PB95-964621
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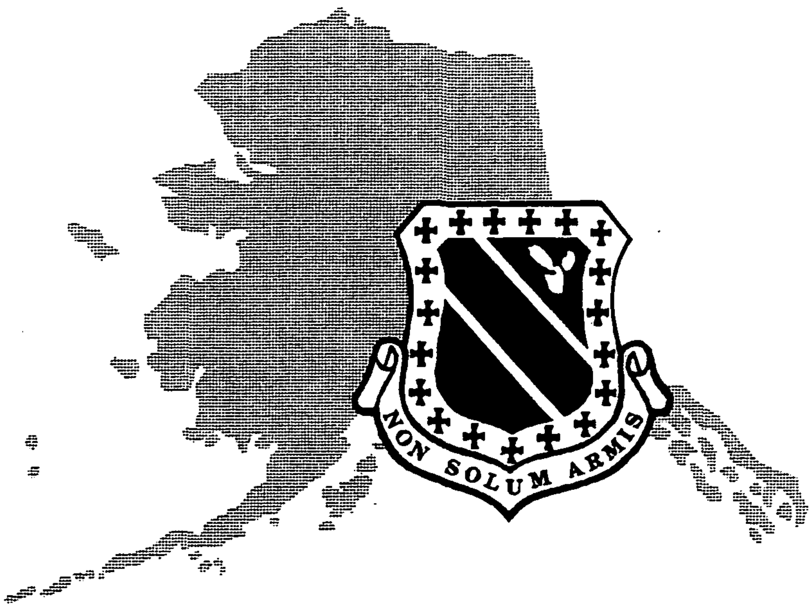
May 1996

EPA Superfund Record of Decision:

Elmendorf Air Force Base Operable Unit 4, AK 9/26/1995



UNITED STATES AIR FORCE
ELMENDORF AIR FORCE BASE, ALASKA

ENVIRONMENTAL RESTORATION PROGRAM

RECORD OF DECISION
OPERABLE UNIT 4

FINAL

SEPTEMBER 1995

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ACRONYM LIST

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ACM	=	Alaska Cleanup Matrix for non-UST soils.
ADEC	=	Alaska Department of Environmental Conservation
ADSA	=	Asphalt Drum Storage Area
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BESG	=	Elmendorf Bioenvironmental Engineering Services Group
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COPC	=	Contaminant of Potential Concern
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ACRONYMS (Continued)

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USEPA	=	U.S. Environmental Protection Agency
UST	=	Underground Storage Tank
VOC	=	Volatile Organic Compound

PART I. DECLARATION

SITE NAME AND LOCATION

Elmendorf Air Force Base (AFB)
Operable Unit (OU) 4
Elmendorf Air Force Base, Alaska

STATEMENT OF BASIS AND PURPOSE

This Record of Decision (ROD) presents the selected remedial action for OU 4 at Elmendorf AFB. It was developed in accordance with the Comprehensive Environmental Response, Compensation, and Liability Act of 1980 (CERCLA) as amended by the Superfund Amendments and Reauthorization Act of 1986 (SARA), 42 U.S.C. §9601 et seq., and, to the extent practicable, in accordance with the National Oil and Hazardous Substances Pollution Contingency Plan (NCP), 40 CFR §300 et seq. The attached administrative record index (Appendix A) identifies the documents upon which the selection of the remedial action was based.

The selected remedy includes the following: 1) active bioventing for deep soils (greater than five feet below the ground surface) at the Fire Training Area (FTA), Hangar 11, and the Asphalt Drum Storage Area (ADSA), and 2) institutional controls with intrinsic remediation for any remaining deep soil contamination, all shallow soils (ground surface to five feet below ground surface), and all groundwater within the upper aquifer. The U.S. Air Force (USAF), the U.S. Environmental Protection Agency (USEPA), and the State of Alaska, through the Department of Environmental Conservation (ADEC), concur with the selected remedy.

ASSESSMENT OF THE SITE

Actual or threatened releases of hazardous substances including halogenated volatile organic compounds (HVOCs), fuels, and fuel constituents from this OU, if not addressed by implementing the response action selected in this ROD, could present an imminent or substantial endangerment to public health, welfare, or the environment. Specific hazardous substances include constituents such as benzene, trichloroethene, tetrachloroethene, and vinyl chloride.

DESCRIPTION OF THE SELECTED REMEDY

The selected remedy was chosen from many alternatives as the best method of addressing contaminated soil and groundwater in OU 4. It addresses the risks to health and the environment caused by the hypothetical exposure of a future resident to contaminated groundwater or soils. The selected remedy addresses this risk by reducing contamination to below cleanup levels established for OU 4.

The major components of the selected remedy include:

Groundwater

- Institutional controls on land use and water use restrictions will restrict access to the contaminated groundwater throughout OU 4 until cleanup levels have been achieved.
- Groundwater will be monitored semi-annually to evaluate contaminant migration and timely reduction of contaminant concentrations by intrinsic remediation. If cleanup levels are not being achieved, further remedial action will be evaluated. Five-year reviews will also assess the protectiveness of the remedial action, as long as contamination remains above cleanup levels.
- All groundwater is expected to be cleaned up within thirteen years.

Soil

- Institutional controls on land use will continue to restrict access to the contaminated shallow soils throughout OU 4 until cleanup levels have been achieved.

- Deep soils at the FTA, the ADSA, and Hangar 11 will be treated with bioventing to accelerate degradation of contaminants in those locations. Deep soils at other source areas will be allowed to degrade through intrinsic remediation.

- Both shallow and deep soils will be monitored bi-annually to evaluate contaminant migration and timely reduction of contaminant concentrations by bioventing and intrinsic remediation. If cleanup levels are not being achieved, further remedial action will be evaluated. This will include five-year reviews to assess the protectiveness of the remedial action, as long as contamination remains above cleanup levels. When concentrations in the bioventing areas are below cleanup levels, bioventing will be discontinued.

- All soils are expected to be cleaned up within eleven years.

STATUTORY DETERMINATIONS

The selected remedy is protective of human health and the environment, complies with federal and state requirements that are legally applicable or relevant and appropriate to remedial action, and is cost-effective. For contaminated soil, this remedy utilizes permanent solutions and alternative treatment technologies to the maximum extent practicable, and satisfies the statutory preference for remedies that employ treatment that reduces toxicity, mobility, or volume as a principal element, however, because treatment of groundwater was found not to be practicable, this remedy does not satisfy the statutory preference for treatment.

Because the remedy will result in contaminants remaining on-site above health-based levels, a review will be conducted within five years after commencement of remedial action. The review will ensure that the remedy continues to provide adequate protection of human health and the environment.

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LEAD AND SUPPORT AGENCY ACCEPTANCE

OF THE RECORD OF DECISION,

ELMENDORF AIR FORCE BASE, OPERABLE UNIT 4

This signature sheet documents agreement between the U.S. Air Force and the United States Environmental Protection Agency on the Record of Decision for Operable Unit 4 at Elmendorf Air Force Base. The Alaska Department of Environmental Conservation concurs with the Record of Decision.

JOHN G. LORBER, General, USAF
Commander, Pacific Air Forces

30 Sep 95
Date

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for CHUCK CLARKE
Regional Administrator
Region X
U.S. Environmental Protection Agency

9/26/95
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KURT FREDRIKSSON — 10-10-95
Director, Spill Prevention and Response — Date
Alaska Department of Environmental Conservation

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PART II. DECISION SUMMARY

This Decision Summary provides an overview of the problems posed by the contaminants at Elmendorf Air Force Base (AFB) Operable Unit (OU) 4. It identifies the areas considered for remedial response, describes the remedial alternatives considered, and analyzes those alternatives compared to the criteria set forth in the National Contingency Plan (NCP). The Decision Summary explains the rationale for selecting the remedy, and how the remedy satisfies the statutory requirements of the Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA).

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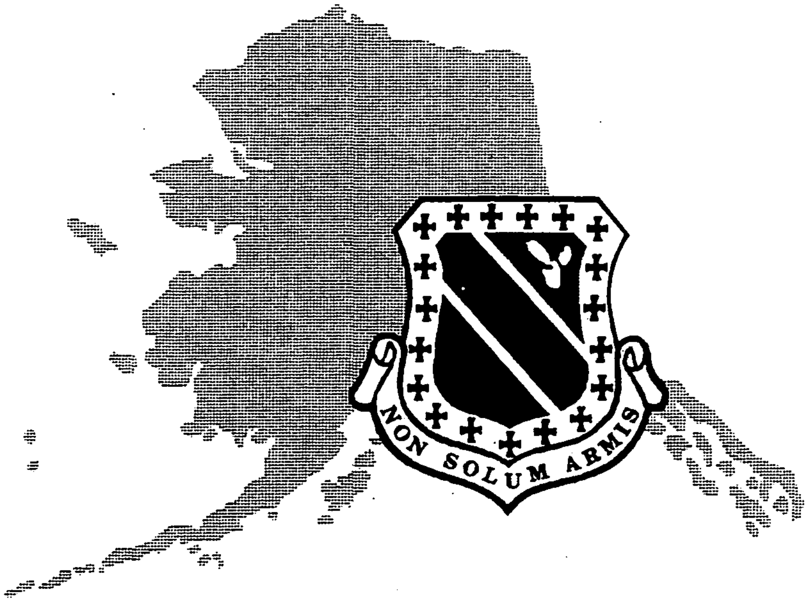

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for Charles Findley
CHUCK CLARKE
Regional Administrator
Region X
U.S. Environmental Protection Agency

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Kurt Fredriksson

KURT FREDRIKSSON
Director, Spill Prevention and Response
Alaska Department of Environmental Conservation

10-10-95
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1.0 SITE DESCRIPTION

The following subsections describe the physical description, land use, and hydrogeology of OU 4, as well as groundwater use.

1.1 Physical Description

Elmendorf AFB is located approximately two miles north of downtown Anchorage (Figure 1-1). The base provides defense for the United States through surveillance, logistics, and communications support. OU 4 is located in the central portion of Elmendorf AFB, and is situated near the main runways (Figure 1-2). OU 4 is made up of two geographic areas, OU 4 West and OU 4 East. The OU was divided into OU 4 West and OU 4 East Study Areas during the Remedial Investigation (RI) based on the proximity of the facilities being investigated to better characterize the nature and extent of contamination and to better evaluate risk.

OU 4 West

OU 4 West is located on relatively flat terrain at an approximate elevation of 195 feet. The terrain slopes generally to the southwest. The boundary of OU 4 West encompasses an area roughly 6000 feet by 2000 feet, approximately 275 acres. This area has been cleared of most vegetation except for some grass. Most of the area within OU 4 is paved or fenced and consists of an active runway and improved grounds and buildings. There are five principal buildings located within OU 4 West: Hangars 8, 10, 11, 12, and 14. The Fire Training Area (FTA) is also located in OU 4 West (Figure 1-2). Each of the five buildings located within OU 4 West and the FTA are former contaminant source areas.

OU 4 East

OU 4 East is also located on relatively flat terrain at an approximate elevation

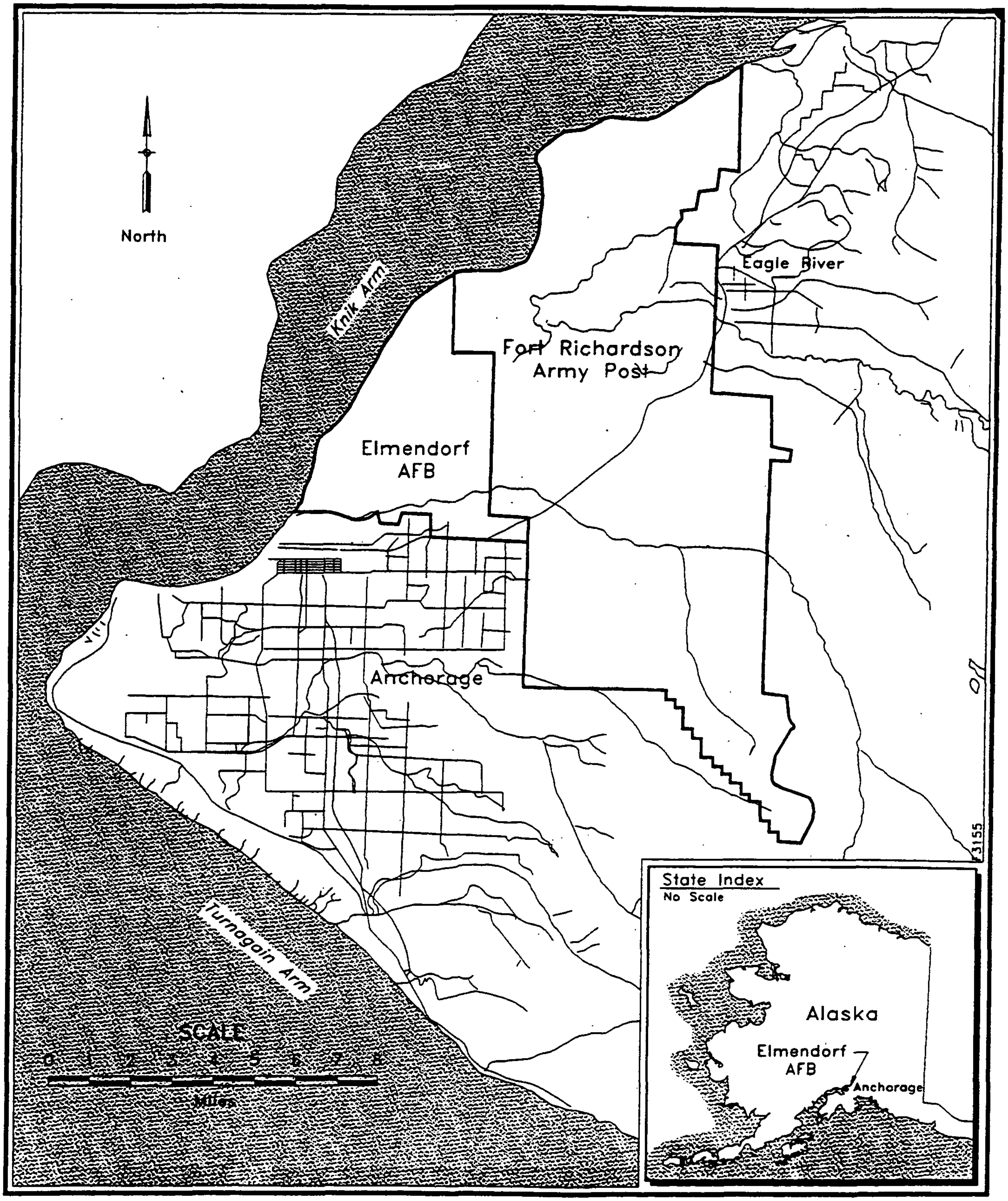

Figure 1-1. Site Location Map, Elmendorf AFB, Anchorage, Alaska

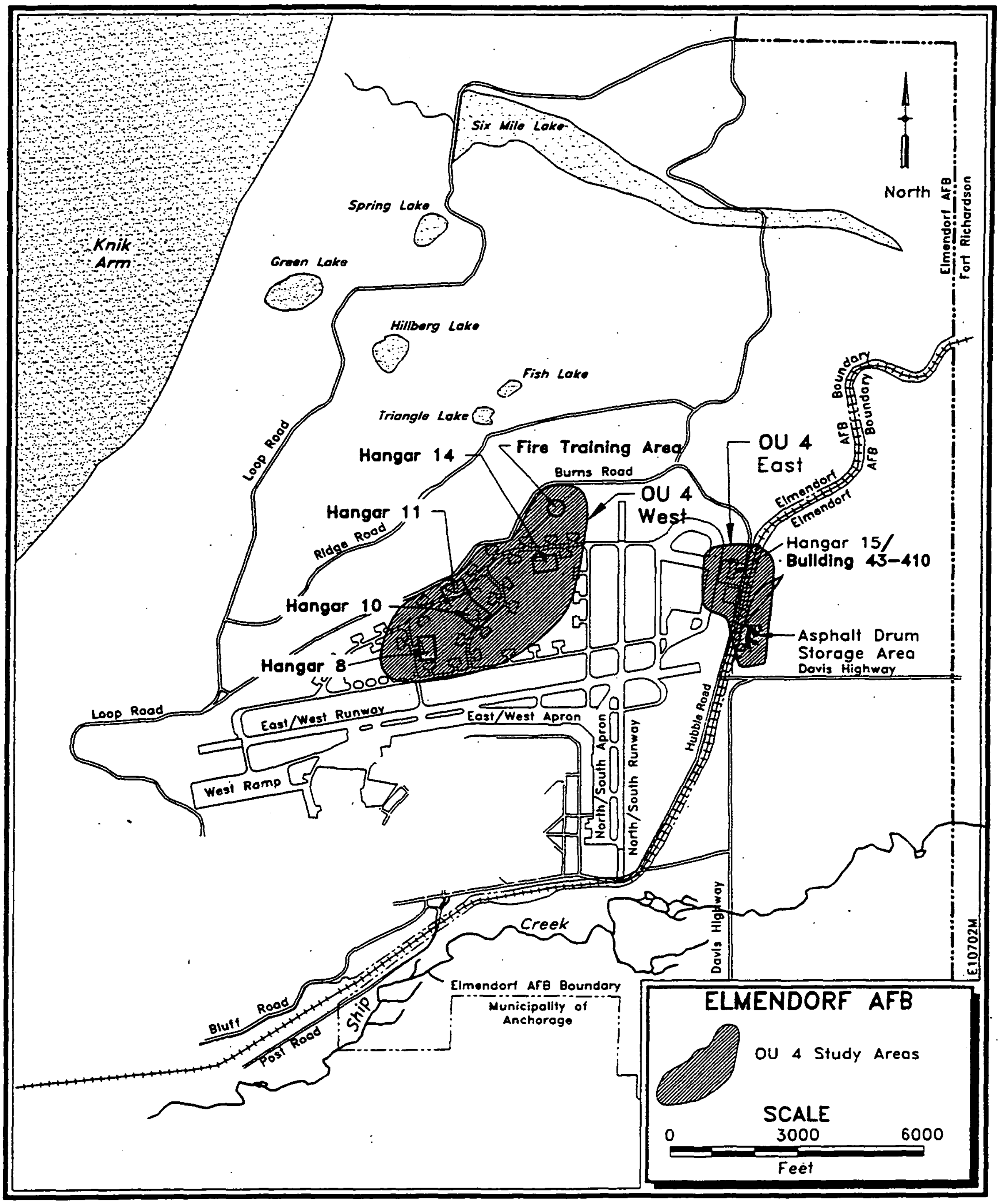

Figure 1-2. Location of Operable Unit 4 West and Operable Unit 4 East Study Areas, Elmendorf AFB, AK

of 195 feet, with the terrain sloping to the southwest. The OU 4 East boundary, as drawn, is approximately 1500 feet by 2500 feet, or about 85 acres. The portion of OU 4 East west of Hubble Road is improved with buildings and/or roads, parking aprons, and taxiways. There are two principal buildings located within this area, Hangar 15 and Building 43-410 (Figure 1-2). The area around the buildings is cleared of vegetation except for grass. The area east of Hubble Road is fairly densely vegetated with only a few roads and an easement and line of the Alaska Railroad. Vegetation consists mostly of alder brush and birch woods. The only exception is in the vicinity of the former Asphalt Drum Storage Area (ADSA), where the area was cleared for the removal of asphalt drums and asphalt stained soil. Both the ADSA and Hangar 15/Building 43-410 are former contaminant source areas.

1.2 Land Use

Land use for both OU 4 West and OU 4 East includes light industrial, aircraft operations and maintenance, and airfield. Light industrial includes maintenance, storage, and supply functions directly related to aircraft. The primary land use within OU 4 is for airfields, which includes active and inactive runways, taxiways, and parking aprons for aircraft. Other land uses include designated outdoor recreation and open areas. The right-of-way for the Alaska Railroad is located within OU 4 East (Figure 1-2). The Base Master Comprehensive Plan has designated this area for airfield, and aircraft operations and maintenance in the future. There are no known historic buildings, archaeologic sites, wetlands, floodplains, or rare or endangered species in OU 4.

1.3 Hydrogeology and Groundwater Use

OU 4 is located in a glacial outwash plain composed predominantly of sand and gravel. There are two aquifers underlying the area, an unconfined shallow aquifer and a deep confined aquifer. The aquifers are separated by the Bootlegger Cove Formation, an impermeable layer composed of silts and clays (Figure 1-3).

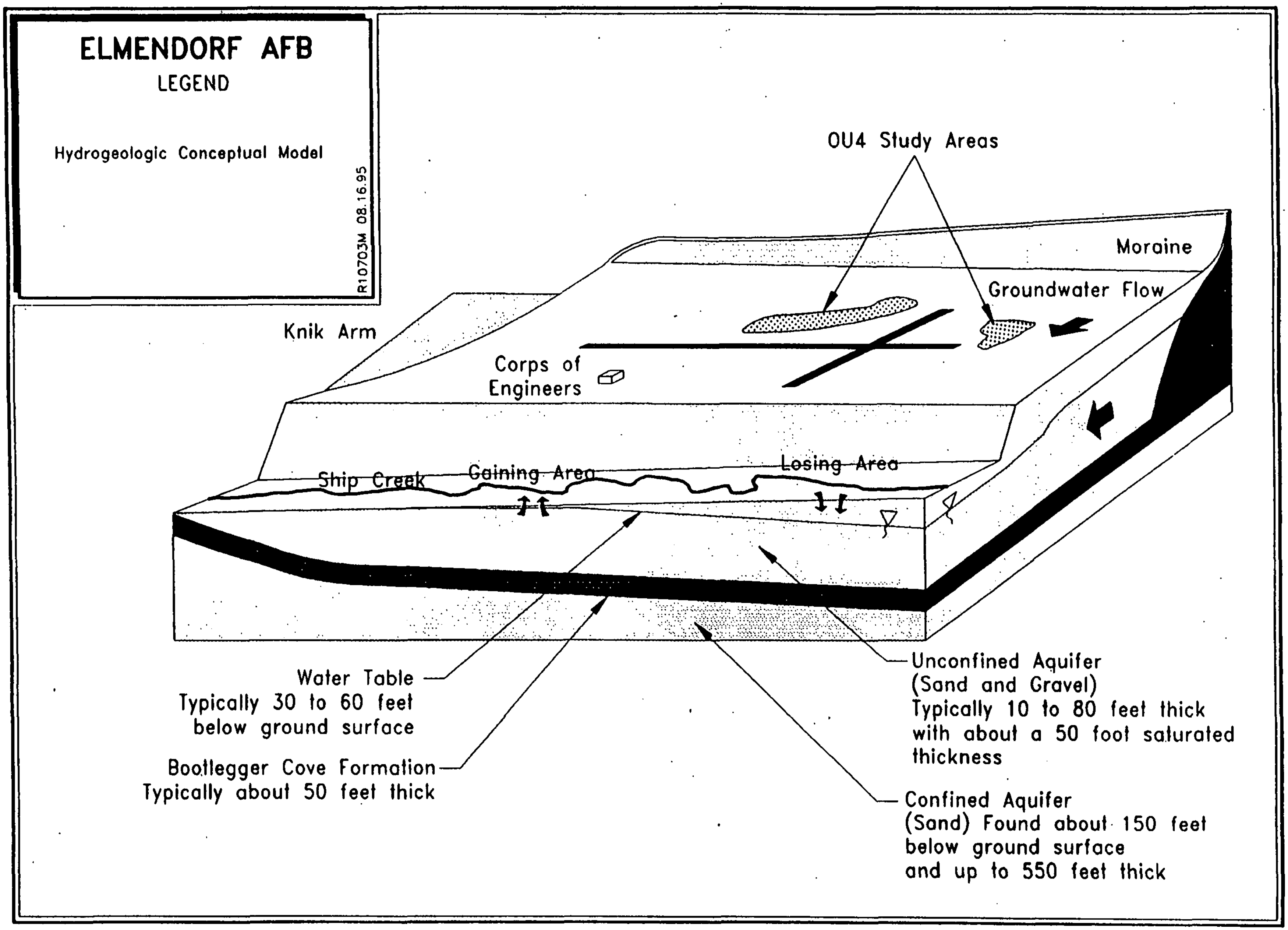

Figure 1-3. Location of Operable Unit 4 West and Operable Unit East Study Areas, Elmendorf AFB, AK

OU 4 West is situated on glacial outwash and alluvial deposits, consisting of sands with varying amounts of gravel and silts. Sand with silt and gravel units comprise the upper 10 to 20 feet of the aquifer and are underlain by gravel and sand units approximately 10 to 50 feet thick. The saturated interval marking the top of the unconfined aquifer varies from approximately 30 feet below surface down to 60 feet below surface. The saturated interval is approximately 50 feet thick. Groundwater flow direction is to the southwest, with a gradient of near 4 feet per mile, increasing to 36 feet per mile towards Ship Creek. The shallow unconfined aquifer is not used for any purpose on base. Its future use, even if the aquifer was uncontaminated, is limited because of the higher yield of the deep, confined aquifer. More detail on impacts in the shallow aquifer is provided in Section 3.0.

The shallow, unconfined aquifer in OU 4 West overlies the Bootlegger Cove Formation. The formation consists of interbedded silts and clay deposits at depths approximately 30 to 125 feet below ground level. The average thickness of the formation in this area is approximately 50 feet. The structural surface of the formation is irregular. Within OU 4 West, the top of the Bootlegger Cove Formation is deepest in the vicinity of the FTA (at approximately 100 feet below ground surface) and near Hangar 14 (at 105 feet below ground surface). Further toward the southwest, the formation becomes shallower. At Hangar 8, this unit is at 39 feet below ground level.

OU 4 East is situated on glacial outwash and alluvial deposits of almost exclusively sandy gravel with minor interbedded cobbles. The shallow unconfined aquifer consists of primarily gravelly sands, and is believed to overlie the Bootlegger Cove Formation as in OU 4 West. The presence of this aquitard has not been verified within OU 4 East, however, the regional geology strongly supports its presence. The top of the Bootlegger Cove Formation is believed to occur at a depth greater than 120 feet below ground surface. Groundwater flow direction in the shallow aquifer is to the west, with a gradient of 6.5 feet per mile increasing toward Ship Creek. As at OU 4 West, the shallow unconfined aquifer at OU 4 East is not used for any purpose on base. More detail on impacts is provided in Section 3.0.

Hydraulic conductivity for the unconfined shallow aquifer in OU 4 ranges from approximately 1.0E-1 cm/sec to 3.0E-1 cm/sec. Transmissivity for the shallow aquifer is estimated to range from approximately 17,000 to 45,000 ft^2/day. This is typical for gravel and coarse sand aquifers. The average linear velocity is estimated to be 3.2 ft/day.

The deep aquifer at OU 4 underlies and is confined by the Bootlegger Cove Formation, and occurs at a depth of approximately 150 feet below ground surface. This aquifer is up to 550 feet thick. While the Bootlegger Cove Formation forms the principal confining unit, the confined aquifer may also be overlain by substantial thicknesses of other fine grained materials. Groundwater flow in the aquifer is to the west-northwest toward Knik Arm.

The deep aquifer supplies large quantities of water for light industrial use such as air conditioning cooling water (no treatment), and washing aircraft and vehicles (chlorination only). There are three active base wells screened in the deep aquifer near OU 4, that were sampled during the remedial investigation. Contamination attributable to OU 4 was not found in these wells. Base Well 29 is located upgradient from OU 4 at Building 42-500. The two remaining wells are located downgradient of OU 4, Base Well 40 near Building 5-800, and Base Well 42 near Building 11-200. These wells also provide water that, after chlorination, is used for drinking water in several buildings.

Results from the hydraulic communication tests conducted at Base Well 42 in an adjacent operable unit (OU 2) are applicable to OU 4. The results indicate there is no communication between the shallow aquifer and the confined aquifer. This result, with concurrent information from sampling of the three base water supply wells screened in the deep aquifer, demonstrate the competency of the Bootlegger Cove Formation as an aquitard between the unconfined and confined aquifers.

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2.0 SITE HISTORY AND ENFORCEMENT ACTIVITIES

The following subsections detail the contaminant history of OU 4, the regulatory and enforcement history, the role of the response action, and the role of the community in defining the response.

2.1 Identification of Activities Leading to Current Contamination at OU 4

As part of the ongoing mission at Elmendorf Air Force Base, aircraft are regularly refueled, and many of the fuel lines and the associated valves and storage tanks are located within OU 4. These fuel systems have, at times, leaked fuel into the soil and groundwater surrounding these facilities. In addition, maintenance of these aircraft regularly occurred at OU 4, and the waste management practices associated with these activities, such as discharge of wastes into floor drains, have also resulted in releases of solvents and fuel-related constituents. Finally, incomplete combustion of fuels at the FTA and waste management activities at the former ADSA have also resulted in discharges of contaminants into the soil and groundwater.

Over 30 underground storage tanks (USTs) are located within OU 4 West. An additional nine are located in OU 4 East. These tanks vary in size, up to a 25,000-gallon capacity. Historical spills at OU 4 West included numerous small fuel spills (less than 1,000 gallons). Specific recovery activities for these spills have not been reported.

In OU 4 East, numerous gasoline and diesel spills have reportedly occurred in the vicinity of the ADSA. In addition, asphalt drums stored at the ADSA leaked substantial quantities of asphalt and fuel residuals onto the ground in that area.

The activities which contributed to past contamination at OU 4 are no longer taking place. As far as fuel related leaks are concerned at OU 4, the valve pit at Hangar 11 was taken out of service. This valve pit served a line to three USTs, which have also been removed. In addition, all base USTs are being upgraded, all lines have been tested (including those in the vicinity of Pumphouse 2), and all leaks have been repaired. Discharge of waste into dry wells through floor drains no longer takes place at OU 4. Fire training activities at the FTA ceased in 1991. Furthermore, a 22,000-gallon UST and the associated excavated soil down to a depth of 12 feet below ground surface have been removed in the immediate vicinity of the FTA. Finally, at the ADSA, all drums and the first few inches of soil (including visible contamination) have been removed and the area has been revegetated.

Environmental investigations have been conducted at OU 4 since the early-1980s. Several studies discovered evidence of contamination in various parts of OU 4. The majority of these investigations were broadly focused across Elmendorf AFB, and covered only portions of the source areas currently included in OU 4.

The first investigation to examine contamination throughout the whole area was done in 1990 by Black and Veatch. The initial study was followed in 1992 by a Limited Field Investigation (LFI) by CH2M Hill. Following the LFI, a full scale Remedial Investigation (RI) was conducted at OU 4 West and OU 4 East in 1993 by Radian Corporation. The RI determined the nature and extent of contamination, and the potential risks to public health and the environment. The results were compiled and analyzed in the RI report. Alternatives for remedial action were evaluated in detail in the OU 4 Feasibility Study (FS), submitted with the RI in September of 1994.

The RI/FS concluded that low levels of soil contamination were primarily the result of vehicular traffic, road paving, and pesticide application. Several specific sources of groundwater contamination were identified, including the training activities at the FTA, a leaking 25,000-gallon UST and some buried drums near the FTA, leaking valve pits and USTs at Hangar 11, leaking valve pits at Hangar 15, and a leaking pumphouse or piping near Hangar 8. Solvent contamination at OU 4 East was attributed to dry wells (wells used to allow waste water, used solvents, etc. to be absorbed by the ground) or an upgradient leach field located by Hangar 15, however, difficult drilling conditions precluded defining the source for the groundwater plume in that area.

2.2 Regulatory and Enforcement History

Based on the results of environmental investigations, Elmendorf AFB was listed on the National Priorities List by the U.S. Environmental Protection Agency (USEPA) in August 1990. This listing designated the facility as a federal site subject to the remedial response requirements of the Comprehensive Environmental Response, Compensation and Liability Act (CERCLA), as amended by the Superfund Amendments and Reauthorization Act of 1986 (SARA). On 22 November 1991, the U.S. Air Force (USAF), the USEPA, and the Alaska Department of Environmental Conservation (ADEC) signed the Federal Facilities Agreement (FFA) for Elmendorf AFB. The contaminated areas of Elmendorf AFB were divided into seven OUs, each to be managed as a separate region and investigated according to varying schedules.

Up until 1992, a total of ten facilities, including a pesticide mixing and storage building, were considered to be part of OU 4. These included source areas SD24, SD25, SD26, SD27, SD28, SD29, SD30, SD31, SS18 and SS63. These facilities were grouped into an Operable Unit because of sharing a common conceptual model for potential contaminant release to the environment, namely, discharge of chemicals to floor drains with potential migration to the environment through dry wells, leach fields, french drains, or other similar structures.

Based on the results of the LFI conducted in 1992, the focus of the investigation at OU 4 shifted away from the individual buildings and floor drains. The conclusions of the LFI were that dry wells and leach fields were not the primary sources of contamination at the OU. Other potential sources of contamination were identified, and recommendations were made as to whether further investigation would be necessary at the individual facilities within the OU. As a result of that study, four of the original facilities, SD26, SD27, SD30 and SS18, were recommended to receive No Further Action (NFA). Based on the LFI results, No Further Action (NFA) Decision Documents were prepared and submitted in April of 1993 for SD26, SD27, SD30, and SS18. These NFA Decision Documents were signed by the USEPA and ADEC on May 7, 1993. In addition, two of the original ten source areas, SS63 and SD31, were moved to other OUs based upon their geographic location. Finally, two other source areas were moved into OU 4. FT23 (the FTA) and SS10 (the ADSA) were added to OU 4 based on their proximity to the other source areas within the OU. A summary of the historical changes in source areas associated with OU 4 is presented in Table 2-1.

Currently there are six facilities located within OU 4 which may be designated as "source areas", including SD24, SD25, SD28, SD29, FT23, and SS10. SD26 and SD27, while recommended for NFA, are still located within the boundary of OU 4. The groundwater and soil contamination associated with these two facilities were considered as part of the overall OU 4 contamination. In keeping with the premise that the contamination associated with OU 4 was not specifically related to individual hangars, the OU was divided into two "study areas", OU 4 West and OU 4 East (Figure 1-2).

In accordance with the FFA, an RI of OU 4 was conducted in the summer of 1993. The RI determined the nature and extent of contamination, and the potential risks to public health and the environment. The results were compiled and analyzed in the RI Report. The RI concluded that fuel, fuel constituents, and low levels of solvents were found in soil and groundwater in OU 4. Low levels of semi-volatile constituents and pesticides were found to be relatively widespread within OU 4 soils. Isolated areas of elevated fuel constituents were detected in the soils at the location of the leaks or spills. In addition, four plumes of dissolved fuel constituents and two plumes of dissolved solvents were identified in the groundwater.

The Final RI/FS was submitted in September, 1994. A Proposed Plan was distributed to the public on 11 April 1995, and a public meeting to discuss the plan was held

Table 2-1

Source Areas at Operable Unit 4
Elmendorf AFB, AK

Source Area	Description	Disposition
SD24	Building 42-400	Remains as part of OU 4
SD25	Building 42-425	Remains as part of OU 4
SD26	Building 43-550	No Further Action*
SD27	Building 42-300	No Further Action*
SD28	Building 43-410	Remains as part of OU 4
SD29	Building 43-450	Remains as part of OU 4
SD30	Building 21-900	No Further Action
SD31	Building 32-060	Moved to OU 3
SD18	Building 22-021	No Further Action
SS63	Building 52-140	Moved to OU 7
FT23	Fire Training Area	Moved to OU 4 from OU 7
SS10	Asphalt Drum Storage Area	Moved to OU 4 from OU 7

* These source areas, while recommended for No Further Action, are still included within the boundary of OU 4.

OPTIONAL FORM 99 (7-90)

on 10 May 1995. The index of documents entered into the Administrative Record for OU 4 is provided as Appendix A.

2.3 Role of Response Action

The CERCLA process described above is intended to identify solutions to contamination issues where they exist. The remedial action described in this Record of Decision (ROD) addresses threats to human health and the environment posed by contamination at OU 4. The RI/FS Report defines these threats as both groundwater and soil contaminants. At this time, soil will be actively treated where the contaminants within the soil pose a potential future threat to groundwater. Intrinsic remediation will be used for all groundwater contamination, and for soil contamination where contaminants do not pose a threat to the groundwater. Groundwater and soil will both be monitored to evaluate the progress of intrinsic remediation processes. Further response actions, coordinated with the regulatory agencies, may be considered if monitoring finds unacceptable contaminant migration occurring, or unacceptable reduction in contaminant concentrations through intrinsic remediation.

2.4 Community Participation

Public participation has been an important component of the CERCLA process at Elmendorf AFB. Activities aimed at informing and soliciting public input regarding base environmental programs include:

- **Environmental Update:** Environmental Update is a newsletter distributed to the community and interested parties. It discusses the progress that has been made on OUs and advises the public about opportunities to provide input concerning decisions to address contaminated areas of the base. Aspects of the OU 4 CERCLA progress have been published in this newsletter.

- **Community Relations Plan:** The base environmental personnel maintain and regularly update a Community Relations Plan. It describes how the base will inform the public of base environmental issues and it solicits public comment on base environmental programs.

- **The Restoration Advisory Board/Technical Review Committee:** Base personnel meet regularly with representatives of the community to discuss base environmental programs and solicit their comments.

- **Public Workshops:** On 5 February 1992, approximately 75 people attended a public workshop where base personnel discussed base environmental programs and encouraged public participation.

- **Videotape:** Base personnel made a videotape describing base environmental activities. The tape is shown to base employees as well as the general public.

- **Speakers Bureau:** The 3rd Wing Public Affairs Office maintains a speakers bureau capable of providing speakers versed in a variety of environmental subjects to military and civic groups.

- **Newspaper Releases:** News releases are published on significant events during the IRP. News releases are made announcing all public meetings that are held to discuss proposed remedial actions.

- **Information Repositories:** Public access to technical documents is provided through information repositories located at the Bureau of Land Management's Alaska Resources Library and the University of Alaska at Anchorage's Consortium Library. The information in the repositories is also maintained in the administrative record. The remedial action was selected based on the information held in the administrative record.

- **Display Board:** During public functions, a display board, showing key elements and progress of the Elmendorf IRP, is used to communicate technical issues to the public. It is used during both on-base and off-base events.

- **Proposed Plan:** The OU 4 Proposed Plan was distributed to the public on 11 April 1995, a public meeting was held 10 May 1995, and the public review period was from 11 April to 12 May 1995. Comments from the public are contained in Part III. Responsiveness Summary of this document.

- **Public Notice:** Public notices have been issued prior to all significant decision points in the IRP. For OU 4, public notice was issued for the Proposed Plan in the *Anchorage Daily News* (4/9/95) and the *Sourdough Sentinel* (4/6/95).

- **Mailing List:** A mailing list of parties interested in the restoration program is maintained by the base. Notices and publications (news releases including the OU 4 Proposed Plan meeting) are released via the mailing list.

- **Responsiveness Summary:** Public comments were received on the OU 4 Proposed Plan. The USAF maintains a record of all comments and has published responses to the comments in this Record of Decision.

All decisions made for OU 4 were based on information contained in the Administrative Record. An index to the documents contained in the Administrative Record for OU 4 is provided as Appendix A.

3.0 SITE CONTAMINATION, RISKS, AND AREAS REQUIRING RESPONSE ACTIONS

This section identifies the areas which were investigated, and those that require remedial action. These areas were chosen based on the risk that contaminants pose to human health and the environment. The basis of this analysis is the data collected during the Remedial Investigation (RI) which identified the nature and extent of contamination in OU 4.

3.1 Nature and Extent of Contamination

The contamination present at OU 4 is associated with contaminant transport in the vadose zone, dissolved aqueous transport, and volatilization. These processes are briefly discussed below.

Vadose Contaminant Transport: Before releases could be detected or remediated, fuel constituents such as benzene, or solvents such as trichloroethene (TCE) migrated from the source to the water table through the vadose zone. A schematic of the principal transport mechanisms, including vadose zone migration is shown on Figure 3-1. Understanding transport is important because the contaminants and risks are not always associated with the source area, but with the area where an exposure is possible. The risk assessment considered the current and future transport of contaminants to potential receptors.

Dissolved aqueous transport: Once contaminants have reached the water table, the principal transport mechanism of solvents and fuels contamination is by aqueous solution in groundwater. Contaminants can dissolve into solution when water passes over contaminated soil. Likewise, as contaminated water migrates, it can deposit contaminants on the soil through which it passes.

Volatilization: Contaminants, such as halogenated volatile organic compounds (HVOCs) and lighter fuel constituents, can become gases, either volatilizing into the soil or

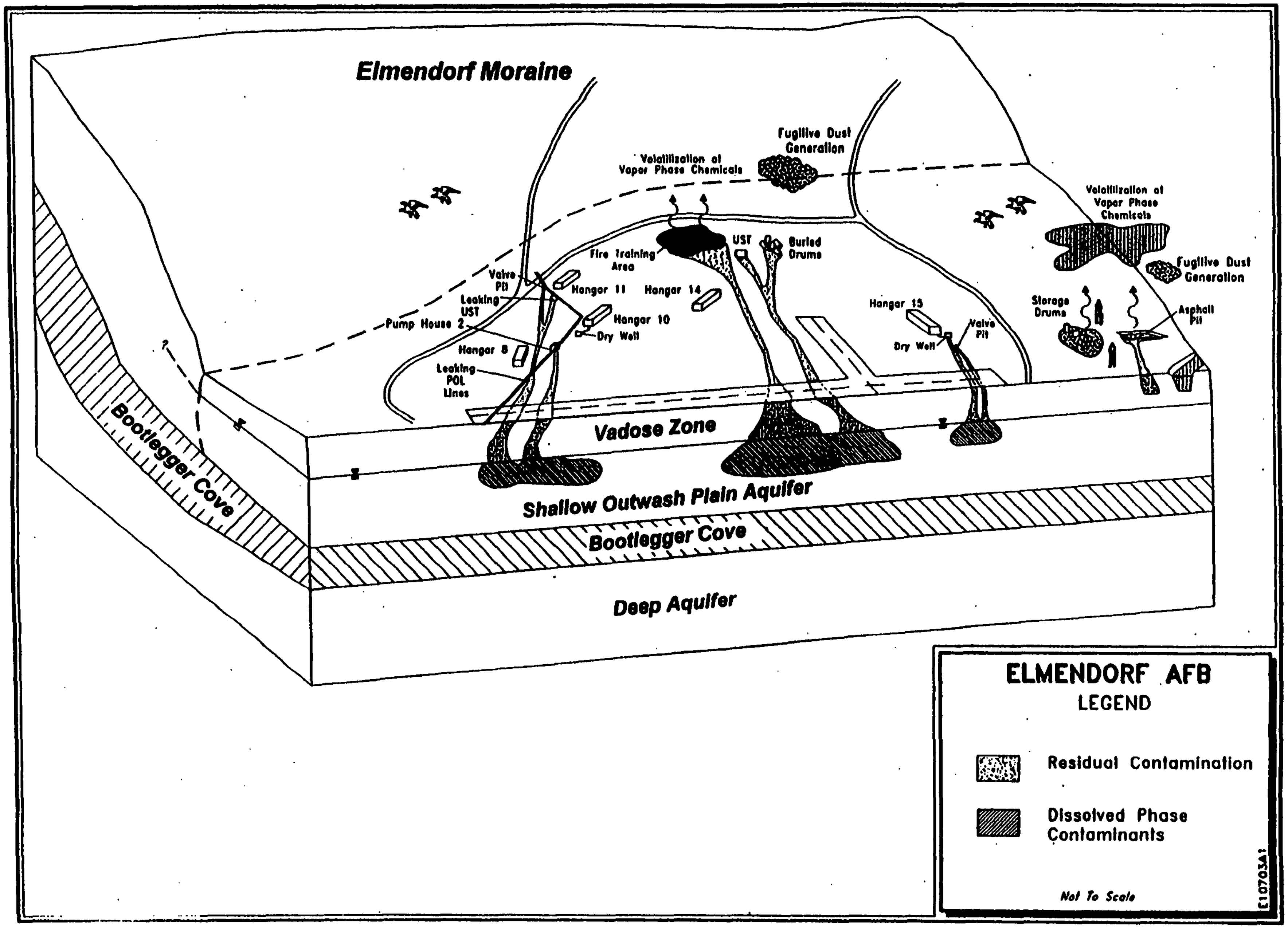

Figure 3-1. A Schematic of Principal Transport Mechanisms in Operable Unit 4, Elmendorf AFB, AK

directly to the atmosphere. Concentrations of volatile organic compounds in soil gas in some locations such as at the FTA and Hangar 11, were detected at elevated concentrations (>100 ppmv) indicating that volatilization of these constituents is occurring.

During the RI, samples of soil and groundwater were collected and analyzed for organic and inorganic constituents. Significant levels of organic contaminants were detected in the soil and groundwater. These contaminants include fuel products such as benzene, halogenated volatile organic compounds such as TCE, and semi-volatile organic compounds (SVOCs) such as naphthalene. Other contaminants include inorganic compounds such as selenium and pesticides such as alpha-BHC.

To evaluate the nature and extent of contamination and assess risk at OU 4, the OU was divided into two study areas, OU 4 East and West, and further divided into several smaller areas: the FTA, Hangar 11, Hangar 14, Hangar 8, Hangar 10, Hangar 15/Building 43-410, and the ADSA. Tables referenced below list the frequency of occurrence, and maximum concentrations of all constituents which were statistically established as contaminants of potential concern (COPC) during the RI in soil and groundwater.

A detailed discussion of the determination of COPC is included in the OU 4 RI/FS Report (USAF, 1994). In summary, COPC were determined by statistically comparing site analytical results with background/upgradient results available for the same constituents. Chemicals retained as COPC are those which were measured on-site at concentrations significantly elevated above background/upgradient concentrations of the same chemicals. Once COPC were statistically established, the list was further refined by removing affected analytes associated with analytical methods that were determined to be non-representative of site conditions, and analytes which had results that were all below instrument-specific detection limits and were not second-column confirmed. The refined list of COPC was then subjected to a risk-based screening procedure during which maximum analyte concentrations were compared with risk-based concentrations associated with: a) a systemic hazard quotient of 0.1; b) a lifetime incremental cancer risk of 10^{-6} for water; and

c) a lifetime incremental cancer risk of 10^{-7} for soil. This risk-based screen helped to produce a list of COPC which were most likely to contribute significantly to the risks associated with OU 4. Mixtures of chemical compounds cannot be assessed in a risk evaluation, so gasoline, diesel, and kerosene did not undergo the rigorous statistical evaluations made on the individual compounds.

The OU 4 data summary tables are provided by area. The tables do not include results below the detection limit. The Maximum Contaminant Levels (MCLs) for groundwater, and the Alaska Cleanup Matrix (ACM) guidelines for soil, are also listed on the tables for all COPC. Figures depicting the locations of all soil and groundwater contaminant occurrences in excess of potential cleanup levels are included where applicable.

3.1.1 Groundwater

Groundwater contamination is discussed based upon contaminant "plumes" delineated during the RI. A total of six groundwater contaminant plumes were identified at OU 4. All plumes are approximated, and are depicted based upon contaminant concentrations greater than 5 μg/L, which coincides with the MCL for commonly occurring constituents such as benzene and trichloroethene. The six groundwater plumes are shown on Figure 3-2.

OU 4 West

Five groundwater plume areas were identified in the OU 4 West study area; one each at Hangar 14, Hangar 11, and at the Hangar 8/10 area, and two plumes at the FTA. Contaminants of concern for groundwater in OU 4 West include fuels, non-halogenated organic compounds (NHVOCs), HVOCs, and pesticides. Metals were also detected in the groundwater at OU 4 West. However, a comparison to background metals concentrations was conducted. Background metals concentrations in groundwater were collected by the USGS in the Anchorage Bowl area and compiled in the *Elmendorf Air*

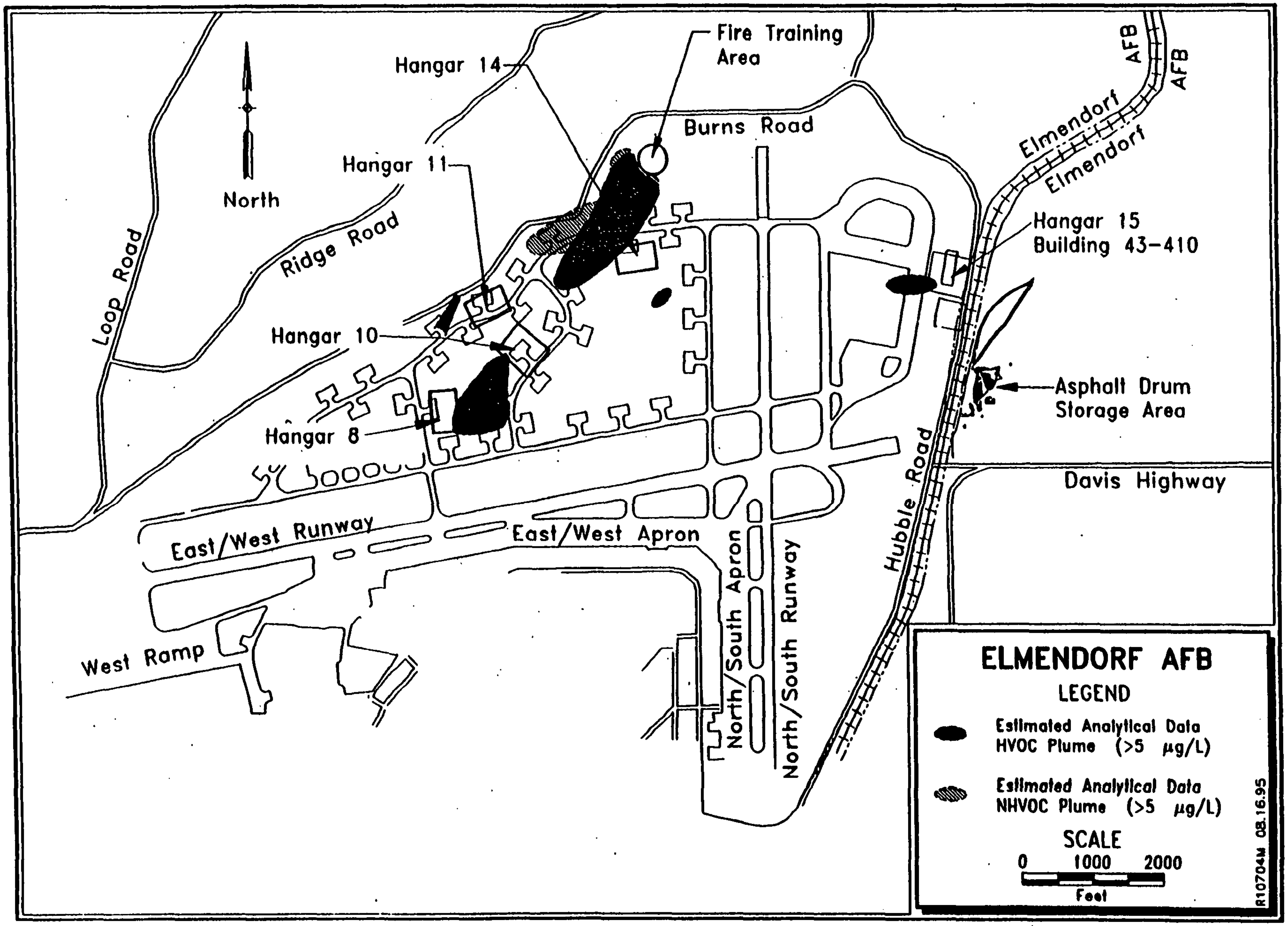

Figure 3-2. Location of OU 4 Groundwater Contaminant Plumes, Elmendorf AFB, AK

Force Base, Alaska, Basewide Background Sampling Report (USAF, 1993). These metals data have been used historically at Elmendorf AFB for comparison with on-site groundwater metals concentrations. Confidence intervals of the USGS data mean for a given metal were compared with confidence intervals for the OU 4 analytical results for the same analyte. If the confidence intervals of the two means overlapped, the two means were considered not to be different and the particular metal was removed from consideration as a COPC. Based on this evaluation, all metals in groundwater at OU 4 West were determined to be at background concentrations. The USGS upper confidence limit concentrations used for the comparisons are the following for the metals in question:

- Antimony: 0.004 μ/L
- Arsenic: 0.042 μg/L
- Iron: 129.83 μg/L
- Manganese: 12.917 μg/L

Two plumes were identified at the FTA, including an HVOC plume and an NHVOC plume. The main contaminant in the HVOC plume is trichloroethene, while benzene and ethylbenzene are of primary interest in the NHVOC plume. Groundwater analytical data for all FTA COPC are summarized in Table 3-1. The two plumes, which are drawn based upon constituents which exceeded groundwater cleanup levels, are depicted in Figure 3-3. The HVOC plume was detected emanating from the southern portion of the FTA, extending roughly parallel to the direction of groundwater flow. The configuration of the plume as drawn is approximately 750 feet by 2000 feet. The NHVOC plume roughly parallels the HVOC plume (Figure 3-3), and has approximate dimensions of 800 feet by 35 feet.

At the FTA, seven compounds exceeded the MCLs. Contaminants that exceeded MCLs and their maximum detected concentrations include: 1,1,1-trichloroethane (TCA), 242 μg/L; 1,1-dichloroethene (1,1-DCE), 13.7 μg/L; 1,2-dichloroethane (1,2-DCA), 12.1 μg/L; tetrachloroethene (PCE), 77.8 μg/L; trichloroethene (TCE), 74.7 μg/L; 1,2-dichloroethene (1,2-DCE), 741 μg/L; and benzene, 398 μg/L. Probable sources for

Table 3-1

Fire Training Area Organic* Groundwater Results for Contaminants of Potential Concern
Elmendorf AFB, AK

Method	Analyte	MCL	Maximum Detected Concentration	Frequency of Detection (total hits/total samples)	Location of Maximum Concentration
Indicator Parameters					
SW8015MP (µg/L)	Unknown compounds within Gasoline range	--	23900 I	9/9	FP56
SW8015ME (µg/L)	Unknown compounds within Diesel range	--	224 I	8/8	FP52
	Unknown compounds within Jet Fuel range	--	5610 I	15/15	FP52
Contaminant Parameters					
SW8010 (µg/L)	1,1,1-Trichloroethane	200	242	20/24	FP56
	1,1,2-Trichloroethane	5	1.17 T	3/24	FP56
	1,1-Dichloroethane	--	84.1	18/24	FP56
	1,1-Dichloroethene	7	13.7 T	4/24	OU4W-11
	1,2-Dichlorobenzene	600	2.62 T	3/24	OU4W-11
	1,2-Dichloroethane	5	12.4 T	11/24	FP56
	1,3-Dichlorobenzene	600	0.557 T	2/24	FP52
	1,4-Dichlorobenzene	75	1.96 T	2/24	OU4W-11
	Chloroethane	--	1.9	1/24	OU4W-6
	Chloroform	100	1.29 HT	4/24	GW-5A
	Chloromethane	--	2.32 T	4/24	FP56
	Tetrachloroethene	5	77.8	17/24	OU4W-11
	Trichloroethene	5	74.7	20/24	FP56
	Trichlorofluoromethane	--	0.379 T	2/24	OU4W-11
	Vinyl Chloride	2	0.125 TH	1/24	OU4W-11
	cis-1,2-Dichloroethene	70	741	16/24	OU4W-11
	cis-1,3-Dichloropropene	--	0.0969	1/24	OU4W-9
	trans-1,2-Dichloroethene	100	0.668 T	2/24	OU4W-11
SW8015ME (µg/L)	Diesel	--	2920	2/24	FP56
SW8015MP (µg/L)	Benzene	5	398	24/26	FP56
	Ethylbenzene	700	448	26/26	FP52
	Toluene	1,000	327	25/26	OU4W-11
	Xylene (total)	10,000	1380	26/26	OU4W-11
SW8080 (µg/L)	delta-BHC	--	0.0276 PH	2/6	FP52
SW8240 (µg/L)	1,1,1-Trichloroethane	200	156	6/6	FP56

Table 3-1

(Continued)

Method	Analyte	MCL	Maximum Detected Concentration	Frequency of Detection (total hits/total samples)	Location of Maximum Concentration
SW8240 (µg/L)	1,1-Dichloroethane	--	70.7	6/6	FP56
	1,1-Dichloroethene	7	8.06	2/6	FP56
	1,2-Dichloroethane	5	12.1	4/6	FP56
	Acetone	--	112 H	2/6	FP52
	Benzene	5	325	6/6	FP56
	Ethylbenzene	700	351	6/6	FP52
	Meta-&Para-Xylene	10,000+	888	6/6	FP52
	Methyl ethyl ketone	--	27.7 H	1/6	FP52
	Ortho-Xylene	10,000+	146	6/6	FP52
	Tetrachloroethene	5	13.6	5/6	FP52
	Toluene	1,000	261	6/6	FP56
	Trichloroethene	5	63	6/6	FP56
	cis-1,2-Dichloroethene	70	39.7	3/6	FP56
SW8270 (µg/L)	1,2-Dichlorobenzene	600	1.36	3/24	OU4W-11
	1,3-Dichlorobenzene	600	0.391	1/24	FP52
	1,4-Dichlorobenzene	75	0.875	2/24	OU4W-11
	2-Methylnaphthalene	--	48.2	12/24	FP52
	2-Methylphenol (o-cresol)	--	2.13	6/24	FP52
	4-Methylphenol (p-cresol)	--	40.6 F	9/24	FP52
	Acenaphthene	--	0.362	1/24	FP52
	Benzoic acid	--	7.98 L	1/24	FP52
	Fluorene	--	0.386	2/24	FP52
	Napthalene	--	58.3	15/24	FP52
	Phenol	--	5.12 L	6/24	FP52

F = Elution with a similar analyte is suspected.
H = Result given is suspected to be biased as much as 50% high.
I = Unknown compounds (that are likely the result of decomposition of fuel or arochlor products, or naturally occurring organic matter), quantified as the listed components.
L = Result may be biased up to 50% low based on QA/QC indicators.
P = Presence of analyte is confirmed; however, concentration was not confirmed, concentration listed is a conservative estimate.
T = No confirmational analysis was performed.
Underline indicates preferred result when multiple analytical methods were performed for a single constituent.
* No inorganic COPCs identified for groundwater at this location.
MCL = Maximum Contaminant Level.
This value is the MCL listed for "Xylenes."

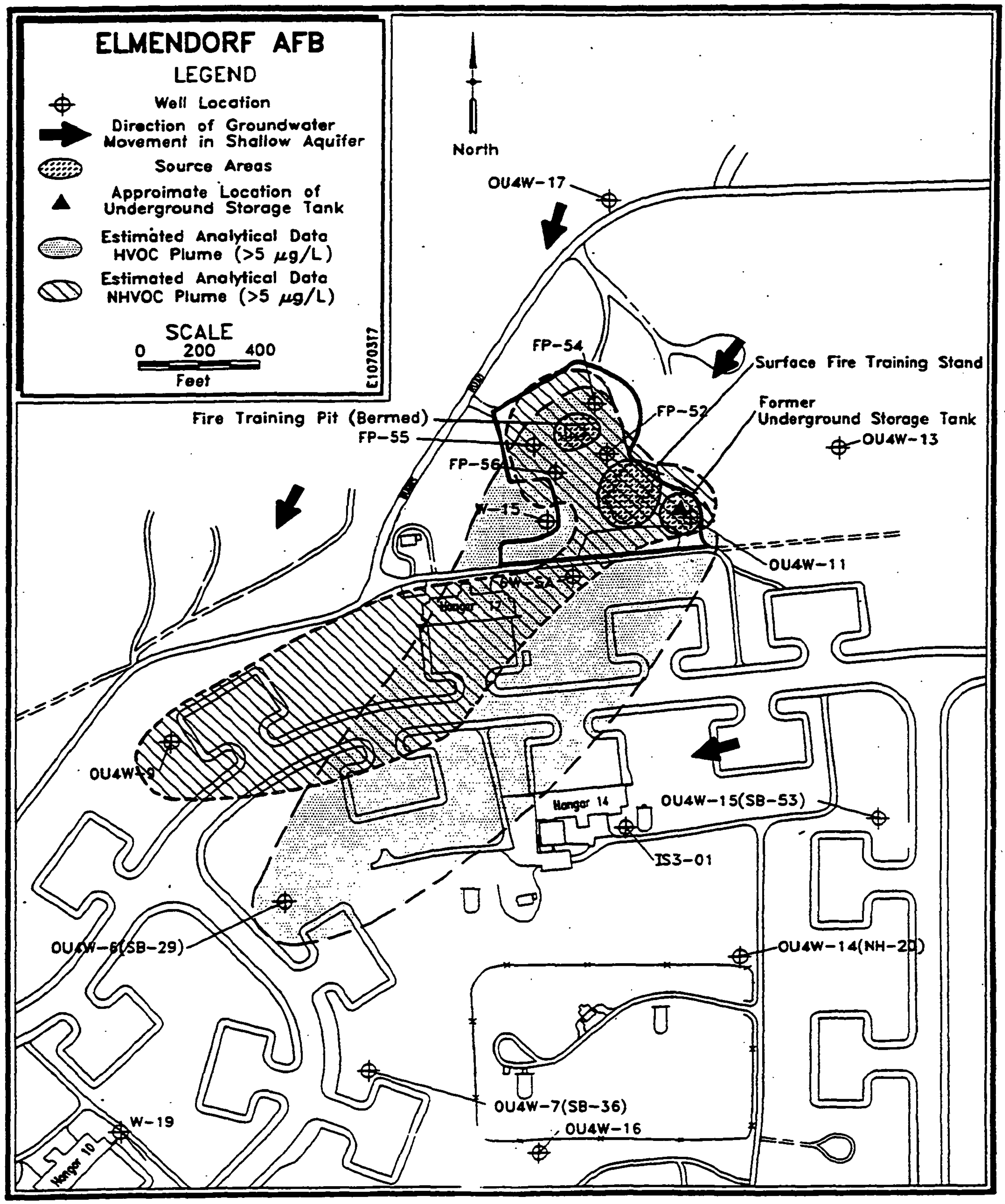

Figure 3-3. Fire Training Area Groundwater Contaminant Plume, Elmendorf AFB, AK

groundwater contamination at FTA include the fire training pit, the surface fire training stand, and a former 22,000-gallon underground storage tank that has been removed.

In the Hangar 14 vicinity, one groundwater plume, approximately 300 feet by 150 feet, composed of benzene was detected. No other fuel-related constituents were identified in this plume (Table 3-2). The plume is located approximately 500 feet southwest of the Hangar (Figure 3-4). Benzene (207 μg/L) was the only constituent exceeding MCLs in this plume. No specific source for the groundwater contamination was identified at Hangar 14.

At Hangar 11, an NHVOC groundwater plume was identified based upon groundwater analytical data (Table 3-3). The plume is located immediately south of Burns Road, and as drawn, is approximately 200 feet wide (Figure 3-5). While the downgradient edge of contamination in this plume was not defined during the RI, several uncontaminated wells are located approximately 1000 feet downgradient of the plume. Three constituents were detected in levels above MCLs, including benzene (2,600 μg/L), ethylbenzene (1,360 μg/L), and toluene (5,590 μg/L). Two sources of contamination were identified: the valve pit located west of Hangar 11, and underground storage tanks located southwest of the Hangar. The valve pit has been taken out of service and the three USTs formerly served by lines connected to this valve pit have been removed.

The Hangar 8/10 area groundwater plume is composed of fuel-related compounds. The plume extends from Hangar 10 to several hundred feet southeast of Hangar 8. The plume roughly parallels groundwater flow, and as depicted, has dimensions of approximately 1200 feet by 700 feet (Figure 3-6). Benzene (266 μg/L) was the only compound detected that exceeded MCLs at this location (Table 3-4). The probable source of this plume is Pumphouse 2 and/or the associated piping in the vicinity of the pumphouse. All lines associated with fuel facilities in the vicinity of Pumphouse 2 have been tested and all leaks have been repaired. In addition, all base USTs are being upgraded to meet current standards.

Table 3-2

Hangar 14 Benzene Plume Area Organic and Inorganic Groundwater Results for Contaminants of Potential Concern, Elmendorf AFB, AK

Method	Analyte	MCL	Maximum Detected Concentration	Frequency of Detection (total hits/total samples)	Location of Maximum Concentration
Indicator Parameters					
SW8015ME (µg/L)	Unknown compounds within Diesel range	--	330 I	7/11	IS3-1
Contaminant Parameters					
SW8010 (µg/L)	Carbon tetrachloride	5	1.26	2/11	OU4W-15
	Chloroform	100	2.61	3/11	OU4W-15
	Chloromethane	--	6.51	3/11	OU4W-7
	Trichloroethene	5	4.73	2/11	OU4W-16
	cis-1,3-Dichloropropene	--	0.0478 H	1/1	OU4W-16
SW8015ME (µg/L)	Diesel	--	330	1/11	IS3-1
SW8015MP (µg/L)	Benzene	5	207	9/14	OU4W-14
	Ethylbenzene	700	1.3	11/14	IS3-1
	Toluene	1,000	1.66	13/14	OU4W-7
	Xylene (total)	10,000	2.63	14/14	IS3-1
SW8080 (µg/L)	4,4'-DDE	--	0.0243	1/7	OU4W-15
	Dieldrin	--	0.0335	1/7	OU4W-15
	Endrin	2	0.0525 P	1/7	OU4W-15
	Heptachlor epoxide	0.2	0.0086 PH	1/7	OU4W-15
	delta-BHC	--	0.0202 H	4/7	IS3-1
SW8240 (µg/L)	Benzene	5	155	2/7	OU4W-14
	Ethylbenzene	700	0.832	1/7	IS3-1
Indicator Parameters					
E353.1 (mg/L)	Nitrate-Nitrite as N	10	48	11/11	OU4W-15

H = Result given is suspected to be biased as much as 50% high.
I = Unknown compounds (that are likely the result of decomposition of fuel or arochlor products, or naturally occurring organic matter), quantified as the listed components.
P = Presence of analyte is confirmed; however, concentration was not confirmed, concentration listed is a conservative estimate.
Underline indicates preferred result when multiple analytical methods were performed for a single constituent.
MCL = Maximum Contaminant Level.

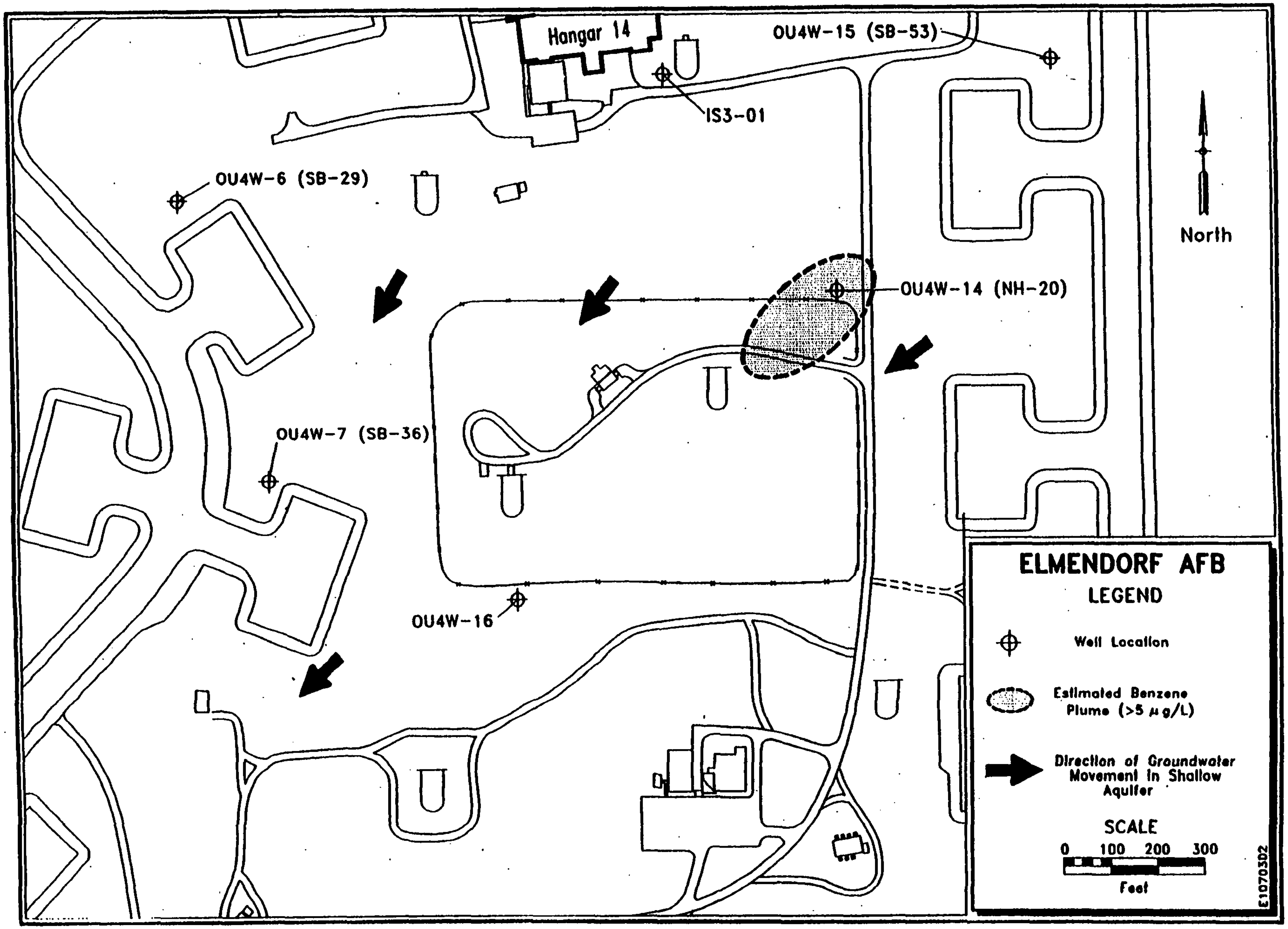

Figure 3-4. Hangar 14 Area Groundwater Contaminant Plume, Elmendorf AF[illegible] AK

Table 3-3

Hangar 11 Plume Area Organic* Groundwater Results for Contaminants of Potential Concern Elmendorf AFB, AK

Method	Analyte	MCL	Maximum Detected Concentration	Frequency of Detection (total hits/total samples)	Location of Maximum Concentration
Indicator Parameters					
SW8015ME (µ/L)	Unknown compounds within Jet Fuel range	--	10800 I	2/2	OU4W-8
SW8015MP (µg/L)	Unknown compounds within Gasoline range	--	49200 I	2/2	OU4W-8
Contaminant Parameters					
SW8010 (µg/L)	1,2-Dichloroethane	5	2.32 H	1/5	OU4W-8
	2-Chloroethyl vinyl ether	--	4.28	1/5	OU4W-8
	Chloromethane	--	8.94	2/5	OU4W-8
	Trichloroethene	5	0.155	1/5	OU4W-8
SW8015MP (µg/L)	Benzene	5	2600	3/5	OU4W-8
	Ethylbenzene	700	1360	4/5	OU4W-8
	Toluene	1,000	5590	5/5	OU4W-8
	Xylene (total)	10,000	3810	5/5	OU4W-8
SW8270 (µg/L)	2-Methylnapthalene	--	24.5	2/5	OU4W-8
	2-Methylphenol(o-cresol)	--	5.13	1/5	OU4W-8
	Naphthalene	--	72.6	2/5	OU4W-8
	Phenol	--	2.8 L	1/5	OU4W-8

H - result given is suspected to be biased as much as 50% high.
I - unknown compounds (that are likely the result of decomposition of fuel or arochlor products, or naturally occurring organic matter), quantified as the listed components.
L - result may be biased up to 50% low based on QA/QC indicators.
MCL - Maximum Contaminant Level.
* - No Inorganic COPCs identified for groundwater at this location.

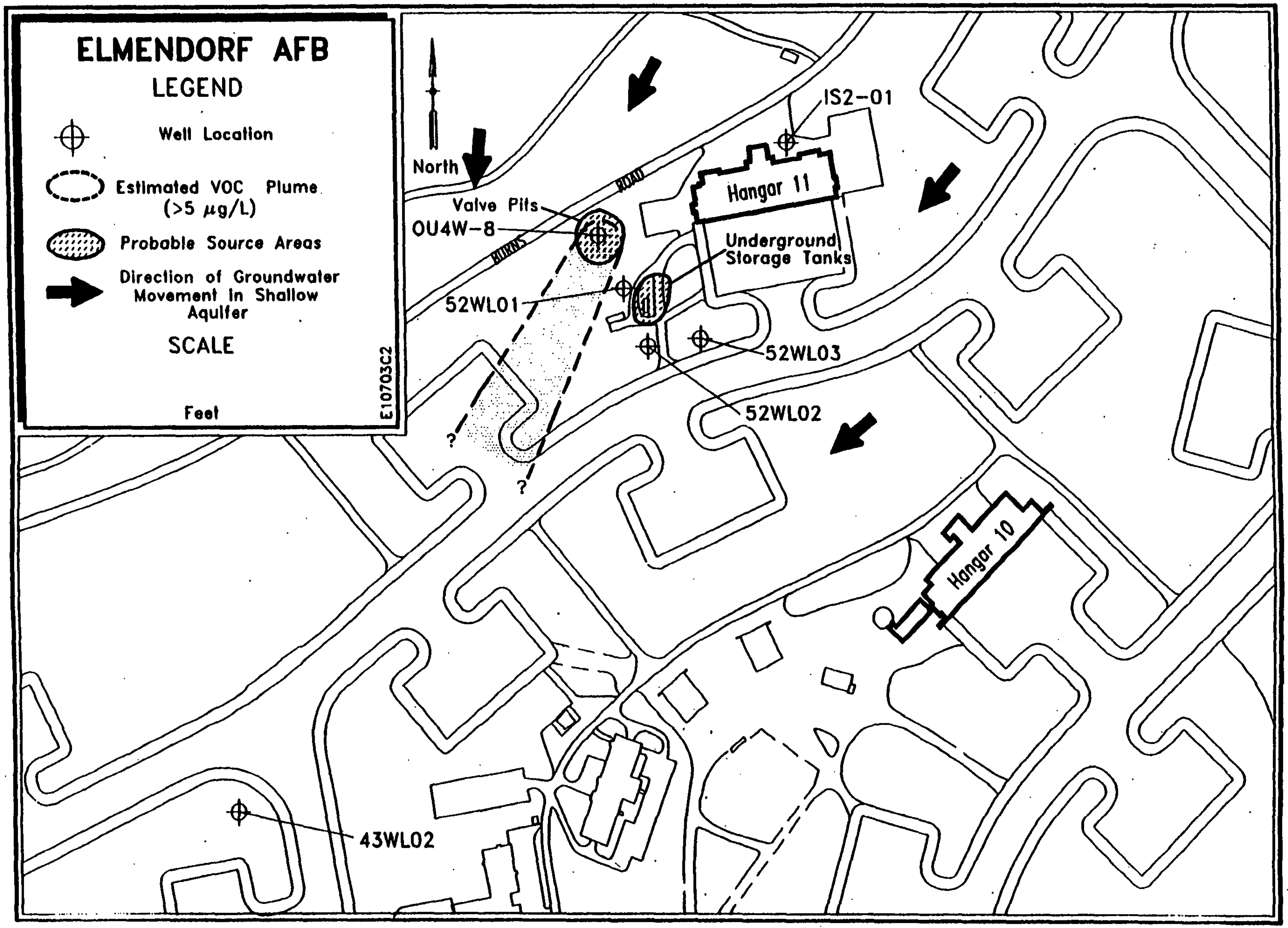

Figure 3-5. Hangar 11 Area Groundwater Contaminant Plume, Elmendorf [illegible] B, AK

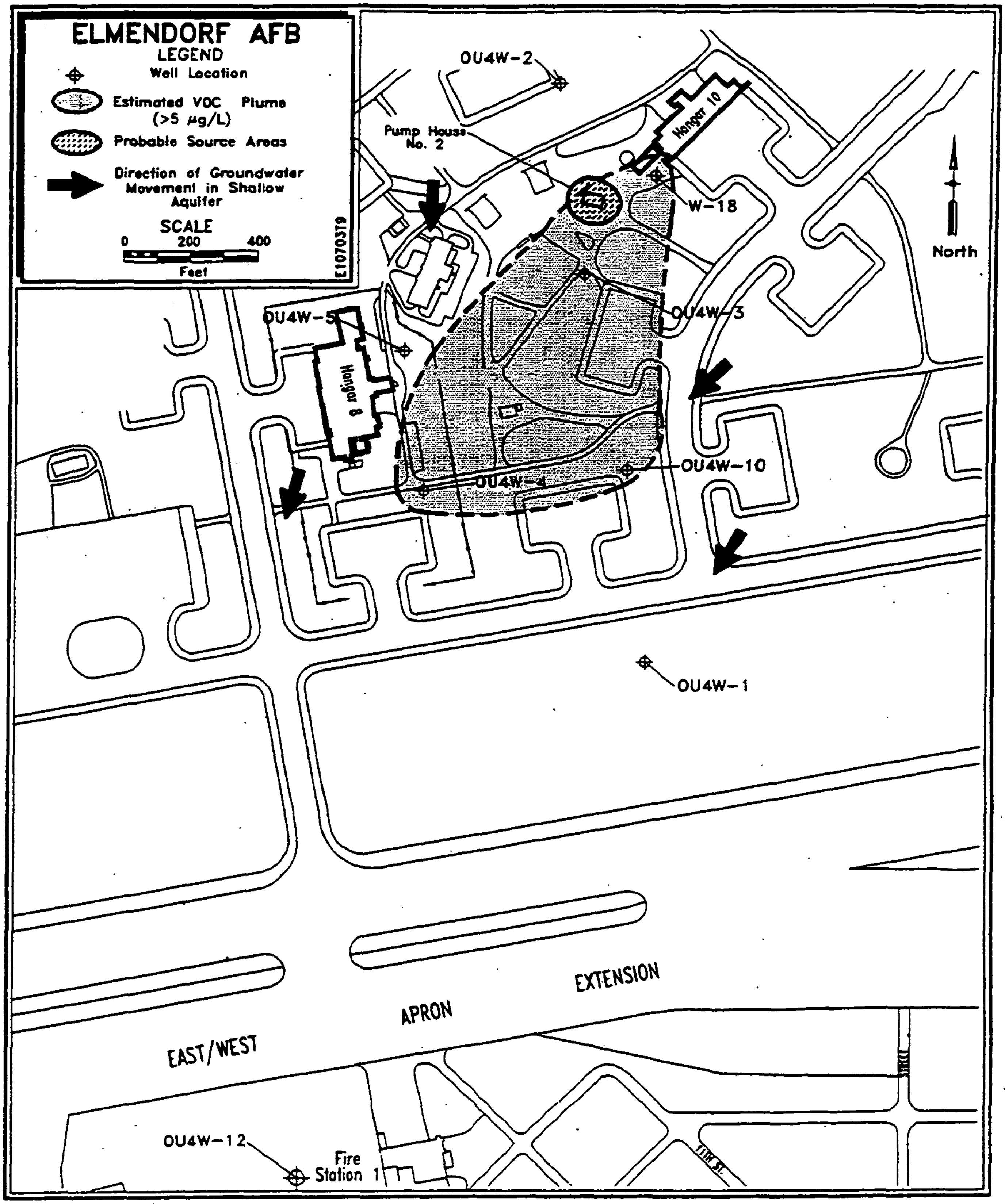

Figure 3-6. Hangar 8/10 Area Groundwater Contaminant Plume, Elmendorf AFB, AK

Table 3-4

Hangar 8/10 Plume Area Organic* Groundwater Results for Contaminants of Potential Concern
Elmendorf AFB, AK

Method	Analyte	MCL	Maximum Detected Concentration	Frequency of Detection (total hits/total samples)	Location of Maximum Concentration
Indicator Parameters					
SW8015ME (µg/L)	Unknown compounds within Jet Fuel range	--	1200 I	7/7	OU4W-4
	Unknown compounds within Kerosene range	--	2560 I	1/1	W-18
SW8015MP (µg/L)	Unknown compounds within Gasoline range	--	4970 I	9/9	OU4W-10
Contaminant Parameters					
SW8010 (µg/L)	1,1,1-Trichloroethane	200	3.7	11/23	OU4W-5
	1,1-Dichloroethane	--	5.81	17/23	W-19
	1,4-Dichlorobenzene	75	0.0866	1/23	OU4W-12
	Chloromethane	--	7.5	6/23	SP-7/10-2
	Trichloroethene	5	0.181	1/23	OU4W-3
SW8015MP (µg/L)	Benzene	5	266	13/24	OU4W-4
	Ethylbenzene	700	150	21/24	OU4W-4
	Toluene	1,000	21.8	19/24	OU4W-10
	Xylene (total)	10,000	363	24/24	OU4W-4
SW8270 (µg/L)	2-Methylnaphthalene	--	3.63	5/23	OU4W-4
	Naphthalene	--	4.56	3/23	OU4W-4

I - Unknown compounds (that are likely the result of decomposition of fuel or arochlor products, or naturally occurring organic matter), quantified as the listed components.
MCL - Maximum Contaminant Level.
* - Inorganic COPCs not identified for groundwater at this location.

OU 4 East

In the OU 4 East study area, one groundwater contaminant plume was identified based upon groundwater analytical results in the Hangar 15/Building 43-410 area. The ADSA was evaluated for groundwater contamination, however no significant contamination was identified. Compounds of concern identified in OU 4 East include HVOCs and NHVOCs. Although metals were detected in groundwater at OU 4 East, no constituents exceeded background levels except aluminum in the Hangar 15/Building 43-410 area. For aluminum, there was insufficient background data available to make a comparison.

An HVOC plume was delineated near Hangar 15 trending east-west (Figure 3-7). An isolated NHVOC plume, located south of Building 43-410, was also identified during groundwater screening, however this plume was not confirmed through laboratory analytical testing. The HVOC plume is characterized by low levels (<25 $\mu g/L$) of TCE and PCE. These were the only two constituents found at concentrations above MCLs (Table 3-5), at concentrations of 19.5 $\mu g/L$ and 23 $\mu g/L$, respectively. Probable sources of contamination for the HVOC plume include a dry well located immediately east of Hangar 15, and a leach field located farther east of the Hangar. The probable sources for the NHVOC plume identified during groundwater screening include valve pits and fuel lines in the area. All fuel lines in the area have been tested and all leaks have been repaired.

At the ADSA, several NHVOCs, including ethylbenzene, total xylenes, and unknown compounds in the diesel range, were detected at low concentrations. The analytical results for COPC from this area are presented with those of the Hangar 15/Building 43-410 area in Table 3-5. No COPC from the ADSA were detected at levels above MCLs.

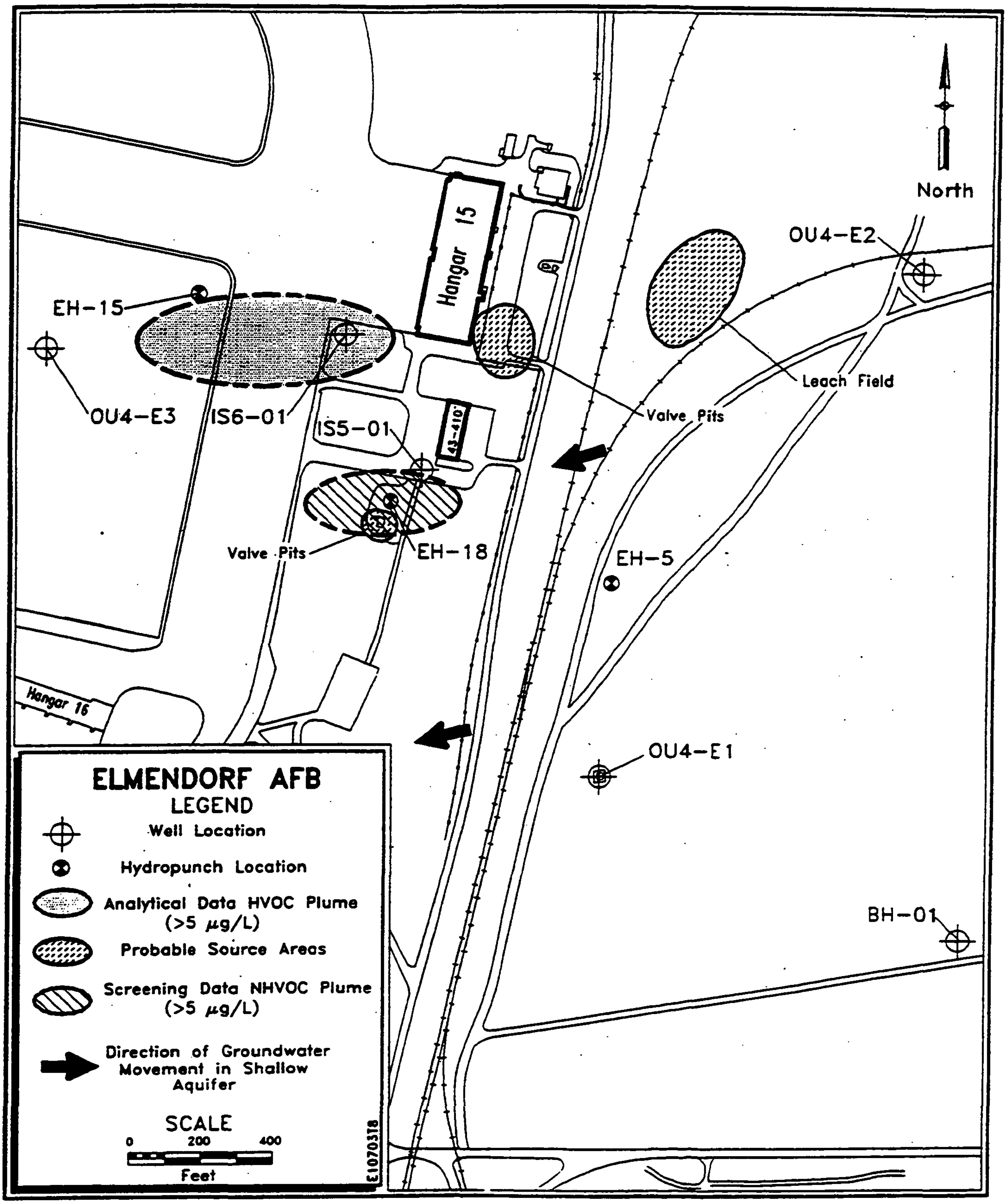

Figure 3-7. Hangar 15/Building 43-410 Area Groundwater Plume, Elmendorf AFB, AK

Table 3-5

Hangar 15/Building 43-410 Plume Area Organic Groundwater Results for Contaminants of Potential Concern, Elmendorf AFB, AK

Method	Analyte	MCL	Maximum Detected Concentration	Frequency of Detection (total hits/total samples)	Location of Maximum Concentration
Contaminant Parameters					
SW8010 (µg/L)	1,1,1-Trichloroethane	200	2.22	1/15	IS6-1
	Chloroform	100	2.72	14/15	OU4E-2
	Chloromethane	--	11.7	4/15	OU4E-2
	Tetrachloroethene	5	19.5	3/15	IS6-1
	Trichloroethene	5	23	3/15	IS6-1
	cis-1,2-Dichloroethene	70	0.853	3/15	IS6-1
SW8015MP (µg/L)	Ethylbenzene	700	1.7	12/15	OU4E-2
	Toluene	1,000	2.05	14/15	OU4E-2
	Xylene (total)	10,000	3.28	12/15	OU4E-2
Indicator Parameters					
E353.1 (mg/L)	Nitrate-Nitrite as N	10,000	7.07	15/15	OU4E-3
SW6010 (mg/L)	Aluminum	0.2 to 0.5 [1]	0.587	13/15	IS5-1

MCL = Maximum Contamination Level.

[1] Secondary MCL

3.1.2 Soils

Soil data from OU 4 was evaluated by area based upon surface and subsurface contaminant occurrences. Surface soils include all soils above five feet. Subsurface soils are those below five feet. Results below the detection limits are not included in the analytical summary tables.

OU 4 West

The contaminants of concern in soil at OU 4 West are primarily fuel-related, including NHVOCs, SVOCs, and pesticides. Contamination at the FTA includes NHVOCs, SVOCs, kerosene and diesel in the shallow soil. Subsurface contamination was primarily fuel-related. Tables 3-6 and 3-7 list the sample depth, maximum concentration, locations, and levels associated with the Alaska Cleanup Matrix for non-UST soil (ACM) for all COPC in the surface, and subsurface soil samples at the FTA.

Metals and pesticides were also identified. Metals were detected at or near background concentrations. Background soil analytical data were collected in association with the basewide background sampling effort (USAF, 1993). During the background soil investigation, 60 soil samples were collected from 14 soil borings drilled at background locations at the base. The analytical results associated with these samples were pooled into surface and subsurface soil results, and were used as the basis to conduct statistical comparisons with on-site results. There are also no known anthropogenic sources for the majority of the metals detected.

Only one constituent was identified in the surface soils at levels above the Alaska Cleanup Matrix for Non-UST soil (ACM): kerosene (2,200 mg/kg). This non-speciated result does not appear as a COPC in Table 3-6, since these results cannot be used in the evaluation of risk. Two constituents, benzene (715 mg/kg), and gasoline (3,710 mg/kg) were identified exceeding the ACM in the subsurface soil. These results do not appear in

Table 3-6

Fire Training Area Organic and Inorganic Surface Soil Results for Contaminants of Potential Concern Elmendorf AFB, AK

Method	Analyte	ACM	Background Upper Tolerance Limit	Maximum Detected Concentration	Frequency of Detection (total hits/ total samples)	Location of Maximum Concentration
Contaminant Parameters						
SW8015MP (µg/kg)	Benzene	500	--	53.1	2/5	SB-21
	Ethylbenzene	--	--	2800	2/5	SS-19
	Toluene	--	--	1480	4/5	SS-19
	Xylene (total)	--	--	8310	5/5	SS-19
	BTEX	100,000	--	12,590	5/5	SS-19
SW8080 (µg/kg)	4,4'-DDD	--	--	13.9	4/6	SS-18
	4,4'-DDE	--	--	2.92	2/6	SB-13
	4,4'-DDT	--	--	38.5	3/6	SB-13
	Aldrin	--	--	4.55	2/6	SS-18
	Endosulfan sulfate	--	--	4.23	2/6	SS-20
	Endrin	--	--	14.8	1/6	SB-21
	Heptachlor	--	--	2.84	1/6	SB-21
	PCB-1260	--	--	151	1/6	SB-23
	alpha-BHC	--	--	0.836	2/6	SS-19
	beta-BHC	--	--	7.02	2/6	SS-18
	gamma-BHC (Lindane)	--	--	0.724 PH	2/6	SB-13
SW8240 (µg/kg)	Meta-& Para-Xylene	1,000,000	--	54.1	1/5	SS-19
	Methylene chloride	--	--	19.8 H	3/5	SS-18
	Ortho-Xylene	1,000,000	--	610	1/5	SS-19
	2-Methylnaphthalene	--	--	0.454	6/11	SB-24
	Acenaphthene	--	--	1.07	4/11	SB-14
	Acenaphthylene	--	--	0.021	1/11	SB-22
	Anthracene	--	--	2.2	5/11	SB-14
	Benzo(a)anthracene	--	--	2.18	6/11	SB-14
	Benzo(a)pyrene	--	--	2.21	6/11	SB-20
	Benzo(b)fluoranthene	--	--	4.72 F	6/11	SB-20
	Benzo(g,h,i)perylene	--	--	0.894	5/11	SB-14
	Benzo(k)fluoranthene	--	--	4.72 F	6/11	SB-20
	Chrysene	--	--	2.44	7/11	SB-14
	Dibenz(a,h)anthracene	--	--	0.54	4/11	SB-14

Table 3-6

(Continued)

Method	Analyte	ACM	Background Upper Tolerance Limit	Maximum Detected Concentration	Frequency of Detection (total hits/ total samples)	Location of Maximum Concentration
SW8240 (µg/kg) (cont'd)	Dibenzofuran	--	--	0.668	4/11	SB-14
	Dibutylphthalate	--	--	0.051	1/11	SB-22
	Fluoranthene	--	--	4.74	6/11	SB-14
	Fluorene	--	--	0.735	4/11	SB-14
	Indeno(1,2,3-cd)pyrene	--	--	0.897	5/11	SB-14
	Naphthalene	--	--	0.624	5/11	SB-14
	Phenanthrene	--	--	5.81	5/11	SB-14
	Pyrene	--	--	4.52	7/11	SB-14
	bis(2-Ethylhexyl)phthalate	--	--	1.17 H	5/11	SS-19
SW8280 (µg/kg)	OCDD	--	--	0.683	1/11	SB-24
Indicator Parameters						
SW6010 (mg/kg)	Calcium	--	8,013.23	9330	11/11	SB-14
	Copper	--	31.67	1120	11/11	SB-23
	Magnesium	--	10,904.10	11900	11/11	SB-14
	Manganese	--	929.98	1820	11/11	SB-14
	Potassium	--	845.75	1560	11/11	SB-14
Contaminant Parameters						
SW6010 (mg/kg)	Chromium	--	48.44	54	11/11	SB-14
	Cobalt	--	19.52	31	11/11	SB-14
	Lead	--	10.69	58.3	11/11	SB-22
	Molybdenum	--	--	2.26	11/11	SB-22
	Nickel	--	50.68	71.6	11/11	SB-14
	Selenium	--	0.54	16.2	7/11	SB-14
	Zinc	--	90.01	641	11/11	SB-23
SW7421 (mg/kg)	<u>Lead</u>	--	10.69	<u>68.8</u>	<u>11/11</u>	SB-22
SW9012 (mg/kg)	Cyanide	--	--	0.316 H	1/11	SS-18

F = Co-elution with a similar analyte is suspected.
H = Result given is suspected to be biased as much as 50% high.
P = Presence of analyte is confirmed, however, concentration was not confirmed, concentration listed is a conservative estimate.
<u>Underline</u> indicates the preferred result when multiple analytical methods were performed for a single constituent.
OCDD = Octachlorodibenzodioxin
ACM = Alaska Cleanup Matrix for Non-UST Soil.

Table 3-7

Fire Training Area Organic and Inorganic Subsurface Soil Results for Contaminants of Potential Concern Elmendorf AFB, AK

Method	Analyte	ACM*	Background Upper Tolerance Limit	Maximum Detected Concentration	Frequency of Detection (total hits/ total samples)	Location of Maximum Concentration
Indicator Parameters						
SW8080 (μg/kg)	PCB-1260	--	--	13.4 I	1/12	SB-18
Contaminant Parameters						
SW8015MP (μg/kg)	Benzene	500	--	110	6/25	SB-19
	Ethylbenzene	--	--	10600	10/25	SB-24
	Toluene	--	--	6360 P	21/25	SB-19
	Xylene (total)	--	--	55700	17/25	SB-24
	BTEX	100,000	--	67,868.5	21/25	SB-24
SW8080 (μg/kg)	alpha-BHC	--	--	0.373 H	2/12	SB-13
	beta-BHC	--	--	5.69	4/12	SB-18
SW8240 (μg/kg)	1,1,1-Trichloroethane	--	--	2.92	1/25	SB-22
	Acetone	--	--	378	4/25	SB-19
	Benzene	500	--	47.1	4/25	SB-22
	Ethylbenzene	1,000,000	--	875	5/25	SB-19
	Meta-&Para-Xylene	1,000,000	--	5840	5/25	SB-19
	Methyl ethyl ketone	--	--	197	11/25	SB-19
	Methylene chloride	--	--	91.5	18/25	SB-22
	Ortho-Xylene	1,000,000	--	2810	5/25	SB-19
	Tetrachloroethene	--	--	6.88	2/25	SB-22
	Toluene	1,000,000	--	293	5/25	SB-19
	Trichloroethene	--	--	36.4	3/25	SB-22
	cis-1,2-Dichloroethene	--	--	19.2	2/25	SB-24

Table 3-7

(Continued)

Method	Analyte	ACM[a]	Background Upper Tolerance Limit	Maximum Detected Concentration	Frequency of Detection (total hits/ total samples)	Location of Maximum Concentration
SW8270 (mg/kg)	2-Methylnaphthalene	--	--	6.2	6/27	SB-22
	Acenaphthene	--	--	0.0594	2/27	SB-20
	Anthracene	--	--	0.208	3/27	SB-20
	Benzo(a)anthracene	--	--	0.69	3/27	SB-20
	Benzo(a)pyrene	--	--	0.946	3/27	SB-20
	Benzo(b)fluoranthene	--	--	1.91 F	3/27	SB-20
	Benzo(g,h,i)perylene	--	--	0.234	3/27	SB-20
	Benzo(k)fluoranthene	--	--	1.91 F	3/27	SB-20
	Chrysene	--	--	0.908	3/27	SB-20
	Dibenz(a,h)anthracene	--	--	0.14	2/27	SB-20
	Dibenzofuran	--	--	0.0653	2/27	SB-18
	Fluoranthene	--	--	1.75	3/27	SB-20
	Fluorene	--	--	0.084	4/27	SB-20
	Indeno(1,2,3-cd)pyrene	--	--	0.313	3/27	SB-20
	Naphthalene	--	--	3.21	5/27	SB-22
	Phenanthrene	--	--	1.23	3/27	SB-20
	Pyrene	--	--	1.59	3/27	SB-20
Indicator Parameters						
SW6010 (mg/kg)	Aluminimum	--	18,116.77	18200	27/27	SB-22
	Calcium	--	10,264.39	16400	27/27	SB-24
	Copper	--	59.84	493	27/27	SB-18

Table 3-7

(Continued)

Method	Analyte	ACM*	Background Upper Tolerance Limit	Maximum Detected Concentration	Frequency of Detection (total hits/ total samples)	Location of Maximum Concentration
Contaminant Parameters						
SW6010 (mg/kg)	Lead	--	10.13	13.9	27/27	SB-13
	Molybdenum	--	--	1.31	25/27	SB-20
	Selenium	--	0.48	12.8	25/27	SB-13
	Zinc	--	76.17	300	27/27	SB-18
SW7421 (mg/kg)	Lead	--	10.13	10.1	26/26	SB-20

B = Sample result is less than the UTL calculated for the blank samples for this analyte in this media.
F = Co-elution with a similar analyte is suspected.
H = Result given is suspected to be biased as much as 50% high.
I = Unknown compounds (that are likely the result of decomposition of fuel or arochlor products, or naturally occurring organic matter), quantified as the listed components.
P = Presence of analyte is confirmed, however, concentration was not confirmed, concentration listed is a conservative estimate.
Underline indicates the preferred result when multiple analytical methods were performed for a single constituent.
ACM = Alaska Cleanup Matrix for Non-UST Soil.
* No fuel constituents identified as COPCs at this location.

Table 3-7, since the benzene result was below the detection limit for that analysis, and the gasoline result represents a non-speciated compound. The locations of areas where soil concentrations exceeded the ACM are depicted on Figure 3-8.

Migration of contaminants into the subsurface is thought to be almost vertical due to the coarse, porous nature of the FTA soils. Deep soil contamination may act as a continuing source of contamination to groundwater. Contaminated soil zones above the water table represent a "smear zone" of contamination, resulting from fuel and solvent constituents that migrated to a higher water table and were left in the vadose zone when the water table receded. The principal sources of contamination at FTA include residual fuels spread on the ground for fire training exercises, fuel supply lines to the training pit, and a former 22,000-gallon underground storage tank. Drums suspected to have been buried in the southern portion of a construction rubble pile east of the FTA, may also be a source of contamination. The underground storage tank has been removed, and the FTA is no longer used.

At Hangar 14, none of the surface or subsurface soil samples had analytical results exceeding the ACM. Tables 3-8 and 3-9 summarize the maximum concentrations, locations, and frequency of occurrence, of surface and subsurface analytical results. The low levels of soil contamination detected show no obvious trends, indicating contaminant sources to be incidental contamination via paving, vehicular traffic, or air traffic residue.

Contamination was detected in numerous surface and subsurface soil samples in the Hangar 10/11 area (Tables 3-10 and 3-11). Contaminants include low levels of SVOCs, NHVOCs, pesticides, and metals. Metals were determined to be the result of background conditions. Contaminant levels exceeded cleanup levels only in the subsurface soils.

Two constituents were identified with concentrations exceeding the ACM in the subsurface soils: Diesel Range Organics (DRO), at 5,900 mg/kg, and Gasoline Range Organics (GRO), at 4,100 mg/kg. These results do not appear in Table 3-11, since they are

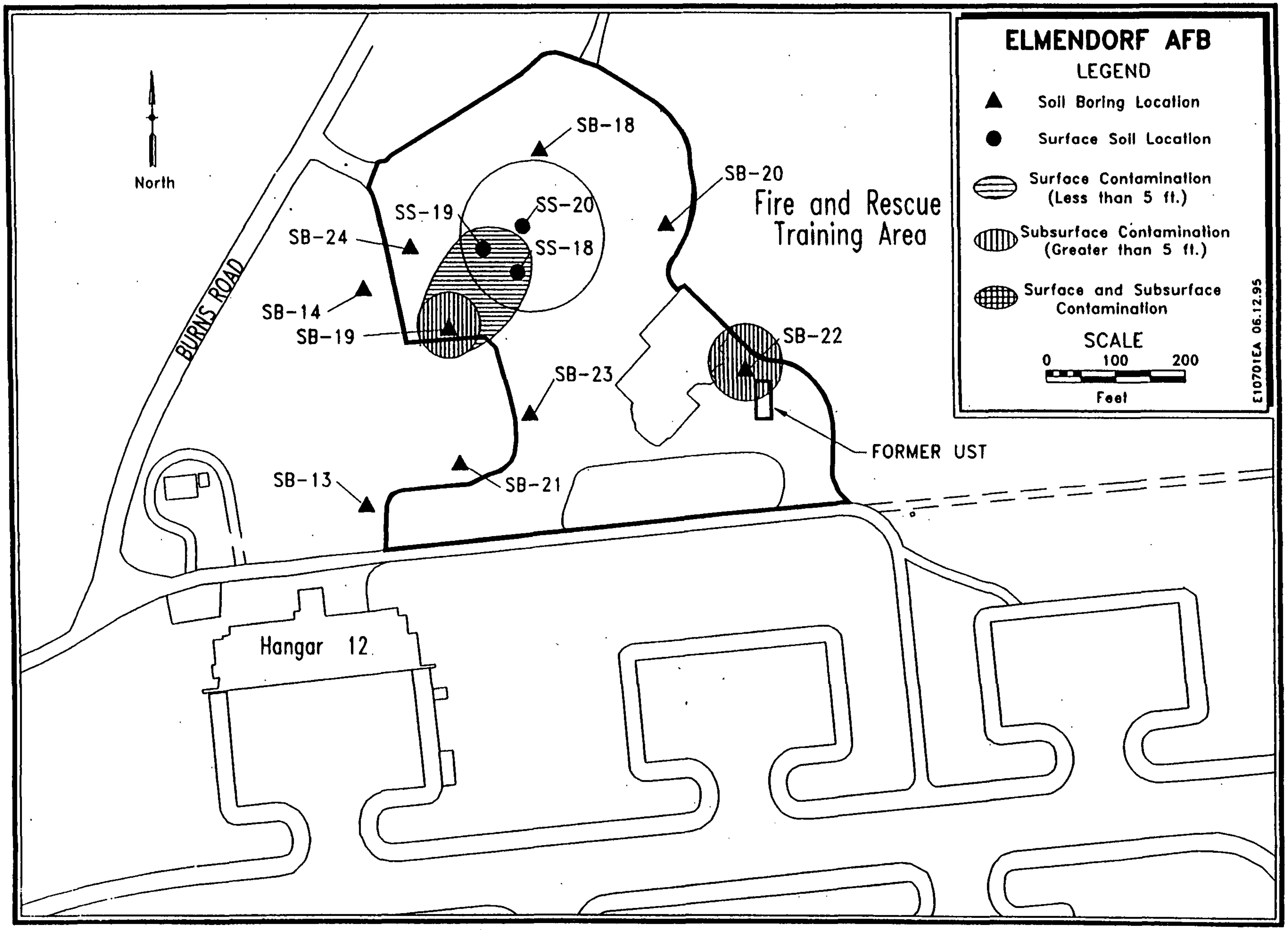

Figure 3-8. Location of Soil ACM Exceedances at the Fire Training Area, Elmendorf AFB, AK

Table 3-8

Hangar 14 Organic and Inorganic Surface Soil Results for Contaminants of Potential Concern
Elmendorf AFB, AK

Method	Analyte	ACM*	Background Upper Tolerance Limit	Maximum Detected Concentration	Frequency of Detection (total hits/ total samples)	Location of Maximum Concentration
Contaminant Parameters						
SW8080 (µg/kg)	4,4'-DDD	--	--	11.3	1/2	SB-40
	4,4'-DDE	--	--	0.601	1/2	SB-29
	4,4'-DDT	--	--	3.21 H	1/2	SB-29
	Aldrin	--	--	9.97	1/2	SB-40
	gamma-BHC (Lindane)	--	--	2.42	1/2	SB-40
SW8270 (mg/kg)	Acenaphthene	--	--	0.0132	1/4	SB-40
	Anthracene	--	--	0.025	1/4	SB-40
	Benzo(a)anthracene	--	--	0.0765	3/4	SB-40
	Benzo(a)pyrene	--	--	0.108	3/4	SB-40
	Benzo(b)fluoranthene	--	--	0.201 F	3/4	SB-40
	Benzo(k)fluoranthene	--	--	0.201 F	3/4	SB-40
	Butylbenzylphthalate	--	--	0.116	1/4	SB-40
	Chrysene	--	--	0.167	3/4	SB-40
	Fluoranthene	--	--	0.984	3/4	SB-40
	Phenanthrene	--	--	0.0678	3/4	SB-40
	Pyrene	--	--	0.179	3/4	SB-40
Indicator Parameters						
SW6010 (mg/kg)	Calcium	--	8,013.23	9900	4/4	SB-29
	Copper	--	31.67	40.4	4/4	SB-56
	Magnesium	--	10,904.10	8600	4/4	SB-29
	Potassium	--	845.75	852	4/4	SB-29

Table 3-8

(Continued)

Method	Analyte	ACM*	Background Upper Tolerance Limit	Maximum Detected Concentration	Frequency of Detection (total hits/ total samples)	Location of Maximum Concentration
Contaminant Parameters						
SW6010 (mg/kg)	Chromium	--	48.44	51.1	4/4	SB-56
	Lead	--	10.69	29.3	4/4	SB-36
	Molybdenum	--	--	0.87	3/4	SB-36
	Nickel	--	50.68	31	4/4	SB-29
	Selenium	--	0.54	12.1	4/4	SB-29
	Zinc	--	90.01	56.9	4/4	SB-29
SW7421 (mg/kg)	Lead	--	10.69	18.5 S	4/4	SB-36

F = Co-elution with a similar analyte is suspected.
H = Result given is suspected to be biased as much as 50% high.
S = Concentration reported was obtained using method of standard addition.
Underline indicates the preferred result when multiple analytical methods were performed for a single constituent.
ACM = Alaska Cleanup Matrix for Non-UST Soil.
* No fuel constituents identified as COPCs at this location.

Table 3-9

Hangar 14 Organic and Inorganic Subsurface Soil Results for Contaminants of Potential Concern
Elmendorf AFB, AK

Method	Analyte	ACM	Background Upper Tolerance Limit	Maximum Detected Concentration	Frequency of Detection (total hits/ total samples)	Location of Maximum Concentration
Contaminant Parameters						
SW8015MP (µg/kg)	Benzene	500	--	16.3 H	2/15	SB-36
	Xylene (total)	--	--	59.5 H	6/15	SB-36
	BTEX	100,000	--	96.6	6/15	SB-36
SW8080 (µg/kg)	4,4'-DDD	--	--	3.97	3/10	SB-53
	4,4'-DDE	--	--	1.35	2/10	SB-53
	4,4'-DDT	--	--	8.49	4/10	SB-53
	Aldrin	--	--	5.93	1/10	SB-40
	Endosulfan sulfate	--	--	5.05	2/10	SB-40
	Heptachlor	--	--	0.26 B	1/10	SB-29
	beta-BHC	--	--	1.53 P	2/10	SB-40
	gamma-BHC (Lindane)	--	--	2.51	2/10	SB-40
SW8240 (µg/kg)	Methylene chloride	--	--	31.5	12/15	SB-29
SW8270 (mg/kg)	Acenaphthene	--	--	0.0811	2/16	SB-53
	Anthracene	--	--	0.156	1/16	SB-53
	Benzo(a)anthracene	--	--	0.335	3/16	SB-53
	Benzo(a)pyrene	--	--	0.291	3/16	SB-53
	Benzo(b)fluoranthene	--	--	0.525 F	3/16	SB-53
	Benzo(g,h,i)perylene	--	--	0.196	2/16	SB-53
	Benzo(k)fluoranthene	--	--	0.525 F	3/16	SB-53
	Butylbenzylphthalate	--	--	0.483	1/16	SB-40
	Chrysene	--	--	0.394	3/16	SB-53
	Dibenz(a,h)anthracene	--	--	0.0839	1/16	SB-53
	Dibutylphthalate	--	--	0.0162	1/16	SB-40
	Fluoranthene	--	--	0.696	3/16	SB-53
	Fluorene	--	--	0.0482	1/16	SB-53
	Indeno(1,2,3-cd)pyrene	--	--	0.19	2/16	SB-53
	Phenanthrene	--	--	0.484	3/16	SB-53
	Pyrene	--	--	0.707	3/16	SB-53

Table 3-9

(Continued)

Method	Analyte	ACM	Background Upper Tolerance Limit	Maximum Detected Concentration	Frequency of Detection (total hits/ total samples)	Location of Maximum Concentration
Indicator Parameters						
SW6010 (mg/kg)	Aluminum	--	18,116.77	20100	16/16	SB-36
	Calcium	--	10,264.39	10200	16/16	SB-29
	Copper	--	59.84	91.1	16/16	SB-29
	Manganese	--	709.45	1210	16/16	SB-36
Contaminant Parameters						
SW6010 (mg/kg)	Lead	--	10.13	28.2	16/16	SB-36
	Molybdenum	--	--	6.23	15/16	SB-53
	Selenium	--	0.48	16.4	14/16	SB-29
	Vanadium	--	66.16	69.1	16/16	SB-53
	Zinc	--	76.17	78.5	16/16	SB-29
SW7421 (mg/kg)	Lead	--	10.13	14.5 S	16/16	SB-36
SW9012 (mg/kg)	Cyanide	--	--	1.51	1/16	SB-29

B = Sample result is less than the UTL calculated for the blank samples for this analyte in this media.
F = Co-elution with a similar analyte is suspected.
H = Result given is suspected to be biased as much as 50% high.
P = Presence of analyte is confirmed, however, concentration was not confirmed, concentration listed is a conservative estimate.
S = Concentration reported was obtained using method of standard addition.
Underline indicates the preferred resul when multiple analytical methods were performed for a single constituent.
ACM = Alaska Cleanup Matrix for Non-UST Soil.

Table 3-10

Hangar 10/11 Organic and Inorganic Surface Soil Results for Contaminants of Potential Concern
Elmendorf AFB, AK

Method	Analyte	ACM	Background Upper Tolerance Limit	Maximum Detected Concentration	Frequency of Detection (total hits/ total samples)	Location of Maximum Concentration
Contaminant Parameters						
SW8015MP (µg/kg)	Ethylbenzene	--	--	55 H	1/2	SB-39
	BTEX	100,000	--	280.28	1/2	SB-39
SW8080 (µg/kg)	4,4'-DDD	--	--	3.08	3/3	SB-34
	4,4'-DDE	--	--	2.42	3/3	SB-37
	4,4'-DDT	--	--	19	3/3	SB-37
	Aldrin	--	--	1.1 H	3/3	SB-37
	Endosulfan sulfate	--	--	1.05 H	1/3	SB-37
	alpha-BHC	--	--	0.384 H	2/3	SB-34
SW8270 (mg/kg)	2-Methylnaphthalene	--	--	0.17	3/9	SB-39
	Acenaphthene	--	--	0.0662	1/9	SB-38
	Anthracene	--	--	0.106	3/9	SB-38
	Benzo(a)anthracene	--	--	0.296	7/9	SB-38
	Benzo(a)pyrene	--	--	0.354	6/9	SB-38
	Benzo(b)fluoranthene	--	--	0.803 F	7/9	SB-38
	Benzo(g,h,i)perylene	--	--	0.0874	4/9	SB-32
	Benzo(k)fluoranthene	--	--	0.803 F	6/9	SB-38
	Chrysene	--	--	0.495	7/9	SB-46
	Dibenz(a,h)anthracene	--	--	0.0489	2/9	SB-32
	Dibenzofuran	--	--	0.0515	1/9	SB-38
	Fluoranthene	--	--	0.63	5/9	SB-38
	Fluorene	--	--	0.0641	1/9	SB-38
	Indeno(1,2,3-cd)pyrene	--	--	0.0937	3/9	SB-32
	Naphthalene	--	--	0.0578 H	3/9	SB-37
	Phenanthrene	--	--	0.598	5/9	SB-38
	Pyrene	--	--	0.649	5/9	SB-38

Table 3-10

(Continued)

Method	Analyte	ACM	Background Upper Tolerance Limit	Maximum Detected Concentration	Frequency of Detection (total hits/ total samples)	Location of Maximum Concentration
Indicator Parameters						
SW6010 (mg/kg)	Calcium	--	8,013.23	8390	9/9	SB-46
	Copper	--	31.67	87.5	9/9	SB-32
	Magnesium	--	10,904.10	7810	9/9	SB-46
	Manganese	--	929.98	592	9/9	SB-30
	Potassium	--	845.75	594	9/9	SB-46
Contaminant Parameters						
SW6010 (mg/kg)	Chromium	--	48.44	34.9	9/9	SB-38
	Lead	--	10.69	66.1	9/9	SB-38
	Molybdenum	--	--	0.984	9/9	SB-31
	Nickel	--	50.68	28.6	9/9	SB-46
	Selenium	--	0.54	13.3	8/9	SB-38
	Zinc	--	90.01	93.9	9/9	SB-32
SW7421 (mg/kg)	<u>Lead</u>	--	10.69	<u>33.3</u>	<u>9/9</u>	SB-37
SW9012 (mg/kg)	Cyanide	--	--	0.325 H	1/9	SB-34

F = Co-elution with a similar analyte is suspected.
H = Result given is suspected to be biased as much as 50% high.
<u>Underline</u> indicates the preferred result when multiple analytical methods were performed for a single constituent.
ACM = Alaska Cleanup Matrix for Non-UST Soil.

Table 3-11

Hangar 10/11 Organic and Inorganic Subsurface Soil Results for Contaminants of Potential Concern Elmendorf AFB, AK

Method	Analyte	ARAR (ACM)	Background Upper Tolerance Limit	Maximum Detected Concentration	Frequency of Detection (total hits/ total samples)	Location of Maximum Concentration
Contaminant Parameters						
SW8015MP (µg/kg)	Benzene	500	--	51.5	6/28	SB-31
	Ethylbenzene	--	--	3860	6/28	SB-33
	Toluene	--	--	526	16/28	SB-33
	Xylene (total)	--	--	14200	16/28	SB-33
	BTEX	100,000	--	18,650.8	16/28	SB-33
SW8080 (µg/kg)	alpha-BHC	--	--	0.356 H	1/5	SB-34
SW8240 (µg/kg)	Benzene	1,000,000	--	1.11 B	2/28	SB-34
	Ethylbenzene	1,000,000	--	251	2/28	SB-33
	Meta- & Para-Xylene	1,000,000	--	786	4/28	SB-33
	Methylene chloride	--	--	51.2	20/28	SB-33
	Toluene	1,000,000	--	28.1	5/28	SB-33
	Trichloroethene	--	--	7.15	2/28	SB-37
SW8270 (mg/kg)	2-Methylnaphthalene	--	--	2.08	3/26	SB-33
	Benzo(a)anthracene	--	--	0.523	2/26	SB-32
	Benzo(a)pyrene	--	--	0.443	6/26	SB-32
	Benzo(b)fluoranthene	--	--	0.853 F	4/26	SB-32
	Benzo(g,h,i)perylene	--	--	0.251	3/26	SB-32
	Benzo(k)fluoranthene	--	--	0.853 F	3/26	SB-32
	Butylbenzylphthalate	--	--	0.0149 H	1/26	SB-33
	Chrysene	--	--	0.478	6/26	SB-32
	Dibenz(a,h)anthracene	--	--	0.134	1/26	SB-32
	Fluoranthene	--	--	1.11	3/26	SB-32
	Fluorene	--	--	0.115	3/26	SB-32
	Indeno(1,2,3-cd)pyrene	--	--	0.241	1/26	SB-32
	Naphthalene	--	--	0.701	3/26	SB-33
	Phenanthrene	--	--	0.858	4/26	SB-32
	Pyrene	--	--	0.819	5/26	SB-32

Table 3-11

(Continued)

Method	Analyte	ARAR (ACM)	Background Upper Tolerance Limit	Maximum Detected Concentration	Frequency of Detection (total hits/ total samples)	Location of Maximum Concentration
Indicator Parameters						
SW6010 (mg/kg)	Calcium	--	10,264.39	10200	26/26	SB-45
	Copper	--	59.84	268	26/26	SB-30
	Manganese	--	709.45	1040	26/26	SB-45
Contaminant Parameters						
SW6010 (mg/kg)	Lead	--	10.13	24.2	26/26	SB-37
	Molybdenum	--	--	1.46	20/26	SB-46
	Selenium	--	0.48	11.4	23/26	SB-30
	Thallium	--	--	9.58	2/26	SB-45
	Vanadium	--	66.16	67.8	26/26	SB-45
	Zinc	--	76.17	171	26/26	SB-30
SW7421 (mg/kg)	Lead	--	10.13	12.6	26/26	SB-33

B = Sample result is less than the UTL calculated for the blank samples for this analyte in this media.
F = Co-elution with a similar analyte is suspected.
H = Result given is suspected to be biased as much as 50% high.
Underline indicates the preferred result when multiple analytical methods were performed for a single constituent.
ACM - Alaska Cleanup Matrix for Non-UST Soil.

from the LFI conducted by CH2M Hill in 1992. The locations of ACM exceedances are graphically displayed on Figure 3-9. Like at the FTA, contaminant migration into the subsurface in this area is thought to be almost vertical due to the coarse nature of the soils in the vicinity of Hangar 10/11. Deep soil contamination at Hangar 11 may act as a continuing source of contamination to groundwater. Sources of contamination for surface and subsurface soils include valve pits and underground storage tanks located southwest of Hangar 11, and possibly a dry well on the northwest side of the Hangar. The valve pit and underground storage tanks have been taken out of service.

Contamination associated with Hangar 8 includes low levels of NHVOCs, SVOCs, pesticides, and metals. All metals detected were consistent with background levels. None of the constituents detected in the surface or subsurface soils exceeded the ACM. Table 3-12 and 3-13 summarize the analytical results for the soil COPC at Hangar 8. The probable source for the soil contamination at Hangar 8 includes Pumphouse 2 (active), and/or the pipes in the vicinity of the pumphouse, as well as general vehicular or air traffic.

OU 4 East

Contaminants of concern in OU 4 East include both NHVOCs and HVOCs, as well as SVOCs, pesticides, and metals. All metals within OU 4 East were consistent with background levels.

Soil contamination in the Hangar 15/Building 43-410 area included gasoline, TCE, and TCA. Tables 3-14 and 3-15 summarize the analytical results for soil COPC in the Hangar 15/Building 43-410 area. No results in this area exceeded the ACM. The low levels of soil contamination detected in this area are typical of contamination resulting from paving, or vehicular traffic. Other probable sources of contamination include a dry well and leach field located east of Hangar 15, as well as valve pits and fuel lines located near Building 43-410.

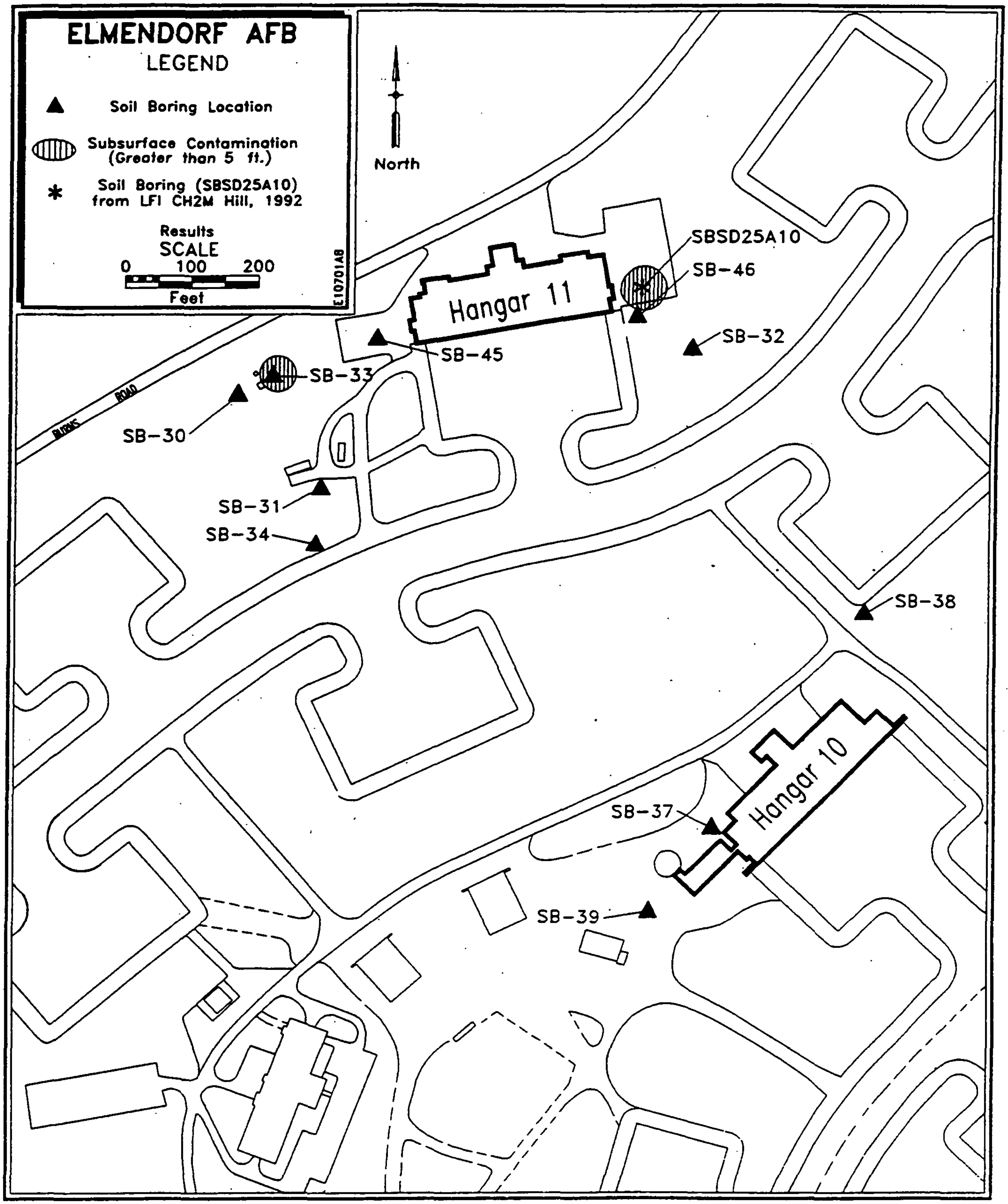

Figure 3-9. Location of Soil ACM Exceedances in the Hangar 10/11 Area, Elmendorf AFB, AK

Table 3-12

Hangar 8 Organic and Inorganic Surface Soil Results for Contaminants of Potential Concern
Elmendorf AFB, AK

Method	Analyte	ACM*	Background Upper Tolerance Limit	Maximum Detected Concentration	Frequency of Detection (total hits/ total samples)	Location of Maximum Concentration
Contaminant Parameters						
SW8080 (μg/kg)	4,4'-DDD	--	--	6.81	1/2	SB-25
	4,4'-DDE	--	--	3.29	2/2	SB-25
	4,4'-DDT	--	--	16.8	2/2	SB-25
	Endrin	--	--	1.21 P	1/2	SB-25
	gamma-BHC (Lindane)	--	--	1.37 P	1/2	SB-25
SW8270 (mg/kg)	2-Methylnaphthalene	--	--	0.0166	1/6	SB-35
	3,3'-Dichlorobenzidine	--	--	0.117	1/6	SB-27
	Acenaphthene	--	--	0.0272	1/6	SB-35
	Anthracene	--	--	0.0483	1/6	SB-35
	Benzo(a)anthracene	--	--	0.17	3/6	SB-35
	Benzo(a)pyrene	--	--	0.208	3/6	SB-35
	Benzo(b)fluoranthene	--	--	0.434 F	4/6	SB-35
	Benzo(g,h,i)perylene	--	--	0.0574	2/6	SB-27
	Benzo(k)fluoranthene	--	--	0.434 F	3/6	SB-35
	Butylbenzylphthalate	--	--	0.046	1/6	SB-26
	Chrysene	--	--	0.223	3/6	SB-35
	Dibenz(a,h)anthracene	--	--	0.0243	1/6	SB-27
	Dibenzofuran	--	--	0.0201	1/6	SB-35
	Fluoranthene	--	--	0.356	3/6	SB-35
	Fluorene	--	--	0.0242	1/6	SB-35
	Indeno(1,2,3-cd)pyrene	--	--	0.0613	2/6	SB-35
	Phenanthrene	--	--	0.307	3/6	SB-35
	Pyrene	--	--	0.387	3/6	SB-35

Table 3-12

(Continued)

Method	Analyte	ACM*	Background Upper Tolerance Limit	Maximum Detected Concentration	Frequency of Detection (total hits/ total samples)	Location of Maximum Concentration
Indicator Parameters						
SW6010 (mg/kg)	Calcium	--	8,013.23	9450	6/6	SB-26
	Copper	--	31.67	50.4	6/6	SB-27
	Magnesium	--	10,904.10	8430	6/6	SB-27
	Manganese	--	929.98	698	6/6	SB-25
	Potassium	--	845.75	794	6/6	SB-28
Contaminant Parameters						
SW6010 (mg/kg)	Chromium	--	48.44	37.8	6/6	SB-35
	Lead	--	10.69	62.5	6/6	SB-35
	Molybdenum	--	--	1.47	5/6	SB-28
	Nickel	--	50.68	30.2	6/6	SB-25
	Selenium	--	0.54	14.5	6/6	SB-28
	Zinc	--	90.01	64.2	6/6	SB-25
SW7421 (mg/kg)	Lead	--	10.69	27.3	5/5	SB-26
SW9012 (mg/kg)	Cyanide	--	--	0.579	1/6	SB-28

F = Co-elution with a similar analyte is suspected.
P = Presence of analyte is confirmed, however, concentration was not confirmed, concentration listed is a conservative estimate.
Underline indicates the preferred result when multiple analytical methods were performed for a single constituent.
ACM = Alaska Cleanup Matrix for Non-UST Soil.
* = No fuel constituents identified as COPCs at this location

Table 3-13

Hangar 8 Organic and Inorganic Subsurface Soil Results for Contaminants of Potential Concern
Elmendorf AFB, AK

Method	Analyte	ACM	Background Upper Tolerance Limit	Maximum Detected Concentration	Frequency of Detection (total hits/ total samples)	Location of Maximum Concentration
Contaminant Parameters						
SW8015MP (µg/kg)	Benzene	500	--	13.1 H	3/16	SB-35
	Toluene	--	--	197	14/16	SB-25
	BTEX	100,000	--	256.14	14/16	SB-25
SW8080 (µg/kg)	4,4'-DDT	--	--	4.58	1/5	SB-28
	Aldrin	--	--	4.96	2/5	SB-28
	Endosulfan Sulfate	--	--	3.45	1/5	SB-28
SW8240 (µg/kg)	Methylene chloride	--	--	112	14/16	SB-26
	Toluene	1,000,000	--	37.4	3/16	SB-25
SW8270 (mg/kg)	2-Methylnaphthalene	--	--	0.0545	1/17	SB-35
	Benzo(b)fluoranthene	--	--	0.0266 F	1/17	SB-26
	Butylbenzylphthalate	--	--	0.017	1/17	SB-27
Indicator Parameters						
SW6010 (mg/kg)	Aluminum	--	18,116.77	17700	17/17	SB-25
	Calcium	--	10,264.39	9330	17/17	SB-28
	Copper	--	59.84	947	17/17	SB-25
	Potassium	--	1,114.35	885	17/17	SB-25
Contaminant Parameters						
SW6010 (mg/kg)	Lead	--	10.13	14.3	17/17	SB-41
	Molybdenum	--	--	0.847	16/17	SB-27
	Selenium	--	0.48	14.9	16/17	SB-28
	Thallium	--	--	6.62	1/17	SB-35
	Vanadium	--	66.16	59	17/17	SB-27
	Zinc	--	76.17	555	17/17	SB-25
SW7421 (mg/kg)	Lead	--	10.13	10 S	17/17	SB-28

F = Co-elution with a similar analyte is suspected.
H = Result given is suspected to be biased as much as 50% high.
S = Concentration reported was obtained using method of standard addition.
Underline indicates the preferred result when multiple analytical methods were performed for a single constituent.
ACM = Alaska Cleanup Matrix for Non-UST Soil.

Table 3-14

Hangar 15/Building 43-410 Organic and Inorganic Surface Soil Results for Contaminants of Potential Concern, Elmendorf AFB, AK

Method	Analyte	ACM*	Background Upper Tolerance Limit	Maximum Detected Concentration	Frequency of Detection (total hits/total samples)	Location of Maximum Concentration
Contaminant Parameters						
SW8080 (μg/kg)	PCB-1260	--	--	35	1/2	SB-49
SW8270 (mg/kg)	2-Methylnaphthalene	--	--	0.132	3/6	SB-43
	Acenaphthene	--	--	0.0113	2/6	SB-43
	Anthracene	--	--	0.0437	1/6	SB-50
	Benzo(a)anthracene	--	--	0.0911	4/6	SB-50
	Benzo(a)pyrene	--	--	0.0681	3/6	SB-50
	Benzo(b)fluoranthene	--	--	0.209 F	3/6	SB-49
	Benzo(g,h,i)perylene	--	--	0.0486	2/6	SB-48
	Benzo(k)fluoranthene	--	--	0.209 F	3/6	SB-48
	Butylbenzylphthalate	--	--	0.031	1/6	SB-48
	Chrysene	--	--	0.107	4/6	SB-43
	Dibenz(a,h)anthracene	--	--	0.0167	1/6	SB-48
	Fluoranthene	--	--	0.181	3/6	SB-50
	Indeno(1,2,3-cd)pyrene	--	--	0.0524	2/6	SB-49
	Isophorone	--	--	0.0274	1/6	SB-48
	Naphthalene	--	--	0.0391 H	1/6	SB-43
	Phenanthrene	--	--	0.107	4/6	SB-50
	Pyrene	--	--	0.164	5/6	SB-50
Indicator Parameters						
SW6010 (mg/kg)	Calcium	--	8,013.23	8530	6/6	SB-44
	Copper	--	31.67	73.5	6/6	SB-44
	Magnesium	--	10,904.10	11700	6/6	SB-44
	Manganese	--	929.98	760	6/6	SB-44
	Potassium	--	845.75	1020	6/6	SB-44

Table 3-14

(Continued)

Method	Analyte	ACM*	Background Upper Tolerance Limit	Maximum Detected Concentration	Frequency of Detection (total hits/total samples)	Location of Maximum Concentration
Contaminant Parameters						
SW6010 (mg/kg)	Chromium	--	48.44	39.6	6/6	SB-44
	Lead	--	10.69	30.4	6/6	SB-49
	Molybdenum	--	--	1.04	5/6	SB-48
	Nickel	--	50.68	49.9	6/6	SB-44
	Selenium	--	0.54	13.4	6/6	SB-44
	Zinc	--	90.01	90	6/6	SB-44
SW7421 (mg/kg)	Lead	--	10.69	37.3	6/6	SB-49

B - Sample result is less than the UTL calculated for the blank samples for this analyte in this media.
F - Co-elution with a similar analyte is suspected.
H - Result given is suspected to be biased as much as 50% high.
Underline indicates the preferred result when multiple analytical methods were performed for a single constituent.
ACM - Alaska Cleanup Matrix for Non-UST Soil.
* - No fuel constituents identified as COPCs at this location.

Table 3-15

Hangar 15/Building 43-410 Organic and Inorganic Subsurface Soil Results for Contaminants of Potential Concern, Elmendorf AFB, AK

Method	Analyte	ACM	Background Upper Tolerance Limit	Maximum Detected Concentration	Frequency of Detection (total hits/ total samples)	Location of Maximum Concentration
Contaminant Parameters						
SW8015MP (µg/kg)	Benzene	500	--	65.4	3/21	SB-50
	Ethylbenzene	--	--	534	3/21	SB-49
	Toluene	--	--	4290	13/21	SB-51
	Xylene (total)	--	--	11800	9/21	SB-51
	BTEX	100,000	--	16,090	13/21	SB-51
SW8240 (µg/kg)	Ethylbenzene	1,000,000	--	107	2/21	SB-51
	Meta-&Para-Xylene	1,000,000	--	3380	2/21	SB-51
	Ortho-Xylene	1,000,000	--	2540	2/21	SB-51
	Tetrachloroethene	--	--	3.9	1/21	SB-43
	Toluene	1,000,000	--	28.2	2/21	SB-51
SW8270 (mg/kg)	2-Methylnaphthalene	--	--	0.0522	2/22	SB-42
	Butylbenzylphthalate	--	--	0.0425	3/22	SB-42
	Dibutylphthalate	--	--	0.0327	2/22	SB-51
Indicator Parameters						
SW6010 (mg/kg)	Aluminum	--	18,116.77	19200	22/22	SB-51
	Calcium	--	10,264.39	13600	22/22	SB-49
	Copper	--	59.84	141	22/22	SB-44
	Potassium	--	1,114.35	994	22/22	SB-49
Contaminant Parameters						
SW6010 (mg/kg)	Lead	--	10.13	27.9	22/22	SB-42
	Molybdenum	--	--	2.08	21/22	SB-43
	Selenium	--	0.48	14.9	21/22	SB-43
	Thallium	--	--	6.9	1/22	SB-50
	Vanadium	--	66.16	59.2	22/22	SB-49
	Zinc	--	76.17	97.8	22/22	SB-44
SW7421 (mg/kg)	Lead	--	10.13	7.61	22/22	SB-42

B - Sample result is less than the UTL calculated for blank samples for this analyte in this media.
Underline indicates the preferred result when multiple analytical methods were performed for a single constituent.
ACM = Alaska Cleanup Matrix for Non-UST Soil.

Numerous contaminated soil intervals were identified at the ADSA. Contaminants detected in the surface soils in the ADSA include NHVOCs, SVOCs, pesticides, and metals. Only one constituent exceeded the ACM in the surface soils: diesel (110,000 mg/kg).

Two constituents, jet fuel (2,100 mg/kg) and "Unspecified Compounds in the Gasoline Range" (15,600 mg/kg), exceeded the ACM in subsurface soil sample results. Each of these constituents represent non-speciated results, and are therefore not included in the analytical summary tables. The heavy hydrocarbons present in the deep soils may result in slow contaminant degradation. Deep contaminants in this area may also act as a source of contamination to groundwater. All subsurface ACM exceedances occurred in samples from soil boring SB-12 (Figure 3-10).

Tables 3-16 and 3-17 summarize the analytical results, and locations of the highest detected concentrations for all COPC in surface and subsurface soils at the ADSA. The locations of these exceedances are depicted on Figure 3-10.

Sources for the contamination seen at the ADSA include residue from former asphalt storage, and fuel or other spills from drums stored in the area. Pesticide contamination is likely the result of historical insect control activities. There is no known anthropogenic source for the majority of the metals detected in the ADSA soils. All drums have been removed, the first few inches of soil have been removed, and the area has been revegetated.

3.2 Risk Evaluation

Based on the concentrations of contaminants detected during the RI, human health and environmental risk assessments were performed to determine if areas should be considered for remedial action. All concentrations of contaminants, including all potential

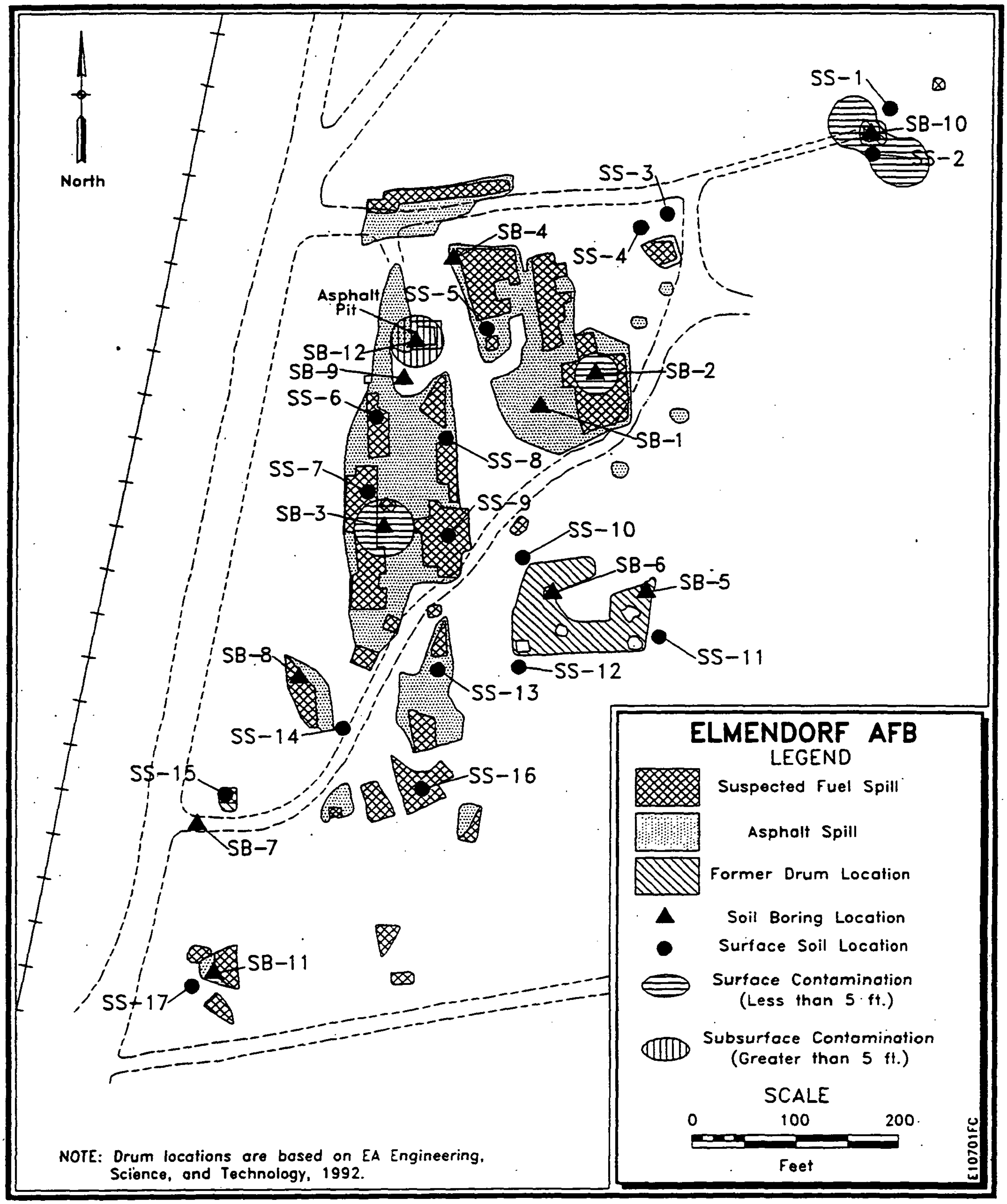

Figure 3-10. Location of Soil ACM Exceedances at the Asphalt Drum Storage Area, Elmendorf AFB, AK

Table 3-16

Asphalt Drum Storage Area Organic and Inorganic Surface Soil Results for Contaminants of Potential Concern, Elmendorf AFB, AK

Method	Analyte	ACM	Background Upper Tolerance Limit	Maximum Detected Concentration	Frequency of Detection (total hits/ total samples)	Location of Maximum Concentration
Contaminant Parameters						
SW8015MP (μg/kg)	Benzene	500	--	13.3 H	2/20	SS-15
	Ethylbenzene	--	--	1280	8/19	SB-03
	Toluene	--	--	209 H	12/20	SB-01
	Xylene (total)	--	--	15500	18/20	SS-02
	BTEX	100,000	--	16,735	13/20	@ SS-02
SW8080 (μg/kg)	4,4'-DDD	--	--	55.4	12/21	SS-02
	4,4'-DDE	--	--	18.7	10/21	SS-14
	4,4'-DDT	--	--	260	14/21	SS-14
	Aldrin	--	--	126	5/21	SS-15
	Dieldrin	--	--	114	2/21	SS-15
	Endosulfan I	--	--	1.34	1/21	SB-01
	Endrin	--	--	9.44 P	2/21	SS-02
	Endrin aldehyde	--	--	34.2	1/21	SS-02
	Heptachlor	--	--	1.15	2/21	SB-01
	Heptachlor epoxide	--	--	0.974 H	2/21	SB-03
	Methoxychlor	--	--	7.99	2/21	SB-01
	alpha-BHC	--	--	51.7	6/21	SS-15
	beta-BHC	--	--	9.96	3/21	SS-10
	delta-BHC	--	--	2.89	2/21	SS-10
	gamma-BHC -(Lindane)	--	--	37.4	6/21	SS-15
SW8240 (μg/kg)	Ethylbenzene	1,000,000	--	120	1/20	SB-03
	Meta-& Para-Xylene	1,000,000	--	773	1/20	SB-03
	Methylene chloride	--	--	148	17/20	SS-02
	Ortho-Xylene	1,000,000	--	589	2/20	SB-03

Table 3-16

(Continued)

Method	Analyte	ACM	Background Upper Tolerance Limit	Maximum Detected Concentration	Frequency of Detection (total hits/ total samples)	Location of Maximum Concentration
	Toluene	1,000,000	--	0.835 B	1/20	SS-06
	Trichloroethene	--	--	2.08	1/20	SS-14
SW8270 (mg/kg)	2-Methylnaphthalene	--	--	2.04	14/27	SS-14
	4-Methylphenol(p-cresol)	--	--	0.0197 F	2/27	SS-09
	Acenaphthene	--	--	1.5	8/27	SS-14
	Acenaphthylene	--	--	0.0382	1/27	SS-14
	Anthracene	--	--	0.641	6/27	SS-14
	Benzo(a)anthracene	--	--	0.554 F	11/27	SS-15
	Benzo(a)pyrene	--	--	0.952	7/27	SB-02
	Benzo(b)fluoranthene	--	--	0.669 F	11/27	SB-02
	Benzo(g,h,i)perylene	--	--	0.1	2/27	SB-03
	Benzo(k)fluoranthene	--	--	0.669 F	7/27	SB-02
	Butylbenzylphthalate	--	--	0.102	2/27	SB-04
	Chrysene	--	--	1.48	16/27	SB-02
	Dibenz(a,h)anthracene	--	--	0.0311	1/27	SS-09
	Dibenzofuran	--	--	1.2	6/27	SS-14
	Dibutylphthalate	--	--	0.0508	4/27	SS-01
	Fluoranthene	--	--	1.51	11/27	SS-14
	Fluorene	--	--	1.35	7/27	SS-14
	Naphthalene	--	--	7.49	11/27	SS-14
	Phenanthrene	--	--	3.82	11/27	SS-14
	Phenol	--	--	0.0417	1/27	SS-14
	Pyrene	--	--	1.18	14/27	SS-14
	bis(2-Ethylhexyl)phthalate	--	--	5.59	16/27	SS-02
Indicator Parameters						
SW6010 (mg/kg)	Aluminum	--	31,183.96	24500	26/26	SB-11
	Calcium	--	8,013.23	8090	26/26	SS-10

Table 3-16

(Continued)

Method	Analyte	ACM	Background Upper Tolerance Limit	Maximum Detected Concentration	Frequency of Detection (total hits/ total samples)	Location of Maximum Concentration
	Copper	--	31.67	34.1	26/26	SB-03
	Iron	--	43,192.35	34300	26/26	SS-16
	Magnesium	--	10,904.10	12700	26/26	SS-12
	Manganese	--	929.98	969	26/26	SB-04
SW6010 (mg/kg)	Potassium	--	845.75	932	26/26	SS-10
Contaminant Parameters						
SW6010 (mg/kg)	Chromium	--	48.44	41.6	26/26	SS-12
	Cobalt	--	19.52	15.9	26/26	SS-12
	Lead	--	10.69	501	26/26	SS-10
	Molybdenum	--	--	6.3	26/26	SS-16
	Nickel	--	50.68	56.7	26/26	SS-12
	Selenium	--	0.54	13.1	24/26	SS-10
	Vanadium	--	101.64	78.1	26/26	SS-01
	Zinc	--	90.01	76.6	26/26	SS-15
SW7421 (mg/kg)	Lead	--	10.69	546	26/26	SS-10
SW9012 (mg/kg)	Cyanide	--	--	3.6	3/27	SS-02

B = sample result is less than the UTL calculated for the blank samples for this analyte in this media.
F = co-elution with a similar analyte is suspected.
H = result given is suspected to be biased as much as 50% high.
P = presence of analyte is confirmed, however, concentration was not confirmed, concentration listed is a conservative estimate.
Underline indicates the preferred result when multiple analytical methods were performed for a single constituent.
ACM = Alaska Cleanup Matrix for Non-UST Soil.

Table 3-17

Asphalt Drum Storage Area Organic and Inorganic Subsurface Soil Results for Contaminants of Potential Concern, Elmendorf AFB, AK

Method	Analyte	ACM	Background Upper Tolerance Limit	Maximum Detected Concentration	Frequency of Detection (total hits/ total samples)	Location of Maximum Concentration
Contaminant Parameters						
SW8015MP (µg/kg)	Ethylbenzene	--	--	71700	4/32	SB-12
	Xylene (total)	--	--	110000	14/32	SB-12
SW8080 (µg/kg)	4,4'-DDD	--	--	7.82	2/15	SB-09
	4,4'-DDE	--	--	3.84	1/15	SB-09
	4,4'-DDT	--	--	13.9	6/15	SB-09
	Aldrin	--	--	3.07	5/15	SB-03
	Dieldrin	--	--	1.22 P	2/15	SB-03
	Endosulfan sulfate	--	--	5.14	6/15	SB-03
	Heptachlor	--	--	0.845	1/15	SB-01
	Heptachlor epoxide	--	--	0.346 B	2/15	SB-09
	beta-BHC	--	--	3.3	1/15	SB-01
	delta-BHC	--	--	1.46 H	1/15	SB-03
	gamma-BHC (Lindane)	--	--	1.1 H	4/15	SB-03
SW8240 (µg/kg)	Ethylbenzene	1,000,000	--	6760	1/29	SB-12
	Meta-& Para-Xylene	1,000,000	--	8780	2/29	SB-12
	Methylene chloride	--	--	226	9/29	SB-12
	Ortho-Xylene	1,000,000	--	11900	2/29	SB-12
SW8270 (mg/kg)	2-Methylnaphthalene	--	--	22.4	4/37	SB-12
	Benzo(g,h,i)perylene	--	--	0.947	2/37	SB-12
	Butylbenzylphthalate	--	--	0.016 H	2/37	SB-10
	Chrysene	--	--	0.543	3/37	SB-12
	Dibutylphthalate	--	--	0.0501	1/37	SB-03
	Fluorene	--	--	0.994	1/37	SB-12
	Naphthalene	--	--	9.59	3/37	SB-12
	Phenanthrene	--	--	0.584	2/37	SB-12

Table 3-17

(Continued)

Method	Analyte	ACM	Background Upper Tolerance Limit	Maximum Detected Concentration	Frequency of Detection (total hits/ total samples)	Location of Maximum Concentration
Indicator Parameters						
SW6010 (mg/kg)	Calcium	--	10,264.39	50400	34/34	SB-05
	Copper	--	59.84	216	34/34	SB-06
	Magnesium	--	14,784.34	16000	34/34	SB-11
	Manganese	--	709.45	988	34/34	SB-09
	Potassium	--	1,114.35	1640	34/34	SB-05
Contaminant Parameters						
SW6010 (mg/kg)	Lead	--	10.13	15.6	34/34	SB-03
	Molybdenum	--	--	12.3	31/34	SB-09
	Selenium	--	0.48	19.9	28/34	SB-09
	Vanadium	--	66.16	86.9	34/34	SB-09
	Zinc	--	76.17	155	34/34	SB-06
SW7421 (mg/kg)	Lead	--	10.13	18.8 S	34/34	SB-05

B = Sample result is less than the UTL calculated for the blank samples for this analyte in this media.
H = Result given is suspected to be biased as much as 50% high.
P = Presence of analyte is confirmed, however, concentration was not confirmed, concentration listed is a conservative estimate.
S = Concentration reported was obtained using method of standard addition.
Underline indicates the preferred result when multiple analytical methods were performed for a single constituent.
ACM = Alaska Cleanup Matrix for Non-UST Soil.

contaminants of concern, whether exceeding maximum contaminant levels (MCLs), or Alaska Cleanup Matrix standards or not, were included in the risk assessments.

3.2.1 Human Health Risk Assessment (HRA)

By determining under what land use conditions people are potentially exposed to what chemicals, for how long, and by what pathways of exposure, the cancer and non cancer risks were determined in the RI/FS.

Exposed Populations and Exposure Pathways -- Listed below are five possible exposure pathways to contamination. Details on the parameters used in the Health Risk Assessment are shown on Table 3-18.

- **Future On-Site Resident:** The HRA evaluated exposure of residents to contaminated surface soil through direct contact (incidental ingestion and dermal absorption) and inhalation of dusts. Their exposure to shallow aquifer groundwater through ingestion, inhalation (showering), and dermal contact (showering) was also evaluated.

- **Future On-Site Worker:** The HRA evaluated exposure of workers to contaminated subsurface soil through direct contact (dermal absorption and incidental ingestion), and inhalation of vapors from the soil. Ingestion of on-site water was also evaluated.

- **Current On-Site Worker:** The HRA evaluated exposure of workers to contaminated surface soil through direct contact (incidental ingestion and dermal absorption) and inhalation of dusts.

- **Construction Worker:** The HRA evaluated exposure of short term construction workers to contaminated subsurface soil through direct contact (incidental ingestion and dermal absorption) and inhalation of dusts.

- **Hypothetical Visitor:** The HRA evaluated exposure of an adult and child visitor to contaminated surface soil through direct contact (incidental ingestion and dermal absorption) and inhalation of dusts.

Table 3-18

Exposure Assumptions for OU 4

Parameters	Hypothetical On-Site Residential				On-Site Occupational		Construction Worker	Visitor	
	Adult		Child		Current	Hypothetical		Adult	Child
	RME	Average	RME	Average	RME	RME	RME	RME	RME
Body Weight (kg)	70^a	70^a	15^a	15^a	70^a	70^a	70^a	70^a	15^a
Exposure Duration (yrs)	30^a	9^b	6^d	6^d	25^a	25^a	1^c	30^c	6^c
Averaging time (carcinogens) (yrs)	70^d	70^d	N	NA	70^d	70^d	70^d	70^d	70^d
Averaging time (noncarcinogens) (yrs)	NA	NA	6^d	6^d	25^d	25^d	1^d	30^d	6^d
Total inhalation rate (m^3/day)	20^d	20^d	16^e	16^e	20^d	20^d	20^d	20^d	16^c
Soil Ingestion/Contact									
Soil Ingestion Rate (mg/day)	200/100$_b$	100^b	200/100$_b$	100^b	50^a	50^a	480^a	200/100^b	200/100^b
Soil to Skin Adherence Factor		.02^f		0.2^f	1^f	1^f	1^f	1^f	1^f
(mg/cm^2)	1^f	1900^b	1^f	1900^b	3160^f	3160^f	3160^f	5000^b	1900^b
Exposed Skin	5000^b	110^g	3900^b	110	SS	185^g	40^c	12^c	12^c
Exposed Frequency (days/yr)	185^g	9^b	185^g	6	—	—	—	24/6^b	24/6^b
Exposure Duration (yrs)	24/6^b		24/6^b						
Water Use									
Water Ingestion (L/day)	2A^a	1.4^e	.07^e	0.419	NA	1^a	NA	NA	NA
Indoor Inhalation Rate (m^3/day)	15^a	15^a	12^c	12	NA	NA	NA	NA	NA
Exposure Frequency (days/yr)	350^a	275^a	350^a	275	NA	250^a	NA	NA	NA
Skin Surface (cm^2)	23000^f	20000^f	10,600^f	8,660	NA	NA	NA	NA	NA
Shower Duration (min)	15^f	10^f	15^f	10	NA	NA	NA	NA	NA

[a] USEPA. Risk Assessment Guidance for Superfund - Volume I - Human Health Evaluation Manual, Supplemental Guidance. Interim Final Report, Office of Emergency and Remedial Response, Washington, D.C., 1991.
[b] USEPA. Supplemental Guidance for Superfund Risk Assessments in Region X. EPA 910/9-91-036, August 23, 1991.
[c] The construction worker scenario evaluates deep soil risk.
[d] USEPA. Risk Assessment Guidance for Superfund - Volume I - Human Health Evaluation Manual, Part A. Interim Final Report. Office of Emergency and Remedial Response, Washington, D.C., December 1989.
[e] USEPA. Exposure Factors Handbook. Office of Health and Environmental Assessment, Washington, D.C., 1989.
[f] USEPA. Dermal Exposure Assessment: Principles and Applications. Interim Report. Office of Health and Environmental Assessment, Washington, D.C., January 1992.
[g] Barnack, K. Personal Communications, 1994.

NA = Not applicable.
SS = Site specific; Hangar Areas-185, Asphalt Storage Area, and Fire Training Area-10 (see text).
RME = Reasonable Exposure.

Exposure Assumptions -- Risk can be calculated both for the average exposure and the reasonable maximum exposure (RME) of the population. All chemicals detected during sampling were evaluated as potential sources of cancer and noncancer health risks. In the case of metals, risks were only calculated if the metals concentrations exceeded back-ground concentrations. Average exposure risks were assessed using the measured concentrations at the site. RME risks were assessed using the 95% upper confidence limit (UCL) of the arithmetic mean concentration in soil and groundwater in subareas such as Hangar 11 or the FTA.

Using exposure levels and standard values for the toxicity of contaminants, excess lifetime cancer risks (ELCRs), and hazard indices (HIs), were calculated to describe cancer and noncancer risks, respectively. The ELCR is the additional chance that an individual exposed to site contamination will develop cancer during his/her lifetime. It is expressed as a probability such as 1×10^{-6} (one in a million).

The HI estimates the likelihood that exposure to the contamination will cause some negative health effect. An HI score above one indicates that some people exposed to the contamination may experience at least one negative health effect.

ELCRs and HIs were calculated using Reference Doses (RfDs) and Cancer Slope Factors (CSFs), which represent the relative potential of compounds to cause adverse noncancer and cancer effects, respectively.

Two sources of RfDs and CSFs were used for this assessment. The primary source was Integrated Risk Information System (IRIS) database, the USEPA repository of agency-wide verified toxicity values. If a toxicity value was not available through IRIS, then the latest available quarterly update of the Health Effects Assessment Summary Tables (HEAST) issued by the USEPA's Office of Research and Development was used as a secondary source. For some chemicals detected at OU 4, no toxicity value from IRIS or

HEAST was available, and toxicity values were provided by EPA Region X as provisional RfDs and cancer slope factors.

Table 3-19 summarizes the carcinogenic and noncarcinogenic human health risks calculated for each of the six areas within OU 4. The risks are based on hypothetical exposure to soil and groundwater. This shallow groundwater aquifer is not presently used, and will not be used in the future for supplying potable or non-potable water. For carcinogenic soil risk, the calculated results for the future resident (RME) and current on-site worker scenarios, which evaluate surface soil risks, are listed. The construction worker scenario results, which evaluates deep soil risk, is also provided. For carcinogenic groundwater risk, the calculated results for the future resident (RME), and future on-site worker scenarios are provided.

Risks exceeded 1×10^{-4} in groundwater in three areas: the FTA, Hangar 14, and Hangar 11. This risk occurs only when future residents drink and bathe with the shallow aquifer groundwater in the area for 30 years. The actual, presently existing risk posed by the shallow groundwater is significantly less than the worst case risk shown in the future residential column in Table 3-19. At the FTA and Hangar 14, the risk drops to below 1×10^{-4} under the future on-site worker scenario. For soil risk, only the FTA had a soil risk in excess of 1×10^{-5}, this occurring under the most conservative scenario for shallow soils. Under the current on-site worker scenario, only Hangars 8 and 10/11 and 10 had shallow soil risks greater than 1×10^{-6}. No subsurface soil risks exceeded 1×10^{-6}.

3.2.2 Environmental Risk Assessment (ERA)

The ERA was performed to determine if the reported concentrations of chemicals or calculated exposures to plants and wildlife at OU 4 are likely to produce adverse effects. Ecological effects were evaluated quantitatively by calculating Ecological Quotients (EQs). EQs are defined as the ratio between measured concentrations or predicted exposures, and critical effects levels. If an EQ is less than 1.0, the effect is unlikely to occur.

Table 3-19

Summary of Human Health Risks at Operable Unit 4, Elmendorf AFB, AK

Source Area	Soil Risk [a]			Chemical(s) Driving Risk
	Shallow Soils (<5feet)		Deep Soil	
	Future Residential [b]	Current On-Site Workers [c]	Construction Worker [d]	
FTA	2.7×10^{-5}	$<10^{-6}$	$<10^{-6}$	Benzo(a)pyrene, benzo(b)fluoranthene, dibenz(a,h)anthracene
Hangar 14	2.5×10^{-6}	$<10^{-6}$	$<10^{-6}$	Aldrin, benzo(a)pyrene, benzo(b)fluoranthene
Hangar 10/11	4.1×10^{-6}	1.5×10^{-6}	$<10^{-6}$	Benzo(a)pyrene, benzo(b)fluoranthene, dibenz(a,h)anthracene
Hangar 8	3.5×10^{-6}	1.2×10^{-6}	$<10^{-6}$	Benzo(a)pyrene, benzo(b)fluoranthene, dibenz(a,h)anthracene
Hangar 15	2.1×10^{-6}	$<10^{-6}$	$<10^{-6}$	Benzo(a)pyrene, PCB-1260, benzo(b)fluoranthene
ADSA	3.1×10^{-6}	$<10^{-6}$	$<10^{-6}$	Benzo(a)pyrene, aldrin, dieldrin

Source Area	Groundwater Risk [a]		Chemical(s) Driving the Risk
	Future Residential [b]	Future On-Site Worker [e]	
FTA	2.1×10^{-4};HI=2.8	1.5×10^{-5};HI=<1	Benzene, ethylbenzene, toluene, HVOCs
Hangar 14	2.0×10^{-4};HI=1.2	1.2×10^{-5};HI=<1	Benzene
Hangar 11	3.5×10^{-3};HI=9.1	2.0×10^{-4};HI=<1	Benzene, toluene ethylbenzene
Hangar 8/10	9.7×10^{-5}	5.8×10^{-6}	Benzene
Hangar 15	1.5×10^{-5}	$<10^{-6}$	TCE, chloroform, chloromethane
ADSA	$<10^{-6}$	$<10^{-6}$	None

[a] Risks are calculated by using the 95% upper confidence limits (UCLs) for contaminants present. The 95% UCLs represent a conservative estimate of the "worst case" contamination.

[b] Excess cancer risks conservatively assumed for 30 yesrs of exposure (drinking groundwater, contact with soil, etc.) by future residents (Reasonable Maximum Exposure).

[c] Excess cancer risks conservatively assumed for 30 years of exposure while working on-site under current conditions.

[d] Excess cancer risks conservatively assumed for 1 year of exposure during on-site construction work (digging, etc.).

[e] Excess cancer risks conservatively assumed for 25 years exposure while working on-site under hypothetical future conditions (drinking groundwater, etc.).

HI = Hazard Index (a measure of noncarcinogenic risk).

Critical effects are defined in the selection of assessment and measurement endpoints. Assessment endpoints are the general environmental resource or value that is being protected. A measurement endpoint is a specific criterium that is used to evaluate the more general assessment endpoint.

Compared to undeveloped portions of the base, the sites that comprise OU 4 do not contain major ecological resources. The naturally occurring vegetation has been removed from most of the areas. The existing vegetation in the contaminated areas varies from barren to sparse grassy areas. The species diversity is much lower in OU 4 than in any of the undeveloped portions of the base.

The ERA focused on evaluating potential impacts of the contamination on the selected indicator species: moose and meadow vole. Because of its large home range, the moose's exposures to OU 4 contaminants were small, resulting in EQs well below 1.0 for all chemicals. Although the meadow vole EQs for copper and lead exceeded 1.0 at many sites, EQs for background concentrations also exceeded 1.0, indicating that the methodology is overly conservative and not useful for evaluating low level contamination. Although the EQs for selenium also exceeded 1.0, the uniform concentrations of selenium at all sites appear to be naturally occurring and not indicative of contamination.

No significant impacts to plants or animals warranting action were determined to be present based on the results of the ERA.

Uncertainties Associated with the Risk Assessment

Risk assessments involve calculations based on a number of factors, some of which are uncertain. The effects of the assumptions and the uncertainty factors may not be known. Usually, the effect is difficult to quantify numerically, so the effect is discussed qualitatively. Some of the major assumptions and uncertainty factors associated with the risk assessment are the following:

- Existing concentrations are assumed to be the concentrations in the future. No reduction through natural degradation and attenuation over time is taken into account (may overestimate risk).
- No increase through additional contamination is assumed (may underestimate risk).
- Potential degradation products of existing organic contaminants are not considered (may overestimate or underestimate risk).
- Potential effects on the moose and meadow vole are assumed to be representative of other animals at OU 4 (may overestimate or underestimate risk).

3.3 Summary

Actual or threatened releases of hazardous substances from OU 4, if not addressed by implementing the response action selected in this ROD, may present an imminent and substantial endangerment to public health, welfare, or the environment.

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4.0 REMEDIAL ACTION OBJECTIVES, ALTERNATIVES, AND COMPARATIVE ANALYSIS

The following subsections discuss the remedial action objectives for OU 4, and present a description of the various cleanup alternatives which were evaluated to achieve those remedial objectives. The results of the detailed comparison made between those alternatives are also presented.

4.1 Contaminants of Concern (COCs)

COCs were developed from the results of the risk assessment and by considering regulatory standards. Each constituent having an individual contribution of greater than 1×10^{-6} carcinogenic (RME) risk, or an HI greater than 1.0, was selected as a COC. In addition, any constituent exceeding potential cleanup levels (MCLs for groundwater or ACM levels for soil) was also considered a COC. The final COCs are shown on Table 4-1, with the individual risk contributed and basis for identifying the COC (risk or regulatory standard). The cleanup levels that will be achieved by the remedial action at OU 4 are also listed in Table 4-1.

4.2 Remedial Action Objectives

Specific remediation alternatives were developed and evaluated for the areas with potential risk, and that exceeded the cleanup levels identified in Section 3.3. Specific remedial action objectives are:

- Protect human health and the environment by preventing ingestion of and contact with contaminated media by people;
- Protect uncontaminated media by preventing releases from sources;
- Use treatment techniques whenever practicable; and

Table 4-1

Summary of Contaminants of Concern[1] Analysis, Operable Unit 4 Elmendorf AFB, AK

Chemical	Maximum Concentration	Maximum Cancer Risk	Maximum Hazard Index	Basis for COC	Cleanup Level	Basis for Cleanup Level
Groundwater:						
Benzene	2,600 µg/L	3.5E-03[a]	--	Exceeds MCL; contributes to a risk > 10^{-6}	5 µg/L	MCL
1,1-Dichloroethene	13.7µg/L	2.8E-04[b]	--	Exceeds MCL; contributes to a risk > 10^{-6}	7 µg/L	MCL
1,2-Dichloroethane	12.1 µg/L	1.3E-05[b]	--	Exceeds MCL; contributes to a risk > 10^{-6}	5 µg/L	MCL
Trichloroethene	74.7 µg/L	1.3E-05[b]	0.19[b]	Exceeds MCL; contributes to a risk > 10^{-6}; contributes to HQ > 0.1	5 µg/L	MCL
Dieldrin	0.0335 µg/L	3.0E-05[c]	--	Contributes to a risk > 10^{-6}	--	--
Chloroform	2.72 µg/L	5.2E-06[d]	--	Contributes to a risk > 10^{-6}	100 µg/L	MCL
Chloromethane	11.7 µg/L	2.9E-06[a]	--	Contributes to a risk > 10^{-6}	--	--
Carbon Tetrachloride	1.26 µg/L	2.2E-06[c]	--	Contributes to a risk > 10^{-6}	5 µg/L	MCL
Vinyl Chloride	0.125 µg/L	1.6E-06	--	Contributes to a risk > 10^{-6}	2 µg/L	MCL
Toluene	5,590 µg/L	--	6.3[a]	Exceeds MCL; contributes to HQ > 0.1	1000 µg/L	MCL
Ethylbenzene	1,360 µg/L	--	2.6[a]	Exceeds MCL; contributes to HQ > 0.1	200 µg/L	MCL
cis-1,2-Dichloroethene	741 µg/L	--	0.61[b]	Exceeds MCL; contributes to HQ >0.1	70 µg/L	MCL
Tetrachloroethene	40.5 µg/L	--	0.17[b]	Exceeds MCL; contributes to HQ >0.1	5 µg/L	MCL
1,1,1-Trichloroethane	23 µg/L	--	--	Exceeds MCL	200 µg/L	MCL

Table 4-1

(Continued)

Chemical	Maximum Concentration	Maximum Cancer Risk	Maximum Hazard Index	Basis for COC	Cleanup Level	Basis for Cleanup Level
Soils:						
Benzo(a)pyrene	2.21 mg/kg	1.8E-05 [e]	—	Contributes to a risk > 10^{-6}	--	--
Benzo(b)fluoranthene	4.72 mg/kg	3.6E-06 [e]	--	Contributes to a risk > 10^{-6}	--	--
Dibenz(a,h)anthracene	0.54 mg/kg	3.0E-06 [e]	--	Contributes to a risk > 10^{-6}	--	--
Benzo(a)anthracene	2.18 mg/kg	2.0E-06 [e]	--	Contributes to a risk > 10^{-6}	--	--
PCB-1260	151 µg/kg	1.9E-06 [e]	--	Contributes to a risk > 10^{-6}	--	--
Benzo(k)fluoranthene	4.72 mg/kg	1.7E-06 [e]	--	Contributes to a risk > 10^{-6}	--	--
Indeno(1,2,3-cd)pyrene	0.897 mg/kg	1.3E-06 [e]	--	Contributes to a risk > 10^{-6}	--	--
Benzene	715 µg/kg	--	--	Exceeds ACM	500 µg/kg	ACM
BTEX	186,040 µg/kg	--	--	Exceeds ACM	100,000 µg/kg	ACM
Diesel	110,000 mg/kg	--	--	Exceeds ACM	2000 mg/kg	ACM
Gasoline	15,600 mg/kg	--	--	Exceeds ACM	1000 mg/kg	ACM
Jet Fuel	13,000 mg/kg	--	--	Exceeds ACM	2000 mg/kg	ACM
Kerosene	2,200 mg/kg	--	--	Exceeds ACM	2000 mg/kg	ACM

[1]Cancer risk ≥ 1.0E-06 or HQ≥0.1 for soil or groundwater scenario with total HQ of ≥1.0; or concentrations found in excess of regulatory levels. If cancer risk or HQ did not exceed standards, it was marked as "--".

[a] Risk calculated for Hangar 11 Area Plume.
[b] Risk calculated for Fire Training Area Plumes.
[c] Risk calculated for Hangar 14 Area Plume.
[d] Risk calculated for Hangar 15/Building 42-410 Area Plume.
[e] Risk calculated for Fire Training Area Soil.

MCL = Maximum Contaminant Level.
ACM = Alaska Cleanup Matrix, Level D.

- Implement a cost effective solution that can achieve the cleanup levels for the final COCs.

These remedial action objectives are applicable for all contaminated groundwater and soil areas.

Measures to meet the second objective have already been taken. At Hangar 11, the leaking USTs and valve pit were taken out of service. The floor drains in the hangars are no longer used. At the FTA, fire-fighting activities have been stopped and a leaking UST was removed. The drums and surface soil at the ADSA were removed and trees were planted.

4.3 Alternatives

As discussed above, the primary COCs are halogenated and non-halogenated volatile organic compounds in groundwater, and semi-volatile organic compounds (SVOCs) and fuel constituents in soils. Cleanup alternatives were developed for groundwater and soil, therefore, the development of alternatives was segregated accordingly. Soil alternatives were divided into those applicable to shallow soils and those applicable to deep soils. Each alternative was evaluated for each source area.

The four most promising groundwater alternatives ("G") and five most promising soil alternatives ("S") were chosen on the basis of the nine CERCLA criteria. These included no action (G1, S1); institutional controls with intrinsic remediation (G2, S2); in-situ air sparging (G3); excavation and recycling (S3); in-situ bioremediation (G4); excavation, biopiling, and backfilling (S4); and in-situ bioventing (S5).

Time to complete cleanup for biological alternatives was calculated using first order decay, with the most conservative published values of half-lives for the primary contaminant of concern at each source area. Biological alternatives include intrinsic remediation(S2), biopiling (S4), and bioventing (S5). For shallow and above ground biological soil treatments, little or no treatment was assumed to occur during the winter months. For groundwater, a two-dimensional fate and transport model was used which considers biodegradation, retardation, advection, dispersion, and adsorption/desorption. Cleanup times for each alternative are presented in the discussion below. This model did not consider soil contamination as a continuing source of contamination to groundwater, but it did consider retardation caused by contaminants adhering to soil particles.

Except for the no action alternative, the cost of each alternative includes monitoring of soil and groundwater for the estimated time period to complete clean up, up to a maximum of 30 years, in accordance with CERCLA guidance. Net present value cost was calculated using a seven percent discount rate. Costs estimates were calculated using the USAF RACER model and have an accuracy of -30% to +50%.

The alternatives are as follows:

Alternatives G1 and S1: No Action (Groundwater and Soils)

There are no costs associated with this alternative.

Evaluation of this alternative is required by CERCLA as a baseline reflecting current conditions without any cleanup. This alternative is used for comparison with each of the other alternatives. It does not take into consideration future events such as intrinsic remediation, however, intrinsic remediation is expected to occur. As a result, cleanup levels are expected to be achieved within the same timeframe as the intrinsic remediation alternative (thirteen years for groundwater and eleven years for soil). This alternative does not include long-term monitoring, controls, or access restrictions; therefore, potential exposure pathways would not be eliminated and future degradation would not be monitored.

Alternatives G2 and S2: Institutional Controls with Intrinsic Remediation (ICIR) (Groundwater and Soils)

Costs and time to cleanup for these alternatives are presented in Table 4-2.

Groundwater and soil would be remediated by natural processes (physical, chemical, and biological) that reduce contaminant concentrations. A study of intrinsic remediation at Elmendorf AFB was conducted by AFCEE. The results of this study indicate that contamination is degrading. Base-wide modeling conducted under OU 5 RI/FS indicates contamination will be reduced. Contaminants should degrade to regulatory levels within 13 years. While intrinsic remediation is working, existing land use restrictions would continue to be used to limit access to contaminated groundwater and soil. Land use restrictions are part of the Base Comprehensive Plan. Hazardous areas will be posted with warning signs. These controls would prohibit construction of residences and groundwater wells over areas with contaminant plumes, and prohibit excavation of soil in areas of soil contamination that exceed acceptable levels. The USAF would continue to monitor groundwater quality semi-annually, and soil quality bi-annually until cleanup levels are achieved. If there is any indication that intrinsic remediation is not achieving the cleanup levels within the expected timeframes, the remedial actions would be reevaluated and additional action taken if necessary.

Alternative G3: In Situ Air Sparging (Groundwater)

Costs and time to cleanup for this alternative are presented in Table 4-3.

In Alternative G3, air sparging wells would be installed in the area of contaminated groundwater. Air would be injected into the wells and be sparged (blown) into the groundwater below the water table. As the air passes through the contaminated groundwater, the contaminants of concern would be stripped from the water phase into the gas phase.

Table 4-2

Costs and Time to Cleanup for Alternative G2 and S2, Operable Unit 4, Elmendorf AFB, AK

Source Area	Costs (Thousands of $)			Time to Cleanup (years)
	Capital	Annual	Present Worth	
Alternative G2: Institution Controls With Intrinsic Remediation (ICIR)(Groundwater)				
FTA	24	19	188	13
Hangar 8	13	10	72	8
Hangar 10/11	10	8	79	13
Hangar 14	9	7	48	7
Hangar 15	8	6	40	7
Alternative S2: Institution Controls With Intrinsic Remediation (ICIR) (Soils)				
FTA	20	9	76	8
Hangar 8	4	3	10	11
Hangar 10/11	12	6	27	2
Hangar 14	4	3	12	4
Hangar 15	8	3	14	3
ADSA	15	8	61	4

Table 4-3

Costs and Time to Cleanup for Alternative G3 and S3, Operable Unit 4, Elmendorf AFB, AK

Source Area	Costs (Thousands of $)			Time to Cleanup (years)
	Capital	Annual	Present Worth	
Alternative G3: In Situ Air Sparging (Groundwater)				
FTA	650	152	1642	9
Hangar 8	767	86	992	3
Hangar 10/11	171	55	389	4
Hangar 14	115	64	334	4
Hangar 15	126	51	336	5
Alternative S3: Excavation and Recycling (Soil)				
FTA	1876	0	1876	1
Hangar 8	136	0	136	1
Hangar 10/11	314	0	314	1
Hangar 14	307	0	307	1
Hangar 15	161	0	161	1
ADSA	374	0	374	1

In addition, some of the oxygen would dissolve into the groundwater, creating an aerobic environment that would enhance biodegradation of some of the remaining contaminants. Some of the contaminants could migrate to the land surface and be emitted to the atmosphere. This alternative also would rely on land use restrictions and the monitoring program described in Alternative G2.

Alternative S3: Excavation and Recycling (Soil)

Costs and time to cleanup for this alternative are presented in Table 4-3.

Alternative S3 consists of excavating the contaminated shallow soils and transporting them to a commercial recycling facility in the Anchorage area. Excavations would be backfilled with clean soil. At the recycling facility, the contaminated soils typically are treated in a low-temperature thermal treatment unit designed to remove volatile contaminants from the soil. The soil is then recycled for road base or other projects. This alternative was developed for shallow soils (15,000 in-place yd^3) only, because excavating all contaminated deep soils (an additional 20,000 in-place yd^3) would not be a cost-effective or technically feasible alternative.

Alternative G4: In Situ Bioremediation (Groundwater)

Costs and time to cleanup for this alternative are presented in Table 4-4.

In this alternative, a series of wells would be installed to extract contaminated groundwater. Extracted groundwater would be piped above ground to a mixing tank, where the pH is adjusted and oxygen and nutrients are added. The groundwater would then be reinjected into the aquifer through injection wells to biodegrade dissolved contaminants in place. When compared with other contaminants, the principal contaminants, halogenated volatile organic compounds (HVOCs) at Hangar 15/Building 43-410, and at part of the FTA, are more resistant to bioremediation. Therefore, Alternative G4 would not be as effective at

Table 4-4

Costs and Time to Cleanup for Alternative G4 and S4, Operable Unit 4, Elmendorf AFB, AK

Source Area	Costs (Thousands of $)			Time to Cleanup (years)
	Capital	Annual	Present Worth	
Alternative G4: In Situ Bioremediation (Groundwater)				
FTA	843	381	3117	8
Hangar 8	1640	675	3409	3
Hangar 10/11	444	147	830	3
Hangar 14	228	75	484	4
Hangar 15	438	125	952	5
Alternative S4: Excavation, Biopile, Backfill (Soils)				
FTA	589	0	589	1
Hangar 8	52	0	52	1
Hangar 10/11	124	0	124	1
Hangar 14	112	0	112	1
Hangar 15	58	0	58	1
ADSA	147	0	147	1

treating the groundwater at these two sites. This alternative also would rely on land use restrictions and the monitoring program described in Alternative G2.

Alternative S4: Excavation, Biopile, Backfill (Soils)

Costs and time to cleanup for this alternative are presented in Table 4-4.

Alternative S4 consists of excavating contaminated shallow soils, transporting them to an on-base biopile cell, treating the soils until acceptable levels are reached, and backfilling the excavations with treated soil or other clean borrow material from on base. At the biopile cell, soils would be mounded over a series of perforated pipes on top of an impermeable liner. Air drawn through the overlying pile would enhance aerobic degradation of organic contaminants and strip the volatile constituents from the soils. Soil from the pile would be sampled periodically to determine the progress of the remediation. Once the soil is remediated, it would be used for backfill on base.

Alternative S5: In Situ Bioventing (Soils)

Costs and time to cleanup for this alternative are presented in Table 4-5.

In bioventing, air is injected into the soils to increase the oxygen content. By increasing the oxygen content of the soil gas, bioventing increases aerobic degradation of the contaminants by naturally occurring microorganisms. Unlike Alternatives S3 and S4, this alternative was developed to address only deep soil contamination. Bioventing is considered highly effective for deep soil contamination. In addition, Alternative S5 calls for the land use restrictions and soil monitoring described in Alternative S2.

Table 4-5

Costs and Time to Cleanup for Alternative S5, Operable Unit 4, Elmendorf AFB, AK

Source Area	Costs (Thousands of $)			Time to Cleanup (years)
	Capital	Annual	Present Worth	
Alternative S5: In Situ Bioventing (Soils)				
FTA	90	46	173	2
Hangar 8	NA	NA	NA	NA
Hangar 10/11	43	18	76	2
Hangar 14	NA	NA	NA	NA
Hangar 15 Bldg 43-410	42	11	53	1
ADSA	43	27	92	9

NA = Not Applicable

4.4 Summary of Comparative Analysis of Alternatives

The comparative analysis describes how each of the alternatives meet the CERCLA evaluation criteria relative to each other.

4.4.1 Threshold Criteria

Overall Protection of Human Health and the Environment

For groundwater, Alternative G3 (air sparging) would provide the greatest protection of human health and the environment from a technical standpoint, because groundwater would be actively treated to acceptable levels. Contaminants would be removed from the groundwater, and be biodegraded or released to the atmosphere. Alternative G4 (in situ bioremediation) is slightly less protective, because although it is an active treatment, it may not be effective for treating the HVOCs which are present at the FTA and Hangar 15. Active treatment of the groundwater is essential where a more immediate removal of the contamination is required, such as if the groundwater is currently being used. Alternative G2 (institutional controls with intrinsic remediation, or ICIR) is not an active treatment, however, it provides some protection of human health and the environment in that the institutional controls associated with this alternative would reduce contact with contaminated groundwater and thus there would continue to be no groundwater risk. Monitoring would also ensure that the institutional controls continued to effectively prohibit groundwater contact, by making sure that the groundwater plumes associated with the OU 4 source areas do not migrate beyond these restricted areas. Alternative G1 (no action) is the least protective, since there would be no institutional controls and no monitoring, so that future contact with groundwater contaminants would still be possible. For each of the five groundwater plumes at OU 4, removal of the source is essential to meeting this criteria. As previously stated, the sources for each of the plumes with high levels of contaminants (FTA, Hangar 11, and Hangar 8) have been decommissioned, removed, or will be treated (deep soils).

For shallow soils, Alternatives S3 (excavation and recycling) and S4 (excavation and biopiling) would equally provide the greatest protection of human health and the environment. In both cases, contaminated soils would be removed (thereby eliminating risks), but some contaminants would be released to the atmosphere during excavation. These alternatives are very effective for treating soils with moderate to high risks, where immediate removal is desirable. At OU 4, soil risks are moderate to low even under the most conservative residential exposure scenario. Under the current land use, there is little or no risk in the OU 4 shallow soils. Soil disposal issues would also need to be addressed with both Alternatives S3 and S4. Alternative S2 (ICIR) would also be protective to human health, using land use restrictions to prohibit contact with, or ingestion of the low risk contaminated shallow soils. Intrinsic remediation of the soils will be monitored to evaluate contaminant reduction. Land use restrictions will remain fully in place until cleanup levels are achieved. High concentrations of heavy hydrocarbons at the ADSA may not degrade. Alternative S1 (no action) is the least protective, since there would be no restricted access to contaminated soils.

For deep soils, Alternative S5 (bioventing) would provide the greatest protection of human health and the environment, because contaminants would be broken down in situ, thereby eliminating the potential for contaminant migration into the groundwater. Soils would not be removed, so disposal concerns and short-term exposures would be minimal. Bioventing may strip some contaminants from the soil into the vapor phase. The soil gas and these contaminants would be released to the atmosphere. Bioventing is an effective alternative for the protection of human health, where active soil treatment is warranted due to the risks the deep soils may pose to other media. Other than the threat the deep soils at the FTA and ADSA pose as a potential contaminant source to groundwater, the deep OU 4 soils pose no other risks without excavation. With Alternative S2, land use restrictions would prohibit excavation of contaminated soil, thereby also eliminating most of the risk to humans. The risk from the potential migration of contaminants into groundwater would still exist. Alternative S1 is the least protective, since there would be no restrictions on excavation of contaminated soil.

Compliance with ARARs

For groundwater, Alternative G3 (air sparging) would comply with applicable or relevant and appropriate cleanup standards (ARARs). It is likely that this type of treatment is unnecessary, however, since there is no current groundwater risk, and no groundwater users. Alternative G4 (in situ bioremediation) would also comply. According to the modeling results and additional studies conducted at OU 4, Alternative G2 (ICIR) would eventually comply with ARARs, only the time to achieve these levels would be increased. The estimated period of time for cleanup is 7-13 years. This is an appropriate length of time, given that the current and future land uses do not include residential or recreational uses. Alternative G1 (no action) would fail to meet the requirements since there would be no way to confirm whether ARARs have been met.

For shallow soils, Alternatives S3 (excavation and recycling) and S4 (biopiling) would both comply with ARARs. These alternatives would provide a rapid response for the removal of soils posing a potential threat to human health and the environment. Alternative S2 (ICIR) would eventually meet the standards, except possibly at the ADSA for some substances (asphalt). Alternative S1 (no action) would fail to meet the requirements since there would be no way to confirm any reduction in contaminant levels.

For deep soils, Alternative S5 (bioventing) would comply with ARARs. Alternative S2 (ICIR) would eventually meet the standards, except possibly at the ADSA and FTA for some substances (high concentrations of heavy hydrocarbons at the ADSA; solvents at the FTA). This alternative would also not address the need for removal of the potential contaminant source for the FTA groundwater plume, or future groundwater contamination at the ADSA. Alternative S1 (no action) would fail to meet the requirements since there would be no way to confirm any reduction in contaminant levels.

4.4.2 Primary Balancing Criteria

Alternatives G2 through G4, and S2 through S5, will be the only alternatives considered further in the comparative analysis. The no action alternatives (G1 and S1) are not evaluated based on the primary balancing criteria or the modifying criteria, since these did not meet the threshold criteria.

Long-Term Effectiveness and Permanence

This criterion has to do with long-term protection of human health and the environment (reduction of risks), and adequacy and reliability of controls. Long-term management ("controls") would include a five-year review, land use restrictions, and annual groundwater monitoring. For groundwater, Alternatives G3 and G4, as aggressive treatments, would reduce contamination. Long-term management after the treated groundwater met cleanup standards would not be needed. Alternative G2 would reduce future risk through land use controls. Contamination is expected to be reduced permanently, but over a longer period of time, therefore requiring additional long-term management. For all three alternatives, decommissioning of the contaminant sources is essential to meeting this criterion.

For shallow soils, Alternative S3 and S4 would reduce risks by removing contaminated soil and treating contaminants. No long-term management would be needed after the contaminated soils are removed and treated. Because of the low risks already associated with the shallow soils at OU 4, aggressive risk reduction may not be necessary. Alternative S2 would reduce risks by prohibiting contact or ingestion of the contaminated medium through institutional controls. Alternative S2 may not meet the cleanup goals at the ADSA. If Alternative S2 does not meet the cleanup goals, more aggressive treatments could be implemented such as Alternatives S3, S4, or S5. Long-term management would include a five-year review, land use restrictions, and soil sampling.

For deep soils, Alternative S5 would reduce the risks associated with potential soil excavation by breaking down contaminants through treatment. No long-term management would be needed. Alternative S2 would also reduce risks through land use restrictions. Long-term management would include a five-year review, land use restrictions, and soil sampling.

Reduction in Toxicity, Mobility, and Volume Through Treatment

For groundwater, Alternative G4 would break down most contaminants, thereby eliminating their toxicity and volume. By extracting contaminated groundwater, contaminant mobility would also be reduced. For sites with an elevated and immediate risk, a groundwater extraction treatment would be the preferred alternative for quickly reducing the effects of the contaminants. The groundwater risk at OU 4 is highest at Hangar 11. However, since this elevated risk is based on a hypothetical scenario and the source of contamination for this plume is out of service, a groundwater treatment remedy may not be necessary here or at the other OU 4 groundwater plumes. Alternative G3 would reduce contaminant toxicity and volume through treatment, however it is uncertain whether this alternative would be effective given the soil and climatic conditions at OU 4. Alternative G2 will reduce toxicity and volume through intrinsic processes, but does not involve groundwater treatment, so the time to achieve the reduction would be longer. Mobility would also not be affected.

For shallow soils, Alternatives S3 and S4 would provide equal contaminant reduction. With Alternative S4, biodegradation would permanently reduce the toxicity, mobility, and volume of contaminants in the soil. With Alternative S3, the contaminated soil would be removed from the base, thereby eliminating on-base contamination. The toxicity, mobility, and volume of contamination would then be reduced by off-site treatment. Again, due to the minimal risks associated with the shallow soils at OU 4, excavation as a treatment option may not be necessary. With Alternative S2, the toxicity and volume of contaminants would be reduced naturally through intrinsic remediation, but mobility would not be affected.

However, this is not significant because the shallow soil fuel residues present at the OU 4 source areas are of low mobility. Alternative S2 does not treat the soils.

For deep soils, Alternative S5 would reduce the toxicity and volume of contaminated soils through biodegradation and volatilization; some contaminants could mobilize, but the overall potential for deep soils to impact groundwater at sites where the deep soils pose this risk would be greatly reduced. Alternative S2 would slowly reduce the toxicity and volume of contaminants intrinsically, but would not affect mobility. The possibility of the deep-soil contamination migrating to groundwater at the FTA, and ADSA, would not be affected.

Short-Term Effectiveness

This criterion evaluates risks to workers, the community, and the environment during the period of time until remedial action objectives are met. For groundwater, Alternatives G3 and G4 are equally effective over the short term with minimal risks. Air sparging (G3) may strip contaminants into the vapor phase and release them to the atmosphere, but concentrations should very low. Alternative G2 would have no significant short-term risk, since implementation would result in an insignificant exposure. Similar worker protection measures would be taken for each of these alternatives. Time until cleanup is complete is listed for each site on Tables 4-2, 4-3, and 4-4. Remediation times for G3 and G4 range from 3 to 9 years. For G2, remediation times range from 7 to 13 years.

For shallow soils, Alternative S2 was determined to be the most effective over the short term, since implementation would require minimal exposure to the contaminated soil. Alternatives S3 and S4 were also determined to be equally effective over the short term. Excavation of soils would pose some risks to workers, but routine safety precautions would make these risks negligible. Remediation times for Alternative S2 are the longest, 2 to 11 years. Alternatives S3 and S4 would be completed in a few weeks.

For deep soils, Alternative S2 and S5 were determined to be equally effective over the short term. With both alternatives, implementation would result in minimal exposure of contamination to workers. Minor air emissions may result from bioventing activities (S5), but concentrations should be very low. Alternative S2 would require 2 to 8 years. Alternative S5 would be completed in less than 2 years.

Implementability

For groundwater, Alternative G2 could be implemented easily, since it entails the installation of long-term monitoring wells only, and would not significantly disturb base operations. Alternatives G3 and G4 might interfere with some base operations near the hangars, and require more substantial maintenance and operations over the life of the systems. Alternative G3 is also a less well-proven technology, and potential heterogeneities in the soil at OU 4 could cause preferential flow paths. With Alternative G4, cold weather may cause aboveground pipes to freeze, winter maintenance would be problematic, and the required equipment would require significant space.

For shallow soils, Alternative S2 could be implemented the most easily, similar to groundwater. Only certain access restrictions and monitoring would be required. With Alternatives S3 and S4, excavation would disturb base operations near the hangars. Necessary equipment and specialists should be readily obtainable. Space for on-base treatment would be required for Alternative S4. For Alternative S3, off-base disposal problems may also complicate the success of this alternative.

For deep soils, Alternative S2 could be implemented the most easily, similar to shallow soils. Only certain access restrictions and monitoring would be required. Alternative S5 could interfere with some base operations near the hangars. Necessary equipment and specialists would be required.

Cost

For all groundwater, Alternatives G4 ($8.8 million) and G3 ($3.7 million) cost significantly more than Alternative G2 ($0.43 million).

For all soils, Alternatives S3 ($3.2 million) and S4 ($2.2 million) cost significantly more than Alternative S5 ($0.39 million—deep soils only) and significantly more than Alternative S2 ($0.39 million).

All costs are in present value.

4.4.3 Modifying Criteria

State Acceptance

The State of Alaska concurs with the USAF and the USEPA in the selection of Alternatives G2 and S2 (ICIR) for groundwater and shallow soils at all source areas, and for the deep soils at Hangar 15; and Alternative S5 (bioventing) for deep soils at the FTA, Hangar 10/11, and the ADSA. The Air Force will investigate and implement other remedial alternatives should the selected remedies prove to be unsuccessful at meeting the required cleanup levels.

Community Acceptance

Based on the comments received during the public comment period, the public has no preference of alternatives. One letter questioned the cost of Alternative S3. The volume of soil to be handled is significantly greater than the in-place volume listed in the Proposed Plan because of bulking during excavation and handling. Also, costs were estimated using the RACER model for consistency between alternatives and there may be differences in actual bids received.

Two letters were received which supported the selection of the preferred alternatives.

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5.0 SELECTED REMEDY

The selected remedy for OU 4 is presented in Table 5-1, and includes Alternatives G2 and S2 (institutional controls with intrinsic remediation - ICIR) for groundwater and shallow soils at all source areas, and deep soils at Hangar 15; and Alternative S5 (bioventing) for deep soils at the Fire Training Area, Hangar 11, and the ADSA. The selected remedy is hereafter referred to as Alternative G2/S2/S5. This alternative best meets the nine CERCLA criteria. It protects human health and the environment, and complies with ARARs. It is effective at reducing contamination both in the short term and long term, and is implementable, cost-effective, and acceptable to the public and the State of Alaska. This alternative provides an appropriate level of treatment to reduce risks and comply with ARARs. Modeling showed that cleanup can occur within a reasonable time (13 years). The known sources of contamination have been controlled, so they are no longer a threat. This remedy will naturally degrade the residual contamination. Bioventing will increase the rate of degradation in those areas that have soil contamination that may impact groundwater or COCs that do not degrade easily.

Alternative G2/S2/S5 was selected because it best provides the following specific benefits at OU 4:

- Deep contaminated soils potentially contributing contaminants to groundwater at the FTA, Hanger 11, and the ADSA are actively treated with bioventing;
  - ▹ At the FTA, some soil COCs have been detected in low levels in the groundwater, thus demonstrating interaction between soil and groundwater;
  - ▹ At Hangar 11, contamination is found in soils close to the groundwater table;
  - ▹ At the ADSA, COCs include heavier hydrocarbons which are more difficult to remediate intrinsically;

Table 5-1

Selected Remedy for Operable Unit 4, Elmendorf AFB, AK

Source Area	Costs (Thousands of $) Capital	Annual	Present Worth	Time to Cleanup (years)
Alternative G2: Institution Controls With Intrinsic Remediation (ICIR)(Groundwater)				
FTA	24	19	188	13
Hangar 8	13	10	72	8
Hangar 10/11	10	8	79	13
Hangar 14	9	7	48	7
Hangar 15	8	6	40	7
Alternative S2: Institution Controls With Intrinsic Remediation (ICIR) (Soils)				
FTA (Shallow)	20	9	76	8
Hangar 8 (Shallow and Deep)	4	3	10	11
Hangar 10/11 (Shallow)	12	6	27	2
Hangar 14 (Shallow and Deep)	4	3	12	4
Hangar 15 (Shallow and Deep)	8	3	14	3
ADSA (Shallow)	15	8	61	4
Alternative S5: In Situ Bioventing (Deep Soils)				
FTA	90	46	173	2
Hangar 10/11	43	18	76	2
ADSA	43	27	92	9

- Institutional controls will protect against potential risk to human health by reducing the possibility that contaminated shallow soils will come in contact with people until cleanup levels (ACM for fuels and fuel constituents) are met; and

- Institutional controls will protect against potential risk to human health by reducing the possibility that contaminated shallow aquifer groundwater will be consumed by people until cleanup levels (MCLs for fuel-related constituents and HVOCs) are met.

Specific components of the selected remedy are illustrated in Figure 5-1 and consist of the following:

Groundwater

- Institutional controls on land use and water use restrictions will restrict access to the contaminated groundwater throughout OU 4 until cleanup levels have been achieved.

- Groundwater will be monitored and evaluated semi-annually to assess contaminant migration and timely reduction of contaminant concentrations by intrinsic remediation. This will include five-year reviews to assess the protectiveness of the remedial action, as long as contamination remains above cleanup levels. A monitoring plan will be prepared to address the details involved in sampling.

- All groundwater is expected to be cleaned up within thirteen years.

Soil

- Institutional controls on land use will restrict access to the contaminated shallow soils throughout OU 4 until cleanup levels have been achieved.

- Deep soils at specified locations and depths at the FTA, the ADSA, and Hangar 11 will be treated with bioventing to accelerate degradation of contaminants in those locations. Deep soils at other source areas will be allowed to degrade through intrinsic remediation.

- Both shallow and deep soils will be monitored and evaluated bi-annually to assess contaminant migration and timely reduction of contaminant

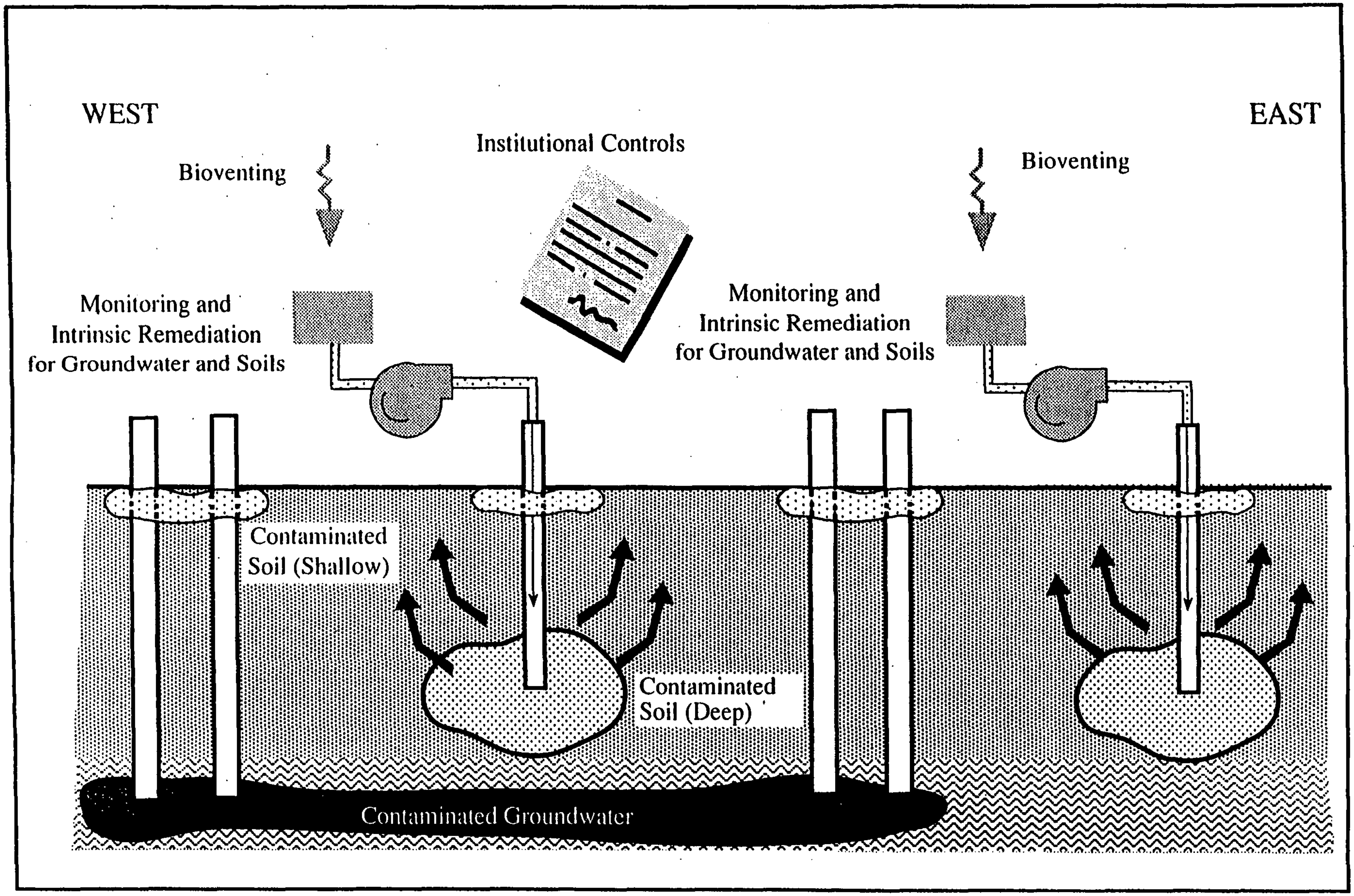

Figure 5-1. A Schematic of Preferred Alternatives for Operable Unit 4, Elmendorf AFB, AK

concentrations by intrinsic remediation. This will include five-year reviews to assess the protectiveness of the remedial action, as long as contamination remains above cleanup levels.

- When concentrations in the bioventing areas are below cleanup levels, bioventing will be discontinued. A monitoring plan will be prepared to address the details involved in sampling.

- All soils are expected to be cleaned up within eleven years.

The remedy will be implemented after the Remedial Design has been completed. A treatability study for bioventing design is currently in progress. Bioventing will be implemented until cleanup levels have been achieved. The actual timeframe for intrinsic remediation at the other source areas is not known, but groundwater and soil modeling predict cleanup levels will be achieved in 10 to 15 years. Groundwater and soil will both be monitored to evaluate the progress of intrinsic remediation processes. Further response actions, coordinated with the regulatory agencies, may be considered if monitoring finds unacceptable contaminant migration occurring, or unacceptable reduction in contaminant concentrations through intrinsic remediation.

Because the remedy will result in contaminants remaining on-site above health based levels, a review will be conducted within five years after commencement of remedial action. The review will ensure that the remedy continues to provide adequate protection of human health and the environment. The cleanup levels to be achieved though the selected remedy for OU 4 are presented in Table 5-2.

5.1 Statutory Determinations

The selected remedy satisfies the requirements under Section 121 of CERCLA to:

- Protect human health and the environment;

Table 5-2

Chemical-Specific ARARs for Groundwater and Soils, Operable Unit 4, Elmendorf AFB, AK

Location	Contaminants of Concern	Maximum Concentrations	Cleanup Level Established by ARAR	Source of Requirements	Approximate Remediation Time (yrs)
Groundwater (µg/L)					
FTA	1,1,1-Trichloroethane 1,1-Dichloroethene 1,2-Dichloroethane Tetrachloroethene Trichloroethene 1,2-Dichloroethene Benzene	242 13.7 12.1 40.5 74.7 741 398	200 7 6 6 6 70 5	MCL[a]	13
Hangar 14	Benzene	207	5	MCL[a]	7
Hangar 11	Benzene Ethylbenzene Toluene	2600 1360 5590	5 700 1000	MCL[a]	13
Hangar 8/10	Benzene	266	5	MCL[a]	8
Hangar 15/ Bldg. 43-410	Tetrachloroethene Trichloroethene	19.5 23	5 5	MCL[a]	7
Soil (mg/kg)					
FTA	DRO[b] GRO[c]	2200 3710	2000 1000	ACM[d]	2 (deep soils) 8 (shallow soils)
Hangar 10/11	DRO[b] GRO[c]	4100 5900	1000 2000	ACM[d]	2 (deep soils) 2 (shallow soils)
ADSA	DRO[b] Jet Fuel Xylene GRO[c]	110,000 13,000 110 15,600	2000 2000 100 1000	ACM[d]	2 (deep soils) 4 (shallow soils)

[a]MCL = Maximum Contamination Level; 40 CFR Part 131, and 18 ACC Chapter 70.010a and d, 70.015 through 70.0110,18 AAC 80.070.
[b]DRO = Diesel Range Organics
[c]GRO = Gasoline Range Organics
[d]ACM = Alaska Cleanup Matrix Level D, 18 AAC 78.315

Note-Soil contamination at Hangars 8, 14, and 15/Bldg. 43-410 was not above regulatory standard.

- Comply with ARARs;
- Be cost effective; and
- Utilize permanent solutions and alternative treatment technologies to the maximum extent practicable.

5.1.1 Protective of Human Health and the Environment

The selected remedy is protective of human health and the environment. The current points of exposure are limited to surface soil. Risks are extremely low. Institutional controls will protect against the potential risk by assuring that the contaminated soils will not come in contact with people while intrinsic remediation is occurring. Deep soils pose no health risk, but at the areas where they could pose a potential threat to groundwater, the soils will be actively treated with bioventing.

Risks were calculated using assumptions regarding exposure pathways and the time receptors were exposed to the contaminants. Each exposure was estimated conservatively in a manner which tends to overestimate the actual risk. Risk management decisions were made considering the uncertainty in the assumptions used in the risk assessment. At OU 4, the shallow groundwater is not used and is not expected to be used in the future, so existing risks and potential risks are significantly less than the worst-case risk.

There are no direct current receptors of groundwater in OU 4. The known sources of contamination have been removed. Deep soil hot spots will be remediated under this selected remedy. Institutional controls will protect against the potential risk to human health by ensuring that contaminated shallow aquifer groundwater will not be consumed by people until cleanup levels (MCLs) are met. The time required to achieve MCLs is not known, but could be as short as 10 to 15 years based on groundwater modeling results. Modeling of contaminant flow at Elmendorf AFB showed that conditions are not expected to deteriorate at OU 4. Over time, conditions will improve and the model predicts that cleanup objectives will be met by intrinsic remediation processes. A remediation period of 10 to 15 years is reasonable given current land use at the site.

5.1.2 Applicable or Relevant and Appropriate Requirements (ARARs)

Chemical-Specific ARARs -- Chemical-specific cleanup levels for OU 4 are identified in Table 5-2. The Maximum Contaminant Levels (MCLs) established for drinking water under State and Federal laws are applicable to groundwater contaminants of concern at OU 4 as a chemical-specific regulation. For petroleum contaminated soil that will be remediated, soil cleanup level D from the Alaska Cleanup Matrix, 18 Alaska Administrative Code (AAC) 78.315, is applicable.

Location-Specific ARARs -- There are no specific ARARs which must be met because of the location of the contamination and remedial actions at OU 4.

Action-Specific ARARs -- The selected remedy will comply with those ARARs applicable or relevant and appropriate to construction and operation of the bioventing system, and to the monitoring activities conducted at all source areas. Action-specific ARARs are identified in Table 5-3.

5.1.3 Cost Effectiveness

The remedy is the most cost effective of the alternatives because it affords overall effectiveness proportional to its costs. Alternative S-5 (bioventing) was chosen for the deep soils at the Fire Training Area, Hangar 11, and the ADSA because the soils in these areas could act as continuing sources for the groundwater pollution in the shallow aquifer. For these areas, Alternative S-5 will cost approximately $178,000 more than Alternative S-2; however, Alternative S-5 will remediate the soils up to six years faster than Alternative S-2. The additional protection that can be achieved by actively treating groundwater and soil in

Table 5-3

Identification of Action-Specific ARARs, Operable Unit 4 Elmendorf AFB, AK

Standard, Requirement, Criteria, or Limitation	Citation	Description	Documentation
Clean Air Act – 42 USC Section 7401			
National Primary and Secondary Ambient Air Quality Standards	40 CFR Part 50	Establishes standards for ambient air quality to protect public health and welfare.	Remedial actions must not result in exceedence of ambient air quality standards. There could be air emissions from bioventing.

the other alternatives, provides only marginal increases in protection of human health and the environment, with a cost several times higher than the selected remedy.

5.1.4 Utilization of Permanent Solutions and Alternative Treatment Technologies to the Maximum Extent Practicable

The USAF, the State of Alaska, and the USEPA have determined that the selected remedy represents the maximum extent to which permanent solutions and treatment technologies can be used in a cost-effective manner at OU 4. Of those alternatives that are protective of human health and the environment, and comply with ARARs, the USAF, the State of Alaska, and the USEPA have determined that the selected remedy provides the best balance of tradeoffs in terms of long-term effectiveness and permanence, reduction in toxicity, mobility, or volume achieved through treatment, short-term effectiveness, implementability, cost (as discussed in the preceding section), and the statutory preference for treatment as a principal element and considering State and community acceptance. The selected remedy will permanently remove the contaminants through natural, biological break down of the contaminants into harmless chemical compounds.

5.1.5 Preference for Treatment as a Principal Element

The selected remedy satisfies this statutory preference by using bioventing to treat contaminated deep soils at source areas where soils may act as a continuing source for groundwater contamination. Because of the substantial additional cost of actively treating groundwater, the potential for intrinsic remediation within 13 years, and the fact that there are no current receptors of groundwater, institutional controls and monitoring are a better way of addressing groundwater contamination than active treatment. Intrinsic remediation and institutional controls are used in areas where active treatment is impracticable.

5.2 Documentation of Significant Changes

The selected remedy was the preferred alternative presented in the Proposed Plan. No significant changes have been made.

In Table 5 of the Proposed Plan, the listing of S5-Bioventing as the preferred alternative for shallow soils at Hangars 10/11 was a misprint. As discussed in the text of the Proposed Plan, S2-ICIR was the preferred alternative for all shallow soils. The bioventing alternative is applicable for deep soils only.

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PART III. RESPONSIVENESS SUMMARY

Public Input into the OU 4 Selected Remedy

The primary avenues of public input have been through the Proposed Plan and public comment period. The Proposed Plan for OU 4 was issued to the public on April 11, 1995. This began a public comment period that ended on May 12, 1995. To encourage public comment, the USAF inserted a pre-addressed, written comment form in distributed copies of the Proposed Plan. The comment forms were also distributed at the May 10, 1995 public meeting, held at the University of Alaska in Anchorage.

The public meeting to receive comments on the Proposed Plan was attended by approximately 35 people, including sixteen representatives from the Restoration Advisory Board (RAB). Oral comments were received from six members of the public. Prior to the conclusion of the public comment period, a written comment was submitted by one individual.

All comments received are documented in the administrative record file for the site. A transcript of the public meeting is available for public review at the site information repositories. The repositories are located at the Bureau of Land Management's Alaska Resources Library and the University of Alaska at Anchorage's Consortium Library. Public comments, relevant to OU 4 and/or the environmental restoration program at Elmendorf, are presented below and have been paraphrased for greater clarity. This ROD is based on the documents in the Administrative Record and comments received from the public.

Response to Written Public Comment:

Public Comment: The costs for soil excavation and recycling are too high.

USAF Response: Costs were developed for all alternatives using the RACER model to provide a consistent data base for alternative comparison. The model includes additional costs such as contingencies as a percentage of the total. Actual costs could vary by up to 50%. Also, the soil quantities listed in the Proposed Plan were in-place soil volumes. Disturbed soil volumes to be excavated and treated would be significantly increased because of bulking.

Response to Oral Public Comments:

Public Comment 1: There was a concern that because the Anchorage area is subject to earthquakes, a large earthquake could increase the risk of the public's exposure to contaminants.

USAF Response: Elmendorf AFB is located on what is called a glacial outwash plain. This is an area that consists of deep deposits of rocks, gravel, sand and silts that have been transported to their present locations by the flow of water from melting glaciers. An earthquake fault or split in the rock will occur in the bed rock or large, continuous rock formations that lie far beneath the outwash plain. Because the glacial outwash plain consists of materials that easily shift and move, but do not shear or separate during an earthquake, there is very little danger of increased risk of exposure to contaminants due to an earthquake.

Public Comment 2: The OU 4 Proposed Plan separates the groundwater into shallow and deep aquifers. It also separates the soil into shallow and deep soils. Some of the deep soils are contaminated, yet the deep aquifer is listed as uncontaminated. How can the deep soil be contaminated, yet the deep aquifer be uncontaminated?

USAF Response: Two different measurements are used to determine deep soil and the deep groundwater aquifer. For OU 4 soil from the ground surface to five feet below the ground surface is called shallow soil. Soil deeper than five feet below the ground surface is called deep soil. The groundwater does not use the five foot below ground surface to distinguish deep from shallow. The top of the shallow aquifer is approximately 50 feet below the ground surface, while the top of the deep aquifer is approximately 140 feet below the ground surface.

Public Comment 3: The report says that modeling shows that groundwater contamination will not migrate off-site. What are the limits of the site? Are they the boundaries of Elmendorf?

USAF Response: This report is addressing OU 4 specifically. The site in this report means that the groundwater contamination will not migrate outside the boundaries of OU 4. The model shows that the contamination will not migrate beyond the East-West runway, which is approximately half of the distance between the source of the contaminants and Ship Creek. Ship Creek is the closest migration path for the contaminants to reach human or environmental receptors.

Public Comment 4: Table 1 of the Proposed Plan for Remedial Action shows a maximum concentration of 110,000 mg/kg for diesel in the asphalt drum storage area (ADSA). This is over fifty times greater than the standard shown in the same table. Shouldn't this be considered a high risk to health and the environment?

USAF Response: The high concentration is shown for shallow soil in the ADSA. The ADSA is located at the east end of the East-West Runway. Access to this area is highly restricted because of the high noise level and safety concerns from low flying aircraft. Normally we are more concerned about shallow soils than deep soils, because human and animal receptors are more likely to come into contact with these soils. However because of its location, access to the ADSA is very restricted, so the shallow soils here are not as great a concern as in other areas. Table 1 also shows that the deep soils at this area are contaminated with jet fuel and gasoline. Because of the comparatively higher level of contamination at the ADSA, and the possibility of these levels being sources that could contaminate the groundwater in the future; we are proposing bio-venting to more quickly remediate this contamination.

Public Comment 5: The proposed plan contains a table on human health risks. It lists numbers like 4.2×10^{-6}. What do these numbers mean? Are they high risk, medium risk or low risk?

USAF Response: The EPA normally establishes the threshold for taking action to be in the range of one in ten thousand (1×10^{-4}) to one in a million (1×10^{-6}). A result of 4.2×10^{-6} is on the borderline of where the EPA would expect action to be taken. Note that these values are for residents living full time on the site which is not allowed in the area around OU 4.

Public Comment 6: Is there more in-depth information available than what is given in the Proposed Plan for Remedial Action?

USAF Response: Complete copies of the Remedial Investigation/Feasibility Study (RI/FS) are available for the public to read at the Bureau of Land Management Library and at the University of Alaska Anchorage Library.

Public Comment 7: What is the basis for determining what alternatives are selected? Is the decision driven solely by the money available?

USAF Response: Although costs are one of the factors used in evaluating alternatives, it is only one of the nine factors considered. The factors considered in selecting the alternatives to use are: protection of human health and the environment; compliance with applicable or relevant and appropriate requirements such as laws and government regulations; long term effectiveness and permanence; reduction in toxicity, mobility or volume through treatment; short term effectiveness; implementability; cost; state acceptance; and community acceptance. All nine factors are used in determining the best alternatives to implement.

Public Comment 8: The proposed alternative calls for Institutional Controls with Intrinsic Remediation in many areas. This would require monitoring of the groundwater for a long period of time. Who will do the actual monitoring of the groundwater?

USAF Response: Taking samples and monitoring the groundwater would be accomplished by a civilian contractor working for the Air Force. We will monitor the groundwater quality for around 15 years.

Public Comment 9: What body or group makes the final decision on what alternatives will be implemented?

USAF Response: Making the decision is a two step process. After we receive and evaluate the comments on our proposed plan, the Air Force will select the best alternatives for each area to implement. This is the first step. Our decision is then sent to the State of Alaska and the U.S. EPA for their review and concurrence. Once we have their concurrence, a final record of decision documenting the selected alternatives to be used is prepared. That record of decision will be signed by the EPA and the Air Force.

Public Comment 10: How long will it take to go from the public comment period, where we are now, to the final completion of the cleanup of OU 4?

USAF Response: The record of decision should be signed in late August of this year. We will then need around 15 months to prepare the plans and specifications and hire a contractor to perform the work. Assuming that the proposed alternatives are the ones actually implemented, it will take up to 15 years before the pollution has been completely remediated.

Public Comment 11: Fifteen years seems to be a long time to wait until the contamination is finally remediated.

USAF Response: If this contamination were an immediate threat to life or health, the Air Force would immediately begin fixing the problem using the fastest and best methods possible. However, the contamination present is not currently a threat to human health or the environment. It is migrating very slowly. We have stopped the leaks and other sources that were causing the pollution. Naturally occurring microorganisms are presently breaking down the contaminants, and will continue to do so until the contaminants are completely broken down. We are committed to long term monitoring of the site to ensure that the contamination is not spreading beyond its predicted limits, and to ensure that the biological breakdown of the contaminants is occurring.

Public Comment 12: Alaska is not the lower 48. Will the methods proposed work well in the cold climate at Elmendorf? Have the proposed methods been used on Elmendorf in the past?

USAF Response: Yes. We have used bioventing on Elmendorf for two and a half years now and have had good results. Bioventing works well in the granular soils that are underneath Elmendorf. Biopiles have also been used successfully on the base.

APPENDIX A

OU 4 ADMINISTRATIVE RECORD INDEX

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Appendix A

Index to OU 4 Documents in Administrative Record

Date Submitted	Document Number	Title/Subject	Author
1/01/90	008490-008515	IRP Stage 3 RI/FS - Technical Document to Support A Remedial Action Alternative	Black and Veatch
5/01/92	015828-016092	Limited Field Investigation Work Plan, OU 4, Elmendorf AFB, AK	EMO/Battelle/CH2M Hill
6/23/92	016093-016096	Addendum to OU 4 Work Plan	EMO/Battelle/CH2M Hill
11/01/92	019100-020057	Operable Unit 4 LFI Report Volume 1	USAF-Elmendorf AFB
4/01/93	021743-021753	Determination of No Further Action, Source SS18, Building 22-021	USAF-Elmendorf AFB
4/01/93	021754-021763	Determination of No Further Action, Source SD26, Building 43-550	USAF-Elmendorf AFB
4/01/93	021779-021790	Determination of No Further Action, Source SD27, Building 42-300	USAF-Elmendorf AFB
4/01/93	021764-021778	Determination of No Further Action, Source SD27, Building 42-300	USAF-Elmendorf AFB
5/01/93	021791-022870	Management Plan, OU 4	USAF-Elmendorf AFB
9/04/94	040819-043917	Operable Unit 4 Remedial Investigation/Feasibility Study Report	USAF-Elmendorf AFB
9/08/94	044339	Memorandum From Elmendorf AFB, Alaska to HQ PACAF/CEVR Hickam AFB, Hawaii	USAF-Elmendorf AFB
4/01/95	052558-052577	Elmendorf AFB, OU 4, The Proposed Plan For Remedial Action	USAF-Elmendorf AFB
4/07/95	052595	Public Notice - Public Comment Period and Public Information Meeting for OU 4 Proposed Plan	USAF-Elmendorf AFB
5/29/95	052598-052653	OU 4 Proposed Plan Public Information Meeting Transcript	USAF-Elmendorf AFB
4/09/95	052596	Public Notice - Public Comment Period and Public Information Meeting for OU 4 Proposed Plan	USAF-Elmendorf AFB

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