RECORD OF DECISION
for
OPERABLE UNIT 4
FORT WAINWRIGHT
FAIRBANKS, ALASKA

61615

RECORD OF DECISION
for
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FAIRBANKS, ALASKA

AUGUST 1996

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DECLARATION STATEMENT
for
RECORD OF DECISION
FORT WAINWRIGHT
FAIRBANKS, ALASKA
OPERABLE UNIT 4
AUGUST 1996

SOURCE AREA NAME AND LOCATION

Operable Unit 4
Fort Wainwright
Fairbanks, Alaska

STATEMENT OF BASIS AND PURPOSE

This Record of Decision (ROD) presents the selected remedial actions for Operable Unit 4 (OU-4) at Fort Wainwright in Fairbanks, Alaska. OU-4 comprises three source areas: the Landfill, the Coal Storage Yard (CSY), and the Fire Training Pits (FTPs). This ROD was developed in accordance with the Comprehensive Environmental Response, Compensation, and Liability Act of 1980 as amended by the Superfund Amendments and Reauthorization Act of 1986; 42 United States Code Section 9601 *et seq.*; and, to the extent practicable, the National Oil and Hazardous Substances Pollution Contingency Plan, 40 Code of Federal Regulations 300 *et seq.* This decision is based on the Administrative Record for this Operable Unit.

The United States Army, the United States Environmental Protection Agency, and the State of Alaska, through the Alaska Department of Environmental Conservation, have agreed to the selected remedies.

ASSESSMENT OF THE SITE

Actual or threatened releases of hazardous substances from the Landfill and CSY source areas, if not addressed by implementing the response actions selected in this ROD, may present substantial endangerment to public health, welfare, or the environment. Specific groundwater contaminants of concern at the Landfill include benzene; 1,1,2-trichloroethane; 1,1,2,2-tetrachloroethane; bis(2-ethylhexyl)phthalate; cis-1,2 dichloroethene; and trichloroethene (TCE). Groundwater contaminants at the CSY include TCE; bis(2-ethylhexyl)phthalate; toluene; and benzene.

This is the second OU to reach a final-action ROD at this National Priorities List site. This ROD addresses soil and groundwater contamination at OU-4.

Contamination at the FTPs was limited to localized contaminated petroleum "hot spots" in surface and shallow subsurface soils. Petroleum contamination, below action levels, was detected in groundwater at the FTPs. The contaminated soils will be adequately addressed through an Army removal action. Therefore, no analysis of remedial alternatives was conducted for the FTPs. It is anticipated that this

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will constitute final action for the FTPs.

DESCRIPTION OF THE SELECTED REMEDIES

Selected remedies were chosen from many alternatives as the best method of addressing contaminated soil and groundwater in OU-4. The selected remedies address the risk by reducing contamination to below cleanup levels established for OU-4.

The remedial action objectives for the Landfill and CSY will:

- Restore groundwater to drinking water quality;
- Prevent further leaching of contaminants into groundwater;
- Reduce or prevent further migration of contaminated groundwater; and
- Prevent use of groundwater containing contaminants above Safe Drinking Water Act and State Water Quality Act Standards.

The major components of the remedy at the Landfill are:

- Capping with engineering controls of the inactive portion of the Landfill;
- Institutional controls to prevent the use of contaminated groundwater and restrict site access (via fencing);
- Natural attenuation to attain Alaska Water Quality Standards (AWQS); and
- A phased approach, implementation of an active groundwater treatment system (Phase 2), will be considered if capping does not result in a significant reduction of groundwater contaminants when evaluated at the five-year review.

The major components of the remedy at the CSY are:

- In situ soil vapor extraction and air sparging of groundwater to remove solvent contaminants to a level that attains Safe Drinking Water Act levels;
- Institutional controls to prevent the use of contaminated groundwater and restrict site access; and
- Natural attenuation to attain AWQS.

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 remedies utilize permanent solutions and alternative treatment technologies to the maximum extent practicable and satisfy the statutory preference for remedies that employ treatments that reduce toxicity, mobility, or volume as a principal element.

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

SIGNATURES

Signature sheet for the foregoing Operable Unit 4, Fort Wainwright, Record of Decision between the United States Army and United States Environmental Protection Agency, Region X, with concurrence by the Alaska Department of Environmental Conservation.

William M. Steele
Lieutenant General, U.S. Army
Commanding

17 Sept 1996
Date

SIGNATURES

Signature sheet for the foregoing Operable Unit 4, Fort Wainwright, Record of Decision between the United States Army and United States Environmental Protection Agency, Region X, with concurrence by the Alaska Department of Environmental Conservation.

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

9/24/96
Date

SIGNATURES

Signature sheet for the foregoing Operable Unit 4, Fort Wainwright, Record of Decision between the United States Army and United States Environmental Protection Agency, Region X, with concurrence by the Alaska Department of Environmental Conservation.

Kurt Fredriksson 9-17-96
Kurt Fredriksson Date
Director, Spill Prevention and Response
Alaska Department of Environmental Conservation

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LIST OF ACRONYMS

AAC	Alaska Administrative Code
ADEC	Alaska Department of Environmental Conservation
ARARs	Applicable or Relevant and Appropriate Requirements
Army	United States Army
AS	Air Sparging
AWQS	Alaska Water Quality Standards
BGS	Below Ground Surface
BTEX	Benzene, Toluene, Ethylbenzene, and Total Xylenes
C	Celsius
CERCLA	Comprehensive Environmental Response, Compensation, and Liability Act
CFR	Code of Federal Regulations
cm/sec	Centimeters Per Second
CSY	Coal Storage Yard
EPA	United States Environmental Protection Agency
feet/day	Feet Per Day
FFA	Federal Facilities Agreement
foot/foot	Foot Per Foot
FS	Feasibility Study
ft/year	Feet Per Year
FTPs	Fire Training Pits
gallons/day	Gallons Per Day
gpm	Gallons Per Minute
LTTD	Low-Temperature Thermal Desorption
MCLs	Maximum Contaminant Levels
μg/L	Micrograms Per Liter
MUS	Municipal Utility System
NCP	National Contingency Plan
NPDES	National Pollution Discharge Elimination System
NPL	National Priorities List
O&M	Operation and Maintenance
OU-4	Operable Unit 4
PCA	1,1,2,2-Tetrachloroethane
POLs	Petroleum, Oil, and Lubricants
PPE	Personal Protective Equipment
RAOs	Remedial Action Objectives
RBCs	Risk-Based Concentrations
RCRA	Resource Conservation and Recovery Act
RI	Remedial Investigation

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List of Acronyms (Cont.)

ROD	Record of Decision
SARA	Superfund Amendments and Reauthorization Act of 1986
TBC	To-Be-Considered
TCE	Trichloroethene
TRPH	Total Recoverable Petroleum Hydrocarbons
USTs	Underground Storage Tanks
UV	Ultraviolet
VES	Vacuum Extraction System
VOC	Volatile Organic Compound

DECISION SUMMARY

RECORD OF DECISION
for
OPERABLE UNIT 4
FORT WAINWRIGHT
FAIRBANKS, ALASKA
AUGUST 1996

This decision summary provides an overview of the problems posed by the contaminants at Fort Wainwright, Operable Unit 4 (OU-4). 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, 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 (CERCLA) statutory requirements.

The Army completed a Remedial Investigation (RI) to provide information on the nature and extent of contamination of soil and groundwater. A Baseline Risk Assessment was 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 (FS) was completed to evaluate remedial options.

Section 1

1.0 SITE DESCRIPTION

1.1 SITE LOCATION AND DESCRIPTION

Fort Wainwright, also referred to as the "site," occupies 918,000 acres on the east side of Fairbanks, Alaska. Fort Wainwright originally was established in 1938 as a cold-weather testing station. During World War II, it served as a crew-transfer point in the Army Air Corps' lend-lease program. After the war, it became a resupply and maintenance base for the remote Distant Early Warning sites and experimental station in the Arctic Ocean. In 1961, all operations were transferred to the United States Army.

Current, primary missions at Fort Wainwright include training of 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. On-site industrial activities include use of fixed-wing aircraft, helicopters, vehicle maintenance, and support activities. Fort Wainwright includes the main post area, a range complex, and two maneuver areas.

OU-4 consists of three source areas which include the Landfill, Coal Storage Yard (CSY), and the Fire Training Pits (FTPs). The Landfill is located on the north side of the Chena River, while the CSY and the FTPs are located on the south side of the River. The Chena River flows through Fort Wainwright and the City of Fairbanks into the Tanana River. Figure 1-1 illustrates the entire installation and each source area's location.

1.1.1 Landfill Source Area

A detailed map of the Landfill source area is depicted on Figure 1-2. The Landfill source area is located at the base of Birch Hill. It includes 60 acres, approximately 40 acres north of River Road and a 20-acre area immediately south of River Road (the former trench area as shown on Figure 1-2). The older southwest portion of the Landfill and the former trench area are inactive; the remaining portion is active. Landfill activities began in the early 1950s. Based on historical aerial photographs, waste was initially dumped into gravel pits, burned, and covered. During the late 1950s, the Landfill began receiving most wastes generated at the Post. In the early 1960s, trenching and burning ceased and wastes were spread, compacted by bulldozer, and covered with coal ash generated from the Fort Wainwright power plant.

The Landfill serves Fort Wainwright only. The City of Fairbanks uses a separate landfill facility. Current refuse disposal activities are restricted to the cleared area north of River Road in accordance with State of Alaska Permit No. 9131-BA007. Refuse is added in "lifts" or compacted layers with a cover application of coal ash or soil and averages approximately 50 feet above the surrounding grade.

Wetlands border the Landfill to the north and east, and black spruce forest borders the remainder of the source area, except in areas cleared for access to the Landfill along River Road. The former trench area south of River Road is covered by an approximately 20-year-old mixed, hardwood/spruce forest. Gravel quarry pits border the former trench area on the west side. The trench area was used as a disposal area for wet garbage. The source area is in a 500-year floodplain. No endangered or threatened species reside in the area. No known historic sites are in the source area.

1.1.2 Coal Storage Yard Source Area

The CSY is south of Fort Wainwright's coal-fired cogeneration power plant as shown on Figure 1-3. This power plant is the sole source of heat and electricity for Fort Wainwright. Coal is stored in the yard directly on the ground. From the 1960s to 1993, the active coal pile was sprayed with waste petroleum fuel products, such as diesel; fuel oil; solvents; and lubricants from tanks, railroad cars, and drums, to increase the British thermal unit content of the coal and output of the plant. This practice has been discontinued.

Contaminated areas resulting from historical practices conducted at the CSY source area include soil under the active coal pile and a fenced storage area adjacent to the active coal pile. Within the fenced storage area, two underground storage tanks (USTs) used to store waste products were removed in the summer of 1995. A third tank used to store diesel for power plant equipment is located in this area. It was upgraded in 1991 and is still in use.

The areas north and east of the CSY are industrial areas, while the areas to the south and west have mixed hardwood forests. The cooling pond is a man-made pond used solely for industrial purposes to cool circulated water from the power plant. The source area is in a 500-year floodplain. No endangered or threatened species reside in the area. No known historic sites are in the source area.

1.1.3 Fire Training Pits

The FTPs source area consists of two FTPs (FTP 3A and FTP 3B) and a depression area located northwest of FTP 3B. FTP 3A consists of a large, square, grassy area surrounded by trees and is accessed through a gate at the northeast corner, as shown on Figure 1-4. Miscellaneous debris and tanks were stored within the area including a row of charred cars, trucks, and aircraft; an aboveground water tank; and empty USTs. These debris were removed in spring 1995. FTP 3B consists of a 7.5-acre area that is approximately 1 to 3 feet lower than the surrounding forest. Each of the cleared FTP areas is surrounded by thickly wooded areas and is accessed by dirt roads throughout the area. The depression area is the smallest portion of the FTP area and contains two circular areas of stained soil. This depression area is 2 feet lower than the surrounding area and is vegetated with grass and saplings.

The FTPs were used to conduct fire training exercises. During these exercises, waste petroleum fuel products such as diesel, jet petroleum, oil, solvents, transmission fluid, hydraulic fluid, and brake fluid were burned. The exercises involved saturating the soil in each unlined training pit with water, discharging fuel into the pit, igniting the fuel, then extinguishing the fire. The source area is in a 500-year floodplain. No endangered or threatened species reside in the area. No known historic sites are in the source area.

1.2 SOILS AND GEOLOGY

Fort Wainwright is underlain by soil and unconsolidated sediment that consists of silt, sand, and gravel and ranges in thickness from 10 feet to more than 400 feet before encountering bedrock. In the OU-4 source areas, soil types are more coarse-grained and include higher percentages of sand and gravel. Discontinuous permafrost is found at depths ranging from 3 feet to 50 feet or more throughout Fort Wainwright but is more prevalent on the north side of the Chena River.

1.3 HYDROGEOLOGY AND GROUNDWATER USE

The main aquifer in the Fort Wainwright area is the Tanana Basin alluvial aquifer in a buried river valley. This aquifer ranges from a few feet thick at the base of Birch Hill to at least 300 feet thick under the fort's main cantonment area. The aquifer may reach a thickness of 700 feet in the Tanana River valley. Groundwater in the Tanana-Chena floodplain generally is considered to be unconfined in permafrost-free areas. A confined aquifer may develop seasonally where the depth to the water table is less than the depth of the seasonal frost penetration.

Groundwater movement between the Tanana and Chena Rivers generally follows a northwest regional direction, similar to the flow direction of the rivers. The Chena River flows through Fort Wainwright and the City of Fairbanks into the Tanana River. The Tanana River borders the southern portion of Fort Wainwright. Flow does fluctuate seasonally because of the effects of changing river stages in the Tanana River and, to a lesser extent, in the Chena River. Groundwater levels near the Chena River fluctuate greatly because of river stage and interactions with the Tanana River. Typically, groundwater levels rise when the river stage increases, particularly during spring breakup and the late summer runoff. Groundwater levels usually drop during fall and winter, when precipitation becomes snow. During winter, groundwater seeps into surface water bodies, such as the Chena River, and produces overflow ice. In addition to shifts in the groundwater flow direction due to the surface water hydrology, the groundwater flow direction may be impacted by high-volume pumping associated with gravel pit dewatering activities.

The depth to groundwater varies and may range between 5 to 15 feet at the OU-4 source areas. Within the upper portion of the aquifer, the predominant groundwater flow direction is toward the Chena River. Groundwater in the deeper portion of the aquifer zone beneath the Landfill generally flows to the west-northwest and is partially confined by discontinuous permafrost.

Where present, permafrost forms discontinuous confining layers that influence groundwater movement and distribution. The presence of near-surface permafrost usually retards groundwater movement within the shallow subsurface. Three types of aquifers are associated with permafrost: suprapermafrost aquifers, intrapermafrost aquifers, and subpermafrost aquifers.

- A suprapermafrost aquifer is located above a permafrost layer where the permafrost acts as a relatively impermeable boundary. Suprapermafrost aquifers are usually seasonal aquifers that freeze or experience significant storage depletion in the winter. Many of the monitoring wells at Fort Wainwright and some domestic wells are completed in the suprapermafrost aquifer;

- Intrapermafrost aquifers are found in unfrozen zones (talik) within the body of permafrost; and

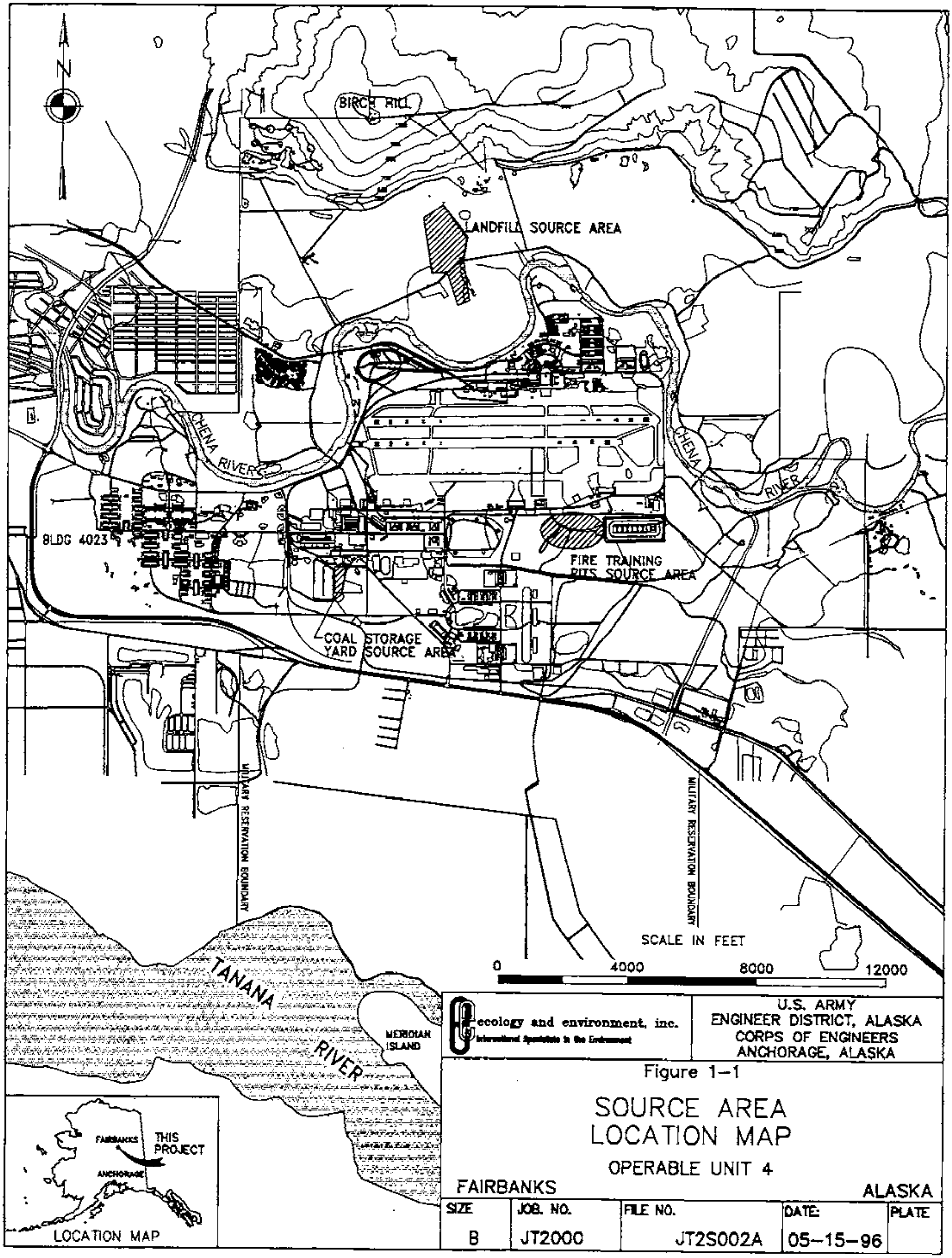
- Subpermafrost aquifers are located below the base of the permafrost.

Groundwater is the only source of potable water used at Fort Wainwright and the Fairbanks area. The Post potable water supply comes from two large-capacity wells located 900 feet hydrologically downgradient of the CSY (see Figure 1-5). The Post water supply wells are completed at depths averaging approximately 120 feet and pump at a rate of 1.5 to 2.5 million gallons per day (gallons/day) into a water treatment plant. Six standby supply wells are also located 900 feet hydrogeologically downgradient of the CSY. These wells, if used in an emergency, will supply unfiltered water to the main drinking water supply system for Fort Wainwright.

The City of Fairbanks uses this same aquifer and has four Municipal Utility System (MUS) wells located 1 mile downgradient of the Post's boundaries, on the banks of the Chena River. These wells serve as the main supply for the majority of the population of the City of Fairbanks. Four MUS wells are completed at depths approximately 90 feet below ground surface (BGS) and pump at a rate of 5 million gallons/day.

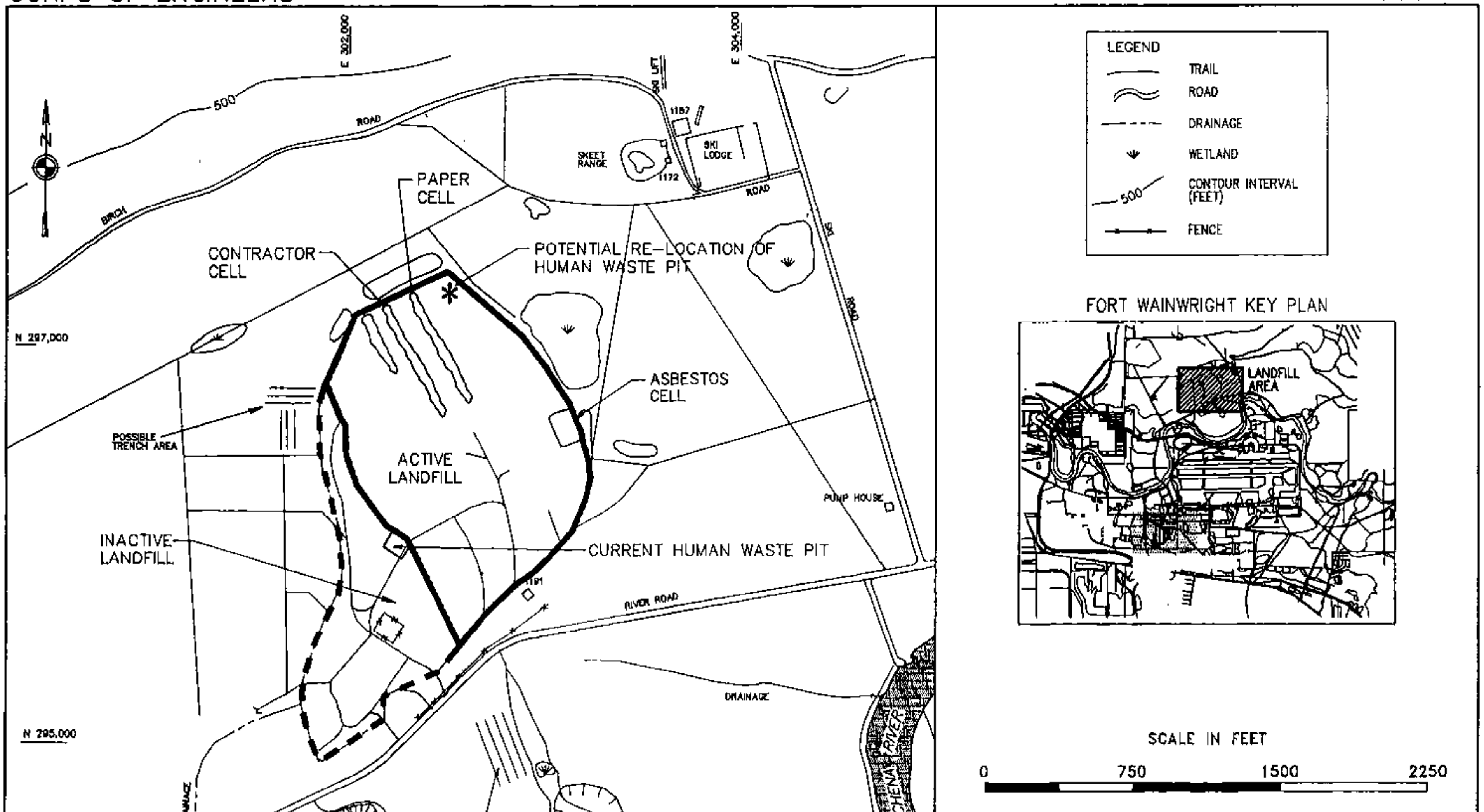
1.4 LAND USE

Current land use for the OU-4 source areas is light industrial. Domestic water use does not occur at the OU-4 source areas; however, groundwater in the aquifer underneath the OU-4 source areas is the sole source of drinking water for both Fort Wainwright and the City of Fairbanks. Access to the inactive portion of the Landfill north of River Road is currently restricted. The CSY source area also is located in a restricted area. The FTPs source area is not developed and is used for military exercises and recreation.


N
BIRCH HILL
LANDFILL SOURCE AREA
CHENA RIVER
CHENA RIVER
BLDG 4023
FIRE TRAINING PITS SOURCE AREA
COAL STORAGE YARD SOURCE AREA
MILITARY RESERVATION BOUNDARY
MILITARY RESERVATION BOUNDARY
SCALE IN FEET
0
4000
8000
12000
TANANA RIVER
MERIDIAN ISLAND
FAIRBANKS
THIS PROJECT
ANCHORAGE
LOCATION MAP
ecology and environment, inc.
U.S. ARMY
ENGINEER DISTRICT, ALASKA
CORPS OF ENGINEERS
ANCHORAGE, ALASKA
Figure 1-1
SOURCE AREA
LOCATION MAP
OPERABLE UNIT 4
FAIRBANKS
ALASKA
SIZE
B
JOB. NO.
JT2000
FILE NO.
JT2S002A
DATE:
05-15-96
PLATE

61639

CORPS OF ENGINEERS U.S. ARMY



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International Specialists in the Environment

U.S. ARMY
ENGINEER DISTRICT, ALASKA
CORPS OF ENGINEERS
ANCHORAGE, ALASKA

Figure 1–2
LANDFILL SOURCE AREA
LOCATION MAP
OPERABLE UNIT 4

FAIRBANKS ALASKA

SIZE	JOB. NO.	FILE NO.	DATE:	PLATE
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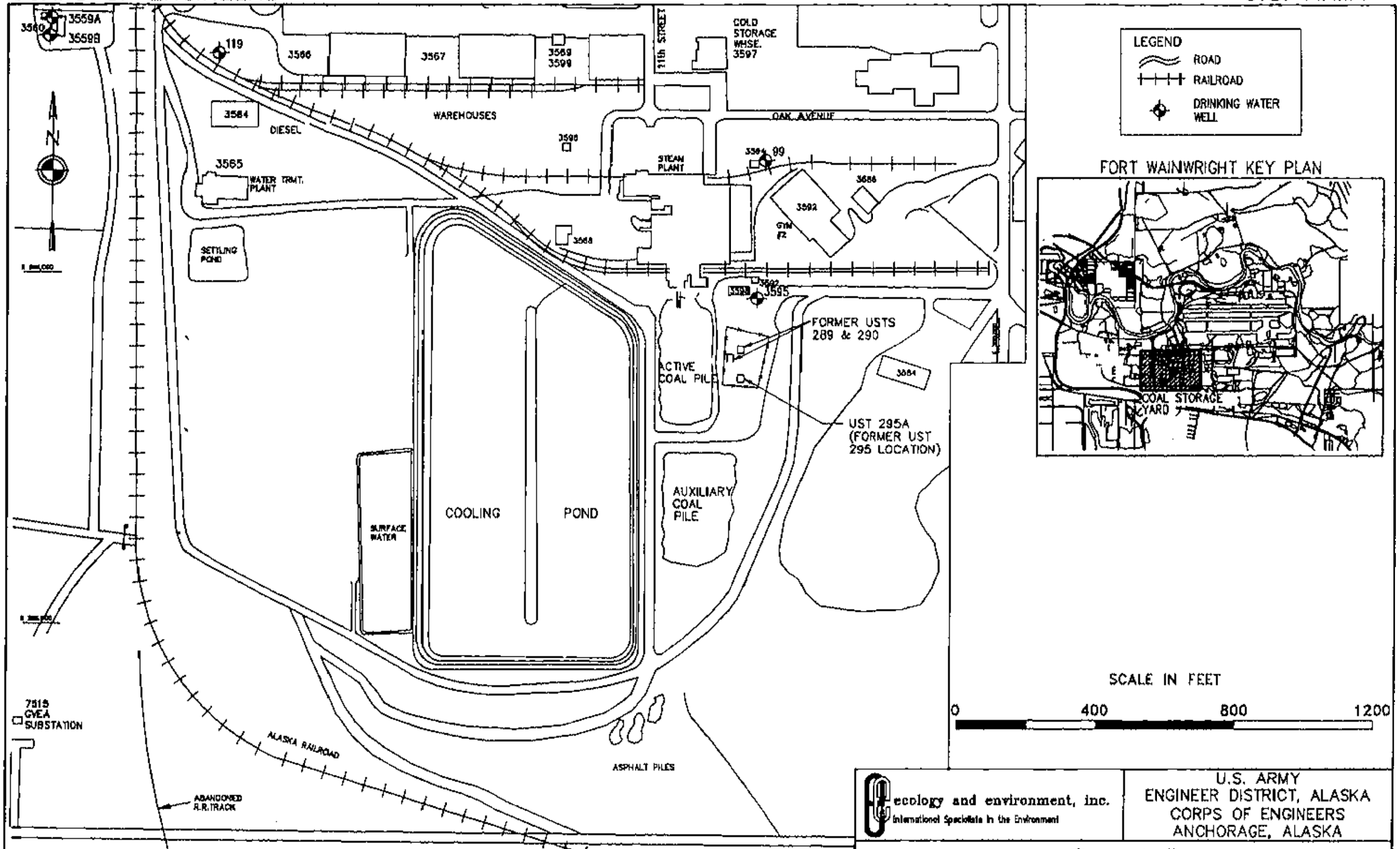
61640

CORPS OF ENGINEERS

U.S. ARMY



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U.S. ARMY
ENGINEER DISTRICT, ALASKA
CORPS OF ENGINEERS
ANCHORAGE, ALASKA

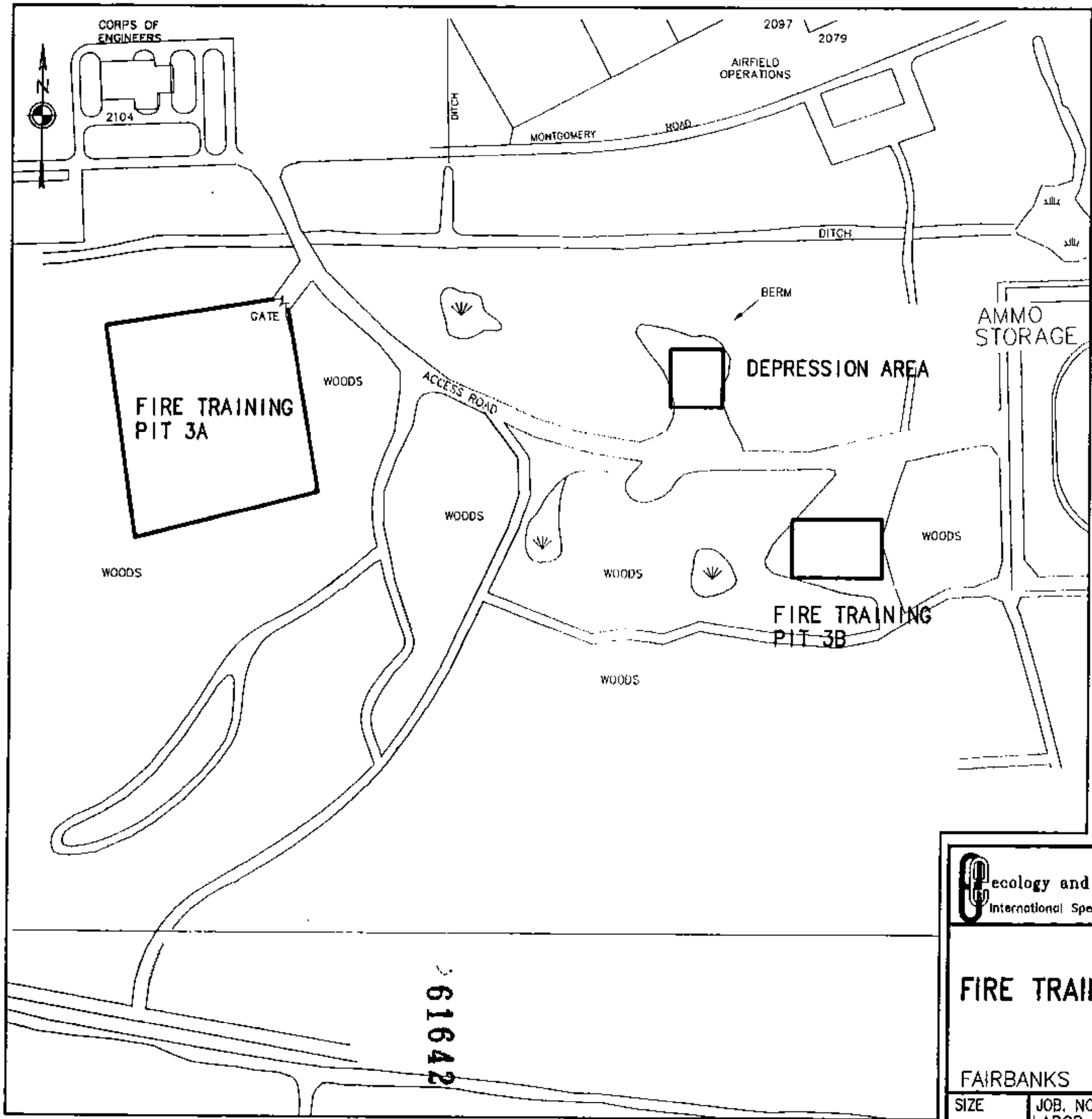
Figure 1–3
COAL STORAGE YARD SOURCE AREA
LOCATION MAP
OPERABLE UNIT 4

FAIRBANKS ALASKA

SIZE	JOB. NO.	FILE NO.	DATE:	PLATE
A	JT2000	JT21–3A	05–17–96	

61641

CORPS OF ENGINEERS U.S. ARMY

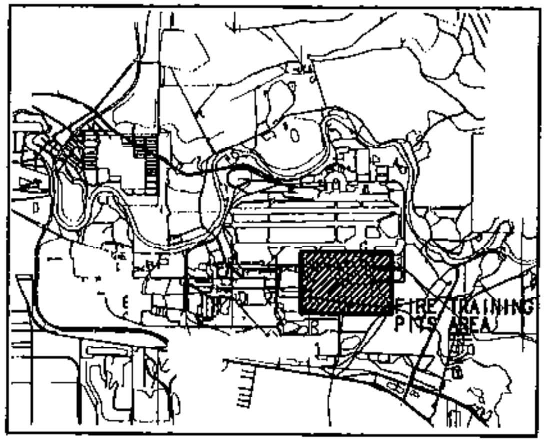


LEGEND

ROAD

WETLAND

FORT WAINWRIGHT KEY PLAN



0 250 500 1,000 1,500 2,000

SCALE: FEET

ecology and environment, inc. International Specialists in the Environment	U.S. ARMY ENGINEER DISTRICT, ALASKA CORPS OF ENGINEERS ANCHORAGE, ALASKA

Figure 1-4

FIRE TRAINING PITS AREA SOURCE AREA LOCATION MAP

OPERABLE UNIT 4

FAIRBANKS ALASKA

SIZE	JOB. NO.	FILE NO.	DATE:	PLATE
B	LABOR-JT2901 COMP-JT2950	JT21-4A.DWG	05-15-96	

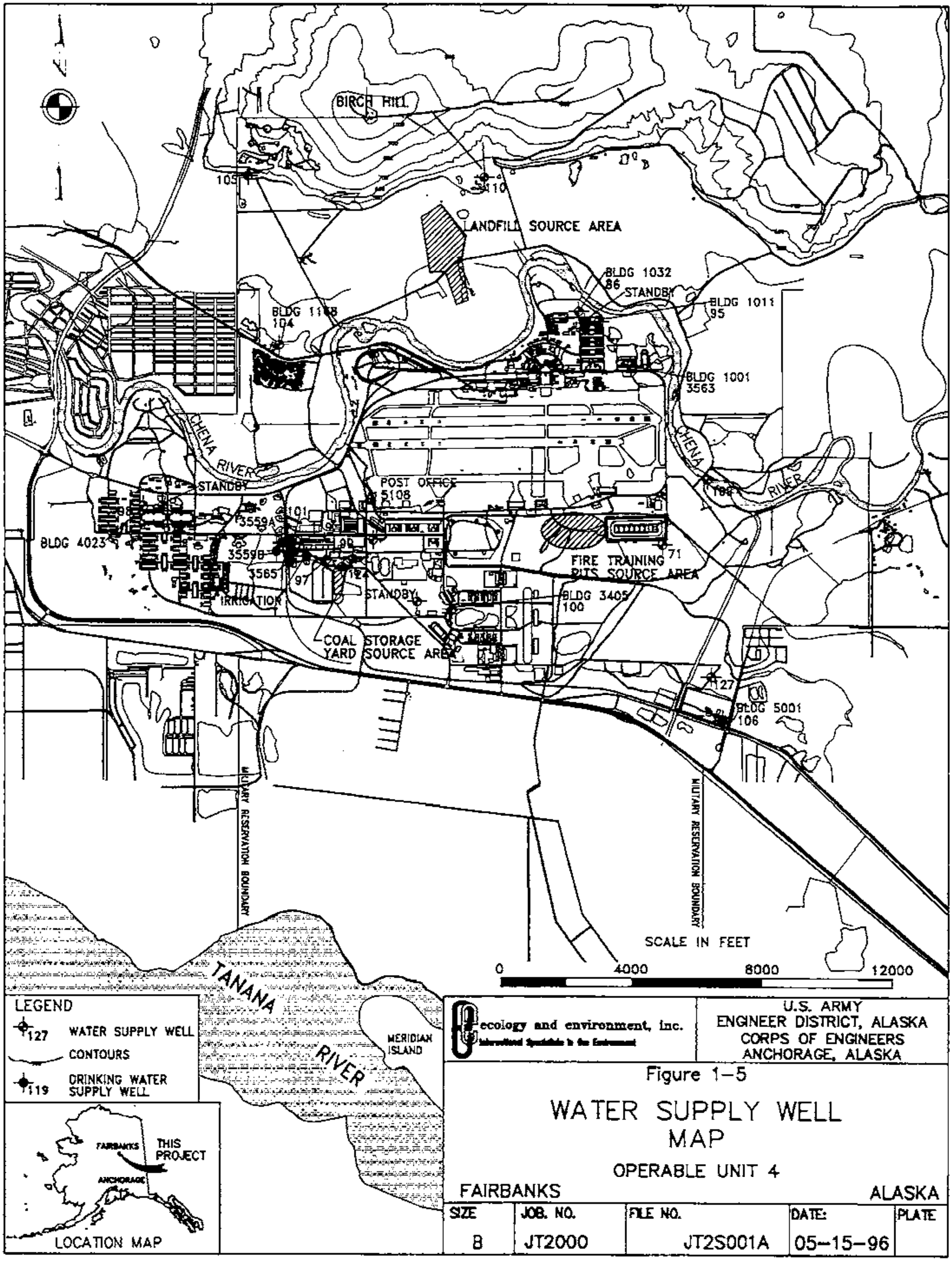


Figure 1–5

WATER SUPPLY WELL MAP

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Section 2

2.0 SITE HISTORY AND ENFORCEMENT ACTIVITIES

2.1 SITE HISTORY

The source areas associated with OU-4 have limited documents available describing past practices, but each source area has undergone prior sampling investigations. The Landfill and FTPs source areas were listed in the Resource Conservation and Recovery Act (RCRA) Facility Assessment as hazardous waste sites that required further evaluation in order to obtain Fort Wainwright's RCRA Part B Permit.

2.1.1 Landfill Source Area

The Landfill was one of two source areas initially used to rank Fort Wainwright on the National Priorities List (NPL), based on samples identifying groundwater contamination in 1986. Wastes that may have been disposed of at the Landfill during the 1950s include human waste; household refuse; waste petroleum, oil, and lubricants (POLs); hazardous waste; solvents; pesticides; asbestos; construction debris; and inert munitions. Historically, the quantity and type of waste disposed at the Landfill were not documented.

Previous investigations identified waste practices and some wastes known or suspected to have been disposed of at the Landfill. A 1983 United States Army Environmental Hygiene Agency study estimated that at that time, 7.7 tons of solid waste were generated per day or approximately 8,000 cubic yards per year. The report stated that the practice of the day was to dispose of approximately 10 pounds per day of dry-cleaning waste and filters (reportedly redistilled prior to disposal to remove perchloroethylene) and approximately 50 gallons per year of vehicular paint waste. Asbestos was bagged and placed in a specific location and there were some rare occurrences of small arms and explosives disposal. The report also stated that triple-rinsed punctured and crushed pesticide cans, rags, and soil from small pesticide spills (less than 1 gallon) were disposed of.

Other waste disposed of in the Landfill includes drums and debris from the Utilidor Expansion Drums Site; paint debris from Building 2077; more than 1,000 empty drums and two tanks from the Blair Lakes Drums Site; approximately 1,000 drums of excavated material from the Glass Park Tar Site; and the remnants of Building 2250, the Golf Course Pesticide Shed.

The active portion of the Landfill operates under a State of Alaska solid waste permit that allows the disposal of domestic and commercial refuse, ash, asbestos, incinerator residue, bagged human waste, and construction or demolition waste.

2.1.2 Coal Storage Yard Source Area

Activities at the CSY began in the 1950s with the industrial operation of the Post power plant. Based on historical documents, the CSY's active coal pile was sprayed with waste petroleum fuel products until 1993, when these practices were revised. As the active coal pile was consumed, the active pile area was graded to include the top layer of soil and intermixed coal, and then burned in the power plant. New coal supplies were then added to the storage yard.

Previous investigations have identified a fenced area, within the CSY, which contained a staging or storage area for drums and where surface spills of materials were common. Leakage or spillage of material from the drums may be another source of contamination. Two USTs within the fenced area contained waste POLs. Data collected during the 1995 investigation from the removal of the USTs were incorporated into the RI.

2.1.3 Fire Training Pits Source Area

The FTPs were used for the training of fire department and rescue crews at Fort Wainwright. Flammable liquids were containerized and stored at the various FTP sites and were burned during the fire extinguishing training exercises. The specific substances and volumes that were incinerated at each location were not recorded. Typically, the fuels included diesel, JP-4, waste oils, and solvents. In general, the sequence of activities for FTP exercises included soaking pit soils with water; filling the pit with fuels, brake fluid, and/or solvents; igniting the flammable mixture; and extinguishing the resultant fire. The bottoms of the FTPs were not lined with impervious material when constructed. FTP 3A contains a 50-foot-diameter circular area of black-stained soils. FTP 3B contains a depression, approximately 5 to 10 feet in diameter, which is filled with gravel and small pieces of concrete. It has been estimated that 1,500 to 2,300 gallons of flammable liquids were burned per year in the FTPs. Construction of the pits included minor excavation on the relatively flat terrain, with no surface water runoff diversion systems.

The contaminants at this source area consist of petroleum products, and they will be addressed through an Army removal action that includes excavation and proper disposal of the petroleum-contaminated soils. This is anticipated to be the final action for this source area. The Army Decision Document for this action is contained in Appendix A. Therefore, the Fire Training Pits will not be further discussed in this record of decision (ROD).

2.2 ENFORCEMENT ACTIVITIES

Fort Wainwright was placed on the CERCLA NPL in August 1990. Consequently, a Federal Facilities Agreement (FFA) was signed in spring 1992 with the United States Environmental Protection Agency (EPA), Alaska Department of Environmental Conservation (ADEC), and the United States Department of Army. The FFA divided Fort Wainwright into five OUs, one of which is OU-4, and outlines the general requirements for investigation and/or remediation of suspected historical hazardous waste source areas and the associated procedures and schedules. It ensures that appropriate actions are taken to protect public health and the environment in accordance with state and federal laws.

An additional goal of the FFA was to integrate U.S. Army's CERCLA response obligations and RCRA corrective action obligations. This enabled the Army to obtain an RCRA Part B permit for interim status facilities. This was issued in spring 1992. Remedial actions implemented will be protective of human health and the environment such that remediation of releases shall obviate the need for further corrective actions under RCRA (i.e., no further corrective action shall be required) for source areas.

2.3 HIGHLIGHTS OF COMMUNITY PARTICIPATION

The public was encouraged to participate in the selection of the remedies for OU-4 during a public comment period from October 10 to November 10, 1995. The *Fort Wainwright Proposed Plan for Remedial Action Operable Unit 4* presented more than 10 combinations of options considered by the United States Army, EPA, and ADEC to address contamination in soil and groundwater at OU-4.

The Proposed Plan was released to the public on October 10, 1995, and was sent to all known interested parties, which included approximately 150 elected officials and concerned citizens. An informational Fact Sheet, dated September 1995, which provided information about the United States Army's entire cleanup program at Fort Wainwright, was distributed to the same mailing list.

The Proposed Plan summarized available information regarding OU-4. 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 was welcome 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 October 17, 1995, in Fairbanks at the Carlson Center. No comments were received from the public during the comment period. Three people attended the public meeting.

Display advertisements in the *Fairbanks Daily News-Miner*, published on October 4, 8, 11, 15, 16, and 17, 1995, also included information regarding the information repositories, the toll-free telephone line, and an address for submitting written comments.

The Responsiveness Summary, Appendix B to this document, provides the background of community involvement activities conducted in association with OU-4.

This decision document presents the selected remedial action for OU-4 chosen in accordance with CERCLA as amended by the Superfund Amendments and Reauthorization Act of 1986 (SARA) and, to the extent practicable, the National Contingency Plan (NCP). The decision for OU-4 is based on the Administrative Record.

2.4 SCOPE AND ROLE OF OPERABLE UNIT OR RESPONSE ACTION

As with many Superfund sites, the problems at Fort Wainwright are complex. OU-4 will be the second OU, following OU-3, at Fort Wainwright to have completed the RI/FS process and to begin remedial action activities. The OU-4 RI and FS were performed in accordance with the RI/FS Management Plan for OU-4. The RI fieldwork was conducted during September and October 1993, and May and July 1994. The final RI, Risk Assessment, and FS reports were submitted to EPA and ADEC in August and September 1995.

The remedial actions described in this ROD address threats to human health and the environment posed by the contamination at the OU-4 source areas.

Section 3

3.0 SUMMARY OF SOURCE AREA CHARACTERISTICS

Physical features, hydrogeologic conditions, and the nature and extent of contamination for the Landfill and CSY source areas are briefly described in the following sections.

3.1 LANDFILL SOURCE AREA

3.1.1 Physical Features, Hydrogeologic Conditions, and Transport Pathways

The RI for the Landfill source area included gathering information to characterize the hydrologic setting, including permafrost conditions, and to identify contaminant transport pathways. The presence of discontinuous permafrost at Fort Wainwright creates a very complex hydrologic system that makes it extremely difficult to predict the direction and rate of groundwater movement, its seasonal and annual changes or variability, and the factors critical to delineating groundwater contaminant transport. Standard techniques, such as drilling and geological analysis as well as state-of-the-art investigative methods, have been used at the Landfill to determine groundwater flow and contaminant transport. Adequate and sufficient data were collected at the Landfill to support remedial action decisions. Because of the complex nature of groundwater flow at the Landfill, further investigations would have been expensive, would not resolve all uncertainties associated with groundwater flow characteristics, and would not influence remedial options.

Permafrost varies in depth and thickness in areas surrounding the Landfill. Where permafrost is present, the aquifer may exhibit shallow (suprapermafrost) and deep (subpermafrost) aquifer zones that are two separate, distinct layers. Where permafrost is absent, as determined in thaw areas, these two aquifer zones are linked together to create a single, unconfined aquifer. In the shallow zone, contaminant transport may be inhibited by the onset of complete frost penetration by March or April, preventing groundwater movement. In this aquifer zone, groundwater generally flows in the southwest direction toward the Chena River. In the deep aquifer zone, groundwater generally flows in the north-northwest direction consistent with the regional flow gradient. In both of these aquifer zones, contaminant transport occurs year-round within talik (unfrozen) zones and near and beneath surface water bodies.

Studies within the Landfill source area show permafrost-free zones beneath the Landfill, as a thaw bulb, and discontinuously throughout the source area. It is unknown whether the thaw bulb beneath the Landfill is continuous to bedrock because there were instrument resolution and drilling limitations. Two thaw channels, which trend toward the Chena River located 1,500 feet downgradient of the Landfill, were identified as transport pathways for groundwater contamination. They are located downgradient on the southwest and southeast corners of the Landfill.

Groundwater hydraulic parameters were estimated using slug test data collected during the 1993 investigation and compared to pump test data reported in other investigations conducted near the Landfill. Slug tests were performed at wells within the southwest drainage area, where groundwater contaminant migration is considered most likely. Results indicate that potential groundwater flow velocities range from 100 feet per year (ft/year) to 5,600 ft/year for groundwater in the upper aquifer zone, and from 1,000 ft/year to 1,400 ft/year for groundwater in the lower aquifer zone. Groundwater flow velocities fluctuate because of variations within the flow system, such as heterogeneities in the lithology, permafrost, snowmelt recharge, precipitation events, or stage changes in the Chena River. Groundwater flow within the southwest drainage area, where contamination is of primary concern, indicates a southwest flow direction at the water table and at depth trends toward the regional flow direction of north-northwest. Influences from the Chena River stage changes are expected to vary the flow direction and gradient seasonally.

The primary sources of contamination at the Landfill are wastes deposited in the Landfill and the coal ash cover material generated at the power plant. Investigations confirmed that transport of Landfill contaminants, including coal ash, through surface runoff from the Landfill to downgradient surface water bodies is not significant. Creation of leachate, through percolation and infiltration of surface water (i.e., rain or snowmelt) through Landfill waste, is believed to have caused groundwater contamination.

While the contaminant plume could not be delineated at the Landfill source area, contaminant transport pathways were identified. The two thaw channels were identified as transport pathways from the source area. Other transport pathways may be present at the Landfill, but the complexity of the hydrologic system limited characterization.

3.1.2 Nature and Extent of Contamination

Numerous investigations occurred at the Landfill before the start of the RI. From 1984 through 1989, investigations included installation of groundwater monitoring wells and completion of electromagnetic surveys, which measured transmissivity and other aquifer characteristics to identify potential leachate plumes.

In 1990, an extensive study that included analytical measurements of soil and water samples was conducted. Several groundwater wells contained volatile organic compound (VOC) contamination. Groundwater sampling was repeated in 1991 and 1992 with similar results. VOCs were detected in shallow groundwater wells in the southwest thaw channel at concentrations that exceeded state and federal water quality standards for trichloroethene (TCE) and 1,2-dichloroethene. Benzene and TCE were also present in deeper groundwater wells within the southwest thaw channel at concentrations below drinking water standards.

Principle objectives of the RI (1993 to 1994 sampling events) were to determine groundwater flow direction, identify fate and transport pathways for contaminants from the Landfill, verify whether groundwater monitoring wells were located within the most significant areas of contamination, and identify potential contaminants of concern for the Baseline Risk Assessment.

In 1993, the RI included geophysical investigations and surface water, sediment, surface and subsurface soil, and groundwater sampling investigations. During the RI, ash samples were collected as surface samples from the daily cover material of the active Landfill. Additional surface soil and sediment samples were collected based on field observations, such as stained soil and results of field screening analyses. The 1994 investigation included gathering additional data to verify the contaminant transport pathways; the existence, depth, and distribution of permafrost; and the connections between the shallow and subpermafrost aquifer zones.

In order to determine groundwater flow direction, velocity, and contaminant concentrations, monitoring wells were placed in the deep and shallow aquifer zones and near the Chena River. Water level measurements were taken daily during the field season to determine local and regional groundwater flow direction trends. Results from the RI indicated that groundwater geochemistry

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(i.e., total ionic content) hydraulically upgradient of the Landfill differs from the geochemistry downgradient. This difference has been used to create a Landfill conceptual site model that predicts that: a) leachate with a higher total ionic content than groundwater upgradient is being generated by the Landfill, and b) the leachate is entering the shallow aquifer and causing the higher total ionic concentrations in groundwater southwest of the Landfill.

The RI results confirmed VOC and semi-VOC contamination in groundwater, specifically benzene; bis(2-ethylhexyl)phthalate; TCE; 1,1,2-trichloroethane; 1,1,2,2-tetrachloroethane (PCA); and cis-1,2-dichloroethene (see Figure 3-1 and Table 3-1). These contaminants were found in the groundwater under the Landfill and in the downgradient southwest transport pathway at concentrations exceeding federal drinking water maximum contaminant levels (MCLs) and the risk-based screening concentration developed by EPA, Region 3. These groundwater contaminant concentrations are indicative of a contaminant source within the Landfill area. Table 3-2 (AP-5588 and AP-5589) illustrates that the concentrations of groundwater contaminants in the southwest drainage have remained relatively constant since sampling began in 1990. Some of the groundwater contaminants detected are intermediate breakdown products of PCA, which was disposed of in the Landfill. Inorganic analytes were retained as contaminants of concern if they exceeded background and/or risk-based concentrations (RBCs) or MCLs. Two metals, lead and chromium, exceeded an MCL or RBC, but were below background levels and therefore not considered further. Also found in the groundwater were two metals, arsenic and manganese, at concentrations exceeding MCLs or RBCs and established background levels. However, these numbers reflect naturally occurring concentrations in this mineralogically rich area. During a well survey performed by the United States Geological Survey in the Fairbanks area in 1993, arsenic concentrations in groundwater were found to range from 0 to 5,100 micrograms per liter (μg/L). Arsenic concentrations in groundwater in the Fairbanks area exceeded the 50 μg/L drinking water standard in 13% of the wells sampled, all attributable to natural conditions.

The southwest thaw channel intersects the Chena River. Groundwater contaminants in this transport pathway may enter the Chena River or threaten downgradient groundwater users including residents of the City of Fairbanks. Groundwater contaminant transport was evaluated using a simplistic groundwater transport model to estimate transport distance from the Landfill. The model estimated that solvent concentrations would reach federal MCLs at a point beyond the Chena River when traveling downgradient from the Landfill.

Based on the RI, petroleum contaminants, specifically bunker fuel and total recoverable petroleum hydrocarbons (TRPH), exist in one discrete surface soil location as a result of a spill. Associated with that spill is a high concentration of lead. This surface soil spill is located in the inactive portion of the Landfill; however, this small location subsequently was covered permanently with approximately 8 feet of construction debris and native soil during the active landfilling stabilization effort conducted in summer 1995. The covering of the spill eliminated the dermal exposure pathway for the lead.

3.2 COAL STORAGE YARD SOURCE AREA

3.2.1 Physical Features, Hydrogeologic Conditions, and Transport Pathways

Permafrost is present on the south side of the Chena River; however, it was not encountered during investigations at the CSY and is not expected to significantly affect groundwater contaminant transport pathways. Groundwater occurs at a depth of approximately 11 to 12 feet below ground surface (BGS), although seasonal variations of several feet occur. Groundwater flow is toward the northwest, which is consistent with the regional flow direction. Water supply wells for Fort Wainwright are located downgradient of the CSY source area and are approximately 900 feet northwest of the active coal pile. Hydraulic parameters were estimated in a similar fashion as with the Landfill source area. Slug-tests were conducted to estimate hydraulic properties. Flow velocities based on measured gradients were estimated to range widely from 243 ft/year to 2,917 ft/year. The cooling pond, which is an unlined excavation adjacent to the active coal pile, is hydrologically connected to the groundwater aquifer and may affect groundwater flow. This was observed during a heavy rainfall in September 1993 when adjacent wells responded with higher relative water levels than wells farther from the cooling pond. In addition, the groundwater elevation was the same as the cooling pond level.

Original contaminant sources at the CSY included diesel fuels, solvents, and lubricants sprayed on the active coal pile and waste oil spills and leaks from tanks and drums. Soils contaminated with these chemicals continue to be a source of groundwater contamination. Contaminants have been transported by overland flow of surface water (i.e., rain or snowmelt), vertical migration through soils to the groundwater aquifer, and volatilization. The power plant cooling pond receives runoff from the coal pile and surrounding coal yard during periods of heavy rainfall and during snowmelt. The cooling pond is located directly west of the storage yard and surrounded by drainage ditches. Vertical migration of contaminants from soil to groundwater is confirmed by the presence of organics such as bis(2-ethylhexyl)phthalate and xylenes in soil and groundwater. Soils are very porous and transmissive, allowing infiltration to occur readily. Solubility of the contaminants makes them subject to further migration via infiltration.

Elevated groundwater temperatures resulting from the discharge of plant effluent to the cooling pond may volatilize contaminants. Volatilization in the cooling pond area may occur until groundwater movement of the contaminants encounters "cooler" groundwater temperatures away from the influence of the cooling pond. With groundwater temperatures averaging 25° Celsius (C), which is approximately 20°C higher than other areas at Fort Wainwright, volatilization is a likely transport mechanism. Heat rising from the groundwater elevates temperatures in the upper soils within the vadose zone, possibly causing volatilization.

3.2.2 Nature and Extent of Contamination

Numerous investigations had occurred at the CSY before the start of the RI. From 1986 to 1991, soil borings and monitoring wells were installed in the CSY vicinity and samples were collected. Soil contaminants detected included DDT, petroleum, benzene, TCE, and other semi-VOCs. Levels of antimony and mercury exceeded background concentrations. Contaminants detected at concentrations below MCLs during groundwater sampling include DDD; endrin; 1,1-dichloroethene; 1,1,1-trichloroethane; and xylenes. Soils within the center of the active coal pile contained the highest concentrations of semi-VOCs. Because the area is actively being used as a coal yard, it was difficult to obtain groundwater samples in the most likely contaminated areas.

In 1993 and 1994, the RI for OU-4 was conducted. The principal objectives were to obtain information about the extent of contamination and to determine the extent of contaminant migration downgradient toward Fort Wainwright drinking water wells. The OU-4 RI field investigation consisted of the following tasks: geophysical survey, field laboratory screening, geoprobe investigation, Microwell sampling, surface and subsurface soil investigations, groundwater monitoring well installation and sampling, surface water and sediment sampling, and aquifer testing.

One round of field sampling was conducted during the RI to identify areas of highest contamination. Groundwater monitoring wells were then installed, and samples of sufficient data quality for a Baseline Risk Assessment were collected.

Groundwater monitoring wells were installed in several nested locations to meet objectives of the RI. This included installation of three nested well sets downgradient of the CSY and upgradient of the Post potable water supply wells. These wells were installed to ensure early detection of off-source contaminant migration. They were installed at the water table and at depths up to 181 feet BGS to match the depths of the water supply wells.

At the time of the RI, ongoing activities at the power plant required a pile of coal approximately 40 feet high. This coal pile was and still is located on the area used for previous coal pile spraying of fuels and was suspected as being the most contaminated. This precluded installing traditional monitoring wells. Groundwater sampling wells were installed in this area using a drive-point well technique (i.e., Microwells). This allowed for groundwater sampling in areas difficult to access via traditional techniques. Although this technology does not allow for traditional well development, these samples were analyzed in accordance with risk assessment protocol.

Surface and subsurface soil samples were collected in locations identified from field screening samples. The ongoing industrial operation at the power plant made it difficult to collect representative samples in the source area. VOC contaminants found in soils at the CSY area, specifically benzene, toluene, ethylbenzene, and total xylenes (BTEX) in the subsurface soil, exceed State cleanup levels (see Figure 3-2). Petroleum contaminants detected in soils at the CSY area also exceed State cleanup levels, specifically bunker fuel and diesel-range organics in the surface soil and TRPH in both the surface and subsurface soil. These contaminated soils are considered a potential ongoing source of contamination to groundwater. Tables 3-3 through 3-5 for the CSY show 1993 groundwater sampling results. These three tables represent data from three separate sampling methods and events. Table 3-6 is a summary of 1994 groundwater results.

Petroleum-related contaminants in the groundwater at the CSY area extend from the background well, southeast of the CSY area, to the wells north of the power plant and west of the cooling pond. VOC contamination in the groundwater appears to be limited laterally to the area under the active coal pile and fenced storage yard, based on monitoring well, GeoProbe, and Microwell groundwater samples. Based on Microwell groundwater samples, BTEX and other benzene compounds appear to be limited to the area directly under the active coal pile. No floating product was encountered (light nonaqueous phase liquid). In addition to contamination at the groundwater interface, contamination was characterized at depth beneath the coal pile. Solvent concentrations in the aquifer do not indicate the presence of a free-product source (dense nonaqueous phase liquid). VOC groundwater contamination found in the CSY area, specifically benzene, toluene, TCE, and semi-VOC contamination, more specifically bis(2-ethylhexyl)phthalate, exceeds risk-based screening concentrations (see Figure 3-3). Inorganic analytes were retained as contaminants of concern if they exceeded background and/or RBCs or MCLs. Two metals, lead and barium, exceeded an MCL or RBC, but were below background levels and therefore not considered further. RBCs for two metals, antimony and manganese, were exceeded; however, these numbers reflect naturally occurring concentrations in this mineralogically rich area.

Table 3-1

SUMMARY OF 1993 GROUNDWATER RESULTS
LANDFILL SOURCE AREA
OPERABLE UNIT 4
FORT WAINWRIGHT, ALASKA

Analyte and Concentration Units	No. of Samples Analyzed[a]/ Detected	Range of Detected Concentrations	Location of Maximum Concentration	Alaska Water Quality Criteria (18 AAC 70)/MCL (18 AAC 80)	10^{-6} Risk-based Conc.[a]	Background Conc.[b]
Total Metals (μg/L)						
Arsenic	20/9	6-110*°	AP-6139	50/50	0.038	72[c]
Barium	20/13	170-1,100°	AP-5588	1,000/2,000	260	988[c]
Calcium	20/17	25,000-190,000	AP-6139	__/__	—	52,000
Chromium	20/5	30-40°	AP-6137, AP-6138, AP-5588	110	10	130c
Copper	20/6	30-70	AP-6137	12/1,300(s)	—	20 U
Iron	20/17	6,900-100,000*°	AP-6139	1,000/300	—	9,500
Lead	20/12	3-23°	AP-6137	3.2/15	—	66[c]
Magnesium	20/17	15,000-44,000	AP-5588	__/__	—	16,000
Manganese	20/17	520-5,800*°	AP-6139	__/50(s)	18	600
Nickel	20/1	50	AP-5588	[d]/100	73	50 U
Potassium	15/12	980-1,100	AP-5588	__/__	—	—
Silica	20/19	150,000-34,000	AP-6138	__/__	—	17,000
Sodium	20/17	4,600-28,000	AP-6133	__/250,000(s)	—	5,700
Zinc	20/8	50-120	AP-6138	47/5,000(s)	1,100	50 U

* Groundwater concentration of detected analyte exceeded MCLs.
° Groundwater concentration of detected analyte exceeded risk-based concentration of 10^{-6}.

Key at end of table.

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Table 3-1

SUMMARY OF 1993 GROUNDWATER RESULTS
LANDFILL SOURCE AREA
OPERABLE UNIT 4
FORT WAINWRIGHT, ALASKA

Analyte and Concentration Units	No. of Samples Analyzed[a]/ Detected	Range of Detected Concentrations	Location of Maximum Concentration	Alaska Water Quality Criteria (18 AAC 70)/MCL (18 AAC 80)	10^{-6} Risk-based Conc.[a]	Background Conc.[b]
Dissolved Metals (μg/L)						
Arsenic	20/7	6-74*°	AP-6139	50/50	0.038	20[c]
Barium	20/15	110-550°	AP-5589	1,000/2,000	260	341[c]
Zinc	20/2	70-90	AP-6138	47/5,000(s)	1,100	50 U
General Water Parameters (μg/L)						
Alkalinity (Total)	20/20	20,000-370,000	AP-6139	<20,000/—	—	170,000
Alkalinity ($CaCO_3$)	20/20	20,000-370,000	AP-6139	__/__	—	170,000
Biochemical oxygen demand	20/2	6,000-7,000	AP-6138	__/__	—	5,000 U
Chloride	20/19	1,100-46,000	AP-5588	—/250,000(s)	—	1,100
Fluoride	20/11	100-980°	AP-6138	2,400/4,000	220	100
Nitrate	20/12	40-130	AP-6132	10,000/10,000	5,800	130
Nitrate/Nitrite	20/12	40-150	AP-6133	10,000/10,000	370	130
Orthophosphate	20/19	30-660	WLF-03	__/__	—	110
Sulfate	20/20	4,200-250,000	AP-6139	—/250,000(s)	—	1,600
Total dissolved solids	20/20	120,000-800,000	AP-6139	—/500,000(s)	—	240,000
Total organic carbon	20/20	3,200-16,000	AP-6133	__/__	—	7,000
Total suspended solids	22/3	19,000-460,000	AP-5591	__/__	—	—

* Groundwater concentration of detected analyte exceeded MCLs.
° Groundwater concentration of detected analyte exceeded risk-based concentration of 10^{-6}.

Key at end of table.

Table 3-1

SUMMARY OF 1993 GROUNDWATER RESULTS
LANDFILL SOURCE AREA
OPERABLE UNIT 4
FORT WAINWRIGHT, ALASKA

Analyte and Concentration Units	No. of Samples Analyzed[a]/ Detected	Range of Detected Concentrations	Location of Maximum Concentration	Alaska Water Quality Criteria (18 AAC 70)/MCL (18 AAC 80)	10^{-6} Risk-based Conc.[a]	Background Conc.[b]
Volatile Organic Compounds (μg/L)						
Acetone	20/5	17-87	FWLF-03	___/___	370	NA
Benzene	20/2	3.3-4.4°	AP-5589	5/5	0.36	NA
Bromodichloromethane	20/2	1.7-2.9°	AP-6138	11,000/100	0.17	NA
Chloroform	20/3	2.5-33°	AP-6138	1,240/100	0.15	NA
Dichlorodifluoromethane	20/2	4.1-5.5	AP-5589	100°/___	39	NA
1,2-Dichloroethane	20/2	3.3-5.1*°	AP-5589	5/5	0.12	NA
cis-1,2-Dichloroethene	20/3	4.5-130*°	AP-5588	___/70	6.1	NA
trans-1,2-Dichloroethene	20/3	2.0-40°	AP-5588	___/100	12	NA
Methylene chloride	20/5	1-1.7	FWLF-2	___/5	4.1	NA
1,1,2,2-Tetrachloroethane	20/2	6.3-1,300°	AP-5588	2,400/___	0.052	NA
Tetrachloroethene	20/1	1.4	AP-5588	840/5	6.1	NA
1,1,2-Trichloroethane	20/1	8.1*°	AP-5588	9,400/5	0.19	NA
Trichloroethene	20/3	3.6-170*	AP-5588	5/5	—	NA
Vinyl chloride	20/2	1.0-1.3°	AP-5589	2/2	0.019	NA
Semivolatile Organic Compounds (μg/L)						
Bis(2-ethylhexyl)phthalate	20/8	8.9-620*°	AP-6136	___/6	4.8	NA

* Groundwater concentration of detected analyte exceeded MCLs.
° Groundwater concentration of detected analyte exceeded risk-based concentration of 10^{-6}.

Key at end of table.

Table 3-1

SUMMARY OF 1993 GROUNDWATER RESULTS
LANDFILL SOURCE AREA
OPERABLE UNIT 4
FORT WAINWRIGHT, ALASKA

Analyte and Concentration Units	No. of Samples Analyzed[a]/ Detected	Range of Detected Concentrations	Location of Maximum Concentration	Alaska Water Quality Criteria (18 AAC 70)/MCL (18 AAC 80)	10^{-6} Risk-based Conc.[a]	Background Conc.[b]
Fuels (μg/L)						
Bunker C-range organics	20/11	110-1,700	AP-6138	__/__	—	NA
Diesel No. 2	20/1	420	AP-5589	__/__	—	NA
Gasoline	20/7	110-140	FWLF-04	__/__	—	NA
Diesel-range organics	2/2	120-120	WLF-03	__/__	—	NA
TRPH (oil and grease)	20/2	70-90	AP-6138	__/__	—	NA

[a] United States Environmental Protection Agency, Region 3, Risk-based Concentration Table, Fourth Quarter 1994, November 1994. Cancer risk = 10^{-6}. Hazard quotient = 0.1.
[b] Groundwater background concentrations derived from sample location AP-6132, unless otherwise noted.
[c] Groundwater background concentrations provided by the Corps.
[d] Criterion is hardness dependent for 18 AAC 80, Alaska Water Quality Standards.
* Groundwater concentration of detected analyte exceeded MCLs.
° Groundwater concentration of detected analyte exceeded risk-based concentration of 10^{-6}.

Key:

— = Value not established.
Conc. = Concentration.
μg/L = Micrograms per liter.
MCL = Maximum contaminant level.
NA = Not applicable.
(s) = Secondary MCL.
TRPH = Total recoverable petroleum hydrocarbons.
U = Not detected.

Table 3-2

VOLATILE ORGANIC COMPOUNDS OF CONCERN
RESULTS FROM 1990 TO 1994
AP-5588 AND AP-5589
OPERABLE UNIT 4
FORT WAINWRIGHT, ALASKA
(μg/L)

Well	Contaminant	4/90[c]	8/91	10/91	4/92	9/92	9/93	7/94	MCL (18 AAC 80)
AP-5588	Vinyl Chloride	ND	1.1	ND(5)	2.6*	1.2	1.3	ND	2
	Carbon Disulfide	ND	0.1	ND(5)	ND(0.1)	ND(0.5)	NA	ND(3.0)	5
	1,2-Dichloroethene (total)	470*	338.5*	60	450*	282*	170*	201*	70
	1,1-Dichloroethane	ND	0.4	ND(5)	ND(0.1)	0.6	ND(1.0)	ND(3.0)	---
	Benzene	5*	2.9	ND(5)	4.5	3.7	3.3	4.5	5
	1,2-Dichloroethane	ND	0.4	ND(5)	ND(0.1)	3.2	3.3	4.5	5
	Trichloroethene	250*	224*	220*	240*	210*	170*	180*	5
	1,2-Dichloropropane	ND	2.7	ND(5)	ND(0.1)	ND(0.5)	ND(1.0)	ND(3.5)	5
	Toluene	ND	0.1	ND(5)	ND(0.1)	ND(0.5)	ND(1.0)	ND(2.0)	1,000
	1,1,2-Trichloroethane	ND	14*	330*	11.4*	ND(0.5)	8.1*	9.9*	5
	Tetrachloroethene	ND	2.1	ND(5)	3.3	2.5	1.4	ND(1.7)	5
	Ethyl Benzene	ND	0.2	ND(5)	ND(0.1)	ND(0.5)	ND(1.0)	ND(1.6)	700
	Total Xylenes	ND	0.4	ND(5)	ND(0.1)	ND(0.5)	ND(1.0)	ND(6.5)	10,000
	1,1,2,2-Tetrachloroethane	ND	1,960*	2,100*	1,000*	15,000*	1,300*	1,000*	RBC 10^{-4}=5.2
AP-5589	Vinyl Chloride	ND	1.9	ND(5)	3*	1.5	1.0	ND(3.0)	2
	Carbon Disulfide	ND	0.2	ND(5)	ND(0.1)	ND(0.5)	NA	ND(5.8)	5
	1,2-Dichloroethene (total)	29	19.4	ND(5)	36.6	23.9	12.6	23.9	—

Key at end of table.

Table 3-2

VOLATILE ORGANIC COMPOUNDS OF CONCERN
RESULTS FROM 1990 TO 1994
AP-5588 AND AP-5589
OPERABLE UNIT 4
FORT WAINWRIGHT, ALASKA
(µg/L)

Well	Contaminant	4/90[c]	8/91	10/91	4/92	9/92	9/93	7/94	MCL (18 AAC 80)
	Benzene	6*	6.7*	6.7*	7.9*	5.6*	4.4	6.3*	5
	1,2-Dichloroethane	ND	4.2	ND(5)	ND(0.1)	5.2*	5.1*	5.1*	5
	Trichloroethene	7*	5.6*	5.8*	7.5*	5.3*	4.7	7.3*	5
	1,2-Dichloropropane	ND	0.4	ND(5)	ND(0.1)	ND(0.5)	ND(1.0)	ND(3.5)	5
	1,1,2,2-Tetrachloroethane	ND	1.0	ND(5)	ND(0.1)	1.8	6.3	5.9	—

[a] United States Environmental Protection Agency, Region 3, Risk-based Concentration Table, Fourth Quarter 1994, November 1994. Cancer risk = 10^{-7}. Hazard quotient = 0.1.
[b] Maximum contaminant level.
[c] Detection limits are unavailable for this data set.
* Groundwater concentration of detected analyte exceeds maximum contaminant level.

Key:

MCL = Maximum contaminant level.
NA = Not applicable
ND = Not detected.
µg/L = Micrograms per liter.
— = Value not established.

Table 3-3

**1993 FIELD SCREENING VOLATILE ORGANIC COMPOUND RESULTS
COAL STORAGE YARD SOURCE AREA
OPERABLE UNIT 4
FORT WAINWRIGHT, ALASKA**

Matrix	Analyte	Number of Samples Analyzed/ Detected	Range of Detected Conc.	Risk-Based Conc.[a]/MCL
Surface Soil (mg/kg)	o-Xylene	5/1	0.0068	16,000/NA
	PCE	5/1	0.018	78/NA
Subsurface Soil (mg/kg)	Benzene	71/11	0.0144-22.3°	2.2/NA
	Toluene	71/9	0.0057-16.4	1,600/NA
	Ethylbenzene	71/11	0.0104-18.7	780/NA
	Chlorobenzene	71/3	0.0199-0.0429	160/NA
	m & p-Xylenes	71/7	0.0059-0.190	16,000/NA
	o-Xylene	71/8	0.0124-0.396	16,000/NA
	1,1-DCE	71/9	0.0153-0.279°	0.110/NA
	TCE	71/11	0.0181-186	—/NA
	1,1,1-TCA	71/4	0.560-38.1	—/NA
	1,1,2-TCA	71/1	0.054	1.1/NA
	PCE	71/11	0.0052-1.1	78/NA
Groundwater (μg/L)	Benzene	84/9	6.8-870*°	0.36/5
	Toluene	84/9	6.1-2,550*°	75/1,000
	Ethylbenzene	84/8	5.5-550°	130/700
	m&p-Xylenes	84/8	9.1-790°	140/10,000
	o-Xylene	84/9	6.0-1,020°	140/10,000
	Total Xylenes	84/9	6.0-1,810	280/20,000°
	1,1-DCA	84/5	13.1-196°	81/—
	TCE	84/9	5.8-820*	—/5
	1,1,1-TCA	84/3	46.5-653	—/—
	1,1,2-TCA	84/1	25.8°	0.19/—
	PCE	84/7	6.0-410*°	6.1/5
	1,1,2,2-PCA	84/3	5.9-653°	0.052/—

a United States Environmental Protection Agency, Region 3, Risk-based Concentration Table, Fourth Quarter 1994, November 1994. Cancer risk for soils = 1×10^{-7}. Cancer risk for groundwater = 1×10^{-6}. Hazard quotient = 0.1.

* Groundwater concentration of detected analyte exceeds MCL.

° Groundwater concentration of detected analyte exceeds risk-based concentration of 10^{-6}.

Key at end of table.

61660

Table 3-3 (Cont.)

Key:

1,1-DCA	= 1,1-Dichloroethane.
1,1-DCE	= 1,1-Dichloroethene.
MCL	= Maximum contaminant level.
mg/kg	= Milligrams per kilogram.
NA	= Not applicable.
1,1,2,2-PCA	= 1,1,2,2-Tetrachloroethane.
PCE	= Tetrachloroethene.
1,1,1-TCA	= 1,1,1-Trichloroethane.
1,1,2-TCA	= 1,1,2-Trichloroethane.
TCE	= Trichloroethene.
µg/L	= Micrograms per liter.
—	= Value not established.

Table 3-4

1993 MICROWELL ANALYTICAL RESULTS
COAL STORAGE YARD SOURCE AREA
OPERABLE UNIT 4
FORT WAINWRIGHT, ALASKA
(μg/L)

Analyte	No. of Samples Analyzed/ Detected	Range of Detected Concentrations	Location of Maximum Result	10^{-6} Risk-Based Conc.[a]/MCL
1,1,1-Trichloroethane (TCA)	30/3	3.8-65	PS-4	—/—
1,1-Dichloroethane	30/2	1-8.1	PS-2	81/—
1,2-Dichloroethane	30/1	0.5-0.5°	PS-2	0.12/—
Benzene	30/17	0.5-800*°	PS-4	0.36/5
cis-1,2-Dichloroethene	30/5	0.7-6.8°	PS-2	6.1/70
Ethylbenzene	30/11	1-650°	PS-4	130/700
Tetrachloroethene (PCE)	30/3	1.7-4.3	PS-4	6.1/5
Toluene	30/9	1-2,300*°	PS-4	75/1,000
Total Xylenes	30/12	2-3,200°	PS-4	1,200/10,000
Trichloroethene (TCE)	30/6	0.6-1.4	PS-4	—/5

a United States Environmental Protection Agency, Region 3, Risk-based Concentration Table, Fourth Quarter 1994, November 1994. Cancer risk = 1×10^{-6}. Hazard quotient = 0.1.
* Groundwater concentration of detected analyte exceeds MCL.
° Groundwater concentration of detected analyte exceeds risk-based concentration of 10^{-6}.

Key:

Conc. = Concentration.
MCL = Maximum contaminant level.
μg/L = Micrograms per liter.
— = Value not established.

Table 3-5

SUMMARY OF 1993 GROUNDWATER RESULTS
COAL STORAGE YARD SOURCE AREA
OPERABLE UNIT 4
FORT WAINWRIGHT, ALASKA

Analyte and Concentration Units	No. of Samples Analyzed/ Detected	Range of Detected Concentrations	Location of Maximum Concentration	Alaska Water Quality Criteria/MCL	10^{-6} Risk-based Concentration[a]	Background Concentration[b]
Total Metals (μg/L)						
Arsenic	20 / 17	3-59*°	AP-5509	50 / 50	0.038	72[c]
Barium	20 / 20	96-500°	AP-5517	1,000 / 2,000	260	988[c]
Calcium	20 / 15	42,100-211,000*	3595-02	— / 2,000	—	71,300[d]
Copper	20 / 13	6-110	AP-5510	12 / 1,300	—	68
Iron	30 / 3	10,900-48,400*	3595-03	1,000 / 300(s)	—	—
Lead	20 / 12	1.6-20*°	AP-6141	3.2 / 15	—	66[c]
Magnesium	3 / 3	30,700-49,200	3595-02	— / —	—	—
Manganese	3 / 3	1,100-2,000*°	3595-01	— / 50(s)	18	—
Nickel	20 / 12	11-38	AP-6141	96 / 100	73	38
Sodium	3 / 3	6,100-8,600	3595-03	— / —	—	—
Zinc	20 / 18	7-120	AP-5509-3559A	47 / 5,000(s)	1,100	97
Dissolved Metals (μg/L)						
Arsenic	20 / 10	4-12°	AP-5735	50 / 50	0.038	20[c]
Antimony	20 / 5	26-37	AP-5508	1,600 / 6	1.5	25U
Barium	20 / 20	80-300°	AP-5737	1,000 / 2,000	260	341[c]

* Groundwater concentration of detected analytes exceeds maximum contaminant concentrations.
° Groundwater concentration of detected analytes exceeds risk-based concentration of 10^{-6}.

Key at end of table.

Table 3-5

SUMMARY OF 1993 GROUNDWATER RESULTS
COAL STORAGE YARD SOURCE AREA
OPERABLE UNIT 4
FORT WAINWRIGHT, ALASKA

Analyte and Concentration Units	No. of Samples Analyzed/ Detected	Range of Detected Concentrations	Location of Maximum Concentration	Alaska Water Quality Criteria/MCL	10^{-6} Risk-based Concentration[a]	Background Concentration[b]
Copper	20 / 1	6	3559A	12 / 1,300	140	5U
Iron	17 / 13	75-15,900*	AP-5735	1,000 / 300(s)	—	1,700
Lead	20 / 2	4-10	3595-02	3.2 / 15	15	9.9[c]
Magnesium	17 / 17	9,900-44,800	AP-5517	— / —	—	23,400
Manganese	17 / 17	60-920*°	AP-5511	— / 50(s)	18	780
Nickel	20 / 4	16-20	3595-02	96 / 100	73	10U
Sodium	17 / 17	4,200-29,600	AP-5517	— / —	—	6,600
Zinc	17 / 3	18-22	3595-03	47 / 5,000	1,100	5U
Organics (μg/L)						
bis(2-Ethylhexyl)phthalate	20 / 4	2-110*°	AP-6142	— / 6	4.8	NA
di-n-Butylphthalate	20 / 19	1-13	AP-5511	— / —	370	NA
Dieldrin	20 / 2	0.01-0.021°	119	— / —	0.0042	NA
Heptachlor	20 / 1	0.08°	3595-02	0.0038 / 0.4	0.0023	NA
Heptachlor epoxide	20 / 2	0.01-0.02°	119	— / 0.2	0.0012	NA
m&p-Xylene	20 / 3	2.0	3595 / 01 / 02 / 03	— / —	52	NA
Methoxychlor	20 / 3	0.044-0.16	119	0.03 / 40	18	NA

* Groundwater concentration of detected analytes exceeds maximum contaminant concentrations.
° Groundwater concentration of detected analytes exceeds risk-based concentration of 10^{-6}.

Key at end of table.

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Table 3-5

SUMMARY OF 1993 GROUNDWATER RESULTS
COAL STORAGE YARD SOURCE AREA
OPERABLE UNIT 4
FORT WAINWRIGHT, ALASKA

Analyte and Concentration Units	No. of Samples Analyzed/ Detected	Range of Detected Concentrations	Location of Maximum Concentration	Alaska Water Quality Criteria/MCL	10^{-6} Risk-based Concentration[a]	Background Concentration[b]
Methylene chloride	20 / 2	4-6*•	3595-01	— / 5	4.1	NA
o-Xylene	20 / 3	1.0	3595-01 / 02 / 03	— / —	140	NA
Trichloroethene	20 / 2	7-56	3595-01	5 / 5	—	NA
Trichlorofluoromethane	20 / 1	29	3595-03	11,000 / —	2,300	NA
Fuels (µg/L)						
TRPH	20 / 12	25-2,000	AP-6143	— / —	—	NA
Diesel No. 2	20 / 1	310	AP-6142	— / —	—	NA
Bunker Oil (No. 6 Diesel)	20 / 9	390-1,100	AP-6142	— / —	—	NA
Other (µg/L)						
Alkalinity ($CaCO_3$)	20 / 20	122,000-590,000	3595-02	— / —	—	NA
Chloride	20 / 20	1,800-102,000	AP-5517	— / 250,000(s)	—	8,300
Fluoride	20 / 5	130-260	3559A / B	2,400 / 4,000	—	500
Orthophosphate	20 / 11	52-260	AP-5509	— / —	—	68
Silica	20 / 20	8,200-20,900	AP-6142	— / —	—	12,700
Sulfate	20 / 20	9,600-152,000	3595-02	— / 250,000(s)	—	NA
Total organic compounds	20 / 20	7,100-145,000	3595-02	— / —	—	NA

* Groundwater concentration of detected analytes exceeds maximum contaminant concentrations.
• Groundwater concentration of detected analytes exceeds risk-based concentration of 10^{-6}.

Key at end of table.

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Table 3-5

SUMMARY OF 1993 GROUNDWATER RESULTS
COAL STORAGE YARD SOURCE AREA
OPERABLE UNIT 4
FORT WAINWRIGHT, ALASKA

Analyte and Concentration Units	No. of Samples Analyzed/ Detected	Range of Detected Concentrations	Location of Maximum Concentration	Alaska Water Quality Criteria/MCL	10^{-6} Risk-based Concentration[a]	Background Concentration[b]
Total dissolved solids	20 / 20	68,000-1,780,000	AP-5509	— / —	—	NA
Biochemical oxygen demand	20 / 11	1,300-654,000	AP-5510	— / —	—	NA
Nitrate-Nitrate	20 / 10	27-5,300°	AP-5517	10,000 / 10,000	370	64
Dioxin/Furans (pg/L)						
1,2,3,4,6,7,8,9-OCDD	20 / 3	48.6-77.7	3595-03	— / 30,000	430	NA
1,2,3,4,6,7,8,9-OCDF	20 / 1	5.46	3595-01	— / 30,000	430	NA
1,2,3,4,6,7,8-HpCDD	20 / 3	10.7-18.3	3595-03	— / 3,000	43	NA
1,2,3,4,6,7,8-HpCDF	20 / 2	2.82-4.28	3595-03	— / 3,000	43	NA
1,2,3,4,7,8-HxCDF	20 / 1	2.43	3595-03	— / 300	4.3	NA
1,2,3,6,7,8-HxCDF	20 / 3	0.943-1.45	3595-03	— / 300	4.3	NA
1,2,3,7,8,9-HxCDD	20 / 1	1.34	3595-02	— / 300	4.3	NA
1,2,3,7,8,9-HxCDF	20 / 1	0.971	3595-02	— / 300	4.3	NA
1,2,3,7,8-PeCDD	20 / 1	1.95°	3595-02	— / 60	0.86	NA
2,3,4,6,7,8-HxCDF	20 / 2	3.26-3.42	3595-03	— / 300	4.3	NA
Total HpCDD	20 / 3	18.3-24.9	3595-02	— / —	—	NA
Total HpCDF	20 / 2	3.14-4.75	3595-03	— / —	—	NA

* Groundwater concentration of detected analytes exceeds maximum contaminant concentrations.
° Groundwater concentration of detected analytes exceeds risk-based concentration of 10^{-6}.

Key at end of table.

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Table 3-5

SUMMARY OF 1993 GROUNDWATER RESULTS
COAL STORAGE YARD SOURCE AREA
OPERABLE UNIT 4
FORT WAINWRIGHT, ALASKA

Analyte and Concentration Units	No. of Samples Analyzed/ Detected	Range of Detected Concentrations	Location of Maximum Concentration	Alaska Water Quality Criteria/MCL	10^{-6} Risk-based Concentration[a]	Background Concentration[b]
Total HxCDD	20 / 2	2.53-9.4	3595-02	— / —	—	NA
Total HxCDF	20 / 2	0.997-19.9	3595-02	— / —	—	NA
Total PeCDD	20 / 3	1.95-1.95	3595-02	— / —	—	NA
Total PeCDF	20 / 1	4.01-55.4	3595-02	— / —	—	NA
Total TCDF	20 / 2	0.674-19.3	3595.02	— / —	—	NA

[a] United States Environmental Protection Agency, Region 3, Risk-based Concentration Table, Fourth Quarter 1994, November 1994. Cancer risk = 1×10^{-6}. Hazard quotient = 0.1.
[b] Background data from sample locations AP-5734 and AP-6141, unless otherwise noted.
[c] Background data provided by the Corps.
[d] Background data from sample location AP-5734 only.
* Groundwater concentration of detected analytes exceeds maximum contaminant concentrations.
° Groundwater concentration of detected analytes exceeds risk-based concentration of 10^{-6}.

Key at end of table.

Table 3-5 (Cont.)

Key:

HpCDD	=	Heptachlorodibenzo-p-dioxin.
HpCDF	=	Heptachlorodibenzofuran.
HxCDD	=	Hexachlorodibenzo-p-dioxin.
HxCDF	=	Hexachlorodibenzofuran.
MCL	=	Maximum contaminant level.
µg/L	=	Micrograms per liter.
NA	=	Not applicable.
OCDD	=	Octachlorodibenzo-p-dioxin.
OCDF	=	Octachlorodibenzofuran.
PeCDD	=	Pentachlorodibenzo-p-dioxin.
pg/L	=	Picograms per liter.
(s)	=	Secondary MCL.
TRPH	=	Total recoverable petroleum hydrocarbons.
U	=	Not detected.
—	=	Value not established.

Table 3-6

SUMMARY OF 1994 GROUNDWATER RESULTS
COAL STORAGE YARD SOURCE AREA
OPERABLE UNIT 4
FORT WAINWRIGHT, ALASKA

Analyte and Concentration Units	Number of Samples Analyzed/ Detected	Range of Detected Concentrations	Location of Maximum Concentration	Alaska Water Quality Criteria/MCL	10^{-6} Risk-based Concentration[a]	Background Concentration[b]
Total Metals (μg/L)						
Arsenic	8 / 8	2.3 - 8.4°	AP-6523	50 / 50	0.038	72[c]
Lead	8 / 2	1.6 - 6.8	AP-6520	3.2 / 15	15	66[c]
Selenium	8 / 1	3.8	AP-6524	— / —	—	—
Zinc	8 / 2	6.2 - 6.4	AP-6519	47 / 5,000(s)	1,100	97
Dissolved Metals (μg/L)						
Arsenic	8 / 8	1.5 - 13.0°	AP-6522	50 / 50	0.038	20[c]
Selenium	8 / 1	3.4	AP-6524	— / —	—	—
Zinc	8 / 4	12 - 20	AP-6521	47 / 5,000	1,100	5U
Organics (μg/L)						
bis(2-Ethylhexyl)phthalate	7 / 3	2J - 13*°	AP-6521	— / 6	4.8	NA
di-n-Butylphthalate	/ 7	2JB - 5JB	AP-6521	— / —	370	NA
Dieldrin	/ 1	0.03°	AP-6522	— / 2.0	0.0042	NA
Heptachlor	/ 1	0.04°	AP-6522	3.8 / 0.4	0.0023	NA

* Groundwater concentration of detected analyte exceeds MCLs.
° Groundwater concentration of detected analyte exceeds risk-based concentration of 10^{-6}.

Key at end of table.

Table 3-6

SUMMARY OF 1994 GROUNDWATER RESULTS
COAL STORAGE YARD SOURCE AREA
OPERABLE UNIT 4
FORT WAINWRIGHT, ALASKA

Analyte and Concentration Units	Number of Samples Analyzed/ Detected	Range of Detected Concentrations	Location of Maximum Concentration	Alaska Water Quality Criteria/MCL	10^{-6} Risk-based Concentration[a]	Background Concentration[b]
Methylene chloride	10 / 3	3JB	AP-5735	— / 5	4.1	NA
Trichloroethene	5 / 2	9 - 11*°	3595-01	5 / 5	—	NA
Trichlorofluoromethane	5 / 1	140	3595-03	11,000 / —	2,300	NA
Fuels (μg/L)						
TRPH (Mod 8015)			AP-6523	— / —	—	NA
DRO	3 / 2	<100,000 - 320,000	3595-03	— / —	—	NA
Bunker Oil (No. 6 Diesel)	3 / 2	250,000	AP-6523, AP-6521	— / —	—	NA
Other (μg/L)						
Benzene	5 / 1	3J*°	3595-03	5 / 5	0.36	NA
Chloroform	10 / 6	7B - 10B	AP-6140	1,240 / 100	0.15	NA
4,4-DDE	/ 1	0.09	AP-6522	0.001 / —	0.2	NA
cis-1,2-dichloroethylene	5 / 1	2J	3595-03	— / 70	6.1	NA
Endrin Ketone	/ 1	0.14	AP-6522	— / —	—	NA

* Groundwater concentration of detected analyte exceeds MCLs.
° Groundwater concentration of detected analyte exceeds risk-based concentration of 10^{-6}.

Key at end of table.

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Table 3-6 (Cont.)

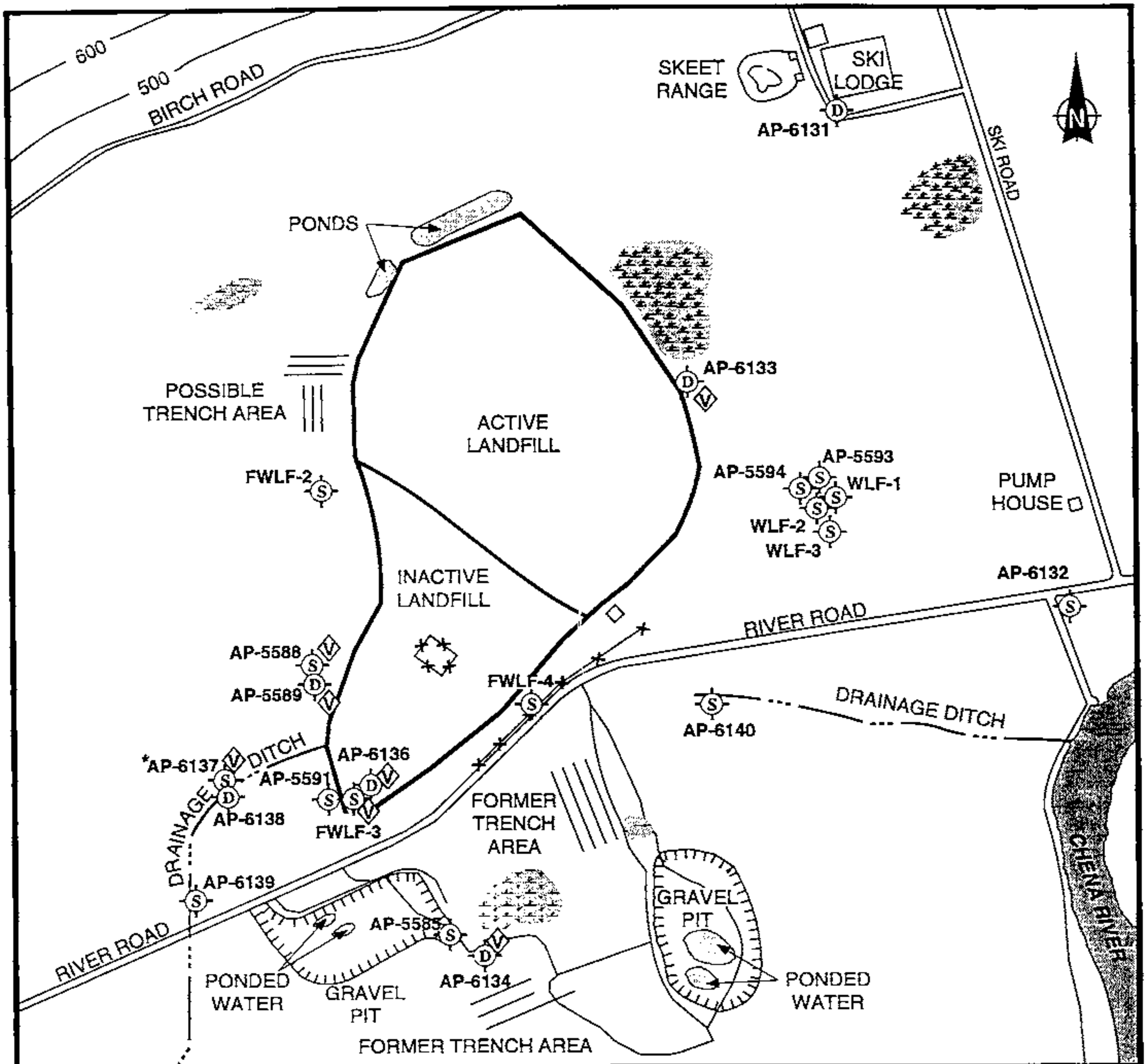
[a] United States Environmental Protection Agency, Region 3, Risk-based Concentration Table, Fourth Quarter 1994, November 1994. Cancer risk = 1×10^{-6}. Hazard quotient = 0.1.

[b] Background data from sample locations AP-5734 and AP-6141, unless otherwise noted.

[c] Background data provided by the Corps.

Key:

B = Blank concentration.
DDE = Dichlorodiphenyldichloroethene.
DRO = Diesel range organics.
J = Estimated quantity.
MCL = Maximum contaminant level.
µg/L = Micrograms per liter.
NA = Not applicable.
S = Secondary MCL.
TRPH = Total recoverable petroleum hydrocarbons.
U = Not detected.
— = Value not established.



CONTAMINANTS OF CONCERN

ORGANIC COMPOUNDS:

1,1,2,2-Tetrachloroethane - exceeds drinking water standards and acceptable risk range

Trichloroethene - exceeds drinking water standards

Bis(2-ethylhexyl) phthalate - exceeds drinking water standards and acceptable risk range

Benzene - exceeds drinking water standards

1,1,2-Trichloroethane - exceeds drinking water standards

Cis-1,2-dichloroethene - exceeds drinking water standards

SCALE IN FEET

0 400 800 1,200

KEY:

- -500- Contour interval (feet)
- Road
- Railroad
- Drainage
- (S) Shallow monitoring well
- (D) Deep monitoring well
- (V) Organic compounds detected above cleanup goals

*AP-6137 was formerly known as DH6534 (MW8)

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ALASKA DISTRICT
ANCHORAGE, ALASKA

Figure 3-1

LANDFILL SOURCE AREA
CONTAMINANTS OF CONCERN
IN GROUNDWATER
OPERABLE UNIT 4

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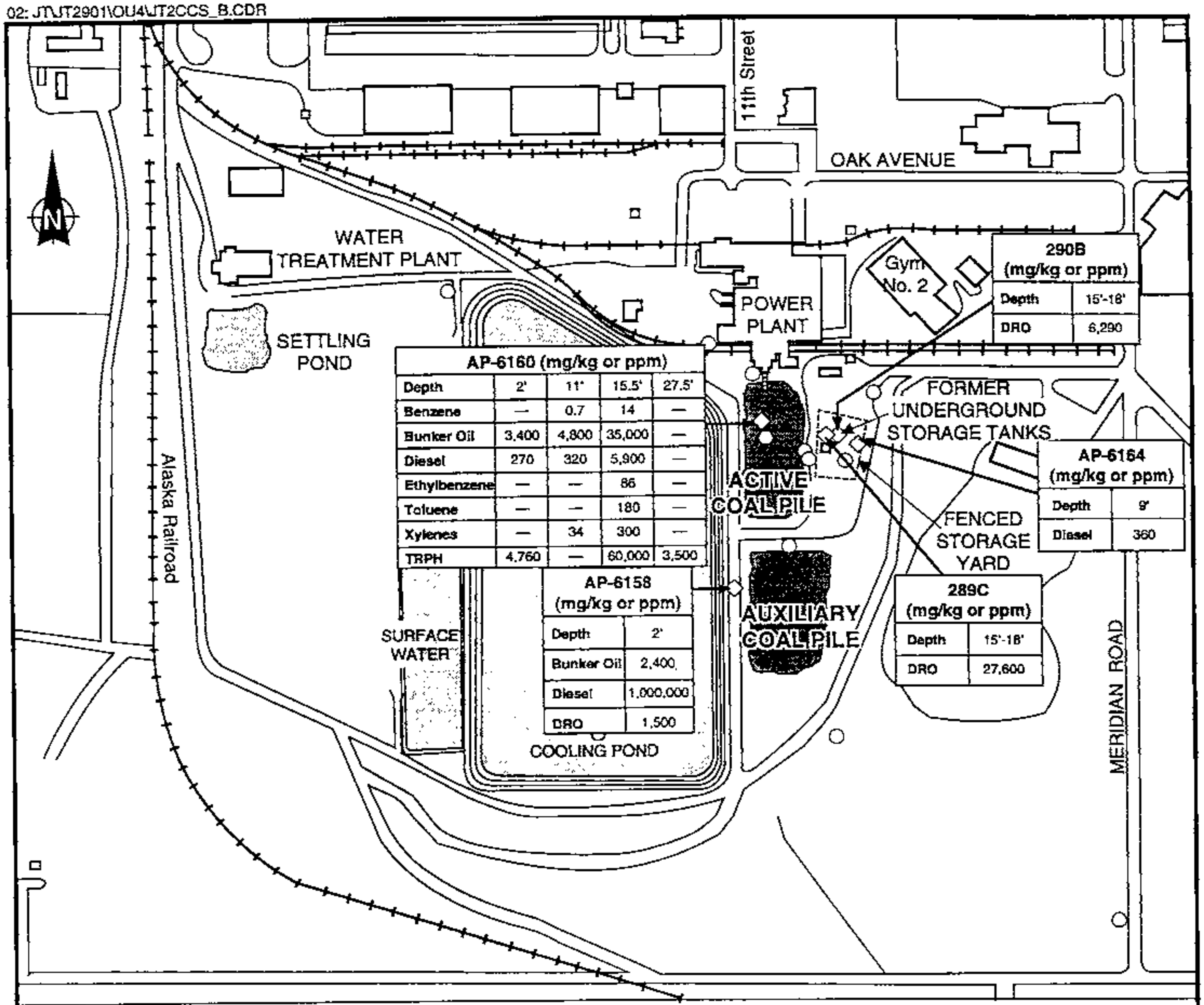
Fairbanks Alaska

SIZE	JOB NO.	FILE NO.	DATE	PLATE
A	JT2901	JT2CCGB2.CDR	96MAY03	

02: JT\JT2901\OU4\JT2CCS_B.CDR



SCALE IN FEET
0 250 500

KEY:
- Road
- Railroad
- ○ Soil Sample Locations
- ◇ Soil contaminants detected above cleanup goals
- DRO Diesel Range Organics
- TRPH Total Recoverable Petroleum Hydrocarbons
- mg/kg Milligram per kilogram
- ppm Parts per million

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ALASKA DISTRICT
ANCHORAGE, ALASKA

Figure 3-2
COAL STORAGE YARD SOURCE AREA
CONTAMINANTS OF CONCERN IN SOIL
OPERABLE UNIT 4

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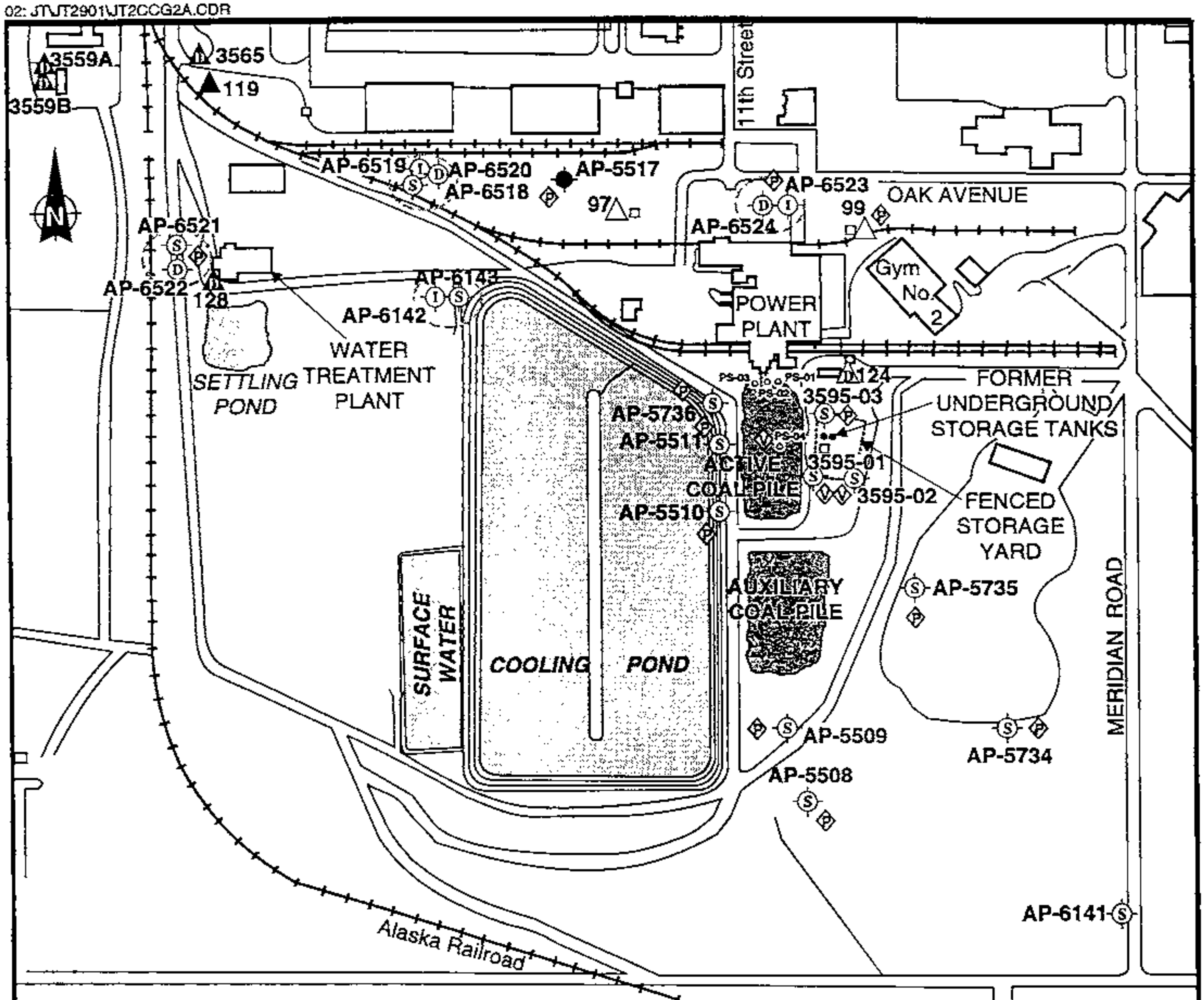
Fairbanks Alaska

SIZE	JOB NO.	FILE NO.	DATE	PLATE
A	JT2901	JT2CCS_B.CDR	96MAY03	

02: JT\JT2901\JT2CCG2A.CDR



CONTAMINANTS OF CONCERN

ORGANIC COMPOUNDS:

Trichloroethene - exceeds drinking water standards

Bis(2-ethylhexyl) phthalate - exceeds drinking water standards

Benzene - exceeds drinking water standards and acceptable risk range

PETROLEUM COMPOUNDS:

Total Recoverable Petroleum Hydrocarbons - exceeds drinking water standards

Diesel Range Organics - exceeds drinking water standards

SCALE IN FEET

0 250 500

KEY:

- Road
- Railroad
- Nested monitoring well
- Shallow monitoring well
- Intermediate monitoring well
- Deep monitoring well
- Drinking water supply well
- Deep drinking water supply well
- Water supply well
- Deep water supply well
- Microwells
- Monitoring well depth unknown
- Organic compounds detected above cleanup goals
- Petroleum compounds detected

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ALASKA DISTRICT
ANCHORAGE, ALASKA

Figure 3-3

COAL STORAGE YARD SOURCE AREA
CONTAMINANTS OF CONCERN
IN GROUNDWATER
OPERABLE UNIT 4

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Fairbanks Alaska

SIZE	JOB NO.	FILE NO.	DATE	PLATE
A	JT2901	JT2CCG2.CDR	96MAY03	

Section 4

4.0 SUMMARY OF SITE RISKS

The Baseline Human Health and Ecological Risk Assessment is one mechanism for determining the need for taking action at the source areas and indicates the exposure pathways that need to be addressed by remedial action. Risk assessments are performed using information on toxicity of contaminants and assumptions regarding the extent to which people may be exposed to them. This summary of the Baseline Human Health Risk Assessment for the source areas is divided into the five following sections:

- Identification of contaminants of concern;
- Exposure assessment;
- Toxicity assessment;
- Risk characterization, which is an integration and summary of the information gathered and analyzed in the preceding sections; and
- Analysis of the uncertainty involved in developing the Risk Assessment.

The summary concludes with the results of the Ecological Risk Assessment conducted for the Landfill and CSY source areas.

Human Health and Ecological Risk Assessments were conducted for OU-4 to determine potential risks in the absence of remedial action. CERCLA guidance allows the Baseline Risk Assessment to reflect the expected future use of a site. Scenarios involving future residential use of the Landfill and CSY source areas were completed. However, these scenarios were determined to be inappropriate for soils because industrial use is the reasonably anticipated future use based on the Post master plan and historical use of both areas.

It was determined, because of site hydrologic conditions, 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 these source areas, the beneficial use is domestic water supply.

4.1 IDENTIFICATION OF CHEMICALS OF CONCERN (SCREENING ANALYSIS)

Selection of contaminants of concern, which are chemicals that potentially contribute to human health risks at the source areas, was a two-step process. First, the maximum concentrations of contaminants detected in on-site soil and water during 1993 investigations were compared to health-based screening levels for drinking water, soil, and air in accordance with EPA, Region X, *Supplemental Risk Assessment Guidance*. Region X recommends the use of EPA, Region 3, risk-based concentration (RBC) values (April 20, 1994). These standards reflect residential exposure assumptions and 1×10^{-6} and 1×10^{-7} risks associated with groundwater and soil, respectively, or a hazard quotient of 0.1 for all media. If risk-based screening numbers were not available, maximum groundwater concentrations were compared to Safe Drinking Water Act MCLs. Secondly, inorganic chemicals were compared to

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naturally occurring background levels. If concentrations were found below established background levels, they were eliminated from further evaluation. At the Landfill, 10 chemicals were identified as contaminants of concern in groundwater, and nine contaminants were identified as contaminants of concern in groundwater at the CSY. While soil contamination did not pose a direct threat to human health, it does act as an ongoing source of contamination to groundwater. Table 4-1 presents the contaminants of concern identified in each environmental medium evaluated.

4.2 EXPOSURE ASSESSMENT

The exposure assessment estimates the type and magnitude of exposures to the contaminants of concern 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 contaminant of concern from each medium for each population at risk.

The Human Health Risk Assessment for OU-4 was divided into the Landfill, CSY and FTP source areas. The FTPs were eliminated from further consideration because of the limited extent and type of contamination.

4.2.1 Identification of Site Uses, Exposed Populations, and Exposure Pathways

4.2.1.1 Source Area Land Use Scenarios

The exposure assessment for the Landfill and CSY source areas considers land use scenarios to evaluate exposed populations. The Baseline Human Health Risk Assessment evaluated future residential land use of the source areas, which assumes that individuals would spend 30 years of their time at the source. Although this use scenario is unlikely, it provides a conservative baseline to avoid underestimation of risks. The industrial scenario assumes that the sources would continue to be used for industrial purposes and that workers would spend 25 years of continuous employment at the site. Tables 4-2 and 4-3 identify the potential exposure routes evaluated for the Human Health Risk Assessment; however, it was determined that only the industrial scenario would be appropriate for these source areas.

4.2.1.2 Exposed Populations and Pathways

An exposure pathway is the mechanism by which chemicals migrate from their source or point of release to the population at risk. Four elements comprise a complete exposure pathway: 1) a source of a chemical release; 2) movement of contaminants through environmental media; 3) a point of potential human contact with a contaminated medium; and 4) entry into the body or exposure route.

The exposure pathways considered in the Baseline Risk Assessment varied depending on the land use and on the population potentially exposed. The exposure assessment identified potential pathways for contaminants of concern to reach the exposed population for each source area (see Tables 4-2 and 4-3). A "complete" exposure pathway must exist for a contaminant to pose a human health risk (i.e., the potential for a receptor to be exposed to a contaminant must exist).

4.2.1.3 Calculation of Exposure

EPA's Superfund guidance requires that the reasonable maximum exposure be used to calculate potential health impacts at Superfund sites. The reasonable maximum exposure, the highest exposure that is reasonably expected to occur at the source areas, is calculated using conservative assumptions in order to represent exposures that are reasonable and protective. The Baseline Human Health Risk Assessment reasonable maximum exposure and average exposures were estimated for the residential and industrial land use scenarios. Average exposures were calculated in order to represent exposures of a more typical person.

To estimate exposure, data regarding the concentrations of contaminants of concern in the media of concern at the source area (the exposure point concentrations) are combined with information about the projected behaviors and characteristics of the people who potentially may be exposed to these media (exposure parameters). These elements are described below.

a) Exposure Point Concentrations. Averages of defined sub-areas for surface and subsurface soil and sediment sample results for each source area were used as exposure point concentrations for the reasonable maximum exposure and average exposure calculations. Sources were divided into sub-areas for soils to reflect differences in geographic locations and nature and extent of contamination. Individual well data were used to determine groundwater risks. Tables 4-4 and 4-5 contain the exposure point concentrations for carcinogenic and noncarcinogenic contaminants of concern in surface and subsurface soil, sediments, and groundwater at the source areas.

b) Exposure Parameters. The parameters used to calculate the reasonable maximum exposure include body weight, age, contact rate, frequency of exposure, and exposure duration. Exposure parameters were obtained from EPA, Region X, risk assessment guidance (*EPA, Region X Supplemental Risk Assessment Guidance for Superfund* [EPA 1991]). The default exposure factors were modified to reflect site-specific climatological and other factors at Fort Wainwright. Site-specific exposure assumptions were made for soil contact, including ingestion, dermal contact, and inhaling dust, based on snow cover half the year.

For all of the media, exposures were estimated assuming long-term exposures to source area contaminants.

4.3 TOXICITY ASSESSMENT

The Baseline Human Health Evaluation provides toxicity information for the chemicals of concern. Generally, cancer risks are calculated using toxicity factors known as "slope factors," while noncancer risks rely on reference doses.

EPA has developed slope factors for estimating lifetime cancer risks associated with exposure to potential carcinogens. Slope factors are expressed in units of (mg/kg-day^{-1}) and are multiplied by the estimated intake of a potential carcinogen, in mg/kg-day, to provide an upper-bound estimate of the excess lifetime cancer risk associated with exposure at that intake level. The term "upper-bound" reflects the conservative estimate of the risks calculated from the slope factor. Use of this approach makes it highly unlikely that the actual cancer risk would be underestimated. Slope factors are derived from the results of human epidemiological studies or chronic animal bioassays to which mathematical extrapolations from high to low dose and from animal to human dose have been applied.

Reference doses have been developed to indicate the potential for adverse health effects from ingestion of potential contaminants of concern that exhibit noncancer effects, such as damage to organ systems (e.g., the nervous system, blood-forming system, etc.). They are also expressed in units of mg/kg-day. Reference doses are estimates within an order of magnitude of lifetime daily exposure levels for people, including sensitive individuals, who are likely to be without risk of adverse effect. Estimates of intakes of contaminants of concern from environmental media (e.g., the amount of a contaminant of concern ingested from contaminated drinking water) can be compared to the reference dose. Reference doses are derived from human epidemiological studies or from animal studies to which uncertainty factors have been applied.

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 at this time, other criteria, such as MCLs promulgated under the Safe Drinking Water Act, were used to assess potential hazards.

4.4 RISK CHARACTERIZATION

The purpose of the risk characterization is to integrate the results of the exposure assessment and the toxicity assessment to estimate risk to humans from exposure to site contaminants. Risks were calculated for carcinogenic (cancer-causing) and noncarcinogenic (toxic) effects based on the reasonable maximum exposure (see exposure assessment discussion). To estimate cancer risk, the slope factor is multiplied by the exposure expected for that chemical to provide an upper-bound 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. EPA considers that excess lifetime cancer risks between 1 in 1 million (1×10^{-6}) and 1 in 10,000 (1×10^{-4}) are 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 exposure to noncancer-causing contaminants, EPA considers acceptable exposure levels as 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's contaminant to that contaminant's reference dose. If this ratio, called a "hazard quotient," is less than 1, then adverse noncancer health effects are not likely to occur. Hazard quotients for individual contaminants of concern are summed to yield a hazard index for the sub-area. The potential excess lifetime cancer risks and hazard indices described in this summary were calculated using reasonable maximum exposure assumptions. Table 4-6 presents cancer and noncancer risks for groundwater for the Landfill and CSY.

The potential human health risks at Fort Wainwright were characterized for groundwater by estimating risks on a well-specific basis. Soils were evaluated on a sub-area basis to allow for differences in geographic location as well as nature and extent of contamination. This approach retains information on the geographic distribution of risk throughout the source areas. The well and sub-area-specific risk assessment approach were used to distinguish specific Landfill and CSY areas that exceed risk-based levels. Excess lifetime cancer risks and hazard indices for current and future scenarios for groundwater are summarized in Figures 4-1 through 4-4. Excess lifetime cancer risks for current and future scenarios for soil, sediment, and air contamination are below or within the 1-in-10,000 to 1-in-1 million risk range.

Under current land use conditions, the estimates of carcinogenic and noncarcinogenic effects for the OU-4 source areas fell within or below the acceptable risk range for the CERCLA sites. The future land use for both the CSY and the Landfill was determined to be industrial. However, a residential scenario for groundwater use is considered appropriate and representative of risk to current downgradient users, given Landfill and CSY hydrological conditions. When considering groundwater as a source of domestic water, several contaminants were detected in groundwater at concentrations above EPA's acceptable risk range for both source areas. These risk drivers include manganese; antimony; arsenic; benzene; bis(2-ethylhexyl)phthalate; dioxins and furans; and 1,1,2,2-tetrachloroethane. Note, however, that the manganese, antimony, and arsenic concentrations detected at OU-4 reflect background concentrations in this mineralogically rich area. Dioxin and furan concentrations are below drinking water MCLs. The presence of benzene and bis(2-ethylhexyl)phthalate remains a risk driver for both source areas, and 1,1,2,2-tetrachloroethane is a risk driver at the Landfill.

Risks associated with TCE were not calculated for either source area, although this contamination is present in groundwater at both locations. This is because the cancer slope factors for TCE have been withdrawn from the toxicological data bases, Integrated Risk Information System, and Health Effects Assessment Summary Tables. In the absence of an accepted risk value, the MCL is used to establish the need for action for TCE at the Landfill and CSY.

4.4.1 Landfill Source Area

Excess lifetime cancer risks associated with potential downgradient drinking water use of Landfill groundwater ranged from 2×10^{-7} to 3×10^{-3}, depending on which well is used. The contaminants of concern that are attributable to Landfill activities and that exceed the acceptable risk range are 1,1,2,2-tetrachloroethane and bis(2-ethylhexyl)phthalate. Arsenic was the only contaminant in one downgradient well found at concentrations exceeding 1×10^{-4}. Hazard indices associated with future residential groundwater use ranged from 0.3 to 39, with manganese being solely responsible for all hazard indices over 1. Arsenic and manganese concentrations are contaminants of concern naturally occurring at these concentrations detected and not associated with Landfill activities.

A semi-quantitative evaluation of TCE risks was completed by comparing contaminant concentrations to Region 3 risk-based concentrations. The evaluation indicated that TCE would have a relatively minor impact on total risk estimates at the Landfill.

EPA's screening level of 1,000 mg/kg for lead in soil at industrial sites was exceeded at one location where a small petroleum spill apparently occurred at the Landfill. Consequently, the soil lead concentrations detected at the Landfill (up to 2,480 mg/kg) could elicit adverse health effects if children were to be exposed through inhalation or ingestion of the soils. However, this small location subsequently was permanently covered with approximately 8 feet of building debris and landfill cover material during a landfill stabilization effort conducted in summer 1995. Therefore, this small source no longer poses a risk from dermal contact.

4.4.2 Coal Storage Yard Source Area

No risks greater than 1×10^{-6} or a hazard quotient of 1 were associated with current or future use of CSY soils. Risks associated with potential downgradient drinking water users do exceed an excess lifetime cancer risk of 1×10^{-4}. The primary contaminants of concern are benzene and dioxins/furans. However, the dioxin/furan compounds do not exceed state and federal drinking water standards. Hazard indices associated with downgradient residential groundwater use ranged from 0.001 to 7; the principal contaminants of concern were antimony and manganese. Both of these metals are considered to be naturally occurring.

A semi-quantitative evaluation of TCE risks was completed by comparing contaminant concentrations to Region 3 RBCs. The evaluation indicated that the exclusion of trichlorethene may serve to underestimate potential risks at one well at the CSY. TCE at the CSY will be treated through the selected remedial alternative.

4.5 MAJOR UNCERTAINTIES

Uncertainty is associated with every step of the risk assessment process. The principal uncertainties associated with the OU-4 risk assessment process that could result in overly conservative risk evaluations are summarized below:

- Derivation of future surface soil concentrations from subsurface soil data. The assumption that subsurface soil would be disturbed and mixed with the present surface soil layer is an extremely conservative approach.

Uncertainties that may serve to underestimate site-related risk and exposures include:

- Sampling of CSY environmental media may not have occurred in the most contaminated areas because of sampling constraints associated with operational activities;

- Qualified data from the analysis of dioxin/furan samples for the CSY soils resulted in exclusion of these data from the quantitative Risk Assessment. Consequently, risks associated with these analytes may be underestimated in this Baseline Human Health Risk Assessment; and

- High sample quantitation limits. Several analytes consistently exhibited sample quantitation limits greater than EPA's Region 3 RBCs, reflecting sample matrix interference, sample dilution, or inadequate detection limits for analytes not anticipated to be contaminants of concern at OU-4.

4.6 ECOLOGICAL RISKS

An Ecological Risk Assessment addresses the impacts and potential risks posed by contaminants to natural habitats, including plants and animals, in the absence of remedial action. The three main phases of the Ecological Risk Assessment are problem formulation, analysis, and risk characterization.

The following section presents a brief discussion of the Ecological Risk Assessment steps described above.

4.6.1 Problem Formulation

To narrow the scope and to focus the Ecological Risk Assessment on the most important aspects of OU-4, many steps were performed. A physical site description of the ecological features of interest at the Landfill and CSY was prepared, and previous ecological investigations, including wildlife inventories and Environmental Impact Statements, were reviewed. A description of the regional and local ecology was completed and threatened, endangered, sensitive, or rare species were identified.

Chemicals of potential ecological concern were identified by reviewing the OU-4 analytical data base with regard to data quality, spatial representation and adequacy for an Ecological Risk Assessment; frequency with which analytes are detected in environmental media; comparison to background concentrations; and comparison to ecological risk-based criteria for sediment and surface water. Next, pathways of contaminant migration and exposure were identified by evaluating sources of contaminants and the mechanisms by which they may be transported to media of ecological concern, plants, and animals.

Potential ecological effects are summarized by reviewing the toxicological literature. These summaries present a review of the known toxicological effects of the chemicals of potential ecological concern on wildlife species.

Two types of ecological endpoints are considered in the Ecological Risk Assessment: assessment and measurement endpoints:

- Assessment endpoints are qualitative or quantitative expressions of the environmental values to be protected at OU-4 and are selected by considering species that play important roles in community structure or function; species of societal significance or concern; species of concern to federal and state agencies; diet, habitat preference, and behaviors that predispose the species to chemicals of potential ecological concern exposure; amenability of the selected species to measurement or prediction of effects; and species that may be particularly sensitive to the chemicals of potential ecological concern identified at OU-4; and

- Measurement endpoints include the species and communities used to quantify the potential ecological impacts posed by OU-4 chemicals of potential ecological concern. Representative measurement species are selected based on the relative abundance of each species and establishing functional groups based on trophic level and preferred habitat. Representative indicator species are then selected based on the potential for exposure and the availability of toxicological data. The following measurement species and communities were selected for evaluation at OU-4: aquatic macroinvertebrates, terrestrial vegetation, soil macroinvertebrates (e.g., earthworms), masked shrews, mallards, American robins, and American kestrels.

The refined conceptual ecological exposure models for OU-4 can be summarized by the following working hypotheses:

- Potential ecological risks may result from exposure of terrestrial wildlife and vegetation to chemicals of potential ecological concern found in the surface soils of OU-4;

- Potential ecological risks may result from exposure of waterfowl to the chemicals of potential ecological concern found in the Landfill wetlands and the CSY cooling pond; and

- Chemicals of potential ecological concern in Landfill wetlands, the CSY cooling pond, and Chena River surface water and sediment may affect the populations of aquatic and benthic macroinvertebrates that inhabit them.

4.6.2 Analysis

The analysis phase of the Ecological Risk Assessment evaluates receptor exposure to chemicals of potential ecological concern and the potential adverse effects of that exposure. Analysis of exposure and effects is based on the ecological endpoints and refined conceptual site model derived during the problem formulation phase. Analysis comprises two principal components:

- Exposure assessment, in which exposure point concentrations and chemicals of potential ecological concern intakes for the measurement species are calculated; and

- Ecological effects assessment, in which toxicity benchmark values are derived from the literature and toxicological data bases, and uncertainty factors are selected and applied to the toxicity benchmark values to yield toxicity reference values. The uncertainty factors are used to compensate for applying data derived from laboratory or domestic animal studies to free-ranging wildlife (for which little empirical data are available).

4.6.3 Risk Characterization

Risk characterization involves two major components: risk estimation and risk description.

4.6.3.1 Risk Estimation

Risk estimation involves calculating hazard quotients to assess potential ecological risks to measurement species and communities. This method involves comparing calculated exposure doses or media concentrations with toxicity reference values and/or experimentally derived risk-based concentrations.

Ecological effects are quantified by calculating the ratio between a chemical of potential ecological concern's estimated intake or concentration and its corresponding toxicity reference value (i.e., the intake level or concentration at which no adverse ecological effects are expected to occur). If this ratio (i.e., the hazard quotient) exceeds 1, then adverse ecological effects may be expected for the chemical of potential ecological concern. The hazard quotients described in this summary were calculated using conservative reasonable maximum exposure assumptions.

The hazard quotients for each exposure pathway (e.g., soil ingestion and surface water ingestion) may be summed for each chemical of potential ecological concern to establish contaminant-specific hazard indices for each measurement species. The hazard indices provide a species- and contaminant-specific characterization of the potential ecological risks across all of the assessed exposure pathways. Finally, the hazard indices can be added across contaminants that have similar effects.

4.6.3.2 Risk Description

Risk description involves summarizing the ecological significance of the potential risks and presenting the uncertainties associated with the Ecological Risk Assessment.

The results of the Ecological Risk Assessment for OU-4 indicate a potential for effects to small mammals (shrews, voles, etc.) at the Landfill, reflecting ecologically significant concentrations of copper, and at the CSY based on concentrations of copper, cadmium, and selenium. These risks are associated with ingestion of soil and earthworms. These contaminants do not appear to be associated with historical source area activities and are consistent with regional background concentrations. Barium poses potential risks to passerine birds (robins, sparrows, etc.) at the Landfill, and barium and copper pose a risk to passerine birds at the CSY through ingestion of soil and earthworms. However, these locations represent a relatively small habitat area. Additionally, both the Landfill and CSY are industrial areas with a significant amount of heavy equipment and human activity. The habitat area in these locations has been significantly altered from the surrounding land. Specific species surveys and traps were not used for the Landfill and CSY. The actual number of animals that could be affected by these chemicals could be very low. No significant effects were predicted for waterfowl (mallards), raptors (kestrels), or terrestrial vegetation.

At the Landfill wetlands and the CSY cooling pond, benthic (sediment-dwelling) invertebrates may be slightly impacted by metals or dichlorophenyltrichloroethane (also known as "DDT") and its metabolites present in the sediments. These concentrations are consistent with Postwide levels and most likely represent residues associated with historical aerial spraying of the Fairbanks area for mosquito control. These concentrations do not appear to be associated with a chemical release associated with Landfill or CSY activities. No potential effects were predicted for aquatic (surface water-dwelling) species. There do not appear to be unacceptable potential ecological risks associated with the Landfill or CSY source areas. However, capping of the Landfill will minimize surface exposure to passerine birds. Remediation activities at the CSY are not expected to change inorganic chemical concentrations.

The Ecological Risk Assessment is subject to uncertainties because virtually every step in the risk assessment process involves assumptions involving professional judgment. Principal uncertainties associated with the OU-4 Ecological Risk Assessment include the following:

- A limited number of samples was collected from the source areas, and the samples were biased toward areas of "expected" soil contamination. This is likely to result in an overestimation of potential risks to the OU-4 ecological receptors;

- Exposure parameters for all measurement species were selected based on professional judgment. The amount of food consumed on a daily basis, the different types of food consumed, and the percentage of the whole diet that each food item contributes were estimated based on a combination of scientific literature and limited field observation information. In addition, the amount of time spent foraging on site is estimated using similar information. Without extensive site-specific field data, it is unclear whether potential risks are underestimated or overestimated using the selected exposure parameters;

- Ingestion rates for all measurement species were converted from a wet- to a dry-weight basis for use in the ecological exposure model. To convert these ingestion rates, assumptions regarding moisture content of food items for measurement were made. It is unclear whether these assumptions overestimate or underestimate potential risks to undeveloped Landfill species;

- For the shrew, mallard, and robin, exposure through incidental ingestion of surface soil accounted for a significant portion of the estimated risk for these species. Species-specific soil ingestion rates were unavailable for the shrew and the robin. It was assumed that these two receptors ingested soil at 10.4% of their daily dietary intake while foraging. This assumption is likely to result in an overestimation of potential risks from soil ingestion for these species;

- The modeling approach used to estimate site-related chemical of potential ecological concern concentrations in vegetation and shrew and robin tissue is a major source of uncertainty. Plant uptake and small mammal and bird bioaccumulation factors were derived from data reported in the scientific literature and likely are correlated with site-specific variables such as soil type, soil chemistry, and wildlife species. It is unclear whether the application of these literature-derived values overestimate or underestimate potential risks to measurement communities;

- Frequently, toxicity and exposure data from literature sources were not specific to the target receptors; therefore, extrapolation of the data to the species of concern was necessary. Differences in toxic response between species are well-documented, even among species of the same genus. Because toxicity data were unavailable for the shrew, mallard, and robin, values were derived from laboratory species (i.e., rat, mouse, Japanese quail, California quail, bobwhite quail, chicken, turkey, mallard, ringneck pheasant, and American kestrel). The differences in species-specific toxicity were addressed in this assessment using uncertainty factors, which may not accurately predict inter- and intra-species differences in toxic response. Therefore, actual risk may be overestimated or underestimated;

- Uncertainty factors obtained from available literature and based on best professional judgment were applied to normalize toxicological data to chronic no observed effect levels. Considerable uncertainty is associated with their application; however, the desired result is a conservative estimate of the no observed effect level, which should result in a conservative estimate of any potential risks;

- Toxicity values were not found for several of the chemicals of potential ecological concern, which resulted in an underestimation of potential risks to OU-4 species;

- Most of the available toxicity values were determined with laboratory animals under laboratory conditions. Such studies may not accurately reflect the effects of similar doses on free-ranging wildlife;

- Toxicity values determined with indirect effect measures (such as increased body weight) may not represent other significant indirect effects (such as behavioral changes) that may be realized in wild populations; and

- Suitable phytotoxicity and soil macroinvertebrate information was very limited. In cases where data were available, the lowest reported a chemical of potential ecological concern concentration that elicited an adverse effect was selected. However, this value was specific for the species tested and may not be representative of species found on OU-4.

The approach described in this Ecological Risk Assessment used realistic assumptions wherever possible; reasonable and conservative assumptions were used when empirical data were unavailable. As a consequence, potential ecological risks to OU-4 species are more likely to be overestimated than underestimated.

Table 4-1

CHEMICALS OF CONCERN
FROM HUMAN HEALTH RISK ASSESSMENT
OPERABLE UNIT 4
FORT WAINWRIGHT, ALASKA

Analyte	Source Area	
	Landfill	Coal Storage Yard
INORGANICS		
Antimony	—	GW[a]
Arsenic	Soil[b], GW	—
Beryllium	—	Soil
Lead	Soil	—
Manganese	GW	GW
ORGANICS		
1,1,2,2-Tetrachloroethane	GW	—
1,1,2-Trichloroethane	GW	—
1,2-Dichloroethane	GW	—
2,3,7,8-TCDD	—	GW
4,4'-DDE	—	GW
Benzene	GW	GW
bis(2-ethylhexyl)phthalate	GW, Soil	GW
Bromodichloromethane	GW	—
Chloroform	GW	—
Dieldrin	—	GW
Heptachlor	—	GW
Heptachlor epoxide	—	GW
Vinyl chloride	GW	—

[a] COC in groundwater.
[b] COC in surface soil, subsurface soil, and ash (Landfill only).

Key:

— = Not identified as a COC in environmental media at this source area.
COC = Chemical of concern.
DDE = Dichlorodiphenyldichloroethene.
GW = Groundwater.
TCDD = Tetrachlorodibenzo-*p*-dioxin.

Table 4-2

POTENTIAL EXPOSURE ROUTES
LANDFILL SOURCE AREA
FROM HUMAN HEALTH RISK ASSESSMENT
OPERABLE UNIT 4
FORT WAINWRIGHT, ALASKA

Exposure Medium and Route	Commercial and Industrial Population[a]	Site Visitor and Recreational Population[a]	Potential Impacted Supply Aquifer Scenario
Groundwater			
Ingestion	—	X	X
Dermal contact	—	X	X
Air			
Inhalation of indoor vapors[b]	—	—	X
Inhalation of fugitive dust (soil)[c]	X	X	—
Inhalation of fugitive dust (ash)[d]	X	X	—
Surface Soil			
Ingestion	X	X	—
Subsurface Soil[e]			
Ingestion	X (future)	X (future)	—
Ash			
Ingestion	X	X	—
Dermal contact	X	X	—

[a] Evaluated in current and future land use scenarios, unless otherwise noted.

[b] Indoor vapors originate from groundwater.

[c] Fugitive dust originates from soil (surface soil only for current scenarios and surface and subsurface soil combined for future scenarios).

[d] Fugitive dust originates from ash.

[e] Subsurface soil is assumed to be mixed with surface soil for future scenarios. Therefore, the subsurface soil data will be combined with the surface soil data for future scenarios.

Key:

— = Exposure of this population through this route is not likely to occur.

X = Exposure of this population through this route will be evaluated in the baseline human health risk assessment.

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Table 4-3

**POTENTIAL EXPOSURE ROUTES
COAL STORAGE YARD SOURCE AREA
FROM HUMAN HEALTH RISK ASSESSMENT
OPERABLE UNIT 4
FORT WAINWRIGHT, ALASKA**

Exposure Medium and Route	Commercial and Industrial Population[a]	Site Visitor and Recreational Population[a]	Potential Impacted Supply Aquifer Scenario
Groundwater			
Ingestion	—	X	X
Dermal contact	—	X	X
Air			
Inhalation of indoor vapors[b]	—	X	X
Inhalation of fugitive dust (soil)[c]	X	X (future)	—
Surface Soil[d]			
Ingestion	X	X (future)	—
Subsurface Soil[e]			
Ingestion	X (future)	X (future)	—

[a] Evaluated in current and future land use scenarios, unless otherwise noted.
[b] Indoor vapors originate from groundwater.
[c] Fugitive dust originates from soil (surface soil only for current scenarios and surface and subsurface soil combined for future scenarios).
[d] Dermal contact with soil was not evaluated at the Coal Storage Yard because insufficient dermal absorption data are available for the contaminants of potential concern associated with soil.
[e] Subsurface soil is assumed to be mixed with surface soil for future scenarios.

Key:

— = Exposure of this population through this route is not likely to occur.
X = Exposure of this population through this route will be evaluated in the baseline human health risk assessment.

Table 4-4

**EXPOSURE POINT CONCENTRATIONS FOR SOILS
CURRENT AND FUTURE EXPOSURE SCENARIOS
FROM HUMAN HEALTH RISK ASSESSMENT
OPERABLE UNIT 4
FORT WAINWRIGHT, ALASKA**

Source Area/Sub-Area	Soil Type	COPC	EPC (mg/kg)	No. of Samples Analyzed/Detected	EPC Derivation
CURRENT EXPOSURE SCENARIOS					
Landfill/Sub-Area A— Drainage SE of landfill, north of River Road.	Surface	Aluminum	38,000	8/8	Maximum detected concentration
		Dieldrin	0.099	8/4	Maximum detected concentration
		Manganese	426	8/8	Maximum detected concentration
		Vanadium	56	8/8	Maximum detected concentration
Landfill/Sub-Area B— Drainage SE of landfill, south of River Road.	Surface	DDT	0.247	5/4	Maximum detected concentration
		Arsenic	21	5/5	Maximum detected concentration
		Manganese	530	5/5	Maximum detected concentration
Landfill/Sub-Area C— Hot spot near off-road vehicle recreation area.	Surface	Manganese	343	1/1	Only detected concentration
Landfill/Sub-Area D— Drainage SW of landfill, south of River Road.	Surface	DDE	0.191	6/1	Maximum detected concentration
		DDT	0.692	6/1	Maximum detected concentration
		Manganese	515	6/6	Maximum detected concentration

Key at end of table.

Table 4-4

**EXPOSURE POINT CONCENTRATIONS FOR SOILS
CURRENT AND FUTURE EXPOSURE SCENARIOS
FROM HUMAN HEALTH RISK ASSESSMENT
OPERABLE UNIT 4
FORT WAINWRIGHT, ALASKA**

Source Area/Sub-Area	Soil Type	COPC	EPC (mg/kg)	No. of Samples Analyzed/Detected	EPC Derivation
Landfill/Sub-Area E— SS-29 - Hot spot west of landfill.	Surface	Barium	559	1/1	Only detected concentration
		Bis(2-ethylhexyl)pht-halate	43.5	1/1	Only detected concentration
		Cadmium	11	1/1	Only detected concentration
		Chromium	42	1/1	Only detected concentration
		Lead	2,480	1/1	Only detected concentration
Coal Storage Yard/AP-6159	Surface	Aluminum	44,100	1/1	Maximum detected concentration
		Barium	2,630	1/1	Maximum detected concentration
		Beryllium	2.2	1/1	Maximum detected concentration
		Manganese	572	1/1	Maximum detected concentration
		Selenium	52	1/1	Maximum detected concentration
		Vanadium	112	1/1	Maximum detected concentration
Coal Storage Yard/AP-6162	Surface	Beryllium	0.52	1/1	Maximum detected concentration
		Cadmium	54	1/1	Maximum detected concentration
		Manganese	321	1/1	Maximum detected concentration

Key at end of table.

Table 4-4

EXPOSURE POINT CONCENTRATIONS FOR SOILS CURRENT AND FUTURE EXPOSURE SCENARIOS FROM HUMAN HEALTH RISK ASSESSMENT OPERABLE UNIT 4 FORT WAINWRIGHT, ALASKA

Source Area/Sub-Area	Soil Type	COPC	EPC (mg/kg)	No. of Samples Analyzed/Detected	EPC Derivation
Coal Storage Yard/Sub-Area F— East of cooling pond, south of railroad tracks.	Surface	Beryllium	0.475	2/2	Maximum detected concentration
FUTURE EXPOSURE SCENARIOS					
Landfill/Sub-Area A— Drainage SE of landfill, north of River Road.	Surface and Subsurface	Aluminum	21,361	11/11	UCL - log-normal distribution
		Dieldrin	0.025	1/41	UCL - Helsel's method
		Manganese	338	11/11	UCL - normal distribution
		Vanadium	41.3	11/11	UCL - normal distribution
Landfill/Sub-Area B— Drainage SE of landfill, south of River Road.	Surface	DDT	0.247	5/4	Maximum detected concentration
		Arsenic	21	5/5	Maximum detected concentration
		Manganese	530	5/5	Maximum detected concentration
Landfill/Sub-Area C— Hot spot near off-road vehicle recreation area.	Surface	Manganese	343	1/1	Only detected concentration
Landfill/Sub-Area D— Drainage SW of landfill, south of River Road.	Surface and Subsurface	DDE	0.191	7/1	Maximum detected concentration
		DDT	0.692	7/1	Maximum detected concentration
		Manganese	515	7/7	Maximum detected concentration

Key at end of table.

Table 4-4

**EXPOSURE POINT CONCENTRATIONS FOR SOILS
CURRENT AND FUTURE EXPOSURE SCENARIOS
FROM HUMAN HEALTH RISK ASSESSMENT
OPERABLE UNIT 4
FORT WAINWRIGHT, ALASKA**

Source Area/Sub-Area	Soil Type	COPC	EPC (mg/kg)	No. of Samples Analyzed/Detected	EPC Derivation
Landfill/Sub-Area E— SS-29 - Hot spot west of landfill.	Surface	Barium	559	1/1	Only detected concentration
		bis(2-ethylhexyl)pht-halate	43.5	1/1	Only detected concentration
		Cadmium	11	1/1	Only detected concentration
		Chromium	42	1/1	Only detected concentration
		Lead	2,480	1/1	Only detected concentration
Coal Storage Yard/AP-6159	Surface and Subsurface	Aluminum	44,100	2/2	Maximum detected concentration
		Barium	2,630	2/2	Maximum detected concentration
		Beryllium	1.7	2/2	Maximum detected concentrations
		Manganese	493	2/2	Maximum detected concentrations
		Selenium	52	2/1	Maximum detected concentration
		Vanadium	112	2/2	Maximum detected concentration
Coal Storage Yard/AP-6162	Surface and Subsurface	Beryllium	0.47	2/2	Maximum detected concentration
		Cadmium	54	2/1	Maximum detected concentration
		Manganese	285	2/2	Maximum detected concentration

Key at end of table.

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Table 4-4

EXPOSURE POINT CONCENTRATIONS FOR SOILS
CURRENT AND FUTURE EXPOSURE SCENARIOS
FROM HUMAN HEALTH RISK ASSESSMENT
OPERABLE UNIT 4
FORT WAINWRIGHT, ALASKA

Source Area/Sub-Area	Soil Type	COPC	EPC (mg/kg)	No. of Samples Analyzed/Detected	EPC Derivation
Coal Storage Yard/Sub-Area F—East of cooling pond, south of railroad tracks.	Surface and Subsurface	Beryllium	0.44	10/10	UCL - normal distribution
		Manganese	301	10/10	UCL - normal distribution

Key:

COPC = Contaminant of potential concern.
DDE = Dichlorodiphenyldichloroethylene.
DDT = Dichlorodiphenyltrichloroethane.
EPC = Exposure point concentration.
mg/kg = Milligrams per kilogram.
UCL = Upper confidence limit on the mean.

Table 4-5

EXPOSURE POINT CONCENTRATIONS IN GROUNDWATER (µg/L)
FROM HUMAN HEALTH RISK ASSESSMENT
OPERABLE UNIT 4
FORT WAINWRIGHT, ALASKA

Analyte	Coal Storage Yard Wells								
	AP-5508	AP-5509	AP-5510	AP-5511	AP-5736	AP-6142	AP-6143	MW-1D	MW-2S
Antimony	26	ND	28	32	20.25	ND	ND	ND	ND
Manganese	< BKGD	< BKGD	< BKGD	920	< BKGD	< BKGD	< BKGD	ND	ND
1,1,2,2-Tetrachloroethane	ND	ND	ND	ND	ND	ND	ND	ND	ND
1,1,2-Trichloroethane	ND	ND	ND	ND	ND	ND	ND	ND	ND
1,2-Dichloroethane	ND	ND	ND	ND	ND	ND	ND	ND	ND
2,3,7,8-TCDD	ND	1.32E-05	ND	ND	6.4E-08	ND	ND	ND	ND
4,4'-DDE	ND	ND	ND	ND	ND	ND	ND	ND	0.09
Benzene	ND	ND	ND	ND	ND	ND	ND	ND	ND
bis(2-ethylhexyl)phthalate	ND	ND	ND	ND	ND	110	12	2	ND
Bromodichloromethane	ND	ND	ND	ND	ND	ND	ND	ND	ND
Chloroform	ND	ND	ND	ND	ND	ND	ND	ND	ND
cis-1,2-Dichloroethene	ND	ND	ND	ND	ND	ND	ND	ND	ND
Dieldrin	ND	ND	ND	ND	ND	ND	ND	ND	0.03
Heptachlor	ND	ND	ND	ND	ND	ND	ND	ND	0.04
Heptachlor Epoxide	ND	ND	ND	ND	ND	ND	ND	ND	ND
Methylene Chloride	ND	ND	ND	ND	ND	ND	ND	ND	ND
trans-1,2-Dichloroethene	ND	ND	ND	ND	ND	ND	ND	ND	ND
Trichlorofluoromethane	ND	ND	ND	ND	ND	ND	ND	ND	ND
Vinyl Chloride	ND	ND	ND	ND	ND	ND	ND	ND	ND

Key at end of table.

Table 4-5

EXPOSURE POINT CONCENTRATIONS IN GROUNDWATER (μg/L)
FROM HUMAN HEALTH RISK ASSESSMENT
OPERABLE UNIT 4
FORT WAINWRIGHT, ALASKA

Analyte	Coal Storage Yard Wells						
	MW-2D	WS-099	WS-119	3559-A	3595-01	3595-02	3595-03
Antimony	ND	37	ND	ND	ND	ND	ND
Manganese	ND	< BKGD	< BKGD	< BKGD	2,000[a]	1,100[a]	1,909[a]
1,1,2,2-Tetrachloroethane	ND	ND	ND	ND	ND	ND	ND
1,1,2-Trichloroethane	ND	ND	ND	ND	ND	ND	ND
1,2-Dichloroethane	ND	ND	ND	ND	ND	ND	ND
2,3,7,8-TCDD	ND	ND	4.8E-06	ND	4.5E-08	ND	ND
4,4'-DDE	ND	ND	ND	ND	ND	ND	ND
Benzene	ND	ND	ND	ND	ND	ND	2.8
bis(2-ethylhexyl)phthalate	13	R	ND	6	ND	ND	ND
Bromodichloromethane	ND	ND	ND	ND	ND	ND	ND
Chloroform	ND	ND	ND	ND	ND	ND	ND
cis-1,2-Dichloroethene	ND	ND	ND	ND	ND	ND	2.3
Dieldrin	ND	0.01	0.012	ND	ND	ND	ND
Heptachlor	ND	ND	ND	ND	ND	0.08	ND
Heptachlor Epoxide	ND	0.01	0.013	ND	ND	ND	ND
Methylene Chloride	ND	ND	ND	ND	4.3	4	ND
trans-1,2-Dichloroethene	ND	ND	ND	ND	ND	ND	ND
Trichlorofluoromethane	ND	ND	ND	ND	ND	ND	84.5
Vinyl Chloride	ND	ND	ND	ND	ND	ND	ND

Key at end of table.

Table 4-5

EXPOSURE POINT CONCENTRATIONS IN GROUNDWATER (μg/L)
FROM HUMAN HEALTH RISK ASSESSMENT
OPERABLE UNIT 4
FORT WAINWRIGHT, ALASKA

Analyte	Landfill Wells								
	AP-5585	AP-5588	AP-5589	AP-5591	AP-5593	AP-5594	AP-6133	AP-6134	AP-6136
Arsenic	< BKGD	< BKGD	ND	< BKGD	ND	ND	ND	ND	ND
Barium	< BKGD	370	550	< BKGD	< BKGD	< BKGD	< BKGD	R	No Data
Fluoride	ND	ND	< BKGD	< BKGD	ND	ND	< BKGD	< BKGD	< BKGD
Manganese	1,300[a]	2,200[a]	1,600[a]	1,500[a]	770[a]	< BKGD[a]	< BKGD[a]	R	810[a]
1,1,2,2-Tetrachloroethane	ND	1,133	6.1	ND	ND	ND	ND	ND	ND
1,1,2-Trichloroethane	ND	9.2	ND	ND	ND	ND	ND	ND	ND
1,2-Dichloroethane	ND	4.1	5.1	ND	ND	ND	ND	ND	ND
2,3,7,8-TCDD	NA	NA	NA	NA	NA	NA	NA	NA	NA
4,4'-DDE	ND	ND	ND	ND	ND	ND	ND	ND	ND
Benzene	ND	4.1	5.4	1.7	ND	ND	ND	ND	2.9
bis(2-ethylhexyl)phthalate	ND	ND	88	ND	ND	ND	48	69	620
Bromodichloromethane	ND	ND	ND	ND	ND	ND	1.7	ND	ND
Chloroform	ND	ND	ND	ND	ND	ND	20	ND	ND
cis-1,2-Dichloroethene	ND	143.3	14.5	ND	ND	ND	ND	ND	ND
Dieldrin	R	R	ND	ND	ND	ND	ND	ND	ND
Heptachlor	R	R	ND	ND	ND	ND	ND	ND	ND
Heptachlor Epoxide	R	R	ND	ND	ND	ND	ND	ND	ND
Methylene Chloride	2	ND	5.7	ND	ND	R	ND	ND	ND
trans-1,2-Dichloroethene	ND	48.3	3.8	ND	ND	ND	ND	ND	ND
Trichlorofluoromethane	ND	ND	ND	ND	ND	ND	ND	ND	ND
Vinyl Chloride	ND	1.3	1.4	ND	ND	ND	ND	ND	ND

Key at end of table.

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Table 4-5

EXPOSURE POINT CONCENTRATIONS IN GROUNDWATER (μg/L)
FROM HUMAN HEALTH RISK ASSESSMENT
OPERABLE UNIT 4
FORT WAINWRIGHT, ALASKA

Analyte	Landfill Wells								
	AP-6137	AP-6138	AP-6139	FWLF-02	FWLF-03	FWLF-04	WLF-01	WLF-02	WLF-03
Arsenic	< BKGD	ND	74	ND	ND	ND	ND	ND	< BKGD
Barium	< BKGD	No Data	360	< BKGD	< BKGD	< BKGD	< BKGD	< BKGD	R
Fluoride	< BKGD	980	< BKGD	ND	< BKGD	< BKGD	ND	ND	ND
Manganese	1,400[a]	< BKGD[a]	5,800[a]	< BKGD[a]	840[a]	2,000[a]	660[a]	890[a]	R
1,1,2,2-Tetrachloroethane	6.4	ND	ND	ND	ND	ND	ND	ND	ND
1,1,2-Trichloroethane	ND	ND	ND	ND	ND	ND	ND	ND	ND
1,2-Dichloroethane	ND	ND	ND	ND	ND	ND	ND	ND	ND
2,3,7,8-TCDD	NA	NA	NA	NA	NA	NA	NA	NA	NA
4,4'-DDE	ND	ND	R	ND	ND	ND	ND	ND	ND
Benzene	2.5	2.7	ND	ND	0.73	1.7	ND	ND	ND
bis(2-ethylhexyl)phthalate	15	73	ND	ND	16	ND	ND	ND	ND
Bromodichloromethane	ND	2	ND	ND	ND	ND	ND	ND	ND
Chloroform	1.7	17.2	ND	ND	ND	ND	ND	ND	ND
cis-1,2-Dichloroethene	8.8	ND	ND	ND	ND	ND	ND	ND	ND
Dieldrin	ND	ND	R	ND	ND	ND	ND	ND	ND
Heptachlor	ND	ND	ND	ND	ND	ND	ND	ND	ND
Heptachlor Epoxide	ND	ND	R	ND	ND	ND	ND	ND	ND
Methylene Chloride	4.6	ND	2.5	R	ND	ND	3.8	ND	ND
trans-1,2-Dichloroethene	4.8	ND	ND	ND	ND	ND	ND	ND	ND
Trichlorofluoromethane	ND	ND	ND	ND	ND	ND	ND	ND	ND
Vinyl Chloride	ND	ND	ND	ND	ND	ND	ND	ND	ND

Key at end of table.

Table 4-5 (Cont.)

[a] The result for total manganese is reported due to the lack of dissolved data.

Key:

< BKGD	=	Less than the background concentration for the analyte.
NA	=	Not analyzed.
ND	=	Not detected.
R	=	Data rejected for use in the human health risk assessment.
2,3,7,8-TCDD	=	2,3,7,8-tetrachlorodibenzo-*p*-dioxin.
4,4'-DDE	=	4,4'-dichlorodiphenyldichloroethene.

Table 4-6

POTENTIAL RME RISKS: ON-SITE GROUNDWATER
FROM HUMAN HEALTH RISK ASSESSMENT
OPERABLE UNIT 4
FORT WAINWRIGHT, ALASKA

Sample Location	Cancer Risk	Hazard Index
Landfill		
AP-5585	2E-07	7E+00
AP-5588	3E-03	1E+01
AP-5589	1E-04	9E+00
AP-5591	7E-07	8E+00
AP-5593	—	4E+00
AP-6133	3E-05	3E-01
AP-6134	3E-05	3E-01
AP-6136	3E-04	7E+00
AP-6137	3E-05	8E+00
AP-6138	4E-05	8E-01
AP-6139	2E-03	4E+01
FWLF-03	8E-06	5E+00
FWLF-04	7E-07	1E+01
WLF-01	3E-07	4E+00
WLF-02	—	5E+00
Coal Storage Yard		
3559A[a]	3E-06	2E-02
3595-01[a]	4E-06	1E+01
3595-02[a]	7E-06	6E+00
3595-03[a]	1E-06	1E+01
99[a]	5E-06	3E+00
AP-5508	—	2E+00
AP-5509	1E-03	—
AP-5510	—	2E+00
AP-5511	—	73+00
AP-5736	5E-06	1E+00
AP-6142	53-05	4E-01
AP-6143	5E-06	5E-02
MW-1D	9E-07	8E-03
MW-2D	6E-06	5E-02
MW-2S	1E-05	3E-02
PS-1	3E-07	—
PS-2	1E-06	2E-02
PS-3	9E-07	1E-03
PS-4	2E-04	6E-01
WS-119	4E-04	5E-02

[a] Potential risks associated with current groundwater use from existing wells.

Key:

COPC = Chemical of potential concern.
— = Carcinogenic or noncarcinogenic COPCs not detected.
RME = Reasonable maximum exposure.

61700

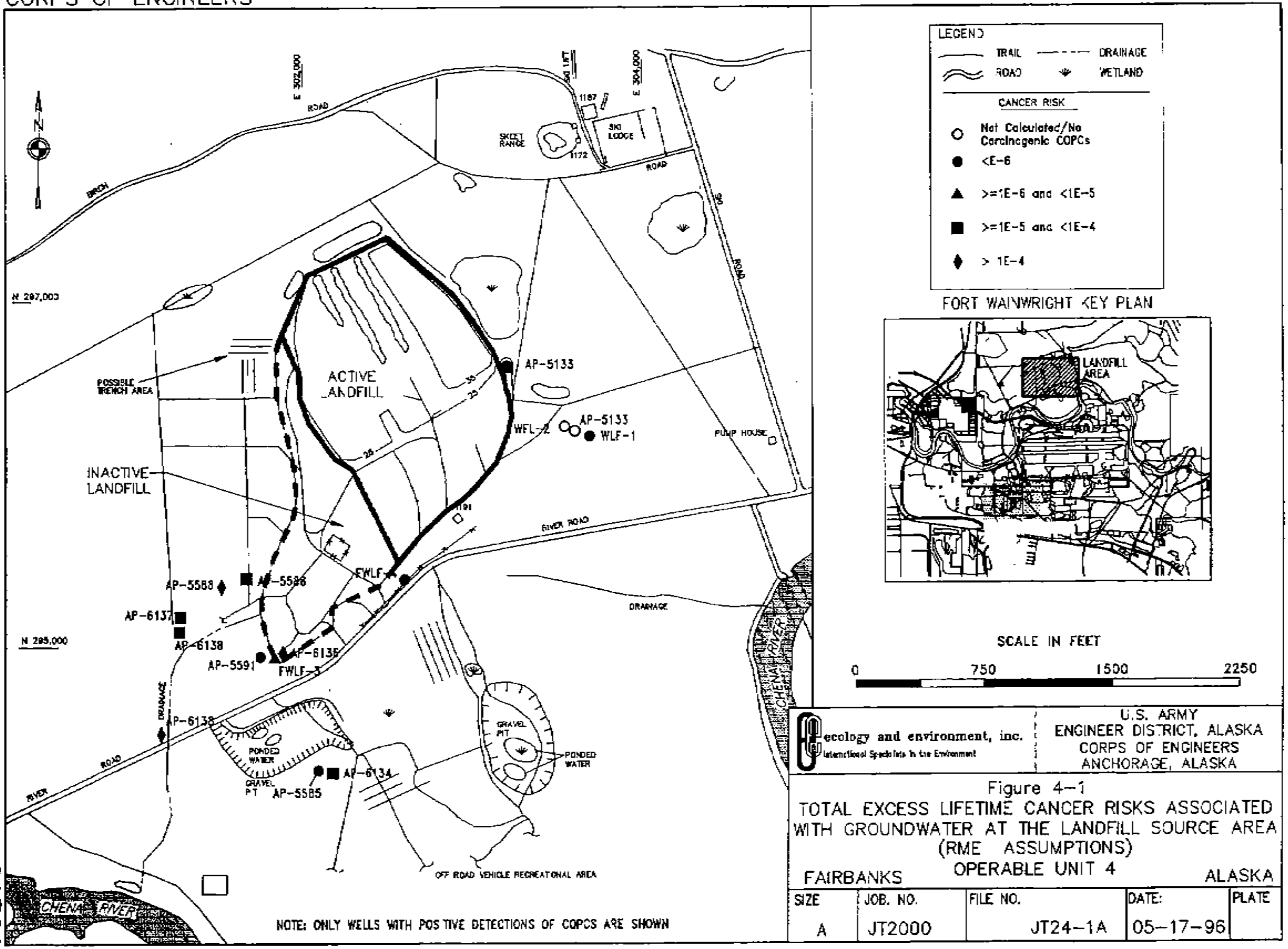

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Figure 4-1
TOTAL EXCESS LIFETIME CANCER RISKS ASSOCIATED WITH GROUNDWATER AT THE LANDFILL SOURCE AREA (RME ASSUMPTIONS)
OPERABLE UNIT 4

FAIRBANKS ALASKA

SIZE	JOB. NO.	FILE NO.	DATE:	PLATE
A	JT2000	JT24-1A	05-17-96	

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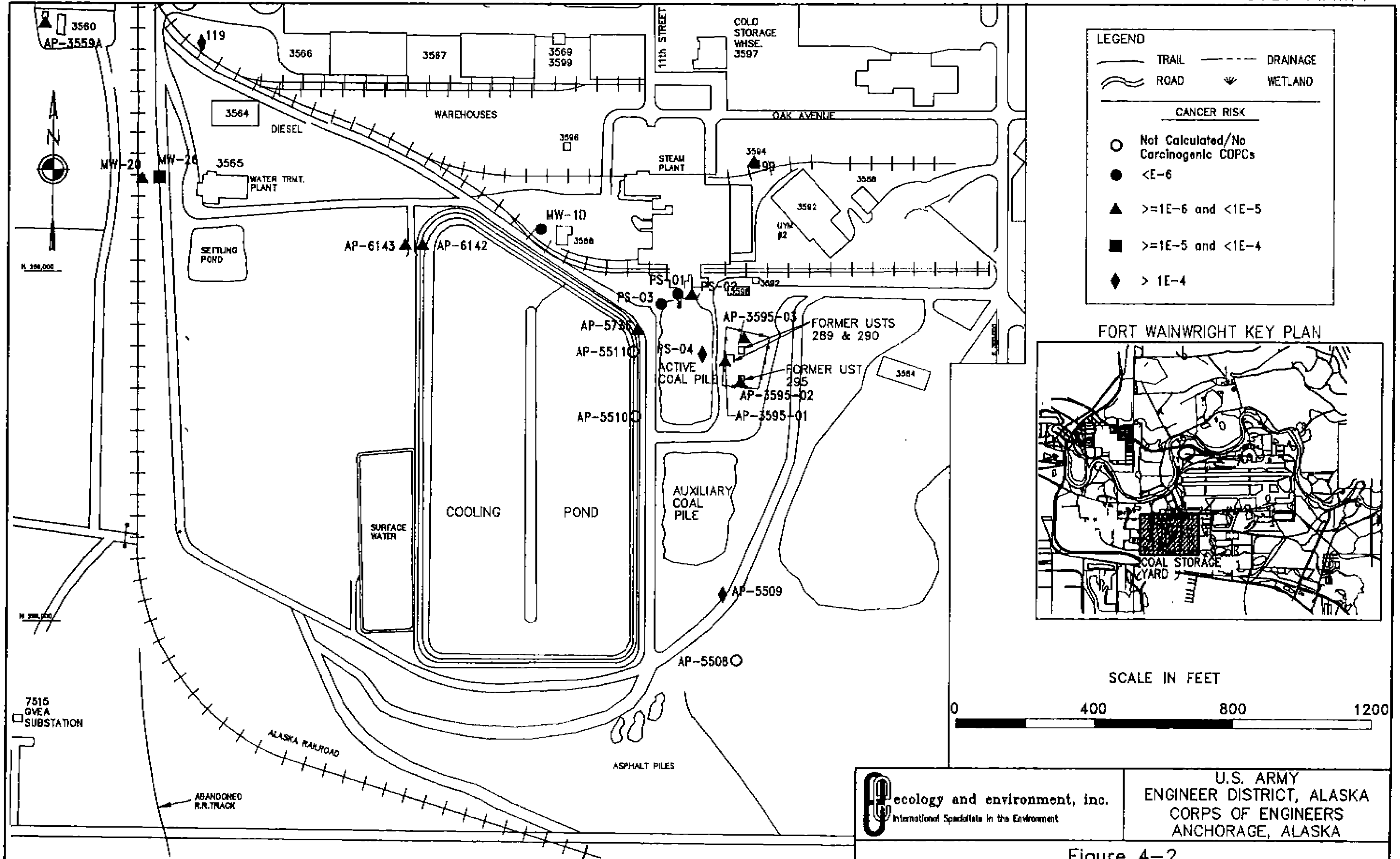

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Figure 4-2
TOTAL EXCESS LIFETIME CANCER RISKS ASSOCIATED WITH GROUNDWATER AT THE COAL STORAGE YARD AREA (RME ASSUMPTIONS)
OPERABLE UNIT 4

FAIRBANKS ALASKA

SIZE	JOB. NO.	FILE NO.	DATE:	PLATE
A	JT2000	JT24-2A	05-17-96	

61702

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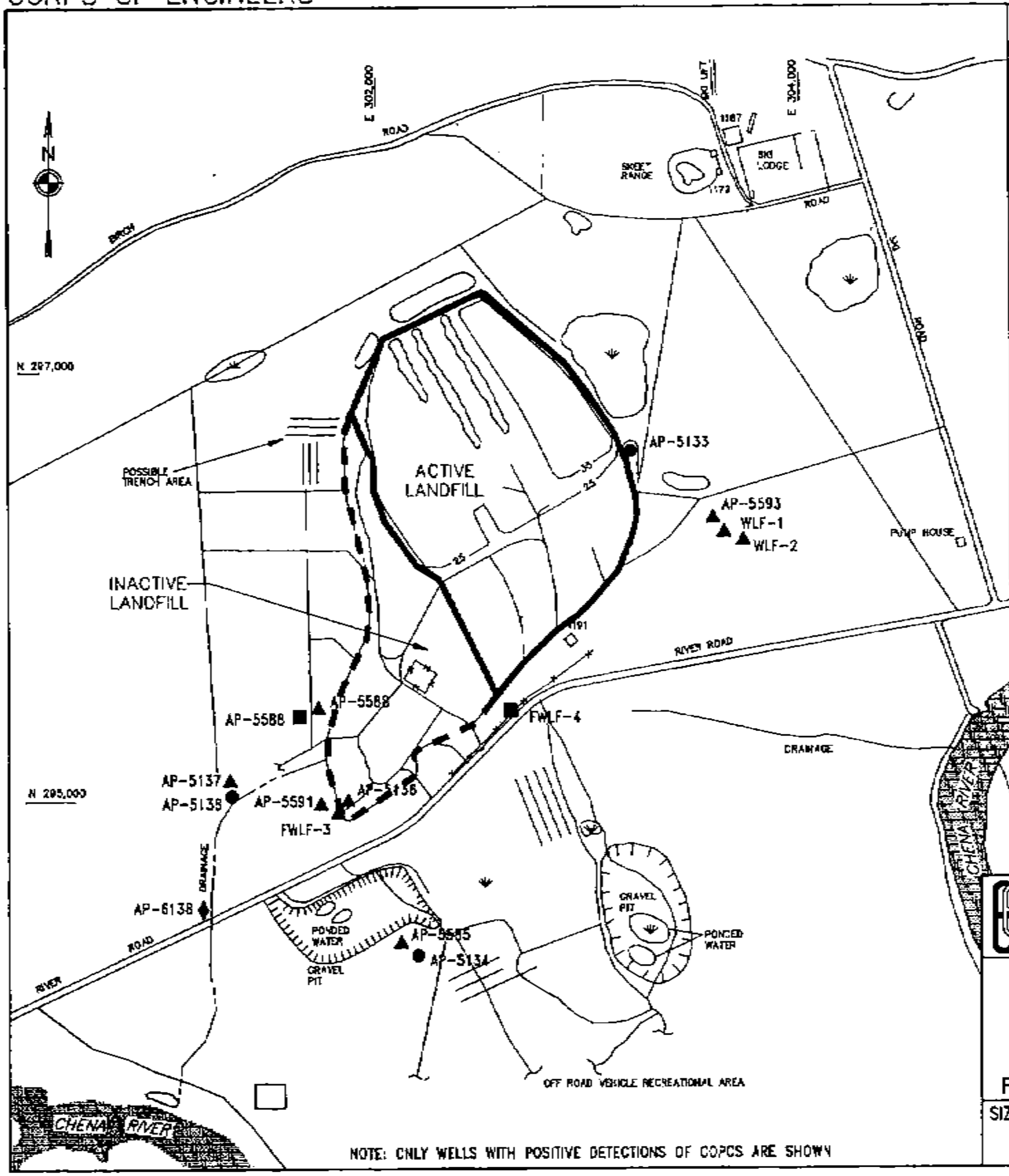

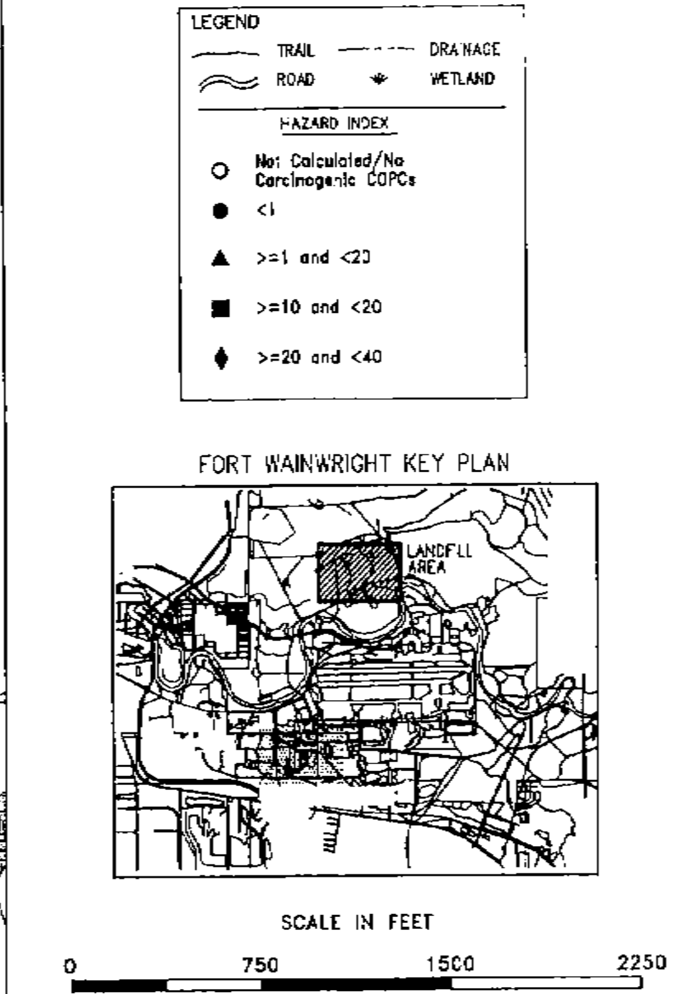

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Figure 4-3
TOTAL HAZARD INDICES ASSOCIATED WITH GROUNDWATER AT THE LANDFILL SOURCE AREA (RME ASSUMPTIONS)
OPERABLE UNIT 4

FAIRBANKS ALASKA

SIZE	JOB. NO.	FILE NO.	DATE:	PLATE
A	JT2000	JT24-3A	05-17-96	

61703

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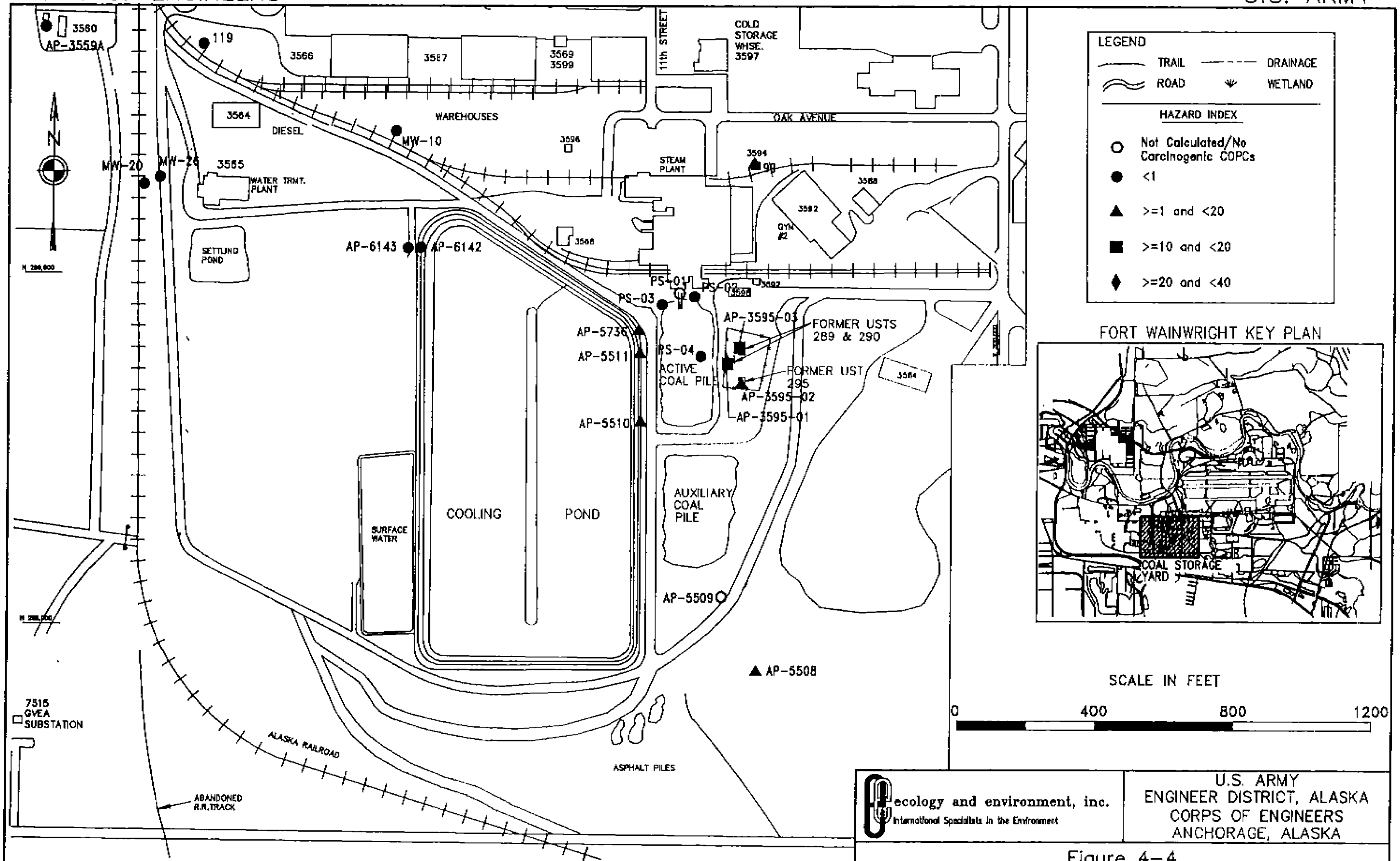

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Figure 4–4
TOTAL HAZARD INDICES ASSOCIATED WITH GROUNDWATER AT THE COAL STORAGE YARD SOURCE AREA (RWE ASSUMPTIONS)
OPERABLE UNIT 4

FAIRBANKS ALASKA

SIZE	JOB. NO.	FILE NO.	DATE:	PLATE
A	JT2000	JT24–42A	05–17–96	

61704

Section 5

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5.0 DESCRIPTION OF ALTERNATIVES

5.1 NEED FOR REMEDIAL ACTION

Actual or threatened releases of hazardous substances from the OU-4 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 Landfill and CSY to protect human health and the environment.

Groundwater is the only source of potable water for Fort Wainwright. The Fort Wainwright aquifer is unconfined except in areas of permafrost. The presence of discontinuous permafrost in the OU-4 source areas creates a complex groundwater hydrology that is difficult to characterize or model. Contaminated soil and Landfill waste act as an ongoing source of contamination to the groundwater. Remedial action is recommended to protect groundwater.

5.1.1 Landfill Source Area

The specific reasons for conducting remedial actions at the Landfill source area are provided below, with the primary emphasis being protection of groundwater:

- VOCs and semi-volatile organic compounds in groundwater, downgradient of the Landfill, are present at concentrations above federal MCLs; and

- VOCs and semi-VOCs in groundwater pose a potential risk to downgradient groundwater users.

The Chena River is located approximately 0.25 mile hydraulically downgradient of the Landfill. The groundwater intakes for the City of Fairbanks are downgradient of this location and within close proximity of the Chena River. The RI/FS determined that groundwater generally flows in a southwest direction toward the Chena River in the shallow aquifer zone at the Landfill. Limited sampling did not indicate contamination in the subpermafrost aquifer zone, which flows in a westerly direction. Although contamination was not found in the deep aquifer, the complexity of the aquifer conditions at the Landfill source area made it difficult to determine whether all potential thaw channels were identified. Potential thaw channels could transport contaminants to the deeper aquifer, which travels in a western direction, or movement under the Chena River to the southern side of the main post area may occur. It was determined by the project managers that adequate and sufficient information about Landfill subsurface hydrology exists and that further investigation is unlikely to result in significant additional information that could be used in remedial decision making.

5.1.2 Coal Storage Yard Source Area

The specific reasons for conducting remedial actions at the CSY are provided below, with the primary focus being protection of groundwater:

- VOCs and semi-VOCs in groundwater, underlying the CSY, are present at concentrations exceeding federal MCLs;

- VOCs and semi-VOCs in groundwater present a potential risk to downgradient users; and

- Petroleum- and BTEX-contaminated surface and subsurface soils act as a continuing source of groundwater contamination because of shallow aquifer conditions and annual groundwater fluctuations. These contaminants are present at concentrations above State of Alaska requirements for soil cleanup.

The RI/FS determined that groundwater generally flows in a northwest direction at the CSY. The main post potable water supply wells are located less than 900 feet downgradient of the source, in the same aquifer and at approximately the same depths as the identified groundwater contamination at the CSY. Backup potable supply wells are located within 500 feet of the CSY. Active soil and groundwater treatment is necessary to contain this plume and prevent migration.

5.2 REMEDIAL ACTION OBJECTIVES

Table 5-1 summarizes the chemical-specific cleanup goals for groundwater at the Landfill.

5.2.1 Landfill Source Area

The remedial action objectives (RAOs) for the Landfill are as follows:

5.2.1.1 Groundwater

- Restore groundwater to its beneficial use of drinking water quality within a reasonable time frame;

- Reduce further migration of contaminated groundwater from the source areas; and

- Prevent use of groundwater containing contaminants at levels above federal MCLs and Alaska Water Quality Standards (AWQS; 18 Alaska Administrative Code [AAC] 70); and

- Use natural attenuation to attain AWQS (18 AAC 70).

5.2.2 Coal Storage Yard Source Area

Table 5-2 summarizes the chemical-specific cleanup goals for groundwater and soil at the CSY.

The RAOs for the CSY are as follows:

5.2.2.1 Groundwater

- Restore groundwater to its beneficial use of drinking water quality within a reasonable time frame;

- Reduce further migration of contaminated groundwater from the source areas;

- Prevent use of groundwater containing contaminants at levels above federal MCLs and AWQS (18 AAC 70); and

- Use natural attenuation to attain AWQS (18 AAC 70).

5.2.2.2 Soil

- Prevent migration of soil contaminants to groundwater that could result in groundwater contamination and exceedances of federal MCLs and AWQS (18 AAC 70).

5.3 GOALS OF REMEDIAL ACTION

The overall goal of a remedial action is to provide the most effective mechanism for protecting human health and the environment from contaminated media associated with a site. To facilitate selection of the most appropriate remedial action, source area-specific cleanup objectives that specify the contaminants of concern in each medium of interest, exposure pathways and receptors, and an acceptable contaminant level or range of levels that is protective of human health and the environment have been developed. The remediation goals identified in Tables 5-1 and 5-2 have been established for the specific contaminants of concern determined to require remedial action at both source areas. These goals are intended for the areas where active remediation will occur.

RAOs are based on either human health risk estimates that exceed or fall within 1×10^{-6} to 1×10^{-4} risk range or federal and state applicable or relevant and appropriate requirements (ARARs). All groundwater RAOs are based on federal or state MCLs with the exception of 1,1,2,2-trichloroethane. A 1×10^{-4} RAO was selected for this contaminant. This level is consistent with RAOs established for other solvents for the OU-4 source areas. An RAO for vinyl chloride is provided even though MCL exceedances have not been detected to date at the Landfill. This cleanup goal is specified to provide for action in the event that the vinyl chloride concentration increases as degradation of TCE occurs.

Monitoring at the Landfill and CSY will be conducted to ensure that RAOs are achieved. The goal of this monitoring will be:

- To ensure that no off-source migration of contaminants is occurring;

- To indicate contaminant concentration and compliance with federal MCLs; and

- To determine whether natural attenuation is occurring at the source areas.

5.4 SIGNIFICANT APPLICABLE OR RELEVANT AND APPROPRIATE REQUIREMENTS

A full list of ARARs can be found in Section 8. The following ARARs are the most significant regulations that apply to the remedy selections for the Landfill and CSY:

- Federal and state MCLs are relevant and appropriate for groundwater. This sets the active remediation goals for groundwater. AWQS (18 AAC 70) are also applicable; and

- Alaska Oil Pollution regulations are applicable, and Alaska regulations for leaking USTs are relevant and appropriate. These regulations require cleanup of petroleum-contaminated soils to protect groundwater quality.

5.5 DESCRIPTION OF ALTERNATIVES

5.5.1 Landfill Source Area

Remedial alternatives for the Landfill are described below. Numerous assumptions were made in order to determine cleanup time frames. These values should be considered as estimates, but are comparable within the alternatives provided for this source area.

5.5.1.1 Alternative 1: No Action

The no-action alternative for the Landfill source area involves no environmental monitoring, institutional controls, or remedial action and would leave the VOC- and semi-VOC-contaminated groundwater in its present state. The landfill materials would continue to be subjected to surface water runoff and infiltration, as well as vertical seepage, which could cause surface water contamination and further contamination of the groundwater. The groundwater plume would continue to migrate in the direction of groundwater flow through the downgradient portion of the aquifer, potentially discharging to or migrating beneath the Chena River. Development of the no-action alternative is required by the NCP to provide a basis of comparison for the remaining alternatives, serving as a baseline reflecting current conditions without any cleanup effort. The no-action alternative was evaluated consistent with NCP requirements. No present worth, capital, operation and maintenance (O&M), or groundwater monitoring costs are associated with this no-action alternative.

5.5.1.2 Alternative 2: Institutional Controls, Natural Attenuation, and Groundwater Monitoring/Evaluation

Institutional controls for the Landfill source area could include access restrictions (i.e., posted signs, fencing around the inactive portion of the Landfill, 6-foot industrial-grade security fence with appropriate entry gates, deed restrictions on future land use, restrictions on groundwater well installation, restrictions on the use of wells, and well use advisories). No action that would reduce the source of contamination to the groundwater (i.e., leaching of Landfill wastes) would occur. The VOC- and semi-VOC-contaminated groundwater would remain as it currently exists at this source area, thereby not reducing contaminant concentrations except through natural processes. However, institutional controls would decrease or minimize human or wildlife exposure to contaminants. Periodic inspections and maintenance of the institutional controls would be conducted.

Natural attenuation occurs over time and is the reduction of contaminant concentrations in the environment through biological processes (aerobic and anaerobic biodegradation and plant and animal uptake), physical phenomena (advection, dispersion, dilution, diffusion, volatilization and sorption/desorption), and chemical reactions (ion exchange, complexation, and abiotic transformation). Transport (dilution) appeared to be the primary mechanism in the natural attenuation process for groundwater contaminants because of the proximity of the Chena River to the area of known groundwater contamination. Using a conservative average calculated gradient of 0.0005 foot per foot (foot/foot), 25% porosity, and a hydraulic conductivity of 600 feet per day (feet/day), a groundwater velocity of 1.2 feet/day was calculated. Migration of the groundwater would progress toward the Chena River (approximately 1,500 feet downgradient) over a period of approximately 3.5 years. In order to account for sorption/desorption characteristics of the groundwater contaminants, a general retardation factor of 10 was applied to the estimate, resulting in a migration time of 35 years. Because of the complex nature of the aquifer, and limited subsurface data over the 1,500-foot migration path, a conservative uncertainty factor of 50% was applied to the estimated 35-year migration, which resulted in an overall groundwater attenuation of 70 years. It is estimated that an additional 15 years would be required for contamination in soils (i.e., Landfill waste) to naturally attenuate and cease acting as a source of contamination to groundwater. This results in an estimated time frame of 85 years for groundwater to naturally attenuate to cleanup standards. However, because numerous assumptions were made in this estimate and because no source control will be provided, it is likely that the actual time frame for Landfill material degradation will be much longer. This would result in a longer period of time to achieve Alaska Water Quality Standards.

Environmental monitoring would be performed to obtain information on the effectiveness of the attenuation process in remediating the contamination as well as to track the extent of contaminant migration from the site. To the extent practicable, this would be conducted using existing wells that are screened in geological zones hydraulically connected with the contamination source, supplemented by installing groundwater monitoring wells when required. Upgradient wells would be used to provide information on the background groundwater quality at a source. Downgradient wells would be used to monitor the extent of contaminant migration, change in flow direction, or the occurrence of degradation products to protect downgradient drinking water wells.

Monitoring would include analysis for the contaminants that exceeded the MCLs and RBCs as specified in the RAOs for the Landfill source area. Sample collection, analysis, and data evaluation would continue until sufficient data regarding changes in contaminant plume migration and attenuation rates are gathered. Evaluation would include potential seasonal fluctuations in groundwater contaminant concentrations. The frequency of monitoring would be specially defined during the post-ROD activities.

The total estimated present worth cost of this alternative is $1,091,000, which includes $82,000 for capital costs, $10,000 for annual O&M, and $999,000 for annual groundwater monitoring. For costing purposes, it was assumed that the fencing would be installed around the area of contamination (i.e., inactive portion of the Landfill) and that there would be one monitoring event per year for 30 years. The estimated time frame for cleanup goals to be achieved and for monitoring to be performed was 85 years.

5.5.1.3 Alternative 3: A phased approach involving capping of the soils in the older, inactive portion of the Landfill, natural attenuation of groundwater; groundwater monitoring/evaluation; and institutional controls. Phase 2, if necessary, would involve evaluation and implementation of an active groundwater treatment system.

Alternative 3 is a phased approach, with Phase 1 involving capping of the older, inactive portion of the Landfill with low-permeable soil; natural attenuation of groundwater; groundwater monitoring and evaluation; and institutional controls. Phase 2 would involve evaluation and implementation of an active groundwater treatment system (as described in Landfill Alternative 4), if deemed necessary. Reference Landfill Alternative 2 for a description of institutional controls, natural attenuation, and groundwater monitoring for the Landfill source area. It is anticipated that the capping of the inactive portion of the Landfill will constitutes a final cover under ADEC regulations. The active portion of the Landfill will be capped at the time of closure, as required by ADEC; however, this will not be accomplished under CERCLA.

The cap for the inactive portion of the Landfill would be single-layered and consist of native soils with permeability no greater than 1×10^{-5} centimeters per second (cm/sec). In addition, the thickness of the infiltration and erosion layer will be a minimum of 18 and 6 inches, respectively. The area requiring a cap is estimated to be 350,000 square feet (approximately 8 acres) using an estimated 26,000 cubic yards of soil. Vegetative removal, site regrading, and active Landfill access will be done before cap installation. This cap will cover the area of the known petroleum spill. This layer would be suitable to maintain native vegetative growth or grasses, as required by RCRA and ADEC for Landfill closure. In the event that the cap does not promote natural drainage, drainage control structures such as dikes, berms, or waterways would be installed to remove water and prevent ponding and erosion. The cap would require periodic maintenance (probably once a year); however, more frequent inspections will be conducted during the first six months because problems such as erosion, settlement, or subsidence would most likely appear during this time frame. Proper and timely maintenance of any defects would be required to preserve the integrity of the cap. Maintenance would be limited to periodic mowing of the vegetation or grass to prevent naturally occurring invasion by deep-rooted vegetation and/or burrowing animals. The need for a gas collection system will be addressed during design; however, in the event a system is deemed necessary, one possible scheme that could be implemented involves installing vertical gas wells over 25% of the inactive portion of the Landfill at an average depth of 10 feet into the Landfill wastes.

Under Phase 1, existing groundwater contamination would meet RAOs through natural attenuation, thus providing a permanent remedy for groundwater contamination. Because the soils would be capped and surface water flow controlled, production of leachate is expected to significantly decrease; therefore, groundwater would be expected to naturally attenuate faster than if no cap were placed on the soils. For costing purposes, natural attenuation of groundwater to federal MCLs was estimated to take 70 years, as detailed in Landfill Alternative 2. Groundwater monitoring/evaluation would be performed to assess when the groundwater has naturally attenuated and to evaluate any impact to downgradient receptors. The point of compliance for achieving remediation goals will be at the downgradient edge of the Landfill in the known thaw channels, utilizing existing wells to the extent practicable. In the event it is found, through monitoring, that natural attenuation of groundwater is not progressing as expected, or that there is not a significant reduction in leachate, or that site conditions change, or it is determined that human or ecological receptors are being adversely impacted, Phase 2, which calls for evaluation of implementation of an active groundwater treatment system, would be initiated. Should an active groundwater treatment system be necessary, it would be designed to reduce contaminants in groundwater to below MCLs or RBCs as specified in the RAOs, after which it would be left to naturally attenuate to AWQS.

Cost data generated for this alternative is based on expected Phase 1 activities only. In the event that Phase 2 is considered necessary, cost data will be generated at that time. The total estimated present worth cost of this alternative is $1,620,000, which includes $476,000 for capital costs, $150,000 for annual O&M, and $994,000 for annual groundwater monitoring. For costing purposes, it was assumed that the fencing would be installed around the area of contamination (i.e., inactive portion of the Landfill) and that there would be one monitoring event per year. The estimated time frame for cleanup goals to be achieved and for monitoring to be performed was 70 years.

5.5.1.4 Alternative 4: On-Site Treatment of Groundwater Via Extraction and Treatment (Air Stripping with Liquid-Phase Carbon Adsorption of Ultraviolet Oxidation), Groundwater Monitoring/Evaluation, and Institutional Controls

Alternative 4 involves on-site groundwater treatment via extraction and treatment (air stripping with liquid-phase carbon adsorption, or ultraviolet [UV] oxidation), groundwater monitoring/evaluation, and institutional controls. Reference Landfill Alternative 2 for a description of institutional controls and groundwater monitoring for the Landfill source area. Because air stripping is detrimentally affected by cold temperatures and the costs for both air stripping and UV oxidation are comparable, UV would be favored. Other technologies could be considered during detail design.

Groundwater treatment for this alternative includes extraction, through wells and pumps, and treatment of groundwater aboveground to reduce VOC- and semi-VOC contaminated concentrations to below MCLs or RBCs, as specified in the RAOs. The groundwater extraction system would be designed to hydraulically contain the contaminant plume and keep contaminants from migrating farther through the aquifer by installing approximately six wells, at an estimated depth of 5 feet below the top of the aquifer. These wells would extract a total of approximately 150 gallons per minute (gpm). Recharge is expected to be instantaneous because of the aquifer characteristics. The UV oxidation treatment system would produce no vapors. A clarifier, sand filter, or bag filter may be incorporated following UV oxidation to remove extracted metals such as arsenic and manganese to below appropriate regulatory standards (i.e., National Pollutant Discharge Elimination System [NPDES] discharge limits). The treated groundwater would be directly discharged to the Chena River via an open channel or piping. After initiation of the groundwater extraction and treatment system, a groundwater monitoring/evaluation program would be implemented. This program would monitor the progress of remediation and proper operation of the groundwater treatment system, comply with NPDES discharge limits through sampling and analysis of the discharge effluent, and be used to modify the extraction system to make it more effective.

A simple volumetric calculation was used to estimate the cleanup time due to the nature of the groundwater contaminants at the Landfill source area. A radius of 210 feet around each proposed recovery well, a saturated thickness of 75 feet (which accounts for vertical transport), and a porosity of 25% was used to define the volume of groundwater contamination requiring remediation. Applying the lower potential recovery rate of 75 gpm resulted in one pore volume removal in approximately 0.5 per year. Using a 10-pore-volume removal to account for sorption/desorption processes resulted in a five-year estimate. However, because of the complex nature of the aquifer matrix and uncertain impact of the permafrost on contaminant recovery, a removal efficiency of 50%

was used to compute the estimated cleanup time of 10 years for groundwater. Because Landfill waste would have to biodegrade before leaching to groundwater would cease, it is expected that 25 years would be required for groundwater to reach MCLs or RBCs through treatment. AWQS would be met through natural attenuation. Actual flow rates, well locations, optimum number of wells, and actual time frame estimates would be determined during the design phase.

The total estimated present worth cost of this alternative is $8,365,000, which includes $1,319,000 for capital costs, $6,228,000 for annual O&M, and $818,000 for annual groundwater monitoring. For costing purposes, it was assumed that the fencing would be installed around the area of contamination (i.e., the inactive portion of the Landfill) and that there would be one monitoring event per year. The estimated time frame for cleanup goals to be achieved and for monitoring to be performed was 25 years.

5.5.1.5 Alternative 5: Capping of the Older, Inactive Portion of the Landfill, On-Site Treatment of Groundwater Via Extraction and Treatment (Air Stripping with Liquid- Phase Carbon Adsorption or Ultraviolet Oxidation), Groundwater Monitoring/Evaluation, and Institutional Controls

Alternative 5 involves capping of the older, inactive portion of the Landfill and on-site treatment of groundwater via extraction and treatment (air stripping with liquid-phase carbon adsorption or UV oxidation), groundwater monitoring/evaluation, and institutional controls. Reference Landfill Alternatives 2 and 4 for a description of institutional controls and groundwater monitoring as well as a description of the groundwater extraction and treatment system for the Landfill source area.

The total estimated present worth cost of this alternative is $6,033,000, which includes $1,709,000 for capital costs, $3,831,000 for annual O&M, and $493,000 for annual groundwater monitoring. For costing purposes, it was assumed that the fencing would be installed around the area of contamination (i.e., the inactive portion of the Landfill) and that there would be one monitoring event per year. The estimated time frame for cleanup goals to be achieved and for monitoring to be performed was 10 years.

5.5.2 Coal Storage Yard Source Area

Preliminary remedial alternatives for the CSY area are described below. Numerous assumptions had to be made in order to determine cleanup time frames. These values should be considered as estimates, but are comparable within the alternatives provided for this source area.

5.5.2.1 Alternative 1: No Action

The no-action alternative for the CSY source area involves no environmental monitoring, institutional controls, or remedial action and would leave the petroleum-contaminated soils and VOC- and semi-VOC-contaminated groundwater in their present state. The contaminated soils would continue to be subjected to surface water runoff and infiltration, as well as vertical seepage, which could cause surface water contamination and further contamination of the groundwater. The groundwater plume would continue to migrate in the direction of groundwater flow through the downgradient portion of the aquifer, potentially affecting the Post drinking water wells and the Chena River. Development of the no-action alternative is required by the NCP to provide a basis of comparison for the remaining alternatives, serving as a baseline reflecting current conditions without any cleanup effort. The no-

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action alternative was evaluated consistent with NCP requirements. No present worth, capital, O&M, or groundwater monitoring costs are associated with this no-action alternative.

5.5.2.2 Alternative 2: Institutional Controls, Natural Attenuation, and Groundwater Monitoring/Evaluation

Institutional controls for the CSY source area would include access restrictions (i.e., posted signs, deed restrictions on future land use, restrictions on groundwater well installation, restrictions on the use of wells, and well use advisories). The contaminated soils and groundwater would remain untreated, thereby not reducing contaminant concentrations or the threat to Post water supply wells. However, institutional controls would decrease or minimize human or wildlife exposure to contaminants. Periodic inspections and maintenance of the institutional controls would be conducted.

Natural attenuation occurs over time and is the reduction of contaminant concentrations in the environment through biological processes (aerobic and anaerobic biodegradation and plant and animal uptake), physical phenomena (advection, dispersion, dilution, diffusion, volatilization, and sorption/desorption), and chemical reactions (ion exchange, complexation, and abiotic transformation). Estimation of natural attenuation rates of soil contamination at the CSY consisted of evaluation of two primary mechanisms: degradation and transport. Because of the characteristic slow rate of fuel degradation, it is not considered a significant factor in the attenuation process. However, transport or leaching of soil contamination to the groundwater appears to represent a major factor in the attenuation process. Based on an annual groundwater recharge rate of 6 inches per year and considering reductions of soil contaminant concentrations due to leaching over time, it is estimated that attenuation of the soil contamination will be accomplished in 15 years.

Groundwater natural attenuation rates at the CSY area were estimated similar to the natural attenuation rates at the Landfill area. The major difference is that a conservative average calculated gradient of 0.0021 foot/foot was used to yield a groundwater velocity of 5 feet/day at the CSY area. Migration of groundwater would progress toward the Chena River (approximately 2,000 feet downgradient) over a period of approximately one year. This contaminant plume would intercept Post water supply wells, located 900 feet from the CSY, before reaching the Chena River. To account for sorption/desorption characteristics of the groundwater contaminants, a general retardation factor of 10 was applied to the estimate, resulting in a migration time of 10 years. Because of the complex nature of the aquifer and limited subsurface data over a 2,000-foot migration path, a conservative uncertainty factor of 50% was applied to the estimated 10-year migration, which produced an overall groundwater attenuation of 20 years. Because the contaminants in the soil would have to naturally attenuate before the groundwater could do so, groundwater is expected to naturally attenuate to AWQS in 35 years.

Environmental monitoring and data evaluation will be performed to obtain information on the effectiveness of the attenuation process in remediating the contamination as well as to track the extent of contaminant migration from the site. To the extent practicable, this will be conducted using existing wells that are screened in geological zones hydraulically connected with the contamination source, supplemented by installing groundwater monitoring wells when required. Upgradient wells would be used to provide information on the background groundwater quality at a source. Downgradient wells would be used to monitor the extent of contaminant migration, change in flow direction, or the occurrence of degradation products that could affect downgradient drinking water wells.

Monitoring requirements that would be followed will target the contaminants that were found to exceed the MCLs and RBCs, as specified in the RAOs for the CSY source area. Sample collection and analysis would continue until sufficient data regarding changes in contaminant plume migration (including potential seasonal fluctuations in groundwater contaminant concentrations) are gathered. The frequency of monitoring will be specially defined during the post-ROD activities.

The total estimated present worth cost for this alternative is $955,000, which includes $53,000 for capital costs, $8,000 for annual O&M, and $894,000 for annual groundwater monitoring. The estimated time frame for cleanup goals to be reached and for monitoring to be performed was 35 years.

5.5.2.3 Alternative 3: Excavation and Off-Site Treatment of Soils Via Low-Temperature Thermal Desorption, Natural Attenuation, Groundwater Monitoring/Evaluation, and Institutional Controls

Alternative 3 involves excavation and treatment of soils through low-temperature thermal desorption (LTTD), natural attenuation of groundwater, groundwater monitoring/evaluation, and institutional controls. Reference CSY Alternative 2 for a description of institutional controls, natural attenuation, and groundwater monitoring for the CSY source area.

Approximately 223 cubic yards of petroleum-contaminated soils in the CSY area require remediation. Excavation would be easy to implement in two of the areas of contamination within the CSY source area because they would be excavated to relatively shallow depths and groundwater would not be encountered. However, at the third area, excavation would not be feasible after groundwater was encountered (between 20 and 25 feet BGS; see Figure 5-1). The remaining soils, which could be highly contaminated, would be left in-place to naturally attenuate. Verification sampling would be performed, and excavated areas would be backfilled with clean soil.

Excavation of the contaminated soil would require a preparation program for the areas of excavation within the CSY area, including clearing and grubbing of the site and construction of a decontamination pad. Excavated contaminated soils would be temporarily stored on site in a designated staging area. This area would be constructed using an impermeable liner, surface water controls, a leachate collection system, and a cover.

The total estimated present worth cost for this alternative is $983,000, which includes $126,000 for capital costs, $8,000 for annual O&M, and $849,000 for annual groundwater monitoring. Costs are sensitive to the tons of soil to be treated by LTTD. For costing purposes, it was assumed that there would be one monitoring event per year. The estimated time frame for cleanup goals to be reached and for monitoring to be performed was 20 years.

5.5.2.4 Alternative 4: Excavation and Off-Site Treatment of Soils Via Low-Thermal Temperature Desorption, On-Site Treatment of Groundwater Via Extraction and Treatment (Air Stripping with Liquid-Phase Carbon Adsorption or Ultraviolet Oxidation), Groundwater Monitoring/Evaluation, and Institutional Controls

Alternative 4 involves excavation and treatment of soils through LTTD as described in CSY Alternative 3, on-site treatment of groundwater via extraction and treatment (air stripping with liquid-phase carbon adsorption or UV oxidation), groundwater monitoring/evaluation, and institutional controls. Because air stripping is detrimentally affected by cold temperatures and the costs for both air stripping and UV oxidation are comparable, UV would be favored. Reference CSY Alternative 2 for a description of institutional controls and groundwater monitoring for the CSY source area.

The groundwater extraction system for the CSY source area would consist of an estimated seven extraction wells, approximately 5 feet below the top of the aquifer, pumping groundwater at a total estimated rate of 70 to 140 gpm. A variability in the proposed pumping rates is due to uncertainty in the transmissivity of the aquifer matrix. For purposes of cost estimating, the higher estimated flow rate would be used as the proposed flow rate for each of the recovery wells.

A simplified volumetric calculation was used because of the nature of the groundwater contaminants at the site. A radius of 180 feet around each of the proposed recovery wells, a saturated thickness of 75 feet (which accounts for vertical transport), and a porosity of 25% were used to define the volume of groundwater contamination requiring remediation. Applying the lower potential recovery rate of 70 gpm, accounting for sorption/desorption processes, and using the removal efficiency of 50%, resulted in an estimated cleanup time of eight years for the treatment of groundwater to federal MCLs, with natural attenuation to AWQS. Contaminated soils will be removed to the extent practicable. However, excavation would not be feasible after groundwater was encountered (between 20 and 25 feet BGS). The remaining soils would be left in place to naturally attenuate. However, for purposes of cost estimating, it was assumed that all contaminated soils were excavated, thereby removing the source of groundwater contamination and eliminating contaminant leaching to groundwater. Using the source removal assumption, the time required to treat the aquifer would be relatively short. Actual flow rates, well locations, optimum number of wells, and actual time frame estimates would be determined during the design phase.

The total estimated present worth cost for this alternative is $3,113,000, which includes $1,114,000 for capital costs, $1,627,000 for annual O&M, and $372,000 for annual groundwater monitoring. The most sensitive costs for this alternative were found to be associated with the tons of soil treated via LTTD, discussed in Alternative 3. Additionally, costs were found to be sensitive to the flow rate for the groundwater pump-and-treat system. The estimated time frame for cleanup goals to be reached and for monitoring to be performed was eight years.

5.5.2.5 Alternative 5: In Situ Treatment of Soils Via Vacuum Extraction System Enhanced by Steam Injection or Bioventing, Natural Attenuation, Groundwater Monitoring/Evaluation, and Institutional Controls

Alternative 5 involves treatment of soils in place through a vapor extraction system (VES), which could be enhanced by steam injection and bioventing, natural attenuation of groundwater, and institutional controls. Reference CSY Alternative 2 for a description of natural attenuation, groundwater monitoring, and institutional controls for the CSY source area. This system would be operational year-round.

The VES collects soil vapors from the subsurface soils by applying a vacuum at a series of extraction points. The vacuum would draw vapors from the contaminated soils and would decrease the pressure around the soil particles, thereby releasing additional volatiles. This vapor removal could be maximized by the use of "pulsed venting," where the blower would be turned off and on to allow the soil vapor to re-equilibrate, or by venting different combinations of wells to change the flow field. Under current air quality regulations, no off-gas treatment is required.

This system could be enhanced by bioventing, which injects clean air into the soils through a separate air injection system. This re-injection of clean air enhances air movement through the soil and stimulates biodegradation. Air injection also assists in controlling flow paths of the extracted vapor, which results in more efficient contaminant removal. Bioventing, if chosen as an enhancement to VES, would be evaluated before implementation and tested during the Design Verification Study.

Steam injection could be used rather than bioventing to thermally enhance vacuum extraction. Steam would be injected into the contaminated soils through the injection wells to help volatilize the organics in the soil. These volatilized organics would be recovered through the extraction wells. Steam injection would also be expected to thaw the soil during the winter months. Steam injection, if chosen as an enhancement to VES, would be evaluated before implementation and tested during the Design Verification Study.

The VES would be designed so that its flow rate would be capable of handling three times the volume of the injection rate; however, pilot or field tests would be conducted in the source areas of the CSY to determine the actual site-specific design parameters. Those parameters include the determination of the gas permeability and obtainable flow rates, the radius of influence, initial and final off-gas concentrations from the VES, water level changes, and vacuum well pressures for full-scale design and implementation. Regular monitoring of the enhanced VES system would be done to ensure the progress of cleanup, to estimate the volume of petroleum hydrocarbons removed by the system, and to establish a timetable for completion of the project.

For costing purposes, it is assumed that the major components of the enhanced VES system would include two injection wells and two extraction wells; below ground polyvinyl chloride piping, valves, sampling ports, and vacuum gauges; an injection and extraction centrifugal blower; an air/water separator; and a heat exchanger. The centrifugal blower would be housed in a temporary building. The VES would consist of explosion-proof equipment and automatic safety devices that would deactivate the system if the treatment building interior atmosphere were to exceed 20% of the lower explosive limit. Any water extracted from the air/water separator will be treated by a carbon filtration system. Costs for enhancements to the VES system, if incorporated into the design, are considered minimal and will be calculated into the construction cost estimates during the Remedial Design.

The total estimated present worth cost for this alternative is $1,046,000, which includes $153,000 for capital costs, $115,000 for annual O&M, and $778,000 for annual groundwater monitoring. Because of climatic conditions at Fort Wainwright, it is estimated that the VES would operate for three years to achieve RAOs. In order for the groundwater to begin to naturally attenuate, the soil needs to be fully remediated. With groundwater estimated to naturally attenuate to AWQS in 20 years after the soil is remediated, a total of 23 years is required for the remediation of both soils and groundwater.

5.5.2.6 Alternative 6: In Situ Treatment of Soils Via Vacuum Extraction Enhanced by Steam Injection or Bioventing, In Situ Treatment of Groundwater Via Air Sparging, Groundwater Monitoring/Evaluation, and Institutional Controls

Alternative 6 involves treatment of soils in place through a VES, which could be enhanced by steam injection or bioventing as discussed in CSY Alternative 5. Contaminated groundwater would be treated on site via air sparging and groundwater monitoring/evaluation. Reference CSY Alternative 2 for a description of groundwater monitoring and institutional controls for the CSY source area.

Two major differences distinguish the air sparging system (AS) from the VES/bioventing or steam injection systems described in CSY Alternative 5. First, with AS, the air is injected below the groundwater table, unlike VES/bioventing or steam injection in which the air is injected above the groundwater table to enhance biodegradation of VOCs and to promote their movement to extraction wells. Secondly, each injection well of the AS system would be collocated with an extraction well to capture the vadose zone air stream that carries volatile hydrocarbons.

Similar to VES/bioventing or steam injection, the AS system would consist of extraction and injection wells, well piping, a compressor and vacuum blower, an air/water separator, a heat exchanger, a housing and heating system, and monitoring devices. For costing purposes, it is assumed that the AS system would require 10 injection and 10 extraction wells. Import and design parameters, such as the radius of influence of the AS system at different injection flows and pressure, the radius of influence of the VES, and the pressure and vacuum requirements for effective treatment and effective capture of volatilized materials, could be determined by pilot testing or by adapting design parameters from existing VES/AS systems on Fort Wainwright. For costing purposes, it was estimated that VES coupled with AS would take nine years to remediate soil and groundwater to meet ADEC soil cleanup goals and for federal MCLs, respectively. Natural attenuation will be used to achieve AWQS for groundwater once federal MCLs are met.

Estimation of cleanup efficiency using air sparging was based on the relative efficiency of the sparging technique compared with the pump-and-treat technology. Empirical data on air sparging indicate cleanup efficiencies of 25% to 50% greater than for pump-and-treat technology. Assuming the lower range of cleanup efficiency, air sparging would operate simultaneously with enhanced VES for nine years to ensure optimum efficiency.

The total estimated present worth cost for this alternative is $1,544,000, which includes $364,000 for capital costs, $730,000 for annual O&M, and $450,000 for annual groundwater monitoring. Costs for this alternative were found to be most sensitive to the time of treatment via enhanced vacuum extraction. A cost sensitivity analysis was run for a variation in the time of treatment from minus one year to plus one year. In addition, enhanced vacuum extraction was found to be cost-sensitive to the tons of soil to be treated. The estimated time frame for cleanup goals to be reached and for monitoring to be performed was nine years.

Table 5-1

CHEMICAL-SPECIFIC CLEANUP GOALS FOR GROUNDWATER
LANDFILL SOURCE AREA
OPERABLE UNIT 4
FORT WAINWRIGHT, ALASKA

CLEANUP GOALS FOR GROUNDWATER									
	ARARs			TBCs					
				Site RA RBC					
Analyte	Federal MCL	Alaska Drinking Water Standards (state MCLs)	Alaska State Water Quality Standards	HI	10^{-4}	Site-Specific Groundwater[a] Background Corps[b]	Remedial Action Objective[c]	Maximum Detected Concentration	Site Cleanup Goal
Organics (µg/L)									
Benzene	5	5	5	—	—	ND	5	6.3	5
cis-1,2-Dichloroethene	70	70	—	—	—	ND	70	150	70
1,1,2,2-Tetrachloroethane	—	—	2,400	—	35	ND	5.2	1,300	5.2[a]
1,1,2-Trichloroethane	5	—	9,400	—	—	ND	5	10	5
Trichloroethene	5	5	5	—	—	ND	5	180	5
Vinyl chloride	2	2	2	—	—	ND	2	1.3	2
bis(2-Ethylhexyl)phthalate	6	6	—	260	220	ND	6	620	6

[a] Site-specific background groundwater concentration.
[b] Background concentrations from Corps-recommended background value for Fort Wainwright.
[c] Groundwater remediation goals are based on Region 3 1×10^{-4} RBCs. There is no federal or state MCL for this contaminant.

Key at end of table.

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Table 5-1 (Cont.)

Key:

—	=	Value not established.
ADEC	=	Alaska Department of Environmental Conservation.
ARAR	=	Applicable or relevant and appropriate requirement.
Corps	=	United States Army Corps of Engineers, Alaska District.
HI	=	Hazard index.
µg/L	=	Micrograms per liter.
MCL	=	Maximum contaminant level.
ND	=	Not detected.
RA	=	Human health risk assessment.
RBC	=	Risk-based concentration.
TBC	=	To be considered.
TRPH	=	Total recoverable petroleum hydrocarbon.

Table 5-2

CHEMICAL-SPECIFIC CLEANUP GOALS FOR GROUNDWATER
COAL STORAGE YARD SOURCE AREA
OPERABLE UNIT 4
FORT WAINWRIGHT, ALASKA

CLEANUP GOALS FOR GROUNDWATER								Maximum Detected Concentration	Site Cleanup Goal
	ARARS			TBCs					
				Site RA RBC					
Analyte	Federal MCL	Alaska Drinking Water Standards (state MCL)	Alaska State Water Quality Standards	HI	10^{-4}	Site-Specific Groundwater[a] Background Corps[b]	Remedial Action Objective[c]		
Cleanup Goals for Groundwater									
Organics (µg/L)									
Benzene	5	5	10[d]	—	250	NA	5	800	5
bis(2-Ethylhexyl)phthalate	6	6	—	—	220	2[a]	6	110	6
Trichloroethene	5	5	5	—	—	NA	5	56	5
Toluene	1,000	1,000	10[d]	—	—	NA	1,000	1	1,000

Key at end of table.

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Table 5-2

CHEMICAL-SPECIFIC CLEANUP GOALS FOR SOIL
COAL STORAGE YARD SOURCE AREA
OPERABLE UNIT 4
FORT WAINWRIGHT, ALASKA

CLEANUP GOALS FOR SOIL					
		Diesel	Gasoline/Unknown		
Matrix Score = 39 BTEX = 15 mg/kg Benzene = 0.5 mg/kg VPH = 100 mg/kg EPH = 200 mg/kg		Diesel-range petroleum hydrocarbons (EPH)	Gasoline-range petroleum hydrocarbons (VPH)	Benzene	BTEX
Level A[e]	>40	100	50	0.1	10
Level B	27 - 40	200	100	0.5	15
Level C	21 - 26	1,000	500	0.5	50
Level D	<20	2,000	1,000	0.5	100

a Site-specific background groundwater concentration.

b Background concentrations from Corps-recommended background value for Fort Wainwright.

c Groundwater remediation goals are based on federal and state MCLs for organic contaminants in public water supply systems (40 CFR 141.147 and 18 AAC 80).

d 18 AAC 70, Water Quality Standards. The regulatory level for BTEX is 10 μg/L.

e Level A cleanup goal is applied to the total matrix score of 39 due to the soil acting as an ongoing source of contamination to groundwater.

Key:

ACC = Alaska Administrative Code.
ADEC = Alaska Department of Environmental Conservation.
ARAR = Applicable or relevant and appropriate requirement.
BTEX = Benzene, toluene, ethylbenzene, xylene.
CFR = Code of Federal Regulations.
Corps = United States Army Corps of Engineers, Alaska District.
μg/L = Micrograms per liter.
mg/kg = Milligram per kilogram.
MCL = Maximum contaminant level.
NA = Not available.
RA = Human Health Risk Assessment.
RBC = Risk-based concentrations.
TBC = To be considered.

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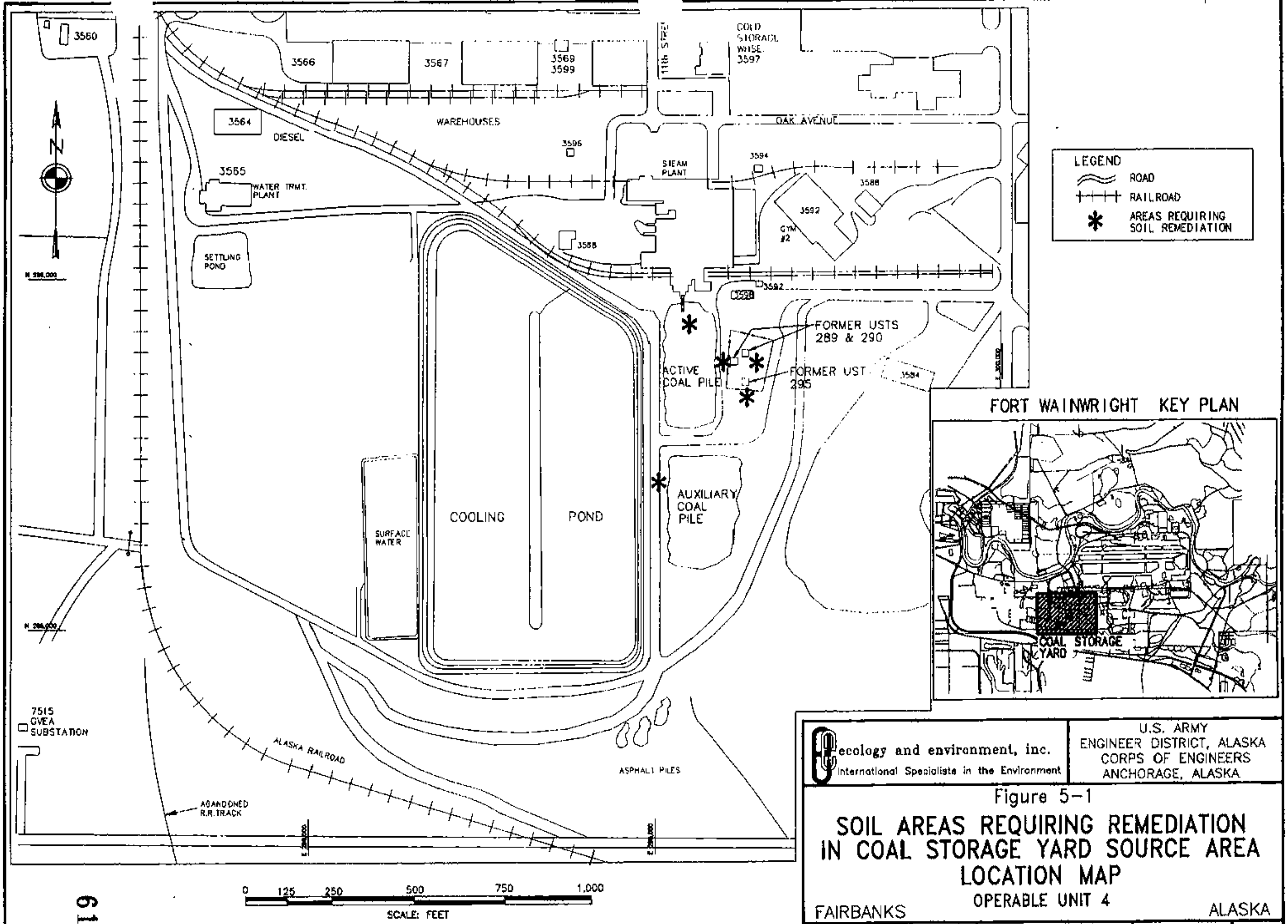

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Figure 5-1

SOIL AREAS REQUIRING REMEDIATION IN COAL STORAGE YARD SOURCE AREA LOCATION MAP

OPERABLE UNIT 4

FAIRBANKS ALASKA

SIZE	JOB. NO.	FILE NO.	DATE:	PLATE
B	LABOR-JT2901 COMP-JT2950	JT21-5A.DWG	05-15-96	

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Section 6

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6.0 SUMMARY OF COMPARATIVE ANALYSIS OF ALTERNATIVES

In accordance with federal regulations, the five alternatives for the Landfill source area and the six alternatives for the CSY source area were evaluated based on the nine criteria presented in the NCP.

6.1 LANDFILL SOURCE AREA (COMPARATIVE ANALYSIS OF ALTERNATIVES)

6.1.1 Threshold Criteria

6.1.1.1 Overall Protection of Human Health and the Environment

All alternatives with the exception of Alternative 1 (no action) would use institutional controls to prevent the use of contaminated groundwater until cleanup standards are achieved. Alternative 5 would provide the greatest protection and degree of cleanup by capping the Landfill material, which protects against future groundwater contamination, and treatment of groundwater to address existing contamination. Alternative 2 would provide some protection to human health and the environment through institutional controls, which would reduce contact with contamination. Alternative 3 does not treat current groundwater contamination but focuses on source control and thus prevents future groundwater contamination. However, Alternative 3 does provide for groundwater treatment in Phase 2 of the alternative, which would protect against current groundwater contamination. Alternative 4 actively remediates groundwater but does nothing to control the contaminant source. Alternatives 3 and 5 would reduce leaching of contaminants to the groundwater by installing a Landfill cap, thereby reducing the time required to achieve groundwater RAOs. Under Alternatives 2 and 3, groundwater would be monitored to determine whether natural attenuation of contaminants is progressing as expected. In the event that it does not, the need for an active groundwater treatment system would be evaluated under Phase 2 of Alternative 3. Alternatives 4 and 5 actively treat contaminated groundwater.

6.1.1.2 Compliance with Applicable or Relevant and Appropriate Requirements

Alternatives 4 and 5 and Phase 2 of Alternative 3 are expected to achieve groundwater RAOs more rapidly than the other alternatives. Alternatives 1 and 2 and Phase 1 of Alternative 3 rely on natural processes to slowly reduce contaminant concentrations in the groundwater. Under Alternative 3, groundwater treatment will be evaluated if groundwater contaminant concentrations do not decrease over time. Alternatives 4 and 5 and Phase 2 of Alternative 3 are expected to achieve federal or state MCLs or RAOs through active treatment, then AWQS through natural attenuation. The functional equivalent of NPDES permit requirements must be met to discharge treated groundwater to the Chena River for Alternatives 4 and 5 and Phase 2 of Alternative 3.

ADEC and relevant and appropriate RCRA solid waste landfill closure requirements for Fort Wainwright would be met for Alternatives 3 and 5. Alternatives 1, 2, and 4 would not fulfill the solid waste landfill closure requirements for Fort Wainwright.

6.1.2 Primary Balancing Criteria

6.1.2.1 Long-Term Effectiveness and Permanence

Alternatives 3 and 5 are expected to achieve long-term effectiveness and permanence with respect to groundwater cleanup through either active treatment of groundwater, capping a portion of the Landfill, or a combination of both. Alternative 4 is expected to achieve long-term effectiveness and permanence with respect to groundwater cleanup but does nothing to prevent continued leaching of Landfill contaminants to the groundwater. None of the contaminants would be addressed by Alternatives 1 and 2, except through natural processes. Therefore, Alternatives 1 and 2 would provide the least effective long-term permanence because neither active treatment of groundwater nor capping of the Landfill materials will be conducted under these two alternatives.

6.1.2.2 Reduction of Toxicity, Mobility, and Volume Through Treatment

The toxicity and volume of contaminated groundwater would be reduced through Alternatives 4 and 5 and Phase 2 of Alternative 3 because they provide for direct treatment of extracted groundwater. Furthermore, the hydraulic control provided by the extraction system would limit the mobility of the groundwater contaminants. Neither Alternatives 1 and 2 nor Phase 1 of Alternative 3 would reduce toxicity or mobility of contaminants in groundwater through treatment; over time it would reduce toxicity through natural attenuation.

Although capping of Landfill materials under Alternatives 3 and 5 is not considered treatment, it will reduce mobility of contaminant leaching to groundwater. Alternatives 1, 2, and 4 do not reduce mobility of contaminants to the groundwater. None of the alternatives reduce toxicity or volume of Landfill materials because the contamination would remain under the cap.

6.1.2.3 Short-Term Effectiveness

Alternatives 3 and 5 would pose some short-term potential risks to on-site workers through generation of dust and noise and through potential exposure to contaminated soils during two months for capping activities. Alternatives 4 and 5 and Phase 2 of Alternative 3 pose short-term potential risks to on-site workers during one month of the installation of the extraction and treatment system. These risks would be minimized by the use of engineering controls and personal protective equipment (PPE). Natural attenuation of groundwater under Phase 1 of Alternative 3 poses no short-term risks. Alternatives 1 and 2 do not include active treatment, and therefore, risks would not change over time except through natural processes. Alternatives 2, 3 (Phase 1), 4, and 5 would meet groundwater cleanup goals in 85, 70, 25, and 10 years, respectively.

6.1.2.4 Implementability

All alternatives would use readily available technologies and would be feasible to construct. Alternatives 1 and 2 would be readily implementable because they would require no additional action other than monitoring or institutional controls. Alternatives 4 and 5 and Phase 2 of Alternative 3, pilot studies, would be required to determine the best design for the groundwater extraction and treatment system. Discharge piping would have to be constructed to the Chena River so that treated groundwater can be discharged. Because air stripping is negatively affected by cold temperatures, oxidation is favored for treatment of contaminated groundwater.

6.1.2.5 Cost

Based on the information available at the time the alternatives were developed, the estimated costs for each alternative evaluated for the Landfill source area are in Table 6-1. If monitoring is required for a longer period of time because of slower than estimated attenuation rates, then cost would increase proportionally.

6.1.3 Modifying Criteria

6.1.3.1 State Acceptance

ADEC has been involved with the development of remedial alternatives for OU-4 and agrees with the selected remedy for the Landfill source area.

6.1.3.2 Community Acceptance

No comments regarding remedial action at OU-4 were received during the comment period. This may indicate that there is no opposition to any of the preferred alternatives. The Responsiveness Summary, Appendix B to this document, provides the background of community involvement activities conducted in association with OU-4.

6.2 COAL STORAGE YARD SOURCE AREA (COMPARATIVE ANALYSIS OF ALTERNATIVES)

6.2.1 Threshold Criteria

6.2.1.1 Overall Protection of Human Health and the Environment

Alternatives 4 and 6 would provide the greatest protection and degree of cleanup by actively treating the contaminated soils and groundwater. Alternatives 3 and 5 would protect human health and the environment from contaminated soils through treatment but would rely on natural attenuation to remediate groundwater. Alternative 2 would provide some protection to human health and the environment through institutional controls, which would reduce contact with contamination. Alternative 1 (No Action) would be the least protective.

6.2.1.2 Compliance with Applicable or Relevant and Appropriate Requirements

Alternative 6 is expected to achieve regulatory requirements more rapidly than the other alternatives because it includes active soil and groundwater treatment. While Alternative 4 would also achieve regulatory requirements rapidly, excavation of contaminated soil is limited by depth to groundwater. Alternatives 3 and 5, which include soil treatment and natural attenuation of groundwater, are expected to achieve regulatory requirements within a longer time frame. Alternatives 1 and 2 would rely on natural processes to slowly decrease soil and groundwater contamination. However, under Alternative 1, compliance with regulatory requirements would not be determined because monitoring will not be completed. State and federal drinking water standards will be achieved through active treatment. AWQS would be achieved through natural attenuation under all five alternatives.

6.2.2 Balancing Criteria

6.2.2.1 Long-Term Effectiveness and Permanence

Alternatives 4 and 6 provide long-term effectiveness and permanence through active soil and groundwater treatment; Alternative 6 is most effective. Alternatives 3, 4, 5, and 6 provide long-term groundwater protection through treatment of contaminated soils. Alternatives 5 and 6 provide a more effective soil treatment than Alternatives 3 and 4 because they address the saturated soils that can not be excavated. None of the contaminants would be addressed by Alternatives 1 and 2, except through natural processes. Therefore, Alternatives 1 and 2 would provide the least effective long-term permanence because active treatment of soil or groundwater will not be conducted under these two alternatives.

6.2.2.2 Reduction of Toxicity, Mobility, and Volume Through Treatment

The toxicity and mobility of contaminated groundwater would be reduced through Alternative 4, which provides for direct treatment and hydraulic control of extracted water. The toxicity of contaminated groundwater would also be reduced through Alternative 6, which provides for in-place treatment of contaminated groundwater. Although Alternatives 3 and 5 would not reduce the mobility of contaminants in groundwater, over time, they would reduce toxicity through natural attenuation.

Alternative 5 would treat more soil contaminants than Alternative 3 because it would treat soils under the active coal pile. Alternatives 3, 4, 5, and 6 involve treatment technologies that would reduce the toxicity and mobility of soil contaminants. In addition, Alternatives 3 and 4 would reduce the volume of the contaminated soils of the CSY source area through LTTD. These four alternatives are expected to be able to reduce the soil contamination to levels that do not pose risks to human health or the environment.

6.2.2.3 Short-Term Effectiveness

Alternatives 3, 4, 5, and 6 would pose some short-term potential risks to on-site workers during the estimated two months for excavation of soils and/or installation of the treatment systems. These risks, however, would be minimized by the use of engineering controls and PPE. Natural attenuation of groundwater under Alternatives 3 and 5 poses no short-term risks. Alternatives 1 and 2 do not include active treatment, and therefore, risks would not change over time, except through natural processes. Alternatives 2, 3, 4, 5, and 6 would meet soil and groundwater cleanup goals in 35, 20, eight, 23, and nine years, respectively.

6.2.2.4 Implementability

All alternatives would use readily available technologies and would be feasible to construct. Alternatives 1 and 2 would be readily implementable because they would require no additional action other than monitoring or institutional controls. Alternatives 3 and 4, which involve movement of the coal pile, would be difficult to implement. The presence of the coal pile and depth of required excavation would complicate implementation. The presence of shallow groundwater will limit the amount of soils that can be excavated. Enhanced vacuum extraction under Alternatives 5 and 6 would be more complex to design but easier to implement than complete soil excavation and ex situ soil remediation technologies. For Alternative 4, pilot studies are required to determine the best design for the groundwater extraction and treatment system. Because air stripping is negatively affected by cold temperatures, UV oxidation is favored for treatment of contaminated groundwater.

6.2.2.5 Costs

Based on the information available at the time the alternatives were developed, the estimated costs for each alternative evaluated for the CSY source area are in Table 6-2.

6.2.3 Modifying Criteria

6.2.3.1 State Acceptance

ADEC has been involved with the development of remedial alternatives for OU-4 and agrees with the selected remedy for the CSY source area.

6.2.3.2 Community Acceptance

No comments regarding remedial action at OU-4 were received during the comment period. This may indicate that there is no opposition to any of the preferred alternatives. The Responsiveness Summary, Appendix B to this document, provides the background of community involvement activities conducted in association with OU-4.

Table 6-1

PRESENT-WORTH COSTS[a]
FOR REMEDIAL ALTERNATIVES
LANDFILL SOURCE AREA
OPERABLE UNIT 4
FORT WAINWRIGHT, ALASKA

Description	Present-Worth Capital Cost	Present-Worth Operation and Maintenance Cost	Total Present-Worth Cost
Landfill Source Area			
Alternative 1: No action.	$0	$0	$0
Alternative 2: Institutional Controls, Natural Attenuation, and Groundwater Monitoring.	$82,000	$1,009,000	$1,091,000
Alternative 3: Phased approach. Phase 1: Capping, security fencing, and monitoring.	$476,000	$1,144,000	$1,620,000
Alternative 4: Groundwater pump and treat (UV oxidation) security fencing, and monitoring.	$1,319,000	$7,046,000	$8,365,000
Alternative 5: Landfill capping, security fencing, groundwater pump and treat (UV oxidation) and monitoring.	$1,709,000	$4,324,000	$6,033,000

[a] These costs are estimated. Actual costs are likely to be within +50% to -30% of the table values. Present worth is based on a 7% discount rate over the life of the project.

Table 6-2

**PRESENT-WORTH COSTS[a]
FOR REMEDIAL ALTERNATIVES
COAL STORAGE YARD SOURCE AREA
OPERABLE UNIT 4
FORT WAINWRIGHT, ALASKA**

Description	Present-Worth Capital Cost	Present-Worth Operation and Maintenance Cost	Total Present-Worth Cost
Coal Storage Yard Source Area			
Alternative 1: No action.	$0	$0	$0
Alternative 2: Institutional Controls, Natural Attenuation, and Groundwater Monitoring.	$53,000	$902,000	$955,000
Alternative 3: Ex situ low-temperature thermal desorption of contaminated soils, natural attenuation, and monitoring.	$126,000	$857,000	$983,000
Alternative 4: Ex situ low-temperature thermal desorption of contaminated soils, groundwater pump and treat (UV oxidation), monitoring and security fencing.	$1,114,000	$1,999,000	$3,113,000
Alternative 5: Enhanced vacuum extraction of contaminated soils, natural attenuation, groundwater monitoring, and security fencing.	$153,000	$893,000	$1,046,000
Alternative 6: Enhanced vacuum extraction of contaminated soils, treatment of groundwater via air sparging, monitoring, and security fencing.	$364,000	$1,180,000	$1,544,000

[a] These costs are estimated. Actual costs are likely to be within +50% to -30% of the table values. Present worth is based on a 7% discount rate over the life of the project.

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Section 7

7.0 SELECTED REMEDIES

7.1 LANDFILL SOURCE AREA

The selected remedy for groundwater contamination at the Landfill source area is Alternative 3 because it best meets the nine CERCLA criteria. Alternative 3 includes a phased approach, with Phase 1 being capping of the older, inactive portion of the Landfill, with natural attenuation, monitoring/evaluation of groundwater, and institutional controls. Source control through capping of the older, inactive portion of the Landfill is considered more cost-effective and protective than additional investigation. Historical records indicate that the older area of the Landfill contains a significant portion of chemicals contributing to groundwater contamination. It is anticipated that the capping will result in decreased percolation of rainwater and snowmelt through the Landfill lifts and will result in decreased Landfill leachate entering the groundwater. Existing contaminants in the groundwater would attenuate through natural processes. Groundwater downgradient of the Landfill will be closely monitored in order to assess the natural attenuation process under Phase 1 of this alternative. If significant contamination is persistent, the need for an active groundwater treatment system will be evaluated and implemented, if necessary, under Phase 2 of this alternative.

Alternative 3 is believed to be the most cost-effective option for control of Landfill leachate generation to achieve adequate protection of human health and the environment and ARARs. Landfill capping will minimize additional leachate reaching the groundwater, reduce contaminant movement, and achieve groundwater MCLs in a shorter time frame. Modeling estimates used to project cleanup times for Alternative 3 were based on estimated contaminant loading rates to the groundwater. Under Alternative 3, the 70 years to achieve RAOs is considered a reasonable time frame. This protection is not provided under Alternative 2. Additionally, Alternative 2 does not meet State ARARs for solid waste. It was determined that protection of human health and the environment is attainable without the use of aggressive groundwater treatment because institutional controls will provide protection until MCLs are achieved at this source area. However, in the event that landfill capping does not result in the expected decreases in groundwater contamination, Phase 2 of the selected alternative requires evaluation and potential implementation of an active groundwater treatment system.

7.1.1 Major Components of the Selected Remedy

- Capping with a minimum of 2 feet of native soil of the approximately 8 acres of the inactive portion of the Landfill to achieve a permeability no greater than 10^{-5} cm/sec;

- The cap would maintain native vegetative growth or grasses and promote natural drainage to prevent ponding and erosion;

- Based on the historical landfilling operations, a methane gas collection system is not anticipated; however, the need for a gas collection system will be considered during the Remedial Design;

- Achieving RAOs for groundwater would be through natural attenuation;

- Monitoring groundwater downgradient of the Landfill and evaluating

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results to determine the effectiveness of the capping and natural attenuation with respect to RAOs (see Table 7-1); and

- Maintaining institutional controls restricting access to and development at the site as long as hazardous substances remain onsite at levels that preclude unrestricted use.

The goal of this remedial action is to restore groundwater to its beneficial use, which is, at this site, a potential drinking water aquifer. The point of compliance for achieving RAOs will be at wells downgradient of the Landfill. In the event that it is found through monitoring that natural attenuation of groundwater is not progressing as expected, or that there is not a significant reduction in leachate, Phase 2 of this alternative, which calls for evaluation and implementation of an active groundwater treatment system, would be initiated. Adequate natural attenuation would be measured by comparing contaminant levels with historical data and MCLs. Effectiveness of Phase 1 will be evaluated during the five year review.

Based on information obtained during the RI and on careful analysis of all remedial alternatives, the Army, EPA, and ADEC believe that the selected remedy would be able to achieve this goal.

7.2 COAL STORAGE YARD SOURCE AREA

Alternative 6 is the preferred alternative for the CSY source area because it best meets the nine CERCLA criteria presented in Section 6. This alternative involves in-place treatment of soils via vacuum extraction enhanced by steam injection and bioventing; in-place, on-site treatment of groundwater via air sparging; groundwater monitoring/evaluation; and institutional controls. Alternative 6 is expected to achieve overall protection of human health and the environment and to meet ARARs through active treatment of both soil and groundwater (see Table 7-2). This alternative protects the downgradient drinking water supply wells by treating and controlling the source of contamination and is viewed as being an effective and permanent solution to contamination at the CSY.

After a thorough assessment of the applicable alternatives for the CSY source area, taking groundwater risks, cleanup times, and cost into consideration, it was determined that protection of human health and the environment is best attained through active in-place treatment of soils and groundwater. This alternative is believed to provide the best balance of criteria among the alternatives evaluated.

7.2.1 Major Components of the Selected Remedy

- In situ treatment of groundwater via air sparging to remove VOCs, thereby attaining state and federal drinking water standards. Air sparging wells will be placed in areas of highest contamination;

- In situ treatment of soils via soil vapor extraction to prevent contaminated soils from acting as an ongoing source of contamination to groundwater. Soil vapor extraction wells will be placed in areas of highest contamination and operated until groundwater MCLs are achieved;

- The treatment system will be evaluated and modified as necessary to optimize effectiveness in achieving RAOs;

- Duration of treatment system operation is estimated to be nine years to meet ADEC soil cleanup goals and federal MCLs. A combination of groundwater monitoring and off-gas measurements will be used to determine attainment of RAOs;

- After active treatment achieves MCLs, natural attenuation will be relied on to achieve AWQS;

- Monitoring of the nested downgradient wells to ensure protection of Post drinking water supply wells during remedial action; and

- Maintaining institutional controls, including restricted access and well development restrictions, as long as hazardous substances remain on site at levels that preclude unrestricted use. Restrictions on groundwater will be implemented until contaminant levels are below federal MCLs and AWQS.

The goal of this remedial action is to restore groundwater to its beneficial use, which is, at this site, a drinking water aquifer. The point of compliance for groundwater will be at the treatment system wells. Based on information obtained during the RI and on careful analysis of all remedial alternatives, the Army, EPA, and ADEC believe that the selected remedy would be able to achieve this goal.

Table 7-1

CHEMICAL-SPECIFIC CLEANUP GOALS FOR GROUNDWATER
LANDFILL SOURCE AREA
OPERABLE UNIT 4
FORT WAINWRIGHT, ALASKA

CLEANUP GOALS FOR GROUNDWATER									
	ARARs			TBCs					
				Site RA RBC					
Analyte	Federal MCL	Alaska Drinking Water Standards (state MCLs)	Alaska State Water Quality Standards	HI	10^{-4}	Site-Specific Groundwater[a] Background Corps[b]	Remedial[c] Action Objective	Maximum Detected Concentration	Site Cleanup Goal
Organics (µg/L)									
Benzene	5	5	5	—	—	ND	5	6.3	5
cis-1,2-Dichloroethene	70	70	—	—	—	ND	70	150	70
1,1,2,2-Tetrachloroethane	—	—	2,400	—	35	ND	5.2	1,300	5.2[a]
1,1,2-Trichloroethane	5	—	9,400	—	—	ND	5	10	5
Trichloroethene	5	5	5	—	—	ND	5	180	5
Vinyl chloride	2	2	2	—	—	ND	2	1.3	2
bis(2-Ethylhexyl)phthalate	6	6	—	260	220	ND	6	620	6

[a] Site-specific background groundwater concentration.
[b] Background concentrations from Corps-recommended background value for Fort Wainwright.
[c] Groundwater remediation goals are based on Region 3 1 × 10^{-4} RBCs. There is no federal or state MCL for this contaminant.

Key:

— = Value not established.
ARAR = Applicable or relevant and appropriate requirement.
Corps = United States Army Corps of Engineers, Alaska District.
HI = Hazard index.
µg/L = Micrograms per liter.
MCL = Maximum contaminant level.
ND = Not detected.
RA = Human health risk assessment.
RBC = Risk-based concentration.
TBC = To be considered.
TRPH = Total recoverable petroleum hydrocarbon.

Table 7-2

**CHEMICAL-SPECIFIC CLEANUP GOALS FOR GROUNDWATER AND SOIL
COAL STORAGE YARD SOURCE AREA
OPERABLE UNIT 4
FORT WAINWRIGHT, ALASKA**

CLEANUP GOALS FOR GROUNDWATER									
	ARARS			TBCs					
				Site RA RBC					
Analyte	Federal MCL	Alaska Drinking Water Standards (state MCL)	Alaska State Water Quality Standards	HI	10^{-4}	Site-Specific Groundwater[a] Background Corps[b]	Remedial Action Objective[c]	Maximum Detected Concentration	Site Cleanup Goal
Cleanup Goals for Groundwater									
Organics (µg/L)									
Benzene	5	5	5	—	250	NA	5	800	5
bis(2-Ethylhexyl)phthalate	6	6	—	—	220	2[a]	6	110	6
Trichloroethene	5	5	5	—	—	NA	5	56	5
Toluene	1,000	1,000	10[d]	—	—	NA	1,000	1	1,000

Key at end of table.

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Table 7-2 CHEMICAL-SPECIFIC CLEANUP GOALS FOR GROUNDWATER AND SOIL COAL STORAGE YARD SOURCE AREA OPERABLE UNIT 4 FORT WAINWRIGHT, ALASKA					
CLEANUP GOALS FOR SOIL					
COAL STORAGE YARD SCORE		ADEC Cleanup Level (mg/kg)			
		Diesel	Gasoline/Unknown		
Matrix Score = 39 BTEX = 15 mg/kg Benzene = 0.5 mg/kg VPH = 100 mg/kg EPH = 200 mg/kg		Diesel-range petroleum hydrocarbons (EPH)	Gasoline-range petroleum hydrocarbons (VPH)	Benzene	BTEX
Level A[e]	>40	100	50	0.1	10
Level B	27 - 40	200	100	0.5	15
Level C	21 - 26	1,000	500	0.5	50
Level D	<20	2,000	1,000	0.5	100

[a] Site-specific background groundwater concentration.
[b] Background concentrations from Corps-recommended background value for Fort Wainwright.
[c] Groundwater remedial goals are based on federal and state MCLs for organic contaminants in public water supply systems (40 CFR 141.147 and 18 AAC 80).
[d] 18 AAC 70, Water Quality Standards. The regulatory level for BTEX is 10 μg/L.
[e] Level A cleanup goal is applied to the total matrix score of 39 due to the soil acting as an ongoing source of contamination to groundwater.

Key:

— = Level has not been established.
AAC = Alaska Administrative Code.
ADEC = Alaska Department of Environmental Conservation.
ARAR = Applicable or relevant and appropriate requirement.
BTEX = Benzene, toluene, ethylbenzene, xylene.
CFR = Code of Federal Regulations.
CORP = United States Army Corps of Engineers, Alaska District.
μg/L = Micrograms per liter.
mg/kg = Milligram per kilogram.
MCL = Maximum contaminant level.
NA = Not available.
RA = Human Health Risk Assessment.
RBC = Risk-based concentrations.
TBC = To be considered.

Section 8

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8.0 STATUTORY DETERMINATIONS

The primary responsibility of the Army, EPA, and ADEC 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 utilize permanent treatment technologies or resource recovery technologies to the extent practicable. The statute also contains a preference for remedies that permanently or significantly reduce the volume, toxicity, or mobility of hazardous substances through treatment. Lastly, 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 the Landfill and CSY source areas will provide long-term protection of human health and the environment and satisfy the requirements of Section 121 of CERCLA.

8.1.1 Landfill Source Area

The selected remedy will provide long-term protection of human health and the environment in two ways. Leachate from Landfill materials will be reduced by placing a protective cover over the older portion of the Landfill. Contaminant concentrations currently in the groundwater will attenuate by natural processes over time. Groundwater monitoring/evaluation will continue until such time as attenuation has been completed or implementation of Phase 2 (groundwater treatment) is under way.

8.1.2 Coal Storage Yard Source Area

The selected remedy will provide long-term protection of human health and the environment by removing the contamination from soils and groundwater through installation of a vapor extraction/air sparging system. The remedy will eliminate the potential exposure routes and minimize the possibility of contamination migrating to drinking water sources. Groundwater monitoring/evaluation will be completed to assess contaminant plume movement and concentrations.

8.2 COMPLIANCE WITH APPLICABLE OR RELEVANT AND APPROPRIATE REQUIREMENTS AND TO-BE-CONSIDERED GUIDANCE

The selected remedy for each source area will comply with all ARARs of federal and state environmental and public health laws. These include compliance with all the location-, chemical-, and action-specific ARARs listed below. No other waiver of any ARAR is being sought or invoked for any component of the selected remedies.

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, which 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, which while not

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legally applicable to the circumstances at CERCLA site, address situations sufficiently similar to those encountered at the CERCLA site so that their use 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; and

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

To-be-considered (TBC) requirements are nonpromulgated federal or state standards or guidance documents that are to be used on an "as appropriate" basis in developing cleanup standards. Because they are not promulgated or enforceable, they 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 on how to perform or evaluate site investigations or response actions; and

- State or federal agency policy documents.

8.2.2 Chemical-Specific Applicable or Relevant and Appropriate Requirement

- Federal Safe Drinking Water Act 40 Code of Federal Regulations [CFR] 141) and Alaska Drinking Water Regulation (18 AAC 80): The MCL and nonzero MCL goals established under the Safe Drinking Water Act are relevant and appropriate requirements for groundwater that is a potential drinking water source.

- AWQS (18 AAC 70): Alaska Water Quality Standards for Protection of Class (1)(A) Water Supply, Class (1)(B) Water Recreation, and Class (1) Aquatic Life and Wildlife (18 AAC 70) are applicable to both source areas. Many of the constituents of groundwater regulated by AWQS are identical to MCLs in Drinking Water Standards.

- Alaska Oil Pollution Regulation (18 AAC 75): Alaska Oil Pollution regulations are applicable and responsible parties required to clean up oil or hazardous releases. Soil cleanup remediation will be designed to protect groundwater in accordance with State of Alaska Drinking Water Standards.

- Alaska Regulations for Leaking Underground Storage Tanks (18 AAC

78): The State of Alaska cleanup requirements for contaminated soils from leaking underground storage tanks to protect groundwater are relevant and appropriate for the CSY.

- Alaska Solid Waste Management Regulations (18 AAC 60): The Alaska Solid Waste Management regulations are applicable to the Landfill.

8.2.3 Location-Specific Applicable or Relevant and Appropriate Requirement

- Clean Water Act Section 404: Section 404 of the Clean Water Act, which is implemented by 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 U.S. without a permit. This statute is relevant and appropriate to the protection of wetlands adjacent to the Landfill and CSY source areas.

8.2.4 Action-Specific Applicable or Relevant and Appropriate Requirement

- RCRA Solid Waste Landfill Closure Criteria (40 CFR 258.60): 40 CFR 258.60 includes relevant and appropriate regulations pertaining to installation of a cap on a solid waste landfill. Specifically, according to 40 CFR 258.60 (1), if a final cover system is installed at Fort Wainwright, it is required to have a permeability no greater than 1×10^{-5} cm/sec. Additionally, 40 CFR 258.60 (2)(3) specifies that the thickness of an infiltration and erosion layer must be a minimum of 18 and 6 inches of earthen material, respectively, and that the erosion layer must be capable of sustaining native plant growth; and

- Federal Clean Air Act (42 United States Code 7401), as amended, is applicable for venting contaminated vapors.

8.2.5 Information To-Be-Considered

The following information TBC will be used as a guideline when implementing the selected remedy:

- State of Alaska Guidance for Storage, Remediation, and Disposal of Non-UST Petroleum Contaminated Soils (July 29, 1991) for the CSY; and

- State of Alaska Interim Guidance for Surface and Groundwater Cleanup Levels (September 26, 1990) for the CSY.

8.3 COST EFFECTIVENESS

The selected remedy for each source area is cost-effective when the degree of protectiveness it provides is compared to the overall protectiveness provided by the other treatment alternatives.

8.4 UTILIZATION OF PERMANENT SOLUTIONS AND ALTERNATIVE TREATMENT TECHNOLOGIES OR RESOURCE RECOVERY TECHNOLOGIES TO THE MAXIMUM EXTENT PRACTICABLE

The United States Army, State of Alaska, 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 OU-4 source areas. Of those alternatives that protect human health and the environment and comply with ARARs, the Army, State of Alaska, 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, or 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 PRINCIPAL ELEMENT

The selected remedy for the CSY satisfies the statutory preference for treatment for both groundwater and soil. Phase 1 of the Landfill remedy does not actively treat groundwater; however, Phase 2 would use groundwater treatment as a principal element if deemed necessary.

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9.0 DOCUMENTATION OF SIGNIFICANT CHANGES

The selected remedy for the Landfill and CSY source areas is the same preferred alternative for each area presented in the Proposed Plan. No changes in the components of the preferred alternative have been made.

Appendix A

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APPENDIX A

ARMY DECISION DOCUMENT FOR THE FIRE TRAINING PITS

DEPARTMENT OF THE ARMY
HEADQUARTERS, U.S. ARMY ALASKA
600 RICHARDSON DRIVE # 5000
FORT RICHARDSON, ALASKA 99505-5000

REPLY TO
ATTENTION OF:

DECISION DOCUMENT
for
FIRE TRAINING PITS, OPERABLE UNIT 4

1. PURPOSE OF REMOVAL ACTION:

a. This decision document describes the removal action for the Fire Training Pits (FTPs) 3A and 3B Source Area, Operable Unit 4, at Fort Wainwright. This removal action has been chosen in accordance with Comprehensive Environmental Response, Compensation, Liability Act (CERCLA) as amended by Superfund Amendment Reauthorization Act (SARA), the National Contingency Plan (NCP), Resource Conservation and Recovery Act (RCRA), and Army Regulation 200-1, as applicable.

b. The FTPs at Fort Wainwright include two wide, shallow pits designated as FTP-3A and FTP-3B, and a 2-foot depression area northwest of FTP-3B. The FTPs are located in the main cantonment area west of the ammunition storage area, as shown in Figure 1-4. The FTPs Source Area was utilized by Fort Wainwright's fire department and rescue crews from approximately 1970 to 1988 for training in fire extinguishing exercises. The exercises included soaking the soils of the pits with water, filling the pits with petroleum products (i.e., fuels, brake fluid, waste oil, and/or solvents), igniting the flammable mixture, and extinguishing the resultant fire. Approximately 1,500 to 2,300 gallons of flammable liquids were burned each year in the unlined pits. Soil investigations at the FTPs Source Area revealed petroleum as the only contaminant requiring remediation, specifically diesel and Diesel Range Organics (DRO) in the surface soils and Total Recoverable Petroleum Hydrocarbons (TRPH) in both the surface and subsurface soils. Volatile Organic Compounds (VOC), Semi-Volatile Organic Compounds, pesticide, and dioxin/furan contaminants were found in the soils below action levels. Inorganics are naturally occurring at Fort Wainwright and were also found in the soils. Some of the inorganics, specifically Arsenic and Selenium, were found to have higher concentrations in isolated locations at the FTPs Source Area. These isolated hits were determined to be natural occurrences since no former or current practice or source could be found to cause these high inorganic concentration levels. Investigations on the groundwater at the FTPs Source Area revealed one VOC, Trichloroethylene, detected in only one groundwater sample. Subsequent groundwater sampling revealed no VOC contaminants. Semi-VOCs and petroleum constituents were detected in the groundwater below federal and

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state maximum contaminant levels. Based on the results of the soil and groundwater investigations at the FTPs Source Area, a removal action of the petroleum contaminated soils will be conducted. This action will remove the source and eliminate the risk to human health and the environment.

c. This decision document was developed by the Fort Wainwright, Directorate of Public Works with support from the State of Alaska Department of Environmental Conservation (ADEC) and the U.S. Environmental Protection Agency (EPA). Regulatory agency concurrence, i.e., ADEC and the EPA, with this Decision Document removal action can be found in the Record of Decision for Operable Unit 4, Fort Wainwright.

2. SUMMARY OF SITE RISK:

a. The primary source of contamination at the FTPs Source Area is residual material from past burning operations. Contaminant groups detected during the Remedial Investigation included inorganics (i.e., metals), VOCs, petroleum hydrocarbons, dioxins/furans, and pesticides; however, petroleum contaminants, specifically diesel and DRO in the surface soils and TRPH in the surface and subsurface soils, are the only contaminants that require remediation. The baseline human health risk assessment estimated the potential excess lifetime cancer risks and hazard indices for current landuse conditions at the FTPs Source Area to be within or below the regulatory benchmarks, defined by the EPA Superfund program. These estimated cancer and noncancer risks were low because of the low concentrations of contaminants detected and because there were no current, complete exposure pathways for groundwater. The only risks that were encountered during the human health risk assessment were those associated with future residential use of groundwater. The ecological risk assessment conducted at the FTPs Source Area revealed adverse effects to small mammals and robins from the isolated hits of inorganics found in the soils at the FTPs Source Area. The Remedial Investigation determined these hits to be natural occurrences, since no former or current practice or source could be found to cause the high inorganic concentration levels. For this reason, the inorganics are not identified as a contaminant requiring remediation and are not addressed in the removal action.

b. The migration pathways that affect human health and the environment at the FTPs Source Area are surface water migration and groundwater flow and discharge. Surface soil contamination (i.e., DRO, diesel, and TRPH), which was identified within both pits during the Remedial Investigation, was found in several isolated areas of drainage ditches and wetlands due to surface water migration. Subsurface soil contamination (i.e., TRPH), which was identified as not being widespread but isolated under both pits and a depression area northwest of FTP-3B during the Remedial Investigation, extends from the ground surface, through the vadose zone, to the groundwater and soil interface. Presently, groundwater contaminants throughout the FTPs Source Area fall below federal or state maximum contaminant levels. However, soil contaminant levels pose a threat to the groundwater. If the source of petroleum contamination is not removed from the soils at the FTPs Source Area, the soils will continue to contribute contamination to the groundwater, via infiltration and percolation, and potential cancer and noncancer risks for future residential use of groundwater will exceed the regulatory benchmarks. Risks will remain at the FTPs Source Area if no action is taken.

3. SUMMARY OF REMOVAL ACTION:

a. The removal action for the FTP Source Area is summarized below and described in the Feasibility Study Final Report, Operable Unit 4, Fort Wainwright, Alaska, Ecology and Environment, Inc., dated November 1995.

REMOVAL ACTION	COST($)
Ex-situ low-temperature thermal desorption of contaminated soils	$5,000

b. Petroleum contaminants, specifically diesel and diesel range organics in the surface soils and total recoverable petroleum hydrocarbons in the surface and subsurface soils, are the only contaminants at the FTP Source Area that require remediation. In order to minimize continued contamination of the impacted media, the Army has opted to use removal authority, as specified in the NCP, to excavate and remediate (via low-temperature thermal desorption) the petroleum-contaminated soils. The contract to complete the removal action was awarded and is projected to occur in the spring of 1996. It is anticipated that the removal at the FTP Source Area will constitute final action for this source of soil contamination.

c. This site is currently listed under the Three Party Agreement between the Department of the Army, ADEC, and the EPA under Operable Unit 4 of the Federal Facilities Agreement for Fort Wainwright. Failure to take corrective

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action, as required by the agreement, may result in penalties stipulated in the agreement.

4. PUBLIC/COMMUNITY INVOLVEMENT:

a. It is DOD and Army policy to involve the local community as early as possible and throughout the Removal process at an installation. To accomplish this, the FTPs Source Area has complied with the public participation requirements of CERCLA/SARA (Sections 113 (K) (2) (A) and 117). Information regarding the history, operational practices, and removal action for the FTPs Source Area was disseminated to the public through the following mechanisms:

- Proposed Plan for Remedial Action at Operable Unit 4
- Fort Wainwright Superfund Update Newsletter
- Environmental Restoration Newsletter
- Operable Unit 4 Public Meeting

b. Future community involvement at the FTPs Source Area consists of updating the Administrative Record for Fort Wainwright once the excavation and remediation of the contaminated soils is complete. The Administrative Record is open to the public and located at three Information Repositories in Fairbanks.

5. DECLARATION: The selected remedy is protective of human health and the environment, attains Federal and State requirements that are applicable or relevant and appropriate to this removal action, and is cost effective. This remedy satisfies the statutory preference for remedies that employ treatment that reduces toxicity, mobility or volume as a principal element and utilizes permanent solutions and alternative treatment technologies to the maximum extent practicable. Because this remedy will not result in hazardous substances remaining on-site above levels that allow for unlimited use and unrestricted exposure, the five-year review will not apply to this action.

KENNETH W. SIMPSON
Major General, USA
Commanding

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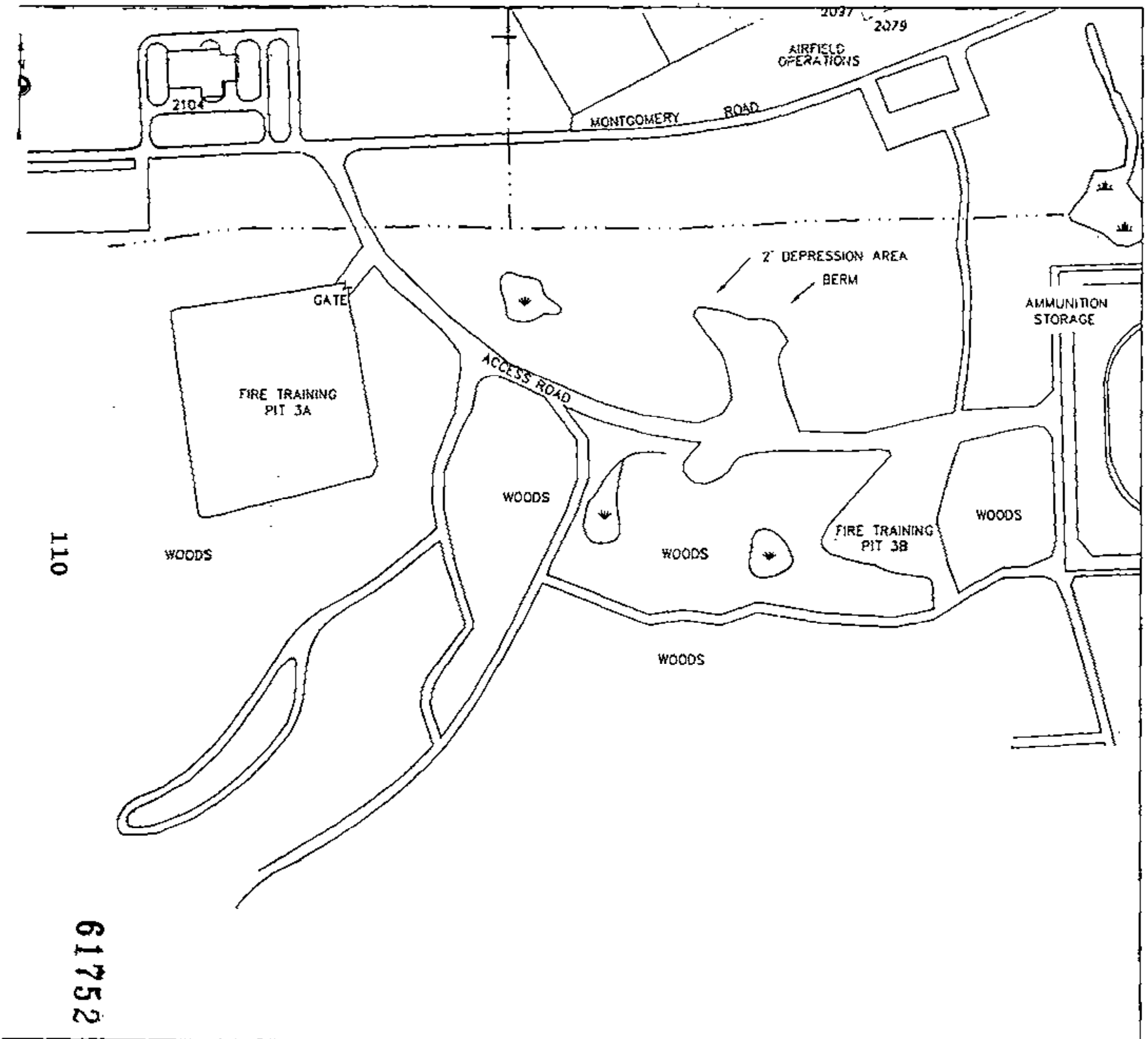

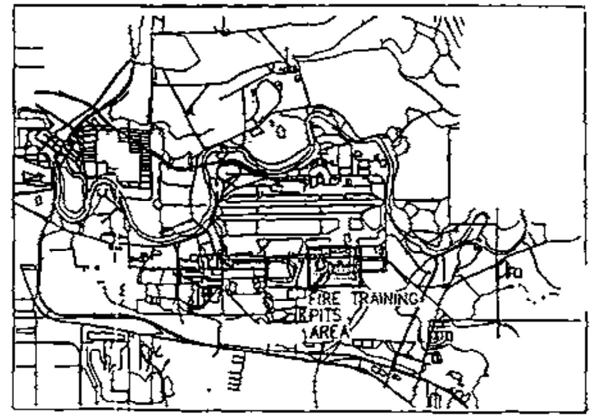

FORT WAINWRIGHT KEY PLAN

LEGEND

ROAD

DRAINAGE DITCH

WETLAND

APPROXIMATE SCALE IN FEET

0 600 1,200 1,800

ecology and environment, inc.

U.S. ARMY
ENGINEER DISTRICT, ALASKA
CORPS OF ENGINEERS
ANCHORAGE, ALASKA

Figure 1-4
FIRE TRAINING PITS AREA
LOCATION MAP
OPERABLE UNIT 4

FAIRBANKS ALASKA

SIZE	JOB. NO.	FILE NO.	DATE:	PLATE
B	JV8040	JV850138	10-06-95	

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Appendix B

APPENDIX B

RESPONSIVENESS SUMMARY

RESPONSIVENESS SUMMARY FOR THE RECORD OF DECISION FOR REMEDIAL ACTION AT OPERABLE UNIT 4, FORT WAINWRIGHT, ALASKA

OVERVIEW

The United States Army (Army), Alaska, United States Environmental Protection Agency, and the Alaska Department of Environmental Conservation, collectively referred to as "the Agencies," distributed a Proposed Plan for remedial action at Operable Unit 4 (OU-4), Fort Wainwright, Alaska. OU-4 comprises three source areas: the Landfill; the Coal Storage Yard (CSY); and the Fire Training Pits (FTPs).

The Proposed Plan identified preferred remedial alternatives for two of the three source areas within OU-4. The third source area, the FTP area, was not considered for remedial action in the Proposed Plan. The contaminants at this source area consist of petroleum products and will be addressed through an Army removal action that includes excavation and disposal.

The major components of the remedial alternatives for the Landfill are a phased approach:

Phase 1:

- Involving capping the older, inactive portion of the Landfill,
- Natural attenuation,
- Groundwater monitoring, and
- Institutional controls.

Phase 2:

- Evaluation and implementation of active groundwater treatment systems, if necessary.

The major components of the remedial alternatives for the CSY are:

- In-place treatment of soils via vacuum extraction enhanced by steam injection and bioventing;
- In-place, on-site treatment of groundwater via air sparging;
- Groundwater monitoring; and
- Institutional controls.

No formal comments regarding the Proposed Plan for the OU-4 remedial action were submitted during the public comment period.

BACKGROUND OF COMMUNITY INVOLVEMENT

The public was encouraged to participate in the selection of the final remedies for OU-4 during a public comment period from October 10 to November 10, 1995. The *Fort Wainwright Proposed Plan for Remedial Action at Operable Unit 4* presented 11 combinations of options considered by the Agencies to address contamination in soil and groundwater at OU-4. The Proposed Plan was released to the public on October 10, 1995, and copies were sent to all known interested parties, including elected officials and concerned citizens. Informational Fact Sheets, dated March and September 1995, which provided information about the Army's entire cleanup program at Fort Wainwright, were mailed to the addresses on the same mailing list.

The Proposed Plan summarized available information regarding the OU. Additional materials were placed into 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 was welcome 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, by calling a toll-free telephone number to record a comment, or by attending and commenting at a public meeting on October 17, 1995, at the Carlson Center in Fairbanks.

Basewide community relations activities conducted for Fort Wainwright, which includes OU-4, have included:

- 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; and
- April 22, 1994—Establishment of information repositories at the Noel Wien Library and the Fort Wainwright Post Library and the Administrative Record at Building 3023 on Fort Wainwright.

Community relations activities specifically conducted for OU-4 included:

- October 4, 8, 11, 15, 16, and 17, 1995—Display advertisement announcing the public meeting in the *Fairbanks Daily News-Miner*;
- October 10, 1995—Distribution of the Proposed Plan for final remedial action at OU-4;

- October 10 to November 10, 1995—Thirty-day public comment period. No extension was requested;

- October 10 to November 10, 1995—Toll-free telephone number for citizens to provide comments during the public comment period. The toll-free telephone number was advertised in the Proposed Plan and the newspaper display advertisement that announced the public meeting; and

- October 17, 1995—Public meeting at the Carlson Center to provide information, a forum for questions and answers, and an opportunity for public comment regarding OU-4.

SUMMARY OF COMMENTS RECEIVED DURING THE PUBLIC COMMENT PERIOD

No comments were received during the public comment period.

Appendix C

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APPENDIX C

COST CALCULATIONS

LANDFILL AND COAL STORAGE YARD SOURCE AREAS

LIFE CYCLE COST

10/4/95 10:39

Project Name: OU4	Analysis Base Date: Dec 94
Project Number: JV8000	Analyis End Date: Dec 94
Installation & Location: OU4 - Landfill	BOD for Analysis:
Alt. No. : 2	Annual Discount Rate: 0.07
Title: Institutional Controls and Groundwater Monitoring-Natural Attenuation of Groundwater with semi-annual Monitoring and institutional Controls	Escalation Rate: 0.00

ONE-TIME COSTS	(Midpoint) Years from ABD	Cost on ABD	Discount Factor	Present Worth on ABD
GROUNDWATER MONITORING (25 WELLS @ $200/Well):				
1. Monitoring Workplan	1	$5,000	NA	$5,000
INSTITUTIONAL CONTROL:				
1. Fencing (2700 LF @ $19.07/LF, plus 2 gates)	1	$54,000	NA	$54,000
		SUBTOTAL P/W		$59,000
		25% INDIRECT		$14,750
		10% CONTINGENCY		$7,375
		TOTAL		$82,000 *

* The total has been rounded up to the nearest $1,000.

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Landfill
Alternative 2
Capital Costs

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Table A-3

LIFE CYCLE COST

10/4/95 10:45

Project Name: OU4	Analysis Base Date: Dec 94
Project Number: JV8000	Analyis End Date: Dec 94
Installation & Location: OU4 - Landfill	BOD for Analysis:
Alt. No. : 2	Annual Discount Rate: 0.07
Title: Institutional Controls and Groundwater Monitoring - Natural Attenuation of Groundwater with Semi-Annual Monitoring and Institutional Controls	Escalation Rate: 0.00

ANNUAL COSTS	YEARS FROM ABD: First Incurred	Last Incurred	Total Number of Payments	Annual Cost on ABD	Discount Factor	Present Worth on ABD
GROUNDWATER MONITORING (25 WELLS @ $2650/WELL):						
1. Equipment Shipping	1	85	85	600	14.24	$ 8,544
2. Sampling Equipment (jars, pump, generat., labels, etc.)	1	85	85	$3,750	14.24	$ 53,400
3. Travel Expenses (Air Fare, Per Diem, Rental Car, etc.)	1	85	85	$3,030	14.24	$ 43,147
4. Field Team (2-Man, 25-hrs @ $160/hr)	1	85	85	$8,000	14.24	$ 113,920
5. Sample Shipping Costs (20 Coolers at $75/Cooler)	1	85	85	$3,000	14.24	$ 42,720
6. Sample Analysis (Two Analytes)	1	85	85	$26,250	14.24	$ 373,800
7. Quality Assurance Report (0.5-hr per analyt @ $80/hr)	1	85	85	$4,000	14.24	$ 56,960
8. Summary Report	1	85	85	$4,640	14.24	$ 66,074
9. Investigation Derived Waste Management	1	85	85	$8,000	14.24	$ 113,920
10. Administration Costs	1	85	85	$2,500	14.24	$ 35,600
INSTITUTIONAL CONTROL:						
1. Maintain Fencing	1	15	15	$1,000	9.108	$9,108
				SUBTOTAL P/W		$ 917,193
				10% CONTINGENCY		$91,719
				TOTAL		$1,009,000 *

* The total has been rounded up to the nearest $1,000.

Landfill
Alternative 2
Annual Costs

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LIFE CYCLE COST

10/4/95 10:43

Project Name: OU4	Analysis Base Date: Dec 94
Project Number: JV8000	Analyis End Date: Dec 94
Installation & Location: OU4 - Landfill	BOD for Analysis:
Alt. No. : 3	Annual Discount Rate: 0.07
Title: Phased Approach. Phase 1 - Cap Inactive Portion of Landfill with Institutional Controls and Natural Attenuation of Groundwater with Semi-Annual Monitoring.	Escalation Rate: 0.00

	(Midpoint) Years from ABD	Cost on ABD	Discount Factor	Present Worth on ABD
ONE-TIME COSTS				
LANDFILL CAP:				
1. Earthwork (26,000 cy, 2-ft depth @ $6.77/cy)	1	$177,000	NA	$177,000
2. Develop/Restore Soil Borrow Pit (4 acres)	1	$61,000	NA	$61,000
3. Hydraseed Cap (8 acres @ $1694/acre)	1	$14,000	NA	$14,000
4 Gas Collection (6 wells, piping, flare, building)	1	$35,000	NA	$35,000
INSTITUTIONAL CONTROL:				
1 Fencing (2,700 LF @ $19.07/LF, plus 2 gates)	1	$54,000	NA	$54,000
GROUNDWATER MONITORING (25 WELLS @ $200/Well):				
1. Monitoring Workplan	1	$5,000	NA	$5,000
		SUBTOTAL P/W		$346,000
		25% INDIRECT		$86,500
		10% CONTINGENCY		$43,250
		TOTAL		$476,000 *

* The total has been rounded up to the nearest $1,000.

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Landfill
Alternative 3
Capital Costs

Table A-3

LIFE CYCLE COST

10/4/95 10:41

Project Name: OU4 Project Number: JV8000 Installation & Location: OU4 - Landfill Alt. No. : 3 Title: Phased Approach. Phase 1 - Cap Inactive Portion of Landfill with Institutional Controls and Natural Attenuation of Groundwater with Semi-Annual Monitoring	Analysis Base Date: Dec 94 Analyis End Date: Dec 94 BOD for Analysis: Annual Discount Rate: 0.07 Escalation Rate: 0.00

ANNUAL COSTS	YEARS FROM ABD: First Incurred	Last Incurred	Total Number of Payments	Annual Cost on ABD	Discount Factor	Present Worth on ABD
LANDFILL CAP:						
1. Blower Power (Continuously run @ $0.10/kW-hr)	1	30	30	$2,000	12.409	$24,818
2. Misc. Costs(Erosion & Pump Maint., Admin., Monitoring)	1	30	30	$8,000	12.409	$99,272
GROUNDWATER MONITORING (25 WELLS @ $2650/WELL):						
1 Equipment Shipping	1	70	70	600	14.16	$ 8,496
2. Sampling Equipment (jars, pump, generat., labels, etc.)	1	70	70	$3,750	14.16	$ 53,100
3. Travel Expenses (Air Fare, Per Diem, Rental Car, etc.)	1	70	70	$3,030	14.16	$ 42,905
4. Field Team (2-Man, 25-hrs @ $160/hr)	1	70	70	$8,000	14.16	$ 113,280
5. Sample Shipping Costs (20 Coolers at $75/Cooler)	1	70	70	$3,000	14.16	$ 42,480
6. Sample Analysis (Two Analytes)	1	70	70	$26,250	14.16	$ 371,700
7. Quality Assurance Report (0.5-hr per analyt @ $80/hr)	1	70	70	$4,000	14.16	$ 56,640
8. Summary Report	1	70	70	$4,640	14.16	$ 65,702
9. Investigation Derived Waste Management	1	70	70	$8,000	14.16	$ 113,280
10. Administration Costs	1	70	70	$2,500	14.16	$ 35,400
INSTITUTIONAL CONTROL:						
1. Maintain Fencing	1	30	30	$1,000	12.409	$12,409
				SUBTOTAL P/W		$1,039,482
				10% CONTINGENCY		$103,948
				TOTAL		$1,144,000 *

* The total has been rounded up to the nearest $1,000.

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Landfill
Alternative 3
Annual Costs

Tabl. .-3

LIFE CYCLE COST

10/4/95 10:50

Project Name: OU4
Project Number: JV8000
Installation & Location: OU4 - Landfill
Alt. No. : 4
Title: UV Oxidation of Groundwater with Institutional Controls and Semi-Annual Monitoring

Analysis Base Date: Dec 94
Analyis End Date: Dec 94
BOD for Analysis:
Annual Discount Rate: 0.07
Escalation Rate: 0.00

	(Midpoint) Years from ABD	Cost on ABD	Discount Factor	Present Worth on ABD
ONE-TIME COSTS				
INSTITUTIONAL CONTROLS:				
1. Fencing (2,700 LF @ $19.07/LF, plus 2 gates)	1	$54,000	NA	$54,000
GROUNDWATER MONITORING (25 WELLS @ $200/Well):				
1. Monitoring Workplan	1	$5,000	NA	$5,000
GROUNDWATER PUMP AND TREAT (UV OXIDATION)				
1. Extraction Wells (6 @ 23.5 lf @ $100/lf)	1	$15,000	NA	$15,000
2. Extraction Piping (1300 lf @ $30/lf)	1	$39,000	NA	$39,000
3. UV Oxidizers (180 kW system)	1	$297,000	NA	$297,000
4. Post UV Filtration for Metals	1	$100,000	NA	$100,000
5. Building (2000 sf @ $60/sf)	1	$120,000	NA	$120,000
6. Electrical (Controllers, switches, contracting)	1	$50,000	NA	$50,000
7. Equipment Installation (unloading, leveling, anchoring)	1	$50,000	NA	$50,000
8. Plumbing/Misc.(Cooling Water, Steam, H2O2 Tank)	1	$75,000	NA	$75,000
9. Furnace/Heat Exchangers	1	$3,750	NA	$3,750
10. Pilot Scale Studies for UV Treatment	1	$150,000	NA	$150,000
		SUBTOTAL P/W		$958,750
		25% INDIRECT		$239,688
		10% CONTINGENCY		$119,844
		TOTAL		$1,319,000 *

* The total has been rounded up to the nearest $1,000.

Landfill
Alternative 4
Capital Costs

Table A-3

LIFE CYCLE COST

10/4/95 10:48

Project Name: OU4	Analysis Base Date: Dec 94
Project Number: JV8000	Analyis End Date: Dec 94
Installation & Location: OU4 - Landfill	BOD for Analysis:
Alt. No. : 4	Annual Discount Rate: 0.07
Title: UV Oxidation of Groundwater with Institutional Controls and Semi-Annual Monitoring	Escalation Rate: 0.00

ANNUAL COSTS	YEARS FROM ABD: First Incurred	Last Incurred	Total Number of Payments	Annual Cost on ABD	Discount Factor	Present Worth on ABD
PUMP AND TREAT (UV OXIDATION):						
1. UV Oxidizers (electrical, H2O2)	1	25	25	$280,500	11.654	$3,268,947
2. Extraction Well Pumps (6 - 8 hp pumps)	1	25	25	$31,368	11.654	$365,560
3. Sampling (Weekly, 3 sample points @ $180/point)	1	25	25	$28,080	11.654	$327,244
4. Metals Filter (filter replacement, consumables)	1	25	25	$144,869	11.654	$1,688,297
GROUNDWATER MONITORING (25 WELLS @ $2650/WELL):						
1. Equipment Shipping	1	25	25	600	11.654	$ 6,992
2. Sampling Equipment (jars, pump, generat., labels, etc.)	1	25	25	$3,750	11.654	$ 43,703
3. Travel Expenses (Air Fare, Per Diem, Rental Car, etc.)	1	25	25	$3,030	11.654	$ 35,312
4. Field Team (2-Man, 25-hrs @ $160/hr)	1	25	25	$8,000	11.654	$ 93,232
5. Sample Shipping Costs (20 Coolers at $75/Cooler)	1	25	25	$3,000	11.654	$ 34,962
6. Sample Analysis (Two Analytes)	1	25	25	$26,250	11.654	$ 305,918
7. Quality Assurance Report (0.5-hr per analyt @ $80/hr)	1	25	25	$4,000	11.654	$ 46,616
8. Summary Report	1	25	25	$4,640	11.654	$ 54,075
9. Investigation Derived Waste Management	1	25	25	$8,000	11.654	$ 93,232
10. Administration Costs	1	25	25	$2,500	11.654	$ 29,135
INSTITUTIONAL CONTROL:						
1. Maintain Fencing	1	25	25	$1,000	11.654	$11,654
				SUBTOTAL P/W		$6,404,879
				10% CONTINGENCY		$640,488
				TOTAL		$7,046,000 *

* The total has been rounded up to the nearest $1,000.

Landfill
Alternative 4
Annual Costs

LIFE CYCLE COST

10/4/95 10:54

Project Name: OU4	Analysis Base Date: Dec 94
Project Number: JV8000	Analyis End Date: Dec 94
Installation & Location: OU4 - Landfill	BOD for Analysis:
Alt. No. : 5	Annual Discount Rate: 0.07
Title: Cap Inactive Portion of Landfill, UV Oxidation of Groundwater with Institutional Controls and Semi-Annual Monitoring	Escalation Rate: 0.00

	(Midpoint) Years from ABD	Cost on ABD	Discount Factor	Present Worth on ABD
ONE-TIME COSTS				
LANDFILL CAP:				
1. Earthwork (26,000 cy, 2 FT depth @ $6.77/cy)	1	$177,000	NA	$177,000
2. Develop/Restore Soil Borrow Pit (4 acres)	1	$61,000	NA	$61,000
3. Hydraseed Cap (6 acres @ $1694/acre)	1	$11,000	NA	$11,000
4 Gas Collection (6 wells, piping, flare, building)	1	$35,000	NA	$35,000
INSTITUTIONAL CONTROL:				
1. Fencing (2,700 LF @ $19.07/LF, plus 2 gates)	1	$54,000	NA	$54,000
GROUNDWATER MONITORING (25 WELLS @ $200/Well):				
1. Monitoring Workplan	1	$5,000	NA	$5,000
GROUNDWATER PUMP AND TREAT (UV OXIDATION)				
1. Extraction Wells (6 @ 23.5 lf @ $100/lf)	1	$15,000	NA	$15,000
2. Extraction Piping (1300 lf @ $30/lf)	1	$39,000	NA	$39,000
3. UV Oxidizers (180 kW system)	1	$297,000	NA	$297,000
4. Post UV Filtration for Metals	1	$100,000	NA	$100,000
5. Building (2000 sf @ $60/sf)	1	$120,000	NA	$120,000
6. Electrical (Controllers, switches, contracting)	1	$50,000	NA	$50,000
7. Equipment Installation (unloading, leveling, anchoring)	1	$50,000	NA	$50,000
8. Plumbing/Misc.(Cooling Water, Steam, H2O2 Tank)	1	$75,000	NA	$75,000
9. Furnace/Heat Exchangers	1	$3,750	NA	$3,750
10. Pilot Scale Studies for UV Treatment	1	$150,000	NA	$150,000
		SUBTOTAL P/W		$1,242,750
		25% INDIRECT		$310,688
		10% CONTINGENCY		$155,344
		TOTAL		$1,709,000 *

* The total has been rounded up to the nearest $1,000.

Landfill
Altnerative 5
Capital Costs

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Tab. ..-3

LIFE CYCLE COST

10/4/95 10:52

Project Name: OU4	Analysis Base Date: Dec 94
Project Number: JV8000	Analyis End Date: Dec 94
Installation & Location: OU4 - Landfill	BOD for Analysis:
Alt. No. : 5	Annual Discount Rate: 0.07
Title: Cap Inactive Portion of Landfill, UV Oxidation of Groundwater with Institutional Controls and Semi-Annual Environmental Monitoring	Escalation Rate: 0.00

ANNUAL COSTS	YEARS FROM ABD: First Incurred	Last Incurred	Total Number of Payments	Annual Cost on ABD	Discount Factor	Present Worth on ABD
LANDFILL CAP:						
1. Blower Power (Continuously run @ $0.10/kW-hr)	1	10	10	$2,000	7.024	$ 14,048
2. Misc. Costs(Erosion & Pump Maint., Admin., Monitoring)	1	10	10	$8,000	7.024	$ 56,192
PUMP AND TREAT (UV OXIDATION)						
1. UV Oxidizers (electrical, H2O2)	1	10	10	$280,500	7.024	$ 1,970,232
2. Extraction Well Pumps (6 - 8 hp pumps)	1	10	10	$31,368	7.024	$ 220,327
3. Sampling (Weekly, 3 sample points @ $180/point)	1	10	10	$28,080	7.024	$ 197,234
4. Metals Filter (filter replacement, consumables)	1	10	10	$144,869	7.024	$ 1,017,556
GROUNDWATER MONITORING (25 WELLS @ $2650/WELL):						
1. Equipment Shipping	1	10	10	600	7.024	$ 4,214
2. Sampling Equipment (jars, pump, generat., labels, etc.)	1	10	10	$3,750	7.024	$ 26,340
3. Travel Expenses (Air Fare, Per Diem, Rental Car, etc.)	1	10	10	$3,030	7.024	$ 21,283
4. Field Team (2-Man, 25-hrs @ $160/hr)	1	10	10	$8,000	7.024	$ 56,192
5. Sample Shipping Costs (20 Coolers at $75/Cooler)	1	10	10	$3,000	7.024	$ 21,072
6. Sample Analysis (Two Analytes)	1	10	10	$26,250	7.024	$ 184,380
7. Quality Assurance Report (0.5-hr per analyt @ $80/hr)	1	10	10	$4,000	7.024	$ 28,096
8. Summary Report	1	10	10	$4,640	7.024	$ 32,591
9. Investigation Derived Waste Management	1	10	10	$8,000	7.024	$ 56,192
10. Administration Costs	1	10	10	$2,500	7.024	$ 17,560
INSTITUTIONAL CONTROL:						
1. Maintain Fencing	1	10	10	$1,000	7.024	$7,024
				SUBTOTAL P/W		$3,930,534
				10% CONTINGENCY		$393,053
				TOTAL		$4,324,000 *

* The total has been rounded up to the nearest $1,000.

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Table [illegible]-3

LIFE CYCLE COST

10/4/95 10:10

Project Name: OU4	Analysis Base Date: Dec 94
Project Number: JV8000	Analyis End Date: Dec 94
Installation & Location: OU4 - Coal Storage Yard	BOD for Analysis:
Alt. No. : 2	Annual Discount Rate: 0.07
Title: Institutional Controls and Groundwater Monitoring- Natural Attenuation of Groundwater with Semi-Annual Monitoring and Institutional Controls	Escalation Rate: 0.00

	(Midpoint) Years from ABD	Cost on ABD	Discount Factor	Present Worth on ABD
ONE-TIME COSTS				
GROUNDWATER MONITORING (25 WELLS @ $200/Well):				
1. Monitoring Workplan	1	$5,000	NA	$5,000
INSTITUTIONAL CONTROL:				
1. Fencing ($19.07/LF for 1600-LF and 2 Gates)	1	$33,000		$33,000
		SUBTOTAL P/W		$38,000
		25% INDIRECT		$9,500
		10% CONTINGENCY		$4,750
		TOTAL		$53,000 *

* The total has been rounded up to the nearest $1,000.

Coal Storage Yard
Alternative 2
Capital Costs

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Table A-3

LIFE CYCLE COST

10/4/95 11:06

Project Name: OU4	Analysis Base Date: Dec 94
Project Number: JV8000	Analyis End Date: Dec 94
Installation & Location: OU4 - Coal Storage Yard	BOD for Analysis:
Alt. No. : 2	Annual Discount Rate: 0.07
Title: Institutional Controls and Groundwater Monitoring- Natural Attenuation of Groundwater with Semi-Annual Monitoring and Institutional Controls	Escalation Rate: 0.00

ANNUAL COSTS (Semi-Annual Sampling) GROUNDWATER MONITORING (25 WELLS @ $2610/WELL):	YEARS FROM ABD: First Incurred	Last Incurred	Total Number of Payments	Annual Cost on ABD	Discount Factor	Present Worth on ABD
1. Equipment Shipping	1	35	35	600	12.948	$ 7,769
2. Sampling Equipment (jars, bailers, labels, rope, etc.)	1	35	35	$2,750	12.948	$ 35,607
3. Travel Expenses (Air Fare, Per Diem, Rental Car, etc.)	1	35	35	$3,030	12.948	$ 39,232
4. Field Team (2-Man, 25-hrs @ $160/hr)	1	35	35	$8,000	12.948	$ 103,584
5. Sample Shipping Costs (20 Coolers at $75/Cooler)	1	35	35	$3,000	12.948	$ 38,844
6. Sample Analysis Costs (Two Analytes)	1	35	35	$26,250	12.948	$ 339,885
7. Quality Assurance Report (0.5-hr per analyt @ $80/hr)	1	35	35	$4,000	12.948	$ 51,792
8. Summary Report	1	35	35	$4,640	12.948	$ 60,079
9. Investigation Derived Waste Management	1	35	35	$8,000	12.948	$ 103,584
10. Administration Costs	1	35	35	$2,500	12.948	$ 32,370
INSTITUTIONAL CONTROL:						
1. Maintain Fencing	1	35	35	$500	12.948	$ 6,474
				SUBTOTAL P/W		$ 819,220
				10% CONTINGENCY		$81,922
				TOTAL		$ 902,000 *

* The total has been rounded up to the nearest $1,000.

Coal Storage Yard
Alternative 2
Annual Costs

Table A-3

LIFE CYCLE COST

10/4/95 10:17

Project Name: OU4	Analysis Base Date: Dec 94
Project Number: JV8000	Analyis End Date: Dec 94
Installation & Location: OU4 - Coal Storage Yard	BOD for Analysis:
Alt. No. : 3	Annual Discount Rate: 0.07
Title: Excavation, Low Temp Thermal Desorption of Soils, with Natural Attenuation of Groundwater, Semi-Annual Environmental Monitoring and Institutional Controls	Escalation Rate: 0.00

	(Midpoint) Years from ABD	Cost on ABD	Discount Factor	Present Worth on ABD
ONE-TIME COSTS				
EXCAVATION AND BACKFILL:				
1. Excavation (240 tons @ $100.00/ton)	1	$24,000	NA	$24,000
2. Backfill (240 tons @ $10.00/ton)	1	$2,400		$2,400
LOW TEMP THERMAL DESORPTION (LTTD) OF SOILS				
1. LTTD for Soil (240 tons @ $250/ton)	1	$60,000	NA	$60,000
GROUNDWATER MONITORING (25 WELLS @ $200/Well):				
1. Monitoring Workplan	1	$5,000	NA	$5,000
INSTITUTIONAL CONTROLS				
1. No Capital Costs	1	$0	NA	$0
		SUBTOTAL P/W		$91,400
		25% INDIRECT		$22,850
		10% CONTINGENCY		$11,425
		TOTAL		$126,000 *

* The total has been rounded up to the nearest $1,000.

Coal Storage Yard
Alternative 3
Capital Costs

Table ..-3

LIFE CYCLE COST

10/4/95 10:15

Project Name: OU4 Project Number: JV8000 Installation & Location: OU4 - Coal Storage Yard Alt. No. : 3 Title: Excavate, Low Temp Thermal Desorption of Soils, with Natural Attenuation of Groundwater, Semi-Annual Environmental Monitoring and Institutional Controls	Analysis Base Date: Dec 94 Analyis End Date: Dec 94 BOD for Analysis: Annual Discount Rate: 0.07 Escalation Rate: 0.00

ANNUAL COSTS	YEARS FROM ABD: First Incurred	Last Incurred	Total Number of Payments	Annual Cost on ABD	Discount Factor	Present Worth on ABD
EXCAVATION:						
1. No Annual Costs	NA	NA	NA	$0	NA	$0
LOW TEMP THERMAL DESORPTION OF SOILS:						
1. No Annual Costs	NA	NA	NA	$0	NA	$0
GROUNDWATER MONITORING (25 WELLS @ $2610/WELL):						
1. Equipment Shipping	1	20	20	600	12.409	$ 7,445
2. Sampling Equipment (jars, bailers, labels, rope, etc.)	1	20	20	$2,750	12.409	$ 34,125
3. Travel Expenses (Air Fare, Per Diem, Rental Car, etc.)	1	20	20	$3,030	12.409	$ 37,599
4. Field Team (2-Man, 25-hrs @ $160/hr)	1	20	20	$8,000	12.409	$ 99,272
5. Sample Shipping Costs (20 Coolers at $75/Cooler)	1	20	20	$3,000	12.409	$ 37,227
6. Sample Analysis Costs (Two Analytes)	1	20	20	$26,250	12.409	$ 325,736
7. Quality Assurance Report (0.5-hr per analyt @ $80/hr)	1	20	20	$4,000	12.409	$ 49,636
8. Summary Report	1	20	20	$4,640	12.409	$ 57,578
9. Investigation Derived Waste Management	1	20	20	$8,000	12.409	$ 99,272
10. Administration Costs	1	20	20	$2,500	12.409	$ 31,023
INSTITUTIONAL COSTS:						
1. No Annual Costs	1	NA	NA	$0	NA	$ -
				SUBTOTAL P/W		$778,913
				10% CONTINGENCY		$77,891
				TOTAL		$857,000 *

* The total has been rounded up to the nearest $1,000.

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Coal Storage Yard
Alternative 3
Annual Costs

LIFE CYCLE COST

10/4/95 10:25

Project Name: OU4	Analysis Base Date: Dec 94
Project Number: JV8000	Analyis End Date: Dec 94
Installation & Location: OU4 - Coal Storage Yard	BOD for Analysis:
Alt. No. : 4	Annual Discount Rate: 0.07
Title: Excavation, Low Temp Thermal Desorption of Soils and UV Oxidation of Groundwater with Semi-Annual Monitoring and Institutional Controls	Escalation Rate: 0.00

ONE-TIME COSTS	(Midpoint) Years from ABD	Cost on ABD	Discount Factor	Present Worth on ABD
EXCAVATION AND BACKFILL:				
1. Excavation (240 tons @ $100.00/ton)	1	$24,000	NA	$24,000
2. Backfill (240 tons @ $10.00/ton)	1	$2,400		$2,400
LOW TEMP THERMAL DESORPTION (LTTD) OF SOILS				
1. LTTD for Soil (240 tons @ $250/ton)	1	$60,000	NA	$60,000
GROUNDWATER PUMP AND TREAT (UV OXIDATION)				
1. Extraction Wells (7 @ 30 lf @ $100/lf)	1	$21,000	NA	$21,000
2. Extraction Piping (2625 lf @ $30/lf)	1	$78,750	NA	$78,750
3. UV Oxidizers (120 kW system)	1	$125,280	NA	$125,280
4. Post UV Filtration for Metals	1	$43,500	NA	$43,500
5. Building (2000 sf @ $60/sf)	1	$120,000	NA	$120,000
6. Electrical (Controllers, switches, contracting)	1	$50,000	NA	$50,000
7. Equipment Installation (unloading, leveling, anchoring)	1	$50,000	NA	$50,000
8. Plumbing/Misc.(Cooling Water, Steam, H2O2 Tank)	1	$43,500	NA	$43,500
9. Furnace/Heat Exchangers	1	$3,750	NA	$3,750
10. Pilot Scale Studies for UV Treatment	1	$150,000	NA	$150,000
GROUNDWATER MONITORING (25 WELLS @ $200/Well):				
1. Monitoring Workplan	1	$5,000	NA	$5,000
INSTITUTIONAL CONTROL:				
1. Fencing ($19.07/LF for 1600-LF and 2 Gates)	1	$33,000	NA	$33,000
		SUBTOTAL P/W		$810,180
		25% INDIRECT		$202,545
		10% CONTINGENCY		$101,273
		TOTAL		$1,114,000 *

* The total has been rounded up to the nearest $1,000.

Coal Storage Yard
Alternative 4
Capital Costs

Table A-3

LIFE CYCLE COST

10/18/95 9:47

Project Name: OU4	Analysis Base Date: Dec 94
Project Number: JV8000	Analyis End Date: Dec 94
Installation & Location: OU4 - Coal Storage Yard	BOD for Analysis:
Alt. No. : 4	Annual Discount Rate: 0.07
Title: Excavate, Low Temp Thermal Desorption of Soils and UV Oxidation of Groundwater with Semi-Annual Monitoring and Institutional Controls	Escalation Rate: 0.00

ANNUAL COSTS	YEARS FROM ABD: First Incurred	Last Incurred	Total Number of Payments	Annual Cost on ABD	Discount Factor	Present Worth on ABD
EXCAVATION:						
1. No Annual Costs	NA	NA	NA	$0	NA	$0
LOW TEMP THERMAL DESORPTION OF SOILS						
1. No Annual Costs	NA	NA	NA	$0	NA	$0
PUMP AND TREAT (UV OXIDATION)						
1. UV Oxidizers (electrical, H2O2, lump)	1	8	8	$113,100	5.389	$609,496
2. Extraction Well Pumps (7 - 8 hp pumps)	1	8	8	$36,596	5.389	$197,215
3. Sampling (Weekly, 3 sample points @ $180/point)	1	8	8	$28,080	5.389	$151,323
4. Metals Filter (filter replacement, consumables)	1	8	8	$96,027	5.389	$517,490
INSTITUTIONAL CONTROL:						
1. Maintain Fencing	1	8	8	$500	5.389	$ 2,695
GROUNDWATER MONITORING SEMI-ANNUAL (25 WELLS @ $2610/WELL):						
1 Equipment Shipping	1	8	8	600	5.389	$ 3,233
2. Sampling Equipment (jars, bailers, labels, rope, etc.)	1	8	8	$2,750	5.389	$ 14,820
3. Travel Expenses (Air Fare, Per Diem, Rental Car, etc.)	1	8	8	$3,030	5.389	$ 16,329
4. Field Team (2-Man, 25-hrs @ $160/hr)	1	8	8	$8,000	5.389	$ 43,112
5. Sample Shipping Costs (20 Coolers at $75/Cooler)	1	8	8	$3,000	5.389	$ 16,167
6. Sample Analysis Costs (Two Analytes)	1	8	8	$26,250	5.389	$ 141,461
7. Quality Assurance Report (0.5-hr per analyt @ $80/hr)	1	8	8	$4,000	5.389	$ 21,556
8. Summary Report	1	8	8	$4,640	5.389	$ 25,005
9. Investigation Derived Waste Management	1	8	8	$8,000	5.389	$ 43,112
10. Administration Costs	1	8	8	$2,500	5.389	$ 13,473

SUBTOTAL P/W	$1,816,487
10% CONTINGENCY	$181,649
TOTAL	$1,999,000 *

* The total has been rounded up to the nearest $1,000.

Coal Storage Yard
Alternative 4
Annual Costs

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Table A-3

LIFE CYCLE COST

10/4/95 10:25

Project Name: OU4	Analysis Base Date: Dec 94
Project Number: JV8000	Analyis End Date: Dec 94
Installation & Location: OU4 - Coal Storage Yard	BOD for Analysis:
Alt. No. : 4	Annual Discount Rate: 0.07
Title: Excavation, Low Temp Thermal Desorption of Soils and UV Oxidation of Groundwater with Semi-Annual Monitoring and Institutional Controls	Escalation Rate: 0.00

ONE-TIME COSTS	(Midpoint) Years from ABD	Cost on ABD	Discount Factor	Present Worth on ABD
EXCAVATION AND BACKFILL:				
1. Excavation (240 tons @ $100.00/ton)	1	$24,000	NA	$24,000
2. Backfill (240 tons @ $10.00/ton)	1	$2,400		$2,400
LOW TEMP THERMAL DESORPTION (LTTD) OF SOILS				
1. LTTD for Soil (240 tons @ $250/ton)	1	$60,000	NA	$60,000
GROUNDWATER PUMP AND TREAT (UV OXIDATION)				
1. Extraction Wells (7 @ 30 lf @ $100/lf)	1	$21,000	NA	$21,000
2. Extraction Piping (2625 lf @ $30/lf)	1	$78,750	NA	$78,750
3. UV Oxidizers (120 kW system)	1	$125,280	NA	$125,280
4. Post UV Filtration for Metals	1	$43,500	NA	$43,500
5. Building (2000 sf @ $60/sf)	1	$120,000	NA	$120,000
6. Electrical (Controllers, switches, contracting)	1	$50,000	NA	$50,000
7. Equipment Installation (unloading, leveling, anchoring)	1	$50,000	NA	$50,000
8. Plumbing/Misc.(Cooling Water, Steam, H2O2 Tank)	1	$43,500	NA	$43,500
9. Furnace/Heat Exchangers	1	$3,750	NA	$3,750
10. Pilot Scale Studies for UV Treatment	1	$150,000	NA	$150,000
GROUNDWATER MONITORING (25 WELLS @ $200/Well):				
1. Monitoring Workplan	1	$5,000	NA	$5,000
INSTITUTIONAL CONTROL:				
1. Fencing ($19.07/LF for 1600-LF and 2 Gates)	1	$33,000	NA	$33,000
		SUBTOTAL P/W		$810,180
		25% INDIRECT		$202,545
		10% CONTINGENCY		$101,273
		TOTAL		$1,114,000 *

* The total has been rounded up to the nearest $1,000.

Coal Storage Yard
Alternative 4
Capital Costs

Table .-3

LIFE CYCLE COST

10/4/95 10:28

Project Name: OU4	Analysis Base Date: Dec 94
Project Number: JV8000	Analyis End Date: Dec 94
Installation & Location: OU4 - Coal Storage Yard	BOD for Analysis:
Alt. No. : 5	Annual Discount Rate: 0.07
Title: Vacuum Extraction/Steam Injection and Bio-venting of Soils and Natural Attenuation of Groundwater with Semi-Annual Environmental Monitoring and Institutional Controls	Escalation Rate: 0.00

ONE-TIME COSTS	(Midpoint) Years from ABD	Cost on ABD	Discount Factor	Present Worth on ABD
VES:				
1. Extraction Wells (2 @ $2500/ea.)	1	$5,000	NA	$5,000
2. Injection Wells (2 @ $2500/ea.)	1	$5,000	NA	$5,000
3. Extraction Well Piping (150 lf @ $30/lf)	1	$4,500	NA	$4,500
4. Injection Well Piping (150 lf @ $30/lf)	1	$4,500	NA	$4,500
5. Joints (10 @ $16/ea)	1	$160	NA	$160
6. Vacuum Gauges (2 @ $75/ea)	3	$150	NA	$150
7. Sampling Ports (2 @ $30/ea)	1	$60	NA	$60
8. Gas Flow Meter (2 @ $300/ea)	1	$600	NA	$600
9. Extraction Blowers	1	$10,500	NA	$10,500
10. Injection Blowers	1	$10,500	NA	$10,500
11. Air/Water Separators (1 @ $2,400/ea)	1	$2,400	NA	$2,400
12. Heat Exchanger (1 @ $1400/ea)	1	$1,400	NA	$1,400
13. Housing Shed (1 @ $8500/ea)	1	$8,500	NA	$8,500
14. Heating System (1 @ $10,000)	1	$10,000	NA	$10,000
15. Pilot Tests	1	$10,000	NA	$10,000
INSTITUTIONAL CONTROL:				
1. Fencing ($19.07/LF for 1600-LF and 2 Gates)	1	$33,000	NA	$33,000
ANNUAL GROUNDWATER MONITORING (25 WELLS @ $200/Well):				
1. Monitoring Workplan	1	$5,000	NA	$5,000

SUBTOTAL P/W	$111,270
25% INDIRECT	$27,818
10% CONTINGENCY	$13,909
TOTAL	$153,000 *

* The total has been rounded up to the nearest $1,000.

Coal Storage Yard
Alternative 5
Capital Costs

LIFE CYCLE COST

10/4/95 10:29

Project Name: OU4	Analysis Base Date: Dec 94
Project Number: JV8000	Analyis End Date: Dec 94
Installation & Location: OU4 - Coal Storage Yard	BOD for Analysis:
Alt. No. : 5 .	Annual Discount Rate: 0.07
Title: Vacuum Extract/Steam (VES), Biovent, with Natural Attenuation of Groundwater, Semi-Annual Environmental Monitoring and Institutional Controls	Escalation Rate: 0.00

ANNUAL COSTS	YEARS FROM ABD: First Incurred	Last Incurred	Total Number of Payments	Annual Cost on ABD	Discount Factor	Present Worth on ABD
VES						
1. Power for Blowers (20 hp @ $0.10/kW-hr,runs continuous)	1	3	3	$17,520	2.6243	$45,978
2 Misc. (Monitoring, Admin, Maintenance, etc)	1	3	3	$20,000	2.6243	$52,486
INSTITUTIONAL CONTROL:						
1. Maintain Fencing	1	23	23	$500	11.272	$ 5,636
GROUNDWATER MONITORING (25 WELLS @ $2610/WELL):						
1 Equipment Shipping	1	23	23	600	11.272	$ 6,763
2. Sampling Equipment (jars, bailers, labels, rope, etc.)	1	23	23	$2,750	11.272	$ 30,998
3. Travel Expenses (Air Fare, Per Diem, Rental Car, etc.)	1	23	23	$3,030	11.272	$ 34,154
4. Field Team (2-Man, 25-hrs @ $160/hr)	1	23	23	$8,000	11.272	$ 90,176
5. Sample Shipping Costs (20 Coolers at $75/Cooler)	1	23	23	$3,000	11.272	$ 33,816
6. Sample Analysis Costs (Two Analytes)	1	23	23	$26,250	11.272	$ 295,890
7. Quality Assurance Report (0.5-hr per analyt @ $80/hr)	1	23	23	$4,000	11.272	$ 45,088
8. Summary Report	1	23	23	$4,640	11.272	$ 52,302
9. Investigation Derived Waste Management	1	23	23	$8,000	11.272	$ 90,176
10. Administration Costs	1	23	23	$2,500	11.272	$ 28,180
				SUBTOTAL P/W		$811,643
				10% CONTINGENCY		$81,164
				TOTAL		$893,000 *

* The total has been rounded up to the nearest $1,000.

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Coal Storage Yard
Alternative 5
Annual Costs

Tab. A-3

LIFE CYCLE COST

10/4/95 10:35

Project Name: OU4 Project Number: JV8000 Installation & Location: OU4 - Coal Storage Yard Alt. No. : 6 Title: Vacuum Extraction/Steam Injection and Bioventing of Soils and Air Sparging of Groundwater with Semi-Annual Monitoring and Institutional Controls	Analysis Base Date: Dec 94/June 95 Analyis End Date: Dec 94/June 95 BOD for Analysis: Dec 95/June 95 Annual Discount Rate: 0.07 Escalation Rate: 0.00

ONE-TIME COSTS	(Midpoint) Years from ABD	Cost on ABD	Discount Factor	Present Worth on ABD
VES:				
1. Extraction Wells (2 @ $2500/ea.)	1	$5,000	NA	$5,000
2. Injection Wells (2 @ $2500/ea.)	1	$5,000	NA	$5,000
3. Extraction Well Piping (150 lf @ $30/lf)	1	$4,500	NA	$4,500
4. Injection Well Piping (150 lf @ $30/lf)	1	$4,500	NA	$4,500
5. Joints (10 @ $16/ea)	1	$160	NA	$160
6. Vacuum Gauges (2 @ $75/ea)	1	$150	NA	$150
7. Sampling Ports (2 @ $30/ea)	1	$60	NA	$60
8. Gas Flow Meter (2 @ $300/ea)	1	$600	NA	$600
9. Extraction Blowers	1	$10,500	NA	$10,500
10. Injection Blowers	1	$10,500	NA	$10,500
11. Air/Water Separators (1 @ $2,400/ea)	1	$2,400	NA	$2,400
12. Heat Exchanger (1 @ $1400/ea)	1	$1,400	NA	$1,400
13. Housing Shed (1 @ $8500/ea)	1	$8,500	NA	$8,500
14. Heating System (1 @ $10,000)	1	$10,000	NA	$10,000
15. Pilot Tests (1 @ $10,000)	1	$10,000	NA	$10,000
AIR SPARGING:				
1. Extraction Wells (10 @ $2500/ea.)	1	$25,000	NA	$25,000
2. Injection Wells (10 @ $2500/ea.)	1	$25,000	NA	$25,000
3. Extraction Well Piping (750 lf @ $30/lf)	1	$22,500	NA	$22,500
4. Injection Well Piping (750 lf @ $30/lf)	1	$22,500	NA	$22,500
5. Joints (50 @ $16/ea)	1	$800	NA	$800
6. Vacuum Gauges (10 @ $75/ea)	3	$750	NA	$750
7. Sampling Ports (10 @ $30/ea)	1	$300	NA	$300
8. Gas Flow Meter (10 @ $300/ea)	1	$3,000	NA	$3,000
9. Extraction Blowers	1	$10,500	NA	$10,500
10. Injection Blowers	1	$10,500	NA	$10,500
11. Air/Water Separators (1 @ $2,400/ea)	1	$2,400	NA	$2,400
12. Heat Exchanger (1 @ $1400/ea)	1	$1,400	NA	$1,400
13. Housing Shed (1 @ $8500/ea)	1	$8,500	NA	$8,500
14. Heating System (1 @ $10,000)	1	$10,000	NA	$10,000
15. Pilot Tests (1 @ $10,000)	1	$10,000	NA	$10,000
GROUNDWATER MONITORING (25 WELLS @ $200/Well):				
1. Monitoring Workplan	1	$5,000	NA	$5,000
INSTITUTIONAL CONTROL:				
1. Fencing ($19.07/LF for 1600-LF and 2 Gates)	1	$33,000	NA	$33,000
		SUBTOTAL P/W		$264,420
		25% INDIRECT		$66,105
		10% CONTINGENCY		$33,053
		TOTAL		$364,000 *

* The total has been rounded up to the nearest $1,000.

Coal Storage Yard
Alternative 6
Capital Costs

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Table A-3

LIFE CYCLE COST

10/4/95 10:35

Project Name: OU4	Analysis Base Date: Dec 94/June 95
Project Number: JV8000	Analyis End Date: Dec 94/June 95
Installation & Location: OU4 - Coal Storage Yard	BOD for Analysis: Dec 95/June 95
Alt. No. . 6	Annual Discount Rate: 0.07
Title: Vacuum Extraction/Steam Injection and Bioventing of Soils and Air Sparging of Groundwater with Semi-Annual Monitoring and Institutional Controls	Escalation Rate: 0.00

ONE-TIME COSTS	(Midpoint) Years from ABD	Cost on ABD	Discount Factor	Present Worth on ABD
VES:				
1. Extraction Wells (2 @ $2500/ea.)	1	$5,000	NA	$5,000
2. Injection Wells (2 @ $2500/ea.)	1	$5,000	NA	$5,000
3. Extraction Well Piping (150 lf @ $30/lf)	1	$4,500	NA	$4,500
4. Injection Well Piping (150 lf @ $30/lf)	1	$4,500	NA	$4,500
5. Joints (10 @ $16/ea)	1	$160	NA	$160
6. Vacuum Gauges (2 @ $75/ea)	1	$150	NA	$150
7. Sampling Ports (2 @ $30/ea)	1	$60	NA	$60
8. Gas Flow Meter (2 @ $300/ea)	1	$600	NA	$600
9. Extraction Blowers	1	$10,500	NA	$10,500
10. Injection Blowers	1	$10,500	NA	$10,500
11. Air/Water Separators (1 @ $2,400/ea)	1	$2,400	NA	$2,400
12. Heat Exchanger (1 @ $1400/ea)	1	$1,400	NA	$1,400
13. Housing Shed (1 @ $8500/ea)	1	$8,500	NA	$8,500
14. Heating System (1 @ $10,000)	1	$10,000	NA	$10,000
15. Pilot Tests (1 @ $10,000)	1	$10,000	NA	$10,000
AIR SPARGING:				
1. Extraction Wells (10 @ $2500/ea.)	1	$25,000	NA	$25,000
2. Injection Wells (10 @ $2500/ea.)	1	$25,000	NA	$25,000
3. Extraction Well Piping (750 lf @ $30/lf)	1	$22,500	NA	$22,500
4. Injection Well Piping (750 lf @ $30/lf)	1	$22,500	NA	$22,500
5. Joints (50 @ $16/ea)	1	$800	NA	$800
6. Vacuum Gauges (10 @ $75/ea)	3	$750	NA	$750
7. Sampling Ports (10 @ $30/ea)	1	$300	NA	$300
8. Gas Flow Meter (10 @ $300/ea)	1	$3,000	NA	$3,000
9. Extraction Blowers	1	$10,500	NA	$10,500
10. Injection Blowers	1	$10,500	NA	$10,500
11. Air/Water Separators (1 @ $2,400/ea)	1	$2,400	NA	$2,400
12. Heat Exchanger (1 @ $1400/ea)	1	$1,400	NA	$1,400
13. Housing Shed (1 @ $8500/ea)	1	$8,500	NA	$8,500
14. Heating System (1 @ $10,000)	1	$10,000	NA	$10,000
15. Pilot Tests (1 @ $10,000)	1	$10,000	NA	$10,000
GROUNDWATER MONITORING (25 WELLS @ $200/Well):				
1. Monitoring Workplan	1	$5,000	NA	$5,000
INSTITUTIONAL CONTROL:				
1. Fencing ($19.07/LF for 1600-LF and 2 Gates)	1	$33,000	NA	$33,000
		SUBTOTAL P/W		$264,420
		25% INDIRECT		$66,105
		10% CONTINGENCY		$33,053
		TOTAL		$364,000 *

* The total has been rounded up to the nearest $1,000.

Coal Storage Yard
Alternative 6
Capital Costs

Table A-3

LIFE CYCLE COST

10/18/95 9:48

Project Name: OU4	Analysis Base Date: June 95
Project Number: JV8000	Analyis End Date: June 95
Installation & Location: OU4 - Coal Storage Yard	BOD for Analysis: June 95
Alt. No. : 6	Annual Discount Rate: 0.07
Title: Vacuum Extraction/Steam Injection and Bioventing of Soils with Air Sparging of Groundwater, Semi-Annual Monitoring, and Institutional Controls.	Escalation Rate: 0.00

ANNUAL COSTS	YEARS FROM ABD: First Incurred	Last Incurred	Total Number of Payments	Annual Cost on ABD	Discount Factor	Present Worth on ABD
VES:						
1. Power for Blower Sys. (20 hp @ $0.10/kW-hr, contin.)	1	9	9	$17,520	6.515	$114,143
2. Misc. (Monitoring, Admin, Maintenance, etc)	1	9	9	$20,000	6.515	$130,300
AIR SPARGING:						
1. Power for Blower Sys. (50 hp @ $0.10/kw-hr, contin.)	1	9	9	$43,800	6.515	$285,357
2. Misc. (Monitoring, Admin, Maintenance, etc)	1	9	9	$20,000	6.515	$130,300
GROUNDWATER MONITORING (25 WELLS @ $2610/WELL):						
1. Equipment Shipping	1	9	9	600	6.515	$ 3,909
2. Sampling Equipment (jars, bailers, labels, rope, etc.)	1	9	9	$2,750	6.515	$ 17,916
3. Travel Expenses (Air Fare, Per Diem, Rental Car, etc.)	1	9	9	$3,030	6.515	$ 19,740
4. Field Team (2-Man, 25-hrs @ $160/hr)	1	9	9	$8,000	6.515	$ 52,120
5. Sample Shipping Costs (20 Coolers at $75/Cooler)	1	9	9	$3,000	6.515	$ 19,545
6. Sample Analysis Costs (Two Analytes)	1	9	9	$26,250	6.515	$ 171,019
7. Quality Assurance Report (0.5-hr per analyt @ $80/hr)	1	9	9	$4,000	6.515	$ 26,060
8. Summary Report	1	9	9	$4,640	6.515	$ 30,230
9. Investigation Derived Waste Management	1	9	9	$8,000	6.515	$ 52,120
10. Administration Costs	1	9	9	$2,500	6.515	$ 16,288
INSTITUTIONAL CONTROL:						
1. Maintain Fencing	1	9	9	$500	6.515	$ 3,258
				SUBTOTAL P/W		$1,072,305
				10% CONTINGENCY		$107,231
				TOTAL		$1,180,000 *

* The total has been rounded up to the nearest $1,000.

Coal Storage Yard
Alternative 6
Annual Costs