure process, the Army will submit a closure plan in accordance with procedures described in Section 9.6.

9.6 Closure Process

The OB/OD area was identified in the 1991 Federal Facility Compliance Agreement (FFCA), signed by the Army and EPA, as a RCRA-regulated land-based unit. As such, the OB/OD area is subject to the interim status standards codified in 40 CFR 265. Under the 1991 FFCA, the Army was required to submit a closure plan and a post-closure plan for this unit in compliance with the interim status standards for closure codified in 40 CFR 265, Subparts G and P. In addition, pursuant to the terms of the 1992 CERCLA FFA, the Army, ADEC, and EPA agreed that RCRA corrective actions required at solid waste management units at Fort Wainwright would be integrated with any ongoing CERCLA response actions, but also agreed that such integration efforts would not relieve the Army of responsibility for other hazardous waste activities for which federal law remained fully applicable. The integration of RCRA corrective action and CERCLA response actions does not relieve the Army from meeting RCRA closure and post-closure obligations for regulated units.

Although the OB/OD area is not currently active, EPA believes it is appropriate to allow final RCRA closure of the OB/OD area concurrently with final clearance of the operating range. Because the OB/OD area is physically part of the operating range and because it is anticipated that UXO will continue to be present at the operating range, RCRA closure at this time would be technically complex, with little, if any demonstrable environmental benefit. The EPA is approving a delay of closure of the OB/OD) area in accordance with 40 CFR 265.113(b)(1)(i). Delay of closure under this provision is subject to the requirements of 40 CFR 165.113(b), which states, among other things, that final closure, by necessity, will take longer than 180 days to complete.

Additionally, the facility must take, and continue to take, all steps to prevent threats to human health and the environment from the unclosed, but not operating, hazardous waste regulated unit, including compliance with applicable interim status requirements, 40 CFR 265.113(b)(2). The Army has indicated, and the EPA agrees through the signing of this ROD, that the OB/OD) area meets the requirements for an extension of time for closure specified in 40 CFR 265.113(b)(1)(i), provided that a draft interim closure plan and draft interim post-closure plan acceptable to the EPA is completed by the Army as specified below. The Army will submit, within 320 days from the date this ROD becomes final, a draft interim closure plan and draft interim post-closure plan for the OB/OD area that meets the requirements specified in 40 CFR 265, Subparts G and P. The draft interim closure plan and draft interim post-closure plan will be developed and completed in accordance with the procedures for submittal and review of primary documents specified in Paragraphs 20.12 through 21.11 of the 1992 FFA. Final closure will occur under the authority of the 1991 FFCA, RCRA, and its implementing regulations.

No less often than during the CERCLA 5-year reviews, the Army will evaluate whether delay of closure is no longer viable for one of the following reasons:

- The active range is no longer operating.
- The post is being closed.
- Any other reason.

The findings of this evaluation will be submitted to the EPA for review and approval. If either the EPA or the Army believe that delay of closure is no longer viable, the OB/OD area will be closed under the substantive and procedural RCRA closure requirements in effect at that time, and at that time, the Army will revise and resubmit the draft closure plan and draft post-closure plan for the OB/OD area to the EPA for review and approval. Upon approval of the final closure plan and final post-closure plan, the Army will close the OB/OD area in accordance with the terms and conditions of that final closure plan and final post-closure plan. In addition, the Army may elect to close the site under 40 CFR 265, Subparts G and P, at any earlier time. This closure also will require compliance with all substantive and administrative closure requirements, including EPA approval.

SECTION 10

Documentation of Significant Changes

In the Proposed Plan, the OB/OD area was not identified as a RCRA-regulated unit subject to closure. Subsequent review of the Administrative Record indicated that it is necessary to close the OB/OD area in accordance with the administrative and substantive requirements in 40 CFR 265, Subparts G and P, and in the 1991 FFCA. Section 9 of this ROD specifies the process the Army will follow to close the OB/OD area.

Appendix A
Responsiveness Summary

APPENDIX A

Responsiveness Summary

Overview

The U.S. Army Alaska (Army), U.S. Environmental Protection Agency (EPA), and Alaska Department of Environmental Conservation (ADEC), collectively referred to as the Agencies, distributed a Proposed Plan for remedial action at Operable Unit 5 (OU5), Fort Wainwright, Alaska. OU5 consists of six source areas: West Quartermasters Fueling System (WQFS), East Quartermaster's Fueling System (EQFS), Remedial Area 1A, Open Burning/Open Detonation (OB/OD) Area, Motor Pool Areas, and Former Explosive Ordnance Disposal (EOD) Range.

The Proposed Plan identified the preferred remedial alternative for WQFS, EQFS, and Remedial Area 1A. No cleanup action was recommended for the OB/OD Area, Motor Pool Areas, and Former EOD Range. Institutional controls that control groundwater and land use and control access into Remedial Area 1A will continue.

The following are major components of the remedy selected for Subarea 1 of the WQFS (WQFS1):

- In situ treatment of the source area with air sparging and soil vapor extraction to attain state and federal standards for drinking water
- Potential in-place soil heating at hot spots, pending results of a treatability study to increase contaminant removal
- Operation of the treatability study on the downgradient air-sparging trench to prevent migration of contaminants to the Chena River and potential downgradient receptors

The following are major components of the remedy selected for Subarea 2 of the WQFS (WQFS2):

- Hot-spot treatment with air sparging and soil vapor extraction to attain state and federal standards for drinking water
- Continued operation of the downgradient air-sparging curtain to prevent migration of contaminants to the Chena River
- Groundwater monitoring to determine downgradient concentrations

The following is the major component of the remedy selected for Subarea 3 of the WQFS (WQFS3):

- Hot-spot treatment with air sparging and soil vapor extraction to attain state and federal standards for drinking water

The following is the major component of the remedy selected for EQFS:

- Continued operation of the treatability study of air sparging and soil vapor extraction at Building 1060 to attain state and federal drinking water standards

All selected remedies for the EQFS and WQFS areas include the following:

- Institutional controls to restrict access, water use, and land use

- Monitored and evaluated natural attenuation to determine achievement of remedial action objectives

The major component of the remedy selected for Remedial Area 1A is as follows:

- Institutional controls to restrict access and land use

No written comments and no verbal comments about the Proposed Plan for OU5 remedial action were received during the public comment period.

Background of Community Involvement

The public was encouraged to participate in selection of the final remedy for OU5 during a public comment period from June 17 to July 17,1998. *The Proposed Plan for Remedial Action at Operable Unit 5, Fort Wainwright, Alaska,* presents options considered by the Agencies to address contamination in WQFS, EQFS and Remedial Area 1A. The Proposed Plan was released to the public on June 16, 1998, and copies were sent to all known interested parties, including elected officials and concerned citizens. Informational Fact Sheets, prepared since July 1993, provided information about the Army's entire cleanup program at Fort Wainwright and were mailed to the addresses on the same mailing list.

The Proposed Plan summarizes available information about OU5. Additional information was placed into two information repositories: the Noel Wien Library in Fairbanks and the Fort Wainwright Post Library. An Administrative Record, including all items placed into the information repositories and other documents used in the selection of the remedial action, was established at the Directorate of Public Works in Building 3023 on Fort Wainwright. The public was encouraged to inspect materials available in the Administrative Record and the information repositories during business hours.

Interested citizens were invited to comment on the Proposed Plan and the remedy selection process by mailing comments to the Fort Wainwright project manager, calling a toll-free telephone number to record a comment, or attending and commenting at a public meeting conducted on June 25, 1998, at the Carlson Center in Fairbanks. The proceedings of the meeting were recorded by a court reporter, and the transcript became a part of the Administrative Record for OU5.

Basewide community relations activities conducted for Fort Wainwright, which includes OU5, have consisted of the following:

- July 1992—community interviews with local officials and interested parties

- April 1993—preparation of the Community Relations Plan

- July 1993—distribution of an informational Fact Sheet covering all OUs at Fort Wainwright
- July 22,1993—an informational public meeting covering all OUs
- April 22,1994—establishment of informational repositories at the Noel Wien Library in Fairbanks and the Fort Wainwright Post Library. Establishment of the Administrative Record at the Directorate of Public Works in Building 3023 on Fort Wainwright.
- March 1995—distribution of an informational Fact Sheet covering all OUs at Fort Wainwright
- September 1995—distribution of an informational Fact Sheet covering all OUs at Fort Wainwright
- March 1996—distribution of an informational Fact Sheet covering all OUs at Fort Wainwright
- January 1997—distribution of an informational Fact Sheet covering all OUs at Fort Wainwright
- March 1997—distribution of an informational Fact Sheet soliciting interest from the community for the
  formation of a Restoration Advisory Board (RAB) to support Fort Wainwright. The fact sheet included a RAB membership application.
- September 1997—distribution of an informational Fact Sheet covering all OUs at Fort Wainwright
- October 1997—revision of the Community Relations Plan
- October 14,1997—first meeting of the Fort Wainwright RAB
- January 13,1998—second meeting of the Fort Wainwright RAB
- arch 31,1998—third meeting of the Fort Wainwright RAB
- June 1998—distribution of an informational Fact Sheet covering all OUs at Fort Wainwright
- June 25, 1998—fourth meeting of the Fort Wainwright RAB

Community relations activities specifically conducted for OU5 included the following:

- June 15, 1998—distribution of the Proposed Plan for final remedial action at OU5
- June 19, 21, 24, and 25, 1998—display advertisement in the Fairbanks Daily News-Miner announcing the public comment period and public meeting
- June 17 to July 17,1998—30-day public comment period for final remedial action at OU5. No extension was requested.
- June 17 to July 17, 1998—availability of a toll-free number for citizens to provide comments during the public comment period. The toll-free number was advertised in

the Proposed Plan and the newspaper display advertisement that announced the public review period.

- June 25,1998—public meeting at Carlson Center in Fairbanks to provide information, a forum for questions and answers, and an opportunity for public comment about OU5

Summary of Comments Received During the Public Comment Period and Agency Responses

No comments were received during the public comment period.

Appendix B
Administrative Record

ADMINISTRATIVE RECORD INDEX
OPERABLE UNIT 5
FORT WAINWRIGHT, ALASKA

Start Page	End Page	Date	Title	OU No.	Category No.	Author Name/Affiliation	Recipient Name/Affiliation
20371	20460	11/12/91	Fort Wainwright Comprehensive Environmental Response, Compensation, and Liability Act Federal Facilities Agreement.	IRP	7.9	Cynthia Mackey USEPA	Tamela Tobia U.S. Army
68439	68441	3/1/97	Disposition of review Comments Draft Work Plan Operable Unit 5 West QFS Sub-Area WQFS2 Treatability Study, Fort Wainwright, Alaska	5	3.2	None given HLA	None given COE
68442	68529	3/12/97	Work Plan Operable Unit 5 West QFS Sub-Area WQFS2 Treatability Study, Fort Wainwright, Alaska	5	3.2	S. Yancey and T. Gould HLA	Ted Bales COE
68530	71556	11/22/96	Operable Unit 5 Final Remedial Investigation Report, Fort Wainwright, Alaska	5	3.1.2	P. Ramert and G. Drewett HLA	Ted Bales COE
71557	71699	3/7/97	Work Plan Operable Unit 5 Sub-Area WQFS1 Horizontal Well Treatability Study, Fort Wainwright, Alaska	5	3.2	H. Hoen and T. Gould HLA	Ted Bales COE
71700	71773	8/1/97	Intrinsic Remediation Treatability Study Work Plan, East Quartermasters Fuel System Area, Delivery Order 14, Fort Wainwright, Alaska	5	3.2	Win Westervelt CH2M HIL	Mark Wallace COE
71774	71781	3/1/97	Disposition of Review Comments Draft Work Plan Operable Unit 5 West WFS Sub-Area A Horizontal Well Treatability Study, Fort Wainwright, Alaska	5	3.2	None given HLA	None given COE
71782	71852	11/15/96	Fort Wainwright Operable Unit 5 Precision, Accuracy,Representativeness, Completeness, and Comparability Analysis Data Quality Assessment, Operable Unit 5 Remedial Investigation/Feasibility Study	5	3.1.2	R. Howe and P. Ramert HLA	Ted Bales COE
71853	71975	1/17/97	Laboratory Bioremediation Study, Operable Unit 5, Fort Wainwright, Alaska	5	3.1.2	Paul Ramert HLA	Ted Bales COE

ADMINISTRATIVE RECORD INDEX
OPERABLE UNIT 5
FORT WAINWRIGHT, ALASKA

Start Page	End Page	Date	Title	OU No.	Category No.	Author Name/Affiliation	Recipient Name/Affiliation
71976	71977	1/27/97	Letter from Dianne Soderlund to Cristal Fosbrook re: Comments on Three Precision, Accuracy, Representativeness, Completeness, and Comparability (PARCC) Analysis documents for Operable Units 2, 5 and Postwide Risk Assessment Data, Fort Wainwright, Alaska	5	3.3	Dianne Soderlund USEPA	Cristal Fosbrook DPW
71978	71979	4/30/97	Letter from Wm. David Brown to Dianne Soderlund and Rielle Markey re: Army seeking extension for comments on the Primary Document, Draft Feasibility Study, Operable Unit 5. Fort Wainwright, Alaska	5	4.5	Wm. David Brown U.S Army	D. Soderlund & R. Markey USEPA and ADEC
71980	72180	8/29/97	Quarterly Report Operable Unit 5 West Quartermaster's Fueling System, Sub-Area 2 Oxygen Releasing Compound Treatability Study, Fort Wainwright, Alaska	5	3.2	H. Hoen and C. Wilson HLA	Ted Bales COE
72182	72258	9/10/97	Final Work Plan for 1997 Chena River Aquatic Assessment Postwide Risk Assessment, For Wainwright, Alaska	5	3.1.1	None Given ABR, HLA and CH2M Hill	Mark Wallace COE
72259	72508	11/21/97	Operable Unit 5 Feasibility Study Fort Wainwright, Alaska	5	4.2	M. Schmetzer & J. McElro HLA	Ted Bales COE
72509	72564	11/1/97	Disposition of Review Comments Draft Remedial Investigation Report Operable Unit 5, Fort Wainwright, Alaska	5	3.1.2	None given HLA	None given COE
72565	72612	11/7/96	Fort Wainwright Postwide Risk Assessment Precision, Accuracy, Representativeness, Completeness, and Comparability Analysis Data Quality Assessment	5	8.0	R. Howe and S. Sexton HLA	Ted Bales COE
72613	72649	10/25/96	Fort Wainwright Postwidc Risk Assessment Data Validation Summary, Operable Unit 5, Fort Wainwright, Alaska	5	8.0	R. Howe and S. Sexton HLA	Ted Bales COE

ADMINISTRATIVE RECORD INDEX
OPERABLE UNIT 5
FORT WAINWRIGHT, ALASKA

Start Page	End Page	Date	Title	OU No.	Category No.	Author Name/Affiliation	Recipient Name/Affiliation
72650	72663	2/26/97	Letter from Douglas Cox and Paul Ramert to Ted Bales re: Conceptual Approach for Integrating Postwide Risk Assessment Issues into the Operable Unit 5 Feasibility Study, Fort Wainwright, Alaska	5	8.3	D. Cox and P. Ramert HLA	Ted Bales COE
72664	72675	12/10/96	Disposition of Review Comments Draft Postwide Risk Assessment, Fort Wainwright, Alaska	5	8.0	Various HLA	Rich Jackson COE
72676	72678	12/10/96	Minutes of Review Conferences Draft Postwide Risk Assessment, Fort Wainwright, Alaska	5	8.0	Shaun Sexton HLA	Rich Jackson COE
72679	72832	6/19/97	Addendum to Operable Unit 5 Remedial Investigation Report, Fort Wainwright, Alaska	5	3.1.2	J. Ditsworth and P. Ramert HLA	Ted Bales COE
51538	52072	11/29/95	North Airfield Groundwater Investigation (PSE), Fort Wainwright, Alaska	5	1.3.2	Karol Lorraine, J. Robert HLA	Richard Jackson COE
61851	61972	9/5/96	Operable Unit 5 Magnetic Anomaly Test Pit Investigation Site Safety and Health Plan, Work Plan and Responses to Review Comments	5	1.4.1	Paul Ramert HLA	Rich Jackson COE
13180	13186		OB/OD Range Closure Plan, Post-Closure Plan, and Financial Requirements	5	2.1.1	None given None given	None given None given
13187	13194	6/1/91	Open Burning/Open Detonation Ground Sampling Plan for FTW and FTR	5	3.1	None given AEHA	Cristal Fosbrook DPW
44345	47512	8/16/95	Final Management Plan, OU5, Fort Wainwright, Alaska, Remedial Investigation/Feasibility Study	5	3.1.1	Paul C. Ramert HLA	None given COE
61973	61974	9/27/96	Public Works Letter re: extension for the delivery of Primary Document, RI/FS for Operable Unit 5	5	3.3	Wm. David Brown Public Works	D. Soderlund and R. Markey USEPA & ADEC

ADMINISTRATIVE RECORD INDEX
OPERABLE UNIT 5
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Start Page	End Page	Date	Title	OU No.	Category No.	Author Name/Affiliation	Recipient Name/Afilliation
61975	61998	7/18/96	Alternatives Evaluation Report Operable Unit 5 Feasibility Study, Fort Wainwright, Alaska	5	4.2	Paul Ramert and Michael Sc HLA	None given COE
61999	62034	6/28/96	Remedial Action Objectives, Operable Unit 5 Feasibility Study, Fort Wainwright, Alaska	5	4.2	Paul Ramert HLA	Richard Jackson COE

ADEC Alaska Department of Environmental Conservation
COE = U.S. Army Corps of Engineers
HLA = Harding Lawson Associates
USEPA = U.S. Environmental Protection Agency

Appendix C
No Further Action Sites and Fort Wainwright CERCLA Federal Facility Agreement Recommended Actions

APPENDIX C

No Further Action Sites and Fort Wainwright CERCLA Federal Facility Agreement Recommended Actions

Two source areas investigated in Operable Unit (OU) 5 have been identified for no further action (NFA) under the Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA). The NFA source areas are as follows:

- Former Explosive Ordnance Disposal (EOD) Range (Blair Lakes Alpha Impact Area)
- Motor Pool Buildings

These source areas are shown in Figure C-1 on the following page.

Table C-1 lists the Motor Pool Buildings and describes the facilities and their current status.

This appendix also includes two signed Recommended Actions from the Federal Facility Agreement (FFA), which identifies the authorities and responsibilities of the U.S. Environmental Protection Agency, Department of the Army, and Alaska Department of Environmental Conservation and integrates requirements under CERCLA. The Recommending Actions are for the former EOD Range and the Motor Pool Buildings.

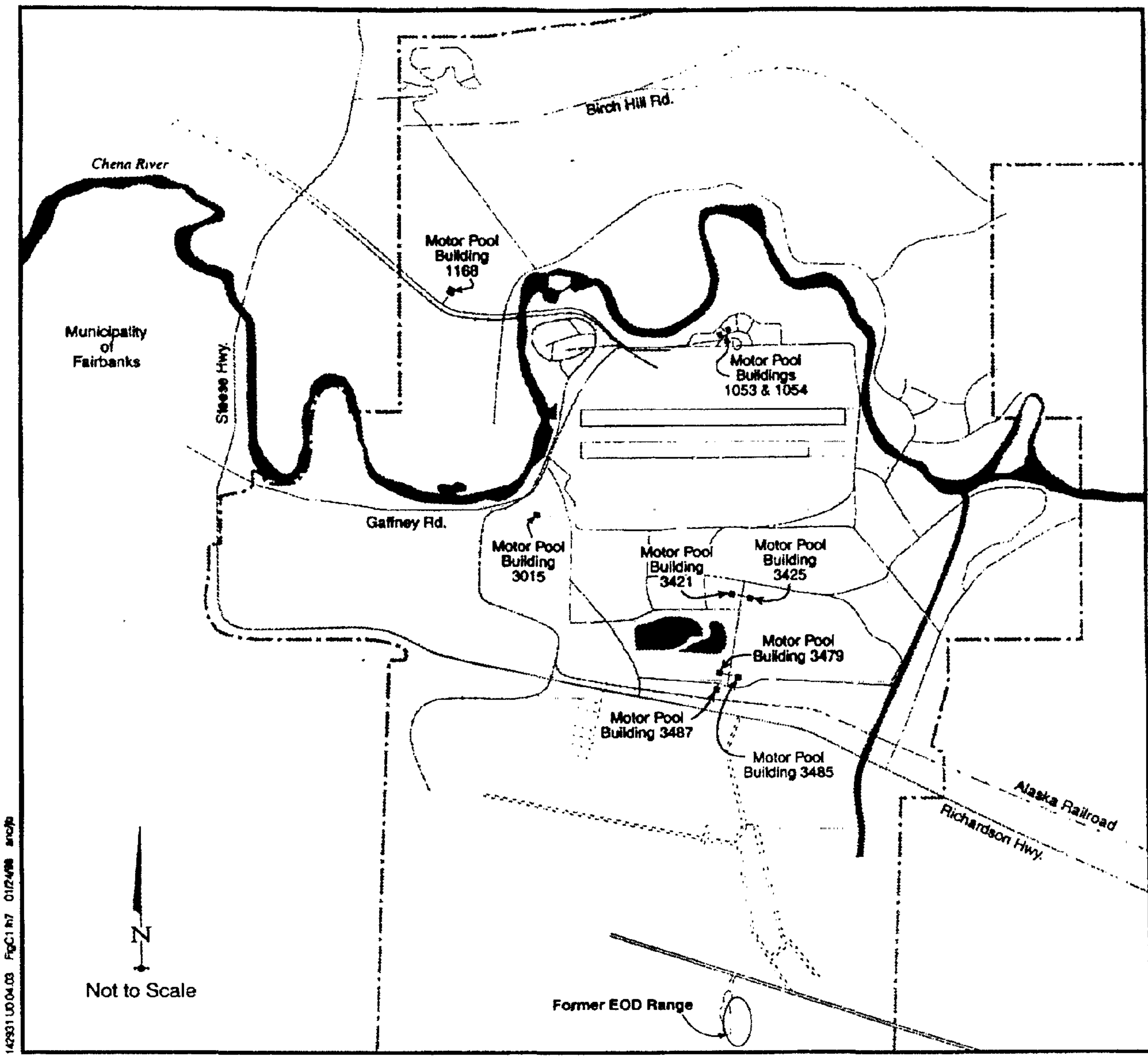

Figure C-1. No Further Action Sites

TABLE C-1
Summary of Motor Pool Buildings and Current Activities

Building Number	Number of Motor Pools	Description of Motor Pool Facility	Status[a]
1053 and 1054	one each	Built in 1947 as a vehicle maintenance, repair, and storage facilities. Drums contained oils, fuels, antifreeze, and solvents. Diesel-range organics (DRO) were detected in soil in both areas, but at concentrations below established cleanup criteria. No evidence that soil contamination from either area was posing unacceptable risk to human health or the environment.	Soil–no further action Groundwater–addressed as part of the East Quartermaster's Fueling System
1168	one	An air sparging (AS) and vapor extraction (VE) system was installed to treat contamination from an underground storage tank (UST). The system is currently being monitored to assess the effectiveness of the remediation system.	Soil/groundwater-continued operation of the AS/VE system
3015	one	Excavated and thermally treated soils associated with two UST removals in 1989. Alaska Department of Environmental Conservation (ADEC) closure received for the USTs. Recommended closure for eight seepage pits.	Soil/groundwater–no further action
3421	two	ADEC closure received for this site, which removed it from the Two-Party Agreement	Soil/groundwater– no further action
3425	two	Isolated soil contamination, believed to be the result of a surface spill, was excavated and thermally remediated as part of a removal action in July 1997. ADEC recommends semiannual groundwater monitoring to determine whether upward trend of DRO contamination	Soil–recommended for closure
3479	two	ADEC closure received for this site, which removed it from the Two-Party Agreement	Groundwater–semiannual monitoring
3485	two	ADEC closure received for this site, which removed it from the Two-Party Agreement	Soil/ groundwater–no further action
3487	one	On south side of post near Buildings 3479 and 3485	Unknown

[a] Status as agreed to in the NFA document being developed

7 May 96

FORT WAINWRIGHT

CERCLA FEDERAL FACILITY AGREEMENT

RECOMMENDED ACTION

Source Area: Motorpools (13 estimated)

Recommended Action: Referral from Operable Unit 1 to Operable Unit 5

Background: A no further action document under CERCLA is being prepared. The information needed to complete this actions is not complete in time to meet the schedules of Operable Unit 1. It was agreed by the Project Manager to move these source areas to Operable Unit 5.

This decision document will become part of the Record of Decision (ROD) for Operable Unit (OU) 2, as designated by the Federal Facility Agreement (FFA), which was signed by EPA the Alaska Department of Environmental Conservation (ADEC) and the US Army.

Comments:

Approvals: The following project managers, representing their respective agencies which are signatories to the FFA, concur with this evaluation.

Rielle Markey — 5-7-96
Rielle Markey
Alaska Department of Environmental Conservation
Remedial Project Manager
Date

Dianne Soderlund — 5/7/96
Dianne Soderlund
US Environmental Protection Agency
Remedial Project Manager
Date

Cristal Fosbrook — 5/7/96
Cristal Fosbrook
US Army, Alaska
Directorate of Public Works
Remedial Project Manager
Date

FORT WAINWRIGHT

CERCLA FEDERAL FACILITY AGREEMENT

RECOMMENDED ACTION

Source Area: Blair Lakes Alpha Impact Area.

Recommended Action: Referral from Operable Unit 1 to Operable Unit 5 and change the name of the source to Former EOD Range.

Back-ground: Based on a review of available historical information and interviews with individuals having an institutional knowledge of Fort Wainwright it was determined that this source consisted of a former open burning and open detonation area located in the Alpha Impact Area. This source is listed in the RCRA Facility Assessment as Site D-20, Former EOD Range, Alpha Impact Area. The current name of this source is broad and does not adequately describe the source area.

Operable Unit 5 contains a similar type source area located within one mile of this site. This source would be more efficiently investigated and remediated under this operable unit.

Comments:

Approvals: The following project managers, representing their respective agencies which are signatories to the FFA, concur with this evaluation.

Rielle Markey — 1/13/94

RIELLE MARKEY — Date
Alaska Department of Environmental Conservation
Remedial Project Manager

Dianne Soderlund — 1/13/94

Dianne Soderlund — Date
US Environmental Protection Agency
Remedial Project Manager

Cristal Fosbrook — 13 Jan 94

Cristal Fosbrook — Date
6th Division (Light), US Army Garrison
Directorate of Public Works
Remedial Project Manager

APPENDIX D
Fort Wainwright Petroleum Strategy: Two-Party Agreement Sites and Fort Wainwright CERCLA Federeal Facility Agreement Recommended Action

APPENDIX D

Fort Wainwright Petroleum Strategy: Two-Party Agreement Sites and Fort Wainwright CERCLA Recommended Action

This appendix provides supporting information for the strategies developed to clean up petroleum contaminated sites at Fort Wainwright. A Two-Party Agreement between the Department of the Army (Army) and the Alaska Department of Environmental Conservation (ADEC) is part of the Federal Facility Agreement (FFA) for Operable Unit 5. The Two-Party Agreement, which presents the petroleum cleanup strategy, documents all known historical petroleum sources on Fort Wainwright and their current cleanup status. It also verifies the Army's commitment to adequately address petroleum sites in a manner consistent with state regulation.

Figure D-1 and Table D-1 identify the Two-Party Agreement sites.

Also included in this appendix is the Fort Wainwright Petroleum Strategy, which is an FFA Recommended Action

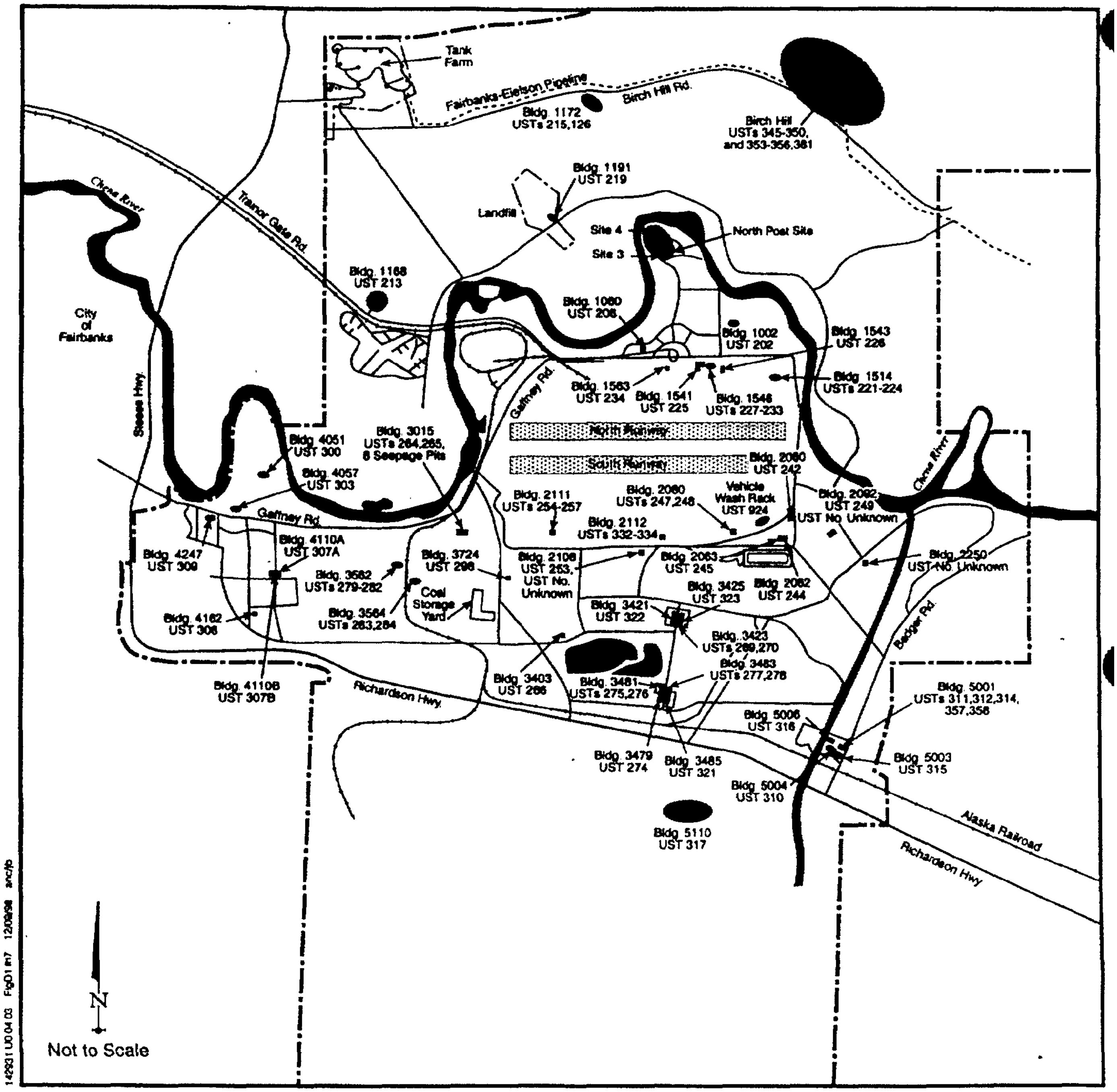

Figure D-1. Two-Party Agreement Sites

TABLE D-1
Two-Party Agreement Sites

POL Source Areas Recommended for Closure Discussions or letters	
! Building 1541	! Building 4110A
! Building 2092	! Petrolem Contaminated soil piles
! Building 3425	! Forward Air Refueling Point
! Building 4051	
POL Source Areas Conducting Active Treatment or Institutional Controls	
! Building 1002	! Building 2112
! Building 1168	! Building 2250
! Building 1546	! Building 3483
! Building 1599	! Building 3562
! Building 2060	! Building 3564
! Building 2062	! DRMO POL Sites
! Building 2063	! Birch Hill AST Tank Farm
! Building 2077	! North Post Sites 3 and 4
! Building 2111	
POL Source Areas Referred to an Operable Unit	
! Building 1053	! Building 1173
! Building 1059	! Building 1565
! Building 1060	! Building 3595
! Building 1070	! Pipeline Break North Post
POL Source Areas Undergoing Long-Term Monitoring	
! Building 1172	! Building 5110
! Building 3481	
POL Source Areas Closed Under the Two-Party Agreement	
! Building 1056	! Building 3485
! Building 1191	! Building 3570
! Building 1541	! Building 3724
! Building 1543	! Building 4057
! Building 1563	! Building 4065
! Building 1594	! Building 4109
! Building 2080	! Building 4110B
! Building 2106	! Building 4162
! Building 2108	! Building 4247
! Building 3015	! Building 5004
! Building 3403	! Bich Hill UST Sites
! Building 3421	! Contaminated Soil 1
! Building 3423	! Nike Sites B and C
! Building 3471	! Tar Sites
! Building 3479	

Revised 12 January 1998

FORT WAINWRIGHT

CERCLA FEDERAL FACILITY AGREEMENT

RECOMMENDED ACTION

FORT WAINWRIGHT PETROLEUM STRATEGY

The objective of this document is to confirm-that Petroleum, Oil, and Lubricant (POL) source areas, as identified in the Army/Alaska Department of Environmental Conservation (ADEC) Two-Party POL Agreement, including all newly discovered petroleum sites to-date, are and will continue to be adequately addressed under the Army/ADEC Two-Party Agreement (attached). This site summary confirms that these sources are being adequately addressed under a program and are not required to be included in the Remedial Investigation/Feasibility Study Management Plan, or subsequent investigations, for Operable Unit (OU) 5, pursuant to Section 2.1 of Attachment 1 of the Fort Wainwright Federal Facility Agreement (FFA). This document confirms that all known POL historic sources at Fort Wainwright are being addressed under either the Army/ADEC Two-Party Agreement or within an Operable Unit.

This document provides the mechanism for the inclusion of newly discovered POL sources and the closure of all POL sources under the Army/ADEC Two-Party POL Agreement.

Petroleum sites with soil and/or groundwater contamination have been identified and updated in the Two-Party Agreement pursuant to Section 4.3 of Attachment 1 of the FFA for Fort Wainwright. The attached POL Strategy report satisfies the requirements of this section. The POL report accurately reflects current status of all identified POL sources at Fort Wainwright, other than those being addressed through the CERCLA process, and is routinely updated.

Currently, 33 of the original 63 listed sites (all listed in the attached “POL Two-Party Listed Sites Tracking Tables”), have received or will receive ADEC closure, requiring no additional investigation. Seven of the 27 closed sites were removed before 1988, prior to the promulgated regulations, removing the sites from the ADEC closure requirements. All of the 63 listed sites have been investigated to determine the extent of contamination existing at the sites. Corrective action plans are being discussed and implemented.

FORT WAINWRIGHT POL STRATEGY

Thirteen (if the 63 listed sites are undergoing active remedial treatment, including soil vapor extraction/air sparging, air injection, bioventing, bioremediation, thermal desorption, or other technologies deemed appropriate by the remedial project managers based on site-specific conditions. Three of the 63 listed sites are undergoing intrinsic remediation, to assess when remediation, through natural aftenuation, has occurred and when closure for the site can be implemented. Eight of the 63 listed sites have been referred from the Two-Party Agreement to be investigated and remediated in the Three Party Agreement, under one of the five Operable Units.

It is the goal of the Army, ADEC, and Environmental Protection Agency (EPA) to proceed as follows:

- To assure that sites currently being addressed will continue to make progress under the Two Party Agreement;

- To assure that newly discovered POL sites will be added to the Two Party Agreement;

- To determine that ultimately, all identified POL sources will be adequately addressed in a manner consistent with 18 AAC 78 and 18 AAC 75; and

- To assure that continued funding for remediation of these sites will be sought.

To accomplish these goals, the following actions will be taken:

- A meeting will be held on an annual basis, or more frequently if deemed necessary, to update the Two-Party list. POL sources will appear on an annual updated list, located In the Federal Facilities Agreement Appendices Section. During this meeting, source status, remediation progress, source closure, and schedules will be discussed;

- Site closure can occur through issuance of closure notices for UST/LUST or a closure letter from the ADEC CERCLA Project Manager. When closure occurs with alternate clean up levels, appropriate DEC approval will be attained; and

- The Army will continue to request funding in accordance with Army funding priorities and procedures.

Based on these criteria, it is determined that petroleum sources have been and continue to be adequately addressed through the Army/ADEC Two-Party POL Agreement and should not be included in the OU 5 Management Plan or subsequent investigations. This document, as updated, will serve as a record of actions taken and will be included in the Operable Unit 5 Record of Decision.

CONCURRENCE

APPROVALS: The following Project Managers, representing their respective agencies which are signatories to the Federal Facilities Agreement, concur with this strategy.

Rielle Markey — 1-13-98

Rielle Markey — **Date**
Alaska Department of Environmental Conservation
Remedial Project Manager

Dianne Soderlund — 1/21/98

Dianne Soderlund — **Date**
U.S. Environmental Protection Agency, Region 10
Remedial Project Manager

Cristal Fosbrook — Jan 13, 1998

Cristal Fosbrook — **Date**
U.S. Army Alaska
Directorate of Public Works, Alaska
Remedial Project Manager

Appendix E
Operable Unit 5 Cost Estimates for Remedial Alternatives

APPENDIX E

Operable Unit 5 Cost Estimates for Remedial Alternatives

Baseline costs for the remedial alternatives presented in this Record of Decision (ROD) were originally developed based on assumptions presented in the *Final OU5 Feasibility Study (FS), Fort Wainwright, Alaska* (June 1998). These estimated costs are expected to provide an accuracy of +50 percent to !30 percent.

The capital and operations and maintenance costs for the selected alternatives have since been refined to incorporate new information that has become available since the preparation of the FS. These revised costs are summarized in the table below. They also are presented in this appendix. Cost summary tables for each sub-area are presented first, followed by capital cost assumptions, then monitoring cost assumptions.

Remediation Area	Capital Cost ($)	Net Present Value of Annual Cost ($)	Total Cost ($)
WQFS1 (With Heating)	$ 3,610,000	$ 3,890,000	$ 7,500,000
WQFS2	$ 1,070,000	$ 1,730,000	$ 2,800,000
WQFS3	$ 440,000	$ 950,000	$ 1,390,000
EQFS	$ 220,000	$ 1,070,000	$ 1,290,000
RA1A	$ 8,000	$ 180,000	$ 190,000
Chena River	$ -	$ 1,560,000	$ 1,560,000
Total with heating			**$ 14,730,000**
WQFS1 (No Heating)	$ 3,220,000	$ 3,320,000	$ 6,540,000
Total without heating			**$ 13,770,000**

Cost estimates for the alternatives that were not selected in this ROD are presented in the FS.

Cost Summaries

Table E-1
Overall OU5 Cost Summary

Remediation Area	Capital Cost ($)	Net Present Value of Annual Cost ($)	Total Cost ($)
WQFS1 (With Heating)	3,610,000	3,890,000	7,500,000
WQFS2	1,070,000	1,730,000	2,800,000
WQFS3	440,000	950,000	1,390,000
EQFS	220,000	1,070,000	1,290,000
RA1 A	8,000	180,000	190,000
Chena River	-	1,560,000	1,560,000
Total (with heating)			**14,730,000**
WQFS1 (No Heating)	3,220,000	3,320,000	6,540,000
Total (without heating)			**13,770,000**

Table E-2
Cost Summary for Chena River Aquatic Assessment Program
Biennial Sampling (Every Other Year for 10 Years)

Year	Total Annual Costs	NPV of Annual Costs	Total NPV of Annual Costs
1	$0	$0	$1,561,607
2	$350,000	$336,794	
3	$0	$0	
4	$350,000	$324,083	
5	$0	$0	
6	$350,000	$311,870	
7	$0	$0	
8	$350,000	$300,097	
9	$0	$0	
10	$350,000	$288,763	

Table E-3
Cost Summary for WOFS 1 Selected Alternative (Alternative 5 With Heating)

Direct Capital Costs

	Cost	
Natural Attenuation Groundwater Monitoring Nests		
Probe installation (nested groups at 20', 40', 60')	29,800	
Active Treatment System		
Treatment System	549,302	
Instrumentation	132,150	
Horizontal AS Wells Total Feet	273,294	
SVE Wells	22,400	
Monitoring Wells	32,400	
Trenching and Pipe Installation	157,500	
Procurement and Scheduling	80,000	
Mobilization	40,000	
Existing Fuel Pipeline Pigging	20,800	
Electric Utility Connections and As-builts	38,700	
Installation Oversight	80,000	
Baseline Sampling and Startup Testing	149,700	
Site Restoration and Demob	89,500	$ 1,985,546
Soil Heating System		
Install heating wells	112,000	
Set structures and complete connections	26,000	
Installation oversight	30,600	
Install heating and monitoring points	30,000	
Mob and demob	99,600	$ 298,000
Air Sparging Trench		
Mobilization	112,500	
AS Pipe Installation, 1200 feet	300,000	
Treatment systems	100,000	
AS Instrumentation	25,000	
Installation oversight	7,500	
Demobilization	30,000	$ 625,000
Closure and Decommissioning		
Decommission existing wells and probes	43,800	
Total Direct Capital Costs	$2,651,146	

Indirect Capital Costs

Engineering (10% of Direct Capital Costs):	
Engineering Institutional Control Planning	547.00
Engineering Natural Attenuation Program Planning	2,880.00
Engineering Active Treatment System Design	257,884.62
Engineering Planning for decommissioning	46,660.00
Engineering Modify Fort Wainwright Comprehensive Plan	4,303.00
License and Contingency:	
License/Permit/Legal (4% of capital)	164,430.77
Contingency (15% of capital)	461,696.92
Total Indirect Capital Costs	958,363.16
Total Direct and Indirect Capital Costs	$ 3,609,509

The Selected Alternative (Alternative 5) for WOFS1 is:
Source Area Treatment with Soil Vapor Extraction and Air Sparging, Operation of the Potential Downgradient Air Sparging Trench, Potential in-place Soil Heating, Institutional Controls, and Monitored and Evaluated Natural Attenuation

Assumes the following treatability studies are in operation and will be incorporated into the RD/RA
1 Horizontal AS/SVE Wells
2 Source Area AS/SVE using vertical wells (the Hart Crowser treatability study is located on the west side of WOFS1)
3 Source Area AS/SVE using vertical wells (the CH2M HILL treatability study is located on the east side of WOFS1)

Assumes the following treatment systems are not currently installed but will be installed as part of the RD/RA
1 Source Area AS/SVE in portions of the free product plume not addressed by the current treatability studies
2 Potential downgradient AS trench
3 Potential in-place Soil Heating

Note:
Soil heating O&M Repair includes rental of transmitter, vendor labor and reporting

Operations and Maintenance Costs

Milestones:
- Source area treatment, horizontal well operation, and soil heating operation (Years 1–5)
- Downgradient Sparge Trench Operation (Years 1–10)
- Benzene MCL met in the Chena River within 10 years (Years 1–10)

Year	1	2	3	4	5	6	7	8	9	10
Operation of Active Treatment System										
Periodic Site Visits for System Checks	20,160	20,160	6,720	6,720	6,720	3,360	3,360	3,360	3,360	3,360
Source Area SVE/AS O&M Repairs (5% of capital)	83,277	83,277								
Soil Heating O&M Repair (5% of capital)	815,800	815,800								
AS Trench O&M Repairs (5% of capital)	31,250	31,250	31,250	31,250	31,250	31,250	31,250	31,250	31,250	31,250
SVE/AS system propane	100,000	100,000								
Source Area Monitoring										
Project Management	25,920	25,920	8,640	8,640	8,640					2,160
Vapor monitoring (pre- and post- offgas)	40,320	40,320								
Groundwater monitoring within Source Area	71,780	71,780	35,880	35,880	35,880					
In situ monitoring of physical parameters	44,000	44,000								
Subsurface Soil sampling (baseline and confirmation)	43,560	43,560								
Reporting	34,560	34,560	17,280	17,280	17,280					2,880
Natural Attenuation and Institutional Controls										
Natural Attenuation Monitoring	18,780	18,780	18,780	18,780	18,780					9,380
Institutional Controls	10,000	10,000	10,000	10,000	10,000	10,000	10,000	10,000	10,000	10,000
Maintenance Reserve Fund (Contingency)										
(5% of capital costs prorated for 30 years)	6,016	6,016	6,016	6,016	6,016	6,016	6,016	6,016	6,016	6,016
Closure and Decommissioning Costs										
Closure soil sampling (Yr5)					163,000					
Decommission source area SVE/AS (Yr 5)					244,700					
Decommission Horizontal Well (Yr 5)					20,000					
Decommission Soil Heating System (Yr 5)					20,000					
Decommission Sparge Trench (Yr 30)										
Decommission NA monitoring nets (Yr 30)										
Total Annual Costs	1,345,203	1,346,203	134,586	134,586	522,296	50,626	50,626	50,626	50,626	65,056
NPV of Annual Costs	1,318,580	1,294,445	127,019	124,801	474,386	46,110	44,250	43,408	42,581	53,674

Year	11	12	13	14	15	16	17	18	19	20
Operation of Active Treatment System										
Periodic Site Visits for System Checks	3,360	3,360	3,360	3,360	3,360	3,360	3,360	3,360	3,360	3,360
Source Area SVE/AS O&M Repairs (5% of capital)										
Soil Heating O&M Repair (5% of capital)										
AS Trench O&M Repairs (5% of capital)										
SVE/AS system propane										
Source Area Monitoring										
Project Management					2,160					2,160
Vapor monitoring (pre- and post- offgas)										
Groundwater monitoring within Source Area										
In situ monitoring of physical parameters										
Subsurface Soil sampling (baseline and confirmation)										
Reporting					2,880					2,880
Natural Attenuation and Institutional Controls										
Natural Attenuation Monitoring					9,380					9,380
Institutional Controls	10,000	10,000	10,000	10,000	10,000	10,000	10,000	10,000	10,000	10,000
Maintenance Reserve Fund (Contingency)										
(5% of capital costs prorated for 30 years)	6,016	6,016	6,016	6,016	6,016	6,016	6,016	6,016	6,016	6,016
Closure and Decommissioning Costs										
Closure soil sampling (Yr5)										
Decommission source area SVE/AS (Yr 5)										
Decommission Horizontal Well (Yr 5)										
Decommission Soil Heating System (Yr 5)										
Decommission Sparge Trench (Yr 30)										
Decommission NA monitoring nets (Yr 30)										
Total Annual Costs	19,376	19,376	19,376	19,376	33,806	19,376	19,376	19,376	19,376	33,806
NPV of Annual Costs	15,881	15,383	15,088	14,802	25,335	14,244	13,972	13,708	13,445	23,012

Year	21	22	23	24	25	26	27	28	29	30
Operation of Active Treatment System										
Periodic Site Visits for System Checks	3,360	3,360	3,360	3,360	3,360	3,360	3,360	3,360	3,360	3,360
Source Area SVE/AS O&M Repairs (5% of capital)										
Soil Heating O&M Repair (5% of capital)										
AS Trench O&M Repairs (5% of capital)										
SVE/AS system propane										
Source Area Monitoring										
Project Management					2,160					2,160
Vapor monitoring (pre- and post- offgas)										
Groundwater monitoring within Source Area										
In situ monitoring of physical parameters										
Subsurface Soil sampling (baseline and confirmation)										
Reporting					2,880					2,880
Natural Attenuation and Institutional Controls										
Natural Attenuation Monitoring					9,380					9,380
Institutional Controls	10,000	10,000	10,000	10,000	10,000	10,000	10,000	10,000	10,000	10,000
Maintenance Reserve Fund (Contingency)										
(5% of capital costs prorated for 30 years)	6,016	6,016	6,016	6,016	6,016	6,016	6,016	6,016	6,016	6,016
Closure and Decommissioning Costs										
Closure soil sampling (Yr5)										
Decommission source area SVE/AS (Yr 5)										
Decommission Horizontal Well (Yr 5)										
Decommission Soil Heating System (Yr 5)										
Decommission Sparge Trench (Yr 30)										20,000
Decommission NA monitoring nets (Yr 30)										15,000
Total Annual Costs	19,376	19,376	19,376	19,376	33,806	19,376	19,376	19,376	19,376	68,806
NPV of Annual Costs	12,938	12,692	12,450	12,213	20,902	11,752	11,528	11,308	11,093	30,643

Total NPV of Annual Costs $ 3,889,254

Total Costs $ 7,498,763

Table E-4
Cost Summary for WQFS 1 Selected Alternative (Alternative 5 Without Heating

Direct Capital Costs

	Cost		
Natural Attenuation Groundwater Monitoring Nests			
Probe installation (nested groups at 20' 40' 60')	28,800		
Active Treatment System			
Treatment System	569,302		
Instrumentation	13[illegible] 150		
Horizontal AS Wells Total Feet	2[illegible] 294		
SVE Wells	[illegible] 400		
Monitoring Wells	32,400		
Trenching and Pipe Installation	157,500		
Procurement and Scheduling	80 000		
Mobilization	4[illegible] 000		
Existing Fuel Pipeline Pigging	[illegible] 600		
Electric Utility Connections and As-builts	3[illegible] 700		
Installation Oversight	60,000		
Baseline Sampling and Startup Testing	149 700		
Site Restoration and Demob	89,500	$	1[illegible],5,546
Mobilization	112,500		
AS Pipe Installation, 1200 feet	360,000		
Treatment systems	100,000		
AS instrumentation	25,000		
Installation oversight	7,500		
Demobilization	20,000	$	625,000
Closure and Decommissioning			
Decommission existing wells and probes	43,800		
Total Direct Capital Costs	$ 2,363,146		

Indirect Capital Costs

Engineering (10% of Direct Capital Costs):	
Engineering Institutional Control Planning	547
Engineering Natural Attenuation Program Planning	2,880
Engineering Active Treatment System Design	229,086
Engineering · Planning for decommissioning	44,150
E	4,924
License and Contingency:	
License/Permit/Legal (6% of capital)	165,651
Contingency (15% of capital)	414,127
Total Indirect Capital Costs	861,333
Total Direct and Indirect Capital Costs	$ 3,224,479

The Selected Alternative (Alternative 5 without heating) for WQFS1 is:
Source Area Treatment with Soil Vapor Extraction and Air Sparging, Operation of the Potential Downgradient Air Sparging Trench Institutional Controls, and Monitored and Evaluated Natural Attenuation

Assumes the following treatability studies are in operation and will be incorporated into the RD/RA.
1 Horizontal AS/SVE Wells
2 Source Area AS/SVE using vertical wells (this Hart Crowser treatability study is located on the west side of WQFS1)
3 Source Area AS/SVE using vertical wells (this CH2M HILL treatability study is located on the east side of WQFS1)

Assumes the following treatment systems are not currently installed but will be installed as part of the RD/RA:
1 Source Area AS/SVE in portions of the free product plume not addressed by the current treatability studies
2 Potential downgradient AS trench

Operations and Maintenance Costs

Milestones: Source area treatment, and horizontal well operation (Years 1–5); Downgradient Sparge Trench Operation (Years 1–10); Benzene MCL met in the Chena River within 10 years (Years 1–10)

Year	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
Operation of Active Treatment System															
Periodic Site Visits for System Checks	16,800	16,800	16,800	16,800	16,800	5,600	5,600	5,600	2,800	2,800	2,800	2,800	2,800	2,800	2,800
SVE/AS system O&M (5% of capital)	83,277	83,277	83,277	83,277	83,277										
AS Trench O&M (5% of capital)	31,250	31,250	31,250	31,250	31,250	31,250	31,250	31,250	31,250	31,250					
SVE/AS system propane	100,000	100,000	100,000	100,000	100,000										
Source Area Monitoring															
Project Management	25,920	25,920	25,920	25,920	25,920	8,640	8,640	8,640		2,160					2,160
Vapor monitoring (pre- and post- offgas)	40,320	13,440	13,440	13,440	13,440										
Groundwater monitoring within Source Area	71,760	71,760	71,760	71,760	71,760	35,880	35,880	35,880							
In situ monitoring of physical parameters	44,000	44,000	44,000	44,000	44,000										
Subsurface Soil sampling (baseline and confirmation)	43,560				43,560										
Reporting	34,560	34,560	34,560	34,560	34,560	17,280	17,280	17,280		2,880					2,880
Natural Attenuation Monitoring and Institutional Controls															
Natural Attenuation Monitoring	18,780	18,780	18,780	18,780	18,780	18,780	18,780	18,780		9,390					9,390
Institutional Controls	10,000	10,000	10,000	10,000	10,000	10,000	10,000	10,000	10,000	10,000	10,000	10,000	10,000	10,000	10,000
Maintenance Reserve Fund (Contingency)															
(5% of capital costs prorated for 30 years)	5,374	5,374	5,374	5,374	5,374	5,374	5,374	5,374	5,374	5,374	5,374	5,374	5,374	5,374	5,374
Closure and Decommissioning Costs															
Closure soil sampling (Yr 8)								103,000							
Decommission source area SVE/AS (Yr 8)								244,700							
Decommission Horizontal Well (Yr 8)								20,000							
Decommission sparge Trench (Yr 30)															
Decommission NA monitoring nest (Yr 30)															
Total Annual Costs	525,60	456,161	456,161	456,161	498,721	132,804	132,804	500,504	40,424	63,854	18,174	18,174	18,174	18,174	32,604
NPV of Annual Costs	515,580	437,987	429,634	421,457	453,010	118,336	116,080	429,142	41,570	52,882	14,709	14,429	14,154	13,884	24,424
Total NPV of Annual Costs	$ 3,316,546														
Total Costs	$ 6,541,045														

Year	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30
Periodic Site Visits for System Checks	2,800	2,800	2,800	2,800	2,800	2,800	2,800	2,800	2,800	2,800	2,800	2,800	2,800	2,800	2,800
Project Management					2,160					2,160					2,160
Reporting					2,880					2,880					2,880
Natural Attenuation Monitoring					9,390					9,390					9,390
Institutional Controls	10,000	10,000	10,000	10,000	10,000	10,000	10,000	10,000	10,000	10,000	10,000	10,000	10,000	10,000	10,000
(5% of capital costs prorated for 30 years)	5,374	5,374	5,374	5,374	5,374	5,374	5,374	5,374	5,374	5,374	5,374	5,374	5,374	5,374	5,374
Decommission sparge Trench (Yr 30)															20,000
Decommission NA monitoring nest (Yr 30)															10,000
Total Annual Costs	18,174	18,174	18,174	18,174	32,604	18,174	18,174	18,174	18,174	32,604	18,174	18,174	18,174	18,174	62,604
NPV of Annual Costs	13,380	13,106	12,856	12,611	22,194	12,136	11,904	11,678	11,456	20,159	11,023	10,813	10,607	10,405	35,180

Table E-5

Cost Summary for WQFS2 Selected Alternative (Alterna·ve 3)

Direct Capital Costs

	Cost	
Natural Attenuation Groundwater Monitoring Nests		
Probe installation (nested groups at 20' 40' 60'	21,800	
Active Treatment System		
Treatment System	215,400	
Instrumentation	53,850	
A' Wells	26,500	
SVE Wells	4,200	
Monitoring wells	14,400	
Trenching and Pipe Installation	141,250	
Procurement and Scheduling	40,000	
Mobilization	35,000	
Existing fuel pipeline piggin	20,000	
Electric Utility Connections and As built	36,725	
Installation Oversight	45,000	
Baseline Sampling and Startup Testing	84,600	
Site Restoration and Demob	12,500	$728,825
Closure and Decommissioning		
Decommission existing wells and probes	20,000	
Total Direct Capital Costs	$770,425	

Indirect Capital Costs

Engineering (10% of Direct Capital Costs):		
Engineering: Institutional Control Planning		$47
Engineering: Natural Attenuation Program Planning		2,180
Engineering: Active Treatment System Design		72,883
Engineering: Planning for Decommissioning		19,800
Engineering: Modify Fort Wainwright Comprehensive Plan		4,924
License and Contingency:		
License/Permit/Legal (6% of capital)		58,436
Contingency (15% of capital)		141,964
Total Indirect Capital Costs	$	300,513
Total Direct and Indirect Capital Costs	$	1,070,938

The Selected Alternative (Alternative 3) for WQFS2 is:
Hot Spot Treatment with Soil Vapor Extraction and Air Sparging, Continued Operation of the Downgradient Air Sparging Curtain, Groundwater Monitoring, Institutional Controls, and Monitored and Evaluated Natural Attenuation

Assumes the following treatability studies are in operation and will be incorporated into the RD/RA:
1. Downgradient AS Curtain

Assumes the following treatment systems are not currently installed but will be installed as part of the RD/RA.
1. Hotspot AS/SVE

Note
It was assumed that the O&M Repair cost for the AS Curtain would cost approximately the same amount as the hot spot AS/SVE O&M Repairs because the sizes of both systems are similar

Operations and Maintenance Costs

Milestones: Source area treatment and downgradient sparge curtain operation (Years 1–5); Benzene MCL met in the Chena River within 10 years (Years 1–10)

Year	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
Operation of Active Treatment System															
Periodic Site Visits for System Checks	13,440	13,440	13,440	13,440	13,440										
SVE/AS system O&M Repairs (5% of capital)	36,441	36,441	36,441	36,441	36,441										
AS Curtain O&M Repairs	36,441	36,441	36,441	36,441	36,441										
SVE/AS system propane	30,000	30,000	30,000	30,000	30,000										
Source Area Monitoring															
Project Management	17,280	17,280	17,280	17,280	17,280	5,760	5,760	5,760		1,440					1,440
Vapor monitoring (pre- and post- offgas)	23,520	7,840	7,840	7,840	7,840										
Groundwater monitoring within Source Area	23,760	33,780	33,780	33,780	33,780	16,880	16,880	16,880							
In situ monitoring of physical parameters	11,000	11,000	11,000	11,000	11,000										
Subsurface Soil sampling (baseline and confirmation)	29,320				29,320										
Reporting	30,720	30,720	30,720	30,720	30,720	15,360	15,360	15,360		2,560					2,560
Natural Attenuation and Institutional Controls															
Natural Attenuation Monitoring	9,280	9,280	9,280	9,280	9,280	9,280	9,280	9,280		4,640					4,640
Institutional Controls	10,000	10,000	10,000	10,000	10,000	10,000	10,000	10,000	10,000	10,000	10,000	10,000	10,000	10,000	10,000
Maintenance Reserve Fund (Contingency) (5% of capital costs prorated for 30 years)	1,785	1,785	1,785	1,785	1,785	1,785	1,785	1,785	1,785	1,785	1,785	1,785	1,785	1,785	1,785
Closure and Decommissioning Costs															
Closure soil sampling (Yr 8)								51,000							
Decommission source area SVE/AS 1 (Yr 8)								125,000							
Decommission sparge curtain (Yr 8)								17,000							
Decommission NA monitoring nest (Yr 30)															
Total Annual Costs	282,987	237,987	237,987	237,987	267,307	58,085	59,085	252,085	11,785	20,425	11,785	11,785	11,785	11,785	20,425
NPV of Annual Costs	277,597	229,006	224,640	220,365	242,907	52,630	51,627	216,126	9,912	16,851	9,530	9,366	9,178	9,003	15,307
Total NPV of Annual Costs	$1,728,804														
Total Costs	$2,800,831														

Year	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30
Source Area Monitoring															
Project Management					1,440					1,440					1,440
Reporting					2,560					2,580					2,560
Natural Attenuation and Institutional Controls															
Natural Attenuation Monitoring					4,640					4,640					4,640
Institutional Controls	10,000	10,000	10,000	10,000	10,000	10,000	10,000	10,000	10,000	10,000	10,000	10,000	10,000	10,000	10,000
Maintenance Reserve Fund (Contingency) (5% of capital costs prorated for 30 years)	1,785	1,785	1,785	1,785	1,785	1,785	1,785	1,785	1,785	1,785	1,785	1,785	1,785	1,785	1,785
Decommission NA monitoring nest (Yr 30)															10,500
Total Annual Costs	11,785	11,785	11,785	11,785	20,425	11,785	11,785	11,785	11,785	20,425	11,785	11,785	11,785	11,785	30,925
NPV of Annual Costs	8,663	8,498	8,336	8,178	13,903	7,869	7,719	7,572	7,428	12,629	7,148	7,012	6,878	6,747	17,388

Table E-6

Cost Summary for WQFS3 Selected Alternative (Alternative 3)

Direct Capital Costs

	Cost
Natural Attenuation Groundwater Monitoring Nests	
Probe installation (nested groups at 20', 40', 60')	14 400
Active Treatment System	
Treatment System	74,00[illegible]
Instrumentation	18 5[illegible]
AS Wells	4 [illegible]0
SVE Wells	1 400
Monitoring wells	10 800
Trenching and Pipe Installation	23,750
Procurement and Scheduling	20 000
Mobilization	20,000
Existing fuel pipeline pigging	20,000
Electric Utility Connections and As-builts	12,025
Installation Oversight	15 000
Baseline Sampling and Startup Testing	33,00[illegible]
Site Restoration and Demob	12 500
	265,475
Closure and Decommissioning	
Decommission existing wells and probes	31,000
Total Direct Capital Costs	$ 310,875

Indirect Capital Costs

Engineering (10% of Direct Capital Costs):	
Engineering: Institutional Control Planning	547
Engineering: Natural Attenuation Program Planning	1 440
Engineering: Active Treatment System Design	26,548
Engineering: Planning for Decommissioning	12,650
Engineering: Modify Fort Wainwright Comprehensive Plan	4,924
License and Contingency:	
License/Permit/Legal (6% of capital)	24,023
Contingency (15% of capital)	60,056
Total Indirect Capital Costs	$ 129,587
Total Direct and Indirect Capital Costs	$ 440,462

The Selected Alternative (Alternative 3) for WQFS3 is:
Hot Spot Treatment with Soil Vapor Extraction and Air Sparging, Institutional Controls, and Monitored and Evaluated Natural Attenuation

Assumes there are currently no treatability studies

Assumes the following treatment systems are not currently installed but will be installed as part of the RD/RA:
1 Hotspot AS/SVE

Operations and Maintenance Costs

Milestones: Source Area Treatment operation (Years 1–5); Benzene MCL met in the Chena River within 10 years

Year	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
Operation of Active Treatment System															
Periodic Site Visits for System Checks	6,720	6,720	6,720	6,720	6 720										
AS SVE O&M Repairs (5% of capital)	13,274	13,274	13,274	13,274	13,274										
SVE/AS system propane	20,000	20,000	20,000	20,000	20,000										
Source Area Monitoring															
Project Management and Field Coordination	12,980	12,980	12,980	12,980	12,980	4,320	4,320	4,320		1,080					1,080
Vapor monitoring (pre- and post- offgas)	15 120	5,040	5,040	5,040	5,040										
Groundwater monitoring within Source Area	26,160	26,160	26,160	26,160	26,160	13,080	13,080	13,080							
In situ monitoring of physical parameters	6,000	6,000	6,000	6,000	6,000										
Subsurface Soil sampling (baseline and confirmation)	29 320				29 320										
Reporting	23,040	23,04C	23,040	23,040	23 040	11,520	11,520	11,520		1 920					1 920
Natural Attenuation Monitoring and Institutional Controls															
Natural Attenuation Monitoring	7,380	7,380	7,380	7,380	7,380	7,380	7,380	7,380		3 690					3,690
Institutional Controls	5,000	5,000	5,000	5,000	5 000	5,000	5,000	5,000	5,000	5,000	5,000	5 000	5,000	5,000	5,000
Maintenance Reserve Fund (Contingency)															
(5% of capital costs prorated for 30 years)	734	734	734	734	734	734	734	734	734	734	734	734	734	734	734
Closure and Decommissioning Costs															
Closure soil sampling (Yr 8)								52,000							
Decommission source area SVE/AS (Yr 8)								30,000							
Decommission NA monitoring nest (Yr 30)															
Total Annual Costs	165,708	126 308	126 308	126,308	156,628	42 034	42,034	124,034	5 734	12 424	5,734	5 734	5 734	5,734	12 424
NPV of Annual Costs	162,552	121,542	119,224	116,955	141,363	37,465	36 741	106,349	4 823	10,758	4 641	4 563	4 466	4 381	9 311

Year	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30
Operation of Active Treatment System															
Periodic Site Visits for System Checks															
AS SVE O&M Repairs (5% of capital)															
SVE/AS system propane															
Source Area Monitoring															
Project Management and Field Coordination					1,080					1,080					1,080
Vapor monitoring (pre- and post- offgas)															
Groundwater monitoring within Source Area															
In situ monitoring of physical parameters															
Subsurface Soil sampling (baseline and confirmation)															
Reporting					1,920					1,920					1,920
Natural Attenuation Monitoring and Institutional Controls															
Natural Attenuation Monitoring					3 690					3,690					3 690
Institutional Controls	5,000	5,000	5,000	5,000	5,000	5 000	5 000	5 000	5 000	5,000	5,000	5,000	5,000	5,000	5,000
Maintenance Reserve Fund (Contingency)															
(5% of capital costs prorated for 30 years)	734	734	734	734	734	734	734	734	734	734	734	734	734	734	734
Closure and Decommissioning Costs															
Closure soil sampling (Yr 8)															
Decommission source area SVE/AS (Yr 8)															
Decommission NA monitoring nest (Yr 30)															7 500
Total Annual Costs	5,734	5,734	5 734	5 734	12 424	5 734	5 734	5 734	5 734	12 424	5 734	5 734	5 734	5,734	12 424
NPV of Annual Costs	4,215	4 135	4 056	3,979	8 457	3 829	3,756	3 684	3 614	7 682	3 478	3 412	3 347	3 283	6 978

Total NPV of Annual Costs $ 952,589

Total Costs $ 1,392,971

Table E-7

Cost Summary for EOFS Selected Alternative (Alternative 2)

Direct Capital Costs

	Cost
Institutional Controls:	
Install High Visibility Signs	16,905
Natural Attenuation Groundwater Monitoring Nests	
Probe installation (nested groups at 20', 40', 60'	53,517
Active Treatment System	
Existing fuel pipeline pigging (before system install)	-
Procurement, scheduling and permitting	-
Mobilization	-
Install/develop horizontal AS wells	-
Install/develop vertical SVE wells	-
Install conveyance piping, set connex, and connect	-
Electrical hook up and as-built survey	-
Install monitoring nests (groundwater and vadose)	-
Site restoration and demobilization	-
Baseline sampling and startup testing	-
Closure and Decommissioning	
Decommission existing wells and probes	90,108
Total Direct Capital Costs	$ 160,530

Indirect Capital Costs

Engineering (10% of Direct Capital Costs):	
Engineering: Institutional Control Planning	1,691
Engineering: Natural Attenuation Program Planning	5,352
Engineering: Active Treatment System Design	-
Engineering: Planning for Decommissioning	18,181
Engineering: Modify Fort Wainwright Comprehensive Plan	7,055
License and Contingency:	
Lic (6% installed capital costs)	15,134
Co (15% capital costs)	37,835
Total Indirect Capital Costs	$ 57,878
Total Direct and Indirect Capital Costs	$ 218,408

The Selected Alternative (Alternative 2) for EOFS is:
Continued Operation of the Building 1060 SVE/AS Treatability Study System, Institutional Controls, and Monitored and Evaluated Natural Attenuation

Assumes the following treatability studies are in operation and will be incorporated into the RD/RA.
1 Building 1060 SVE/AS

Assumes no additional treatment systems will be installed as part of the RD/RA.

Note:
The Building 1060 TS O&M Repairs were assumed to be equal to the O&M Repairs for the WOFS3 Hot Spot AS/SVE system

Operations and Maintenance Costs

Milestones: Continued Operation of Bldg 1060 TS (Years 1–5); Benzene MCL met in the Chena River within 10 years (Years 1–10)

Year	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
Operation of Active Treatment System															
Periodic Site Visits for System Checks	3,360	3,360	3,360	3,360	3,360										
Building 1060 TS O&M Repairs	13,274	13,274	13,274	13,274	13,274										
Source Area Monitoring															
Project Management	6,480	6,480	6,480	6,480	6,480	4,320	4,320	4,320		1,080					1,080
Vapor monitoring (pre- and post- offgas)	5,040	5,040	5,040	5,040	5,040										
Groundwater monitoring within Source Area	33,760	33,760	33,760	33,760	33,760	16,880	16,880	16,880							
In situ monitoring of physical parameters	6,000	6,000	6,000	6,000	6,000										
Subsurface Soil sampling (baseline and confirmation)	22,200				22,200										
Reporting	23,040	23,040	23,040	23,040	23,040	11,520	11,520	11,520		1,920					1,920
Natural Attenuation Monitoring and Institutional Controls															
Natural Attenuation Monitoring	9,280	9,280	9,280	9,280	9,280	9,280	9,280	9,280		4,640					4,640
Institutional Controls	5,000	5,000	5,000	5,000	5,000	5,000	5,000	5,000	5,000	5,000	5,000	5,000	5,000	5,000	5,000
Maintenance Reserve Fund (Contingency)															
(5% of capital costs prorated for 30 years)	546	546	546	546	546	546	546	546	546	546	546	546	546	546	546
Closure and Decommissioning Costs															
Closure soil sampling (Yr 8)								52,000							
Decommission source area Building 1060 TS (Yr 8)								30,000							
Decommission NA monitoring nest (Yr 30)															
Annual Costs	346,389	105,782	105,783	105,784	127,985	47,552	47,553	129,554	5,556	13,196	5,557	5,558	5,559	5,560	13,201
NPV of Annual Costs	339,791	101,791	99,860	97,951	116,254	42,372	41,565	111,082	4,672	10,887	4,497	4,413	4,329	4,246	9,893

Year	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30
Operation of Active Treatment System															
Periodic Site Visits for System Checks															
Building 1060 TS O&M Repairs															
Source Area Monitoring															
Project Management					1,080					1,080					1,080
Vapor monitoring (pre- and post- offgas)															
Groundwater monitoring within Source Area															
In situ monitoring of physical parameters															
Subsurface Soil sampling (baseline and confirmation)															
Reporting					1,920					1,920					1,920
Natural Attenuation Monitoring and Institutional Controls															
Natural Attenuation Monitoring					4,640					4,640					4,640
Institutional Controls	5,000	5,000	5,000	5,000	5,000	5,000	5,000	5,000	5,000	5,000	5,000	5,000	5,000	5,000	5,000
Maintenance Reserve Fund (Contingency)															
(5% of capital costs prorated for 30 years)	546	546	546	546	546	546	546	546	546	546	546	546	546	546	546
Closure and Decommissioning Costs															
Closure soil sampling (Yr 8)															
Decommission source area Building 1060 TS (Yr 8)															
Decommission NA monitoring nest (Yr 30)															9,700
Annual Costs	5,562	5,563	5,564	5,565	13,206	5,567	5,568	5,569	5,570	13,211	5,572	5,573	5,574	5,575	22,916
NPV of Annual Costs	4,089	4,012	3,936	3,862	8,989	3,717	3,647	3,578	3,511	8,168	3,380	3,316	3,253	3,192	12,870

Total NPV of Annual Costs $ 1,067,115

Total Costs $ 1,285,523

Table E-8
Cost Summary for RA1A Selected Alternative (Alternative 2)

Direct Capital Costs

	Cost
Institutional Controls	
Install High Visibility Signs	6,000
Active Treatment System	
Soil Cover and Revegetation	0
Total Direct Capital Costs	$ 6,000

Indirect Capital Costs

Engineering (10% of Direct Capital Costs):	
Engineering: Institutional Control Planning	600
License and Contingency:	
Lice (6% installed capital costs)	360
Con (15% capital costs)	900
Total Indirect Capital Costs	1,860
Total Direct and Indirect Capital Costs	$ 7,860

The Selected Alternative (Alternative 2) for RA1A is:
Institutional Controls

Assumes fencing surrounding the site is already in place.

Operations and Maintenance Costs

Year	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
Institutional Controls															
Maintenance	8,000	8,000	8,000	8,000	8,000	8,000	8,000	8,000	8,000	8,000	8,000	8,000	8,000	8,000	8,000
Maintenance Reserve Fund															
(5% of capital costs prorated for 30 years)	13	13	13	13	13	13	13	13	13	13	13	13	13	13	13
Total Annual Costs	8,013	8,013	8,013	8,013	8,013	8,013	8,013	8,013	8,013	8,013	8,013	8,013	8,013	8,013	8,013
NPV of Annual Costs	7,860	7,711	7,564	7,420	7,279	7,140	7,004	6,871	6,740	6,611	6,485	6,362	6,240	6,122	6,005
Total NPV of Annual Costs	$ 180,911														
Total Costs	$ 188,771														

Year	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30
Institutional Controls															
Maintenance	8,000	8,000	8,000	8,000	8,000	8,000	8,000	8,000	8,000	8,000	8,000	8,000	8,000	8,000	8,000
Maintenance Reserve Fund															
(5% of capital costs prorated for 30 years)	13	13	13	13	13	13	13	13	13	13	13	13	13	13	13
Total Annual Costs	8,013	8,013	8,013	8,013	8,013	8,013	8,013	8,013	8,013	8,013	8,013	8,013	8,013	8,013	8,013
NPV of Annual Costs	5,891	5,778	5,668	5,560	5,455	5,351	5,249	5,149	5,051	4,955	4,860	4,768	4,677	4,588	4,500

Direct Capital Costs

Table E-9
Direct Capital Costs for WQFS1 Selected Alternative (Alternative 5 with Heating)

	WQFS1 Cost			
Item	**Number**	**Unit Cost**	**Total**	
Natural Attenuation Well Installation	12	$ 2,400	$ 28,800	
Treatment System	1	$ 569,302	$ 569,302	
Instrumentation	1	$ 132,150	$ 132,150	
Horizontal AS Wells, Total Feet	3037	$ 90	$ 273,294	
SVE Wells	16	$ 1,400	$ 32,400	
Monitoring Wells	18	$ 1,800	$ 32,400	
Trenching and Pipe Installation	1	$ 157,500	$ 157,500	
Procurement and Scheduling	1	$ 80,000	$ 80,000	
Mobilization	1	$ 40,000	$ 40,000	
Existing Fuel Pipeline Pigging	1	$ 20,600	$ 20,600	*
Electric Utility Connections and As-builts	1	$ 38,700	$ 38,700	*
Installation Oversight	800	$ 75	$ 60,000	
Baseline Sampling and Startup Testing	1	$ 149,700	$ 149,700	*
Site Restoration and Demob	1	$ 89,500	$ 89,500	*
Decommissioning Existing Wells	1	$ 43,800	$ 43,800	*
Total			**$1,738,146**	

Notes:

Standard monitoring wells are assumed to be 30 feet deep (average) and $60/foot ($1,800 each).

Natural Attenuation monitoring wells are assumed to be 40 feet deep (average) and $60/foot ($2,400 each).

All monitoring wells are augered.

Air sparging wells are driven.

SVE wells are augered.

The treatment system includes the connex, blowers, actuated valves, motor starters, switches, PLC system, and catalytic oxidation / thermal treatment system for off gas.

Includes capital and operating costs for the air sparge trench.

Includes capital and operating costs for soil heating.

Capital costs are not included for the Hart Crowser TS or the DO 17 TS. However, operating costs are included.

Costs for the AS/SVE treatment system are based on scaling up the DO16 connex based on area treated.

= Taken directly from Final OU5 FS with no change

Table E-10
Direct Capital and Operating Costs for Soil Heating, WQFS1

Item	WQFS1 Cost				WQFS1 Cost			
	Quantity	Unit Cost	Unit	Total	Quantity	Unit Cost	Unit	Total
Direct Capital Costs								
Install heating well	140	$ 800	ea.	$ 112,000				
Set structures and complete connections	1	$ 26,000	LS	$ 26,000				
Install heating and monitoring points	1	$ 30,000	LS	$ 30,000				
Mob and demob	1	$ 90,000	LS	$ 90,000				
Subtotal				**$ 258,000**				

Operating Cost	Year 1				Year 2			
Heating System Monitoring								
Labor	52	$ 4,000	week	$ 208,000	52	$ 4,000	week	$ 208,000
Equipment and materials	12	$ 47,300	month	$ 567,600	12	$ 47,300	month	$ 567,600
Quarterly reporting	4	$ 5,000	quarter	$ 20, 000	4	$ 5, 000	quarter	$ 20,000
Routine Maintenance								
Heating system maintenance	1	$ 10,000	LS	$ 10,000	1	$ 10,000	0	$ 10,000
Maintenance reserve fund	1	$ 10,000	LS	$ 10,000	1	$ 10,000	0	$ 10,000
Subtotal				**$ 815,600**				**$ 815,600**

Notes:
Assumes a two-year heating period. Half the area is treated the first year and half is treated the second year.
A total of approximately four acres is treated over the two-year period.

Table E-11
Direct Capital Costs for WQFS1 Selected Alternative (Alternative 5 Without Heating)

Item	WQFS1 Cost			
	Number	Unit Cost	Total	
Natural Attenuation Well Installation	12	$ 2,400	$ 28,800	
Treatment System	1	$ 569,302	$ 569,302	
Instrumentation	1	$ 132,150	$ 132,150	
Horizontal AS Wells, Total Feet	3037	$ 90	$ 273,294	
SVE Wells	16	$ 1,400	$ 22,400	
Monitoring Wells	18	$ 1,800	$ 32,400	
Trenching and Pipe Installation	1	$ 157,500	$ 157,500	
Procurement and Scheduling	1	$ 80,000	$ 80,000	
Mobilization	1	$ 40,000	$ 40,000	
Existing Fuel Pipeline Pigging	1	$ 20,600	$ 20,600	*
Electric Utility Connections and As-builts	1	$ 38,700	$ 38,700	*
Installation Oversight	800	$ 75	$ 60,000	
Baseline Sampling and Startup Testing	1	$ 149,700	$ 149,700	*
Site Restoration and Demob	1	$ 89,500	$ 89,500	*
Decommissioning Existing Wells	1	$ 43,800	$ 43,800	*
Total			**$ 1,738,146**	

Notes:
Standard monitoring wells are assumed to be 30 feet
deep (average and $60/foot ($1,800 each).

Natural Attenuation monitoring wells are assumed to be 40 feet deep (average) and $60/foot ($2,400 each).
All monitoring wells are augered.
Air sparging wells are driven.
SVE wells are augered.

The treatment system includes the connex, blowers, actuated valves, motor starters, switches, PLC system, and catalytic oxidation / thermal treatment system for off gas.
Includes capital and operating costs for the air sparge trench.
Includes capital and operating costs for soil heating.

Capital costs are not included for the Hart Crowser TS or the DO 17 TS. However, operating costs are included.

Costs for the AS/SVE treatment system are based on scaling up the DO 16 connex based on area treated.
* = Taken directly from Final OU5 FS with no change

Table E-12
Direct Capital Costs for WQFS2 Selected Alternative (Alternative 3)

	WQFS2 Cost			
Item	**Number**	**Unit Cost**	**Total**	
Natural Attenuation Well Installation	9	$ 2,400	$ 21,600	
Treatment System	1	$ 215,400	$ 215,400	
Instrumentation	1	$ 53,850	$ 53,850	
AS Wells	53	$ 500	$ 26,500	
SVE Wells	3	$ 1,400	$ 4,200	
Monitoring Wells	8	$ 1,800	$ 14,400	
Trenching and Pipe Installation	1	$ 141,250	$ 141,250	
Procurement and Scheduling	1	$ 40,000	$ 40,000	
Mobilization	1	$ 35,000	$ 35,000	
Existing Fuel Pipeline Pigging	1	$ 20,000	$ 20,000	*
Electric Utility Connections and As-builts	1	$ 36,725	$ 36,725	
Installation Oversight	600	$ 75	$ 45,000	
Baseline Sampling and Startup Testing	1	$ 84,000	$ 84,000	*
Site Restoration and Demob	1	$ 12,500	$ 12,500	*
Decommissioning Existing Wells	1	$ 20,000	$ 20,000	*
Total			**$ 770,425**	

Notes:

Standard monitoring wells are assumed to be 30 feet deep (average) and $60/foot ($1,800 each).

Natural Attenuation monitoring wells are assumed to be 40 feet deep (average) and $60/foot ($2,400 each).

The Treatment system includes the connex, blowers, actuated valves, motor starters, switches, PLC system, and catalytic oxidation / thermal treatment system for off gas.

* = Taken directly from Final OU5 FS with no change

Costs do not include capital costs for air sparging curtain, but do include operating and maintenance cost for the curtain.

Table E-13
Direct Capital Costs for WQFS3 Selected Alternative (Alternative 3)

Item	Number	Unit Cost	Total	
	WQFS2 Cost			
Natural Attenuation Well Installation	6	$ 2,400	$ 14,400	
Treatment System	1	$ 74,000	$ 74,000	
Instrumentation	1	$ 18,500	$ 18,500	
AS Wells	9	$ 500	$ 4,500	
SVE Wells	1	$ 1,400	$ 1,400	
Monitoring Wells	6	$ 1,800	$ 10,800	
Trenching and Pipe Installation	1	$ 23,750	$ 23,750	
Procurement and Scheduling	1	$ 20,000	$ 20,000	
Mobilization	1	$ 20,000	$ 20,000	
Existing Fuel Pipeline Pigging	1	$ 20,000	$ 20,000	*
Electric Utility Connections and As-builts	1	$ 12,025	$ 12,025	
Installation Oversight	200	$ 75	$ 15,000	
Baseline Sampling and Startup Testing	1	$ 33,000	$ 33,000	*
Site Restoration and Demob	1	$ 12,500	$ 12,500	*
Decommissioning Existing Wells	1	$ 31,000	$ 31,000	*
Total			**$ 310,875**	

Notes:

Standard monitoring wells are assumed to be 30 feet deep (average) and $60/foot ($1,800 each).

Natural Atural Attenuation monitoring wells are assumed to be 40 feet deep (average) and $60/foot ($2,400 each).

Monitoring wells are augered.

Air sparging wells are driven.

SVE wells are augered.

The treatment system includes the connex, blowers, actuated valves, motor starters, switches, PLC system, and catalytic oxidation / thermal treatment system for off gas.

* = Taken directly from Final OU5 FS with no change

Monitoring Costs

Table E-14

Monitoring Costs for WQFS1 Selected Alternative (Alternative 5 with Heating)

Sampling and Labor Assumptions

	Samples per event	Analysis cost per sample ($)	Labor Hours per Event	Labor Rate per hour ($)	Time Period	Events per year	Total Analysis Cost	Total Labor Cost	Total	Time Period	Events per year	Total Analysis Cost	Total Labor Cost	Total	Time Period	Events per year	Total Analysis Cost	Total Labor Cost	Total
Operation of Active Treatment System																			
Monthly Site Visits for System Checks			24	$70	Years 1 and 2	12		$20,160	$20,160	Years 3 to 5	4		$6,720	$6,720	30	2		$3,360	$3,360
Source Area Monitoring																			
Project management and field coordination			24	$90	Years 1 and 2	12		$25,920	$25,920	Years 3 to 5	4		$8,640	$8,640	15, 20, 25,	1		$2,160	$2,160
Vapor monitoring (pre- and post- offgas treatment)	8	$350	8	$70	Year 1	12	$33,600	$6,720	$40,320	Year 2	12	$33,600	$6,720	$40,320					
Groundwater monitoring within Source Area	18	$600	102	$70	Years 1 and 2	4	$43,200	$28,560	$71,760	Years 3 to 5	2	$21,600	$14,280	$35,880					
In situ monitoring of physical parameters					Years 1 and 2				$44,000										
Subsurface Soil sampling (baseline and confirmation)	12	$3,000	108	$70	Years 1 and 2	1	$36,000	$7,560	$43,560										
Reporting			36	$80	Years 1 and 2	12		$34,560	$34,560	Years 3 to 5	6		$17,280	$17,280	15, 20, 25,	1		$2,880	$2,880
Natural Attenuation Monitoring																			
Natural Attenuation Monitoring	9	$600	57	$70	Years 1 to 5	2	$10,800	$7,980	$18,780							1	$5,400	$3,990	$9,390

Bold numbers indicate the parameters that vary by Sub-area

Assumptions:

Project Management time assumes24 hrs per month; twelve months during Years 1 to 5, four months during Years 6 to 8, and one month during Years 10, 15, 20, 25, and 30

Vapor Monitoring assumes 2 samples each from: horizontal well TS, Hart Crowser TS, Source area TS, and the one connex installed under the RD/RA (8 locations total).

Groundwater and Natural Attenuation Monitoring Labor: two staff to sample, 2.5 hrs per sample. 4 hrs mob/demob, 8 hrs lab coordination and data management.

Subsurface soil sampling: Number of samples indicates number of borings to be installed; cost per boring includes borehole advancement, sample collection, and sample analysis.

Subsurface soil sampling Labor: two staff to sample, 4 hrs per borehole, 4 hrs mob/demob, 8 hrs lab and subcontractor coordination, and data management.

Reporting time assumes 36 hrs per month; twelve months during Years 1 to 5, six months during Years 6 to 8, and one month during Years 10, 15, 20, 25, and 30.

Table E-17

Monitoring Costs for WQFS3 Selected Alternative (Alternative 3)

Sampling and Labor Assumptions

	Samples per event	Analysis cost per sample ($)	Labor Hours per Event	Labor Rate per hour ($)	Time Period	Events per year	Total Analysis Cost	Total Labor Cost	Total	Time Period	Events per year	Total Analysis Cost	Total Labor Cost	Total	Events per year	Total Analysis Cost	Total Labor Cost	Total
Operation of Active Treatment System																		
Monthly Site Visits for System Checks			8	$70	Years 1 to 5	12		$6,720	$6,720									
Source Area Monitoring																		
Project management and field coordination			12	$90	Years 1 to 5	12		$12,960	$12,960	Years 6 to 8	4		$4,320	$4,320	1		$1,080	$1,080
Vapor monitoring (pre- and post- offgas treatment)	2	$350	8	$70	Year 1	12	$8,400	$6,720	$15,120	Years 2 to 5	4	$2,800	$2,240	$5,040				
Groundwater monitoring within Source Area	6	$600	42	$70	Years 1 to 5	4	$14,400	$11,760	$26,160	Years 6 to 8	2	$7,200	$5,880	$13,080				
In situ monitoring of physical parameters					Years 1 to 5				$8,000									
Subsurface Soil sampling (baseline and confirmation)	8	$3,000	76	$70	Years 1 and 5	1	$24,000	$5,320	$29,320									
Reporting			24	$80	Years 1 to 5	12		$23,040	$23,040	Years 6 to 8	6		$11,520	$11,520	1		$1,920	$1,920
Natural Attenuation Monitoring																		
Natural Attenuation Monitoring	3	$600	27	$70	Years 1 to 8	2	$3,600	$3,780	$7,380						1	$1,800	$1,890	$3,690

Bold numbers indicate the parameters that vary by Sub-area.

Assumptions:

Project Management time assumes 12 hrs per month; twelve months during Years 1 to 5, four months during Years 6 to 8, and one month during Years 10, 15, 20, 25, and 30.

Vapor Monitoring assumes 2 samples from the connex installed during the RD/RA.

Groundwater and Natural Attenuation Monitoring Labor: two staff to sample, 2.5 hrs per sample, 4 hrs mob/demob, 8 hrs lab coordination and data management.

Subsurface soil sampling: Number of samples indicates number of borings to be installed; cost per boring includes borehole advancement, sample collection, and sample analysis.

Subsurface soil sampling Labor: two staff to sample, 4 hrs per borehole, 4 hrs mob/demob, 8 hrs lab and subcontractor coordination, and data management.

Reporting time assumes 24 hrs per month; twelve months during Years 1 to 5, six months during Years 6 to 8, and one month during Years 10, 15, 20, 25, and 30.

Table E-16

Monitoring Costs for WQFS2 Selected Alternative (Alternative 3)

Sampling and Labor Assumptions

	Samples per event	Analysis cost per sample ($)	Labor Hours per Event	Labor Rate per hour ($)	Time Period	Events per year	Total Analysis Cost	Total Labor Cost	Total	Time Period	Events per year	Total Analysis Cost	Total Labor Cost	Total	Events per year	Total Analysis Cost	Total Labor Cost	Total
Operation of Active Treatment System																		
Monthly Site Visits for System Checks			16	$70	Years 1 to 5	12		$13,440	$13,440	-								
Source Area Monitoring																		
Project management and field coordination			16	$90	Years 1 to 5	12		$17,280	$17,280	Years 6 to 8	4		$5,760	$5,760	1		$1,440	$1,440
Vapor monitoring (pre- and post- offgas treatment)	4	$350	8	$70	Year 1	12	$15,800	$6,720	$23,520	Years 2 to 5	4	$5,600	$2,240	$7,840				
Groundwater monitoring within Source Area	8	$600	52	$70	Years 1 to 5	4	$19,200	$14,560	$33,760	Years 6 to 8	2	$9,600	$7,280	$16,880				
In situ monitoring of physical parameters					Years 1 to 5				$11,800									
Subsurface Soil sampling (baseline and confirmation)	8	$3,000	76	$70	Years 1 and 5	1	$24,000	$5,320	$29,320									
Reporting			32	$80	Years 1 to 5	12		$30,720	$30,720	Years 6 to 8	6		$15,360	$15,360	1		$2,560	$2,560
Natural Attenuation Monitoring																		
Natural Attenuation Monitoring	4	$600	32	$70	Years 1 to 8	2	$4,800	$4,480	$9,280						1	$2,400	$2,240	$4,640

Bold numbers indicate the parameters that vary by Sub-area.

Assumptions:

Project Management time assumes 16 hrs per month; twelve months during Years 1 to 5, four months during Years 6 to 8, and one month during Years 10, 15, 20, 25, and 30.

Vapor Monitoring assumes 2 samples each from: the AS/SVE Curtain TS, and the one connex installed during the RD/RA (two locations)

Groundwater and Natural Attenuation Monitoring Labor: two staff to sample, 2.5 hrs per sample, 4 hrs mob/demob, 8 hrs lab coordination and data management.

Subsurface soil sampling: Number of samples indicates number of borings to be installed; cost per boring includes borehole advancement, sample collection, and sample analysis.

Subsurface soil sampling Labor: two staff to sample, 4 hrs per borehole, 4 hrs mob/demob, 8 hrs lab and subcontractor coordination, and data management.

Reporting time assumes 32 hrs per month; twelve months during Years 1 to 5, six months during Years 6 to 8, and one month during Years 10, 15, 20, 25, and 30

Table E-15

Monitoring Costs for WQFS 1 Selected Alternative (Alternative 5 without Heating)

Sampling and Labor Assumptions

	Samples per event	Analysis cost per sample ($)	Labor Hours per Event	Labor Rate per hour ($)	Time Period	Events per year	Total Analysis Cost	Total Labor Cost	Total	Time Period	Events per year	Total Analysis Cost	Total Labor Cost	Total	Time Period	Events per year	Total Analysis Cost	Total Labor Cost	Total
Operation of Active Treatment System																			
Monthly Site Visits for System Checks			20	$70	Years 1 to 5	12		$16,800	$16,800	Years 6 to 8	4		$5,600	$5,600	Years 9 to 30	2		$2,800	$2,800
Source Area Monitoring																			
Project management and field coordination			24	$80	Years 1 to 5	12		$25,920	$25,920	Years 6 to 8	4		$8,640	$8,640	20, 25, 30	1		$2,160	$2,160
Vapor monitoring (pre- and post- offgas treatment)	8	$350	8	$70	Year 1	12	$33,600	$6,720	$40,320	Years 2 to 5	4	$11,200	$2,240	$13,440					
Groundwater monitoring within Source Area	18	$600	102	$70	Years 1 to 5	4	$43,200	$28,560	$71,760	Years 6 to 8	2	$21,600	$14,280	$36,880					
In situ monitoring of physical parameters					Years 1 to 5				$44,000										
Subsurface Soil sampling (baseline and confirmation)	12	$3,000	108	$70	Year 1	1	$36,000	$7,560	$43,560	Year 5	1	$36,000	$7,560	$43,560					
Reporting			36	$80	Years 1 to 5	12		$34,560	$34,560	Years 6 to 8	6		$17,280	$17,280	20, 25, 30	1		$2,880	$2,880
Natural Attenuation Monitoring																			
Natural Attenuation Monitoring	9	$600	57	$70	Years 1 to 5	2	$10,800	$7,980	$18,780	Years 6 to 8	2	$10,800	$7,980	$18,780	20, 25, 30	1	$5,400	$3,990	$9,390

Bold numbers indicate the parameters that vary by Sub-area

Assumptions:

Project Management time assumes 24 hrs per month; twelve months during Years 1 to 5, four months during Years 6 to 8, and one month during Years 10, 15, 20, 25, and 30.
Vapor Monitoring assumes 2 samples each from: horizontal wall TS, Hart Crowser TS, Source area TS, and the one connex installed under the RD/RA (4 locations total).
Groundwater and Natural Attenuation Monitoring Labor: two staff to sample, 2.5 hrs per sample, 4 hrs mob/demob, 8 hrs lab coordination and data management.
Subsurface soil sampling: Number of samples indicates number of borings to be installed; cost per boring includes borehole advancement, sample collection, and sample analysis.
Subsurface soil sampling Labor: two staff to sample, 4 hrs per borehole, 4 hrs mob/demob, 8 hrs lab and subcontractor coordination, and data management
Reporting time assumes 36 hrs per month; twelve months during Years 1 to 5, six months during Years 6 to 8, and one month during Years 10, 15, 20, 25, and 30.

Table E-18

Monitoring Costs for EQFS Selected Alternative (Alternative 2)

Sampling and Labor Assumptions

	Samples per event	Analysis cost per sample ($)	Labor Hours per Event	Labor Rate per hour ($)	Time Period	Events per year	Total Analysis Cost	Total Labor Cost	Total	Time Period	Events per year	Total Analysis Cost	Total Labor Cost	Total	Events per year	Total Analysis Cost	Total Labor Cos'	Total
Operatior .1 Active Treatment System																		
Monthly Site Visits for System Checks			8	$70	Years 1 to 5	6		$3,360	$3,360									
Source Area Monitoring																		
Project management and field coordination			12	$90	Years 1 to 5	6		$6,480	$6,480	Years 6 to 8	4		$4,320	$4,320	1		$1,080	$1,080
Vapor monitoring (pre- and post- offgas treatment)	2	$350	8	$70	Year 1	4	$2,800	$2,240	$5,040	Years 2 to 5	4	$2,800	$2,240	$5,040				
Groundwater monitoring within Source Area	8	$600	52	$70	Years 1 to 5	4	$19,200	$14,560	$33,760	Years 6 to 8	2	$9,600	$7,280	$16,880				
In situ monitoring of physical parameters					Years 1 to 5				$6,000									
Subsurface Soil sampling (baseline and confirmation)	6	$3,000	60	$70	Year 1	1	$18,000	$4,200	$22,200	Year 5	1	$18,000	$4,200	$22,200				
Reporting			24	$80	Years 1 to 5	12		$23,040	$23,040	Years 6 to 8	6		$11,520	$11,520	1		$1,920	$1,920
Natural Attenuation Monitoring																		
Natural Attenuation Monitoring	4	$600	32	$70	Years 1 to 5	2	$4,800	$4,480	$9,280	Years 6 to 8	2	$4,800	$4,480	$9,280	1	$2,400	$2,240	$4,640

Bold numbers indicate the parameters that vary by Sub-area

Assumptions:

Project Management time assumes 8 hrs per month; four months during Years 1 to 8, and one month during Years 10, 15, 20, 25, and 30.

Vapor Monitoring assumes 2 samples from the Building 1060 TS.

Groundwater and Natural Attenuation Monitoring Labor: two staff to sample, 2.5 hrs per sample, 4 hrs mob/demob, 8 hrs lab coordination and data management.

Subsurface soil sampling. Number of samples indicates number of borings to be installed; cost per boring includes borehole advancement, sample collection, and sample analysis.

Subsurface soil sampling Labor: two staff to sample 4 hrs per borehole, 4 hrs mob/demob, 8 hrs lab and subcontractor coordination, and data management.

Reporting time assumes 20 hrs per month; twelve months during Years 1 to 5, six months during Years 6 to 8, and one month during Years 10, 15, 20, 25, and 30.