ATSDR
AGENCY FOR TOXIC SUBSTANCES AND DISEASE REGISTRY

Public Health Assessment for

EIELSON AIR FORCE BASE (EAFB)
FAIRBANKS NORTH STAR BOROUGH, ALASKA
EPA FACILITY ID: AK1570028646
JUNE 14, 2006

U.S. DEPARTMENT OF HEALTH AND HUMAN SERVICES
PUBLIC HEALTH SERVICE
Agency for Toxic Substances and Disease Registry

THE ATSDR PUBLIC HEALTH ASSESSMENT: A NOTE OF EXPLANATION

This Public Health Assessment was prepared by ATSDR pursuant to the Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA or Superfund) section 104 (i)(6) (42 U.S.C. 9604 (i)(6)), and in accordance with our implementing regulations (42 C.F.R. Part 90). In preparing this document, ATSDR has collected relevant health data, environmental data, and community health concerns from the Environmental Protection Agency (EPA), state and local health and environmental agencies, the community, and potentially responsible parties, where appropriate.

In addition, this document has previously been provided to EPA and the affected states in an initial release, as required by CERCLA section 104 (i)(6)(H) for their information and review. The revised document was released for a 30-day public comment period. Subsequent to the public comment period, ATSDR addressed all public comments and revised or appended the document as appropriate. The public health assessment has now been reissued. This concludes the public health assessment process for this site, unless additional information is obtained by ATSDR which, in the agency's opinion, indicates a need to revise or append the conclusions previously issued.

Agency for Toxic Substances & Disease Registry ..... Julie L. Gerberding, M.D., M.P.H., Administrator
Howard Frumkin, M.D., Dr.P.H., Director

Division of Health Assessment and Consultation…. ..... William Cibulas, Jr., Ph.D., Director
Sharon Williams-Fleetwood, Ph.D., Deputy Director

Health Promotion and Community Involvement Branch ..... Susan J. Robinson, M.S., Chief

Exposure Investigations and Consultation Branch ..... Susan M. Moore, Ph.D., Chief

Federal Facilities Assessment Branch ..... Sandra G. Isaacs, B.S., Chief

Superfund and Program Assessment Branch ..... Richard E. Gillig, M.C.P., Chief

Use of trade names is for identification only and does not constitute endorsement by the Public Health Service or the U.S. Department of Health and Human Services.

Additional copies of this report are available from:
National Technical Information Service, Springfield, Virginia
(703) 605-6000

You May Contact ATSDR TOLL FREE at
1-888-42ATSDR
or
Visit our Home Page at: http://www.atsdr.cdc.gov

PUBLIC HEALTH ASSESSMENT

EIELSON AIR FORCE BASE (EAFB)

FAIRBANKS NORTH STAR BOROUGHS, ALASKA

EPA FACILITY ID: AK1570028646

Prepared by:

Federal Facilities Assessment Branch
Division of Health Assessment and Consultation
Agency for Toxic Substances and Disease Registry

PUBLIC HEALTH ASSESSMENT

EIELSON AIR FORCE BASE (EAFB)
FAIRBANKS NORTH STAR BOROUGH, ALASKA
EPA FACILITY ID: AK1570028646

June 2006

Federal Facilities Assessment Branch
Division of Health Assessment and Consultation
Agency for Toxic Substances and Disease Registry

Foreword

The Agency for Toxic Substances and Disease Registry, ATSDR, is an agency of the U.S. Public Health Service. It was established by Congress in 1980 under the Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA), also known as the Superfund law. This law set up a fund to identify and clean up our country's hazardous waste areas. The U.S. Environmental Protection Agency (EPA) and the individual states regulate the investigation and clean up of the areas.

Since 1986, ATSDR has been required by law to conduct a public health assessment at each of the areas on the EPA National Priorities List. The aim of these evaluations is to find out if people are being exposed to hazardous substances and, if so, whether that exposure is harmful and should be stopped or reduced. (The legal definition of a health assessment is included on the inside front cover.) If appropriate, ATSDR also conducts public health assessments when petitioned by concerned individuals. Public health assessments are carried out by environmental health scientists from ATSDR and from the states with which ATSDR has cooperative agreements.

Exposure: As the first step in the evaluation, ATSDR scientists review environmental data to see how much contamination is at an area, where it is, and how people might come into contact with it. Generally, ATSDR does not collect its own environmental sampling data. Instead, it reviews information provided by EPA, other government agencies, businesses, and the public. When there is not enough environmental information available, the report will indicate what further sampling data is needed.

Health Effects: If the review of the environmental data shows that people have or could come into contact with hazardous substances, ATSDR scientists then evaluate whether or not there will be any harmful effects from these exposures. The report focuses on public health, or the health impact on the community as a whole, rather than on individual risks. Again, ATSDR generally makes use of existing scientific information, which can include the results of medical, toxicologic, and epidemiologic studies and the data collected in disease registries. The science of environmental health is still developing, and occasionally scientific information on the health effects of certain substances is not available. When this is so, the report will suggest what further research studies are needed.

Conclusions: The report presents conclusions about the level of health threat, if any, posed by an area. In its public health action plan, the report recommends ways to stop or reduce exposure. ATSDR is primarily an advisory agency, so usually these reports identify what actions are appropriate to be undertaken by EPA, other responsible parties, or the research or education divisions of ATSDR. However, if there is an urgent health threat, ATSDR can issue a public health advisory to warn people of the danger. ATSDR can also authorize health education or

pilot studies of health effects, full-scale epidemiology studies, disease registries, surveillance studies, or research on specific hazardous substances.

Interactive Process: The health assessment is an interactive process. ATSDR solicits and evaluates information from numerous city, state, and federal agencies, the companies responsible for cleaning up the area, and the community. ATSDR then shares its conclusions with them. Agencies are asked to respond to an early version of the report to make sure that the data they provide is accurate and current. When informed of ATSDR's conclusions and recommendations, the agencies sometimes will begin to act on them before the final release of the report.

Community: ATSDR also needs to learn what people in the area know about the area and what concerns they may have about its impact on their health. Consequently, throughout the evaluation process, ATSDR actively gathers information and comments from the people who live or work near an area, including residents of the area, civic leaders, health professionals, and community groups. To ensure that the report responds to the community's health concerns, an early version is also distributed to the public for comment. All the comments received from the public are responded to in the final version of the report.

Comments: If, after reading this report, you have questions or comments, we encourage you to send them to us.

Letters should be addressed as follows:

Attention: Chief, Program Evaluation, Records, and Information Services Branch, Agency for Toxic Substances and Disease Registry, 1600 Clifton Road, NE (MS E-32), Atlanta, GA 30333.

Table of Contents

List of Tables

List of Figures

List of Abbreviations

ADEC	Alaska Department of Environmental Conservation
AOC	area of concern
ATSDR	Agency for Toxic Substances and Disease Registry
BTEX	benzene, toluene, ethylbenzene, and xylene
CEL	cancer effect level
CERCLA	Comprehensive Environmental Response, Compensation, and Liability Act
CREG	ATSDR's cancer risk evaluation guide
CRP	community response plan
CV	comparison value
DCE	dichloroethylene
DRO	diesel range organics
EAFB	Eielson Air Force Base
EMEG	ATSDR's environmental media evaluation guide
EPA	U.S. Environmental Protection Agency
FUDS	Formerly-Used Defense Site
GS	Garrison Slough
IRP	installation restoration program
LOAEL	lowest-observed adverse effect level
MCL	EPA's maximum contaminant level
mg/kg/day	milligram per kilogram per day
MRL	ATSDR's minimum risk level
NOAEL	no-observed-adverse-effect level
NPL	EPA's National Priorities List
OSHA	Occupational Safety and Health Administration
PCBs	polychlorinated biphenyls
PCE	tetrachloroethylene
PHA	public health assessment
PHAP	Public Health Action Plan
ppb	parts per billion
ppm	parts per million
RAB	restoration advisory board
RBC	EPA Region III's risk-based concentration
RfD	EPA's reference dose
RI	remedial investigation
RMEG	ATSDR's reference dose media evaluation guide
ROD	record of decision
RRO	residual range organics
SWMP	sitewide monitoring program
TCE	trichloroethylene
USAF	U.S. Air Force
VOCs	volatile organic compounds

Eielson Air Force Base
Public Health Assessment

I. Summary

The Agency for Toxic Substances and Disease Registry (ATSDR) prepared this public health assessment (PHA) to evaluate potential health hazards from past, current, and future exposures to contaminants originating from Eielson Air Force Base (EAFB). EAFB is an active U.S. Air Force (USAF) base located about 24 miles southeast of the city of Fairbanks, in Alaska's North Star Borough. The base encompasses roughly 19,700 acres.

Over the years, materials used in industrial or general base support operations spilled or were released to the underlying groundwater because of accidents and/or accepted waste management practices for the time. These materials came primarily from aircraft and vehicle maintenance and repair activities, and included waste fuel, oils, solvents, pesticides, plating wastes, and paint. The primary contaminants of concern are polychlorinated biphenyls (PCBs), volatile organic compounds (VOCs), and fuel-related compounds. These contaminants have been detected mostly in soil, groundwater, and fish tissue samples. On November 21, 1989, because of environmental releases and the presence of contamination, the U.S. Environmental Protection Agency (EPA) placed EAFB on its National Priorities List of sites to be investigated. In coordination with the Alaska Department of Environmental Conservation (ADEC) and the EPA, the USAF has been investigating and remediating known sources of environmental contamination on the base.

To evaluate possible public health hazards associated with environmental contamination at EAFB, ATSDR conducted this PHA. ATSDR's PHA process identifies populations who may have been or are exposed to hazardous substances and determines the public health implications of those exposures. As part of the process, ATSDR conducted site visits and met with representatives from EAFB in 1991 and 2004. Using information gathered during the site visits and findings of site investigations conducted at EAFB, ATSDR examined the nature and extent of contamination associated with the site and evaluated the possibility of past, current, and future exposures. On the basis of this evaluation, ATSDR identified five potential exposure situations.

- ***Past ingestion of VOCs and/or arsenic in EAFB drinking water***. Former operations and waste disposal practices at EAFB contaminated the groundwater beneath the base with VOCs. These contaminants impacted on-base drinking water sources that were used in the past at outlying areas of the base. Former drinking water wells at the EAFB Ravenwood Ski Lodge and Engineer Hill were closed in 1987 and 1991 respectively, after VOCs were detected above EPA's maximum contaminant levels (MCLs). Naturally occuring arsenic has also impacted groundwater at some locations beneath EAFB. Prior to 1997, arsenic was detected above EPA's maximum contaminant level (MCL) in an active drinking water supply well at the EAFB Birch Lake Resort. However, people who consumed drinking water at Ravenwood Ski Lodge, Engineer Hill, or Birch Lake Resort in the past were not exposed to VOCs or arsenic at levels known to cause adverse health effects.

- ***Ingestion of VOCs in off-base drinking water sources near Salcha.*** VOCs were detected in the groundwater at a former artillery barracks, less than one mile from private drinking water wells near Eielson Farm Road near Salcha. The site was initially investigated by the Air Force as AOC 8. However, the Air Force transferred and decommissioned the property, subsequent remedial actions are being governed by the Army Corps of Engineers under the Formerly Used Defense Sites (FUDS) program. Monitoring data from 2000 indicated that VOCs were not impacting private drinking water wells at that time. The Army Corps of Engineers plans additional environmental investigations to define the potential for off-site contaminant migration.

- ***Ingestion of VOCs in off-base drinking water sources in Moose Creek Village.*** Drinking water wells in Moose Creek Village are north of EAFB and downgradient of some base-related contaminant sources. Sampling from five sentinel wells located along the northern base boundary, indicates the groundwater quality meets the EPA's federal drinking water standards for base-related contaminants. EAFB will continue to monitor groundwater along the north boundary of the base to ensure the safety of drinking water in Moose Creek Village.

- ***Vapor intrusion to indoor air.*** VOC-contaminated groundwater has migrated near certain on-base buildings. Occupants of these buildings were most likely not exposed to indoor air vapors at high enough levels for long enough periods to develop long-term health effects. Indoor air concerns for base buildings are investigated by the base Bioenvironmental Engineering (BEE) organization. The IRP office will coordinate with the BEE organization during indoor air investigations for buildings that are in close proximity to contaminated sites to ensure indoor air quality is within OSHA standards.

- ***Fish contamination at Garrison Slough.*** Anglers who infrequently consume fish (six 8-oz meals per year) from the off-base section of Garrison Slough are not expected to be exposed to harmful levels of pesticides or PCBs. Anglers who consume fish from the on-base section of Garrison Slough could be exposed to PCBs at levels above ATSDR's CVs. The base currently informs anglers, as they acquire their on-base fishing permit, to not eat fish from the slough. The base also added 22 signs along access points to the slough delineating the fish advisory. People who follow the base advisory will not be exposed to these contaminants. As a prudent public health action, ATSDR recommends that people follow the established base policy and avoid eating fish from Garrison Slough.

II. Background

II.A. Site Description and Operational History

Eielson Air Force Base (EAFB) is an active base in Alaska's Fairbanks North Star Borough, 24 miles southeast of Fairbanks, Alaska, and 10 miles southeast of North Pole, Alaska. The base occupies 19,700 acres along the Richardson Highway, including 3,650 acres of developed land and 16,050 acres of forest and wetlands including lakes, ponds, and streams (Batelle-PNL 1995 and Eielson AFB 2002a). U.S. Army Fort Wainwright surrounds EAFB to the south and to the east. Elsewhere, the base adjoins private and public lands that are zoned for general use (Eielson AFB 2001). See Figure 1 for a map of the area.

EAFB was established during World War II as an offshoot of Ladd Air Field (Ladd), presently known as Fort Wainwright. Ladd was a strategic hub for the transfer of aircraft and supplies to the Soviet Union and to American bases throughout the Pacific during World War II. Poor winter flying conditions at Ladd during the first years of World War II prompted the military to construct a new airfield adjacent to Ladd, initially dubbed "26-Mile-Strip." Two parallel runways and a hanger were completed in 1944. On February 4, 1948, "26-Mile-Strip" became EAFB, shortly after the US Air Force became an independent agency of the military. In the years since 1948, EAFB has supported a variety of combat aircraft as well as weather reconnaissance aircraft, tactical units from Alaskan Air Command, and aerial tankers (Eielson AFB 2004a).

II.B. Remedial and Regulatory History

As a result of past operational practices and spills, hazardous wastes have been released into the environment at many on-base locations. In the past there were numerous leaks and spills from storage tanks, pipelines, and other components of the base's industrial infrastructure. Industrial wastes were buried in landfills, discharged into surface water bodies and drainage systems, and

burned during fire training exercises. These chemical wastes, generated primarily from aircraft and vehicle maintenance services, included fuels, oils, solvents, pesticides, paints, and PCBs.

EAFB began to address environmental contamination in 1982 under the U.S. Air Force Installation Restoration Program (IRP). Subsequent investigations identified 66 sites as possible contamination sources and qualified EAFB for classification on the EPA National Priorities List (NPL) on November 21, 1989. In May 1991, the United States Air Force (USAF) entered into a Federal Facilities Agreement (FFA) with EPA Region X and the Alaska Department of Environmental Conservation (ADEC) to outline a comprehensive strategy for conducting environmental investigations and completing remedial actions on EAFB property where hazardous materials might have been disposed of, spilled, or stored (Eielson AFB 2001 and FWEC et al 2003).

On the basis of IRP investigations, sites that exhibited a significant risk to human health and the environment were placed into seven operable units (OUs). Conditions at other sites that showed low levels of contamination during IRP investigations were assessed in Source Evaluation Reports (SER) for either placement into an OU or no further action. The OUs were grouped based on the nature of contamination and location of each site (Eielson AFB 2001 and EA-ST 2004).

- *Operable Unit 1* has nine IRP sites contaminated with petroleum, oil, and lubricants (POL).
- *Operable Unit 2* contains seven IRP sites with POL contamination.
- *Operable Unit 3* has five IRP sites contaminated with chlorinated solvents and POL.
- *Operable Unit 4* consists of 10 IRP sites contaminated with POL from spills and leaks during fuel storage and transport operations.
- *Operable Unit 5* comprises six sites: five landfills and a fire training area.

- *Operable Unit 6* consists of the EAFB ski area. Past fuel leaks from underground storage tanks have contaminated groundwater in the fractured bedrock beneath the ski hill (Eielson AFB 2001).
- *Site Wide Operable Unit* includes all surface water bodies, streams, and land areas affected by sources of contamination at EAFB. This includes Garrison Slough, which flows through the industrial portion of the base, and has sustained significant PCB contamination in fish and sediment.

Between 1991 and 1995, EAFB assessed environmental conditions at each OU. EPA and ADEC approved remediation plans from 1994 to 1998. Environmental conditions and cleanup methods have undergone continued evaluation through the EAFB Sitewide Groundwater Monitoring Program (SWMP) and Remedial Process Optimization studies. Presently, the Air Force has recommended 41 of the 66 IRP sites for no further action because they pose no risk to human health or they have been remediated to cleanup standards (EA-ST 2004).

II.C. ATSDR Activities

Through the PHA process, ATSDR assesses site conditions from a public health perspective to determine whether people can be exposed to site-related contaminants through contact with groundwater, drinking water, surface water, soil, biota, or air. As part of the PHA process, ATSDR conducted an initial visit to EAFB in 1991. The purpose of the visit was to collect information necessary to rank the site according to its potential public health hazard, to identify public health issues related to environmental contamination at the base, and to identify community health concerns. During the visit, ATSDR met with Air Force personnel and representatives from federal and state agencies.

ATSDR visited EAFB again in June 2004 to tour the base and obtain updated information related to environmental studies at the base. Based on discussions, the site visit, and data reviews, ATSDR concluded at that time there was little potential for immediate threats to human health.

ATSDR did, however, identify five exposure pathways that required further evaluation, including past ingestion of VOCs and arsenic in EAFB drinking water, ingestion of VOCs in off-base drinking water sources in Salcha, ingestion of VOCs in off-base drinking water sources in Moose Creek Village, and consumption of PCBs in fish from Garrison Slough.

II.D. Demographics

ATSDR examines demographic information, or population information, to identify the presence of sensitive populations, such as young children (age 6 and under), the elderly (age 65 and older), and women of childbearing age (age 15-44). Demographics also provide details on population mobility and residential history in a particular area. This information helps ATSDR evaluate how long residents might have been exposed to environmental contaminants.

EAFB supports approximately 9,100 people, which includes 4,521 residents. The residential population consists of about 1,371 military personnel and 3,064 dependents. In 2000, about 2,329 children (under 18 years) lived on base, including 770 children under the age of 5 and 718 children between the ages of 5 and 9 years old (U.S. Census Bureau 2000). There are 1,476 housing units on base within townhouse and single unit housing developments, apartment complexes, and multiplexes (Jerry Andrews, Eielson AFB Housing Flight Chief, personal communication, 2004; Malcom Nason, Eielson AFB Water Systems Superintendent, personal communication, 2004).

The Fairbanks North Star Borough School District operates three schools on base: Anderson Elementary on Kodiak Street, Crawford Elementary on Ravens Way, and Ben Eielson Junior/Senior High on Ravens Way. Approximately 1,015 students attend both elementary schools and 633 students attend the secondary school. A child development center located at Century Park provides developmental care and educational services for children 6 weeks to 11 years of age. A youth center and a school-age care program also provide after school and summer programs for children (Eielson AFB 2004b).

Two small villages border EAFB along Richardson Highway: Moose Creek (population 574) to the north and Salcha (population 865) to the south and west. In 2000, the two villages combined had a population of 198 children under the age of 10 and 75 adults above the age of 65. EAFB is also 10 miles south of the city of North Pole (population 1,646) and 24 miles southwest of Fairbanks, the largest city in the Fairbanks North Star Borough (population 29,486), (ADCED 2004 and U.S. Census Bureau 2000). See Figure 3 for a demographic map of EAFB and surrounding communities.

II.E. Land Use

ATSDR examines land use to determine what activities might increase the likelihood of exposure to contaminants released at EAFB. Land at EAFB is used for military operations, recreation, and residential housing. The base is restricted to military personnel, base residents, and civilian employees. A member of the general public can only enter the base by passing security guard stations located at the main entrance, registering his or her vehicle, and obtaining a temporary pass.

Land use controls were established for each OU at EAFB. EAFB prohibits access to contaminated sites and use of on-base groundwater, regulates construction projects near contaminated areas, and advises individuals against consuming fish from Garrison Slough. Fence enclosures and manned gates restrict access to some areas of the base (USAF 2004).

The land surrounding EAFB consists of large undeveloped sections of U.S. Army Fort Wainwright, low-density civilian areas, and forests and wetlands. Camping, fishing, hunting, and other outdoor recreational activities occur throughout the area. A large agricultural and residential area is located to the west of EAFB. The Trans-Alaska and MAPCO Pipelines transect EAFB from the north.

II.G. Quality Assurance and Quality Control

ATSDR reviewed and evaluated information provided in the referenced documents. Documents prepared for the Comprehensive Environmental Response, Compensation and Liability Act (CERCLA) program must meet standards for quality assurance and control, chain of custody, laboratory procedures, and data reporting. The environmental data presented in this PHA come from USAF site and remedial investigations. ATSDR has determined that the data quality is adequate for making public health decisions.

III. Evaluation of Environmental Contamination and Potential Exposure Pathways

III.A. Introduction

Identifying Exposure

PHAs are exposure (or contact) driven. People who work or live near polluted areas can only be exposed to a contaminant if they come in contact with it. Exposure might occur by breathing, eating, drinking, or touching (skin contact) a substance containing a contaminant. Therefore, *a release does not always result in exposure*.

ATSDR evaluates site conditions to determine if people could have been (a past scenario), are (a current scenario), or could be (a future scenario) exposed to site-related contaminants. When evaluating exposure pathways, ATSDR identifies whether exposure to contaminated media (soil, water, air, waste, or biota) has occurred or will occur through ingestion, dermal (skin) contact, or inhalation. ATSDR evaluates exposure pathways as *completed*, *potential*, or *incomplete.* Completed exposure pathways exist if all elements of a human exposure are present. (See Figure 4 for a description of the elements of a completed exposure pathway.) A potential pathway is one in which one or more of the pathway elements cannot be definitely proved or disproved. A pathway is incomplete if one or more of the elements are absent. Pathways deemed incomplete are eliminated from further evaluation.

More information about the ATSDR evaluation process can be found in ATSDR's Public Health Assessment Guidance Manual at http://www.atsdr.cdc.gov/HAC/HAGM/ or by contacting ATSDR at 1-888-42ATSDR.

Exposure and Health Effects

Given sufficient exposure levels, chemical contaminants can cause adverse health effects. The type and severity of health effects that occur in an individual from contact with a contaminant depends on the exposure concentration (how much), the frequency and/or duration of exposure (how long), the route of exposure (breathing, eating, drinking, or skin contact), and the age, sex, nutritional status, genetics, and lifestyle of the exposed individual. Together, these factors determine the health effects that might occur as a result of exposure to a contaminant in the environment.

ATSDR selects contaminants for further evaluation by comparing them against health-based comparison values, or CVs. CVs are developed by ATSDR from the available scientific literature on exposure and health effects. They are derived for each of the different media and reflect an estimated contaminant concentration that is *not expected* to cause adverse health effects for a given chemical, assuming a standard daily contact rate (e.g., amount of water or soil consumed or amount of air breathed) and body weight. In order to be protective of public health, ATSDR CVs are generally based on contaminant concentrations *many times lower than levels at which no effects were observed* in experimental animals or human epidemiologic studies. ATSDR CVs are not used to predict the occurrence of adverse health effects, but serve as a protective screen and first step in evaluation of public health implications.

ATSDR CVs include environmental media evaluation guides (EMEGs), reference dose media evaluation guides (RMEGs), and cancer risk evaluation guides (CREGs). CREGs, EMEGs, and RMEGs are non-enforceable, health-based CVs developed by ATSDR for screening environmental contamination for further evaluation. In addition, ATSDR uses EPA's maximum contaminant levels (MCLs). MCLs are enforceable drinking water regulations developed to protect public health. (See Appendix B for a further description of the CVs.) If contaminant concentrations are above CVs, ATSDR then analyzes exposure variables (for example, duration

and frequency), the toxicology of the contaminant, and epidemiology studies for possible health effects. See Figure 4 for an overview of ATSDR's exposure evaluation process.

Possible Exposure Situations at Eielson Air Force Base

ATSDR reviewed data for the 66 IRP sites and other environmentally impacted areas of EAFB to determine if any are associated with past, current, or future public health hazards. Table 1 describes each of the IRP sites and briefly summarizes environmental investigations, remedial actions, and ATSDR's public health hazard evaluation. When evaluating these areas, ATSDR assessed the level of contamination present or degree of physical hazard, the extent to which individuals come into contact with the contamination or hazard, and whether this contact would result in a public health hazard. The review indicated that most sites at EAFB do not represent public health hazards because: (1) no site-related contaminants are present, (2) contaminant concentrations detected are too low to pose a health hazard, or (3) past and current exposure to the general public has been prevented. However, ATSDR identified five completed or potential exposure situations at EAFB for further evaluation.

Completed Exposures:

- Past ingestion of VOCs and/or arsenic in EAFB drinking water.

Potential Exposures:

- Ingestion of VOCs in off-base drinking water sources near Salcha.
- Ingestion of VOCs in off-base drinking water sources in Moose Creek Village.
- Inhalation of VOC vapors in buildings on-base.
- Consumption of PCBs in fish from Garrison Slough.

Contaminated soil, surface water, and sediment are not associated with any public health hazards at EAFB because there is:

- *Limited potential for exposure*. Soil contamination has remained confined to the subsurface.

- *Limited contamination*. Surface water and sediments do not have harmful levels of contamination (Eielson AFB 1996).

This PHA does not evaluate lead-based paint in EAFB housing because the base has implemented programs to prevent lead exposures. Residents are informed about the lead paint and potential health impacts from exposure to lead paint when they first move into base housing and EAFB has an active program to remove lead hazards from residential units as they are vacated (EAFB undated). As long as people take recommended precautions to prevent lead exposures, no apparent public health hazard exists.

The five exposure situations at EAFB are evaluated in detail in the following discussion and summarized in Table 2. To acquaint the reader with terminology and methods used in this PHA, Appendix A provides a glossary of environmental and health terms presented in the discussion and Appendix B describes the methods ATSDR used to evaluate whether health hazards exist.

III.B. Concern: Past Ingestion of VOCs and/or Arsenic in EAFB Drinking Water

Former operations and waste disposal practices at EAFB have contaminated the groundwater beneath the base with volatile organic compounds (VOCs). These contaminants have spread near active drinking water supply wells and impacted drinking water sources used in the past at outlying areas of the base. Former drinking water wells at the EAFB Ravenwood Ski Lodge and Engineer Hill were closed in 1987 and 1991 respectively, after VOCs were detected above EPA's maximum contaminant levels (MCLs). Naturally occuring arsenic has also impacted groundwater at some locations beneath EAFB, and was detected above the MCL from an active drinking water supply well at the EAFB Birch Lake Resort prior to 1997. People who consumed drinking water at Ravenwood Ski Lodge, Engineer Hill, or Birch Lake Resort in the past were not exposed to VOCs or arsenic at levels known to cause adverse health effects.

Hydrogeology

Groundwater beneath EAFB moves through cracks and spaces in porous units of rock and sediment known as aquifers. The permeability of the rock and sediment layers influences the speed at which the groundwater flows. EAFB has two underlying aquifers: the Tanana Valley Alluvial Aquifer, made up of sand and gravel deposits from the Tanana River, and the Bedrock Aquifer, made up of schist[1].

- *Tanana Valley Alluvial Aquifer:* This aquifer consists of sand, gravel, cobble, sediments, and small amounts of clay and silt. The groundwater table begins roughly 6-10 feet below the land surface and moves freely through most of the aquifer, in a northwesterly direction that is parallel with the Tanana River. The aquifer is approximately 200-700 feet thick. Surface water bodies, water supply wells, and permafrost can cause local variations in groundwater flow (Batelle-PNL 1995 and EA-ST 2004).

[1] Schist is a medium to course grained rock made up of flaky layers of mineral ingredients.

- *Bedrock Aquifer:* This aquifer is a ridge made of weathered fractured bedrock, partially located in the EAFB uplands. The ridge consists of yellow-brown to red-brown quartz-biotite schist, referred to as Birch Creek Schist, underlying approximately 250-300 feet of schist and shallow layers of sediment deposits from the Tanana River. Fractures in the bedrock create multidirectional groundwater flow (ES 1994).

Groundwater Use

EAFB has five active drinking water supply wells, A, B, D, E, and 7, that serve most of the base's water needs. Each well connects to a base-wide distribution system, where groundwater undergoes treatment (with fluoride and chlorine), before entering circulation. Areas of the base that are not connected to the distribution system receive hauled water that has been treated or obtain water from non-treated local area wells that are periodically sampled (Birch Lake Resort and Family Camp). The depth of each well is provided in Table A below (Eielson AFB 2002b and Earth Tech 2004).

Table A. EAFB Drinking Water Supply Wells

Well	Depth (ft)	Comment
A	123.6	Each of these wells is connected to the water distribution system at EAFB. They provide nearly all of the drinking water used at the base.
B	89.5	
D	115.3	
E	145	
7	120	
Birch Lake	NA	Recreational area wells: In service from Memorial day to Labor day.
Family Camp	NA	
NA = Not Available		

Source: Earth Tech 2004

EAFB monitors drinking water to ensure its safety as required by the EPA and the state of Alaska. Water supplies are tested annually for pesticides at the water treatment facility and quarterly for VOCs at each water supply well. Supply wells and/or the distribution system are tested for metals every 9 years with the exception of lead and copper, which are tested for every

3 years. Water from the distribution system is also tested daily for fluoride and weekly for fecal coliform, and faucets are tested periodically for lead, copper, and fecal coliform (Eielson AFB 2003; and Malcolm Nason, Eielson AFB Water Systems Superintendent, personal communication, 2004).

Groundwater Contamination

Contaminants released at EAFB have impacted groundwater at multiple on-site locations. Chlorinated solvents; benzene, toluene, ethylbenzene, and xylenes (BTEX compounds); polycyclic aromatic hydrocarbons (PAHs); and floating petroleum products exceed health-based CVs at some on-base locations of both the Tanana Valley Alluvial Aquifer and the Bedrock Aquifer. The locations of contaminated groundwater at EAFB identified since 2002 are provided in Table B below.

All water supply wells currently in use at EAFB meet safe drinking water guidelines. Well D, located directly north of the Power Plant, lies about 230 feet downgradient from a BTEX plume (IRP Site ST48). Groundwater monitoring and fate and transport studies indicate that BTEX is not moving toward the well, however those studies have not been recently verified (USAF 1994, Ballestero et al 1995, Youcha 2005b).

VOCs were detected above MCLs from drinking water sources at the Ravenwood Ski Lodge and Engineer Hill prior to 1991. Both of these sites, located in outlying upland regions of the base, accessed the Bedrock Aquifer as a local drinking water source during the 1980s before VOCs were detected in the water supplies. Because neither the Ravenwood Ski Lodge nor Engineer Hill has connected to the main base water distribution system, water is currently hauled to both sites (ADEC 2004).

Table B. Contaminants in EAFB Groundwater Above ATSDR CVs, 2002 to 2004

IRP Site		Site Name	Contamination
OU1	SS50–54	Blair Lakes Target Facilities	Benzene Floating product
	ST20	Refueling Complex	Benzene
	ST48	Power Plant Area	BTEX*
	ST10 SS14	POL Storage Area	Benzene Floating product
OU2	ST13, DP26	Fuel Storage Area	BTEX Lead
	ST19	Fuel Spill Area	BTEX
OU3	WP45, SS57	Photo Lab	TCE Benzene
	ST56	Engineer Hill	PCE
	SS61	Vehicle Maintenance Building	TCE
OU4	SS37	Drum Storage Area	Benzene
	ST58	Old Quartermaster Service Station	Lead
OU5	LF03, FT09	Inactive landfill and fire training area	PCE, TCE, benzene, metals
	LF04	Landfill and emergency ordnance demolition area	Benzene
OU6	WP38	Ski Area	Benzene Metals

Source: EA-ST 2004; FWEC et al 2003

Key: BTEX = benzene, toulene, ethylbenzene, and xylene
IRP= Installation Restoration Program
OU= Operable Unit
PCE = tetrachloroethylene
TCE = trichloroethylene

* In 2002, 6 inches of floating product was identified in well 48MO1 and petroleum sheen was observed in well 48MO8. ADEC has requested additional groundwater investigations at this site due to increasing concentrations of benzene in one monitoring well (48MO8). The water supply wells are monitored for VOCs quarterly, and drinking water standards have been consistently met (Youcha 2005b).

Volatile organic compounds (VOCs) and fuel-related constituents were detected in the groundwater beneath EAFB. VOCs are a group of organic chemicals with similar physical properties. At EAFB these chemicals were used as paint thinners, fuel additives, and cleaning and dry cleaning solvents. Constituents found in the groundwater as a result of spills and disposal practices include BTEX, trichloroethylene (TCE), and tetrachloroethylene (PCE).

EAFB began testing drinking water supplies for VOCs in 1986. In August 1986, when benzene was detected once above the MCL (at 145 ppb) during initial tests at the Ravenwood Ski Lodge, the supply well was immediately shut down. In September 1986, benzene was detected again above the MCL in a replacement well at the Ravenwood Ski Lodge that never went into service. In 1987 a third well, installed further from the Ravenwood Ski Lodge than the other two wells, went online briefly before benzene was detected below the MCL. After finding contamination in the third well, EAFB permanantely closed all drinking water wells at the ski area (Eielson AFB 1994a and FWEC et al 2003). See Table 3 for a list of chemicals detected above ATSDR health-based CVs at Ravenwood Ski Lodge.

Tetrachloroethylene (PCE) was detected in drinking water at Engineer Hill above the MCL in 15 out of 22 samples collected between December 1986 and April 1991. The highest PCE concentration (59 ppb) was detected in May 1989. Additional VOCs (such as benzene and trichloroethylene [TCE]) were also detected above MCLs in one drinking water sample at Engineer Hill in June 1989. In 1990, the base shut down the supply well at Engineer Hill and installed a new well in 1991. PCE was detected above the MCL in water samples from the new well in January and April 1991. Since then, the base has only used well water at Engineer Hill for non-drinking purposes. See Table 3 for a list of chemicals detected above ATSDR health-based CVs at Engineer Hill (ADEC 2004, EA-ST 2004, and Eielson AFB 1995).

Groundwater studies indicate naturally occurring arsenic exists in some locations on EAFB. Samples from the EAFB supply well at Birch Lake Resort contained arsenic from 0 to 119 parts per billion (ppb). Arsenic was also detected in background groundwater samples from EAFB at an average concentration of 25 ppb. Since 1994, arsenic has not been detected in main base water

supplies. See Table 3 for a list of chemicals detected above ATSDR health-based CVs at Birch Lake Resort (ADEC 2004, Eielson AFB 2002b, and Eielson AFB 2004c).

Public Health Evaluation

ATSDR evaluated contaminants detected above health-based CVs in drinking water using conservative assumptions about consumption of impacted drinking water. At the Ravenwood Ski Lodge, ATSDR assumed that over a 3-year period in the 1980s children consumed 1 liter of contaminated water from the tap daily during the winter (92 days/year), and that adult year-round workers consumed 1 liter of contaminated water from the tap every day of the work week (261 days/year). ATSDR assumed a 3-year period because that is the average length of residence at EAFB (Jerry Andrews, Eielson AFB Housing Flight Chief, personal communication, 2004). At Engineer Hill, ATSDR assumed that over a 3-year period in the 1980s and early 1990s, adults (workers) also consumed 1 liter of contaminated water from the tap every day of the work week (261 days). Children do not access Engineer Hill and, therefore, would not have come into contact with contaminated drinking water from that area. At Birch Lake Resort, ATSDR assumed that over a 3-year period between 1990 and 1996[2], adults consumed 2 liters and children consumed 1 liter of arsenic-contaminated water from the tap every day between Memorial Day and Labor Day (92 days).

Based on these exposure estimates, VOCs and arsenic were not present in drinking water at Ravenwood Ski Lodge, Engineer Hill, or Birch Lake, at levels known to cause adverse health affects. See Appendix B for a complete exposure assessment.

[2]Arsenic data from the drinking water supply well at Birch Lake Resort was only available between 1990 and 1996.

III.C. Concern: Ingestion of VOCs in Off-base Drinking Water Sources near Salcha

Fuels have impacted groundwater beneath a former artillery barracks (AOC 8) directly west of EAFB and north of Salcha. EAFB has identified six wells within a 1 mile radius of the former artillery barracks, including three wells down-gradient and two wells cross-gradient from contaminated groundwater. Previous sampling conducted by the Air Force indicates the groundwater contaminants were not affecting private off-base drinking water wells. The Army Corps of Engineers plans additional environmental investigations in this area to define the potential for off-site contaminant migration.

Extent of Contamination

EAFB found floating and dissolved fuels in the groundwater, including diesel range organics (DRO), residual range organics (RRO), and polyaromatic-hydrocarbons (PAHs) beneath a 35-acre former artillery barracks (AOC 8). This site is located about one mile to the west of EAFB, north of Salcha, and within one mile of private drinking water wells on Eielson Farm Road. The former artillery site was transferred to the Bureau of Land Management by the Air Force in 1966, and subsequently patented to the State of Alaska in 1967 (Jackson 2005). It was decommissioned in 1997, when demolition work was performed by the Air Force (AMEC 2001). The former artillery site (AOC 8) is now listed as a Formerly Used Defense Site (FUDS). As a FUDS, the Army Corps of Engineers will govern future actions at AOC 8. This site is now known as the Eielson Farm Road Anti-Aircraft Artillery (AAA) site (ACOE 2003).

EAFB identified the impacted area of the site based on soil studies in 1997, and then sampled underlying groundwater in 1999-2000. Groundwater contamination appeared under an 11-acre area within the former artillery barracks. DRO exceeded Alaska Department of Environmental Conservation (ADEC) cleanup levels[3] in 6 out of 27 samples, ranging from 39,000 to 910,000 ppb and RRO exceeded ADEC cleanup levels in 1 out of 9 samples, at 2,300 ppb. BTEX, PAHs,

[3] Alaska Department of Environmental Conservation (ADEC) cleanup levels reflect Alaska's drinking water quality guidelines: TPH DRO= 1500 ppb, TPH RRO= 1100 ppb.

and pesticides, except for benzo(a)anthracene (0.2 ppb), appeared below MCLs in both samples collected from the north and south ends of the site. No contaminants were detected above MCLs along the perimeter of the study area (AMEC 2001). The Army Corps of Engineers plans further studies of this area to define the define the nature and extent of potential off-site contaminant migration (Jackson 2006)

Public Health Evaluation

Groundwater sampling conducted in 2000 indicated that VOCs detected in groundwater beneath the former artillery site had not migrated beyond the contaminant source area and was not impacting the private drinking water wells located on Eielson Farm Road. The Army Corps of Engineers plans additional environmental investigations in this area to define the potential for off-site contaminant migration. Due to the limited amount of available groundwater sampling ATSDR cannot conclusively determine whether the contaminant plume has migrated to the private wells.

III.D. Concern: Ingestion of VOCs in Off-base Drinking Water Sources in Moose Creek Village

Moose Creek Village obtains its drinking water from groundwater that is in close proximity to EAFB's northern border. Because groundwater from the base flows beneath Moose Creek Village, monitoring wells on the base's north boundary are tested annually for VOCs, solvents, and metals. VOCs, solvents, and metals have not been detected at harmful levels in groundwater samples collected from monitoring wells on the base's northern boundary south of Moose Creek Village. Therefore, ATSDR concluded that drinking water in Moose Creek Village is not likely to contain base-related contaminants at levels that could cause health effects.

Drinking Water Wells

Drinking water wells in Moose Creek Village are directly north and downgradient of EAFB. According to a Moose Creek Village resident; BTEX, solvents, and heavy metals found on base

less than 1 mile from the village have impacted groundwater at the same depths where drinking water wells in Moose Creek Village are located (Terry Huisman, RAB Chairperson, personal communication 2004).

Extent of Contamination

In 1992, the Air Force installed five sentinel wells along the northern boundary of EAFB, (referred to as the North Boundary wells) directly south of Moose Creek Village, to monitor for off-base contaminant migration. The Air Force has conducted annual sampling at the North Boundary wells for BTEX and TPHs since 1992, and PCE and TCE between 1995 and 2002. Metals were sampled for annually between 1992 and 1996, and again in 2002 and 2003. Each of the five wells was tested seven times for metals, and between 10 and 12 times for BTEX, TPHs, PCE, and TCE (Batelle-PNL 1995; EA-ST 2004; FWEC at al 2003).

Sampling results show little to no contaminants present in the North Boundary wells. BTEX compounds did not exceed CVs. No PCE or TCE were detected. Metal concentrations were consistent with levels found throughout the aquifer, except for thallium, which was detected in one sample (5.9 ppb) above the MCL in 2002, and lead, which was detected in two samples (16 ppb and 22 ppb) above the MCL in 1994 (EA-ST. 2004 and FWEC et al 2003). See Table 4 for a list of chemicals detected above ATSDR health based CVs at the North Boundary wells.

Public Health Evaluation

VOCs have never exceeded MCLs in the North Boundary wells of the base. Levels are not expected to increase in the future, based on groundwater monitoring and fate and transport studies conducted by the Air Force. Periodic monitoring of sentinel wells at the North Boundary by the base should ensure that VOC contamination does not migrate off site and impact off-base drinking water wells in Moose Creek Village in the future (Batelle-PNL 1995 and EA-ST 2004). ATSDR concludes that drinking water in Moose Creek Village is not likely to be impacted by base-related contaminants at levels that could cause health effects.

III.E. Concern: Vapor Intrusion to Indoor Air

Contaminated groundwater has migrated near certain buildings on base. The most common groundwater contaminants are VOCs. Under some conditions, VOC vapors can travel from the groundwater through the soils, seeping into air inside buildings. Occupants of on-site buildings were most likely not exposed to indoor air vapors at high enough levels for long enough periods to develop long-term health effects. In the past, where indoor air quality concerns have been identified, EAFB personnel have addressed the situation to correct the problem. The base process for identifying and evaluating vapor intrusion is expected to address future concerns.

Extent of Contamination

Indoor air concerns have been identified by workers and during environmental investigations. In response, EAFB has conducted sampling to identify the contaminant source and remedial activities to prevent harmful exposures.

- In June 1996, workers in Building 6225, near a bioventing system at site ST10, complained of petroleum hydrocarbon vapors. A soil vapor extraction unit was installed to reduce vapor migration into the building and began operating in October 1996. Subsequent air monitoring found concentrations to be near or below detection limits (Eielson AFB 1998).
- In 1996, utilidor systems maintenance personnel reported experiencing headaches, nausea, and other ill-effects as a result of petroleum hydrocarbon vapors while working in the utilidor near site SS37. EAFB sealed joints and cracks in the utilidor, and subsequent air monitoring indicated significantly reduced vapor concentrations in the utilidor (AEE 1997a).
- In 1996, elevated hydrocarbon readings were observed at site ST13/DP26, Building 4480, a pump room for an aircraft de-icing agent infrequently used by base personnel. EAFB sealed cracks to prevent petroleum hydrocarbon vapors from seeping into the building (AEE 1997b).

Currently, ADEC is interested in the vapor intrusion potential for buildings located near or above groundwater contaminant plumes. One specific site of concern at EAFB is site WP45/SS57, due to elevated concentrations of TCE in the groundwater (Youcha 2005a).

Public Health Evaluation

Historically, EAFB has responded to complaints regarding indoor air quality with the appropriate remedy. Previous issues at sites ST10, SS37, and ST13/DP26 were addressed and the available air monitoring shows that these sites are no longer a concern. The actual exposure of the workers to the indoor air contaminants could not be identified, however the exposures were for short periods of time and unlikely to cause a long-term health effect.

Indoor air concerns for base buildings are investigated by the base Bioenvironmental Engineering (BEE) organization and may include indoor air sampling. The IRP office will coordinate with the BEE organization during indoor air investigations for buildings that are in close proximity to contaminated sites to ensure that indoor air quality is within OSHA standards. This procedure is expected to address potential vapor intrusion concerns.

III.F. Concern: Fish Contamination at Garrison Slough

Since 1993, studies have found PCBs and pesticides in fish from Garrison Slough at levels above health-based CVs. The highest contaminant levels appear in fish from Lower Garrison Slough, upstream of the Arctic Avenue Bridge. People who consume fish from Garrison Slough could be exposed to PCBs and pesticides. Infrequent consumption of fish from the off-base section of Garrison Slough is not expected to cause health effects. On-base anglers are advised to not eat fish from the on-base section of Garrison Slough when they apply for their on-base fishing permit. On-base anglers who follow this advice will not be exposed to PCBs or pesticides from this source. As a prudent public health action, ATSDR recommends that people follow the base policy and avoid eating fish from the on-base section of Garrison Slough.

Garrison Slough

Garrison Slough flows north through the center of the developed portion of EAFB, parallel to Central Avenue and Richardson Highway. At the northern end of the base, the slough veers west

and continues about 3,000 feet before converging with Moose Creek, in Moose Creek Village. The midsection of the slough runs directly through heavily industrial areas of the base (FWEC et al 2003). Hazardous wastes have likely entered the slough from drainage channels, former seeps and outfalls, and the shallow aquifer beneath EAFB. Wastewater from the EAFB sewage treatment plant also drained into Garrison Slough regularly until 1979 (Batelle-PNL 1995).

Extent of Contamination at Garrison Slough

During the IRP investigation, EAFB tested 15 sediment samples from 15 locations at Garrison Slough, (four stations in 1989 and 11 stations in 1990) for PCBs and pesticides. Four contaminants were detected at concentrations above health-based CVs: one PCB, Aroclor 1260 (7.65 ppm), and three pesticides, 4'4-DDT (62.4 ppm), 4'4-DDD (58.6 ppm), and 4'4-DDE (2.05 ppm) (Batelle-PNL 1995 and EA-ST 2004).

During the remedial investigaton in 1993 and 1994, EAFB collected additional sediment samples from Garrison Slough. Results from 20 sediment samples, collected at 14 locations, found PCBs (Aroclor 1260), 4'4-DDT, and 4'4-DDD at concentrations as high as 55 ppm, 4.2 ppm, and 11 ppm, respectively. The highest PCB and pesticide concentrations were detected in sediment collected at a former pesticide mixing area (IRP Site SS35) near the intersection of Central Avenue and Tenakee Street, and at lower Garrison Slough, 900 feet upstream of the Arctic Avenue Bridge. Studies indicate that PCBs entered the slough upstream from the Arctic Avenue Bridge through a former drainage channel. EAFB suspects that these PCBs originated from transformers stored near a former masonry shop (Batelle-PNL 1995 and USAF 2004).

In 1993, EAFB began sampling biota from Garrison Slough, including two species of fish (arctic grayling and northern pike), aquatic macrophyte vegetation, and benthic invertebrates. Biota samples were collected from five areas of the slough located both on and off base and in Moose Creek, near the Moose Creek-Garrison Slough confluence. Four fish, an invertebrate sample, and a plant sample, were collected at each of the five sampling areas (Batelle-PNL 1995).

Pesticides, most notably 4'4 DDD (1.45 ppm in fish), were detected in biota samples collected from the mid-section of Garrison Slough, near North and Kodiak Streets, downstream of the former pesticide mixing area (IRP Site SS35). PCB levels (3 ppm in fish) were highest in biota in the lower slough, near the Arctic Avenue Bridge. Biota from other sections of the slough, outside the areas with peak contaminant concentrations, showed significantly lower levels of PCBs and pesticides (Batelle-PNL 1995).

PCB monitoring has continued in three species of large predatory fish, (arctic grayling, northern pike, and rainbow trout) on an annual/semi-annual basis at Garrison Slough since 1993. Maximum concentrations on base (up to 12 ppm in 1996) remain localized to the lower slough, downstream of the former drainage channel. Fish caught in other sections of the slough further downstream from the drainage channel, as far away as Moose Creek, have also contained PCBs above health-based screening values. The highest off-base PCB concentration (1.1 ppm) was detected in 1997 from a trout caught in Moose Creek near Pete's Crossing (EA-ST 2004).
In 1996 and 1997, EAFB excavated contaminated sediments in lower Garrison Slough and constructed screen barriers to prevent fish from exiting and entering contaminated areas upstream from the Arctic Avenue Bridge. Since these remedial actions took place, PCB levels have diminished in some areas and leveled off in others. In 2002 and 2003 the base sampled fish born both before and after the 1996-1997 sediment excavations, to determine whether active sources of PCB contamination remain in the slough. EAFB collected 50 fish in 2002 and 2003, including 31 fish younger and 19 fish older than 5 years old. PCB concentrations in fish born both before and after removal of PCB contaminated sediments in 1996-1997 varied widely. PCB levels ranged from 0.019 ppm to 0.649 ppm in young fish less than 5 years old and 0.003 ppm to 0.445 ppm in older fish. The highest PCB levels were found in fish collected from Lower Garrison Slough (EA-ST 2004). Tables 5 and 6 present a list of fish tissue sample results from Garrison Slough.

Public Health Evaluation

ADEC has classified Garrison Slough as an impaired water body due to high levels of PCBs (EPA 2003). PCBs and pesticides have accumulated in sediment and large predatory fish (rainbow trout, arctic grayling, and northern pike) at recreational areas in the slough on and off base. A variety of local areas are used for fishing including local rivers and streams and stocked surface water bodies, such as Bear Lake, Manchu Lake, Hidden Lake, and Piledriver Slough (EAFB 1997). Contaminants have not been detected at harmful levels in sediment and surface water from any of the stocked surface water bodies in the vicinity of EAFB (Eielson AFB 1996).

EAFB allows recreational fishing on base but warns anglers not to consume fish caught from Garrison Slough. These warnings are conveyed to anglers verbally by the EAFB Department of Natural Resources when they obtain fishing permits (Tom Slater, Department of Natural Resources, Eielson AFB, personal communication 2004). Anglers, including school-aged children, fish the slough in the summer on an infrequent basis. The extent that residents follow the fish advisory at Garrison Slough is not known. In order to further remind anglers not to consume fish from the advisory area, Eielson AFB placed 22 “fishing advisory” signs along access points to Garrison Slough (US. Air Force 2005) during the summer of 2005.

ATSDR evaluated potential health effects based on the assumption that community members have, on occasion, caught and eaten contaminated fish from Garrison Slough. ATSDR used fish sampling data from Garrison Slough to estimate the amount of PCBs and pesticides that residents at EAFB and nearby villages could consume by eating contaminated fish. Please see Appendix B for more details. Because Garrison Slough is not used for swimming, wading, or boating, ATSDR has concluded that significant exposures to contaminated sediments at Garrison Slough have not occurred (Tom Slater, Department of Natural Resources, Eielson AFB, personal communication 2004). Therefore ATSDR did not evaluate health affects associated with sediment exposures.

Would consumption of a small amount of fish from Garrison Slough result in a harmful exposure to pesticides?

Exposure to pesticides in fish at Garrison Slough is not expected to cause adverse health affects for people who consume six or fewer fish per year.

ATSDR estimated the potential pesticide exposure for people consuming up to six 8-oz fish meals per year from the Garrison Slough. ATSDR assumed that each fish contained the maximum pesticide concentrations found during the sampling events. Results of the evaluation indicates that consuming up to six fish per year from the Garrison Slough would not result in pesticide exposures at levels likely to cause adverse health effects.

Would consumption of a small amount of fish from Garrison Slough result in a harmful exposure to PCBs?

People who infrequently consume fish (six 8-oz fish meals per year or less) from the off-base section of Garrison Slough are not expected to be exposed to harmful levels of PCBs. People who consume fish from the on-base section of Garrison Slough would likely be exposed to PCBs at levels exceeding ATSDR's CV. As a prudent public health action, ATSDR recommends that people follow the base fish advisory and avoid eating fish from the on-base section of Garrison Slough.

ATSDR estimated the potential PCB exposure for people consuming up to six 8-oz fish meals per year from both the off-base and on-base sections of the Garrison Slough. ATSDR assumed that each fish contained the PCB concentration equal to the average concentration measured during the annual sampling event. Results of the evaluation indicates that consuming up to six fish per year from the off-base section of Garrison Slough would not be expected to result in PCB exposure exceeding ATSDR's CV and would be unlikely to cause adverse health effects. Results of the evaluation also indicate that people who consume fish from the on-base section of

Garrison Slough would likely be exposed to PCBs at levels exceeding ATSDR's CV. While a review of toxicological information indicates the potential PCB exposure from consuming small amounts of fish from the on-base Garrison Slough are below expsosures associated with known health effects, it would be prudent to not eat fish from this area. On-base anglers are verbally advised of the fish advisory when they obtain their on-base fishing permit. In addition, the base has placed signs along the slough delineating the fish advisory. A*s a prudent public health action, ATSDR recommends that people follow the established base policy and avoid eating fish from the on-base section of Garrison Slough.*

IV. Community Health Concerns

Throughout the PHA process, ATSDR gathered information about community health concerns related to potential exposure to EAFB-related environmental contaminants. Most of these concerns were identified during the ATSDR scoping site visits in 1991 and 2004; through meetings with state, local, and USAF officials; and review of site documents, including EAFB's Community Relations Plan (CRP). The CRP provides guidance for involving the community and other interested parties in the remediation decision-making process and for distributing information to these parties.

Citizens expressed concern about possible exposures to contaminants at EAFB, specifically exposures to VOCs in drinking water in Moose Creek Village.

ATSDR met with residents from Moose Creek Village on June 8, 2004 to hear community concerns about a possible linkage between cancer cases in Moose Creek Village and contaminants from EAFB. Residents have suggested that contaminants buried at unknown locations in the past in the vicinity of EAFB may have impacted shallow drinking water wells in Moose Creek Village. Community members indicated that none of the shallow private drinking water wells in the village have been tested for contamination.

ATSDR evaluated groundwater entering Moose Creek Village from EAFB and determined that base-related contaminants are not migrating from the base's northern boundary into the village groundwater supply at harmful levels. As part of this evaluation, ATSDR reviewed environmental monitoring data from 1992 to 2003 from the north boundary of EAFB. More detailed information regarding this evaluation is provided in Section III of this PHA. Residents concerned about the quality of their drinking water can contact the Alaska Department of Environmental Conservation Drinking Water Program.

V. ATSDR Child Health Considerations

In communities faced with air, water, or food contamination, the many physical differences between children and adults demand special attention. Children could be at greater risk than adults from certain kinds of exposure to hazardous substances. Children play outdoors and sometimes engage in hand-to-mouth behaviors that increase their exposure potential. Children are shorter than adults; this means they breathe dust, soil, and vapors close to the ground. A child's lower body weight and higher intake rate results in a greater dose of hazardous substance per unit of body weight. If toxic exposure levels are high enough during critical growth stages, the developing body systems of children can sustain permanent damage. Finally, children are dependent on adults for access to housing, medical care, and risk identification. Thus adults need as much information as possible to make informed decisions regarding their children's health. Therefore, ATSDR is committed to evaluating children's special interests at sites such as EAFB as part of the ATSDR Child Health Considerations.

ATSDR has attempted to identify populations of children in the vicinity. Approximately 770 children under the age of 5 years live on EAFB and 92 live within the two towns, Salcha and Moose Creek Village, surrounding the base (US Census Bureau 2000). A youth activities center, two elementary schools, a junior/senior high school, and a school-age care program are all located on the base (Eielson AFB 2004b).

Like other people living or working at or near EAFB, children may contact contaminated site media. As discussed in the Evaluation of Environmental Contamination and Potential Exposure Situations section of this PHA, past, current, and future exposures for children could include exposure to contaminated fish from Garrison Slough, and exposure to contaminated drinking water off base.

To evaluate whether children might experience adverse health affects through past, current, or future exposures to site contaminants, ATSDR estimated potential exposure doses for children.

To estimate these doses, ATSDR used protective assumptions that overestimate the levels of actual exposure. Appendix B describes in greater detail the methods and assumptions ATSDR used to estimate childhood exposure doses and determine health effects.

ATSDR also reviewed measures established on base to prevent childhood exposures to lead-based paint. Lead can be particularly hazardous to young children because they are prone to hand-to-mouth activities and, therefore, could ingest lead paint chips or lead-contaminated dust. EAFB has taken specific measures to eliminate childhood exposures to lead-based paint in base housing. Exposure to lead can be prevented by keeping children from coming into contact with lead. Every time occupants vacate a residence—every 3 years on average—the EAFB housing division prepares the empty house for the new occupant (Jerry Andrews, Eielson AFB Housing Flight Chief, personal communication, 2004). This includes repairing any surfaces with deteriorated paint and, in most cases, completely repainting the unit with non-lead-based paint. During occupancy, residents are encouraged to report any significant chipped or peeling paint so that it can be dealt with immediately. EAFB advises residents to protect their children against unwanted exposure as follows:

- *Notification about lead-based paint.* A handout from the EAFB Housing Division notifies prospective residents about lead-based paint before they move into base housing (EAFB undated).
- *Temporary cleaning/removal measures*. Lead painted surfaces generally do not pose a health hazard. The EAFB Housing Division, however, advises residents to report severely chipped or peeled painted surfaces to the Bioenvironmental Engineering office because of possible risk to children (EAFB undated).

The Centers for Disease Control and Prevention and the American Academy of Pediatrics have recommended that physicians evaluate the potential for lead exposure to children (9 months to 6 years of age) and, when appropriate, perform blood-lead screening (ATSDR 1999a, 1999b; AAP

1998; CDC 2003). At EAFB, physicians administer questionnaires to children's guardians. Information gathered from the questionnaire helps the physician determine the child's level of lead exposure and what type of further care is needed (Major Rick Mooney and Major Edgar Rodriguez, Eielson AFB Occupational Health Working Group, personal communication 2004).

The Centers for Disease Control and Prevention (CDC) indicate that blood lead levels of 10 μg/dL or greater are high enough to be a concern for lead poisoning. Children with blood lead levels in this range should have follow-up examinations, treatment, or both (ATSDR 1999b; CDC 2003).

VI. Conclusions

Conclusions regarding potential past, current, and future exposure situations on base and in the communities near EAFB are based on a thorough evaluation of site investigation data and observations made during site visits. Conclusions about exposures are described below. (The public health hazard conclusion categories are described in the glossary, Appendix A.)

1. Contaminants have leached into the groundwater beneath EAFB. Exposures to VOCs occurred in the past through the EAFB drinking water supply at the Ravenwood Ski Lodge for an unknown length of time prior to August 1986 and at Engineer Hill for an unknown length of time prior to 1991. Exposures to naturally occurring arsenic in drinking water also occurred prior to 1996 at Birch Lake Resort. None of these chemicals were present at levels that would be expected to cause adverse health effects. The EAFB water supply is routinely tested to ensure that it meets state and federal drinking water standards. *Groundwater beneath EAFB poses no public health hazard.*

2. VOCs were detected beneath a former artillery barracks near Salcha and within one mile of private drinking water wells near Eielson Farm Road. This site was formerly investigated as AOC 8 and is currently part of the FUDS program and no longer under the jurisdiction of Eielson AFB. As a FUDS, the Army Corps of Engineers will govern future actions at AOC 8. Monitoring conducted in 2000 indicated VOCs had not traveled beyond the contaminant source area and were not in contact with private drinking water wells. The Army Corps of Engineers plans additional environmental investigations in this area to better define the potential for off-site contaminant migration. Because ATSDR cannot determine whether the contaminant plume has migrated to the private wells, *this potential pathway was classified as an indeterminate public health hazard.*

3. VOCs in groundwater at EAFB have not migrated off site towards Moose Creek Village at levels above health-based CVs. Sentinel wells along EAFB's north boundary are tested

annually to ensure that contaminated groundwater is not migrating off base. G*roundwater beneath the northern border of EAFB is not impacting off-site drinking water sources in Moose Creek Village and, therefore, poses no public health hazard.*

4. VOC-contaminated groundwater has migrated near certain on-base buildings. Occupants of on-site buildings were most likely not exposed to indoor air vapors at high enough levels for long enough periods to develop long-term health effects. Indoor air concerns for base buildings are investigated by the base Bioenvironmental Engineering (BEE) organization. The IRP office will coordinate with the BEE organization during indoor air investigations for buildings that are close to contaminated sites to ensure indoor air quality is within OSHA standards. Because this procedure is expected to address potential vapor intrusion concerns, *this potential pathway was classified as no apparent public health hazard.*

5. Anglers who infrequently consume fish (six 8-oz meals per year) from the off-base section of Garrison Slough are not expected to be exposed to harmful levels of pesticides or PCBs. *ATSDR categorized infrequent consumption of fish from the off-base section of Garrison Slough as no apparent public health hazard*. Anglers who consume fish from the on-base section of Garrison Slough could be exposed to PCBs at levels above ATSDR's CVs. The base currently informs anglers, as they acquire their on-base fishing permit, to not eat fish from the slough. The base also added 22 signs along access points to the slough delineating the fish advisory. People who follow the base advisory will not be exposed to these contaminants. As a prudent public health action, ATSDR recommends that people follow the established base policy and avoid eating fish from Garrison Slough. *For people who follow the base advisory to not eat fish from the on-base section of Garrison Slough, fishing from the slough poses no public health hazard.*

VII. Recommended Actions

1. ATSDR recommends that on-base anglers follow the established base policy and avoid eating fish from Garrison Slough.

VIII. Public Health Action Plan

The public health action plan (PHAP) for Eielson Air Force Base contains a description of actions taken or to be taken by EAFB, ATSDR, EPA, and ADEC at and in the vicinity of the site subsequent to the completion of this PHA. The purpose of the PHAP is to ensure that this PHA not only identifies potential and ongoing public health hazards, but also provides a plan of action designed to mitigate and prevent adverse human health effects resulting from exposure to hazardous substances in the environment. The public health actions that are completed, and ongoing/planned, are as follows:

Completed Actions

1. The USAF has identified 66 IRP sites at EAFB and has grouped 61 of these sites within seven operable units: OU1-OU6, and Site-wide OU7. EAFB has also investigated an off-base groundwater plume at a former artillery barracks (IRP Site AOC 8) (EA-ST 2004).

2. The USAF has undertaken measures to reduce the sources of contamination at EAFB. These measures include:
   - Removal of soil at the following locations:
     - Main taxiway (SS-13 and DP-26) in 1988, 1990, and 1994,
     - Former cement mixing site (SS-36) in 1989,
     - Drum storage site (SS-64) in 1989,
     - Asphalt Lake (SS-39) in 1992,
     - Old Quartermaster Service Station (ST-58) in 1993, and
     - Vehicle storage facility (ST-18) in 1994.
   - Removal of sediment from Garrison Slough (SS67) in 1996-1998.
   - Removal of fuel storage tanks and pipelines at the following locations:
     - Main taxiway (SS-13 and DP-26) in 1988,
     - Engineer Hill (ST-56) in 1992,
     - Vehicle storage facility (ST-18) in 1994,

  - Alert Hangar (ST-49) in 1995, and
  - POL Storage Facilities (ST10 and SS-14) in 2002.
- Excavation of buried drums from a drum storage site (SS-64) in 1989, Asphalt Lake (SS-39) in 1992, and landfills (LF01, LF04, and LF05) in 1992, 1993, and 1995.
- Removal or closure of dry wells near a photo lab (WP-45) in 1993, a vehicle maintenance shop (SS-61) in 1993, and a vehicle storage facility (ST-18) in 1994.
- Application of a soil cover at an inactive landfill (LF03) in 1995.
- Natural attenuation, accelerated anaerobic bioremediation, or product recovery at several areas where VOCs have contaminated the soil and groundwater.

3. The USAF has recommended 41 IRP sites for no further action because they pose no risk to human health or they have been remediated to cleanup standards (EA-ST 2004).

4. The USAF shut down or replaced drinking water supplies at the Ravenwood Ski Lodge and Engineer Hill after VOC contaminants were detected in drinking water wells in 1987 and 1991, respectively.

5. The USAF implemented a Site Wide Groundwater Monitoring Program (SWMP) in 1992 for the long-term study of groundwater contamination on base.

6. ATSDR visited EAFB in 1991 to tour the site, meet with site representatives, and gather environmental and exposure information to complete the public health evaluation. ATSDR visited the site again in June 2004. During this time, ATSDR also met with community members from Moose Creek Village to hear villager's concerns about possible exposures to contaminants released by EAFB.

7. USAF has added signs along the slough delineating the base fish advisory.

Ongoing and Planned Actions

1. Nine sites are currently undergoing actions to mitigate groundwater pollution through monitored natural attenuation of chlorinated solvents or fuel-related products, systems to recover free-phase jet fuel, or accelerated anaerobic bioremediation (EA-ST 2004).

2. USAF continues to monitor groundwater throughout the base, and monitoring of fish continues at Garrison Slough under the SWMP.

3. EAFB will continue to advise residents not to consume fish from Garrison Slough and maintain fish barriers designed to prevent PCB-contaminated fish from migrating out of the impacted areas.

4. EAFB will continue to remediate or demolish certain base housing units, some of which contain lead-based paint. The Housing Division will continue to inform prospective residents about lead hazards in their homes and ways to prevent exposure.

5. The AOC 8 site, now known as the Eielson Farm Road Anti-Aircraft Artillery (AAA) site, was authorized as a Formerly Used Defense Site (FUDS) in 2003. Two projects have been identified, including removal of an underground storage tank and development of remedial activities to address the contaminated soil and groundwater. Implementation of these projects is subject to funding availability and prioritization by the FUDS Management Action Plan committee members, which include ADEC, EPA, and the Alaska District of the US Army Corps of Engineers (Jackson 2005).

IX. Preparer of Report

This report was prepared under the direction and supervision of the following individuals:

Katherine E. Hanks
Environmental Health Scientist
Federal Facilities Assessment Branch
Division of Health Assessment and Consultation

Susan K. Neurath, Ph.D., P.E.
Environmental Health Scientist
Federal Facilities Assessment Branch
Division of Health Assessment and Consultation

Gary Campbell, Ph.D.
Environmental Health Scientist
Federal Facilities Assessment Branch
Division of Health Assessment and Consultation

X. References

American Academy of Pediatrics (AAP). 1998. Screening for Elevated Blood Lead Levels (RE9815). Pediatric. Vol. 101, Number 6. p. 1072-1078. June 1998.
Available at http://www.aap.org/policy/re9815.html.

U.S. Army Corps of Engineers, Alaska District (ACOE). 2003. Defense Environmental Restoration Program-Formerly Used Defense Sites (DERP-FUDS) Inventory Project Report (INPR) for Property No. F10AK1059, Eielson Farm Road Antiaircraft Artillery (AAA) Site, Salcha, Alaska. Elmendorf Air Force Base, Alaska. March 2003.

Alaska Department of Environmental Conservation (ADEC). 2003. Alaska's Final 2002/2003 Integrated Water Quality Monitoring and Assessment Report. Fairbanks, Alaska. December 2003.

ADEC. 2004. Compilation of various drinking water well data for Eielson Air Force Base received from Linda Grantham, ADEC. Fairbanks, Alaska. October 2004.

ADEC 2005. ADEC Comments Pertaining to ATSDR's PHA Public Comment Release for Eielson AFB, September 19, 2005. November 1, 2005.

Alaska Division of Community and Economic Development (ADCED). 2004. Community Profile Database. Alaska Department of Commerce.
Available at http://www.dced.state.ak.us/dca/commdb/CF_COMDB.htm.

AGRA Earth and Environmental (AEE). 1997a. Utilidor Investigation/Treatment Study. Eielson Air Force Base, Alaska. March 1997.

AEE. 1997b. Addendum 01 Remedial Action Plan, Remedial Design Operable Unit Two. Eielson Air Force Base, Alaska. May 1997.

AMEC Earth and Environmental (AMEC). 2001. Site Characterization Report AOC 8. Eielson Air Force Base, Alaska. July 2001.

Agency for Toxic Substances and Disease Registry (ATSDR). 2000. Toxicological Profile for Arsenic (Update). Atlanta: U.S. Department of Health and Human Services. August 1998.
Available at http://www.atsdr.cdc.gov/toxprofiles/tp17.html U.S.

ATSDR 1999a. Toxicological Profile for Lead (update). Atlanta: US Department of Health and Human Services. Available at http://www.atsdr.cdc.gov/toxprofiles/tp13.html.

ATSDR. 1999b. ToxFAQs for Lead. Atlanta: US Department of Health and Human Services.
Available at http://www.atsdr.cdc.gov.

ATSDR. 2000. Toxicological profile for polychlorinated biphenyls (PCBs). Atlanta: U.S. Department of Health and Human Services.
Available at http://www.atsdr.cdc.gov/toxprofiles/tp17.html.

Ballestero and Brannaka. 1995. Field Report for Activities Associated with the Investigations of Contaminant Transport at EAFB Site ST48. Durham: University of New Hampshire Environmental Research Group. December 1995.

BATELLE-PNL. 1995. Sitewide Remedial Investigation Report: Eielson AFB. Eielson Air Force Base, Alaska. August 1995.

Centers for Disease Control and Prevention (CDC). 2003. Childhood Lead Poisoning Fact Sheet. Atlanta: U.S. Department of Health and Human Services.
Available at http://www.cdc.gov/nceh/lead/lead.htm.

Eielson AFB. Undated. Eielson AFB Lead-Based Paint Awareness. Eielson Air Force Base, Alaska. Available at the Eielson AFB Division of Housing.

Eielson AFB. 1994a. EPA Superfund Record of Decision: Eielson AFB Operable Unit 6. Fairbanks, Alaska. September 1994.

Eielson AFB. 1994b. EPA Superfund Record of Decision: Eielson AFB Operable Unit 1. Fairbanks, Alaska. September 1994.

Eielson AFB. 1994c. EPA Superfund Record of Decision: Eielson AFB Operable Unit 2. Fairbanks, Alaska. September 1994.

Eielson AFB. 1995. EPA Superfund Record of Decision: Eielson AFB Operable Units 3, 4, and 5. Fairbanks, Alaska. September 1995.

Eielson AFB. 1996. EPA Superfund Record of Decision: Eielson AFB Operable Unit 7: Sitewide. Fairbanks, Alaska. September 1996.

Eielson AFB. 1997. Places to Fish Within 200 Miles of Eielson AFB. Eielson Air Force Base, Alaska. February 1997.

Eielson AFB. 1998. OU2 Remedial Action Summary Report. Eielson Air Force Base, Alaska. August 1998.

Eielson AFB. 2001. Eielson AFB 2001 Community Relations Plan. Eielson Air Force Base, Alaska. December 2001.

Eielson AFB. 2002a. Eielson Natural Resources Guide. Eielson Air Force Base, Alaska. November 2002.

Eielson AFB. 2002b. Annual Consumer Report on the Quality of Tap Water. Eielson AFB.

Eielson AFB. 2003. Annual Consumer Report on the Quality of Tap Water. Eielson AFB.

Eielson AFB. 2004a. Eielson Fact Sheet: United States Air Force.
Available at http://www.eielson.af.mil/library/history.htm.

Eielson AFB. 2004b. Eielson Local Schools.
Available at http://www.eielson.af.mil/abt_base/newcomers/newcomers.htm.

Eielson AFB. 2004c. Annual Consumer Report on the Quality of Tap Water. Eielson AFB.
Earth Tech. 2004. Part 1: Sanitary Survey and Contingency Response Assessments Eielson AFB, Alaska. Brooks City-Base, Texas. May 2004.

EA-ST. 2004. The United States Air Force Installation Restoration Program Final: 2003 Sitewide Monitoring Program Report for Eielson Air Force Base, Alaska. Eielson Air Force Base, Alaska. April 2004.

U.S. Environmental Protection Agency (EPA). 1996. PCBs: Cancer Dose-Response Assessment and Application to Environmental Mixtures. Washington, DC. September 1996.
Available at http://www.epa.gov/ORD/WebPubs/pcb/pcb.pdf.

EPA. 1997. Exposure Factors Handbook. National Center for Environmental Assessment. EPA/600/P-95/00Fa. August 1997.
Available at http://www.epa.gov/ncea/exposfac.htm.

EPA. 2002. Draft Guidance for Evaluating the Vapor Intrusion to Indoor Air Pathway from Groundwater and Soils. Washington, DC. November 2002.

Engineering Science Incorporated (ES). 1994. Installation Restoration Program: Operable Unit 6 Remedial Investigation Report. Eielson Air Force Base, Alaska. March 1994.

Foster Wheeler Environmental Corporation and EA Engineering Science and Technology (FWEC and EA-ST). 2003. The United States Air Force Installation Restoration Program Final: 2002 Sitewide Monitoring Program Report for Eielson Air Force Base, Alaska. Eielson Air Force Base, Alaska. June 2003.

Jackson R. 2005. June 10 ATSDR personal communication via electronic mail with Richard Jackson, FUDS Project Manager, US Army Corps of Engineers, Alaska District.

Jackson R. 2006. January 19 Personal Communication Re: Planned Environmental Sampling and Community Point of Contact. Richard Jackson, FUDS Project Manager, US Army Corps of Engineers, Alaska District.

National Research Council. 1999. Arsenic in Drinking Water. National Academy Press.

USAF. 1994. The United States Air Force Installation Restoration Program Remedial Investigation: Operable Unit 1 Eielson Air Force Base. Eielson Air Force Base, Alaska. May 1994.

USAF. 2004. The United States Air Force Installation Restoration Program Final Five-Year ROD Review Report for Eielson AFB, Alaska. Eielson Air Force Base, Alaska. January 2004.

USAF. 2005. Comments to the Eielson Air Force Base Public Health Assessment, Version 19 September 2005. November 4, 2005.

U.S. Census Bureau. 2000 census population: American FactFinder. Washington: US Department of Commerce.
Available at http://factfinder.census.gov/servlet/SAFFFacts?_sse=on.

Youcha E. 2005a. June 16 letter from State of Alaska Department of Environmental Conservation to ATSDR regarding Comments on *Pre-decisional draft for data validation of the Eielson Air Force Base Public Health Assessment (PHA).*

Youcha E. 2005b. November 1 letter from State of Alaska Department of Environmental Conservation to ATSDR regarding Comments on the *Public Comment Public Health Assessment (PHA) for the Eielson Air Force Base.*.

Tables

Table 1. Evaluation of Public Health Hazards at EAFB

Site	Site Description/Disposal History	Investigation Results/ Environmental Monitoring Results	Corrective Activities	ATSDR Evaluation of Public Health Hazards
Operable Unit 1				
Refueling Loop (ST20)	ST20 consists of three fuel facilities at the southern end of the runway: E7, E8, and E9, that consist of fuel pump houses, storage tanks, and pipelines. Fuel spills have ocurred at ST20 in the past. The E-9 facility leaked extensively on at least three occasions in 1988, 1989, and 1992. Fuel may have also escaped from underground pipelines at E-7.	**Groundwater (ppb)**: Benzene (12,000), toluene (22,000), ethylbenzene (3,700), and xylene (11,820) were found above CVs. **Surface Soil (ppm)**: Benzo(a)-pyrene (1.3) was found above the CV.	Remedial actions selected under the ROD signed in September 1994 have focused on decreasing (BTEX) levels in groundwater. They have included passive fuel product recovery, bioventing, soil vapor extraction, and groundwater monitoring.	Based on a review of site data and potential exposure scenarios, ATSDR anticipates no potential public health hazards at ST20. The public has limited access to this site and no drinking water wells are located nearby. Groundwater beneath ST20 will continue to be monitored in the future.
Power Plant (ST48)	The power plant is located near the runway at the intersection of Industrial Drive and Division Street. VOCs found in the groundwater at ST48 likely originated from buried pipelines and a dry well. Supply well D, a main base drinking water well, is located immediately north of the power plant.	**Groundwater (ppb)**: Benzene (7,200), 1,2-DCA (61), toluene (12,500), ethylbenzene (1,600), and xylene (6,820) were found above CVs. **Water Supply Well:** No contaminants have been found at levels above CVs. **Surface Soil (ppm):** Benzo(a)-pyrene (0.98) was found above the CV.	Remedial actions selected under the ROD signed in September 1994 have focused on decreasing BTEX levels in groundwater. They have included passive fuel product recovery, bioventing, soil vapor extraction, and groundwater monitoring.	Based on a review of site data and potential exposure scenarios, ATSDR anticipates no potential public health hazards at ST48. Well D has not been impacted by contamination at ST48 and does not appear likely to in the future, based on the projected path of contaminant migration. The base routinely tests well D to ensure that contaminants do not enter the drinking water supply.

Site	Site Description/Disposal History	Investigation Results/ Environmental Monitoring Results	Corrective Activities	ATSDR Evaluation of Public Health Hazards
Alert Hangar (ST49)	The Alert Hangar is directly south of the main base runway. Contaminated fuels in soil and groundwater at ST49 were likely released from storage tanks.	**Groundwater (ppb)**: Benzene (13) and TCE (9.2) were found above CVs.	Fuel product recovery techniques were implemented in 1989 to remove floating product from the groundwater table. The ROD signed in September 1994 selected no further action as the most appropriate action. Groundwater was periodically monitored at ST49 until 2002.	Based on a review of site data and potential exposure scenarios, ATSDR anticipates no potential public health hazards at ST49. The public has limited access to this site and no drinking water wells are located nearby.
Blair Lakes (SS50-SS54)	Blair Lakes is an aircraft target area, building complex, and drum disposal site about 20 miles southwest of the developed section of EAFB. An old on-site supply well that used to provide the facilities at Blair Lakes with drinking water is located on the site. Fuel leaks from storage tanks have impacted soil and groundwater.	**Groundwater (ppb)**: Benzene (990), toluene (2,080), ethylbenzene (2,210), and xylene (2,800) were found above CVs. **Water Supply Well:** The old supply well at Blair Lakes was taken out of service when petroleum odors were noticed emanating from the water.	Fuel product recovery techniques were implemented in 1992 to remove floating product from the groundwater table. Remedial actions selected under the ROD signed in September 1994 have focused on decreasing BTEX levels in groundwater. They have included passive and active fuel product recovery, bioventing, soil vapor extraction, and groundwater monitoring.	Based on a review of site data and potential exposure scenarios, ATSDR anticipates no potential public health hazards at Blair Lakes. The public has limited access to this site. A former drinking water well at Blair Lakes was shut down because of fuel contamination but there is no evidence of past exposures.
Operable Unit 2				
POL Storage-Railroad Fuel Spill Area (ST10, SS14)	ST10 and SS14 encompass 10-acres of fuel storage and unloading facilities near Spruce Lake in the south-eastern part of EAFB. Two storage tanks are currently operational at SS14. Fuel leaks and spills have impacted both sites in the past. A significant spill was reported at ST10 in 1967.	**Groundwater (ppb)**: Benzene (1,300), toluene (9,500), xylenes (2,800), and lead (61) were found above CVs.	Remedial actions selected under the ROD signed in September 1994 have focused on decreasing BTEX and lead levels in groundwater. They have included passive fuel product recovery, bioventing, soil vapor extraction, and groundwater monitoring.	Based on a review of site data and potential exposure scenarios, ATSDR anticipates no potential public health hazards at ST10 and SS14. The public has limited access to this site, and no drinking water wells are located nearby. Groundwater beneath ST10 and SS14 will continue to be monitored in the future.

Site	Site Description/Disposal History	Investigation Results/ Environmental Monitoring Results	Corrective Activities	ATSDR Evaluation of Public Health Hazards
Fuel Saturated Area (ST11)	ST11 is located in the main industrial portion of the base, east of the runway. Leaks in an underground diesel pipeline formerly connected to a bakery have impacted soil and groundwater in the area. Main base supply well E is directly southwest of the site.	**Groundwater (ppb)**: Benzene (0.6) was found above the CV.	Between 1977 and 1980, the underground fuel pipeline at ST11 was removed and groundwater was treated with an oil-water separator. The ROD signed in September 1994 selected no further action as the most appropriate action. Groundwater was monitored in 2002.	Based on a review of site data and potential exposure scenarios, ATSDR anticipates no potential public health hazards at ST11. Well E has not been impacted by contamination. The base routinely tests well E to ensure that contaminants do not enter the drinking water supply.
E-4 Fuel Storage and Fuel Tank Sludge Burial Area (ST13, DP26)	ST13 and DP26 cover 7-acres along the southeast end of the main base taxiway. Tank sludge was deposited at DP26 before 1980 and fuels were released at ST13 from leaks and spills at storage facilities.	**Groundwater (ppb)**: Benzene (3,100), toluene (9,980), ethyl-benzene (2,020), xylene (11,770), pentachlorophenol (39), bis(2-ethylhexyl)phthalate (11), and lead (5,100) were found above CVs. **Surface Soil (ppm):** Sampling during the RI found benzo(a)-pyrene (1.25) above the CV, and dibenz(a,h)anthracene (0.47) about equal to the CV.	Leaking storage tanks, impacted soils, and Building #1240 were cleared from ST13 and DP26 between 1988 and 1994. Remedial actions selected under the ROD signed in September 1994 have focused on decreasing BTEX and lead levels in groundwater. They have included passive fuel product recovery, bioventing, soil vapor extraction, and groundwater monitoring.	Based on a review of site data and potential exposure scenarios, ATSDR anticipates no potential public health hazards at ST13 and DP26. The public has limited access to this site and no drinking water wells are located nearby. Groundwater beneath ST13 and DP26 will continue to be monitored in the future.
Oil Boiler Fuel Saturated Area (ST18)	ST18 was formerly the base power plant. Today, the site is used for vehicle storage. Fuel contamination was discovered at ST18 in the 1970s. Main base supply well A is directly northeast of the site.	**Groundwater (ppb)**: Benzene (1.6 ppb) was found above the CV. **Water Supply Well:** No contaminants have been found at levels above CVs. **Surface Soil (ppm):** Benzo(a)-pyrene (0.55) was found above the CV.	Contaminated soils, fuel storage tanks, drywells, and associated piping were excavated and replaced at ST18 from 1994-1996. The ROD signed in September 1994 selected no further action as the most appropriate remedial action. Groundwater was monitored in 2002.	Based on a review of site data and potential exposure scenarios, ATSDR anticipates no potential public health hazards at ST18. The public has limited access to this site. Well A is routinely tested to ensure that contaminants do not enter the drinking water supply.

Site	Site Description/Disposal History	Investigation Results/ Environmental Monitoring Results	Corrective Activities	ATSDR Evaluation of Public Health Hazards
JP-4 Fuel Spill, (ST19)	ST19 is northeast of the runway on Cargain Road. A snowplow accident in the 1950s released 200,000 gallons of JP-4 from a damaged pipeline onto surface soils. In 1994 fuels were released at ST19 from a damaged pipeline.	**Groundwater (ppm)**: Benzene (3,240), toluene (13,900), ethylbenzene (7,600), and xylene (31,000) were found above CVs.	The ROD signed in September 1994 selected no further action as the most appropriate remedial action. About 14,700 gallons of fuel were recovered from a spill in December 1994. Groundwater is periodically monitored.	Based on a review of site data and potential exposure scenarios, ATSDR anticipates no potential public health hazards at ST19. Groundwater beneath ST19 will continue to be monitored in the future. No drinking water wells are located nearby.
Operable Units 3, 4, and 5				
Battery Shop Leach Field (DP44)	The Battery Shop is located in the central part of the base, directly east of the runway and aircraft maintenance hangar. Fuel compounds and solvents have been found at DP44. The contamination source is unknown, but is believed to have arisen from past maintenance activities.	**Groundwater (ppb)**: TCE (2,500) and cis-1,2-DCE (260) were found above CVs in 1992 and 1994. **Surface Soil (ppm):** Sampling during the RI found benzo-(a)pyrene (18), benzo(b)-fluoranthene (210), benzo(a)-anthracene (48), dibenzo(a,h)-anthracene (6.5), and indeno-(1,2,3-cd)pyrene above CVs.	The ROD signed in September 1998 selected groundwater monitoring as the most appropriate action.	Based on a review of site data and potential exposure scenarios, ATSDR anticipates no potential public health hazards at DP44. The public has limited access to this site and no drinking water wells are located nearby. Groundwater beneath DP44 will continue to be monitored in the future.

Site	Site Description/Disposal History	Investigation Results/ Environmental Monitoring Results	Corrective Activities	ATSDR Evaluation of Public Health Hazards
Photo Lab and Fire Station Parking Lot (WP45, SS57)	The Photo Lab and Fire Station parking lot are located near the main taxiway in the industrial section of the base. Chlorinated solvents at WP45 and fuel products at SS57 were found in groundwater. The sources of contamination are unknown. Well C, a backup water supply well near the Photo Lab, was taken offline in 2002.	**Groundwater (ppb)**: TCE 94,740), benzene (530) and toluene (1,900) were found above CVs. **Backup Supply Well C:** Arsenic (14 ppb) was found above the CV. **Surface Soil (ppm):** Benzo-(a)pyrene (0.5) was found above the CV.	The ROD signed in September 1995 selected groundwater monitoring as the most appropriate action.	Based on a review of site data and potential exposure scenarios, ATSDR anticipates no potential public health hazards at WP45 and SS57. The public has limited access to this site and no drinking water wells are currently located nearby. WP45 and SS57 will continue to be monitored in the future. Well C, before closure in 2002, was only activated for a few days over a 10-year period. Therefore, any limited exposures to arsenic are not expected to cause adverse health affects.
Engineer Hill (ST56)	Engineer Hill is a munitions storage compound about 3 miles north-northeast of the main part of the base. VOCs were found in water supply wells at ST56 between 1986 and 1991. The origin of contamination is unknown.	**Groundwater (ppb)**: PCE (25.1) was found above the CV. **Water Supply Wells:** Between 1986 and 1994, PCE (59 ppb) was found in the water supply at ST56. In June 1989, benzene (42 ppb), TCE (30 ppb), 1,3,5-trimethylbenzene (15 ppb), and 1,2,4-trimethyl-benzene (38 ppb) were found above CVs; n-butylbenzene (11 ppb), tert-butylbenzene (2 ppb), and n-propylbezene (5.7 ppb), were also detected, but have no CVs. Arsenic (21 ppb) was detected above the CV in April 1990.	Drinking was banned from the Engineer Hill water supply in 1991. Fuel tanks were removed from Building #6158 and Building #6128 in 1992. A septic tank and a leach field were replaced in 1995. The ROD signed in September 1995 selected water treatment at the wellhead and groundwater monitoring as the most appropriate action. Drinking water is currently hauled to ST56.	EAFB personnel were exposed to VOCs above CVs from drinking water at Engineer Hill prior to 1991. These exposures are not expected to cause adverse health affects because of low levels of contaminants, and short-term exposure. Treated water is currently hauled to Engineer Hill and ATSDR anticipates no potential public health hazards.

Site	Site Description/Disposal History	Investigation Results/ Environmental Monitoring Results	Corrective Activities	ATSDR Evaluation of Public Health Hazards
Vehicle Maintenance Building (SS61)	The vehicle maintenance building is in the main part of the base. BTEX and chlorinated solvents, most likely from two former dry wells at the maintenance building, have impacted soil and groundwater.	**Groundwater (ppb)**: Benzene (3.8), toluene (250), TCE (1,100), PCE (15), cis-1,2-DCE (3,200), trans-1,2-DCE (140), arsenic (81), and lead (40 ppb) were found above CVs.	Drywells and contaminated soils were removed in 1993. The ROD signed in September 1995 selected groundwater monitoring as the most appropriate action.	Based on a review of site data and potential exposure scenarios, ATSDR anticipates no potential public health hazards at SS61. The public has limited access to this site and no drinking water wells are currently located nearby. Groundwater beneath SS61 will continue to be monitored in the future.
E-6 Fuel Storage Tank and E-11 Fuel Storage Tank Areas (DP25, ST27)	DP25 and ST37 are adjacent fuel storage sites near Spruce Lake. Fuel leaks and buried tank sludge are potential sources of soil and groundwater contamination.	**Groundwater (ppb)**: Benzene (7,900), toluene (34,000), ethylbenzene (2,000), xylene (9,100) and lead (362) were found above CVs.	The ROD signed in September 1995 selected no further action as the most appropriate remedial action. Groundwater was monitored in 2002.	Based on a review of site data and potential exposure scenarios, ATSDR anticipates no potential public health hazards at DP25 and ST27. The public has limited access to this site and no drinking water wells are located nearby.
Wastewater Plant Effluent Infiltration Pond (WP33)	WP33 is a pond north of the airstrip near the base entrance that has collected discharge from the wastewater treatment plant since 1979.	**Groundwater (ppb)**: Arsenic (62), and barium (784), were found above CVs.	The ROD signed in September 1995 selected no further action as the most appropriate action. Groundwater was monitored in 2002.	Based on a review of site data and potential exposure scenarios, ATSDR anticipates no potential public health hazards at WP33. No drinking water wells are located nearby.

Site	Site Description/Disposal History	Investigation Results/ Environmental Monitoring Results	Corrective Activities	ATSDR Evaluation of Public Health Hazards
Asphalt Mixing and Drum Burial Area (SS35)	SS35 is a grassy area, directly south of the water treatment plant, adjacent to Garrison Slough. Asphalt mixing in the 1950s and the burial of asphalt drums, equipment, and debris are believed to be the source of waste oils, pesticides, and solvents found in soil, surface water, and groundwater.	**Groundwater (ppb):** 4,4'DDT (0.16) and benzene (3.5) were found above CVs. **Biota (ppm):** 4,4-DDE (0.150), 4,4-DDD (8), 4,4-DDT (0.056), dieldrin (0.52), and endosulfan (23) were found above CVs in samples of invertebrates and vegetation. **Sediment (ppm):** 4,4-DDE (8.12), 4,4-DDD (120), 4,4-DDT (47), and endosulfan (23), were detected above CVs. **Surface Soil (ppm):** DDT (49) was found above the CV.	The ROD Amendment signed in September 1998 selected periodic monitoring of groundwater, surface water, sediments, and aquatic invertebrates as the most appropriate action. Eielson AFB has recently requested that the requirements for monitoring contaminants in the groundwater, surface water, sediments, and aquatic invertebrates at site SS35 be lifted. ADEC does not concur with discontinued monitoring, but has proposed less frequent monitoring.	Based on a review of site data and potential exposure scenarios, ATSDR anticipates no potential public health hazards at SS35. No drinking water wells are located nearby.
Drum Storage Area (SS36)	The drum storage area, SS36, is located west of Garrison Slough near the power plant. Cement mixing occurred at SS36 until the 1960s. Since then the area has been used to store paints, solvents, waste oils, and hydraulic fluids.	**Groundwater**: Lead (44 ppb) was found above the CV.	In 1989, paint-contaminated soil was excavated from SS36. The ROD signed in September 1995 selected no further action as the most appropriate action. Groundwater was monitored in 2002.	Based on a review of site data and potential exposure scenarios, ATSDR anticipates no potential public health hazards at SS36.
Drum Storage Area (SS37)	The drum storage area, SS37, is near the southern end of the runway. Petroleum stains have been found at former drum storage locations. Fuel contamination was also found near the utilidor that runs under SS37.	**Groundwater (ppb):** Benzene (26) and lead (242) were found above CVs.	The ROD signed in September 1995 selected groundwater monitoring as the most appropriate action. In 1997 fuels were recovered from groundwater near a utilidor beneath SS37.	Based on a review of site data and potential exposure scenarios, ATSDR anticipates no potential public health hazards at SS37. Public access is limited and no drinking water wells are located nearby. Groundwater monitoring will continue in the future.

Site	Site Description/Disposal History	Investigation Results/ Environmental Monitoring Results	Corrective Activities	ATSDR Evaluation of Public Health Hazards
Asphalt Lake (SS39, SS63)	The asphalt lake and spill site is about 1.2 miles south of the main base gate. Storage of cement at Asphalt Lake in the 1940s lead to leaks that coated the surrounding area with cement.	**Groundwater**: No contaminants have been found above CVs.	In 1992, cement, drums, and contaminated soils were removed from the area. The ROD signed in September 1995 selected no further action as the most appropriate remedial action. Groundwater was monitored in 2002.	Based on a review of site data and potential exposure scenarios, ATSDR anticipates no potential public health hazards at SS39 and SS63.
Quartermaster Service Station (ST58)	The Quartermaster Service Station operated from 1970 to 1988. Fuel-contaminated soil and groundwater at ST58 likely originated from fuel tank and pipeline leaks.	**Groundwater (ppb)**: Benzene (450), TCE (14), benzo(a)-pyrene (48), benzo(a)-flouranthene (17), chloro-methane (1,700), and lead (180) were found above CVs. Phenanthrene (370) was also detected, but has no CV.	Contaminated soil was excavated in 1993. The ROD signed in September 1995 selected groundwater monitoring as the most appropriate action.	Based on a review of site data and potential exposure scenarios, ATSDR anticipates no potential public health hazards at ST58. Groundwater monitoring will continue in the future.
Transportation Maintenance Drum Storage Site (SS64)	SS64 is a former drum storage area immediately north of the water treatment plant adjacent to Garrison Slough. Drums containing solvents, thinners, acids, paint wastes, and asphalt may have leaked during storage.	**Groundwater**: No contaminants have been found above CVs.	Drums and contaminated surface soils were removed at SS64 in 1989 and the area was graveled for use as a parking lot. The ROD signed in September 1995 selected no further action as the most appropriate remedial action. Groundwater was monitored in 2002.	Based on a review of site data and potential exposure scenarios, ATSDR anticipates no potential public health hazards at SS64.

Site	Site Description/Disposal History	Investigation Results/ Environmental Monitoring Results	Corrective Activities	ATSDR Evaluation of Public Health Hazards
Landfills (LF-1, 2, 5, 6, and 7)	Landfills 1, 2, 5, 6 and 7 received both industrial and domestic wastes during the 1950s and 1960s.	**Groundwater (ppb)**: Lead (50), and arsenic (13) at LF1; TCE (6.5), arsenic (295), cadmium (5), chromium (174), lead (104), and nickel (337) at LF2; arsenic (8.9), barium (1,030), chromium (139) and lead (70) at LF5; and arsenic (79), cadmium (5.3), and lead (61) at LF6 were found above CVs. No contaminants have exceeded CVs at LF7.	In 1960, LF1 was covered with clean soil. Drums and surface materials were removed from LF1 and LF5 between 1992 and 1994. The ROD signed in September 1995 selected groundwater monitoring as the most appropriate action at LF-1, 2, 3, and 5. No further action was selected for LF7.	Based on a review of site data and potential exposure scenarios, ATSDR anticipates no potential public health hazards at landfills 1, 2, 5, 6, and 7.
Landfill and Fire Training Area (LF3, FT09)	The fire training area is located inside landfill 3 (LF3) near the south end of the runway. Domestic and industrial wastes were dumped at LF3 between 1967 and 1987. Fire exercises were conducted biweekly at FT09 between 1955 and 1989. JP-4, solvents, and waste oils were used in controlled burns.	**Groundwater (ppb)**: Benzene (46), vinyl chloride (17), chloroethane (49), TCE (150), PCE (53), 1,4-dichlorobenzene (82), and 1,2,4-trimethyl-benzene (18) were found above CVs. 4-methyl-2-pentanone (120) and 2-hexanone (620) were detected, but have no CVs. **Surface Soil (ppm):** Sampling during the RI detected benzo-(a)pyrene (1.7) and dibenz(a,h)-anthracene (0.4) above CVs.	The ROD signed in September 1995 selected groundwater monitoring and the installation and maintenance of a soil cover as the most appropriate actions.	Based on a review of site data and potential exposure scenarios, ATSDR anticipates no potential public health hazards at LF3 and FT09. Public access is limited and no drinking water wells are located nearby. Groundwater monitoring will continue in the future.

Site	Site Description/Disposal History	Investigation Results/ Environmental Monitoring Results	Corrective Activities	ATSDR Evaluation of Public Health Hazards
LF4-Landfill, OU5	Landfill 4 (LF4) is a designated emergency ordnance demolition area about 3.1 miles east of the runway. General refuse, small quantities of waste oil, spent solvents, and munitions are buried at LF04.	**Groundwater (ppb)**: Benzene (31), toluene (230), arsenic (200), barium (2,540), chromium (306), lead (113), nickel (389), and vanadium (480) were found above CVs.	The ROD signed in September 1995 selected groundwater monitoring as the most appropriate action. Waste drums were removed from the landfill in 1995.	Based on a review of site data and potential exposure scenarios, ATSDR anticipates no potential public health hazards at LF4. Public access is restricted at LF4 because it is a designated emergency ordnance demolition area.
Operable Unit 6				
Ski Area (WP38)	The ski area is located southeast of the developed section of EAFB. WP38 is used for recreational activities, including skiing and sledding during winter. This area includes Ravenwood Ski Lodge. Between 1956 and 1972, fuels were stored in eight large fuel tanks at WP38. Spills and leaks at these tanks have impacted groundwater.	**Groundwater (ppb)**: Benzene (1,820) toluene (1,400), arsenic (391), barium (3,860), chromium (670), copper (777), lead (420), nickel (970), and vanadium (1,000) were found above CVs. **Water Supply Wells (ppb):** Benzene (145) was found in drinking water at the Ravenwood Ski Lodge above the CV when sampling for VOCs began in 1986.	Fuel tanks at the ski area were closed in 1972 and removed in 1977. Water supply wells at the ski area were shut down in 1986 and 1987. Since 1987, drinking water has been hauled to storage tanks near the Ravenwood Ski Lodge. The ROD signed in September 1995 selected groundwater monitoring as the most appropriate action.	Residents at EAFB were likely exposed to benzene in drinking water at the ski lodge for an unknown period prior to August 1986. These exposures are not expected to cause adverse health effects. Treated water is currently hauled to Ravenwood Ski Lodge and ATSDR anticipates no potential public health hazards.

Site	Site Description/Disposal History	Investigation Results/ Environmental Monitoring Results	Corrective Activities	ATSDR Evaluation of Public Health Hazards
Sitewide Operable Unit				
Garrison Slough (SS67)	Garrison slough flows northeast through the developed part of EAFB. PCBs and pesticides have been found in the slough near Arctic Avenue and areas downstream. PCBs likely originated from old transformers stored near a former masonry shop adjacent to the slough. Pesticides are found in the Slough near Site SS35, a former pesticide mixing area. In 1998, a bomb was found in the slough.	**Fish (ppm):** DDD (0.361), 4,4-DDT (0.102), 4,4-DDE (0.547), 4,4-DDD (1.45), and PCBs (12) were found above CVs. **Sediment (ppm)**: 4,4'-DDD (58.6), 4,4'-DDT (62.4), 4,4-DDE (2.05), and PCBs (178) were found above CVs.	Remedial actions selected under the ROD signed in March 1997 have focused on decreasing PCB levels in the slough and reducing exposure to contaminated fish. They have included installation of fish control devices (barriers) at impacted areas, removal of sediments containing PCBs above 10 ppm, and long-term monitoring of fish, sediment, and surface water.	Anglers on base are warned that PCB contamination has been found in the Slough and are told that a cancer risk exists if fish from the slough are eaten, when they receive a fishing permit. ATSDR supports base efforts to advise anglers about the fish advisory and the placement of additional signs along the slough. Anglers who follow the base advise are not exposed to hazardous levels of contaminants. A bomb found at Garrison Slough in 1998 was an isolated incident. Evidence of additional explosives in the slough has not been found. Therefore, physical contact with explosives does not pose a potential public health hazard at Garrison Slough.

Site	Site Description/Disposal History	Investigation Results/ Environmental Monitoring Results	Corrective Activities	ATSDR Evaluation of Public Health Hazards
Non-CERCLA Sites				
Chena River Research Annex (SS01)	Chena River Research Annex is located about 10 miles north-northeast of the EAFB runway. The site was used as a tranmitter facility and control center for the Atomic Energy Detection System prior to 1980. Fuel tanks, oil pits, and disposed chemical wastes are all possible sources of contamination at SS01.	**Groundwater (ppb):** Arsenic (316), barium (3,150), cadmium (23), chromium (389), and lead (428) were found above CVs. It should be noted that metals detected above CVs during the 1999 sampling event were below health-based screening values during subsequent sampling events. The lower metals concentrations detected is likely a result of the different methodology— low-flow sampling technique, that was recommended and used in later sampling. Diesel range organics (DRO) and residual range organics (RRO) were above State of Alaska groundwater cleanup levels of 1.3 ppm in 1999 and 2000.	The 1999 Site Characterizaton Report at SS01 selected long- term monitoring as the appropriate action.	Based on a review of site data and potential exposure scenarios, ATSDR anticipates no potential public health hazards at SS01. No EAFB drinking water wells are located near the site.

Site	Site Description/Disposal History	Investigation Results/ Environmental Monitoring Results	Corrective Activities	ATSDR Evaluation of Public Health Hazards
Anti Aircraft Artillery Barracks (AOC 8) This area is currrently being addressed as a formerly used defense site (FUDS) and is designated Eielson Farm Road Anti-Aircraft Artillery site (property # F10AK1059).	Fuel products were found in soil and groundwater beneath a former anti aircraft artillery barracks one mile west of EAFB near Eielson Farm Road, near Salcha. The site is surrounded by private residential land and is located less then one mile from private drinking water wells.	**Groundwater (ppb):** Benzo-(a)anthracene (0.2) was found above the CV. Diesel range organics (910,000) and residual range organics (2,300) were detected, but have no CV.	In 2000, EAFB sampled soil and groundwater. In 2003, the site was authorized for inclusion in the Formerly Used Defense Site (FUDS) program. Planned work includes a UST removal and development of remedial activities to address soil and groundwater contamination. Timing is subject to funding availability and prioritization among other pending Alaska FUDS projects.	AOC 8 poses an indeterminate public health hazard. The extent of contaminant migration and the toxicity of groundwater found beneath the site is not known. Fuel products released at AOC 8 could potenially have impacted or moved closer to drinking water sources off site.

Sources: ADEC 2004; AMEC 2001; BATELLE-PNL 1995; Eielson AFB 1994a; Eielson EAFB 1994b; Eielson AFB 1994c; Eielson AFB 1995; Eielson AFB 1997; FWEC et al 2003; USAF 2004

Key

CV	comparison values
BTEX	benzene, toluene, ethylbenzene, xylene
DCA	dichloroethane
DCE	dichloroethene
4,4`-DDD	4,4`-dichlorodiphenyldichloroethane
4,4`-DDE	4,4`-dichlorodiphenyldichloroethene
4,4`-DDT	4,4`-dichlorodiphenyltrichloroethane
JP-4	jet fuel
PCB	polychlorinated biphenyl
PCE	tetrachloroethylene
ppb	parts per billion
ppm	parts per million
RI	remedial investigation
ROD	record of decision
TCE	trichloroethene
VOC	volatile organic compound

Table 2. Evaluation of Exposure Pathways at EAFB

Pathway	Elements of an Exposure Pathway						Comment
	Source	Media	Point of Exposure	Route of Exposure	Time Frame	Exposed Population	
Completed Exposure Pathways							
On-Base Groundwater Exposure to VOCs in EAFB drinking water wells	VOC plumes at Engineer Hill originated from an unknown source. VOC plumes at the ski area originated from old fuel tanks, removed in 1977.	Groundwater	EAFB drinking water taps	Ingestion	Past	EAFB residents and workers	*Past:* Water supply wells at the Ravenwood Ski Lodge and Engineer Hill contained VOCs above ATSDR's CV and EPA's MCL when they were first sampled in 1986. Exposures occurred, but not likely at levels of health concern. *Current and Future*: Drinking water wells were taken out of service at the Ski Lodge in 1987 and at Engineer Hill in 1991. EAFB currently hauls drinking water to both locations.
Fish from Garrison Slough Potential exposure to PCBs and pesticides in fish from Garrison Slough	Drainage channels upstream of the Arctic Avenue Bridge may have connected to an old masonry shop.	Fish	Garrison Slough	Ingestion	Past Current Future	Anglers using on-base and off-base sections of Garrison Slough	*Past, Current, and Future:* Fish from Garrison Slough contain PCBs above ATSDR's CVs. Exposures could occur at levels of health concern. EAFB advises anglers not to eat fish from Garrison Slough. Anglers who follow the advice will not be exposed.

Table 2. Evaluation of Exposure Pathways at EAFB (cont)

Pathway	Elements of an Exposure Pathway						Comment
	Source	**Media**	**Point of Exposure**	**Route of Exposure**	**Time Frame**	**Exposed Population**	
Potential Exposure Pathways							
Off-Base Groundwater, Salcha Exposure to VOCs in offsite drinking water wells	Groundwater plumes beneath a former off-base artillery site (AOC 8) in Salcha Village.	Groundwater	Private drinking water wells along Eielson Farm Road	Ingestion	Past Current Future	Residents of Salcha that live on Eielson Farm Road near the former artillery site	*Past:* VOCs were not detected in samples outside the former artillery site during groundwater studies in 2000. *Current and Future:* The extent of plume migration is unknown. VOCs could potentially have spread beyond the former artillery site towards downgradient wells since 2000.
Off-Base Groundwater, Moose Creek Village Exposure to VOCs in offsite drinking water wells	Contaminated groundwater beneath EAFB.	Groundwater	Private drinking water wells in Moose Creek Village	Ingestion	Past Current Future	Residents of Moose Creek	*Past, Current, and Future:* VOCs have not been detected in groundwater samples at the north boundary of the base along the border with Moose Creek Village above ATSDR's CVs or EPA's MCLs. EAFB will continue to monitor groundwater at the north boundary to ensure that groundwater exiting the base meets health guidelines.

Table 2. Evaluation of Exposure Pathways at EAFB (cont)

Pathway	Elements of an Exposure Pathway						Comment
	Source	**Media**	**Point of Exposure**	**Route of Exposure**	**Time Frame**	**Exposed Population**	
Potential Exposure Pathways							
Lead Hazards Exposure of children to lead-based paint in EAFB housing	Lead-based paint in EAFB base housing built before 1980.	Lead-based paint	Certain EAFB housing areas built before 1980 with chipped and peeling painted surfaces	Incidental ingestion	Past Current Future	Children who live in base housing built before 1980 with signs of chipped or peeling painted surfaces	*Past:* Certain homes at EAFB contain lead-based paint. Upon request, children living at EAFB are screened for lead poisoning when they have their physical. *Current and Future:* EAFB removes lead-based paint in homes as they are vacated. Residents are advised of temporary measures to reduce lead hazards in their homes. Lead exposure is assessed and blood lead levels screened upon request at children's physicals. These actions would be expected to result in a reduced potential for exposure to lead in the home, and reduced risk of lead poisoning.

Table 3. Contaminants Detected Above Comparison Values in EAFB Drinking Water Wells

Chemical	Sampling Period	Maximum Conc. (ppb)	CV (ppb)	CV Source	Number of Samples Above CV	Number of Samples Analyzed
Engineer Hill						
PCE	1986-1991	59	5	MCL	15	22
TCE	1986-1991	30	5	MCL	1	22
Benzene	1986-1991	42	5	MCL	1	22
1,3,5-Trimethylbezene	1986-1991	15	12	RBC-t	1	22
1,2,4-Trimethylbezene	1986-1991	38	12	RBC-t	1	22
n-Butylbenzene	1986-1991	11	NA	NA	NA	22
Tert-butylbenzene	1986-1991	2	NA	NA	NA	22
n-Propylbenzene	1986-1991	6	NA	NA	NA	22
Arsenic	1986-1991	21	10	MCL	1	22
Ravenwood Ski Lodge						
Benzene	August 1986	145	5	MCL	1	1
Birch Lake Recreational Area						
Arsenic	1990-1996	119	10	MCL	6	9

Sources: ADEC 2004; EA-ST 2004

Key: CV = comparison values
MCL = EPA maximum contaminant level
NA=not available
ppb = parts per billion
RBC-t =EPA reference based concentration for tap water

Note: TCE, benzene, n-butylbenzene, 1,3,5-trimethylbezene, and 1,2,4-trimethylbezene were detected in a single sample from the Engineer Hill supply well collected on June 19, 1989.

Table 4. Contaminants Detected Above Comparison Values in EAFB North Boundary Wells

Chemical	Sampling Period	Maximum Conc. (ppb)	CV (ppb)	CV Source	Number of Samples Above CV	Number of Samples Analyzed
Arsenic	1992-2003	37	10	MCL	24	33
Lead	1992-2003	22	15	EPA-A	2	35
Thallium	1992-2003	5.9	2	MCL	1	9

Source: EA-ST 2004

Key: CV = comparison values
EPA-A = EPA action level
MCL = maximum contaminant level
NA=not available
ppb = parts per billion

Table 5. Pesticides Detected Above CVs in Fish, Invertebrates, and Vegetation, 1993-1994

Chemical	Maximum Concentration (ppm)	Location of Maximum	CV (ppm)	CV Source	Number of Detects	Number of Samples Analyzed
4,4-DDT	0.102	UGS	0.0093	RBC-f	80	133
4,4-DDE	0.547	UGS	0.0093	RBC-f	112	133
4,4-DDD	1.45	MGS	0.013	RBC-f	100	133
2,4-DDD	0.361	MGS	0.013	RBC-f	37	63

Source : Eielson AFB 1996

Key: CV = comparison values
MGS = Middle Garrison Slough
ppm = parts per million
RBC-f =EPA reference based concentration for fish
UGS = Upper Garrison Slough

Note: Samples collected from Garrison Slough, Moose Creek, French Creek, Flightline Pond, and Lily Lake. Detection limits did not exceed 0.0034 ppm.

Table 6. Garrison Slough Fish Tissue Sample Results for PCBs by Year

Year	Average Concentration (ppb)	Total Samples	Minimum Conc. (ppb)	Maximum Conc. (ppb)	Location of Maximums
Fish samples collected on base					
1993	466	4	11	995	Lower Garrison Slough
1995	631	17	<20	3,000	Lower Garrison Slough
1996	3,186	14	29	12,000	Arctic Ave./Manchu Rd.
1997	535	9	39	1,200	Fish Barrier Upstream
1998	223	13	14	680	Arctic Ave./Manchu Road
1999	372	12	27	1,300	Arctic Ave./Manchu Road
2000	419	7	24	2,000	Arctic Ave./Manchu Road
2001	407	24	<22	2,100	Arctic Ave./Manchu Road
2002	205	14	<50	480	Arctic Ave./Manchu Road
2003	237	22	19	649	Lower Garrison Slough
Fish samples collected off base					
1995	91	6	<20	247	Moose Creek/Garrison Slough
1996	100	21	<14	730	Moose Creek/Garrison Slough
1997	158	10	<14	1,100	Moose Creek/Petes Crossing
1998	61	14	14	130	Moose Creek/Garrison Slough
1999	46	8	<14	100	Moose Creek/Garrison Slough
2000	64	2	33	94	Garrison Slough/New Station
2001	94	2	48	140	Garrison Slough/New Station
2002	250	8	<50	500	Garrison Slough/New Station
2003	95	11	3.3	256	Moose Creek/Osage Street

Sources: EA-ST 2004; FWEC et al. 2003

Key: PCBs = polychlorinatedbyphenyls
ppb = parts per billion

Notes: arctic grayling, northern pike, and rainbow trout were sampled at random.
No fish data is available from 1994.

Table 7. Garrison Slough Fish Tissue Sample Results for PCBs by Location, 1993-2003

Sampling Locations	Average Concentration (ppb)	Total Samples	Minimum Conc. (ppb)	Maximum Conc. (ppb)
On base				
Upper Garrison Slough (SS35)	144	20	<20	649
Middle Garrison Slough (SS47)	221	17	<20	2,300
Arctic Avenue/Manchu Road	1,478	34	62	12,000
Lower Garrison Slough	1,227	12	200	3,000
Heritage Park	320	2	190	450
Flightline Pond/Creek (DP44)	162	5	60	330
Wastewater Treatment Plant	229	15	18	940
Fish Screens Upstream	332	16	27	1,200
Fish Screens Downstream	240	13	25	1,400
Off Base				
Garrison Slough New Station	85	13	<14	370
Moose Creek/Petes Crossing	161	15	<50	1,100
Moose Creek/Garrison Slough Conflluence	90	24	5.6	730
Moose Creek/Osage Street	63	27	3.3	260

Sources: EA-ST 2004; FWEC et al. 2003

Key: PCBs = polychlorinated byphenyls
ppb = parts per billion

Note: arctic grayling, northern pike, and rainbow trout were sampled at random.

Figures

Figure 1. Area Map

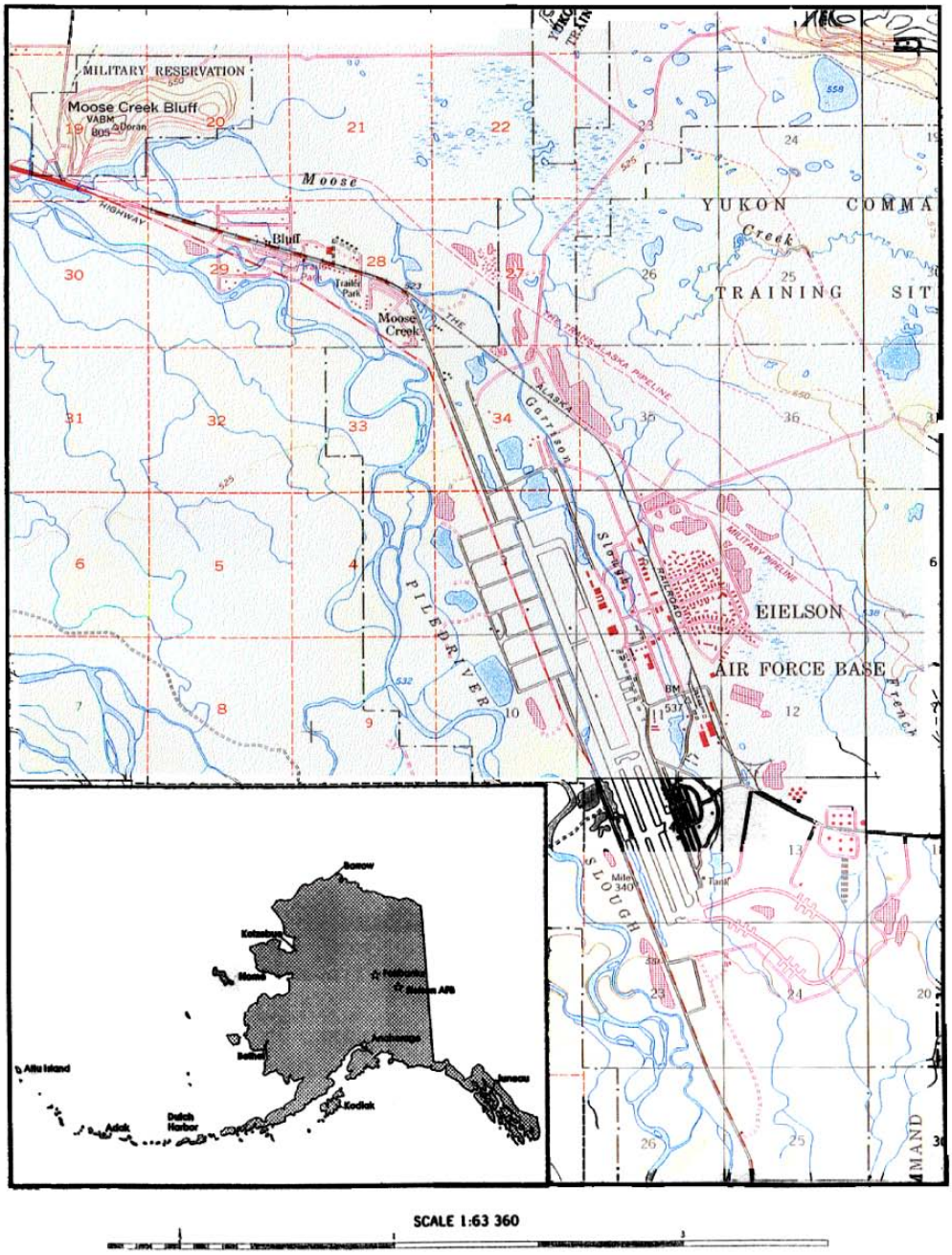


Figure 1-1: Eielson Air Force Base Location

Scale in Miles

Figure 2. IRP Sites at EAFB

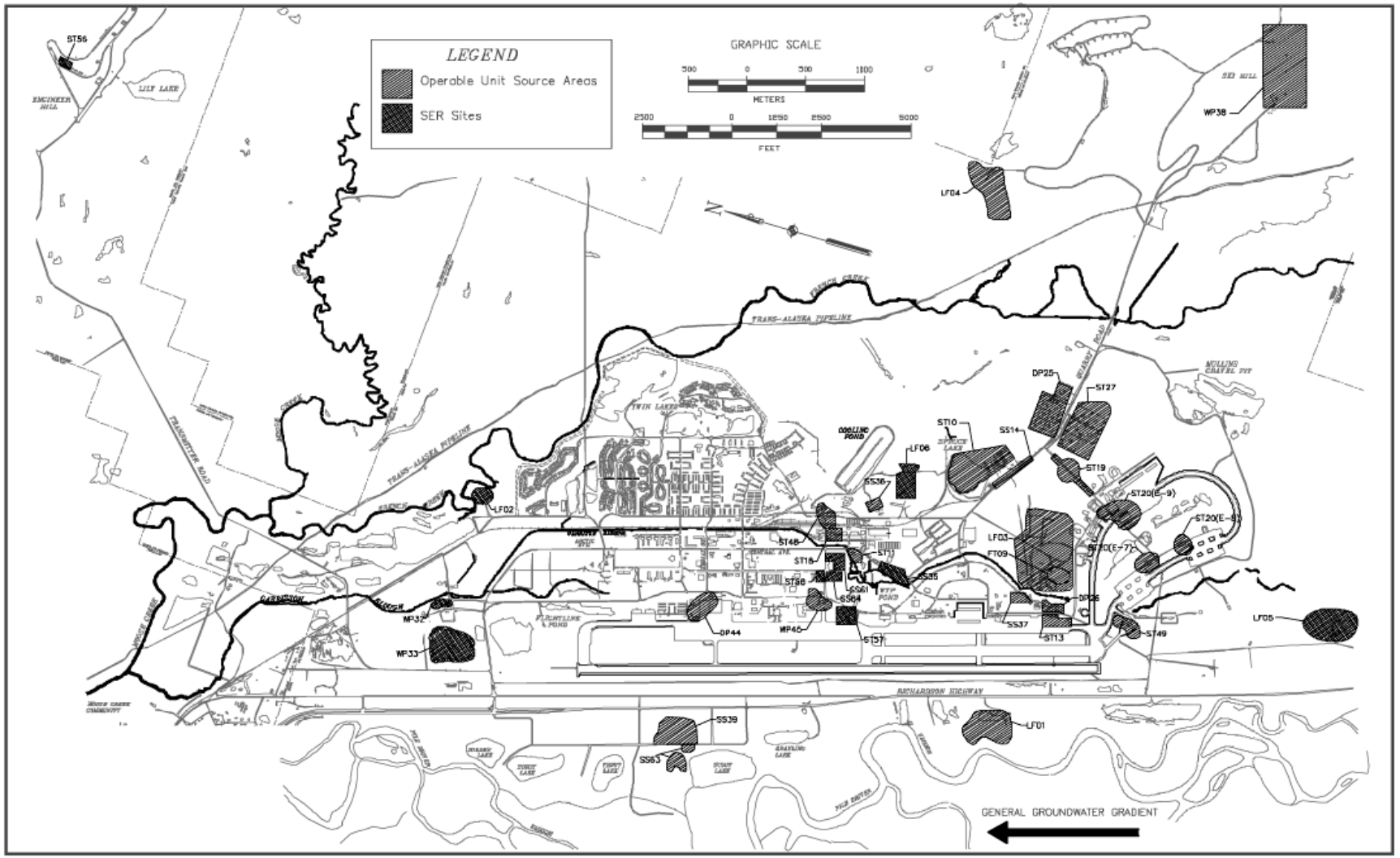


Figure 3. Demographics within a 1-mile Buffer of EAFB

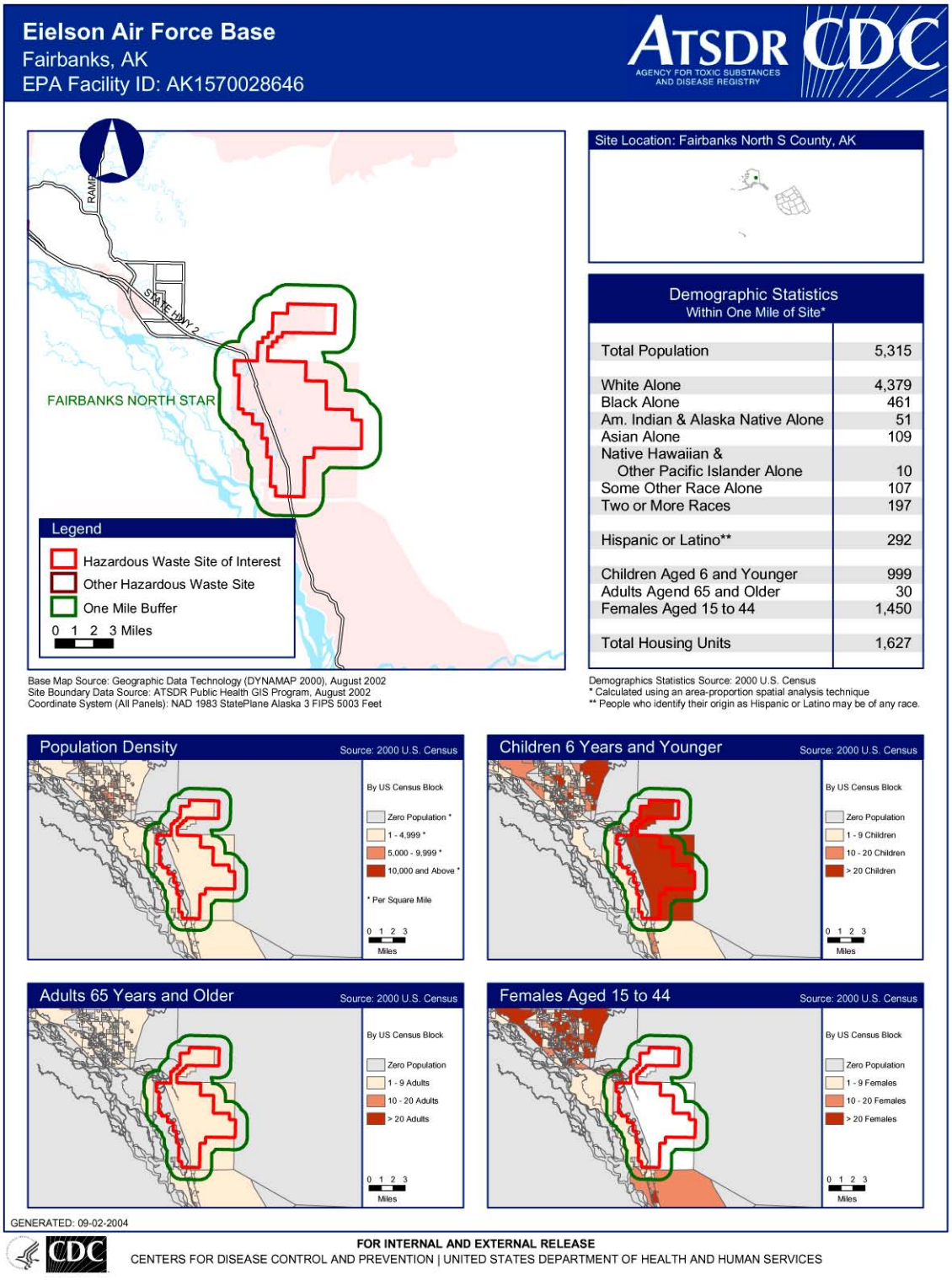
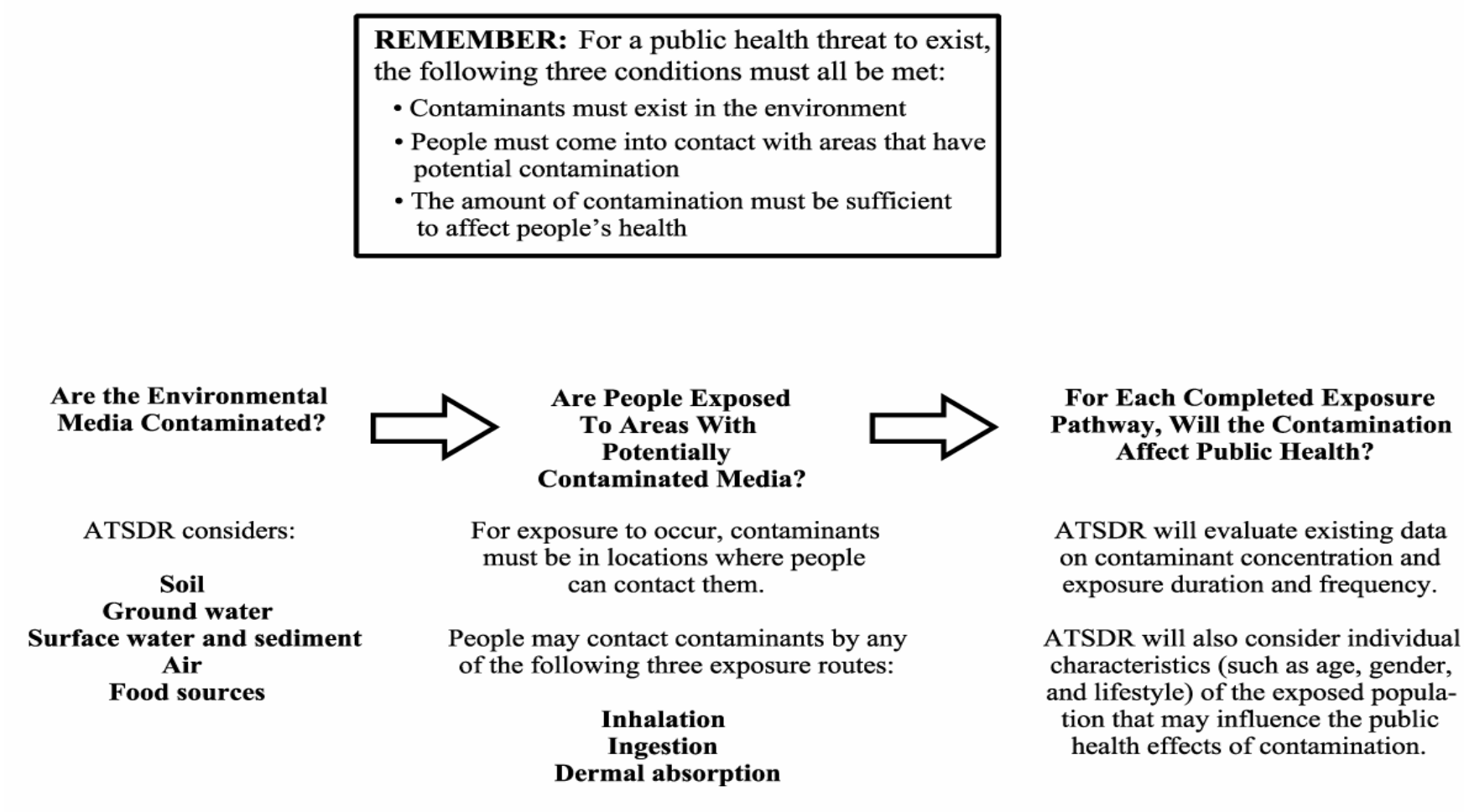


Figure 4. Exposure Pathway



Appendix A. Glossary

Appendix A. Glossary

The Agency for Toxic Substances and Disease Registry (ATSDR) is a federal public health agency with headquarters in Atlanta, Georgia, and 10 regional offices in the United States. ATSDR's mission is to serve the public by using the best science, taking responsive public health actions, and providing trusted health information to prevent harmful exposures and diseases related to toxic substances. ATSDR is not a regulatory agency, unlike the U.S. Environmental Protection Agency (EPA), which is the federal agency that develops and enforces environmental laws to protect the environment and human health. This glossary defines words used by ATSDR in communications with the public. It is not a complete dictionary of environmental health terms. If you have questions or comments, call ATSDR's toll-free telephone number, 1-888-42-ATSDR (1-888-422-8737).

General Terms

Absorption
The process of taking in. For a person or an animal, absorption is the process of a substance getting into the body through the eyes, skin, stomach, intestines, or lungs.

Acute
Occurring over a short time [compare with chronic].

Acute exposure
Contact with a substance that occurs once or for only a short time (up to 14 days) [compare with intermediate duration exposure and chronic exposure].

Adverse health effect
A change in body function or cell structure that might lead to disease or health problems

Analyte
A substance measured in the laboratory. A chemical for which a sample (such as water, air, or blood) is tested in a laboratory. For example, if the analyte is mercury, the laboratory test will determine the amount of mercury in the sample.

Background level
An average or expected amount of a substance or radioactive material in a specific environment, or typical amounts of substances that occur naturally in an environment.

Biota
Plants and animals in an environment. Some of these plants and animals might be sources of food, clothing, or medicines for people.

Cancer
Any one of a group of diseases that occur when cells in the body become abnormal and grow or multiply out of control.

Cancer risk
A theoretical risk for getting cancer if exposed to a substance every day for 70 years (a lifetime exposure). The true risk might be lower.

Carcinogen
A substance that causes cancer.

Central nervous system
The part of the nervous system that consists of the brain and the spinal cord.

CERCLA [see Comprehensive Environmental Response, Compensation, and Liability Act of 1980]

Chronic
Occurring over a long time [compare with acute].

Chronic exposure
Contact with a substance that occurs over a long time (more than 1 year) [compare with acute exposure and intermediate duration exposure]

Comparison value (CV)
Calculated concentration of a substance in air, water, food, or soil that is unlikely to cause harmful (adverse) health effects in exposed people. The CV is used as a screening level during the public health assessment process. Substances found in amounts greater than their CVs might be selected for further evaluation in the public health assessment process.

Completed exposure pathway [see exposure pathway].

Comprehensive Environmental Response, Compensation, and Liability Act of 1980 (CERCLA)
CERCLA, also known as Superfund, is the federal law that concerns the removal or cleanup of hazardous substances in the environment and at hazardous waste sites. ATSDR, which was created by CERCLA, is responsible for assessing health issues and supporting public health activities related to hazardous waste sites or other environmental releases of hazardous substances. This law was later amended by the Superfund Amendments and Reauthorization Act (SARA).

Concentration
The amount of a substance present in a certain amount of soil, water, air, food, blood, hair, urine, breath, or any other media.

Contaminant
A substance that is either present in an environment where it does not belong or is present at levels that might cause harmful (adverse) health effects.

Dermal
Referring to the skin. For example, dermal absorption means passing through the skin.

Dermal contact
Contact with (touching) the skin [see route of exposure].

Detection limit
The lowest concentration of a chemical that can reliably be distinguished from a zero concentration.

Disease registry
A system of ongoing registration of all cases of a particular disease or health condition in a defined population.

DOD
United States Department of Defense.

Dose (for chemicals that are not radioactive)
The amount of a substance to which a person is exposed over some time period. Dose is a measurement of exposure. Dose is often expressed as milligram (amount) per kilogram (a measure of body weight) per day (a measure of time) when people eat or drink contaminated water, food, or soil. In general, the greater the dose, the greater the likelihood of an effect. An "exposure dose" is how much of a substance is encountered in the environment. An "absorbed dose" is the amount of a substance that actually got into the body through the eyes, skin, stomach, intestines, or lungs.

Dose (for radioactive chemicals)
The radiation dose is the amount of energy from radiation that is actually absorbed by the body. This is not the same as measurements of the amount of radiation in the environment.

Dose-response relationship
The relationship between the amount of exposure [dose] to a substance and the resulting changes in body function or health (response).

Environmental media
Soil, water, air, biota (plants and animals), or any other parts of the environment that can contain contaminants.

Environmental media and transport mechanism
Environmental media include water, air, soil, and biota (plants and animals). Transport mechanisms move contaminants from the source to points where human exposure can occur. The environmental media and transport mechanism is the second part of an exposure pathway.

EPA
United States Environmental Protection Agency.

Epidemiology
The study of the distribution and determinants of disease or health status in a population; the study of the occurrence and causes of health effects in humans.

Exposure
Contact with a substance by swallowing, breathing, or touching the skin or eyes. Exposure may be short-term [acute exposure], of intermediate duration, or long-term [chronic exposure].

Exposure assessment
The process of finding out how people come into contact with a hazardous substance, how often and for how long they are in contact with the substance, and how much of the substance they are in contact with.

Exposure investigation
The collection and analysis of site-specific information and biologic tests (when appropriate) to determine whether people have been exposed to hazardous substances.

Exposure pathway
The route a substance takes from its source (where it began) to its end point (where it ends), and how people can come into contact with (or get exposed to) it. An exposure pathway has five parts: a source of contamination (such as an abandoned business); an environmental media and transport mechanism (such as movement through groundwater); a point of exposure (such as a private well); a route of exposure (eating, drinking, breathing, or touching), and a receptor population (people potentially or actually exposed). When all five parts are present, the exposure pathway is termed a completed exposure pathway.

Geographic information system (GIS)
A mapping system that uses computers to collect, store, manipulate, analyze, and display data. For example, GIS can show the concentration of a contaminant within a community in relation to points of reference such as streets and homes.

Groundwater
Water beneath the earth's surface in the spaces between soil particles and between rock surfaces [compare with surface water].

Hazard
A source of potential harm from past, current, or future exposures.

Hazardous Substance Release and Health Effects Database (HazDat)
The scientific and administrative database system developed by ATSDR to manage data collection, retrieval, and analysis of site-specific information on hazardous substances, community health concerns, and public health activities.

Hazardous waste
Potentially harmful substances that have been released or discarded into the environment.

Health education
Programs designed with a community to help it know about health risks and how to reduce these risks.

Health investigation
The collection and evaluation of information about the health of community residents. This information is used to describe or count the occurrence of a disease, symptom, or clinical measure and to evaluate the possible association between the occurrence and exposure to hazardous substances.

Indeterminate public health hazard
The category used in ATSDR's public health assessment documents when a professional judgment about the level of health hazard cannot be made because information critical to such a decision is lacking.

Incidence
The number of new cases of disease in a defined population over a specific time period [contrast with prevalence].

Ingestion
The act of swallowing something through eating, drinking, or mouthing objects. A hazardous substance can enter the body this way [see route of exposure].

Inhalation
The act of breathing. A hazardous substance can enter the body this way [see route of exposure].

Lowest-observed-adverse-effect level (LOAEL)
The lowest tested dose of a substance that has been reported to cause harmful (adverse) health effects in people or animals.

Metabolism
The conversion or breakdown of a substance from one form to another by a living organism.

Metabolite
Any product of metabolism.

mg/kg
Milligram per kilogram.

mg/cm2
Milligram per square centimeter (of a surface).

mg/m3
Milligram per cubic meter; a measure of the concentration of a chemical in a known volume (a cubic meter) of air, soil, or water.

Migration
Moving from one location to another.

Minimal risk level (MRL)
An ATSDR estimate of daily human exposure to a hazardous substance at or below which that substance is unlikely to pose a measurable risk of harmful (adverse), noncancerous effects. MRLs are calculated for a route of exposure (inhalation or oral) over a specified time period (acute, intermediate, or chronic). MRLs should not be used as predictors of harmful (adverse) health effects [see reference dose].

National Priorities List for Uncontrolled Hazardous Waste Sites (National Priorities List or NPL)
EPA's list of the most serious uncontrolled or abandoned hazardous waste sites in the United States. The NPL is updated on a regular basis.

No apparent public health hazard
A category used in ATSDR's public health assessments for sites where human exposure to contaminated media might be occurring, might have occurred in the past, or might occur in the future, but where the exposure is not expected to cause any harmful health effects.

No-observed-adverse-effect level (NOAEL)
The highest tested dose of a substance that has been reported to have no harmful (adverse) health effects on people or animals.

No public health hazard
A category used in ATSDR's public health assessment documents for sites where people have never and will never come into contact with harmful amounts of site-related substances.

NPL [see National Priorities List for Uncontrolled Hazardous Waste Sites]

Plume
A volume of a substance that moves from its source to places farther away from the source. Plumes can be described by the volume of air or water they occupy and the direction they move. For example, a plume can be a column of smoke from a chimney or a substance moving with groundwater.

Point of exposure
The place where someone can come into contact with a substance present in the environment [see exposure pathway].

Population
A group or number of people living within a specified area or sharing similar characteristics (such as occupation or age).

ppb
Parts per billion.

ppm
Parts per million.

Prevention
Actions that reduce exposure or other risks, keep people from getting sick, or keep disease from getting worse.

Public comment period
An opportunity for the public to comment on agency findings or proposed activities contained in draft reports or documents. The public comment period is a limited time period during which comments will be accepted.

Public health action
A list of steps to protect public health.

Public health advisory
A statement made by ATSDR to EPA or a state regulatory agency that a release of hazardous substances poses an immediate threat to human health. The advisory includes recommended measures to reduce exposure and reduce the threat to human health.

Public health assessment (PHA)
An ATSDR document that examines hazardous substances, health outcomes, and community concerns at a hazardous waste site to determine whether people could be harmed from coming into contact with those substances. The PHA also lists actions that need to be taken to protect public health [compare with health consultation].

Public health hazard
A category used in ATSDR's public health assessments for sites that pose a public health hazard because of long-term exposures (greater than 1 year) to sufficiently high levels of hazardous substances or radionuclides that could result in harmful health effects.

Public health hazard categories
Public health hazard categories are statements about whether people could be harmed by conditions present at the site in the past, present, or future. One or more hazard categories might be appropriate for each site. The five public health hazard categories are no public health hazard, no apparent public health hazard, indeterminate public health hazard, public health hazard, and urgent public health hazard.

Public meeting
A public forum with community members for communication about a site.

Reference dose (RfD)
An EPA estimate, with uncertainty or safety factors built in, of the daily lifetime dose of a substance that is unlikely to cause harm in humans.

Registry
A systematic collection of information on persons exposed to a specific substance or having specific diseases [see exposure registry and disease registry].

Remedial investigation
The CERCLA process of determining the type and extent of hazardous material contamination at a site.

RfD [see reference dose]

Risk
The probability that something will cause injury or harm.

Risk reduction
Actions that can decrease the likelihood that individuals, groups, or communities will experience disease or other health conditions.

Route of exposure
The way people come into contact with a hazardous substance. Three routes of exposure are breathing [inhalation], eating or drinking [ingestion], or contact with the skin [dermal contact].

Safety factor [see uncertainty factor]

SARA [see Superfund Amendments and Reauthorization Act]

Sample
A portion or piece of a whole. A selected subset of a population or subset of whatever is being studied. For example, in a study of people the sample is a number of people chosen from a larger population [see population]. An environmental sample (for example, a small amount of soil or water) might be collected to measure contamination in the environment at a specific location.

Sample size
The number of units chosen from a population or an environment.

Solvent
A liquid capable of dissolving or dispersing another substance (for example, acetone or mineral spirits).

Source of contamination
The place where a hazardous substance comes from, such as a landfill, waste pond, incinerator, storage tank, or drum. A source of contamination is the first part of an exposure pathway.

Special populations
People who might be more sensitive or susceptible to exposure to hazardous substances because of factors such as age, occupation, sex, or behaviors (for example, cigarette smoking). Children, pregnant women, and older people are often considered special populations.

Stakeholder
A person, group, or community who has an interest in activities at a hazardous waste site.

Substance
A chemical.

Superfund [see Comprehensive Environmental Response, Compensation, and Liability Act of 1980 (CERCLA) and Superfund Amendments and Reauthorization Act (SARA)

Superfund Amendments and Reauthorization Act (SARA)
In 1986, SARA amended the Comprehensive Environmental Response, Compensation, and Liability Act of 1980 (CERCLA) and expanded the health-related responsibilities of ATSDR. CERCLA and SARA direct ATSDR to look into the health effects from substance exposures at hazardous waste sites and to perform activities including health education, health studies, surveillance, health consultations, and toxicological profiles.

Surface water
Water on the surface of the earth, such as in lakes, rivers, streams, ponds, and springs [compare with groundwater].

Surveillance [see public health surveillance]

Survey
A systematic collection of information or data. A survey can be conducted to collect information from a group of people or from the environment. Surveys of a group of people can be conducted by telephone, by mail, or in person. Some surveys are done by interviewing a group of people [see prevalence survey].

Toxic agent
Chemical or physical (for example, radiation, heat, cold, microwaves) agents that, under certain circumstances of exposure, can cause harmful effects to living organisms.

Toxicological profile
An ATSDR document that examines, summarizes, and interprets information about a hazardous substance to determine harmful levels of exposure and associated health effects. A toxicological profile also identifies significant gaps in knowledge on the substance and describes areas where further research is needed.

Toxicology
The study of the harmful effects of substances on humans or animals.

Tumor
An abnormal mass of tissue that results from excessive cell division that is uncontrolled and progressive. Tumors perform no useful body function. Tumors can be either benign (not cancer) or malignant (cancer).

Uncertainty factor
Mathematical adjustments for reasons of safety when knowledge is incomplete. For example, factors used in the calculation of doses that are not harmful (adverse) to people. These factors are applied to the lowest-observed-adverse-effect-level (LOAEL) or the no-observed-adverse-effect-level (NOAEL) to derive a minimal risk level (MRL). Uncertainty factors are used to account for

variations in people's sensitivity, for differences between animals and humans, and for differences between a LOAEL and a NOAEL. Scientists use uncertainty factors when they have some, but not all, the information from animal or human studies to decide whether an exposure will cause harm to people [also sometimes called a safety factor].

Urgent public health hazard
A category used in ATSDR's public health assessments for sites where short-term exposures (less than 1 year) to hazardous substances or conditions could result in harmful health effects that require rapid intervention.

Volatile organic compounds (VOCs)
Organic compounds that evaporate readily into the air. VOCs include substances such as benzene, toluene, methylene chloride, and methyl chloroform.

Other glossaries and dictionaries:
Environmental Protection Agency (http://www.epa.gov/OCEPAterms/)
National Center for Environmental Health (CDC) (http://www.cdc.gov/nceh/dls/report/glossary.htm)
National Library of Medicine (NIH) (http://www.nlm.nih.gov/medlineplus/mplusdictionary.html)

For more information on the work of ATSDR, please contact:
Office of Policy and External Affairs
Agency for Toxic Substances and Disease Registry
1600 Clifton Road, N.E. (MS E-60)
Atlanta, GA 30333
Telephone: (404) 498-0080

Appendix B. Estimated Exposure and Health Effects

Appendix B. Estimated Exposure and Health Effects

The Agency for Toxic Substances and Disease Registry (ATSDR) evaluated exposures to groundwater and fish in the vicinity of Eielson Air Force Base (EAFB). To do so, ATSDR evaluated available data to determine whether contaminants were above ATSDR's comparison values (CVs). For those that were, ATSDR estimated exposure doses and compared them to health-based guidelines. ATSDR also reviewed relevant toxicological data to obtain information about the toxicity of contaminants of interest.

Comparing Data to ATSDR's CVs

CVs represent media-specific contaminant concentrations that are much lower than exposure concentrations observed to cause adverse health effects, and are protective of public health in essentially all exposure situations. If the concentrations in the exposure medium are less than the CV, the exposures are not of health concern and no further analysis of the pathway is required. Although concentrations below the CV are not expected to lead to any observable health effects, it should not be inferred that a concentration greater than the CV will necessarily lead to adverse effects. Depending on site-specific environmental exposure factors (for example, duration of exposure) and activities of people that result in exposure (time spent in area of contamination), exposure to levels above the CV may or may not lead to a health effect. Therefore, ATSDR's CVs are not used to predict the occurrence of adverse health effects. Rather, they are used by ATSDR to select contaminants for further evaluation to determine the possibility of adverse health effects. The following section describes the types of CVs used in this PHA.

Cancer Risk Evaluation Guide (CREG)

Estimated contaminant concentrations that would be expected to cause no more than one excess cancer in a million (10^{-6}) persons exposed over a 70-year life span. ATSDR's CREGs are calculated from the U.S. Environmental Protection Agency's (USEPA) cancer slope factors (CSFs).

Environmental Media Evaluation Guide (EMEG)

EMEGs are based on ATSDR minimal risk levels (MRLs) and consider body weight and ingestion rates. An EMEG is an estimate of daily human exposure to a chemical (in milligrams chemical/kilograms body weight/day [mg/kg/day]) that is likely to be without noncarcinogenic health effects over a specified duration of exposure, including acute, intermediate, and chronic exposures.

Reference Dose Media Evaluation Guides (RMEG)

ATSDR derives RMEGs from USEPA's oral reference doses (RfDs). The RMEG represents the concentration in water or soil at which daily human exposure is unlikely to result in adverse noncarcinogenic effects.

USEPA Maximum Contaminant Level (MCL)

MCLs are enforceable drinking water standard established by the USEPA. They are the maximum permissible level of a contaminant in water that is delivered to a free-flowing outlet. MCLs are considered protective of human health over a lifetime (70 years) for individuals consuming 2 liters of water per day.

Lifetime Health Advisory for Drinking Water (LTHA)

The LTHA is a lifetime exposure level developed by USEPA for drinking water. The LTHA is the level at which adverse, noncarcinogenic health effects would not be expected to occur.

USEPA Region III Risk-Based Concentration (RBC)

USEPA Region III combines RfDs and CSF with "standard" exposure scenarios (e.g., ingestion of 2 liters of water per day, over a 70-year life span) to calculate RBCs, which are chemical concentrations corresponding to fixed levels of risk (i.e., a hazard quotient of 1, or lifetime cancer risk of 10^{-6}, whichever occurs at a lower concentration) in water, air, fish tissue, and soil.

CVs are derived from available health guidelines, such as ATSDR's MRLs and USEPA's RfDs, and USEPA's CSFs. These guidelines are based on the no-observed-adverse-effect levels (NOAEL), lowest-observed-adverse-effect-levels (LOAELs), or the cancer effect levels (CELs) reported for a contaminant in the toxicologic literature, as described below:

Minimal Risk Levels (MRL)

MRLs are estimates of daily human exposure to a chemical (i.e., doses expressed in mg/kg/day) that are unlikely to be associated with any appreciable risk of deleterious noncancer effects over a specified duration of exposure. MRLs are calculated using data from human and animal studies and are reported for acute ($\leq$14 days), intermediate (15–364 days), and chronic ($\geq$365 days) exposures.

Reference Dose (RfD)

The RfD is an estimate, with safety factors built in, of the daily, life-time exposure of human populations to a possible hazard that is not likely to cause harm to the person.

Cancer Slope Factor (CSF)

Usually derived from dose-response models and expressed in mg/kg/day, CSFs describe the inherent potency of carcinogens and estimate an upper limit on the likelihood that lifetime exposure to a particular chemical could lead to excess cancer deaths.

Lowest-Observed-Adverse-Effect Level (LOAEL)

The LOAEL is the lowest dose of a chemical that was found to produce an adverse effect following human exposure or when it was administered to animals in a toxicity study.

No-Observed-Adverse-Effect Level (NOAEL)

The NOAEL is the highest dose of a chemical in a study, or group of studies, that did not cause harmful health effects in people or animals.

Cancer Effect Level (CEL)

The CEL is the lowest dose of a chemical in a study, or group of studies, that was found to produce increased incidences of cancer (or tumors).

For radioactive contaminants, ATSDR uses information on radiation exposure and its effects, as related to environmental levels. This information comes from federal agencies, including USEPA, the U.S. Department of Energy (DOE), and the Nuclear Regulatory Commission (NRC). ATSDR also uses other publicly available data sources and recommendations on radiation dose limits. The National Council on Radiation Protection and Measurements (NCRP), the International Commission on Radiological Protection (ICRP), and the United Nations Scientific Committee on the Effects of Atomic Radiation (UNSCEAR) develop these sources. The section describes the CVs used for radioactive contaminants.

National Council on Radiation Protection and Measurements, Publication No. 129 (NCRP No. 129)

The National Council on Radiation Protection and Measurements has recommended screening limits for contaminated surface soil based on the contaminant's contribution to a maximum annual effective dose to an individual of less than 25 millirems/year from a single set of sources (one site). The maximum effective yearly dose was recommended in NCRP Report No. 116 (1993).

Code of Federal Regulations Title 10, Part 20 (10CFR20)

The Nuclear Regulatory Commission (NRC) has established standards as part of Title 10, Chapter 1, of the Code of Federal Regulations (CFR) that all facilities receiving a permit from NRC must follow. Part 20 of these regulations (10CFR20) establishes limits for radiation protection. The limits for effluent outlined in Appendix B of Part 20 are equivalent to radionuclide concentrations that produce a total effective dose equivalent to 50 millirems/year if continuously inhaled or ingested for a year.

Notes:

ATSDR	Agency for Toxic Substances and Disease Registry
CEL	Cancer effects level
CREG	ATSDR Cancer Risk Evaluation Guide
CSF	Cancer Slope Factor
CV	Comparison value
EMEG	ATSDR Environmental Media Evaluation Guide
USEPA	U.S. Environmental Protection Agency
LOAEL	Lowest-observable-adverse-effects level

LTHA	USEPA Lifetime Health Advisory for Drinking Water
MCL	USEPA Maximum Contaminant Level
MRL	ATSDR Minimal Risk Level
NOAEL	No-observable-adverse-effects level
NRC	Nuclear Regulatory Commission
RBC	Risk-based Concentration
RfD	USEPA Reference Dose
RMEG	ATSDR Reference Dose Media Evaluation Guide
10CFR20	Code of Federal Regulations Title 10, Part 20 (10CFR20)
mg/kg/day	milligrams chemical/kilograms body weight/day
NCRP No. 129	National Council on Radiation Protection and Measurements, Publication No. 129

For this public health assessment (PHA), ATSDR evaluated data that were collected from groundwater and aquatic biota to determine whether people were exposed to contaminant concentrations that exceeded ATSDR's CVs. The majority of detected contaminants fell at or below CVs. Contaminants that were above CVs necessitated further evaluation, prompting ATSDR to estimate exposure doses (i.e., the amount of chemical a person is exposed to over time) using site-specific exposure assumptions.

Deriving Exposure Doses

When estimating exposure doses, health assessors evaluate (1) contaminant concentrations to which people might have been exposed and (2) length of time and the frequency of exposure. Together, these factors influence an individual's physiological response to chemical contaminant exposure and potential outcomes. Where possible, ATSDR used site-specific information about the frequency and duration of exposures. In cases where site-specific information was not available, ATSDR applied several protective assumptions to estimate exposures for residents, recreational users, and trespassers.

Using Exposure Doses to Evaluate Potential Health Hazards

ATSDR performs analyses to determine whether exposures might be associated with adverse health effects (noncancer and cancer). As part of this process, ATSDR examines relevant toxicologic, medical, and epidemiologic data to determine whether estimated doses are expected to result in adverse health effects. As a first step in evaluating noncancer effects, ATSDR compares estimated exposure doses to standard health guideline values, including ATSDR's minimal risk levels (MRLs) and the U.S. Environmental Protection Agency's (EPA's) reference doses (RfDs). The MRLs and RfDs are estimates of daily human exposure to substances that are not expected to result in noncancer effects over a specified duration. Estimated exposure doses that are less than these values are not considered to be of health concern. To be protective of human health, MRLs and RfDs have built in "uncertainty" or "safety" factors that make them much lower than levels at which health effects have been observed. Therefore, if an exposure dose is higher than the MRL or RfD, it does not necessarily follow that adverse health effects will occur.

II. Evaluation of Exposure to Contaminants in Drinking Water at Ravenwood Ski Lodge, Engineer Hill, and Birch Lake

VOCs and Arsenic

The following equation was used to estimate ingestion of VOCs and arsenic in drinking water:

$$\textbf{Estimated exposure dose} = \frac{\textbf{Conc.} \times \textbf{IR} \times \textbf{EF} \times \textbf{ED}}{\textbf{BW} \times \textbf{AT}}$$

where:

Conc.: Concentration of chemical in drinking water in parts per million (ppm, which is also mg/L)

IR: Ingestion rate:

(1) At Ravenwood Ski Lodge and Engineer Hill the adult IR = 1 liter/day and the child IR = 0.5 liters/day. These ingestion rates reflect non-residential exposure scenarios for adults and children.

(2) At Birch Lake Resort the adult IR = 2 liters/day and the child IR = 1 liter/day. These ingestion rates reflect residential exposure scenarios for adults and children.

EF: Frequency of exposure or number of exposure events per year of exposure:

(1) At Ravenwood Ski Lodge the adult EF for benzene = 261 days/year (5 days/week for 52 weeks) and the child EF for benzene equals 92 days/year (0.25 year). The exposure frequencies for adults and children reflect occupational and recreational exposure scenarios respectively.

(2) At Engineer Hill the adult EF for PCE = 261 days/year (5 days/week for 52 weeks), based on an occupational exposure scenario. The adult EF for all other VOCs at Engineer Hill = 30 days, based on the maximum length of time that well water at Engineer Hill was impacted with VOCs other than PCE.

(3) At Birch Lake Resort the adult and child EF for arsenic = 92 days/year (0.25 year), based on a recreational exposure scenario.

ED: Exposure duration:

(1) For all chemicals detected at Ravenwood Ski Lodge and Birch Lake, and for PCE detected at Engineer Hill, the ED for adults and children = 3 years, based on a 3 year average period of residence at EAFB.

(2) For all other VOCs detected at Engineer Hill the ED = 1 year, based on the limited duration of VOC contamination in the Engineer Hill drinking water supply.

BW: Body weight:

(1) For all adults BW= 70 kg. For all children BW = 15.4 kg, based on the mean body weight for a child 1 to 5 years old.

AT: Averaging time, or the period over which cumulative exposures are averaged:

(1) For all chemicals detected at Ravenwood Ski Lodge and Birch Lake, and for PCE detected at Engineer Hill, the AT for adult and child non-cancer effects = 3 years x 365 days/year.

(2) For all other VOCs detected at Engineer Hill, the AT for adult non-cancer effects = 1 year x 365 days/year.

(3) At all locations, the AT for cancer effects= 70 years x 365 days/year.

To screen out which chemicals do not require further evaluation, ATSDR calculated exposure doses using the maximum concentrations found in EAFB drinking water supplies. The resulting exposure doses for all VOCs detected in drinking water at Engineer Hill and Ravenwood Ski Lodge were below health guidelines for chronic exposure (i.e., they were below MRLs and RfDs and the cancer risk estimates were low). *Therefore, none of these chemicals were detected at a*

level of health concern for people that consumed contaminated water from Ravenwood Ski Lodge or Engineer Hill and will not be discussed further.

Arsenic

Health guideline values were exceeded for arsenic. Therefore, ATSDR examined the health effects levels discussed in the scientific literature and more fully reviewed exposure potential for arsenic. When comparing estimated exposure doses to actual health effects levels in the scientific literature, ATSDR estimates doses based on more realistic exposure scenarios. In this level of the evaluation, an average concentration is used to calculate exposure doses to estimate a more probable exposure (see Table C-1). This approach is taken because it is highly unlikely that anyone would consume water with the maximum concentration on a daily basis and for an extended period of time. It is more likely that water containing a range of arsenic concentrations would be consumed over time.

For noncancer effects, ATSDR found that exposures to the average detected concentration of arsenic at Birch Lake (0.048 ppm) would result in a dose above the MRL/RfD for a child and an adult. For cancer effects, ATSDR found that estimated exposures over 3 years would result in a dose below the cancer effect level (CEL), which is based on an epidemiologic study of people exposed to arsenic for over 45 years. Even though the estimated non-cancer doses slightly exceed the MRL/RfD for arsenic, we do not expect that a child or an adult that consumed water from Birch Lake Resort containing 0.048 ppm of arsenic will experience health effects. The MRL/RfD are set much lower than levels at which health effects have been observed.

ATSDR also reviewed available scientific literature on arsenic to evaluate whether adverse health effects would be likely to occur at the reported concentrations or at the estimated doses. Several epidemiologic investigations suggest an association between arsenic (inorganic) and a wide variety of adverse health effects in humans, but at doses higher than those resulting from drinking arsenic-contaminated water at Birch Lake Resort. Symptoms of chronic oral exposure appear to be skin problems (e.g., hyperkeratosis, hyperpigmentation), neurological effects, cardiovascular problems, and gastrointestinal irritations (e.g., vomiting, abdominal pain). Health effects from prolonged (e.g., 45 years) exposure to arsenic have been detected at doses of 0.014 milligrams contaminant per kilogram body weight per day (mg/kg/day) and higher (ATSDR 1998). The estimated exposure doses for a person drinking well water at Birch Lake Resort for a 3 year period is more than 15 times lower than this dose.

ATSDR looked at potential cancer threats posed by arsenic at the measured concentrations. EPA has classified arsenic as a human carcinogen based on data provided by multiple epidemiologic studies. One of the most cited studies is a Taiwanese study in which the lowest exposure levels associated with the onset of cancer (skin) were observed in people drinking water containing 170 to 800 ppb arsenic for a 45-year exposure period. Although the study demonstrated an association between arsenic in drinking water and skin cancer, the study failed to account for a number of complicating factors, including exposure to other non-water sources of arsenic,

genetic susceptibility to arsenic, and poor nutritional status of the exposed population. Furthermore, arsenic exposure may have been underestimated in the study, possibly leading to an overestimation of the actual risk. These weaknesses and uncertainties may limit the study's usefulness in evaluating cancer risk for residents' drinking water containing arsenic near EAFB.

Furthermore, various studies indicate that at low level exposures, arsenic compounds are detoxified (or metabolized)—that is, changed into less harmful forms—and then excreted in the urine. At higher levels of exposures, our bodies' capacity to detoxify arsenic may be exceeded. Certain studies suggest that the dose at which this happens is somewhere between 0.25 and 0.5 mg/kg/day, which is much higher than the dose level estimated here. When our body's capacity to detoxify is exceeded, blood levels of arsenic increase and adverse health effects may occur. This appears to be true for cancer and noncancer effects. At lower doses, scientists continue to study the relevance between metabolism and toxicity.

At EPA's request, a special subcommittee of the National Research Council (NRC) reviewed the arsenic toxicity database and evaluated the scientific basis of EPA's risk assessment for arsenic in drinking water. They concluded:

1. Sufficient evidence exists from human epidemiologic studies (Taiwan, Chile, and Argentina) that chronic ingestion of water containing several hundred parts per billion of arsenic can cause skin, bladder, and lung cancer. Only very little information is available to address cancer risk at lower concentrations. The subcommittee has therefore recommended further evaluation of the dose-response relationship between arsenic and cancer at lower doses.

2. Noncancer effects (skin, cardiovascular, and neurologic effects) were observed at chronic exposures of 0.01 mg/kg/day and higher. No developmental or reproductive effects were demonstrated in humans, although arsenic passes through the placenta. In addition to characterizing the dose-response relationship at low doses, the subcommittee recommends further study on skin effects, cardiovascular and cerebrovascular diseases, diabetes mellitus, and reproductive effects.

3. More information is needed on the mode of action by which arsenic causes adverse effects and cancer. For example, current information suggests that arsenic causes cancer by "inducing chromosomal abnormalities without interacting directly with DNA." If this is true, the dose-response curve would show sublinear characteristics in the low-dose range.

There is sufficient evidence to suggest that arsenic causes adverse health effects, including cancer, but at levels much higher than those measured at the Birch Lake area well. While scientists are still uncertain about the health effects, if any, of long-term, low-level exposure to arsenic in drinking water, enough evidence exists to suggest that arsenic is tolerated by humans at low doses. *Given this information, ATSDR does not believe that arsenic at the levels measured*

in drinking water at Birch Lake Resort are high enough to cause adverse health effects or cancer.

III. Evaluation of Exposure to PCBs and pesticides in Garrison Slough, On and Off Base

ATSDR evaluated the potential exposure that could occur if people ate small quantities of fish from either on-base, or downstream off-base sections of the Garrison Slough. The following equation was used to estimate exposure doses from ingesting PCBs and pesticides in fish caught in Garrison Slough:

$$\textbf{Estimated exposure dose} = \frac{\textbf{Conc.} \times \textbf{IR} \times \textbf{EF} \times \textbf{ED}}{\textbf{BW} \times \textbf{AT}}$$

where:

Conc.: Concentration of chemical in fish tissue in parts per million

IR: Ingestion rate:
- (1) IR for an adult = 0.004 kilograms (kg) of fish/day. Eating 0.004 kg/day is equivalent to eating 6 fish meals per year for an adult, where one fish meal equals 8 ounces of meat.
- (2) IR for a child = 0.002 kg of fish/day. Eating 0.002 kg/day is equivalent to eating 6 fish meals/ year for a child, where one fish meal equals 4 ounces of meat.

EF: Frequency of exposure, or number of exposure events per year of exposure:
- (1) EF for adults and children = 365 days/year.

ED: Exposure duration:
- (1) ED for adults on base and children on and off base = 5 years.
- (2) ED for adults living off base = 30 years. This value is the 90% upper-bound limit for residency at a single residence and most likely overestimates the actual duration of exposure, which is likely less than 30 years (EPA 1997).

BW: Body weight:
- (1) BW for an adult = 70 kg.
- (2) BW for a child = 15.4 kg., based on the mean body weight for a child 1 to 5 years old.

AT: Averaging time, or the period over which cumulative exposures are averaged:
- (1) AT for noncancer effects = 5 years x 365 days/year.
- (2) AT for cancer effects = 70 years x 365 days/year.

It should be noted that ATSDR did not assume that estimated exposures would be reduced by preparation (i.e., removing the fat) and cooking methods. ATSDR also assumed that all PCBs and pesticides get into the body (100% bioavailability).

To screen out which chemicals do not require further evaluation, ATSDR calculated exposure doses using the maximum concentrations found in the fish. The resulting exposure doses for 2,4-DDD, 4,4-DDD, 4,4-DDE, and 4,4-DDT were below health guidelines for people consuming up to six fish per year from the on-base section of the Garrison Slough (i.e., the exposure doses were below MRLs and RfDs and the cancer risk estimates were low). *Therefore, none of these pesticides were detected at a level of health concern for people eating up to six fish per year caught on base from Garrison Slough, and will not be discussed further.*

Noncancer health effects

Health guideline values were exceeded for the PCB mixture, aroclor 1260. Therefore, ATSDR examined the health effects levels discussed in the scientific literature and more fully reviewed exposure potential for aroclor 1260. When comparing estimated exposure doses to actual health effects levels in the scientific literature, ATSDR estimates doses based on more realistic exposure scenarios. In this level of the evaluation, an average concentration is used to calculate exposure doses to estimate a more probable exposure (see Table B-2). This approach is taken because it is highly unlikely that anyone would ingest fish with the maximum concentration for an extended period of time. Not every fish contains the maximum detected concentration of any given chemical. It is more likely that fish containing a range of concentrations would be ingested over time. ATSDR averaged PCB levels detected in fish each year of sampling (see Table 6) to identify long-term trends in PCB levels.

Tables B-2 and B-3 shows the estimated exposure dose calculated for adults and children consuming six fish meals per year from the on-base and off-base sections of the Garrison Slough respectively. Consuming fish on and off base from Garrison Slough could result in exposure doses ranging from 2.63×10^{-6} to 1.82×10^{-4} mg/kg/day for adults and 5.97×10^{-6} to 4.14×10^{-4} mg/kg/day for children. Notice that only people consuming fish from the on-base section of the slough would consistently have an estimated exposure dose above the ATSDR MRL for long-term exposure to PCBs (2.0E-5 mg/kg/d) or the EPA Reference Dose for long-term exposure (2.0E-5 mg/kg/d). *People who infrequently consume fish from the off-base section of Garrison Slough are not expected to be exposed to harmful levels of PCBs. People who consume fish from the on-base section of Garrison Slough would likely be exposed to PCBs at levels exceeding ATSDR's CV.*

When on-base anglers apply for their on-base fishing permit, they are advised to not eat the fish from Garrison Slough. The following information is provided to help people understand why the on-base section of Garrison Slough is used for catch and release fishing only.

PCBs are a group of synthetic organic chemicals that can cause a number of different harmful health effects. There are no known natural sources of PCBs in the environment. Because they don't burn easily and are good insulating materials, PCBs were widely used as coolants and lubricants in transformers, capacitors, and other electrical equipment. The manufacture of PCBs stopped in the United States in August 1977 because there was evidence that PCBs build up in the environment and may cause harmful effects (ATSDR 2000).

PCBs enter the environment as mixtures containing a variety of individual chlorinated biphenyl components, known as congeners. There are 209 possible PCB congeners. Aroclors are commercial PCB mixtures, containing different congener compositions. Aroclors widely used in the United States were 1016, 1232, 1242, 1248, 1254, and 1260. The first two digits indicate the type of mixture and second two digits reveal how much chlorine by weight is in the mixture.

The toxicology of PCBs has been most thoroughly studied in aroclor 1254, which has similar properties to aroclor 1260. Health effects have been observed in female Rhesus monkeys chronically exposed to 5.0×10^{-3} mg/kg/day of aroclor 1254 (specifically, decreased antibody response and eyelid and toe/finger nail changes; Arnold et al. 1993a, Tryphonas et al. 1989, 1991a as cited in ATSDR 2000). This is the lowest-observed-adverse-effect-level (LOAEL) identified in the scientific literature for chronic exposure to PCB mixtures. ATSDR's highest estimated exposure doses at Garrison Slough are more than one order of magnitude below the LOAEL. In addition, it should be noted that a few studies have shown that humans are less sensitive than monkeys on a dose basis (Arnold 1993a, 1995; Emmett et al. 1988a; Fischbein et al. 1979; James et al. 1993; Kimbrough 1995 as cited in ATSDR 2000).

Cancer health effects

Studies of workers provide evidence that exposure to PCBs may be associated with certain types of cancer in humans, such as cancer of the liver and biliary tract. Rats that ate commercial PCB mixtures throughout their lives developed liver cancer. Based on the evidence for cancer in animals, the Department of Health and Human Services (DHHS) has stated that PCBs may reasonably be anticipated to be carcinogens. Both EPA and the International Agency for Research on Cancer (IARC) have determined that PCBs are probable human carcinogens. Cancer incidence was studied in cohorts of fishermen from the Swedish east and west coasts, who had high intakes of PCBs in fish (Svensson et al. 1995a as cited in ATSDR 2000). There was an indication that the incidence of stomach cancer was elevated, however, the results were confounded by exposure to other contaminants in the fish. The estimated exposure doses from ingesting Garrison Slough fish on base (1.17×10^{-5} to 1.82×10^{-4} mg/kg/day) and off base (2.63×10^{-6} to 1.43×10^{-5}), [4] (see adult exposure doses in Tables B-1 and B2) are well below the CELs reported in the literature (CELs ranged from 1.0–5.4 mg/kg/day in animals; no CELs exist for humans; ATSDR 2000).

Conclusions

While serious health effects have not been identified following PCB exposures similar to those calculated for consumption of fish from the on-base section of Garrison Slough, ATSDR recommends, as a prudent public health action, that people avoid eating fish from this area.

[4] The adult exposure scenario evaluates being exposed to PCBs by eating fish over a lifetime (i.e., 70 years).

Table B-1. Exposure Doses for Drinking Water Contaminants Above Comparison Values

Chemical	Concentration ppm	Exposure Dose		Health Guideline mg/kg/day	Health Guideline Source
		Child mg/kg/day	Adult mg/kg/day		
Ravenwood Ski Lodge					
Benzene	0.145	1.2E-03	1.5E-03	4.0E-03	RfD
Engineer Hill					
PCE	0.059	NA	6.0E-04	1.0E-02	RfD
TCE	0.030	NA	3.52E-05	3.0E-04	RfD
Benzene	0.042	NA	4.93E-05	4.0E-03	RfD
1,3,5-trimethylbenzene	0.015	NA	1.76E-05	5.0E-02	RfD
1,2,4-trimethylbenzene	0.038	NA	4.46E-05	5.0E-02	RfD
Birch Lake					
Arsenic	0.048	**7.86E-04**	**3.46E-04**	3.00E-04	RfD

Key:

mg/kg/day	milligram per kilogram per day
PCE	tetrachloroethylene
ppm	parts per million
RfD	EPA reference dose
TCE	trichloroethene

Notes: Doses that exceed health guidelines are in **Bold**.
All concentrations represent the maximum levels detected in drinking water except for the concentration for arsenic. The concentration for arsenic is equal to the average level found in drinking water at the Birch Lake recreation area between 1990 and 1996.

Table B-2. Exposure Doses for Fish Contaminants Above Comparison Values On Base

Contaminant	Year	Conc. ppm[1]	Estimated Exposure Dose (mg/kg/day)[1]		Health Guideline	
			Adult	Child	mg/kg/day	Source
PCB	1993	0.466	**2.66E-05**	**6.05E-05**	2.00E-05	RfD-chr
PCB	1995	0.631	**3.61E-05**	**8.19E-05**	2.00E-05	RfD-chr
PCB	1996	3.186	**1.82E-04**	**4.14E-04**	2.00E-05	RfD-chr
PCB	1997	0.535	**3.06E-05**	**6.95E-05**	2.00E-05	RfD-chr
PCB	1998	0.223	1.27E-05	**2.90E-05**	2.00E-05	RfD-chr
PCB	1999	0.372	**2.13E-05**	**4.83E-05**	2.00E-05	RfD-chr
PCB	2000	0.419	**2.39E-05**	**5.44E-05**	2.00E-05	RfD-chr
PCB	2001	0.407	**2.33E-05**	**5.29E-05**	2.00E-05	RfD-chr
PCB	2002	0.205	1.17E-05	**2.66E-05**	2.00E-05	RfD-chr
PCB	2003	0.237	1.35E-05	**3.08E-05**	2.00E-05	RfD-chr
4,4-DDT	1993-1994	0.102	5.93E-06	1.32E-05	5.00E-04	RfD-chr
4,4-DDE	1993-1994	0.547	3.13E-05	7.10E-05	5.00E-04	RfD-chr
4,4-DDD	1993-1994	1.45	8.29E-05	1.88E-04	5.00E-04	RfD-chr
2,4-DDD	1993-1994	0.361	2.06E-05	4.69E-05	5.00E-04	RfD-chr

[1] PCB concentrations equal the annual averages during site-wide monitoring. DDT, DDE, and DDD concentrations are the maximum levels found during the RI.

Key:

Conc	concentration
mg/kg/day	milligram per kilogram per day
ppm	parts per million
RfD-chr	chronic EPA reference dose

Notes: Doses that exceed health guidelines are in **Bold**.
No fish data is available from 1994.

Table B-3. Exposure Doses for Fish Contaminants Above Comparison Values Off Base

Contaminant	Year	Conc. (ppm)[1]	Estimated Exposure Dose (mg/kg/day)[1]		Health Guideline	
			Adult	Child	mg/kg/day	Source
PCB	1995	0.091	5.20E-06	1.18E-05	2.00E-05	RfD-chr
PCB	1996	0.1	5.71E-06	1.30E-05	2.00E-05	RfD-chr
PCB	1997	0.158	9.03E-06	**2.05E-05**	2.00E-05	RfD-chr
PCB	1998	0.061	3.49E-06	7.92E-06	2.00E-05	RfD-chr
PCB	1999	0.046	2.63E-06	5.97E-06	2.00E-05	RfD-chr
PCB	2000	0.064	3.66E-06	8.31E-06	2.00E-05	RfD-chr
PCB	2001	0.094	5.37E-06	1.22E-05	2.00E-05	RfD-chr
PCB	2002	0.25	1.43E-05	**3.25E-05**	2.00E-05	RfD-chr
PCB	2003	0.095	5.43E-06	1.23E-05	2.00E-05	RfD-chr

Key:

Conc.	concentration
mg/kg/day	milligram per kilogram per day
ppm	parts per million
RfD-chr	chronic EPA reference dose

Note: PCB concentrations equal the annual averages during site-wide monitoring.
Doses that exceed health guidelines are in **Bold**.

Appendix C. ATSDR's Response to Public Comments

Appendix C: ATSDR's Response to Public Comments

The Agency for Toxic Substances and Disease Registry released the Eielson AFB Public Health Assessment (PHA) for public review and comment on September 19, 2005. The following section shows the comment and the ATSDR response. Editorial suggestions are not included in this list.

Comments and Responses Related to the Eielson Farm Road Anti-Aircraft Artillery Site (previously identified as AOC 8)

Comment
Reference is made to AOC 8 implying that the continued monitoring and implementation of future actions at this site is an Eielson AFB responsibility. Pg 35 paragraph 4 and Pg 17 in the last paragraph clearly document that this is now a formerly used defense site (FUDS) listed site known as "the Eielson Farm Road Anti-Aircraft Artillery site".

The Summary, Conclusions and Recommended Actions sections of this document should reflect the fact that this site is FUDS and that future monitoring and clean-up decisions will be covered under that program. Additionally it would be useful if references to this site used the FUDS site numbers (property number F10AK1059) rather then the Eielson base numbers. This would better show an explicit delineation between the programs and governmental entities. Finally, an attempt to coordinate these ATSDR recommendations with Army FUDS program should be made.

Response
ATSDR has revised the document to reflect the fact that environmental activities associated with AOC 8 are currently being addressed under the DOD's FUDS program. To maintain continuity with the previous versions of the document, the 'AOC 8' designation was frequently included in the site name or description.

Comment
Section III.C – Page 17: AOC 8 is identified as "a former artillery barracks in Salcha," when it actually is directly west of EAFB and north of Salcha.

Response
ATSDR has revised Section III.C Page 17, and other relevant sections, accordingly.

Comment
Section VIII, Bullet 5 – Page 35: Please provide the names of the FUDS Management Action Plan Committee members for AOC 8. Should this group have a representative for the landowner? The UST removal and removal contaminants to DEC cleanup levels should be the first choices for action at AOC 8.

Response
The environmental investigation and remediation of AOC 8 (FUDS site number F10AK1059) is being conducted by the U.S Army Corps of Engineers. For specific

information on the process and procedures used in the investigations and remediation, please contact the project manager, Mr Richard Jackson (907-753-5606). For general information about the program, please contact the U.S Army Corps of Engineers, Alaska District, Public Affairs office (907-753-2522).

Comment
Section III.c – Page 18: Ingestion/contact by humans and wildlife is a potential pathway at AOC 8 due to the history of site use by recreational users and lack of site restrictions.

Section VII – Page 32: The first recommended choice should be removal of the contaminant source material from AOC 8. This would be a better long-term solution and should eliminate the potential for complete contamination pathways, as well as the restrictions, which must inevitably be on the property due to the presence of contamination.

Another possible pathway for contamination is the presence of and contact/ingestion by migratory birds that frequent the pond that is impacted from the site.

Response
ATSDR conducted this PHA for Eielson AFB to evaluate whether local community members are exposed to base-related environmental contaminants at levels that would be expected to cause health effects. Environmental investigations were initiated by the Air Force and will continue under the Army Corps of Engineers. Initial results have identified soil and groundwater contamination, further investigations beginning this summer, are expected to define the nature and extent of contamination. Based on the information provided to ATSDR, there is limited potential for frequent and direct contact by the community with the contaminated soil or groundwater. Unfortunately, no information was identified that described the contaminant concentrations in fish or wildlife in this area. However, there are large amounts of hunting area, lakes, and rivers available to local hunters and anglers. Local hunters and angles who utilize a variety of locations will likely minimize the number of animals they capture that have fed or lived on this site. ATSDR encourages the Army Corps of Engineers and state regulatory offices to identify and coordinate the necessary environmental investigations and remediation efforts.

Comments Related to Specific Information Presented in Tables and Text

Comment
It may be worth noting in Table B that although diesel range organics and gasoline range organics have not been sampled for since 2002, it is unlikely that these contaminants exist in the groundwater above State of Alaska Groundwater Cleanup Levels (18 AAC 75.345, Table C).

Response
ATSDR did not add this information to the PHA text because there was no sampling information to confirm the expectation. Instead, ATSDR relied on the results of the

drinking water monitoring program to conclude that on-base drinking water sources were not impacted by these contaminants and that the base drinking water monitoring program was protective of public health.

Comment
Table B should indicate that floating product is present at site ST48. In 2002, 6 inches of floating product was found in well 48MO1 and well 48MO8 had petroleum sheen. Additionally, the results from groundwater modeling studies during 1994-1999 have not been recently verified or validated to ensure that the predictions made were accurate. ADEC has requested additional monitoring at this site due to increasing concentrations of benzene in one monitoring well (48MO8) and additional comprehensive characterization due to the overall lack of understanding of the contaminant transport and whether there are impacts to the plume from nearby pumping wells. However, please note that the water supply wells are monitored for VOCs quarterly, and drinking water standards have been consistently met.

Response
ATSDR noted the comment regarding the model verification, added a footnote to Table B regarding the presence of floating product in monitoring wells at ST48, and noted that drinking water standards for the water supply wells continue to be met.

Comment
Table B – Page 14: This table does not seem to include the groundwater contamination at AOC 8.

Response
Table B only includes sites within the base boundary that could impact on-base drinking water. ATSDR does include a description of AOC 8 (Eielson Farm Road Anti-Aircraft Artillery site), site investigation/monitoring information, and corrective actions taken in Table 1 on page 54 under Non-CERCLA sites.

Comment
Table 1 indicates that monitoring will continue at site SS35. Please note that Eielson AFB has recently requested the cessation of monitoring for contaminants in the groundwater, surface water, sediments, and aquatic invertebrates at site SS35. ADEC does not concur with discontinued monitoring, but has proposed less frequent monitoring.

Response
ATSDR has revised Table 1, noting the Eielson AFB request to cease monitoring activities and ADEC's proposed reduction in sampling frequency.

Comment
It is worth noting in Table 1 that diesel range organics and residual range organics were above State of Alaska groundwater cleanup levels (18AAC 75.345, Table C) in 1999 and 2000. Please also note that the metals detected during the 1999 sampling event were

below the maximum contaminant levels during subsequent sampling events when the sampling method was changed to recommend low-flow sampling techniques.

Response
ATSDR has revised Table 1 accordingly.

Comment
Please be aware that there are additional non-CERCLA petroleum-contaminated sites at Eielson AFB not listed in Table 1 that remain open with the State of Alaska and are listed in the ADEC Contaminated Sites and Leaking Underground Storage Tank Database available online at http://www.dec.state.ak.us/spar/csp/db_search.htm. These sites are most easily searched by City (Eielson AFB).

Response
ATSDR has noted the presence of petroleum contamination at many of the sites at Eielson AFB and encourages continued monitoring of groundwater and surface water to ensure that drinking water and recreational resources are safe.

Comment
Section II.E – Page 8: The adjacent land uses should include the large agricultural and residential area to the west (Eielson Ag).

Response
ATSDR has made the suggested change to the Land Use section.

Comment
Table I – Page 52: Where is the Chena River Research Annex located? If it is located on the Chena River, contamination issues are likely of concern to the state. Previously stated concerns regarding ingestion and contact with contamination by wildlife and recreational users should be mentioned for AOC 8. Off-site migration potential is a major concern, but not the only potential pathway for contaminants at this site. Future land uses should be considered when developing an action plan.

Response
The Chena River Research Annex (Site SS01) is located on Transmitter Road, 11 miles north of EAFB and about 9 miles northeast of Moose Creek. The location of the Annex's former Building 500, demolished in 1997, is approximately 1.3 miles from the Chena River. The site has undergone several remediation efforts. There are low levels of dissolved phase diesel range organics (DRO) in a very limited and stable plume on the site. According to EAFB personnel, Eielson is currently seeking a "conditional closure" status for the site from ADEC. There are no further remedial activities scheduled for this site.

Comments and Responses Related to the Fish Consumption Evaluations

Comment
In the summer of 2005, Eielson AFB placed 22 fishing advisory signs along access points to Garrison Slough. In addition, the Eielson AFB Natural Resources office will continue to brief base personnel of the Garrison Slough fishing advisory during routine fish permit briefings to anglers.

Response
ATSDR has updated the Final Eielson AFB PHA document to reflect this new information.

Comment
Section III.F – Page 22: The potential presence of PCB-contaminated fish in uncontained waters (potentially state owned navigable waters) located off base is of concern to the state Department of Natural Resources. It appears that even though most source material was removed and barriers put in to block migrating fish from using the most contaminated reaches of Garrison Slough, PCB contamination continues to show up in fish species utilizing the downstream reaches of the slough and Moose Creek. This would indicate a source is still available.

Response
The purpose of this PHA for Eielson AFB was to evaluate whether local community members are exposed to base-related environmental contaminants at levels that would be expected to cause health effects. Although this comment addresses an important facet of the environmental investigation and remediation process, it is beyond the scope of this PHA to identify contaminant sources. ATSDR's primary objective is to ensure the health of people who may consume fish, either recreationally or for subsistence purposes, from areas that have been impacted by hazardous substances. The off-site fish sampling data reviewed by ATSDR suggests that limiting consumption of fish from locations in close proximity to Garrison Slough (e.g., Moose Creek) is prudent. There is considerable variation in the PCB concentrations that have been detected in fish sampled off-site in close proximity to Garrison Slough. However, the average concentration in fish sampled is less than 100 ppb (0.1 ppm). At these levels, even at subsistence consumption rates, there is a lack of clear or compelling evidence in the toxicological literature that indicates people would experience health effects from their exposures. ATSDR does advocate following recommended public health guidance in order to minimize exposure such as removing skin from fish and not eating the liver and other portions of the fish that typically accumulate the highest levels of PCBs.

Comments and Responses Related to the Vapor Intrusion Evaluation

Comment
The potential for vapor intrusion has not been evaluated at most of the contaminated sites on Eielson. The extent of vapor intrusion into buildings on Eielson AFB is mostly

unknown, but has been evaluated at sites where workers have complained of health impacts or strong odors, as discussed in the report. Site WP45/SS57 is one concern to ADEC due to the very high concentrations of volatile organic compounds in the groundwater and the possible presence of non-aqueous phase liquid; however, there are many additional areas at Eielson where the vapor intrusion pathway has not been evaluated.

Response
ATDSR believes it is prudent for the Air Force to consider the potential for vapor intrusion. ATSDR contacted Eielson base representatives to discuss their process for identifying and evaluating buildings where occupants could be exposed to contaminants by the vapor intrusion pathway. Indoor air sampling of base buildings is accomplished by the base bioenvironmental engineering (BBE) organization. The Installation Restoration Program (IRP) office will notify the BBE organization of any environmental contaminants that are in close proximity to buildings near contaminated sites. The IRP office also ensures that indoor air quality is within OSHA standards.

Comment
Page 20, section III.E: Vapor Intrusion to Indoor Air – On page 20, under the paragraph of the section titled Public Health Evaluation, ATSDR agreed with the Alaska Department of Environmental Conservation that Eielson AFB evaluate the possibility of indoor air vapor intrusion potential in industrial buildings near site WP45/SS57, following Occupational Safety and Health Administration (OSHA) standards (EPA 2002).

On July 28, 2005, Bioenvironmental Engineering performed an OSHA standard Indoor Air Quality survey for the DET 460 Maintenance Building 2681, located near site WP45/SS57. Results show that the old trichloroethylene (TCE) spill is not affecting indoor air quality in the DET 460 facility, per the survey report in Attachment 1.

Response
ATSDR reviewed the results of the Bioenvironmental Engineering Indoor Air Quality sampling analysis and obtained additional information regarding detection limits, instrument calibration, and height where sampling probes were placed. The air monitoring used a Photo Ionization Detector (PID) to collect samples. The PID is a portable vapor and gas detector that detects a variety of organic compounds. It is used mostly as a screening tool to detect VOCs in soil, sediment, air and water. The results of the air sampling showed that workers and visitors are not exposed to harmful levels of TCE in the air that they breathe.