RECORD OF DECISION
for
OPERABLE UNIT C
FORT RICHARDSON
ANCHORAGE, ALASKA

September 1998

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Contract No. DAC85-95-D-0015
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Department of the Army
U.S. Army Engineer District, Alaska

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DECLARATION STATEMENT
for
RECORD OF DECISION
FORT RICHARDSON
ANCHORAGE, ALASKA
OPERABLE UNIT C
_____ 1998

SOURCE AREA NAME AND LOCATION

Operable Unit C
Fort Richardson
Anchorage, Alaska

STATEMENT OF BASIS AND PURPOSE

This Record of Decision (ROD) presents the selected remedial actions for Operable Unit C (OU-C). OU-C consists of two source areas: the Eagle River Flats (ERF) and the former Open Burning/Open Detonation (OB/OD) Pad. This ROD was developed in accordance with the Comprehensive Environmental Response, Compensation, and Liability Act of 1980 (CERCLA) as amended by the Superfund Amendments and Reauthorization Act of 1986; 42 *United States Code* 9601 *et seq.*, and, to the extent practicable, the National Oil and Hazardous Substances Pollution Contingency Plan (NCP), 40 *Code of Federal Regulations* 300 *et seq.* This decision is based on the Administrative Record for OU-C.

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

ASSESSMENT OF THE SITE

Actual or threatened releases of hazardous substances resulting from white phosphorus contamination of the ERF source area of OU-C, if not addressed by implementing the response actions selected in this ROD, may present an imminent or substantial threat to public health, public welfare, or the environment. ERF is contaminated with white phosphorus particles.

DESCRIPTION OF THE SELECTED REMEDY

OU-C is the third OU to reach the final-action ROD at the Fort Richardson National Priorities List site. This ROD addresses sediment contamination at the ERF source area of OU-C.

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

The remedial action objectives (RAOs) for the ERF are designed to accomplish the following:

- Within 5 years of the ROD being signed, reduce the dabbling duck mortality rate attributable to white phosphorus to 50 percent of the 1996 mortality rate attributable to white phosphorus. Radio tracking and aerial surveys suggest that about 1,000 birds died from white phosphorus at ERF in 1996. Therefore, the allowable number of duck deaths from white phosphorus would be approximately 500.
- Within 20 years of the ROD being signed, reduce the mortality attributable to white phosphorus to no more than 1 percent of the total annual fall population of dabbling ERF ducks. Currently, that population is about 5,000. Therefore, the allowable number of duck deaths from white phosphorus would be approximately 50. This long-term goal could be adjusted based on future population studies conducted during the monitoring program.

These objectives will be achieved by reducing the area of white phosphorus-contaminated media and reducing the exposure to white phosphorus. Reducing the exposure will reduce the availability of white phosphorus to ducks, which in turn will reduce duck deaths.

Monitoring at ERF will be conducted to verify that RAOs are achieved. The following are goals of monitoring:

- To verify that an exposure pathway does not exist between waterfowl and white phosphorus-contaminated sediment
- To determine the number of waterfowl using ERF
- To determine the number of waterfowl dying as a result of feeding in white phosphorus-contaminated sediment
- To determine whether remedial action is effective or needs modification

The major components of the preferred remedy for OU-C are listed below. It is assumed that implementation of the remedy will begin in 1999 and end in 2018 (duration of 20 years). Treatment will occur between 1999 and 2003, and will be followed by long-term monitoring from 2004 to 2018. The sequence and schedule of operation and maintenance activities are presented in Tables 1 and 2, respectively.

- Treat white phosphorus-contaminated sediment by draining ponds with pumps for five summers beginning in 1999. Pumping would allow the sediments to dry and the white phosphorus to sublimate and oxidize. The treatment season would begin in May and end in September. A pond elevation survey would be conducted to determine the optimal pump placement. To enhance drainage, explosives may be used to make small sumps for the pumps and shallow drainage channels. These shallow drainage channels would enhance hydraulic connectivity between ponds to encourage drainage.
- Implement the following protective procedures to minimize disturbances to wetlands habitat:
  - Restriction of activities that disturb wildlife in Area B and Area D, which are prime waterfowl habitat areas

- Selection of the narrowest and shortest walking corridors to minimize disturbances to vegetation and habitat
- Proper maintenance of equipment and structures
- Minimization of the use of equipment and of staging-area footprints
- Minimal localized use of explosives
- Preparation of work plans and solicitation of agency reviews
- Monitoring for impacts to wetlands habitat
- Monitoring for waterfowl use of ERF

TABLE 1
Sequence of Activities for the Selected Alternative

Activity	Time Frame
Monitoring Activities	
Waterfowl telemetry and mortality study	Every year for first 8 years, Year 10, Year 15, and Year 20 (11 events)
Aerial waterfowl surveys	Every year for first 8 years, Year 10, Year 15, and Year 20 (11 events)
White phosphorus monitoring of treated ponds	Every year for first 5 years (5 events)
White phosphorus composite sampling in untreated areas	Every year for first 5 years (5 events)
GIS database management	Every year for first 8 years, Year 10, Year 15, and Year 20 (11 events)
Pond survey, ground truthing, limited aerial survey	Year 1 and every year from Year 9 to Year 20 (13 events)
Aerial photography and interpretation	Every other year for 10 years (5 events)
Mapping of physical habitat changes and vegetation rebound	Once every 4 years for 20 years (6 events)
Treatment Activities	
Pond pumping treatment	Every year for first 5 years (5 events)
Cap and fill application	Year 5 (1 event)
Cap and fill integrity inspection	Every year for 4 years after material is placed (Year 5, 6, 7, 8), Year 10, Year 15, and Year 20 (7 events)
Hazing (contingency)	Every year for first 5 years (5 events, if needed)

TABLE 2
Schedule of Activities for Selected Alternatives

	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20
Year:	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018
Tide Predictions:	Wet	Wet	Dry	Dry	Dry	Wet	Dry	Dry	Dry	Wet	Wet	Dry	Dry	Wet	Wet	Wet				
Activity:	*Mortality and white phosphorus concentrations decrease consistently each year. Trend established. Short term RAO met at end of Year 5.*					*Continue mortality and white phosphorus monitoring to ensure RAOs are maintained.*				*Mortality monitoring performed at Year 10, Year 15, and Year 20 to ensure that RAOs are maintained. Limited aerial and land surveys conducted periodically.*											
	Pumping performed. More activity during dry years; less during wet years. Only small, isolated amounts of white phosphorus detected.					*Natural processes like sedimentation continue.*														*Long-term RAOs met.*
				Cap-and -fill material applied to areas that do not dry.																
Monitoring																				
Waterfowl telemetry and mortality study	X	X	X	X	X	X	X	X		X					X					X
Aerial waterfowl surveys	X	X	X	X	X	X	X	X		X					X					X
White phosphorus monitoring of treated ponds	X	X	X	X	X															
White phosphorus composite sampling in untreated areas	X	X	X	X	X															
GIS database management	X	X	X	X	X	X	X	X		X					X					X
Ponds survey, ground truthing, limited aerial survey	X								X	X	X	X	X	X	X	X	X	X	X	X
Aerial photography and interpretation	X		X		X		X		X											
Mapping of physical habitat changes and vegetation rebound	X			X				X				X				X				X
Treatment																				
Pond pumping treatment	X	X	X	X	X															
Cap and fill application					X															
Cap and fill integrity inspection					X	X	X	X		X					X					X
Hazing (contingency)	X	X	X	X	X															

Assumptions:

1. Active remediation will be performed until Year 5. Treatment progress and monitoring technique will be evaluated during the 5-year review.
2. Waterfowl mortality will decline after each year of treatment.
3. A trend will be established to justify that reaching the short-term mortality goal is the result of treatment (white phosphorus removal), and not just a limited data set.
4. Cap-and-fill material will be applied to 2.17 acres of pond bottoms at Year 5. It is assumed that 5% of Pond 146, 5% of Pond 155, and 10% of Northern A ponds will not dry.
5. Telemetry and mortality studies, aerial waterfowl surveys, reduced white phosphorus sampling, limited GIS database management, and studies of habitat rebound will be performed for an additional 3 years after active pumping is complete. This additional monitoring is to ensure that cleanup objectives are not only reached, but also maintained.
6. Telemetry and mortality studies, aerial waterfowl surveys, limited GIS database management, and limited studies of habitat rebound will be performed at Years 10, 15, and 20 to ensure that cleanup objectives are maintained.
7. Limited site visits to inspect for waterfowl mortality, physical habitat changes, and vegetation rebound will be performed during years that telemetry mortality studies are not performed. Assessment will be performed visually on foot and by air.

- Sample pond bottoms for white phosphorus at the beginning of the treatment season to confirm or determine that the pond or area requires remediation. The sampling also would establish a white phosphorus baseline and determine additional areas that may require remediation. The baseline sampling would be performed at the beginning of each field pumping season (every year for the first 5 years, starting in 1999).
- Sample pond bottoms for white phosphorus after treatment to determine effectiveness of the treatment system. This verification sampling would be performed at the end of each field pumping season (every year for the first 5 years, starting in 1999).
- Perform telemetry monitoring and aerial surveys every year for the first 5 years concurrently with pumping activities to determine bird populations, usage, and mortality. These activities would begin in 1999. Monitoring would be continued for 3 additional years to verify that short-term goals are maintained. Monitoring also would be conducted at Year 10, Year 15, and Year 20 to ensure that remedial action objectives continue to be maintained.
- Perform limited aerial surveys and ground truthing during Year 9 to Year 20 to evaluate waterfowl mortality, physical habitat changes, and vegetation rebound.
- Perform aerial photography every other year for 10 years (beginning in 1999) to monitor habitat changes resulting from remedial actions. Changes in drainage, topography, and vegetation would be evaluated.
- Perform habitat mapping once every 4 years for 20 years to evaluate impacts to habitat as a result of remedial actions, as well as to observe physical habitat changes and vegetation rebound after pumping is discontinued.
- Perform limited hazing (only as a contingency) during first 5 years starting in 1999 if incidental hazing from pumping operations and other fieldwork activities does not deter bird usage.
- After remedial action objectives are achieved and pumping is discontinued, apply cap-and-fill material in ponded areas that did not drain and dry sufficiently to enable the white phosphorus to sublimate and oxidize. Cap-and-fill material placement is expected to occur in Year 5 (2003).
- Monitor cap and fill material integrity every year for 4 years after the material is placed, and also at Year 10, Year 15, and Year 20.
- Incorporate white phosphorus sampling, telemetry, aerial survey, habitat, and physical landform data into a geographical information system (GIS) database. Perform GIS management every year for the first 8 years, starting in 1999, and then during Year 10, Year 15, and Year 20.
- Maintain institutional controls, including the restrictions governing site access, construction, and road maintenance and the required training for personnel who work at OU-C source areas, as long as hazardous substances, and unexploded ordnance hazards, exist at OU-C.

STATUTORY DETERMINATION

The selected remedy is protective of human health and the environment, complies with federal and state requirements that are legally applicable or relevant and appropriate to the remedial action, and is cost-effective. The remedy uses permanent solutions and alternative treatment technologies to the maximum extent practicable, and satisfies the statutory preference for remedies that employ treatment that reduces toxicity, mobility, or volume as a principal element.

Because the remedy will result in hazardous substances that present a substantial ecological risk remaining on site, a review will be conducted within 5 years after commencement of the remedial action to ensure that the remedy continues to provide adequate protection of human health and the environment. Review will continue for 5-year increments until the RAOs are complete.

SIGNATURE

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

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

SIGNATURE

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

9/30/98

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

SIGNATURE

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

Lynn J. Tomil for 9-30-1998

for Kurt Fredriksson, Director, Spill Prevention and Response
Alaska Department of Environmental Conservation

Contents

Contents, Continued

Contents, Continued

Contents, Continued

Figure

Abbreviations

AAC	*Alaska Administrative Code*
ADEC	Alaska Department of Environmental Conservation
ADFG	Alaska Department of Fish and Game
AOPEC	area of potential ecological concern
AR	Army Regulation
ARAR	applicable or relevant and appropriate requirement
Army	U.S. Army
bw	body weight
CERCLA	Comprehensive Environmental Response, Compensation, and Liability Act of 1980 (Superfund)
CFR	*Code of Federal Regulations*
COE	U.S. Army Corps of Engineers
COPC	chemical of potential concern
COPEC	chemical of potential ecological concern
CRREL	U.S. Army Cold Regions Research and Engineering Laboratory
CSM	conceptual site model
CTV	critical toxicity value
CWA	Clean Water Act
EPA	U.S. Environmental Protection Agency
ERF	Eagle River Flats
FFA	Federal Facility Agreement
FFCA	Federal Facility Compliance Agreement
FS	feasibility study
GIS	geographical information system
HE	high explosive
IRIS	Integrated Risk Information System
LD_{50}	lethal dose for 50 percent of a sample population
LOEL	lowest observed effect level
µg/g	micrograms per gram

µg/kg	micrograms per kilogram
mg	milligram
mg/kg	milligrams per kilogram
msl	mean sea level
NCP	National Contingency Plan
NOEL	no observed effect level
NPL	National Priorities List
OB/OD	Open Burning/Open Detonation
OU	operable unit
RAO	remedial action objective
RCRA	Resource Conservation and Recovery Act of 1976
RI	remedial investigation
RME	reasonable maximum exposure
ROD	Record of Decision
SARA	Superfund Amendments and Reauthorization Act
SOP	Standard Operating Procedure
TBC	to be considered
UCI	Upper Cook Inlet
USAEHA	U.S. Army Environmental Hygiene Agency
USFWS	U.S. Fish and Wildlife Service
UXO	unexploded ordnance

DECISION SUMMARY

RECORD OF DECISION

for

OPERABLE UNIT C
FORT RICHARDSON
ANCHORAGE, ALASKA
SEPTEMBER 1998

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

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

SECTION 1

Site Description

Fort Richardson is an active U.S. Army (Army) installation near Anchorage, Alaska. Fort Richardson was established in 1940 as a military staging and supply center during World War II and originally occupied 162,000 acres north of Anchorage. In 1950, the Fort was divided between the Army and Elmendorf Air Force Base. Fort Richardson now occupies approximately 56,000 acres and includes a central cantonment area surrounded by ranges and by impact and maneuver areas to the north, east, and south. The Fort is bounded to the west by Elmendorf Air Force Base, to the east by Chugach State Park, to the north by Knik Arm, and to the south by the Municipality of Anchorage. The population of the Municipality of Anchorage, which includes Elmendorf Airforce Base and Fort Richardson, is approximately 255,000.

Fort Richardson's land use supports its current mission to provide the services, facilities, and infrastructure necessary to support the rapid deployment of Army forces from Alaska to the Pacific Theater. The area managed by Elmendorf Air Force Base adjacent to Fort Richardson is dedicated to military uses; recreational uses are permitted where consistent with the military mission.

Fort Richardson contains features that include flat to rolling wooded terrain. The upland areas near the adjacent Chugach Mountain Range rise to approximately 5,000 feet above mean sea level (msl). The post is located in a climatic transition zone between the maritime climate of the coast and the continental interior climate of Alaska.

The predominant vegetation type at Fort Richardson comprises varying-aged stands of mixed coniferous and deciduous forest. The diverse plant communities provide habitats for a diverse wildlife population including moose, bear, Dall sheep, swans, and waterfowl. There are no known threatened or endangered species residing on the post.

Fort Richardson straddles both the alluvial fan gravels of the Anchorage plain and the moraine and glacial alluvium complex near the shore of Knik Arm. The gravel alluvium of the Anchorage plain underlies the main cantonment. The confined gravel aquifer is from 197 to 394 feet below the surface in this area of the installation. Groundwater flow in this confined aquifer is in a generally western to northwestern direction.

Just north of the main cantonment is the southern edge of the Elmendorf Moraine, a hummocky, long series of ridges running east-west across Fort Richardson and Elmendorf Air Force Base, roughly parallel to Knik Arm. The moraine is chiefly till, including poorly sorted gravel.

Fort Richardson has generated and disposed of various hazardous substances since it began operations. The Fort was added to the U.S. Environmental Protection Agency (EPA) National Priorities List (NPL) in June 1994. The listing designated the post as a federal site subject to the remedial response requirements of the Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA), as amended by the Superfund Amendments and Reauthorization Act (SARA) of 1986.

On December 5, 1994, the Army, Alaska Department of Environmental Conservation (ADEC), and EPA signed a Federal Facility Agreement (FFA) that outlines the procedures and schedules required for a thorough investigation of suspected historical hazardous substance sources at Fort Richardson. Under the FFA, all remedial response activities will be conducted to protect public health and welfare and the environment, in accordance with CERCLA, the National Contingency Plan (NCP), the Resource Conservation and Recovery Act (RCRA), and applicable state laws.

The FFA divided Fort Richardson into four operable units (OUs): OU-A, OU-B, OU-C, and OU-D. The potential source areas at Fort Richardson were grouped into OUs based on the amount of existing information and the similarity of potential hazardous substance contamination. Only OU-C is addressed in this Record of Decision (ROD). OU-A and OU-B were addressed in a ROD signed in September 1997. OU-D will be addressed in a future ROD.

Figure 1-1 shows the location of Fort Richardson and OU-C.

1.1 Operable Unit C Site Locations and Descriptions

OU-C comprises two source areas: the Eagle River Flats (ERF), an ordnance impact area, and the former Open Burning/Open Detonation (OB/OD) Pad. The majority of this ROD addresses ERF. Section 9 provides detail on the site history, results of the remedial investigation (RI), and future activity at OB/OD Pad.

1.1.1 Eagle River Flats

ERF is a 2,160-acre, cornucopia-shaped, estuarine salt marsh at the mouth of the Eagle River. It is surrounded by forested uplands on the west, south, and east sides, and bounded by the Knik Arm on the north. The Eagle River flows through ERF from southeast to northwest, ultimately discharging into Knik Arm. Two creeks, Clunie and Otter, also drain into ERF (Figure 1-2).

ERF is the only impact area for heavy artillery and mortars on Fort Richardson. Approximately 25 derelict cars and trucks have been placed individually or in groups as targets around ERF. Army personnel practice firing at the targets from more than 25 points, at distances of up to 6 miles. The ERF has been used for military training since 1949, creating thousands of craters in the wetlands and associated mud flats and leaving an estimated 10,000 unexploded mortar and artillery shells buried in the shallow subsurface. Four types of munitions have been fired into ERF: high explosives (HEs), white phosphorus smokes, illumination flares, and hexachloroethane-zinc mixture.

Although ERF is an active impact area, it remains a productive wetland, serving as an important staging ground for migrating waterfowl during the spring and fall migrations. ERF also supports local populations of fish, birds, mammals, and macroinvertebrates. A series of ponds distributed throughout ERF provides excellent habitat for dabbling ducks and other waterfowl.

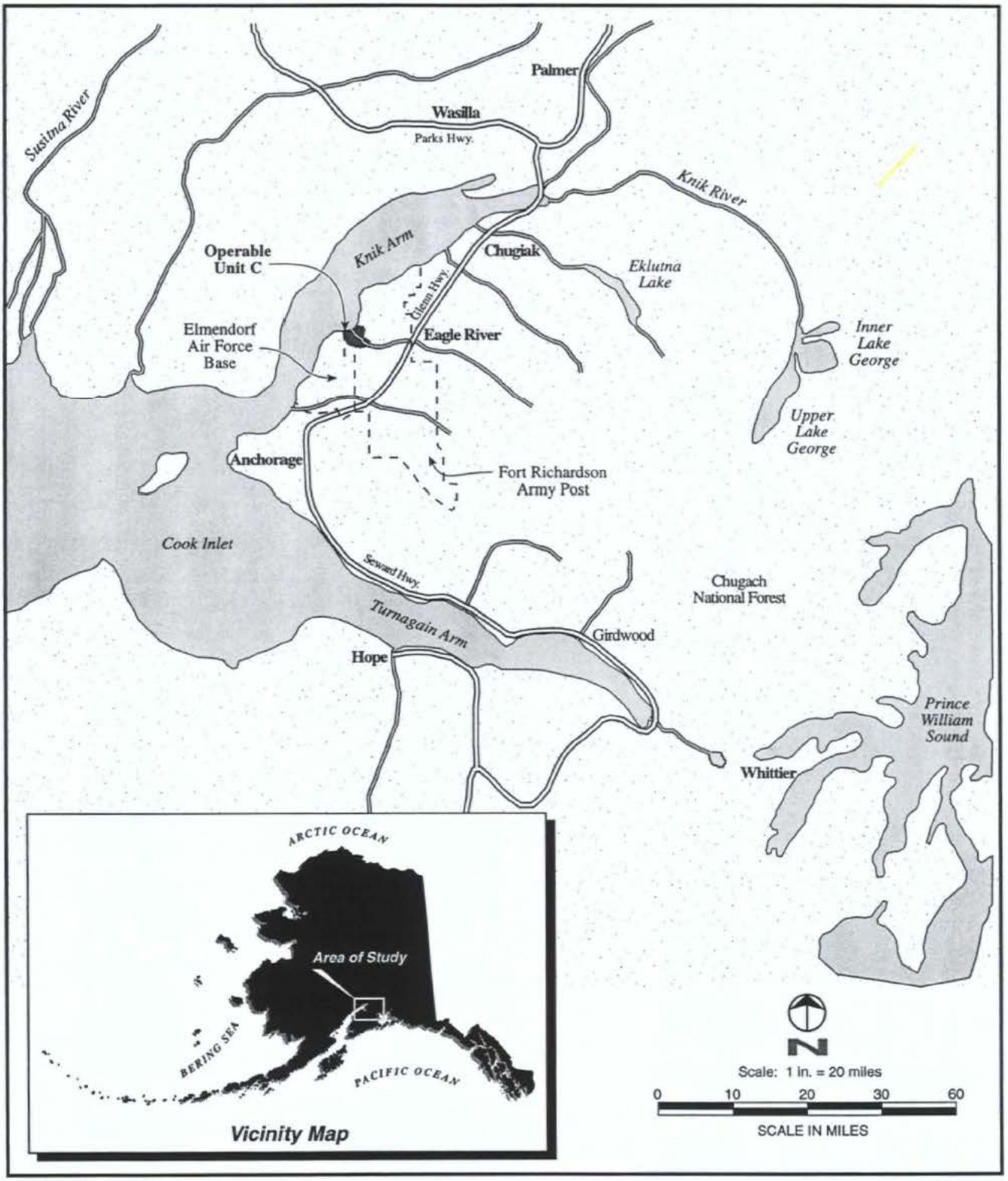

Figure 1-1

Location Map

OU-C Record of Decision

140927 L0.30 OUC LocMap 03/04/98 anc/kh

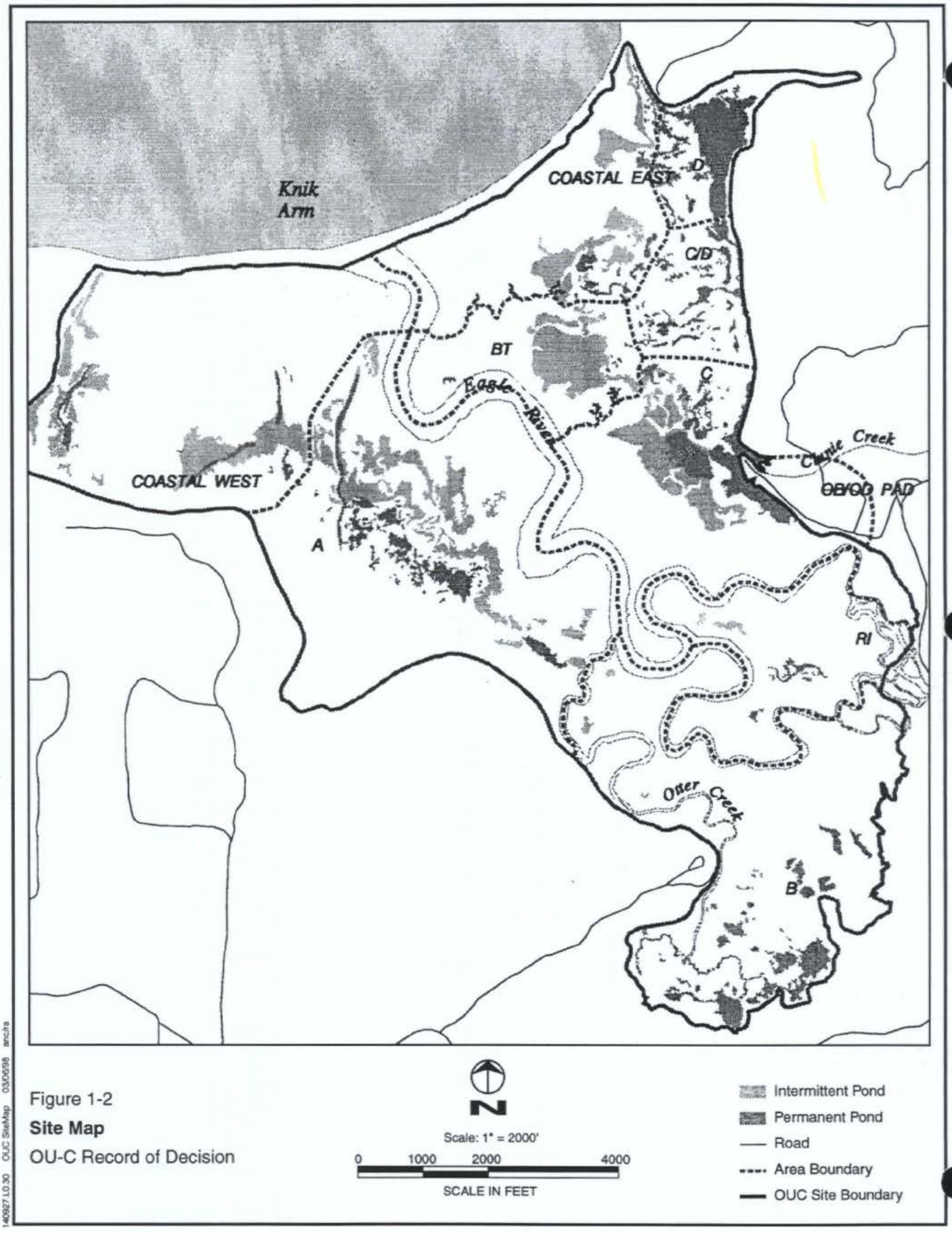

Figure 1-2

Site Map

OU-C Record of Decision

140927.L0.30 OUC SiteMap 03/06/98 anc/ra

1.1.2 OB/OD Pad

The former OB/OD Pad, also referred to as Demolition Area One or Demo 1, is an 8.5 acre clearing with a 4-acre gravel pad constructed along the east side of ERF. Open burning and open detonation of explosives on Fort Richardson historically have been performed on this pad since at least 1956, according to aerial photography. No OB/OD activities have been performed on OB/OD Pad since November 1988. The pad contains the remains of destroyed surplus and outdated munitions, along with assorted objects such as junked vehicles and rocket motor casings.

OB/OD Pad, which was designated a RCRA regulated unit, was scheduled for closure under 40 *Code of Federal Regulations* (CFR) 265, Subparts G and P. This area was included in OU-C under the FFA. The process for closing the OB/OD Pad in accordance with RCRA regulations is detailed in Sections 9.4 and 9.4.1 of this ROD.

An RI at OB/OD Pad in 1996 that included sampling and analysis of soil and groundwater indicated that concentrations of detected chemicals were considerably below regulatory levels specified in the *Operable Unit C RI/FS Management Plan, Fort Richardson, Alaska,* prepared in 1996. In addition, the ecological and human health risk assessments completed during the RI indicate that the risks are very low.

In addition, OB/OD Pad has restricted public access. Entry onto the pad is by road with a locked gate. Access is controlled and monitored by the Range Control at Fort Richardson. These restrictions are not expected to change. Because of the potential unexploded ordnance (UXO) hazard in the area, OB/OD Pad is not available for future development.

1.2 Land Use

OU-C is situated on land that is withdrawn from the public domain for military purposes by Executive Order. The U.S. Army Alaska holds no deed documents to the land. Current land use is military training. In 1990, the Army banned the firing of smokes containing white phosphorus into the ERF. Several additional restrictions currently apply to training activities at ERF as follows:

- A minimum of 6 inches of ice must cover the ERF before it can be used for firing.
- Firing is allowed only between November 1 and March 31.
- Only point-contact detonators may be used.

Although there are no immediate plans to resume warm-weather firing onto the ERF, future changes to the mission of Fort Richardson could necessitate the use of the training area during the summer months.

SECTION 2

Site History and Enforcement Activities

2.1 ERF Site History

Biological, chemical, and physical investigations have been ongoing at ERF since the early 1980s. The focus of the investigations varied, depending on current site knowledge, and questions that needed to be addressed.

A time-line presentation and a chronological listing of investigations and treatability studies completed through 1996 are presented in Figure 2-1 and Table 2-1, respectively.

In 1980, Army biologists noticed an unusually high number of waterfowl carcasses, including several dead swans, in the ERF marshes. Subsequent, random searches by the Army, U.S. Fish and Wildlife Service (USFWS), and Alaska Department of Fish and Game (ADFG) discovered abnormally high numbers of dead waterfowl, indicating a serious problem. Ground searches conducted in September 1983 found 368 waterfowl carcasses, including about 35 fresh carcasses. In August and September 1984, about 175 carcasses were discovered. At that time, the Army estimated the number of waterfowl deaths to be between 1,500 and 2,000 per year. In a later study, a series of aerial and ground surveys in 1988 documented more than 900 waterfowl carcasses and feather piles in one area of ERF.

Several preliminary studies that focused on finding the cause of the mortality were conducted between 1982 and 1987. Although the results of these studies eliminated a number of possible causes from consideration, the actual cause of the mortality was not identified. In late 1987, an interagency task force was formed to identify the cause of waterfowl deaths. The ERF Task Force consisted of representatives from the U.S. Army Alaska, EPA, USFWS, ADFG, and ADEC. The primary objective of the ERF Task Force was to identify the cause of the waterfowl deaths and recommend remedial alternatives.

In addition to the ERF Task Force member agencies, other agencies that have been involved in the investigations in ERF include the following:

- U.S. Army Corps of Engineers (COE), Alaska District
- U.S. Army Cold Regions Research and Engineering Laboratory (CRREL)
- Army Center for Health Promotion and Preventive Medicine (formerly U.S. Army Environmental Hygiene Agency [USAEHA])
- Army Environmental Center (formerly U.S. Army Toxic and Hazardous Materials Agency)
- U.S. Department of Agriculture

After the formation of the ERF Task Force, several studies and investigations were conducted to identify contaminants of concern, characterize the nature and extent of contamination, and evaluate potential remedial alternatives. The approach to determining the cause of waterfowl mortality included a review of physical and chemical data and an evaluation of waterfowl behavior based on biological data. The studies initiated to assess waterfowl behavior included bird utilization of habitat and bird mortality studies.

On the basis of results of the initial bird utilization and mortality studies, ERF was initially divided into four Areas: A, B, C, and D. Over time, four other areas of potential concern were identified: Area C/D (between Areas C and D), Bread Truck Pond, Pond Beyond, and the mud flats. Additional research throughout ERF eventually led to the following designated areas, which were the focus for RI and feasibility study (FS) activities: A, B, C, C/D, D, Coastal East, Coastal West, Bread Truck, and Racine Island. Figure 1-2 shows the locations and approximate boundaries for the ERF areas.

The results of a 1989 investigation indicated that chemicals from explosive ordnance were the probable cause for the waterfowl mortality in ERF. In February 1990, on the basis of conclusions reached in the 1989 study, the Army temporarily suspended the use of ERF for live firing until the causative agent of waterfowl mortality was identified. Despite the closure, large numbers of waterfowl continued to die at ERF during the spring and fall migrations.

Census data for 1988 and 1989 indicated that dabbling ducks comprised the majority of the affected waterfowl and the ducks were continuing to die. The focus of the following 1990 field season was to find the cause of mortality based on the assumptions that the contaminant(s) resided in sediment, were distributed heterogeneously at ERF, and were slow to degrade.

Field and laboratory studies conducted in 1990 provided evidence that white phosphorus was the likely cause of the mortality. In addition, because white phosphorus persists (does not sublimate and oxidize) when wet or submerged, the water and sediment conditions at ERF are conducive to the long-term retention of white phosphorus in the sediments. ERF investigations performed in the following 3 years focused on defining the extent of the white phosphorus contamination, determining site conditions and other factors that affect the likelihood of exposure to white phosphorus, and understanding the physical dynamics of ERF. In March 1991, the Army initiated a public review process that evaluated alternatives for the resumption of live firing. ERF was reopened for training uses in January 1992, following a series of test firings. Several restrictions were established, including elimination of firing during the summer months and permanent elimination of the use of white phosphorus. The Army also banned the use of white phosphorus in wetland impact areas nationwide on the basis of discoveries in ERF.

The results of the 1992 and 1993 ERF sampling program for pond sediments and waterfowl carcasses generally confirmed that the highest concentrations of white phosphorus were near Area C and Bread Truck Pond, in a densely cratered area east of Eagle River. The existence of craters was considered to be another indicator of the extent of white phosphorus.

During 1994 and 1995, several field investigations of the physical system of ERF and laboratory studies of the potential of white phosphorus to bioaccumulate were completed.

FOCUS	1. CONFIRM A WATERFOWL MORTALITY PROBLEM EXISTS 2. BEGIN SEARCHING FOR A CAUSE			1. FIND CAUSE OF MORTALITY 2. UNDERSTAND BIRD BEHAVIOR			1. DEFINE EXTENT OF CONTAMINATION 2. UNDERSTAND PHYSICAL SYSTEM DYNAMICS			1. IDENTIFY HOT SPOTS 2. DEVELOP REMEDIAL TECHNOLOGIES		
	1980	1982-1985	1986-1987	1988	1989	1990	1991	1992	1993	1994	1995	1996
ACTIVITIES	Discovered dead ducks and swans at Eagle River Flats during field reconnaissance	Performed ground sweeps for carcasses Analyzed carcasses for a variety of chemical contaminants Collected initial sediment and surface water samples for common contaminants	Reviewed data and developed questions that defined future approach to investigation	Performed initial mortality census Analyzed carcasses for signs of disease Conducted bioassays using mallard ducks Analyzed sediment and surface water for toxic compounds Identified Areas A, B, C, and D Identified preferred bird habitat/ponds Dosed waterfowl with Eagle River Flats water	Performed in situ and ex situ bioassays Performed necropsy, hematology, and bacterial cultures on affected waterfowl Performed integrated sampling and analysis of sediment and surface water	Analyzed water and sediment sample collected near OB/OD Pad for explosive compounds Sampling augmented to include WP analysis Performed laboratory WP toxicology studies Analytical method for detection of WP in sediment modified and refined Analytical method for detection of WP in tissue developed	Mapped, carcasses, and water depths Screened WP in sediments along transects Collected gizzards from more than 300 hunted ducks	Studied sedimentation and erosion rates Analyzed surface and subsurface samples for WP Tested uptake and disappearance of WP in waterfowl Performed sampling at OB/OD Pad for explosives Evaluated ability of WP to bioaccumulate in waterfowl	Isolated and identified benthic invertebrates Identified habitat and vegetation Performed literature review of WP properties Initiated study of sedimentation, erosion, and regression rates Analyzed plants and roots for WP Initiated waterfowl telemetry study Studied WP poisoning in carcasses, waterfowl at Eagle River Flats, and waterfowl shot at Eagle River Flats Performed composite pond sampling Performed toxicology studies of WP on waterfowl Mapped craters	Established GIS database Expanded study of sedimentation, erosion, sediment transport, and physical transport of WP Performed mapping of topology, craters, water bodies, and terrain Performed integrated risk assessment modeling based on toxicology and environmental setting Installed meteorological station Performed pathological, toxicological, and mortality studies on waterfowl Performed ecological inventory Applied AquaBlok™ at a pond in Racine Island Area	Continued mortality transects and telemetry studies, focusing only on Eagle River Flats (no woodland transects) including • Performed background mortality monitoring • Extended scope of waterfowl telemetry study • Continued eagle telemetry study Continued physical system dynamics study (sedimentation, erosion, WP transport through gullies) Evaluated methods of enhancing natural attenuation Continued monitoring natural attenuation Performed predator and scavenger studies	Mortality censuses were limited to visual observations from Cole Point Hazing was conducted only during the spring WP sample compositing methods were developed Bread Truck Pond was drained by blasting A portion of Pond 146 in Area C was dredged remotely Nine groundwater monitoring wells at OB/OD Pad were installed and sampled Monitored integrity of AquaBlok™ at Racine Island Area A groundwater and soil background study was performed at Fort Richardson
				AERIAL WATERFOWL CENSUS								
								MORTALITY TRANSECTS				
									TELEMETRY			
MILESTONES	◆ Unusually high incidence of waterfowl mortality observed		◆ Interagency Task Force formed			◆ Eagle River Flats closed temporarily as impact area ◆ Causative agent discovered	◆ Begin lab and field scale testing of remedial technologies ◆ Procedures for WP analysis developed	◆ Army resumes test firing during ice periods ◆ Army provides press release and conducts TV interview	◆ Eagle River Flats OUC at Fort Richardson is listed on NPL ◆ FFA signed		◆ Assessment endpoints approach developed	◆ Health and safety requirements are increased and access to flats is restricted
CONCLUSIONS		Results for metals, pesticides/PCBs, explosives, and disease in carcasses were negative Results for pesticides/PCBs and explosives in sediment and surface water were negative Metals were within normal background levels Birds were in good nutritional state prior to death Death was sudden Cause of death is unknown		Disease and trauma do not appear to cause mortality Organic compounds and metals do not appear to cause mortality Waterfowl dosed with Eagle River Flats water did not die during laboratory studies	Causative substance resides in sediment Causative substance is not transferred through food chain Dabbling ducks were dying Inhalation of toxic substances, infectious disease, and concussion were eliminated as causes of mortality Secondary effects of causative substance are not detected in predators and scavengers	WP discovered as primary cause of mortality Water and sediment conditions at Eagle River Flats are conducive to long-term storage of WP in sediment Explosive compounds could be migrating into Eagle River Flats from OB/OD Pad, but do not appear to be causing mortality	Area C and Bread Truck Pond account for most of WP poisoning Area A had low contamination but high carcass counts Human exposure to WP through offsite migration is shown to be minimal No contamination found in hunted birds	Bioaccumulation of WP in food chain may be limited Sedimentation and erosion rates appear high in mud flats and ponds Area C and Bread Truck Pond are confirmed as highly contaminated waterfowl feeding habitat Explosives were detected in all OB/OD Pad samples	Unlikely that plants represent WP pathway WP concentrations are much higher in sediment than water No evidence that WP affects benthic invertebrates Carcasses are positive for WP Gully advancement may cause pond drainage Low turnover of waterfowl at Eagle River Flats during August and September WP in fat of dead birds is the most reliable indicator of exposure Racine Island identified as contaminated based on field observation of ponds and carcass count Pathological signs of waterfowl deaths at Eagle River Flats and in lab are similar	Mortality decreased relative to 1992, possibly because of reduced WP exposure and hazing Waterfowl resuscitation is not possible Ecological inventory may predict highest poisoning risk Natural attenuation of WP in soil/sediment can occur at Eagle River Flats through sublimation and possibly sedimentation	Gully near Bread Truck Pond is advancing at an accelerated rate Enhanced natural attenuation may not be cost effective Mortality in control area is very low Endpoint 1: Background condition defined as dabbling duck and swan deaths in Susitna Flats Endpoint 2: Reduce WP hot spots	Fall 1996 telemetry and census data are representative because they are not influenced by hazing Costs to operate dredge are high Draining Bread Truck Pond reduces waterfowl exposure Groundwater and soil concentrations at OB/OD Pad are below cleanup closure levels

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Figure 2-1
Framework of Investigations
OU-C Record of Decision

TABLE 2-1
Summary of Previous Investigations at Eagle River Flats

Investigation/Report	Investigators	Field Date(s)
Waterbird Utilization of Eagle River Flats and Upper Cook Inlet: April-October 1996	USFWS	1996
Waterfowl Mortality on Eagle River Flats	DWRC	1996
Movement, Distribution, and Relative Risk of Mallards and Bald Eagles Using Eagle River Flats: 1996	DWRC	1996
Report of USDA–APHIS–Animal Damage Control for the U.S. Army at Eagle River Flats, April-October 1996	USDA	1996
Demonstration of Sample Compositing Methods To Detect White Phosphorus Particles	CRREL	1996
Pond Draining Treatability Study: 1996 Studies–The Draining of Bread Truck Pond	CRREL	1996
Monitoring of Contract Dredge Operations at Eagle River Flats, Alaska	CRREL	1996
Draft Physical System Analyses of Natural Attenuation and Intrinsic Remediation of White Phosphorus Contamination, ERF, Fort Richardson, Alaska	CRREL	1995
Waterbird Utilization of ERF and Upper Cook Inlet: April - October 1995	USFWS	1995
Movement, Distribution and Relative Risk of Waterfowl and Bald Eagles Using ERF	DWRC	1995
Evaluation of AquaBlok™ on Contaminated Sediment to Reduce Mortality of Foraging Waterfowl	DWRC	1995
Waterfowl Use and Mortality at ERF	NEILE	1995
Site Conditions, Ecological Inventory	CRREL	1994
Physical System Dynamics, White Phosphorus Fate and Transport, Remediation and Restoration, Eagle River Flats, Fort Richardson, Alaska	CRREL	1994
Climate and Tides	CRREL	1994
White Phosphorus Evaluation and Characterization, White Phosphorus Toxicity and Bioindicators of Exposure in Waterfowl and Raptors.	PWRC	1994
Toxicological Properties of White Phosphorus: Comparison of Particle Sizes on Acute Toxicity and the Biotransfer of White Phosphorus from Hen to Eggs	Dartmouth	1994
Analysis of the Eagle River Flats White Phosphorus Concentration Database	CRREL	1994
Waterbird Utilization of Eagle River Flats: April-October 1994	USFWS	1994
Waterfowl Use and Mortality at Eagle River Flats	NEILE	1994
Movement, Distribution and Relative Risk of Waterfowl, Bald Eagles and Dowitchers Using Eagle River Flats	DWRC	1994
Evaluation of White Phosphorus Effects on the Aquatic Ecosystem, Eagle River Flats, Fort Richardson, Alaska	USAEHA	1994
Integrated Risk Assessment Model (IRAM) for Determining White Phosphorus Encounter Rate by Waterfowl	DWRC/ CRREL/ NEILE	1994

TABLE 2-1
Summary of Previous Investigations at Eagle River Flats

Investigation/Report	Investigators	Field Date(s)
Treatability Studies; Chemical Hazing of Free-Ranging Ducks in Eagle River Flats: Field Evaluation of ReJex-iT™ WL-05	DWRC	1994
Hazing at Eagle River Flats	ADC	1994
Evaluation of AquaBlok™ on Contaminated Sediments to Reduce Mortality of Foraging Waterfowl	DWRC	1994
Screening Study of Barriers to Prevent Poisoning of Waterfowl in Eagle River Flats, Alaska	CRREL	1994
Investigation of Natural Size Reduction of White Phosphorus Particles in Eagle River Flats Sediments	CRREL	1994
Pond Draining Treatability Study	CRREL	1994
Dredging as a Remediation Strategy for White Phosphorus-Contaminated Sediments at Eagle River Flats, Alaska	CRREL	1994
Appendix A. Eagle River Flats Map Atlas	CRREL	1994
Mapped Craters	CRREL	1993
Contaminant Inventory	USAEHA	12-23 Jul 1993
Treatability Study–Hazing Waterfowl in ERF	ADC	May, Sep-Oct 1993
Treatability Study–Laboratory Evaluation of a Methyl Anthranilate Bead Formulation	DWRC	1993
Treatability Study–Field Behavioral Response and Bead Formulations for Methyl Anthranilate	DWRC	Jun, Aug 1993
Treatability Study–Field Evaluation: Mortality of Mallards Feeding in Areas Treated with Methyl Anthranilate	DWRC	Jun 1993
Waterfowl Mortality at ERF	NEILE	Apr-May, Aug-Oct 1993
Distribution and Concentrations of White Phosphorus in ERF	CRREL	1991–1993
Waterfowl Distribution and Movements in ERF	DWRC	Apr-Jun, Aug-Oct 1993
White Phosphorus Poisoning of Water birds in ERF	PWRC	May-Sep 1993
Toxicological Studies of White Phosphorus in Waterfowl	PWRC	1993
Physical System Dynamics (Sedimentation and Erosion at ERF)	CRREL	May 1992-Sep 1993
Food Chain Invertebrates and Fish: Sediment Bioassay	USAEHA	July 12-23 1993
White Phosphorus in Invertebrates and Fish	PWRC	Jun 1993
Habitat and Vegetation in ERF	CRREL	1993
White Phosphorus in Plants at ERF	CRREL	Jun 1993
Water bird Utilization of ERF	USFWS	Apr-Oct 1993
Treatability Study–Pond Draining	CRREL	Jun-Aug 1993
Treatability Study–Air Drying Contaminated Sediments	CRREL	Jun-Aug 1993

TABLE 2-1
Summary of Previous Investigations at Eagle River Flats

Investigation/Report	Investigators	Field Date(s)
Treatability Study–Geosynthetic Covering of Contaminated Sediment	CRREL	Jul 1993
Treatability Study–Evaluation of Concover and BentoBalls on Contaminated Sediments to Reduce Mortality of Foraging Waterfowl	DWRC	Jun 1993
U.S. Army Eagle River Flats: Protecting Waterfowl from Ingesting White Phosphorus	DWRC	1992
Rapid Uptake and Disappearance of White Phosphorus in American Kestrels	CRREL and Dartmouth Medical School	1992
Draft Report–Preliminary Assessment of Sedimentation and Erosion in the Eagle River Tidal Flats, Fort Richardson, Alaska	CRREL	May-Sep 1992
Hazardous Waste Consultation No. 37-66-JR11-92, Soil Sampling Results, Fort Richardson, Alaska, July 6-7, 1992	USAEHA	July 6-7 1992
Draft Report–Water bird Utilization of Eagle River Flats, April - October 1992	USFWS	Apr-Oct 1992
Draft Report–White Phosphorus Contamination of Salt Marsh Sediments at Eagle River Flats, Alaska, February 1993	CRREL	1991-1992
Waterbird Utilization of Eagle River Flats, April–October 1991. December 1991	USFWS	Apr-Oct 1991
Waterfowl Mortality in Eagle River Flats, Alaska, The Role of Munitions Residues. May 1992	CRREL	1990
Waterbird Utilization of Eagle River Flats, April - October 1990. December 1990.	USFWS	Apr-Oct 1990
Eagle River Flats Expanded Site Investigation, Fort Richardson, Alaska. Final Technical Report, June 1990	ESE	Jul-Oct 1989
Eagle River Flats Waterfowl Mortality Progress Report, August 1989	As noted below	
Laboratory Investigations	ADEC	Sep 15, 1988
Laboratory Investigations	EPA	Jul 11, 1988
Laboratory Investigations	EPA	Jul 22, 1988
Bird Utilization of ERF During Spring, Summer, and Fall, and Associated Mortality	USFWS	Apr-Oct, 1988
Investigations of Waterfowl Mortality, ERF	USFWS	1983-88
Laboratory Investigations	USAEHA	1985
Field Investigations	USFWS	1982-85

Notes:
ADC = Animal Damage Control
CRREL = U.S. Army Cold Regions Research and Engineering Laboratory
DWRC = Denver Wildlife Research Center
ER = Eagle River
ESE = Environmental Science and Engineering, Inc.
NEILE = New England Institute of Landscape Ecology
USAEHA = U.S. Army Environmental Hygiene Agency
USDA = U.S. Department of Agriculture

The bioaccumulation studies were performed to assess the impacts of white phosphorus on wildlife at ERF. Additional studies were conducted on waterfowl utilization of ERF, waterfowl mortality, waterfowl distribution and movements in ERF, and toxicological studies of white phosphorus in waterfowl to determine acute lethal doses for ducks (mallards).

From 1994 through 1997, the ERF investigations focused on finding a feasible remedy for white phosphorus contamination in sediments. Areas of priority for cleanup were evaluated by using white phosphorus sampling, waterfowl telemetry, carcass transects, physical system dynamics, and mapping of landcovers (combinations of topographical features such as ponds and vegetation). A comprehensive geographical information system (GIS) database, established in 1994 and continuously updated, contains results of all ERF data. This information has been used to determine the nature and extent of white phosphorus at ERF and plan feasibility studies for possible remedial actions.

Results of a 1994 CRREL study showed that white phosphorus particles remained intact and relatively unaffected in water-saturated sediments, but began to immediately degrade and disappear when the sediments became unsaturated, especially at warmer temperatures. Therefore, sublimation/oxidation was determined to be a viable remedial option for mud flats and intermittent ponds that have the potential to drain and dry. This conclusion led to additional feasibility studies in 1995, 1996, and 1997 to determine potential technologies that could be used in ERF to result in pond draining and drying of sediments so that degradation would occur.

Results of historical investigations and the RI at OU-C are included in the *Operable Unit C Remedial Investigation Report* and the *Operable Unit C Feasibility Study Report*, which were prepared in 1997.

2.2 Enforcement Activities

Fort Richardson was placed on the CERCLA NPL in June 1994. Consequently, an FFA was signed in December 1994 by EPA, ADEC, and the Army. The FFA details the responsibilities and authority associated with each party pursuant to the CERCLA process and the environmental investigation and remediation requirements associated with Fort Richardson. The FFA divided Fort Richardson into four OUs, one of which is OU-C, and outlines the general requirements for investigation and/or remediation of suspected historical hazardous waste source areas associated with Fort Richardson.

An additional goal of the FFA was to integrate the CERCLA response obligations and RCRA corrective action obligations of the Army. Remedial actions implemented will be protective of human health and the environment. Consequently, the remediation of releases will obviate the need for further corrective actions under RCRA (no further corrective action will be required for source areas).

2.3 Agency Cooperation

The ERF investigation and cleanup activities have represented a unique cooperative effort among the Army, EPA, and ADEC. These activities began before the listing of Fort Richardson on the NPL and have focused on the observed waterfowl mortality. The

agencies understand that the historical and anticipated future use of ERF is firing heavy artillery and mortars. Although the inclusion of an active impact area within an OU is unusual, the decision to do so was made to address the waterfowl concerns without adversely affecting the military use of ERF now or in the future.

2.4 Highlights of Community Participation

The public was encouraged to participate in the selection of the remedy for OU-C during a public comment period from February 5 to March 6, 1998. The *Fort Richardson Proposed Plan for Remedial Action, Operable Unit C* presents combinations of options considered by the Army, EPA, and ADEC to address contamination in soil and groundwater. The Proposed Plan was released to the public on February 4, 1998, and was sent to 180 known interested parties, including elected officials and concerned citizens.

The Proposed Plan summarizes available information about OU-C. Additional materials were placed in information repositories established at the Alaska Resources Library, Fort Richardson Post Library, and the University of Alaska Anchorage Consortium Library. The Administrative Record, including other documents used in the selection of the remedial actions, was established in the Public Works Environmental Resource Office on Fort Richardson. The public is welcome to inspect materials available in the Administrative Record and the information repositories during business hours. The Administrative Record Index is provided in Appendix A. The selected remedy presented in Section 7 is based on the Administrative Record.

Interested citizens were invited to comment on the Proposed Plan and the remedy selection process by mailing comments to the Fort Richardson project manager, by calling a toll-free telephone number to record a comment, or by attending and commenting at a public meeting on February 12, 1998, at the Russian Jack Springs Chalet in Anchorage. Twenty-five people attended the public meeting. Five sets of comments were received from the public during the comment period.

The Responsiveness Summary in Appendix B provides more details about community relations activities. It also summarizes and addresses public comments on the Proposed Plan and the remedy selection process.

2.5 Scope and Role of Operable Unit

Four operable units (A, B, C, and D) have been identified at Fort Richardson. Three of these OUs are driven primarily by human health risks. OU-C is the only site at Fort Richardson with white phosphorus contamination and the only site at Fort Richardson driven by ecological risk. OU-C is also unique in that it is still an active impact range. This ROD is the second signed for Fort Richardson. A single ROD for OUs A and B was signed in 1997.

The OU-C RI/FS was performed in accordance with the *Operable Unit C RI/FS Management Plan* (1996). The RI fieldwork at OU-C was conducted during 1996.

The principal threat at the ERF source area within OU-C is particulate white phosphorus in sediment. According to results of the RI, potential risks to the environment are posed by

onsite contamination. Accordingly, the agencies have elected to pursue remedial action under CERCLA to address these potential risks.

The RI at the OB/OD Pad source area within OU-C concluded that the contaminants found do not pose a risk to human health and the environment and do not require cleanup action. Therefore, except for continuing controls that are in place to control access and requiring safety training for personnel who must work at the site, no cleanup action will be conducted for OB/OD Pad.

SECTION 3

Summary of Site Characteristics

3.1 Eagle River Flats

3.1.1 Physical Features, Hydrogeologic Conditions, and Transport Pathways

ERF is characterized as a roughly triangular estuarine salt marsh surrounded by forested uplands and the Knik Arm portion of Cook Inlet. It was formed as the Eagle River eroded through the glacial and alluvial deposits of the Anchorage lowland to create a deep valley that subsequently filled with sediment. The topography of ERF is relatively flat, with landform and vegetation changes, and expected tidal flooding frequencies, occurring with subtle changes in elevation. Measured elevations in ERF range from 3 feet above msl at the river bottom of the Eagle River to 18 feet above msl on top of the highest levees along the river.

The discharge from Eagle River bisects ERF. It can vary substantially from the impacts of spring meltwater and rainstorms. With an average flow rate of 530 cubic feet per second, Eagle River drains approximately 1,300 square miles of mountains and lowlands. Sediment concentration of Eagle River does not depend on the discharge rate of the river, and results of studies of ERF physical dynamics suggest that the tides have a greater suspended sediment concentration than the river.

Distributary channels (or gullies) cut deeply through the mud flats and connect ponds with Eagle River. Subtle changes in elevation of the channel floors dictate whether tidal flooding occurs daily, occasionally, or rarely. Where elevations are 7 feet to 12 feet above msl, as in the bottoms of gullies, flooding occurs daily during high tides. At between 12 and 14 feet above msl, such as the heads of gullies and some mud flats, flooding occurs only with the highest tide of each month. Only extreme high tides, in combination with high river-discharge levels, flood areas between 14 and 15 feet above msl, such as the major pond basins, higher mud flats, and some levees.

In summer, there may be long periods between flooding tides, and parts of ERF can become relatively dry. During winter, Eagle River continues to flow, but ice thickens over ERF with succeeding flood events during cold temperatures. Ice breakup typically occurs in April or early May. It appears that the hydrology and sedimentology of the upper third of ERF is dominated by the river, with the remainder dominated by the tides.

In addition to Eagle River, several small tributary streams enter ERF. Otter Creek, a small perennial stream, drains Otter Lake and enters ERF near its southern end. Clunie Creek, believed to be a groundwater channel depression, drains several small lakes east and northeast of ERF and enters ERF just north of OB/OD Pad.

3.1.2 Nature and Extent of Contamination

As discussed in Section 2, since the initial reports of elevated waterfowl mortality in the early 1980s, a multidisciplinary investigation has been conducted to identify the cause of

the mortality (shown in 1990 to be white phosphorus), the extent of the white phosphorus contamination, and the potential effects of white phosphorus and other munitions on the biota in ERF. White phosphorus was released into ERF by ordnance used to create smoke for marking targets. White phosphorus that did not fully oxidize could remain as particles in the sediment. Ingestion of white phosphorus particles by feeding waterfowl has created high levels of mortality. Birds have been observed to die within hours of ingesting white phosphorus in a number of ponds in ERF.

Sampling results have focused primarily on a relatively small number of areas in ERF where the greatest levels of mortality were observed. The results of this sampling have demonstrated that elevated levels of white phosphorus exist in most ponds where the highest mortality levels occur; however, sampling efforts in several ponds where high mortality has been observed have not demonstrated that white phosphorus exists extensively in the sediment. This finding suggests that some birds may fly away from the point of exposure before succumbing. The potential for birds to move following exposure, coupled with limitations on sampling efforts because of the hazard posed to site workers by UXO, has complicated identification of the horizontal and vertical extent of white phosphorus contamination.

Previous sampling results and detailed observations of wildlife populations within ERF have identified swans and dabbling ducks as the primary receptors of white phosphorus contamination. Although low levels of white phosphorus have been found in plants, macroinvertebrates, and fish, existing data do not show that these populations have been significantly affected by the presence of white phosphorus in ERF. Only a small percentage of plants, macroinvertebrates, and fish contained detectable levels of white phosphorus.

There is some evidence indicating that scavengers that feed on waterfowl carcasses in ERF have been exposed to white phosphorus. It is believed, however, that reducing the mortality effect in dabbling waterfowl to acceptable levels also will reduce effects in the predators and scavengers that have been identified as secondary receptors (that is, those that eat the dabbling ducks) because of the reduction in their exposure concentrations.

Researchers used observations of carcass locations and crater densities in areas used by waterfowl to identify areas most likely to contain white phosphorus. The sediments in these areas were extensively sampled for white phosphorus with the use of radial transects and close sampling in open ponds. The distribution of ponds and analytical results of white phosphorus in sediment were compiled and used in conjunction with landcovers and bird usage data to identify hot ponds that are the areas likely presenting the highest risk. The UXO hazard in ERF makes extensive future sampling efforts infeasible.

The findings documented in the RI report are based primarily on data collected before implementing the CERCLA process at OU-C. Compilation and review of all the data have led to the following conclusions:

1. **White phosphorus is the primary cause of waterfowl mortality.** Symptoms exhibited by ducks exposed to white phosphorus in ERF are similar to those observed in ducks dosed with white phosphorus in the laboratory. White phosphorus also was detected in tissue samples collected from duck carcasses found in ERF.

2. **White phosphorus was deposited in the sediment primarily during range firing activities.** White phosphorus marking rounds were used during training activities in ERF for several decades. Rounds were fired into ERF and detonated, dispersing white phosphorus particles over large areas. Further distribution of the particles likely occurred when HE rounds exploded in white phosphorus-contaminated soil and sediment.

3. **Craters in ERF potentially indicate the level of range firing activity.** Detonation of HE generally creates a crater at the point of impact. Although white phosphorus munitions do not form craters upon detonation, they typically have been used in conjunction with HE training activities. Therefore, it can be deduced that the more craters in an area, the more munitions have likely been fired there, resulting in higher probability of white phosphorus contamination.

4. **The distribution of white phosphorus particles throughout ERF sediments is not uniform.** The dispersion of the white phosphorus particles was affected by the nature of detonations in an area and whether munitions were detonated on land or over water. Some areas were used more frequently as targets and, therefore, received higher amounts of white phosphorus. In addition to differences in the distribution of white phosphorus, particle sizes vary greatly, ranging from 0.01 inch to 0.113 inch. Particle densities vary substantially even within small areas. The impacts of white phosphorus shells typically resulted in "hot spots" of 3 to 6 feet in diameter. These hot spots contain large numbers of white phosphorus particles and are generally surrounded by a 3-foot ring containing fewer particles.

5. **The detection frequencies and concentrations for white phosphorus in sediment are highest in Area C, Bread Truck, and Racine Island.** Sixty-three percent of the overall ERF sampling locations had nondetectable concentrations, but at least 45 percent of the locations in each of these three areas had detectable concentrations. The highest concentration, 3,071 micrograms per gram (µg/g), was found on Racine Island.

6. **White phosphorus particles can break down (sublimate and oxidize) when exposed to air and warm temperatures, but are long lasting in water-saturated sediment.** White phosphorus particles that land on soil or dry sediment are readily oxidized and burn under ambient air conditions. Because they are not water soluble, however, white phosphorus particles have an indefinite life when submerged in the water and allowed to settle into pond or marsh bottom sediments. White phosphorus monitoring has shown that particulate white phosphorus persists in permanently flooded ponds, but naturally sublimates and oxidizes in ponds that only flood intermittently. Therefore, intermittently flooded ponds were eliminated from further remediation.

7. **Waterfowl are exposed to white phosphorus from the sediment of ponds and sedge marshes while they are feeding.** Some white phosphorus particles may resemble seeds and macroinvertebrates that dabbling ducks and swans feed on. As the waterfowl forage for food in pond and marsh bottom sediments, they may intentionally or inadvertently pick up the white phosphorus particles.

8. **Dabbling ducks and swans are the primary receptors of white phosphorus.** Dabbling ducks and swans forage for food in pond and marsh bottom sediments. In addition, mortality rates of dabbling ducks have been observed to be significantly higher than

mortality rates of other waterfowl in ERF as well as in other Upper Cook Inlet (UCI) marshes. Telemetry data in 1996 suggest that the mortality rate among radio-tagged mallards was about 35 percent. Mallards were selected as the indicator species because they are the most frequently observed species of dabbling waterfowl at ERF.

9. **Predation and human exposure to white phosphorus by consumption are not high-level concerns at present.** There has been no verified mortality resulting from predators feeding on white phosphorus-contaminated waterfowl carcasses. Although a dead eagle was found with white phosphorus contamination, current predator mortality appears low. In addition, the results of analyses of tissue collected from dabbling ducks taken by hunters near ERF do not indicate a threat to humans ingesting the meat.

10. **Permanent ponds, with associated sedge marsh, having confirmed presence of white phosphorus and/or moderate-to-high crater density and observed moderate-to-high dabbling duck and/or swan use are the most significant exposure areas.** According to the conceptual site model (CSM), areas of greatest concern are where there is a source (white phosphorus-contaminated sediment), a receptor (dabbling duck or swan), and a potential for exposure (foraging for food).

11. **The movement of white phosphorus through Eagle River to Knik Arm appears to be minimal.** Low-level amounts of white phosphorus have been detected in the sediments traveling through the gullies, but no sediment and water samples from the river had any detectable white phosphorus. No sampling has been performed in the Knik Arm at the mouth of the Eagle River.

During the initial phases of the white phosphorus sampling in ponds, crater density in mud flats adjacent to ponds and mortality observations were the main criteria used in selecting ponds to be sampled. Sampling priority was placed on ponds and adjacent mud flat areas that had high density of crater coverage and high numbers of observations of water bird mortality.

The most significant areas of concern for exposure to white phosphorus are the sediments of ponds and some marshes, for which all of the following conditions apply:

1. White phosphorus presence has been confirmed and/or the number of craters (density) is moderate to high.

2. Moderate to high use by ducks and/or swans has been observed.

3. High numbers of waterfowl deaths have been observed.

The ponds where these conditions exist (hot ponds) are the areas believed to present the highest risk of white phosphorus exposure to waterfowl. Twenty-two hot ponds were identified, covering 57 acres in Areas A, C, C/D, Racine Island and Bread Truck. To aid in the evaluation of alternatives for the FS, the hot ponds identified in the RI were divided into six pond groups based on physical site characteristics: (1) Northern A (7 ponds); (2) Pond 290 (1 pond); (3) Ponds 183 and 146 (2 ponds); (4) Northern C and C/D ponds (8 ponds); (5) Racine Island (3 ponds); and (6) Bread Truck (1 pond). The characteristics of these pond groups are discussed below. Figure 3-1 provides an illustration of the pond group locations.

- **Northern A Pond Group.** Seven ponds in Area A comprise this group. The 14.3-acre area has uneven topography and a medium to high number of craters. The ponds are believed to be interconnected by a small to medium-sized area of surrounding marsh. Thirteen percent of samples collected in Area A contained white phosphorus at detectable concentrations. In 1996 birds being tracked spent more than 60 percent of their time in Area A. In addition, 23 percent of the dead ducks found at ERF in 1996 were found in Area A.

- **Pond 290.** Pond 290 is in Area A and is 2.2 acres in size. This pond does not appear to be connected to other ponds in the area and, therefore, is addressed separately. Low levels of white phosphorus contamination have been detected in the north end of this pond. In 1997 numerous dead ducks were found in Pond 290.

- **Ponds 183 and 146.** Ponds 183 and 146 are in Area C. Pond 183 is 7.2 acres in size, and Pond 146 is 13.6 acres in size. These ponds have a high number of craters. Pond 183 is connected to Pond 146. In 1996, birds that were tracked by radio spent 10 percent of their time in Area C. Thirty-five percent of the dead ducks found at ERF in 1996 were found in Area C. More than 50 percent of the samples collected in Area C contained white phosphorus.

- **Northern C and C/D Ponds.** Eight ponds totaling 8.9 acres comprise the Northern C and C/D pond group. This pond group has a medium to high number of craters. The ponds are believed to be interconnected to a large area of permanent ponds and marsh, which provide constant sources of water flow or recharge. Ten percent of the samples collected in Area C/D had detectable concentrations of white phosphorus. In 1996, birds being tracked spent 8 percent of their time in Area C/D, and 16 percent of the dead ducks among those being tracked were found in Area C/D.

Table 3-1 identifies the 18 ponds described above and provides information on duck use and deaths in these areas.

TABLE 3-1
Identification of ERF Areas, Pond Groups, and Ponds Requiring Cleanup

Hot Pond Group	Size (acres)	ERF Area	1996 Duck Use (%)	1996 Duck Death (%)	Number of Craters
Northern A: Pond Numbers 138, 208, 226, 228, 246, 256, 258	14.3	A	62	23	medium to high
Pond 290	2.2				
Ponds 183 and 146	20.8	C	10	35	high
Northern C and C/D: Pond Numbers 129, 145, 155, 40, 49, 85, 93, 112	8.9	C/D	8	16	medium to high

Note: 1996 duck use and death percentages are based on birds that were radio collared in 1996. Percentages do not add up to 100 percent because areas with low percentages of deaths were not selected for cleanup.

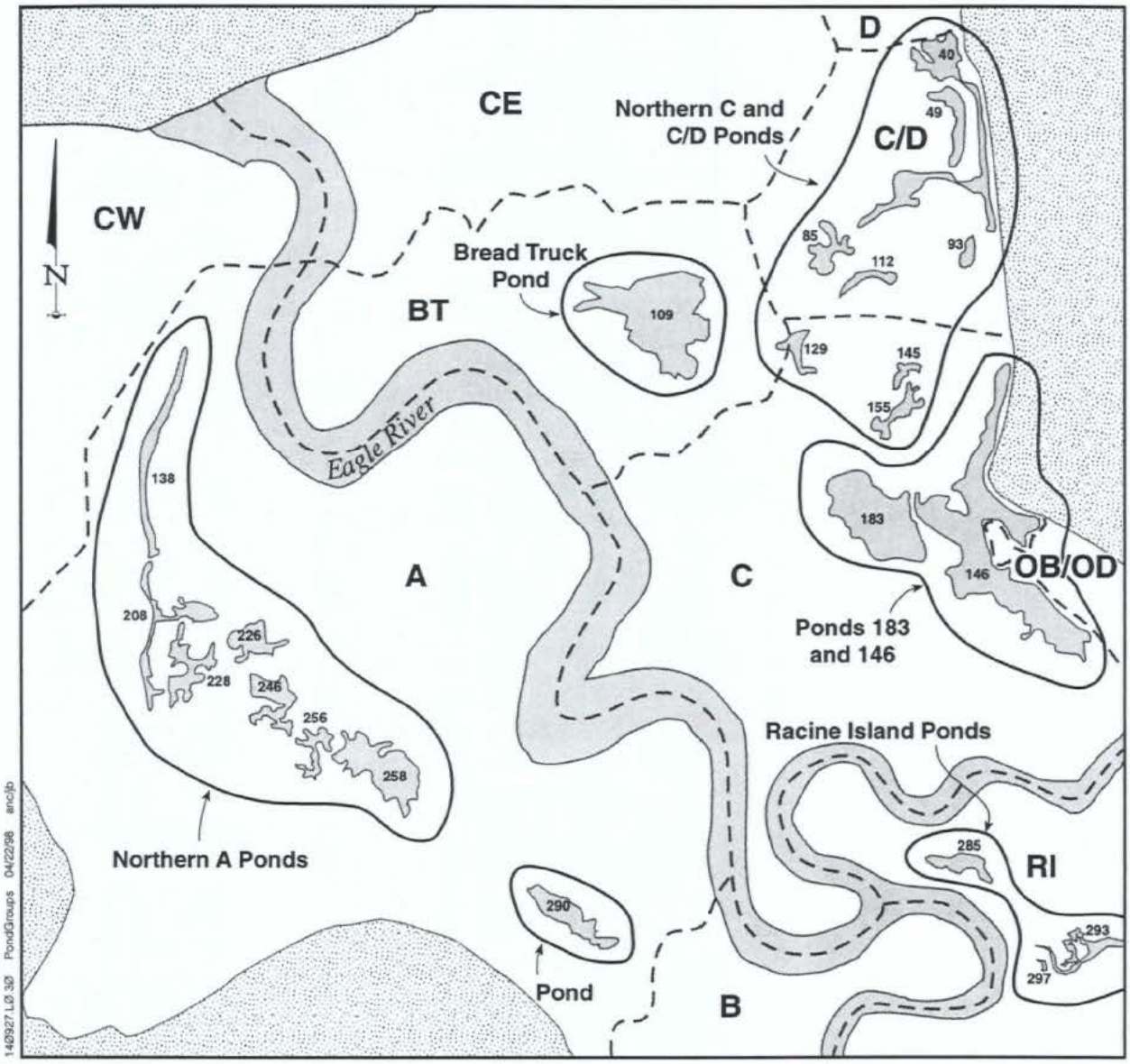

Figure 3-1

Pond Groups

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The remainder of the 22 hot ponds have undergone some treatment during the investigation and treatability study phase at ERF:

- **Racine Island Ponds.** The Racine Island ponds include Ponds 285, 293, and 297, which together total about 2.5 acres in size. Pond 285 is 1 acre, and Ponds 293 and 297 together are 1.5 acres. These ponds contain high numbers of craters. Elevated white phosphorus concentrations, including some of the highest concentrations of all samples collected at ERF, were detected in 73 percent of samples collected in these ponds. In 1996, 16 percent

of the dead ducks found in ERF were found in the Racine Island ponds. Capping and filling technology was tested at Pond 285 in 1995. This pond was filled with a gravel-clay mixture that prevented ducks from feeding in the contaminated sediment. The mixture also supported the growth of vegetation. Ponds 293 and 297 in the Racine Island Area were drained by breaching in 1997. (Draining of Pond 297 will continue in 1998 until completed.) Draining by breaching has discouraged waterfowl use. The treatability study was conducted as a time-critical removal action because the breaching needed to be completed before the ground melted in spring to protect the people performing the work from explosive hazards.

- **Bread Truck Pond.** Pond 109 is about 8.2 acres in size and contains a high number of craters. White phosphorus contamination was detected in 45 percent of samples collected in this pond. In 1996, 5 percent of the dead ducks found at ERF were at this pond. Pond draining by breaching was tested at Pond 109 in 1996. The draining technology removed the duck feeding habitat at Pond 109, which resulted in less duck use.

3.2 Treatability Studies

Because of the heterogeneity of white phosphorus distribution, the UXO safety hazards, and the physical setting, several treatability studies were performed to identify alternatives that were not only effective in reducing exposure to white phosphorus contamination, but also implementable and cost-effective. The technologies listed below were tested at ERF. The first three were considered to be not implementable, not effective, or too expensive. The remaining four technologies were considered feasible, and were incorporated into the alternatives presented in Section 5 of this ROD.

Unfeasible Methods

- Dredging–removal and drying of sediments that contain white phosphorus from permanently flooded areas. This technology was not retained because it was only moderately effective, altered duck habitat, and cost as much as 10 times more than other technologies.

- Geosynthetics–use of textile material as liners for the bottoms of ponds. The material acts as a physical barrier. This technology was not retained because a large-scale implementation method has not been developed. In addition, the use of geosynthetics altered duck habitat and installation of the material presented high risks to human safety.

- Methyl anthranilate–application of this bird repellent. Methyl anthranilate settles to the bottom of ponds and deters waterfowl from feeding. This technology was not retained because its long-term effectiveness was marginal and it was very costly.

Feasible Methods

- Capping and filling–application of a material to act as a physical barrier to the white phosphorus in the sediments of pond bottoms. The material used was called AquaBlok™, a composite mixture of gravel and bentonite that expands in water to form an impenetrable blanket over contaminated sediment. This technology was tested at

Pond 285 at the Racine Island Area in 1995. The gravel-bentonite mixture filled the pond and prevented ducks from feeding in the contaminated sediment. The material also supported the growth of vegetation.

- Hazing–use of visible objects and sounds to deter waterfowl from use of an area, thereby preventing exposure to white phosphorus. Hazing was conducted throughout ERF with propane exploders, pyrotechnics, scarecrows, hovercrafts, flagging, balloons, and other visual, acoustic, and behavioral devices designed to frighten birds. This technology was retained as a contingency response action, in the event birds are not deterred by the incidental hazing associated with remedy implementation. The hazing contingency has been incorporated into Alternatives 2, 3, 4, and 5, which are discussed in Section 5. (Hazing also occurs unintentionally when human activity and equipment operations deter birds.)
- Pond draining by breaching–use of explosives to create a channel from a pond containing white phosphorus, which allows the water to drain into a gully or Eagle River. The draining activity permits the sediments of pond bottoms to dry and reduces the feeding habitat of dabbling ducks in breached ponds. Draining by breaching was retained and incorporated into Alternative 4. Pond draining by breaching was tested at Pond 109 in the Bread Truck Area in 1996 and at Ponds 293 and 297 in the Racine Island Area. Both areas were heavily contaminated with white phosphorus. The draining technology removed or discouraged the duck feeding habitat at Pond 109, which resulted in less duck use.
- Pond draining by pumping–use of pumping systems to draw water from ponds containing white phosphorus. The pumped water is discharged to gullies along the Eagle River. The draining activity permits the sediments of pond bottoms to dry and, therefore, allows white phosphorus to sublimate and oxidize. This technology was tested at Pond 183 in Area C in 1997 and was found to be successful in removing white phosphorus. Draining by pumping was retained and incorporated into Alternatives 3 and 4.

SECTION 4

Summary of ERF Site Risks

Baseline risk assessments were conducted to determine the need for and extent of remediation to be protective of human health and ecological values at ERF. These evaluations are discussed in detail in Appendices A and B of the *Final Operable Unit C, Remedial Investigation Report, Fort Richardson, Alaska* (1997), which is available at the information repositories. The baseline risk assessments for OU-C include the ERF artillery impact range and OB/OD Pad. The baseline risk assessments determined potential risks in the absence of remedial action.

The risk assessments were based on studies that identified the chemicals present and focused on the chemicals of potential concern (COPCs). Results determined that risks within ERF were limited to white phosphorus particles in sediment. The studies documented the history of white phosphorus and ordnance use; the distribution, fate, and transport of white phosphorus particles; and the toxicological effects of white phosphorus contamination within OU-C.

White phosphorus is acutely toxic in minute quantities to humans and wildlife. In humans, toxic effects of white phosphorus exposure include death at low doses, nausea, vomiting, garlic-like odor on breath and in excrement, lethargy, convulsions, coma, fatty infiltration of liver and other organs, enlargement of the liver with jaundice, kidney failure, and electrocardiographic changes suggestive of an acute heart attack.

Eye exposure to white phosphorus fumes causes conjunctivitis, photophobia, and lacrimation. Inhalation causes shortness of breath and hoarseness, but no permanent tissue damage. Chronic occupational exposure causes phossy jaw (a disease of the jawbone leading to tissue destruction and infection).

The most significant white phosphorus impacts at ERF are occurring to bird populations. Dabbling ducks, such as northern pintails, mallards, and green-winged teal, and swans (trumpeter and tundra) are the most affected species, as indicated by their high mortality. Lethal oral doses for waterfowl have been established in toxicity studies. Sublethal effects include reduced reproductive output in hens and teratogenic deformities in embryos, including scoliosis, lordosis, submandibular edema, micropthalmia, and spina bifida.

Sublethal doses caused histopathological changes in the liver, spleen, heart, and duodenum. Changes in blood chemistry (blood urea nitrogen, potassium, lactate dehydrogenase, glucose, hematocrit, and hemoglobin) also were observed. Repeated subchronic exposures resulted in mortality and histopathologic effects (liver and kidney damage) that were consistent with acute exposures from single doses at similar concentrations.

4.1 Human Health Risk Assessment

The human health risk assessment determined that the limited human exposure at ERF reduces potential risks and that risks of potential exposure to white phosphorus were very low. The risk assessment also noted the existence of potential onsite risk to humans from UXO. ERF is currently an active firing range and UXO risks are inherent. Any change in the status of the range (if it became inactive) would be addressed under the Munitions Rule.

This subsection describes the background, approach, and conclusions of the human health risk assessment.

A previous human health risk evaluation of hunters who may eat white phosphorus-contaminated ducks from ERF, prepared in 1991 by the Army and the Alaska State Epidemiologist, concluded that there is a very low human health risk. A baseline human health risk assessment was designed and completed during the RI to determine the current and potential human health risks based on the most up-to-date information available for ERF. The baseline assessment assumed that no remedial action will be performed and included more exposure scenarios than were reviewed in the 1991 risk evaluation.

Initially, several different current and potential exposure scenarios were considered, including onsite and offsite activities. Although hunting in ERF is banned, the offsite hunter scenario was addressed quantitatively because of the current level of hunting in nearby areas and the potential for contaminated ducks to fly to those areas. In addition, because no physical barriers prevent access to ERF from Knik Arm or Eagle River, an onsite recreation scenario was considered.

Other human health risk scenarios were eliminated from consideration because of the low potential for exposure or because exposure was mitigated by other site conditions.

4.1.1 Offsite Hunter Exposure Scenario

The exposure assessment for this scenario was based on an evaluation of the exposure pathway and the estimated reasonable maximum exposure (RME). The RME is defined in EPA guidance as "the highest exposure that is reasonably expected to occur at a site" and represents a conservative exposure case that is still within the range of possibilities.

This offsite hunter scenario was developed from ADFG information to estimate that a very active hunter might consume 23 ducks during a year. This estimate was adjusted, considering the probability that a harvested duck would be contaminated with white phosphorus from ERF. This probability was estimated as 0.005 based on (1) the proportion of ducks in ERF compared to other areas of Cook Inlet and (2) data on the mortality rate from white phosphorus exposure and the proportion of time ducks from ERF spend off site.

The portion sizes of duck meals (112 and 90 grams for an adult and child, respectively) were estimated by using guidance from the EPA. An average concentration of 0.12 µg/g of white phosphorus for the duck portion was estimated by using field and laboratory studies. The chronic oral reference dose developed by EPA (2×10^{-5} milligrams per kilogram [mg/kg] of body weight [bw] per day) and standard risk assessment equations also were used. The calculated hazard quotients, which are estimates of the risk associated with a specified exposure to a noncarcinongenic contaminant, were 0.005 and 0.003, respectively, for the child and adult consumers in the scenario (Table 4-1). These quotients are considerably below the reference value of one, indicating that the likelihood for significant chronic effects from the consumption of contaminated ducks in the offsite hunter scenario is very low.

TABLE 4-1
Noncancer Risks in Offsite Duck Hunter Scenario

	White Phosphorus Concentration (µg/g)	Meat Portion (g/meal)	Meals per year	Exposure (mg/kg/day)	Hazard Quotient
Child	0.12	90	23	7.5×10^{-8}	0.005
Adult	0.12	112	23	6.0×10^{-8}	0.003

Oral reference dose is 2×10^{-5} mg/kg-bw/day (from EPA's Integrated Risk Information System, 1996).
Additional assumptions:
Body weight: 36 kg for child and 70 kg for adult (from EPA *Risk Assessment Guidance for Superfund*, Vols. I and II, 1989).
0.5 percent of consumed ducks were those contaminated by white phosphorus at ERF.

On the basis of assumptions of the scenario, an adult would have to consume between 20 and 39 contaminated ducks each year, depending on the portion size consumed at each meal, before the EPA oral reference dose for white phosphorus would be exceeded. Because the ducks at the ERF represent a small fraction of the total ducks in Cook Inlet, this event appears to have very low likelihood.

EPA has classified white phosphorus as a D carcinogen, meaning that it is not classified for human carcinogenicity, on the basis of no available data for humans or animals. No cancer slope factor is available, and no cancer risk was calculated.

4.1.2 Onsite Recreation Scenario at ERF

Although prohibited, access to ERF is not prevented by physical barriers. Means of access to ERF are from Knik Arm or from upstream on the Eagle River. In addition, people on rafts or other boats on the river can enter ERF by going past the Route Bravo Bridge beyond the boat takeout, which is approximately 500 yards upstream from the bridge. Figure 4-1 shows the locations of Route Bravo Bridge and the ERF vicinity. Few trespassers have been observed in ERF in recent times.

For an upper-bound risk assessment for exposure to white phosphorus, it was assumed that intruders, a child and an adult, enter ERF for a few hours on each of 10 days in the summer, are exposed to an average white phosphorus concentration of 10 µg/g (which exceeds the mean values for all areas except Racine Island), and ingests 200 and 100 milligrams (mg) of sediment, respectively, at each visit. With these conservative assumptions, the calculated hazard quotients are 0.08 and 0.02, respectively, which are much less than 1, the value of concern. No cancer risk was calculated, as discussed in Section 4.1.1.

4.1.3 Uncertainties

The level of uncertainty in the risk results is a function of both site-specific characteristics and the risk assessment process in general. Site-specific contributions include the following:

- White phosphorus concentrations in tissue were available from a variety of sampling events over a period of several years, and little data were available for muscle, which would be the major tissue expected to be ingested by humans.

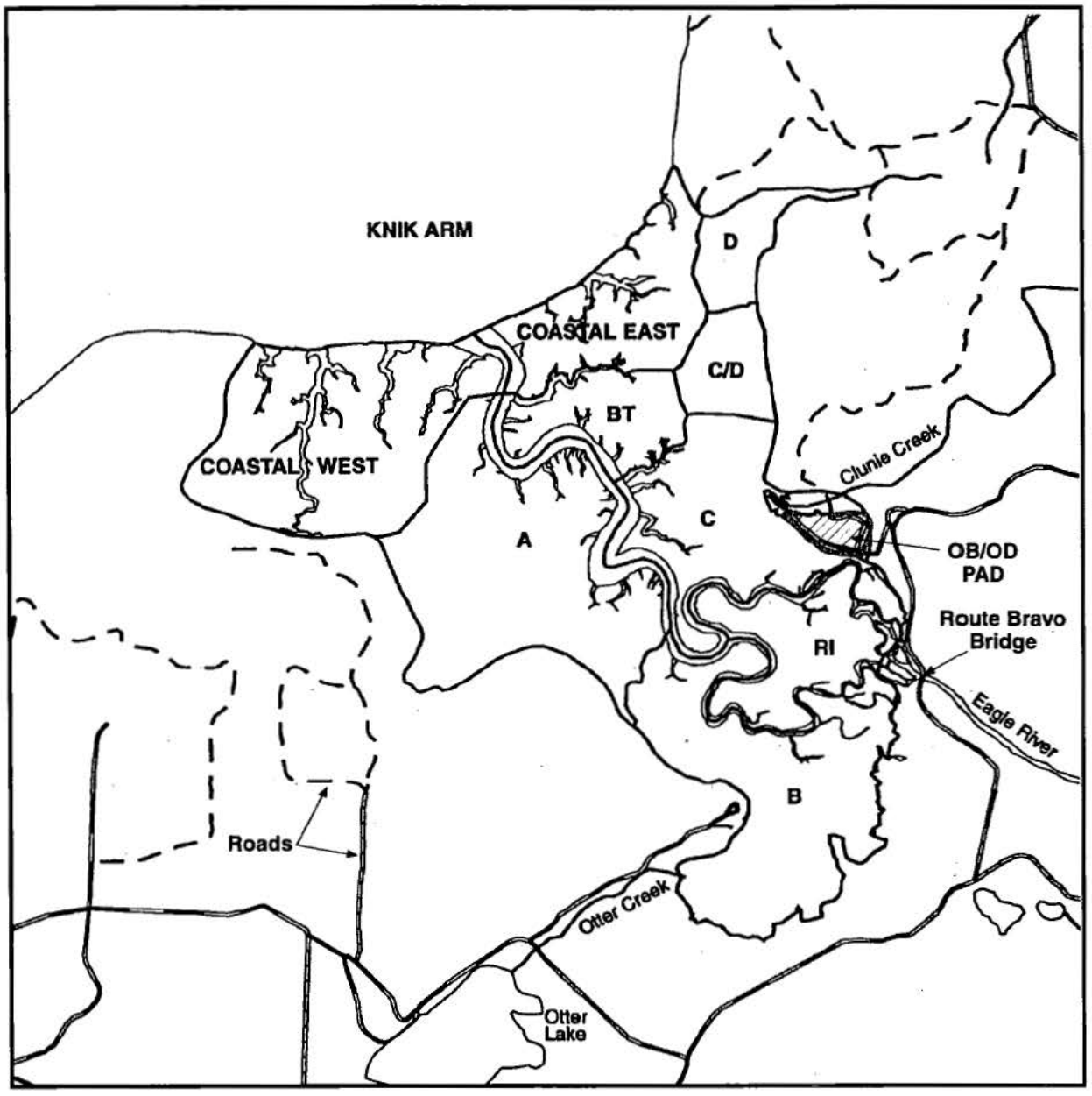

Figure 4-1
Vicinity Map
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N

Scale: 1" = 4000'

0 2000 4000 8000

SCALE IN FEET

Area Designations:

Coastal West
Coastal East
A, B, C, C/D, and D
BT = Bread Truck Pond
RI = Racine Island

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- Measured concentrations were assumed to be representative of the future, which likely overestimates the risk, given the likelihood of white phosphorus losses over time in areas of ERF that occasionally become dry.
- Several judgments, which were designed to be conservative and therefore will lead to an overestimate of the risk, had to be made for the exposure scenarios. Examples of these judgments are the number of potentially contaminated ducks that a hunter would consume and the time of exposure to white phosphorus at ERF in a year.
- The location and explosive potential of onsite UXO are not known.
- The parameter values may not accurately represent current or future conditions that may lead to an over- or underestimate of the risk. In particular, this scenario has not considered hunters who may subsist on duck during the hunting season. Their consumption rate may be up to 10 times greater than that assumed in the offsite hunter scenario. It should be noted, however, that the calculated hazard quotient was 0.001 for the adult consumer in the offsite hunter scenario, and an additional exposure factor of 10 times would still result in a hazard quotient substantially below one.

4.2 Ecological Risk Assessment

An ecological risk assessment was prepared to address the current and future potential impacts posed by white phosphorus contamination to the plants and animals of ERF in the absence of cleanup action. The effects of white phosphorus exposure to ducks and swans have been shown to be lethal. No other direct effects to wildlife or plants were identified. This subsection describes the background, approach, and conclusions of the ecological risk assessment.

The ecological risk assessment was conducted in three steps–problem formulation, analysis, and risk characterization–to determine whether white phosphorus particles in surface water and sediments at ERF may adversely affect local populations of ecological receptors. The assessment was consistent with the EPA framework document for ecological risk assessment and used previous reports and chemical data compiled during RI activities.

4.2.1 Ecological Problem Formulation

Studies at ERF conducted over several years provided detailed habitat surveys and information on relevant receptors (mainly ducks and swans). The previous studies had already established that particulate white phosphorus was the sole chemical of potential ecological concern (COPEC) within ERF.

A CSM was developed for ERF based on information provided in previous reports. A CSM provides a written or pictorial representation of an environmental system and the biological, physical, and chemical processes that determine the transport of contaminants from sources through environmental media to receptors within the system. The CSM for exposure routes and pathways for sediment at ERF is shown in Figure 4-2.

Measurement and assessment endpoints were selected based on characteristics of the COPECs, sensitive receptors or indicator species, and the expected or observed ecological effects caused by the stressors. These biological and physical endpoints can be used to

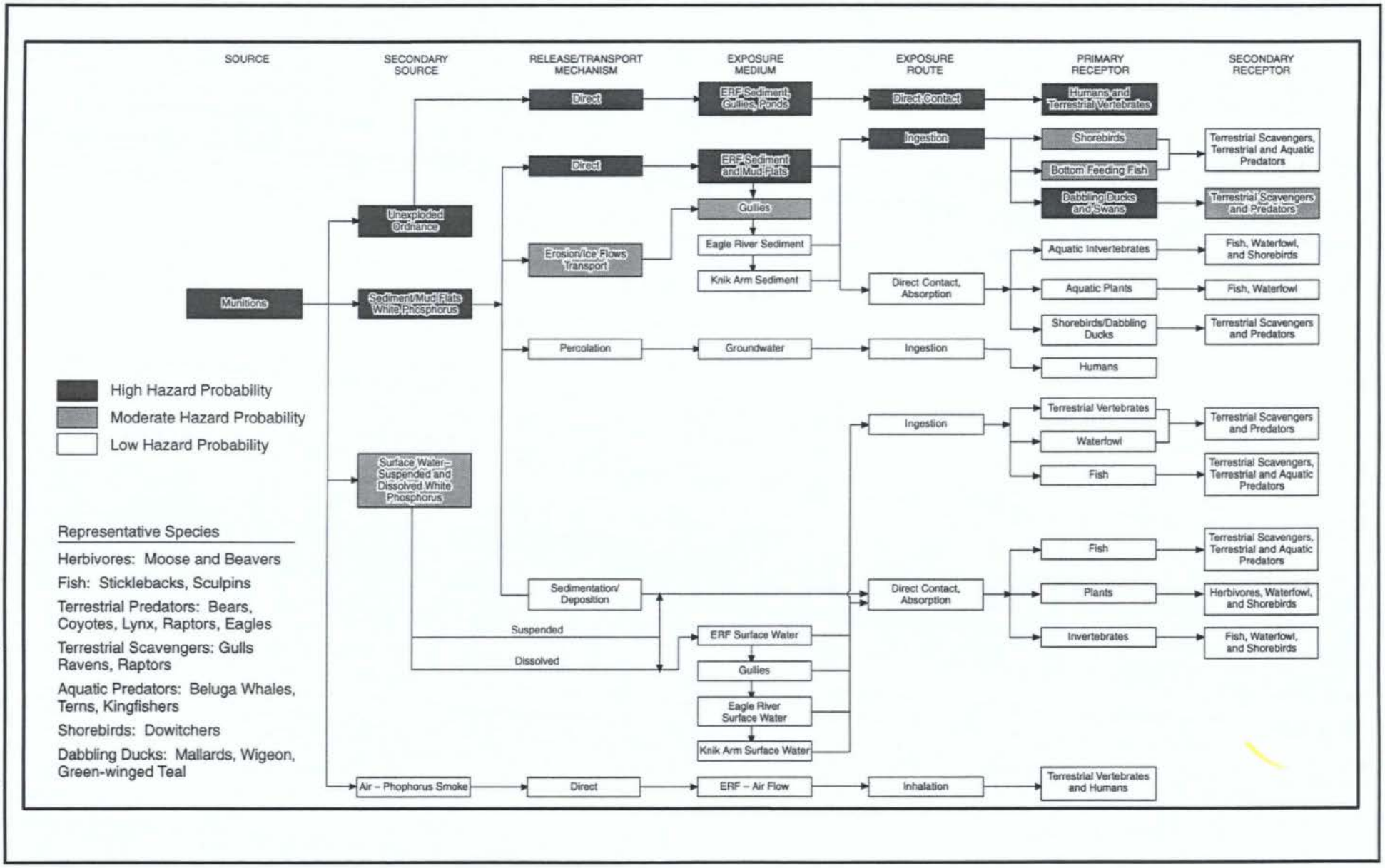

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Figure 4-2

Potential Exposure Routes and Pathways for Sediment

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evaluate remedial success and to guide remedial decisionmaking to protect animals, plants, and their habitat in ERF and nearby Knik Arm.

Areas of potential ecological concern (AOPECs) were chosen based on physical characteristics that corresponded with maximum exposure of waterfowl to white phosphorus or because of their proximity to areas that were known to be contaminated and that waterfowl preferred for feeding habitat. Ponded areas were determined to be AOPECs because they are preferred feeding habitat for dabbling waterfowl. On the basis of earlier studies, these areas include sedge marsh, permanent ponds, and intermittent ponds. The geographical areas of highest potential ecological concern are Areas A , C, and C/D; Bread Truck; and Racine Island, as well as nearby sedge marshes.

The CSM for ERF showed that the primary exposure pathway is by incidental ingestion of white phosphorus particles contained within shallow pond sediments by dabbling ducks when they feed. In deeper ponds, swans are exposed to white phosphorus in a similar manner. Direct ingestion of the white phosphorus particles occurs because birds regularly feed in habitats where white phosphorus is found. These birds either confuse the white phosphorus particles with their natural food items (such as invertebrate larvae or plant seeds) or accidentally ingest the particles along with pond sediments.

Of all bird species observed at ERF, three species of dabbling ducks (mallard, northern pintail, and green-winged teal) have accounted for nearly 97 percent of all bird mortality. These three duck species are considered to be primary ecological receptors that feed mainly in shallow ponds. Swans feed in deeper water habitats than those used by the dabbling ducks and also are considered to be primary ecological receptors. Because minimal shorebird deaths have been discovered during the years of mortality studies in ERF, these receptors have been ranked as having a moderate hazard probability. Shorebirds have less exposure to white phosphorus because they feed in areas that periodically dry (which allows the white phosphorus to sublimate) and they select organisms from the sediment rather than sifting though the sediment or uprooting vegetation like dabbling ducks (and therefore are less likely to ingest nonfood particles).

4.2.2 Ecological Risk Analysis

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

Exposure Assessment. Information used to evaluate potential ecological exposures at ERF includes characterization of the ecosystem, evaluation of tissue concentrations of white phosphorus in biota collected at ERF, and in situ and laboratory analysis of potential exposure to white phosphorus in environmental media from the different areas at ERF. The potential receptors that were considered for ERF included aquatic vegetation, aquatic invertebrates, fish, and birds, as well as their consumers.

Investigations at ERF determined that aquatic plants growing within contaminated sediments contained low levels of white phosphorus in plant roots, but no white phosphorus in plant tissue. Therefore, the risks to grazing animals from plant consumption are very low when compared to incidental ingestion of the sediment containing white

phosphorus particles. No observed mortality of geese and wigeons, waterfowl that feed mainly on vegetation, supports this conclusion.

White phosphorus impacts to aquatic invertebrates and fish were investigated in separate studies. In general, the population diversity of benthic macroinvertebrates was not affected by white phosphorus contamination under field conditions, even though representative aquatic species were shown to be sensitive to white phosphorus in laboratory tests. Sampling and analysis of ERF macroinvertebrates and fish did not reveal significant accumulations of white phosphorus that would constitute a significant risk for birds or mammals who eat them.

Secondary receptors include predators and scavengers such as the bald eagle, herring gull, raven, wolf, coyote, and fox. Studies of activities and potential risk related to scavengers and predators indicated a potential for indirect impacts from white phosphorus exposure through consumption of dead and moribund white phosphorus-contaminated waterfowl. Evidence of direct impacts on scavengers and predators (through direct ingestion of white phosphorus-contaminated sediments) was not confirmed by field studies.

Although the uptake of white phosphorus by predators is rapid, the potential for bioaccumulation in the food chain may be limited because of rapid loss of white phosphorus upon reduction of dose, as seen in laboratory tests. No white phosphorus was detected in the leg muscle of a coyote collected from behind the Canoe point tower in the woods closer to ERF. White phosphorus was detected in one dead eagle collected in ERF; however, the cause of death could not be determined.

The above studies of various ERF biological components have shown that the most significant white phosphorus impacts are occurring to bird populations. Dabbling ducks, such as northern pintails, mallards, and green-winged teal, and swans (trumpeter and tundra) are the most affected species, as indicated by their high mortality at ERF. Mortality of dabbling ducks has been concentrated in areas of ERF where suitable pond habitat is located. White phosphorus measured in tissue samples from field-collected ducks (such as mallards, pintails, and teal) and swans that had been exposed to in situ white phosphorus showed similar or higher white phosphorus concentrations than corresponding tissues of mallards in toxicological feeding studies.

Effects Assessment. The ecological effects assessment evaluated the cause-and-effect relationships between white phosphorus and waterfowl through an evaluation of field studies and laboratory toxicity studies as well as literature on the ecological effects of white phosphorus.

Waterfowl mortality studies were completed by counting duck carcasses along permanent transects in ERF and in the surrounding woods. The studies found that eagle predation and scavenging of white phosphorus-affected ducks and carcasses are much more prevalent in spring than in fall. Some ducks are consumed where they are captured, and some are carried to other locations. The spring duck mortality rate dropped from 1992 to 1995. The declining mortality rates in fall were attributed to the implementation of hazing (use of visible objects and mechanized sounds to intentionally deter waterfowl from entering an area) in the most contaminated areas, lack of suitable foraging habitat, and reduction of available white phosphorus. Because mortality transects were not evaluated during the 1996 field season, the effect of the lack of hazing on duck mortality was not evaluated by using

transects. Although field studies did not establish a reliable estimate of bird mortality in the reference areas of UCI, the mortality rate in ERF is likely much higher than the background mortality rate in reference areas.

Daily movements, habitat preference, turnover rates, site-specific exposure, and mortality of birds in ERF were studied with radio telemetry studies conducted from 1993 to 1996. Radio-transmitted ducks and eagles were used in the telemetry studies. ERF duck habitat preference during nonhazing periods indicated that the two most commonly used habitats were sedge marshes and the permanent ponds (at 28.7 and 11.4 percent, respectively). Other habitat types such as Ramenski's sedge, halophytic herb, interior sedge, and intermittent ponds had progressively lower duck use percentages. Turnover rate among the ERF ducks was high; the average length of stay was 12.5 days. Mortality of radio-equipped ducks on ERF was 35 percent in 1996. Mallard mortality exceeded proportional area use in ERF Areas C and C/D, Racine Island, and Bread Truck Pond. Duck deaths were recorded for each year. None of the 31 radio-equipped bald eagles died from white phosphorus exposure.

The USFWS conducted aerial bird population surveys of ERF during spring, summer, and fall (April through October) from 1989 through 1997 as part of ongoing water bird studies. The objective of these surveys was to monitor bird abundance and distribution in ERF during spring, summer, and fall. Waterfowl were counted or estimated and recorded by species or species group.

Laboratory and field toxicity tests of birds (primarily mallards) and aquatic macroinvertebrates were conducted to determine acute and chronic toxicity as well as potential effects to secondary receptors. A target white phosphorus concentration in sediment at ERF was not established for the following reasons. Because white phosphorus occurs in particulate form in ERF, its uneven distribution, caused by deposition by munition rounds, creates considerable uncertainty for sampling and quantification. Actual dosage to waterfowl from sediment is affected by the suitability of the feeding habitat (such as water depth) and the relative efficiency of each species in locating and ingesting white phosphorus particles of different sizes during feeding.

Birds. Various types of toxicity tests were conducted to determine the lowest dose of white phosphorus resulting in mortality (5.2 mg/kg bw) and the lethal dose for 50 percent of a sample population (LD_{50}) (4.05 to 6.4 mg/kg bw) for mallards. A lowest observed effect level (LOEL) based on mortality was estimated for particles of white phosphorus to be between 3 and 4 mg/kg-bw/day, and a LOEL based on sublethal effects (liver, kidney, and heart tissue damage) would be less than 2 mg/kg-bw/day. Preliminary reproductive studies indicated that hens exposed to sublethal levels of white phosphorus have reduced reproductive output and embryos with teratogenic deformities, including scoliosis, lordosis, submandibular edema, microphthalmia, and spina bifida. Toxicological effects in birds tested under laboratory conditions were similar to those observed in field toxicity tests.

Histopathological changes were observed in the liver, spleen, heart, and duodenum (small intestine) in some birds treated with white phosphorus. The combination of changes in some blood chemistry indicators (such as blood urea nitrogen, potassium, lactate dehydrogenase, glucose, hematocrit, and hemoglobin) could be used as an indicator of possible white phosphorus exposure. Test results for repeated subchronic exposures

indicated that mortality and histopathologic effects (liver and kidney damage) were consistent with acute exposures from single doses at similar concentrations.

The results of studies of white phosphorus toxicity for secondary receptors indicated that the greatest risk was through ingestion of portions of the digestive tract that contained pelletized white phosphorus. For example, a duck gizzard could have more than 100 times the white phosphorus dose compared to other tissues. Although the uptake of white phosphorus by predators is rapid, the potential for bioaccumulation in the food chain may be limited because of the rapid elimination of white phosphorus seen upon reduction of dose in laboratory tests. Bioaccumulation and toxicity could be significant if the ingested dosage exceeds the degradation rate of the receptor. These studies indicate that predators could be exposed to harmful doses of white phosphorus, which could result in sublethal effects such as decreased reproductivity or survival. However, the absorption, distribution, and metabolism of white phosphorus within an individual species results in a low likelihood that white phosphorus is being transferred within the food web.

Macroinvertebrates. Laboratory toxicity tests and field studies of aquatic biota were conducted to determine acute toxicity (lethal concentration for 50 percent of sample population) and chronic toxicity (no observed effect level [NOEL]) of white phosphorus in sediment, as well as impacts on the community structure of benthic macroinvertebrates. Toxicity tests indicated that sediments from Racine Island were not toxic to organisms living in them in the field, but were toxic to laboratory organisms at diluted concentrations. *Chironomus riparius* was more sensitive to white phosphorus than *Hyallela azteca*, and the lowest NOELs were 26 micrograms per kilogram (µg/kg) and 1,500 µg/kg, respectively. The community structure of benthic macroinvertebrates within ERF did not appear to be affected by white phosphorus concentrations in sediment or surface water.

4.2.3 Ecological Risk Characterization

In this part of the risk assessment, the likelihood of adverse ecological effects occurring as a result of exposure to white phosphorus in ERF is evaluated. Risk characterization consists of two steps: (1) risk estimation and (2) risk description. For the ecological risk assessment, waterfowl mortality was considered to be the only significant effect of white phosphorus on ecological resources at ERF.

Area characteristics such as habitat (vegetation, landform, pond), white phosphorus concentrations, and duck use were combined in the GIS database to identify areas where all these factors exist together (overlap) that could be considered as a hot area. Other areas were included because of their proximity to known white phosphorus-contaminated area and because they contain preferred feeding habitat for dabbling waterfowl. The geographical areas of highest potential ecological concern are Areas A , C, and C/D; Bread Truck; and Racine Island, as well as nearby sedge marshes. Dying waterfowl or carcasses have been collected from all these areas. Comparison of white phosphorus levels in various tissues of these ducks showed higher than the corresponding maximum tissue concentrations for mallard white phosphorus toxicity studies, indicating that the ducks ingested enough white phosphorus in ERF to result in mortality.

Duck mortality studies show that the largest proportions of dead or dying ducks in ERF were observed in Area C (37 percent), Racine Island (22 percent), Area A (22 percent), Bread Truck (12 percent), and Area C/D (6 percent). Of these areas, only Area A did not contain

confirmed or identified hot areas for white phosphorus exposure. Dead swans also were observed in Area C (44 percent), Areas A and D (25 percent), and Area C/D (6 percent). No observations of dead or dying birds in the coastal areas (east or west) were recorded in the GIS database. Plant, fish, and invertebrate sampling and white phosphorus analysis from these hot areas did not show significant uptake of white phosphorus.

Duck use of the various areas used in the telemetry studies was estimated by using the telemetry observations during periods when hazing was not occurring. The results indicated relative use by ducks as follows: Area C, 22 percent; Coastal East, 16 percent; Area C/D, 14 percent; Area B, 10 percent; Bread Truck, 7 percent; Area A, 7 percent; Coastal West, 5 percent; Area D, 4 percent; and Racine Island, 3 percent. Comparison of duck mortality to duck use indicates that highest mortality occurs in Area C, Bread Truck, and Racine Island.

Of the three habitat types considered to be preferred by ERF waterfowl, the following percentages of total habitat areas were found in the white phosphorus-contaminated ERF areas (C and C/D, Bread Truck, and Racine Island): permanent ponds, 29 percent; intermittent ponds, 19 percent; and sedge marsh, 51 percent.

The actual percentage of utilization by waterfowl in these white phosphorus-contaminated ERF areas (as indicated by telemetry observations during non-hazing periods) was higher than would be indicated by the relative proportion of those habitats based on area: permanent ponds, 47 percent; intermittent ponds, 31 percent; and sedge marsh, 54 percent. (These percentages are calculated independently by area; they are not expected to add up to 100 percent.)

When the waterfowl utilization of the hot spots was compared to waterfowl utilization for all of ERF (rather than limiting the comparison to the three preferred habitat types only), the percentage of waterfowl utilization was much lower: permanent ponds, 5.4 percent; intermittent ponds, 2.3 percent; and sedge marsh, 16 percent.

Comparison of bird use of ERF with overall bird use in UCI marshes was based on aerial surveys conducted during the 1995 field season. In general, about 3 to 5 percent of waterfowl (swans, geese, ducks) in UCI were found in ERF wetlands. Between 9 and 52 percent of UCI eagles were found to use ERF. The relative proportion of birds would be expected to vary from year to year.

Studies of duck mortality between 1993 and 1995 with telemetry indicated an average annual mortality rate of about 16 percent for ducks in ERF. However, mortality results from the 1996 study based on a larger sample of birds and without hazing indicated a mortality rate of 35 percent, a value that is probably more indicative of current risk at ERF without remediation.

Ecological Risk Summary. The weight of evidence indicates that ingestion of white phosphorus particles by ducks and swans is the cause of most of the elevated waterfowl mortality in ERF. White phosphorus has been identified at elevated levels in the sediment of three areas of ERF: Area C, Bread Truck, and Racine Island. Area C/D is adjacent to these areas and also could have high levels of white phosphorus that were not detected because of the limited sediment sampling. Area A also may be of ecological concern because of its heavy use by waterfowl and documented duck mortality.

The significance of waterfowl mortality at ERF is given perspective by providing an estimate of the proportion of UCI waterfowl that are using ERF. Only a small percentage of UCI waterfowl (3 to 5 percent) may be using ERF (based on 1 year of surveys). If the estimated 35 percent in-ERF mortality rate from telemetry studies is accepted as indicative of current risk at ERF and it is assumed that approximately 5 percent of UCI waterfowl use ERF, the estimated percentage of UCI waterfowl affected by white phosphorus in ERF would be about 2 percent. Field studies have not established a reliable estimate of bird mortality in reference UCI marshes; however, mortality in ERF is much higher than background mortality in the reference areas.

Uncertainties associated with this assessment stem from the nature of the studies used to (1) characterize the ecosystem, (2) estimate white phosphorus concentrations in ERF biota tissues, and (3) characterize exposure of ERF biota to white phosphorus contamination. Limitations of aerial and ground bird census methods contribute to the uncertainty associated with the ecosystem characterization. The actual cause of telemetry bird death was not always determined. Uncertainty in studies to estimate white phosphorus tissue concentrations was affected by live-versus-dead bird samples, uneven distribution of sample locations, lack of predator tissue samples, lack of tissue sample information, and variations in the tissues analyzed and the white phosphorus detection limits and analytical instrumentation. Uncertainty in the exposure analysis resulted from difficulties in sampling and quantification of white phosphorus because of a lack of sampling for white phosphorus in some areas and the irregular distribution of white phosphorus at ERF.

Estimates of uncertainty (or confidence intervals) were not provided in most previous studies. Uncertainties associated with the laboratory tests include intra- and inter-study variations, limitations of study design, and the ability to match laboratory conditions to those observed in the field. Additional uncertainties include the limitations of the bird mortality studies, such as the assumption that birds do not travel a significant distance after exposure before dying, the uneven distribution of mortality transects, and the accuracy of the ground survey counts used in calculating the mortality ratio. In addition, levels of white phosphorus in fish and invertebrates may have been below detection limits. The single largest source of error associated with comparison of ERF bird use to that of the UCI marshes was that the comparison was based on a single field season. Considerable variation from year to year already has been demonstrated in the ERF population studies.

SECTION 5

Description of Alternatives

5.1 Need for Remedial Action

If not addressed by implementing the response action selected in this ROD, the actual or threatened releases of hazardous substances resulting from white phosphorus contamination of the ERF source area of OU-C from exploded ordnances may present an imminent and substantial threat to public health, public welfare, or the environment.

The specific reasons for conducting remedial actions at OU-C are as follows:

- White phosphorus in the shallow ponded sediment of ERF has contributed to elevated waterfowl mortality.
- ERF is an important staging ground for migrating waterfowl during spring and fall migration.

5.2 Remedial Action Objectives

As part of the RI/FS process, remedial action objectives (RAOs) were developed in accordance with the NCP and EPA guidance for conducting RI/FS investigations. The primary objective of the remedial action is to reduce the number of waterfowl deaths attributable to white phosphorus.

Short and long-term RAOs for the remedial action at OU-C are as follows:

- Within 5 years of the ROD being signed, reduce the dabbling duck mortality rate attributable to white phosphorus to 50 percent of the 1996 mortality rate attributable to white phosphorus. Radio tracking and aerial surveys suggest that about 1,000 birds died from white phosphorus at ERF in 1996. Therefore, the allowable number of duck deaths from white phosphorus would be approximately 500.
- Within 20 years of the ROD being signed, reduce the mortality attributable to white phosphorus to no more than 1 percent of the total annual fall population of dabbling ERF ducks. Currently, that population is about 5,000. Therefore, the allowable number of duck deaths from white phosphorus would be approximately 50. This long-term goal could be adjusted based on future population studies conducted during the monitoring program.

These objectives will be achieved by reducing the area of white phosphorus-contaminated media and reducing the exposure to white phosphorus. Reducing the exposure to white phosphorus will reduce the availability of white phosphorus to ducks, which in turn will reduce duck deaths.

Monitoring through aerial surveys and radio telemetry at ERF will be conducted to ensure that RAOs are achieved. The goals of monitoring will be as follows:

- To ensure that an exposure pathway does not exist between white phosphorus-contaminated sediment and waterfowl
- To determine the number of waterfowl using ERF
- To determine the number of waterfowl dying as a result of feeding on white phosphorus-contaminated sediment
- To determine whether remedial action is effective or needs modification

5.3 Significant Applicable or Relevant and Appropriate Requirements and To Be Considered Criteria

A full list of applicable or relevant and appropriate requirements (ARARs) and to-be-considered (TBC) criteria is provided in Section 8. The following ARAR and TBC criterion, respectively, are the most significant regulations that applied to the remedy selections for ERF:

- Section 404 of the Clean Water Act (CWA), which coincides with Alaska water quality standards, for protection of wetlands
- Provisions in the Migratory Bird Treaty Act of 1918 that prohibit unregulated "taking" of birds, including poisoning at waste sites

5.4 Description of Alternatives

Many technologies were considered to clean up the white phosphorus-contaminated sediment at OU-C. Appropriate technologies were identified and screened for applicability to site conditions. The potential technologies were then assembled into alternatives. Potential remedial alternatives for OU-C were identified, screened, and evaluated in the FS.

With the exception of Alternative 1, the following ERF-wide monitoring activities would be conducted throughout all of ERF: a telemetry study of mallard movement and mortality, aerial bird population surveys, and aerial photography of physical changes in habitat. The changes in physical characteristics that are of interest include drainage, topography, and vegetation. Some vegetation differences can be detected with the use of photography that uses varying wavelengths, but some ground truthing and revisiting of study plots also would be required.

In addition to the monitoring activities, hazing would be used as necessary in ERF to deter waterfowl during critical migration periods. Hazing involves the use of visible objects and sounds to deter waterfowl from using an area, thereby preventing exposure to white phosphorus. Visual, acoustic, and behavioral devices have been used throughout ERF to deter birds from contaminated areas.

The activities described above are referred to as ERF-wide activities.

The alternatives evaluated in the FS and the Proposed Plan are described in the following paragraphs. All alternatives include the use of institutional controls to control access. The Army restricts entry by maintaining a locked gate at the entrance to OU-C, posting signs next to Eagle River for boaters, and regulating admission to OU-C through the Range Control.

Alternative 1: No Action

CERCLA requires evaluation of a no-action alternative as a baseline reflecting current conditions without any cleanup effort. This alternative is used for comparison to each of the other alternatives and does not include monitoring.

Published studies suggest that several natural processes occurring at ERF may lead to some natural restoration over time. These processes include white phosphorus sublimation and oxidation, gully advancement that leads to natural pond draining and the sublimation and oxidation of white phosphorus, and the covering of white phosphorus with sediment (called sedimentation). Because no monitoring would occur under Alternative 1, the effects of the natural processes on the white phosphorus in pond sediments and its toxic effects on waterfowl that use ERF would not be known. No costs would be associated with this alternative.

Alternative 2: Detailed Monitoring

No treatment technologies would be implemented in Alternative 2. Only natural processes such as gully recession, sedimentation, and white phosphorus sublimation and oxidation would continue at ERF. However, under this alternative extensive, active monitoring for these natural processes would be performed to understand whether natural processes are occurring and to determine the level of protection for the environment that is achieved.

Alternative 2 expands on the ERF-wide activities currently planned for the entire ERF. It adds the activity of monitoring ERF to determine whether natural restoration is occurring and at what rate. Monitoring would include additional aerial photography, measurement of net sedimentation, and an elevation survey. Aerial photography would measure pond changes and gully recession. Net sedimentation measurements would determine whether exposure pathways between contaminated sediment and waterfowl are being broken. The elevation survey of ground surface and pond bottoms would determine pond interconnectiveness and flooding potential.

In addition, baseline monitoring of white phosphorus in sediment would be performed by using a composite sampling method to determine current white phosphorus levels. This monitoring would help identify areas with white phosphorus contamination and provide baseline information. Limited monitoring of sublimation and oxidation conditions would be performed to detect whether conditions have been suitable for white phosphorus sublimation and oxidation. Verification sampling of white phosphorus also would be performed to confirm the success of this alternative if the pond conditions have been sufficient to expect substantial white phosphorus sublimation/oxidation and loss.

The estimated time frame for cleanup goals to be achieved is between 10 years and more than 50 years, depending on the portion of ERF.

Detailed monitoring would be conducted for 20 years or until it is consistently demonstrated that remedial goals are achieved. The estimated 20-year present-worth cost of this alternative is $5,850,000, which includes $150,000 for capital costs and $286,000 per year for annual monitoring.

Alternative 3: Pumping with Capping and Filling

The objective of this alternative is to temporarily drain ponds to allow the pond sediments to dry and allow white phosphorus to sublimate and oxidize. This alternative consists of draining ponds by pumping after flooding cycles and/or rain. After several drying periods and verification sampling (approximately 5 years), capping and filling would be performed in areas where white phosphorus remains.

This pumping technology was tested during the summer 1997 pond pumping treatability study. Baseline and verification sampling was performed before and after pumping. During the summer of 1997, baseline and verification samplings showed an 80 percent decline in white phosphorus concentrations in the top 3.5 inches of sediments.

In each pond system, a dedicated pump system would be installed annually after spring breakup and would be removed before the winter freeze. The typical useful drying season is mid-May to mid-September. Pumped water would be discharged to an adjacent unconnected pond, river, gully, or open area. Mounted on floats, each pump system would be completely automated to start and stop at established elevations of pond surface. Scheduled maintenance service and refueling would be required. Figure 5-1 provides an illustration of a floating pump system.

To create holes for placement of the pumps and short ditches for drainage from the pumps, minor use of explosives may be included in this alternative. The affected areas would be very small, and impacts would be minimal and temporary.

The pump systems are expected to operate for 5 consecutive years, based largely on tide predictions. Tidal fluctuations affect the ability of the ponds to dry. This alternative includes baseline (before the pumping season) sampling of white phosphorus to confirm the ponds requiring cleanup and verification (after the pumping season) sampling to confirm that white phosphorus has sublimated and oxidized or to determine areas that require further cleanup.

Although Alternative 3 includes the ERF monitoring and hazing activities, it does not include the extensive natural process monitoring described for Alternative 2. Baseline and verification sampling of white phosphorus is expected to continue annually for 5 years.

After 5 years of pumping and monitoring, those pond systems where white phosphorus exposure remains a concern would be capped and filled. A composite material would be applied to areas of the pond systems that do not dry and still contain white phosphorus. These areas generally will be isolated and will contain deep depressions that are not connected hydraulically to other portions of the pond system being drained. The cap-and-fill material is a manufactured gravel and bentonite mixture called AquaBlok™. This material expands in water, sealing spaces in gravel and creating a barrier to permeability. It will be applied only to small, deep portions of the pond bottoms. Therefore, despite its swelling characteristics, it is not expected to significantly change feeding habitat or overall

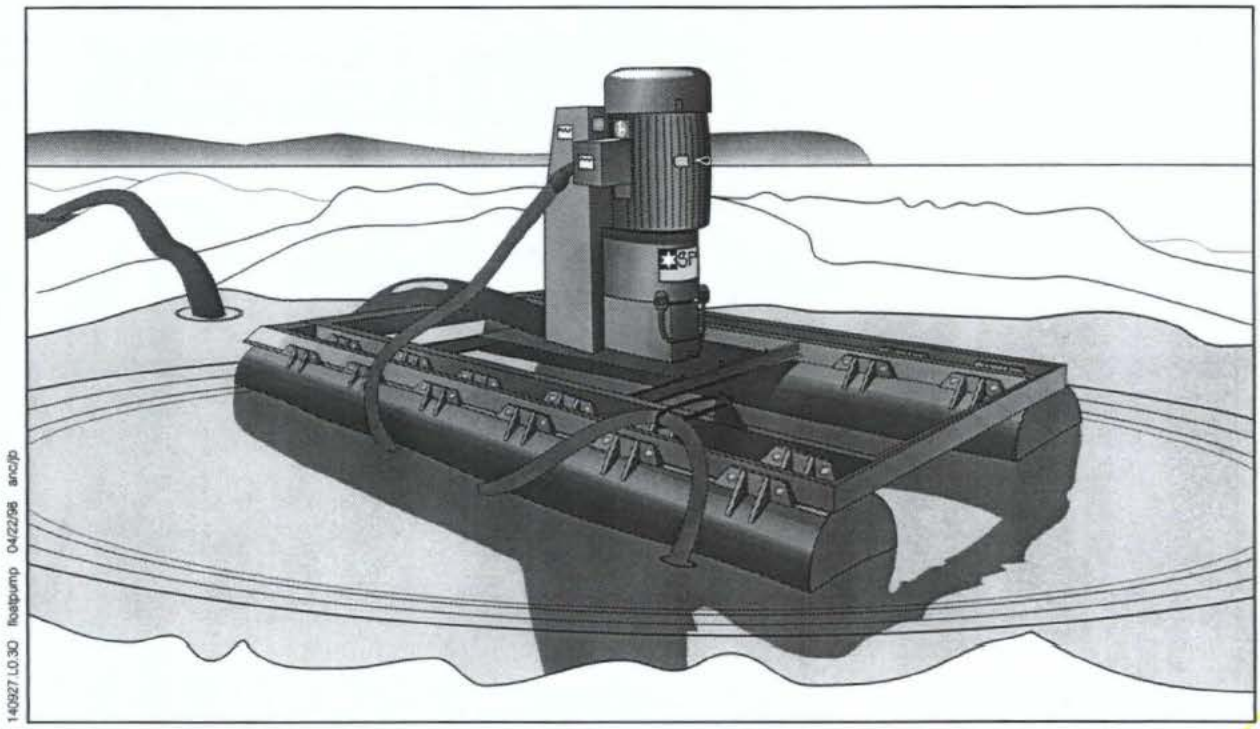


Figure 5-1

Floating Pump System

OU-C Record of Decision

pond depths. This material also supports vegetation growth. It provides a barrier between the dabbling waterfowl and the sediment contaminated with white phosphorus.

During treatability studies at ERF, the cap-and-fill material was applied from a helicopter. The application was similar to spreading fertilizer. Areas where capping and filling would be performed would be inspected regularly for integrity and thickness. Following application, restoration of the pond systems would occur naturally through precipitation and tidal flooding. Figures 5-2 and 5-3 show helicopter and truck applications of cap-and-fill material.

Temporary pumping is expected to be conducted for 5 years or until it is consistently demonstrated that remedial goals are achieved. Minor capping and filling then would be performed in small unremediated ponded areas, where necessary. ERF-wide activities (monitoring) would be performed for the first 8 years of the remedy and then during Year 10, Year 15, and Year 20 to ensure that remedial goals are consistently maintained. On the basis of these assumptions, the estimated 20-year present-worth cost of this alternative is $5,685,000, which includes $251,000 for capital costs (additional pumps) and $272,000 per year for operation and maintenance, which cover monitoring.

Alternative 4: Breaching and Pumping with Capping and Filling

The objective of this alternative is to breach ponds, allowing water to flow out and the sediments to dry. Breaching would be done by using explosive charges. Breaching results in the permanent removal of duck habitat.

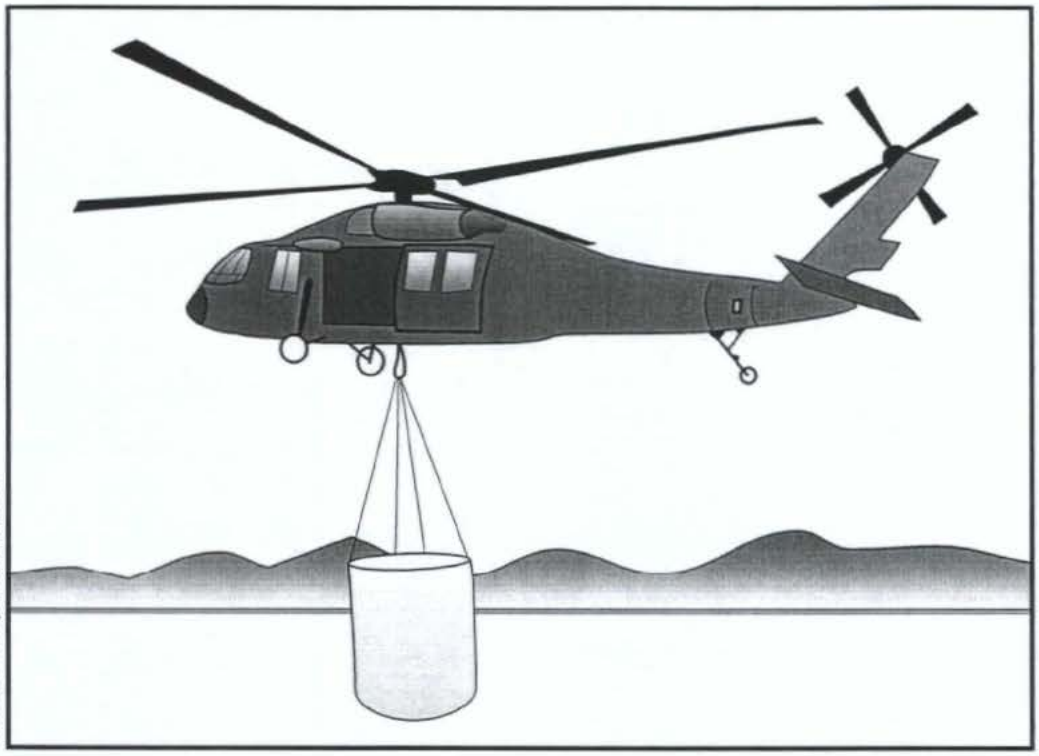


Figure 5-2

Blackhawk Helicopter
Application of Cap-and-Fill Material

OU-C Record of Decision

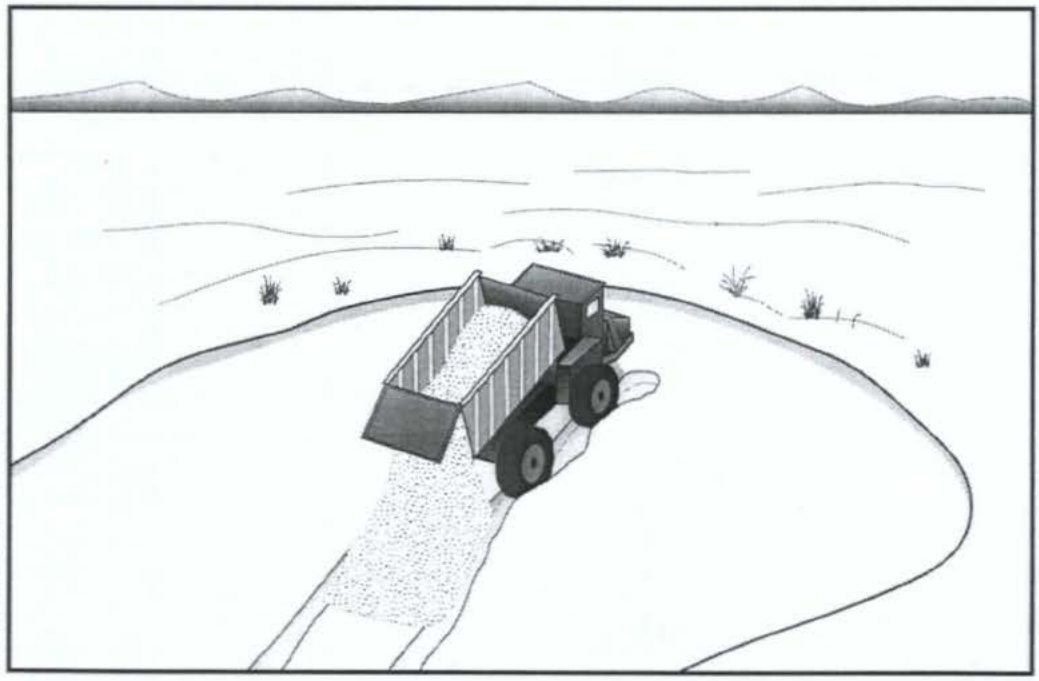


Figure 5-3

Winter Truck Application of
Cap-and-Fill Material

OU-C Record of Decision

Alternative 4 includes the use of explosives to create a ditch from a hot pond (or pond system) to Eagle River or a nearby gully or creek that ultimately would permit the water to drain into Cook Inlet. Areas that do not drain through the breached gully then would be drained with the pump system that is described for Alternative 3. For example, the elevations of some pond bottoms may be lower than the breached gully elevation, and a pump would be needed to fully drain water from the ponds and dry the sediments. Finally, areas that do not dry sufficiently would be capped and filled as described above. Although breaching allows large volumes of water to be drained quickly, it also lowers the threshold elevation and allows a breached pond system to be reflooded often with lower tides.

Use of explosives would occur in March, when ERF is frozen and access is easier. It is expected that explosives would be strategically placed to create a 20-foot-wide, 6-foot-deep ditch. Pumping operations would be similar to those for Alternative 3, but would require smaller pumps because most of the water is expected to be drained through the breached gully system. The drying season also would be the same as described under Alternative 3.

Breaching considerations would include preference of gullies that naturally progress toward pond systems, the shortest possible drainage route, and the shallowest possible ditch. These criteria would minimize negative effects on existing habitat.

Pond breaching would be conducted within the first year of the ROD being signed and would be followed by 8 years of pumping ponds that do not drain. Remedial goals are expected to be achieved in a longer time than under Alternative 3 because the lower breached threshold elevations would result in increased tidal flooding sequences. Additional years for pumping would be needed because breached ponds would be flooded more often, resulting in a lower rate of sublimation and oxidation.

Baseline (before pumping season) and verification (after pumping season) sampling will be performed every year for 8 years. Minor capping and filling then would be performed in small unremediated ponded areas, where necessary. Application of the cap-and-fill material would be similar to that for Alternative 3 and would require the same follow-up inspection. ERF-wide activities (monitoring) would continue to be performed after pumping is complete for the duration of the remedy to ensure that remedial goals are consistently maintained. Alternative 4 does not include the extensive natural process monitoring performed under Alternative 2. On the basis of these assumptions, the estimated 20-year present worth costs of this alternative is $9,132,000, which includes $2,064,000 for capital cost (mostly explosives and additional pumps) and $353,000 per year for operation and maintenance, which cover monitoring.

Alternative 5: Capping and Filling

The objective of this alternative is to cap and fill portions of hot ponds where the presence of white phosphorus has been identified. As mentioned under the discussion of Alternative 3, capping and filling prevents white phosphorus ingestion by ducks. Alternative 5 is particularly well suited for areas that cannot be drained or dried. Unlike the limited applications proposed under Alternatives 3 and 4, capping and filling under Alternative 5 would cover the entire pond systems. Because of the swelling characteristics of the cap-and-fill material, pond bottom elevations likely would be raised, and in some cases, shallow ponds would be filled.

Implementation is expected to take 1 year. The cost of applying cap-and-fill material by helicopter is high. Truck application is about twice as fast as application by helicopter, and the equipment cost for trucks would be as much as one-tenth the cost for helicopter application. Therefore, where capping and filling is required over larger areas, the applications likely would be by vehicles on wheels or tracks during winter. The use of vehicles would require driving heavy equipment on the frozen ground to transport the material. Transport to and spreading at the ponds would be done when ice thickness is sufficient to support the weight without damage to the ground surface. At some ponds, the cap-and-fill material could be spread in a slurry in the spring.

Cap and fill material would be placed within the first 3 years after the ROD being signed, followed by up to 20 years of monitoring to demonstrate that remedial goals are achieved. Alternative 5 includes the ERF-wide activities, as well as baseline sampling for white phosphorus and inspection of the integrity of areas where capping and filling is performed. However, Alternative 5 does not include the extensive natural process monitoring under Alternative 2. The estimated 20-year present worth cost of this alternative is $6,165,000, which includes $2,694,000 for capital costs (cap-and-fill material and application) and $174,000 per year for operation and maintenance, which cover monitoring.

SECTION 6

Summary of Comparative Analysis of Alternatives

The selection of alternatives was based on an evaluation using the nine CERCLA criteria specified in Table 6-1. The first two criteria are known as threshold criteria that must be met by all selected remedial actions. The following five criteria are known as balancing criteria, and the final two criteria are referred to as modifying criteria.

TABLE 6-1
Criteria for Evaluation of Alternatives

THRESHOLD CRITERIA: Must be met by all alternatives.
1. **Overall protection of human health and the environment.** How well does the alternative protect human health and the environment, both during and after construction?
2. **Compliance with requirements.** Does the alternative meet all applicable or relevant and appropriate state and federal laws?
BALANCING CRITERIA: Used to compare alternatives.
3. **Long-term effectiveness and permanence.** How well does the alternative protect human health and the environment after completion of cleanup? What, if any, risks will remain at the site?
4. **Reduction of toxicity, mobility, and volume through treatment.** Does the alternative effectively treat the contamination to significantly reduce the toxicity, mobility, and volume of the hazardous substances?
5. **Short-term effectiveness.** Are there potential adverse effects to either human health or the environment during construction or implementation of the alternative?
6. **Implementability.** Is the alternative both technically and administratively feasible? Has the technology been used successfully at similar areas?
7. **Cost.** What are the relative costs of the alternative?
MODIFYING CRITERIA: Evaluated as a result of public comments.
8. **State acceptance.** What are the state's comments or concerns about the alternatives considered and about the preferred alternative? Does the state support or oppose the preferred alternative?
9. **Community acceptance.** What are the community's comments or concerns about the alternatives considered and the preferred alternative? Does the community generally support or oppose the preferred alternative?

6.1 Threshold Criteria

6.1.1 Overall Protection of Human Health and the Environment

Alternatives 1 and 2 are not protective of the environment and, therefore, will not be further evaluated in this ROD. Risk reduction by natural processes may take from 10 to more than 20 years.

The levels of protection to the environment provided by Alternatives 3 and 4 would be significantly higher. White phosphorus-contaminated sediment would be actively treated through draining, and the exposure pathway between untreated sediment and waterfowl would be blocked with cap-and-fill material. Cap-and-fill material would be applied only to small depressions. Therefore, despite the swelling potential of the material, overall pond bottom depths and feeding habitat are not expected to change significantly from impacts of the cap-and-fill material under Alternatives 3 and 4. No adverse impacts from the cap-and-fill material were observed during previous treatability studies. In addition, the limited application of this material under Alternatives 3 and 4 is expected to preclude significant habitat changes.

Although Alternative 4 would treat and remove white phosphorus, it also would cause permanent large-scale changes to pond habitats. Ponds that were originally waterfowl feeding habitats would be permanently removed. In addition, after long periods of drying, vegetation would die and rebound would be unlikely.

Alternative 5 would provide protection by blocking the exposure pathway with a barrier material; however, it does not treat or remove the white phosphorus. Alternative 5 also would result in changes to habitat because the cap-and-fill material would cover the entire pond system and the elevations of pond bottoms would be raised. In some cases, shallow ponds would be filled entirely.

6.1.2 Compliance with Applicable or Relevant and Appropriate Requirements

A significant ARAR that applies to the OU-C site is Section 404 of the CWA, for protection of wetlands. The Migratory Bird Treaty Act of 1918 is a TBC that prohibits unregulated "taking" of birds.

All state ARARs would be met by Alternatives 3, 4, and 5. These alternatives include active treatment and/or covering of white phosphorus-contaminated sediment to prevent waterfowl exposure.

All federal ARARs would be met by Alternatives 3 and 5. However, Alternative 4 would not meet Section 404 of the CWA, in that this alternative would permanently destroy wetland habitat.

6.2 Balancing Criteria

6.2.1 Long-term Effectiveness and Permanence

Alternatives 3 and 4 would involve treatment and removal of the white phosphorus contamination through sublimation and oxidation and, therefore, would provide long-term effectiveness and permanence. Residual risk of future exposure to white phosphorus would remain in some small areas because capping and filling would not treat and remove white phosphorus. Under Alternatives 3 and 4, cap-and-fill material would be applied to areas of pond bottoms that do not dry.

It is expected that draining ponds by pumping and breaching (Alternatives 3 and 4) would alter, and in some cases temporarily or permanently destroy, some wetlands at ERF. Alternative 4 would have the most destructive impact on wetlands, because it would

permanently eliminate habitat. Under Alternative 3, impacts to the ERF wetlands habitat would be temporary. Under both Alternatives 3 and 4, the protective procedures for conducting activities that may disturb wetlands would be established and followed during the cleanup to minimize impacts. These protective procedures include: (1) pumping restrictions in Area B and Area D, which are prime waterfowl habitat; (2) selection of the narrowest and shortest walking corridors to minimize disturbances to vegetation and habitat; (3) proper maintenance of equipment and structures; (4) minimization of equipment and staging area footprints; (5) minimal localized use of explosives; (6) preparation of work plans and solicitation of agency review; (7) monitoring for impacts to wetlands habitat; and (8) monitoring for waterfowl use of ERF.

Alternative 5 would not provide permanent removal of the white phosphorus, but it would block the exposure pathway. Residual risk, which is risk resulting from contaminants that remain after treatment is complete, would remain in the entire area of the pond that is covered under Alternative 5. Residual risk remains because capping and filling does not actively treat and remove the white phosphorus in sediments; instead, capping and filling only prevents exposure of ducks to white phosphorus-contaminated sediment. The white phosphorus would remain below the cap-and-fill material. The remaining residual white phosphorus would still be present, just not accessible.

6.2.2 Reduction of Toxicity, Mobility, and Volume Through Treatment

Alternatives 3 and 4 would treat the largest area of white phosphorus-contaminated sediment by reducing water level, drying pond sediment, and causing white phosphorus removal by sublimation and oxidation. Residual risk is expected to be low under Alternatives 3 and 4, as demonstrated in treatability studies. Alternative 5 does not involve treatment to reduce toxicity and volume of white phosphorus-contaminated sediment, although it would prevent exposure by reducing the mobility of white phosphorus. Residual risk would be highest under Alternative 5, because contaminated sediment would be only covered and not treated.

6.2.3 Short-term Effectiveness

It is estimated that the cleanup objective of reducing duck deaths by 50 percent in 5 years would be met by Alternatives 3 and 4. RAOs would be achieved faster under Alternative 3, but exposure would be reduced more slowly. The slower removal of exposure would occur under Alternative 3 because bird habitat would still be available until all pond water is removed by pumps. Once the water is removed (1 week), the pond would remain dry and would only become wet again during heavy rains or high tides. Although the threshold elevation of breached ponds would be lowered under Alternative 4 to allow a large volume of water to initially drain to Eagle River, the ponds then would flood more frequently during lower tides. The frequent refilling of the pond system under Alternative 4 would not allow pond sediment to dry quickly. Therefore, 5 years of pumping would be needed for cleanup under Alternative 3, as opposed to 8 years of pumping under Alternative 4.

The criterion of short-term effectiveness also would be met under Alternative 5, when capping and filling were completed. Application of cap-and-fill material throughout ERF is estimated to take a total of 2 to 3 weeks and would occur within the first 3 years of remedy implementation.

Alternatives 4 and 5 may result in permanent changes, and Alternative 3 would result in temporary changes to pond bottoms, habitat, and bird use. The limited application of cap-and-fill material in Alternative 3 is not expected to result in large-scale permanent habitat changes. Short distances of vegetation or uneven topography may restrict water movement within and between ponds. To enhance draining of the ponds, Alternative 3 also may include limited use of explosives to clear small drainage channels that radiate from the pump location. The effects from use of explosives to create the small drainage channels is expected to be very short term.

All alternatives would pose some short-term potential risk to onsite workers during monitoring activities and during setup, operation and maintenance, and removal of monitoring and cleanup equipment. These potential risks could be minimized by engineering and institutional controls. The most significant risk to workers is from the existence of UXO at ERF. To reduce this risk, all areas where workers would be exposed would be cleared of unexploded ordnance either visually or electronically.

The community would not experience any significant effects from the alternatives. The explosions produced for pond breaching in Alternative 4 may affect the community through impacts such as noise and vibration. Use of explosives on clear weather days would reduce these impacts (cloud cover reflects and emphasizes sounds from explosions), and a community relations program would be used to alert the public in advance of these activities.

6.2.4 Implementability

Alternatives 3 and 4 would use readily available technologies and would be feasible to construct and operate. Treatability studies of pond breaching and pond pumping were successfully conducted in the summers of 1996 and 1997. Alternative 5, which includes a containment technology only, also would use readily available materials. Minor technical difficulties are anticipated during application of cap-and-fill material because of the presence of craters throughout ERF. Visual inspections of caps to assess their integrity would be performed under Alternatives 3 through 5.

Alternatives 3 through 5 involve UXO ordnance hazards to onsite field personnel. Steps previously described, including having work areas and pathways cleared by unexploded ordnance specialists, would be taken to minimize risk.

6.2.5 Costs

The estimated costs for each alternative evaluated are provided in Table 6-2. The estimates are based on the information available at the time the alternatives were developed. The costs projected over 20 years are estimated for purposes of comparison and are considered to be accurate to within -30 percent to +50 percent. Costs are described by using the present-worth methodology with a discount rate equal to 5 percent. Capital cost includes the purchase price of the pumps, monitoring equipment, cap-and-fill material, and explosives. It also covers the labor and transportation associated with initial setup of equipment.

Annual operation and maintenance cost includes startup and dismantling activities, routine maintenance, refueling, pump system setup and removal, and annual monitoring. Also included are the activities conducted in the entire ERF and sampling of sediments for white phosphorus. In addition, annual operation and maintenance cost covers labor,

TABLE 6-2
Cost Estimate for Cleanup Action Alternatives

Location	Capital Cost ($000)	Average Annual O&M Present Worth ($000)	20 Year O&M Present Worth ($000)	Total Cost–20 Year O&M ($000)
Alternative 1–No Action	0	0	0	0
Alternative 2–Detailed Monitoring	150	286	5,700	5,850
Alternative 3–Pumping with Capping and Filling	251	272	5,434	5,685
Alternative 4–Breaching and Pumping with Capping and Filling	2,064	353	7,068	9,132
Alternative 5–Capping and Filling	2,694	174	3,471	6,165

Notes:
O&M = Operation and maintenance

Average = The 20-year present-worth O&M cost divided by 20.

Present worth means costs are expressed as U.S. dollars in 1998. The amount indicates moneys needed in 1998 dollars to complete the project over 20 years. The majority of these costs will be used to achieve the 5-year cleanup goal. A discount rate of 5 percent is used.

Costs include ERF-wide long-term monitoring and contingency hazing.

transportation, and clearance of work areas by UXO specialists associated with these activities.

Under Alternative 4, costs do not include restoring breached ponds to reestablish habitat.

6.3 Modifying Criteria

6.3.1 State Acceptance

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

6.3.2 Community Acceptance

Community response to the preferred alternative was generally positive. Community response to the remedial alternatives is presented in the Responsiveness Summary in Appendix B, which addresses comments received during the public comment period.

SECTION 7

Selected Remedy

Alternative 3 is the selected alternative for treating white phosphorus-contaminated sediment at OU-C. It is the least expensive of the treatment-oriented alternatives. A thorough assessment of alternatives considered current risks, residual risks, impacts to habitat, and costs. Alternatives 1 and 2 were eliminated because they did not satisfy threshold criteria. Although Alternative 4 would actively treat a large portion of the ERF, it does not meet overall protection of the environment or ARARs because it permanently removes wetlands. Alternative 5, capping and filling does not provide reduction in contamination through treatment, and would leave a large amount of residual risk.

Protection of human health and the environment and compliance with ARARs will best be attained through pond draining with pumping, ERF-wide monitoring activities, and institutional controls.

7.1 Major Components of the Selected Remedy

The major components of the preferred remedy for OU-C are listed below. It is assumed that implementation of the remedy will begin in 1999 and end in 2018 (duration of 20 years). The sequence and schedule of operation and maintenance activities are presented in Tables 7-1 and 7-2, respectively.

- Treat white phosphorus-contaminated sediment by draining ponds with pumps for five summers beginning in 1999. Pumping would allow the sediments to dry and the white phosphorus to sublimate and oxidize. The treatment season would begin in May and end in September. A pond elevation survey would be conducted to determine the optimal pump placement. To enhance drainage, explosives may be used to make small sumps for the pumps and shallow drainage channels. These shallow drainage channels would enhance hydraulic connectivity between ponds to encourage drainage.
- Implement the following protective procedures to minimize disturbances to wetlands habitat:
  - Restriction of activities that disturb wildlife in Area B and Area D, which are prime waterfowl habitat areas
  - Selection of the narrowest and shortest walking corridors to minimize disturbances to vegetation and habitat
  - Proper maintenance of equipment and structures
  - Minimization of the use of equipment and of staging-area footprints
  - Minimal localized use of explosives
  - Preparation of work plans and solicitation of agency reviews

TABLE 7-1
Sequence of Activities for the Selected Alternative

Activity	Time Frame
Monitoring Activities	
Waterfowl telemetry and mortality study	Every year for first 8 years, Year 10, Year 15, and Year 20 (11 events)
Aerial waterfowl surveys	Every year for first 8 years, Year 10, Year 15, and Year 20 (11 events)
White phosphorus monitoring of treated ponds	Every year for first 5 years (5 events)
White phosphorus composite sampling in untreated areas	Every year for first 5 years (5 events)
GIS database management	Every year for first 8 years, Year 10, Year 15, and Year 20 (11 events)
Pond survey, ground truthing, limited aerial survey	Year 1 and every year from Year 9 to Year 20 (13 events)
Aerial photography and interpretation	Every other year for 10 years (5 events)
Mapping of physical habitat changes and vegetation rebound	Once every 4 years for 20 years (6 events)
Treatment Activities	
Pond pumping treatment	Every year for first 5 years (5 events)
Cap and fill application	Year 5 (1 event)
Cap and fill integrity inspection	Every year for 4 years after material is placed (Year 5, 6, 7, 8), Year 10, Year 15, and Year 20 (7 events)
Hazing (contingency)	Every year for first 5 years (5 events, if needed)

  - Monitoring for impacts to wetlands habitat
  - Monitoring for waterfowl use of ERF

- Sample pond bottoms for white phosphorus at the beginning of the treatment season to confirm or determine that the pond or area requires remediation. The sampling also would establish a white phosphorus baseline and determine additional areas that may require remediation. The baseline sampling would be performed at the beginning of each field pumping season (every year for the first 5 years, starting in 1999).
- Sample pond bottoms for white phosphorus after treatment to determine effectiveness of the treatment system. This verification sampling would be performed at the end of each field pumping season (every year for the first 5 years, starting in 1999).
- Perform telemetry monitoring and aerial surveys every year for the first 5 years concurrently with pumping activities to determine bird populations, usage, and mortality. These activities would begin in 1999. Monitoring would be continued for 3 additional years to verify that short-term goals are maintained. Monitoring also would

TABLE 7-2
Schedule of Activities for Selected Alternatives

	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20
Year:	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018
Tide Predictions:	Wet	Wet	Dry	Dry	Dry	Wet	Dry	Dry	Dry	Wet	Wet	Dry	Dry	Wet	Wet	Wet				
Activity:	*Mortality and white phosphorus concentrations decrease consistently each year. Trend established. Short term RAO met at end of Year 5.*					*Continue mortality and white phosphorus monitoring to ensure RAOs are maintained.*				*Mortality monitoring performed at Year 10, Year 15, and Year 20 to ensure that RAOs are maintained. Limited aerial and land surveys conducted periodically.*											
	Pumping performed. More activity during dry years; less during wet years. Only small, isolated amounts of white phosphorus detected.					*Natural processes like sedimentation continue.*														*Long-term RAOs met.*
				Cap-and -fill material applied to areas that do not dry.																
Monitoring																				
Waterfowl telemetry and mortality study	X	X	X	X	X	X	X	X		X					X					X
Aerial waterfowl surveys	X	X	X	X	X	X	X	X		X					X					X
White phosphorus monitoring of treated ponds	X	X	X	X	X															
White phosphorus composite sampling in untreated areas	X	X	X	X	X															
GIS database management	X	X	X	X	X	X	X	X		X					X					X
Ponds survey, ground truthing, limited aerial survey	X								X	X	X	X	X	X	X	X	X	X	X	X
Aerial photography and interpretation	X		X		X		X		X											
Mapping of physical habitat changes and vegetation rebound	X			X				X				X				X				X
Treatment																				
Pond pumping treatment	X	X	X	X	X															
Cap and fill application					X															
Cap and fill integrity inspection					X	X	X	X		X					X					X
Hazing (contingency)	X	X	X	X	X															

Assumptions:

1. Active remediation will be performed until Year 5. Treatment progress and monitoring technique will be evaluated during the 5-year review.
2. Waterfowl mortality will decline after each year of treatment.
3. A trend will be established to justify that reaching the short-term mortality goal is the result of treatment (white phosphorus removal), and not just a limited data set.
4. Cap-and-fill material will be applied to 2.17 acres of pond bottoms at Year 5. It is assumed that 5% of Pond 146, 5% of Pond 155, and 10% of Northern A ponds will not dry.
5. Telemetry and mortality studies, aerial waterfowl surveys, reduced white phosphorus sampling, limited GIS database management, and studies of habitat rebound will be performed for an additional 3 years after active pumping is complete. This additional monitoring is to ensure that cleanup objectives are not only reached, but also maintained.
6. Telemetry and mortality studies, aerial waterfowl surveys, limited GIS database management, and limited studies of habitat rebound will be performed at Years 10, 15, and 20 to ensure that cleanup objectives are maintained.
7. Limited site visits to inspect for waterfowl mortality, physical habitat changes, and vegetation rebound will be performed during years that telemetry mortality studies are not performed. Assessment will be performed visually on foot and by air.

be conducted at Year 10, Year 15, and Year 20 to ensure that remedial action objectives continue to be maintained.

- Perform limited aerial surveys and ground truthing during Year 9 to Year 20 to evaluate waterfowl mortality, physical habitat changes, and vegetation rebound.
- Perform aerial photography every other year for 10 years (beginning in 1999) to monitor habitat changes resulting from remedial actions. Changes in drainage, topography, and vegetation would be evaluated.
- Perform habitat mapping once every 4 years for 20 years to evaluate impacts to habitat as a result of remedial actions, as well as to observe habitat rebound after pumping is discontinued.
- Perform limited hazing (only as a contingency) during first 5 years starting in 1999 if incidental hazing from pumping operations and other fieldwork activities does not deter bird usage.
- After remedial action objectives are achieved and pumping is discontinued, apply cap-and-fill material in ponded areas that did not drain and dry sufficiently to enable the white phosphorus to sublimate and oxidize. Cap-and-fill material placement is expected to occur in Year 5 (2003).
- Monitor cap and fill material integrity every year for 4 years after the material is placed, and also at Year 10, Year 15, and Year 20.
- Incorporate white phosphorus sampling, telemetry, aerial survey, habitat, and physical landform data into a GIS database. Perform GIS management every year for the first 8 years, starting in 1999, and then during Year 10, Year 15, and Year 20.
- Maintain institutional controls, including the restrictions governing site access, construction, and road maintenance and the required training for personnel who work at OU-C source areas.

The concept of appropriate institutional controls and expectations about their use, as specified in the NCP at 40 CFR 300.430(a)(1)(iii)(D), is incorporated by reference into this ROD.

Institutional control SOPs applicable to selected remedies at CERCLA OUs on Fort Richardson are currently being developed by the Army in close consultation with the EPA and ADEC. They will be completed and incorporated into the final OU-D ROD for Fort Richardson. These institutional control SOPs will be implemented sitewide for all of Fort Richardson when the OU-D ROD is signed. The SOPs will include institutional controls that specify particular restrictions, controls, and mechanisms that will be used to protect public health, safety, and the environment. The objective of these institutional controls is protection of human health, safety, and the environment by limiting or preventing access to contaminated areas or otherwise denying exposure pathways.

7.2 Agency Review of the Selected Remedy

The goal of this remedial action is to reduce waterfowl deaths attributed to white phosphorus. Section 5 outlines the RAOs for OU-C. On the basis of information obtained during the RI and careful analysis of all remedial alternatives, the Army, EPA, and ADEC believe that the selected remedy will achieve this goal. Monitoring data will be reviewed by the EPA, ADEC, and the Army every year pumping occurs to determine whether the selected remedy is meeting or will meet the short-term and long-term RAOs. This telemetry monitoring will continue until short-term RAOs are met. It will continue for 3 years after achieving the short-term RAO to ensure that the short-term RAO is consistently maintained. After that time, monitoring will be conducted at Year 10, Year 15, and Year 20 to determine whether the long-term RAOs are being met by the selected remedy.

If at any time, monitoring data reveal that either the short-term or long-term RAOs (or both) are not being met, then the EPA, ADEC, and Army will meet within 3 months of the discovery of these failures of the selected remedy in order to determine what, if any, changes are needed to the selected remedy in order to provide adequate protection of human health and the environment.

Because the remedy will result in hazardous substances remaining on site above levels specified in the long-term RAOs, a review will be conducted within 5 years after commencement of the selected remedial action to ensure that the remedy continues to provide adequate protection of human health and the environment. This 5-year review process will continue on 5-year increments until the selected remedy has been certified by the EPA, ADEC, and Army to be complete. After the first 5 years of implementation, if the monitoring and performance data indicate that the selected remedy and any enhancements to the selected remedy are not protective of human health and the environment, the selected remedy will be reevaluated by the EPA, ADEC, and Army to determine what, if any, changes or additional remedial actions are necessary to protect human health and the environment. At this time, the telemetry results, interpretation methods, and remedial action objectives will also be reevaluated.

SECTION 8

Statutory Determinations

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

8.1 Protection of Human Health and the Environment

The selected remedy for OU-C will provide long-term protection of human health and the environment and satisfy the requirements of Section 121 of CERCLA.

The selected remedy will provide long-term protection of human health and the environment by draining ponds and removing the white phosphorus contamination from sediments through drying of the sediments and subsequent sublimation and oxidation of the white phosphorus particles. The small, deep, isolated areas of pond bottoms that do not dry sufficiently will be covered with a cap-and-fill technology. Draining ponds and drying sediments to allow the white phosphorus to sublimate will eliminate the potential exposure route for waterfowl. Monitoring will be completed to ensure the effectiveness of the remedy.

Hazing will be conducted at ERF as a contingency measure during critical migration periods to reduce the threat of exposure to contaminated sediments until remediation goals are met.

Institutional controls will be in place to limit access to OU-C and minimize the threat of exposure to Army training activities and onsite UXO.

No unacceptable short-term risks will be caused by implementation of the remedy.

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

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

8.2.1 Applicable or Relevant and Appropriate Requirements

An ARAR may be either applicable or relevant and appropriate. Applicable requirements are those cleanup standards, criteria, or limitations promulgated under federal or state law that specifically address the situation at a CERCLA site. A requirement is applicable if the jurisdictional prerequisites of the environmental standard show a direct correspondence when objectively compared with the conditions at the site. An ARAR is relevant and appropriate if, although it may not meet the definition of "applicable," it is promulgated under federal or state law and still addresses problems or situations sufficiently similar to those encountered at the CERCLA site so that the use of the ARAR is well-suited to the particular area.

Pursuant to EPA guidance, ARARs generally are classified into three categories: chemical-specific, location-specific, and action-specific requirements. This classification was developed to help identify ARARs, some of which do not fall precisely into one group or another. These categories of ARARs are defined below:

- **Chemical-specific ARARs** are usually health- or risk-based numerical values or methodologies that establish an acceptable amount or concentration of a chemical in an ambient environment.
- **Location-specific ARARs** are restrictions placed on the concentration of hazardous substances or the conduct of activity solely because the ARARs occur in special locations.
- **Action-specific ARARs** are usually technology- or activity-based requirements for remedial actions.

TBC requirements are generally nonpromulgated federal or state standards or guidance documents that are to be used on an as-appropriate basis in developing cleanup standards. They usually fall into three categories:

- Health effect information with a high degree of certainty
- Technical information about how to perform or evaluate site investigations or response actions
- State or federal policy documents

8.2.2 Chemical-Specific ARARs

On the basis of available information collected to date about the chemicals of concern associated with past activities at OU-C, white phosphorus at ERF has been identified as the chemical of concern. Currently, there are no promulgated numerical cleanup or discharge limitation values for white phosphorus; therefore, there are no chemical-specific ARARs for potential remedial actions at OU-C.

8.2.3 Location-Specific ARARs

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

This statute is applicable to the protection of wetlands at ERF. Section 404 of the CWA authorizes the COE to regulate the discharge of dredged or fill material into all "waters of the United States (including wetlands)." The definition of "discharge of dredged material" was revised by the EPA and COE (*Federal Register*, 58:45008) on August 25, 1993. Under the newly defined "discharge of dredged material," the COE regulates discharges associated with mechanized land clearing, ditching, channelization, and other excavation activities that destroy or degrade wetlands or other waters of the United States under Section 404 of the CWA.

The substantive requirements of the CWA Section 404 (b)(1) guidelines (hereinafter referred to as the Guidelines) are applicable to cleanup activities that involve water discharges from the pumping operations and channel clearing conducted in wetlands at ERF. The Guidelines were promulgated as regulations in 40 CFR 230.10 and include the following:

- 40 CFR 230.10(a) states that no discharge of dredged or fill material will be permitted if a practicable alternative exists to the proposed discharge that would have less impact on the aquatic ecosystem, as long as the alternative does not have other significant adverse environmental consequences.

- 40 CFR 230.10(b) states that no discharge of dredged or fill material will be permitted if it causes or contributes to violations of any applicable state water quality standard or violates any applicable toxic effluent standard or discharge prohibition under CWA Section 307.

- 40 CFR 230.10(c) prohibits discharges (or activities) that will cause or contribute to significant degradation of the waters of the United States.

- 40 CFR 230.10(d) states that when a discharge (or activity) would degrade the waters of the United States, and there are no practicable alternatives to the discharge, compliance with the Guidelines can be achieved generally through the use of appropriate and practicable mitigation measures to minimize or compensate for potential adverse impacts of the discharge (or activity) on the aquatic ecosystem.

8.2.4 Action-Specific Requirements

- Alaska Oil Pollution Regulations (Title 18, *Alaska Administrative Code*, Chapter 75 [18 AAC 75]) set requirements for discharge reporting, cleanup, and disposal of hazardous substances for spills of hazardous substances to Alaska's land or water within specified time frames. The broad ADEC definition of "hazardous substance" includes constituents such as oil and other petroleum products. The selected remedy will involve the use of onsite diesel generators to power the pump systems. These regulations are applicable for the discovery and cleanup of spills of diesel fuel or other hazardous substances at OU-C that are regulated by the State of Alaska.

- Alaska Water Quality Standards (18 AAC 70) in general, apply to groundwater and surface water and establish criteria for protected classes of water use. Where water is used for more than one purpose, the most stringent water-quality criteria ARARs will be used. Eagle River is protected for all water use classes. Specific criteria applicable to Eagle River will depend on the parameter being evaluated and the potential impact or discharge that may occur as a result of implementation of the remedy. The "Criteria for

Growth, Propagation of Fish, Shellfish, other Aquatic Life and Wildlife" are the most stringent and, therefore, applicable to OU-C. Because pumping and installation of cap-and-fill material may affect surface water, these ARARs are applicable.

- Regulations contained in 40 CFR 266, Subpart M, specify when military munitions become solid, and possibly hazardous, wastes and include requirements for storage and transportation of military munitions wastes that are designated as hazardous waste.

8.2.5 To-Be-Considered Criteria or Guidance

- Migratory Bird Treaty Act of 1918 and the treaties cited therein: This statute implements the 1916 Convention between the United States and Great Britain (for Canada) for the protection of migratory birds. It establishes a federal prohibition, to be enforced by the Secretary of the Interior, against the illegal taking of migratory birds. This prohibition applies to birds included in the respective international conventions between the United States and Great Britain, Mexico, Japan, and the Soviet Union. Fort Richardson is implementing remedial action at ERF primarily to protect migratory birds, to satisfy the intent of this treaty.

- Executive Order 11990, Protection of Wetlands: 40 CFR 6, Subpart A sets forth EPA policy for carrying out the provisions of Executive Order 11990, Protection of Wetlands. These regulations are applicable to cleanup and monitoring activities conducted in ERF wetlands. Activities will be conducted during implementation of the selected remedy to minimize adverse impacts to the wetlands.

- ADEC, Draft Water Quality Standards (18 AAC 70) and Draft Revision to Oil and Hazardous Substances Cleanup Standards, May 4, 1998 (18 AAC 75): These proposed regulations include numerical cleanup standards and procedures for developing risk-based cleanup standards for hazardous substance releases to ensure protection of human health and the environment. These draft regulations are TBCs for the cleanup of releases of hazardous substances, such as diesel fuel from pump generators, during remediation.

- Army Regulation (AR) 200-2 (Environmental Quality), Environmental Effects of Army Actions, states Department of Army policy, assigns responsibilities, and establishes procedures for the integration of environmental considerations into Army planning and decisionmaking in accordance with 42 *United States Code* 4321 *et seq., National Environmental Policy Act of 1969*; the Council on Environmental Quality regulations of November 29, 1978; and Executive Order 12114, *Environmental Effects Abroad of Major Federal Actions*, January 4, 1979.

- AR 210-20 (Master Planning for Army Installations) explains the concept of comprehensive planning and establishes policies, procedures, and responsibilities for implementing the Army Installation Master Planning Program. It also establishes the requirements and procedures for developing, submitting for approval, updating, and implementing the Installation Master Plan.

- AR 190-13 (Enforcement of Hunting, Trapping and Fishing on Army Lands in Alaska): Appendix B in this Army regulation describes enforcement of hunting, trapping, and fishing laws on Fort Richardson, Alaska. The appendix lists the Eagle River Flats Impact

Area, including a 300-meter buffer zone, as closed to all hunting and fishing; and also specifies that no fishing or watercraft are allowed in the Eagle River Flats Impact Area.

- AR 385-63 (Access Restrictions to Army Impact Areas and Ranges): Range safety, trespassing precautions, and education programs for range impact areas are included in Chapter 2 of this Army regulation. The regulation requires that SOPS be published for the safe operation and use of ranges and that ranges, maneuver areas, and training facilities be maintained and managed. In addition, range boundaries must be surveyed and posted as off-limits to prevent trespass by unauthorized personnel. This regulation also includes precautions that must be taken to prevent all unauthorized persons from entering the surface danger zones of a range before firing, trespassing on target ranges during firing, and entry into an impact area by unauthorized personnel until it has been searched and any duds are destroyed. Access for training maneuvers may be permitted upon completion of a visual surface clearance operation. Education requirements included in the regulation specify that all personnel must be properly cautioned on the dangers of UXO; military family members must be instructed that ranges are off-limits and cautioned about the hazards; and the local news media will be used periodically to warn nearby communities of the hazards in trespassing on range areas and handling UXO.

AR 350-2: Chapter 5 of this AR addresses impact areas, which include a high hazard impact area such as ERF. In the regulation, a high hazard impact area is defined as an impact area that is permanently designated within the training complex and used to contain sensitive HE ammunition and explosives and the resulting fragments, debris, and components. The regulation also requires that all impact areas are marked with warning signs, barriers, and/or guards. Passing any of these hazard warnings without Range Control permission is forbidden. Entry into an impact area must be approved by Range Control. In addition, the regulation requires that anyone observing personnel or vehicles in an impact area inform Range Operations immediately. Range Control will investigate, and request military police assistance, at the site.

8.3 Cost Effectiveness

The combination of remedial actions identified as the selected remedy for OU-C will reduce or eliminate the risks to human health and the environment at an expected cost of $5.7 million. The remedy is cost-effective. It provides an overall protectiveness proportional to its cost.

By tailoring the remedy so that pumping treatment is applied to ponds that are preferred by waterfowl and where white phosphorus has been detected and/or craters observed, the selected remedy cost-effectively provides an appropriate level of protection. Allowing natural processes to recover intermittent ponds avoids costly and unnecessary remedial action.

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

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

The selected remedy would use readily available technologies and would be feasible to construct. The placement and use of pumping systems and later use of cap-and-fill material would be focused on the areas of highest white phosphorus contamination in ERF sediments. Pumping and potential cap-and-fill technologies provide a permanent solution by eliminating the source of white phosphorus contamination or eliminating the exposure pathway.

8.5 Preference for Treatment as a Main Element

The selected remedy for OU-C satisfies the statutory preference for treatment of sediment by using pond pumping as the main method to permanently reduce the toxicity, mobility, and volume of contaminated sediment. Pond pumping will dry the pond bottoms to encourage sublimation and oxidation of white phosphorus particles from the sediment.

SECTION 9

OB/OD Pad

9.1 Site History

OB/OD Pad was used for open burning and open detonation of explosives on Fort Richardson from at least 1956, according to historical aerial photographs. Records and literature that specifically address OB/OD Pad are limited, especially information about the types and quantities of wastes burned and disposed. Most of the historical records were destroyed; however, some documentation is available for 1983 and 1985. Much of the recorded history of pad operations, acquired from file records and interviews with Explosive Ordnance Disposal personnel, is summarized in the *Operable Unit C RI/FS Management Plan* (1996) and the *Operable Unit C OB/OD Pad Site Investigation Work Plan* (1996).

The quantity of material disposed of at the site since its initial use in the 1950s is not known. From available Fort Richardson file information, the pad was used approximately five times per year during the summer months. Charges were limited to 100 pounds or less, and were frequently set off in sets of three to eight charges. Open detonation activities were typically conducted 1 day per month, from late spring to early fall. OB/OD activities conducted in the 1980s were limited to a 2-acre area in the western portion of the pad. Occasionally, explosive materials from non-military sources were detonated on the pad. Many of the materials destroyed at the pad were originally reactive, ignitable, and toxic. According to Explosive Ordnance Disposal personnel, no liquids, such as paint thinner or antifreeze, were disposed of at OB/OD Pad. Small quantities of diesel fuel, approximately 5 gallons or less, were used to ignite smaller pieces of ordnance in the 1960s. No OB/OD activities have been conducted at the pad since November 1988.

The only sampling program conducted at OB/OD Pad before the 1996 RI was the collection of surface soil samples by USAEHA in 1992. The sampling was intended to screen for potential surface soil contamination from OB/OD operations. Sampling was limited to surface soils primarily because of the danger of encountering UXO in subsurface soils.

9.2 Site Characteristics

9.2.1 Physical Features, Hydrogeologic Conditions, and Transport Pathways

OB/OD Pad was engineered in glacial till composed of sandy gravel and gravelly sand. The pad slopes toward the southwest, from the surrounding upland forest to the edge of ERF. The surface soils consist of poorly sorted sandy gravels, with a mix of pebbles, cobbles, and clayey soils. The gravel pad has been periodically graded in the past by the Army to facilitate use and access. Most of the grading occurred in the southwest corner, where most of the OB/OD activities were conducted in the past. The pad was graded as recently as 1994 during construction of a dredge spoils-retention basin. The pad supports a sparse vegetative cover in the form of woody shrubs, with some grasses and broad-leaved herbaceous plants.

A berm separates the pad from the forest on the northern border. The berm appears to consist of local material bulldozed from the pad surface and is more heavily vegetated than the pad. Beyond the berm lies a mixed forest of white spruce, alder, paper birch, and poplar. A road, controlled by a gate one-quarter mile from the pad, enters at the southeast corner of the pad and provides the primary vehicular access to the site.

On its southern side, OB/OD Pad contacts the wetlands of ERF. The contact appears to consist of surface material pushed from the pad a short distance onto the wetlands. This edge now forms a bluff rising approximately 10 feet from the marsh.

Disposal through burning was performed either on the ground surface or in an excavated pit. Materials that were destroyed during OB/OD activities included fuses, HE projectiles, smoke pots, mortar rounds, star clusters, flares, mines, rocket motors, shape charges, detonation cord, dynamite, and some flammable solids. Existing records indicate that no liquids were disposed of there. During the 1960s, smaller pieces of ordnance were ignited on the ground surface by using diesel fuel. Occasionally pits were excavated and small-arms ammunition was disposed of by covering with other material soaked in a small volume of diesel fuel and igniting. The ordnance disposal by detonation would tend to spread shrapnel and explosives over adjacent areas on the pad surface.

During well drilling for the 1996 RI, a layer of gravel, generally 6 to 13 feet thick, was observed overlying poorly graded sand throughout the depth the wells were drilled. The coarse-grained material suggests that precipitation infiltrates freely through the pad surface to the groundwater table. Groundwater elevations range from 19 to 36 feet below the ground surface. On the basis of groundwater measurements taken during the RI, the water table appears to be generally flat with a slight gradient to the southwest. It is believed that the groundwater movement patterns are strongly influenced by both the tides and Eagle River.

9.2.2 Nature and Extent of Contamination

Surface soil sampling conducted by USAEHA in 1992 for a list of five explosive-related analytes showed that contaminants were spread throughout the pad, with most contamination found at depths less than 18 inches and predominantly on the western half of the pad. An additional study conducted at the ERF in 1991 analyzed 128 sediment samples collected along transects extending from the edge of OB/OD Pad into ERF. Elevated concentrations (greater than 1 part per million) of 2,4-dinitrotoluene (2,4-DNT) were recorded in over half the samples, indicating that some migration of OB/OD Pad contaminants into ERF had occurred in the past. The concentrations of 2,4-DNT were not considered acutely toxic.

The RI of the soil and groundwater at OB/OD Pad was completed in 1996. Nine monitoring wells were installed and developed, and groundwater samples were collected. Surface and subsurface soil and groundwater samples were analyzed for an extensive list of volatile and semivolatile organic chemicals, including those included in the 1992 investigation, and metals. During the 1996 RI, very few chemicals were detected in either the soil or the groundwater All detected chemicals had concentrations considerably below their action levels specified in the *Operable Unit C RI/FS Management Plan* (1996). Figures 9-1 and 9-2 show sampling locations and the metal and organic concentrations detected in soil samples collected during the RI. Table 9-1 summarizes the regulatory levels for soil compared to the

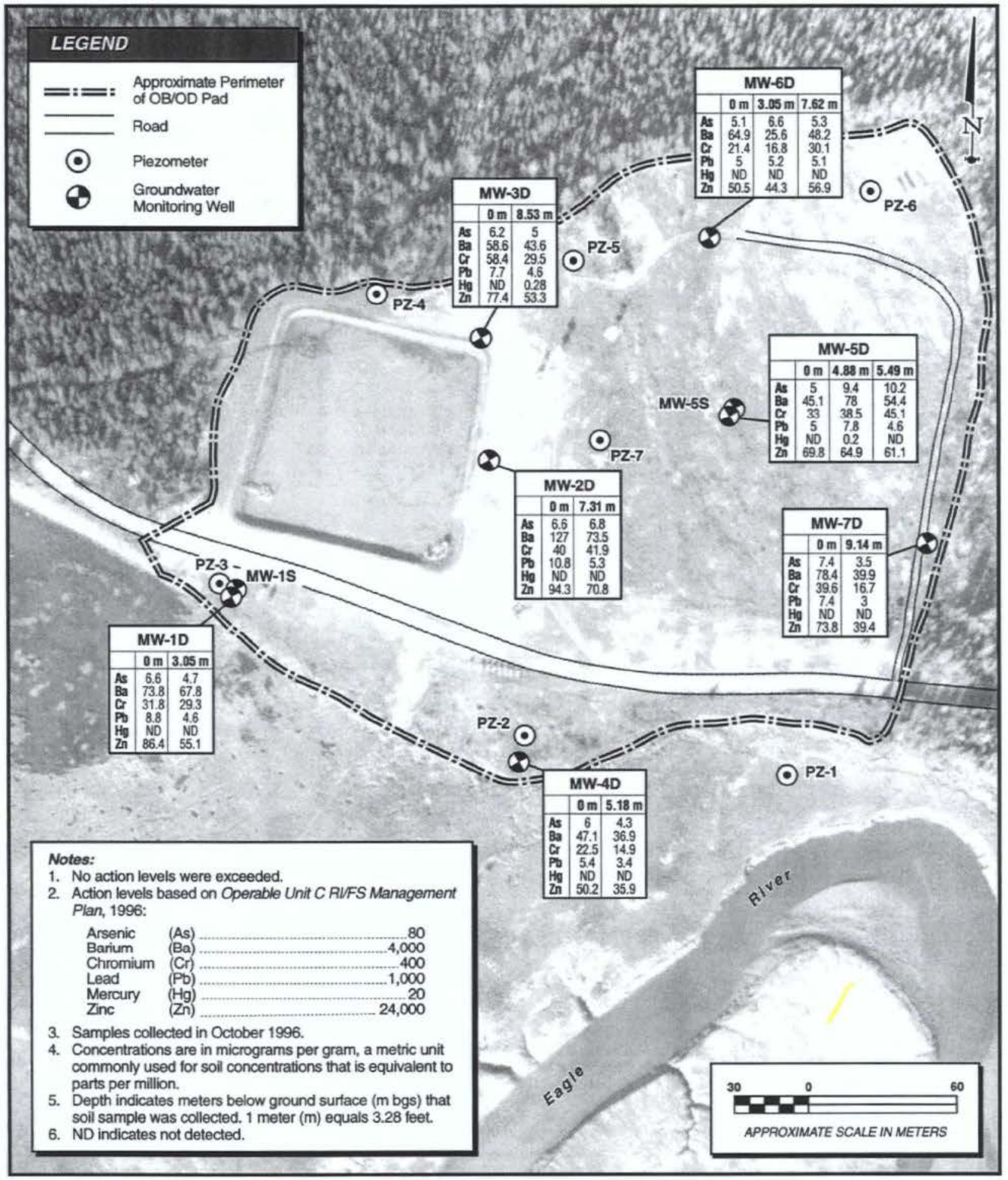


Figure 9-1

Metal Concentrations in Soil

OU-C Record of Decision

140927.LO.30 Metals 06/16/98 anc/jb

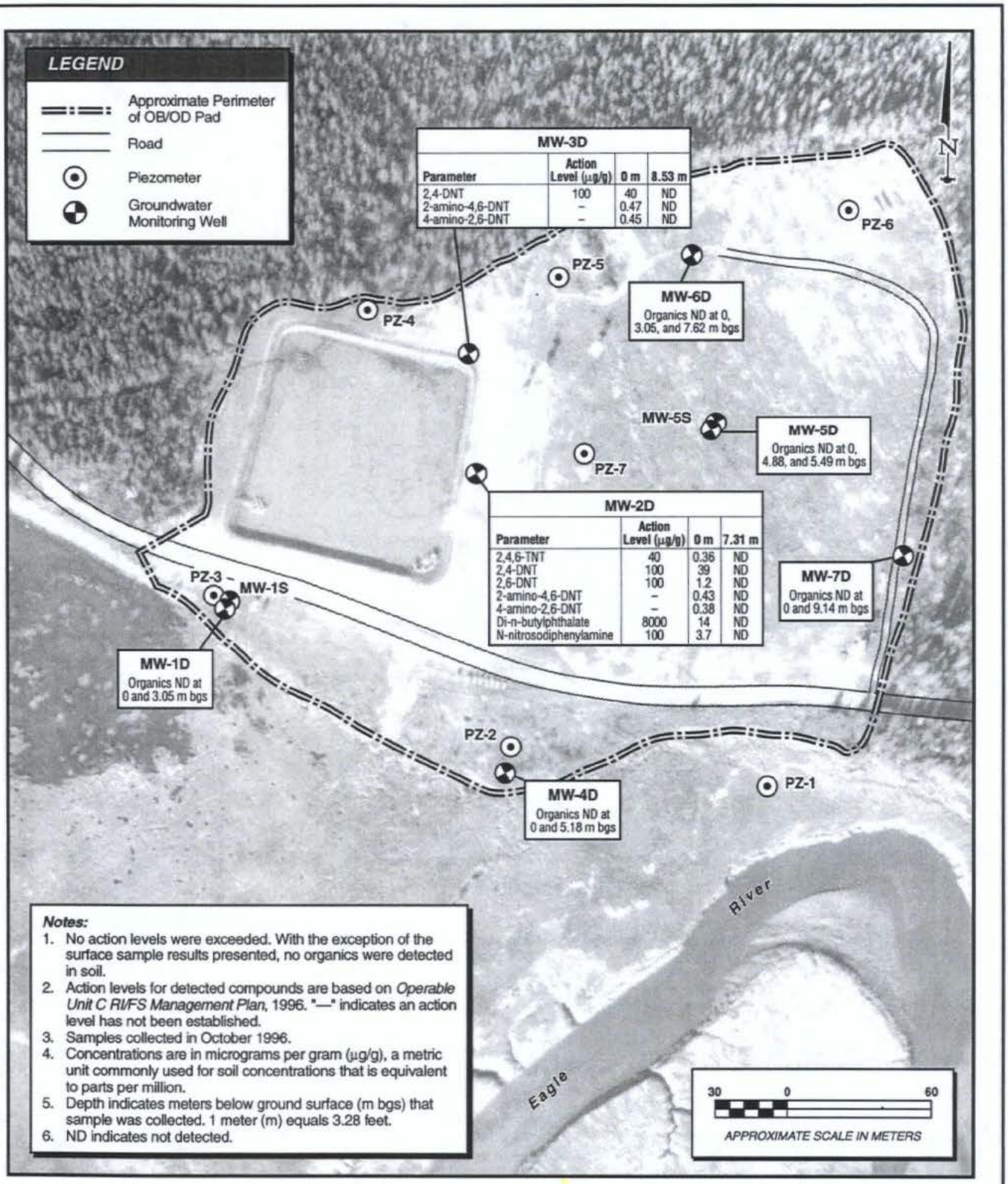


Figure 9-2

Organic Concentrations in Soil

OU-C Record of Decision

140927 LO 30 Organics 06/16/98 anc/lp

TABLE 9-1
Regulatory Levels for Detected Chemicals in Soil

Parameter	Action Level[a] (µg/g)	Maximum Concentration in OB/OD Pad Samples (µg/g)	Number of Boreholes with Detected Constituents
2,4,6-TNT	40	0.36	1
2,4-DNT	100	40	2
2,6-DNT	100	1.20	1
2-Amino-4,6-DNT	none	0.47	2
4-Amino-2,6-DNT	none	0.45	2
Arsenic	80	10.2	7
Barium	4,000	127	7
Chromium	400	58.4	7
Lead	1,000	10.8	7
Mercury	20	0.28	2
Zinc	24,000[b]	86.4	7
Di-n-butylphthalate	8,000	14	1
N-nitrosodiphenylamine	100	3.7	1

[a] Source: *Operable Unit C RI/FS Management Plan*, 1996.

[b] For zinc chloride (as total zinc).

maximum concentrations for the detected chemicals in soil. Table 9-2 summarizes maximum metals concentrations from OB/OD Pad soil samples and representative values from reference areas in Alaska. The concentrations at OB/OD Pad are in the range of the reference values.

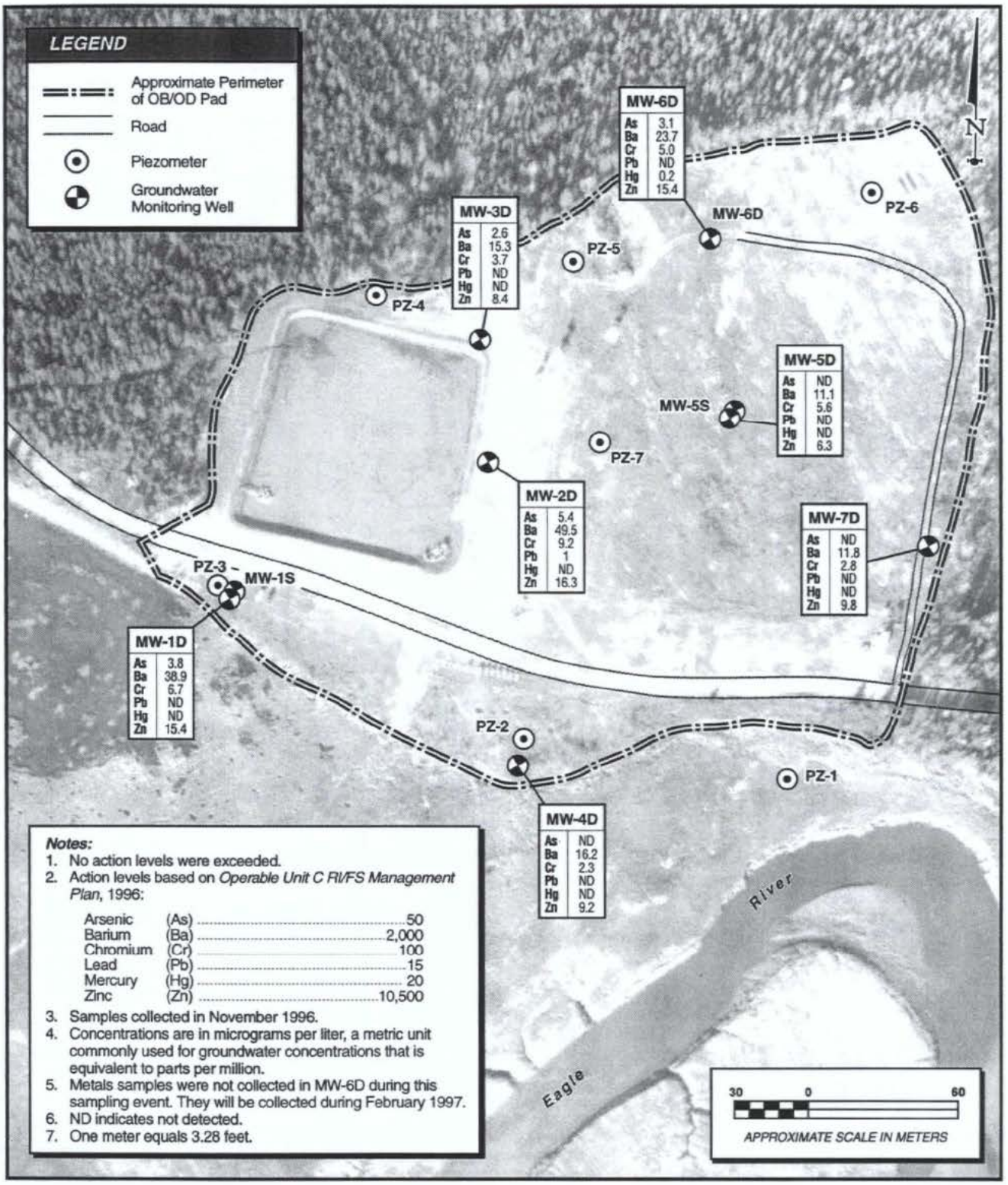
Figures 9-3 and 9-4, respectively, summarize the detected inorganic and organic concentrations for groundwater samples collected from the monitoring wells at OB/OD Pad. Table 9-3 summarizes the maximum detected organic and inorganic concentrations and compares them with reference values and cleanup action levels in the 1996 Management Plan. All groundwater concentrations were considerably below closure action levels, with the possible exceptions of chromium and zinc, which were determined to be naturally occurring compounds.

No organic compounds were detected in subsurface samples collected during the RI. Surface contamination was very low, indicating contaminants have not sorbed to soil particles. Very limited low-plasticity material was observed in the subsurface. It is likely that the limited presence and low concentrations of contaminants on the surface are the result of regular grading of OB/OD Pad.

TABLE 9-2
Sediment/Soil Concentrations from OB/OD Pad and Reference Areas (µg/g)

Chemical	Maximum in OB/OD Investigation	Fort Richardson and Elmendorf Mean Background[a]	Goose Bay Sediments[b]	Alaska Soils and Surficial Materials[c] (geometric mean, arithmetic mean)	Alaska Stream and Lake Sediments[c] (arithmetic mean)	Chugach Mountains[c] (geometric mean)	Average of Alaska Means[c] (geometric mean, arithmetic mean)	Arithmetic Mean of Eagle River Bridge and Cottonwood Slough Sediments[c]
Arsenic	10.2	5.46-7.2	15, 13	6.7, 9.6	17.3	--	6.7, 13	7
Barium	127	52.5-113.8	140, 110	595, 678	811	672	633, 744	190
Chromium	58.4	19.8-32	42, 21	50, 64	115	111	80, 89	56
Lead	10.8	5.3-10	12, 7.9	12, 14	12	25	18, 13	15
Mercury	0.28	--	<0.1, <0.1	--	--	--		0.097
Zinc	86.4	36.7-52.1	100, 86	70, 79	157	--	70, 118	133

[a]From *Background Data Analysis Report, Fort Richardson, Alaska,* Ecology and Environment, Inc., 1996.
[b]From *Interagency Expanded Site Investigation: Evaluation of White Phosphorus Contamination and Potential Treatability at Eagle River Flats, Alaska,* C. Bouwkamp, CRREL, 1994.
[c]From *Eagle River Flats Expanded Site Investigation,* Environmental Science and Engineering, Inc., 1990.



Notes:

1. No action levels were exceeded.
2. Action levels based on *Operable Unit C RI/FS Management Plan*, 1996:

Arsenic	(As)	50
Barium	(Ba)	2,000
Chromium	(Cr)	100
Lead	(Pb)	15
Mercury	(Hg)	20
Zinc	(Zn)	10,500

3. Samples collected in November 1996.
4. Concentrations are in micrograms per liter, a metric unit commonly used for groundwater concentrations that is equivalent to parts per million.
5. Metals samples were not collected in MW-6D during this sampling event. They will be collected during February 1997.
6. ND indicates not detected.
7. One meter equals 3.28 feet.

Figure 9-3

Metal Concentrations in Groundwater

OU-C Record of Decision

140927.L0.30 GW Metals 06/16/98 anc/jb

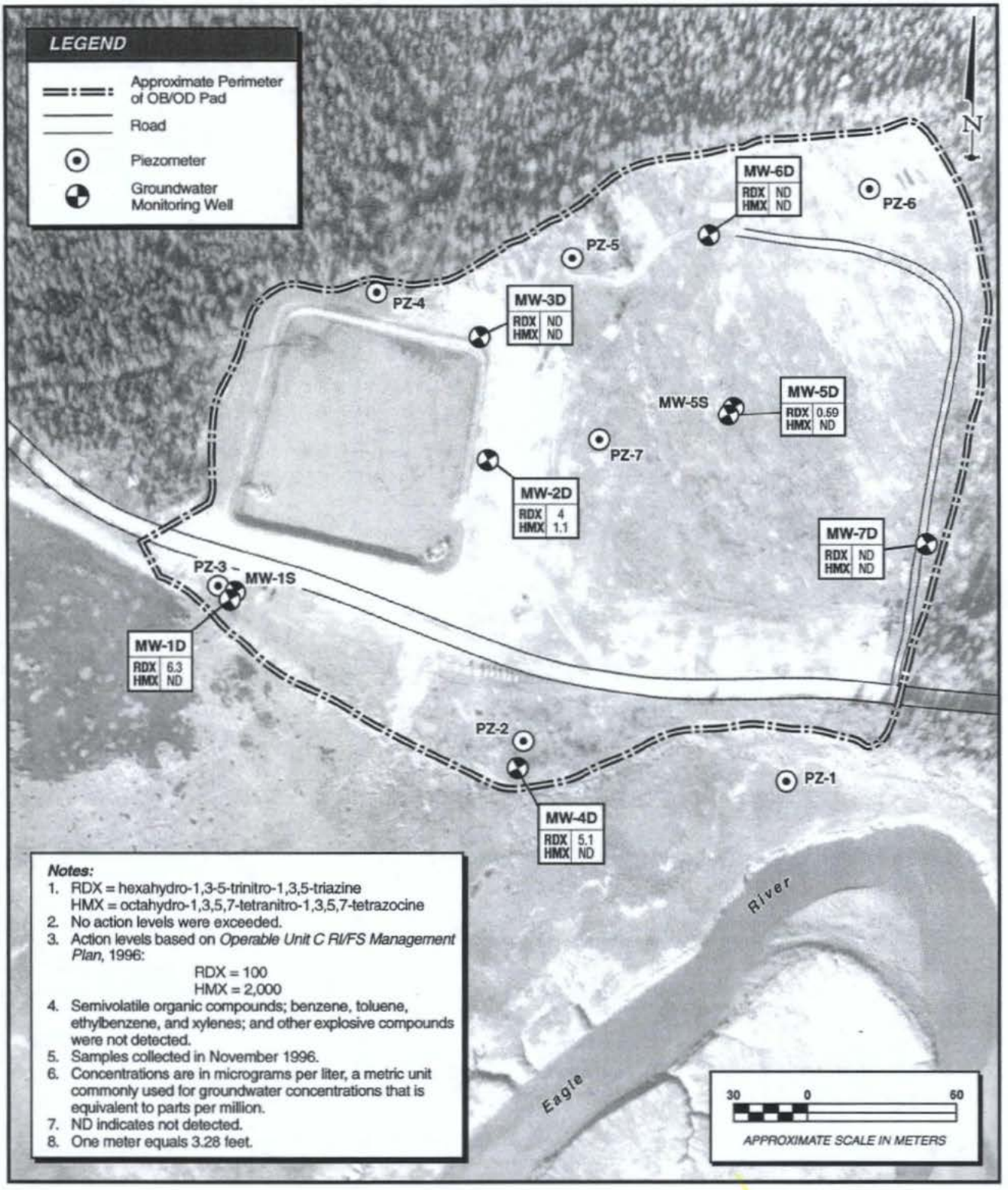


Figure 9-4

Organic Concentrations in Groundwater

OU-C Record of Decision

140927.LO.30 GW Organics 06/16/98 anc/jb

TABLE 9-3
Detected Chemicals in Groundwater

Parameter	Concentration (µg/L) Action Level[a]	Background[b]	Reference Area[c]	MCL[d]	Maximum in OB/OD Pad Investigation	Number of Wells with Detects
RDX	100	–	none	NA	6.3	4
HMX	2,000	–	none	NA	1.1	1
Arsenic	50	1-9.9	5	50	5.4	3
Barium	2,000	0.50-510	42	2,000	49.5	6
Chromium	100	1-46	5	100	9.2	6
Lead	15	0.23-11,200	1	15[e]	1	1
Mercury	2	0.10-0.64	2	2	0.2	1
Zinc	10,500[f]	1-1,300	6	5,000[g]	16.3	6

NA = Not available

[a]Source: *Operable Unit C RI/FS Management Plan, Fort Richardson, Alaska* 1996.

[b]Filtered metals, Fort Richardson background concentrations, *from Background Data Analysis Report, Fort Richardson, Alaska,* 1996.

[c]Eagle River Valley groundwater from *Eagle River Flats Expanded Site Investigation, Fort Richardson, Alaska*, 1990.

[d]MCL = Maximum contaminant level (EPA).

[e]Action level

[f]For zinc chloride (as total zinc).

[g]Secondary MCL.

9.3 Summary of Site Risks

9.3.1 Human Health Risk Assessment

The human health risk assessment for OB/OD Pad used an onsite recreation scenario to evaluate site risk. Although currently prohibited, people on rafts or other boats might gain access to OB/OD Pad by going under the Route Bravo Bridge on Eagle River or coming upstream from Knik Arm and hiking across ERF (Figure 4-1). Pad access is also possible by a road, but there is a locked gate with warning signs. No trespassers have been observed at OB/OD Pad, however.

For the recreational scenario in OB/OD Pad, an upper-bound risk assessment for exposure to the surface soil was performed. As with this scenario at ERF, it was assumed that child and adult intruders are on OB/OD Pad for a few hours on each of 10 days in the summer. A child was assumed to weigh 36 kg, ingest 200 mg of soil per visit, and visit the pad 10 times per year for 10 years. An adult was assumed to weigh 70 kg, ingest 100 mg of soil per visit, and visit the pad 10 times per year for 20 years. These were considered to be conservative values given that no trespassers had been observed at the pad.

Exposure to soil was calculated according to the following equation:

$$E = C*IR*EF*ED/(1{,}000{,}000*BW*AT)$$

where:

E	=	exposure (mg/kg-bw/day)
C	=	soil concentration (µg/g)
IR	=	soil ingestion rate (mg/day)
EF	=	exposure frequency (days/year)
ED	=	exposure duration (years)
BW	=	body weight (kg)
AT	=	days averaging time (365*ED for noncancer effects and 25,550 for cancer effects)

Hazard indexes and cancer risks were calculated for the detected chemicals at each sampling location. The noncancer risks were evaluated as a hazard quotient, which is calculated as follows:

$$HQ = E/RfD$$

where:

HQ	=	hazard quotient
E	=	exposure (mg/kg-bw/day)
RfD	=	reference dose (mg/kg-bw/day)

The cancer risk was calculated from:

$$R = E*SF$$

where:

R	=	cancer risk (excess lifetime cancer risk)
E	=	exposure (mg/kg-bw/day)
SF	=	oral slope factor (kg-day/mg)

By using the recreational scenario assumptions described above, the calculated cancer risks were about 10^{-7} for the child and adult, and the largest calculated hazard indexes were 0.01 and 0.003 for the child and adult, respectively.

The concentrations of arsenic and chromium are similar to those at nearby reference areas. If these chemicals are excluded from the risk calculations, the cancer risks and hazard indexes decrease because these metals are significant contributors. The EPA has used a cancer risk level of 1×10^{-6} and a hazard index of 1 as levels of concern. Calculated risks for the recreational scenario are substantially less than these levels of concern.

Table 9-4 summarizes the toxicological characteristics from the EPA 1996 Integrated Risk Information System (IRIS) database for the detected chemicals. Because IRIS does not have information on two of the detected chemicals, 2-amino-4,6-DNT and 4-amino-2,6-DNT, they are not included in the table.

Excess lifetime cancer risk is the incremental increase in the risk of getting cancer over and above the rate one would have if not exposed to the conditions of the defined recreational

TABLE 9-4
Toxicological Parameters

Chemical	Noncancer Effects						Cancer Effects	
	Oral Reference Dose (mg/kg/day)	Uncertainty Factor	Modifying Factor	Confidence in Study	Confidence in Database	Confidence in Value	Weight of Evidence	Oral Slope Factor (kg-day/mg)
Arsenic	0.0003	3	1	medium	medium	medium	A	1.5
Barium	0.07	3	1	medium	medium	medium		
Chromium III	1	100	10	low	low	low		
Chromium VI	0.005	500	1	low	low	low	A	
Lead							B2	
Mercury							D	
Zinc	0.3	3	1	medium	medium	medium	D	
2,4,6-TNT	0.0005	1,000	1	medium	medium	medium	C	0.03
2,4-DNT	0.002	100	1	high	high	high		
2,6-DNT	0.001	3,000						
Di-n-buytlphthalate	0.1	1,000	1	low	low	low		
N-nitrosodiphenylamine							B2	0.0049

Modifying factor—An uncertainty factor which is greater than zero and less than or equal to 10; the magnitude of the MF depends upon the professional assessment of scientific uncertainties of the study and database not explicitly treated with the standard uncertainty factors (e.g., the completeness of the overall data base and the number of species tested); the default value for the MF is 1.

Uncertainty factor—One of several, generally 10-fold factors, used in operationally deriving the reference dose (RfD) from experimental data. UFs are intended to account for (1) the variation in sensitivity among the members of the human population; (2) the uncertainty in extrapolating animal data to the case of humans; (3) the uncertainty in extrapolating from data obtained in a study that is of less-than-lifetime exposure; and (4) the uncertainty in using lowest-observed adverse effect data rather than no-observed adverse effect data.

Weight-of-evidence for carcinogenicity—The extent to which the available biomedical data support the hypothesis that a substance causes cancer in humans. A: Human carcinogen. B1: Probable human carcinogen, indicating that limited human data are available. B2: Probable human carcinogen, sufficient evidence in animals, and inadequate or no evidence in humans. C: Possible human carcinogen. D: Not classifiable as to human carcinogenicity. E: Evidence of noncarcinogenicity for humans.

exposure scenarios. The individual chemical cancer risks were summed across chemicals to estimate the risk associated with a simultaneous exposure to multiple chemicals.

Table 9-5 summarizes the calculated risks. The calculated cancer risks are about 10^{-7} for the child and adult at all sampling locations, with the major contribution from the arsenic concentrations. However, concentrations of arsenic in OB/OD Pad are similar to other surrounding non-contaminated areas. If arsenic is excluded from the cancer risk estimate, the calculated cancer risks decrease by about an order of magnitude.

TABLE 9-5
Summary of Risks in the Onsite Recreational Scenario

	Hazard Index		Cancer Risk	
Location	**Adult**	**Child**	**Adult**	**Child**
MW-1	0.0030	0.001	1×10^{-7}	2×10^{-7}
MW-2	0.0008	0.003	1×10^{-7}	2×10^{-7}
MW-3	0.003	0.01	1×10^{-7}	2×10^{-7}
MW-4	0.0002	0.008	1×10^{-7}	2×10^{-7}
MW-5	0.0003	0.001	8×10^{-8}	2×10^{-7}
MW-6	0.0002	0.0008	9×10^{-8}	2×10^{-7}
MW-7	0.0004	0.001	1×10^{-7}	2×10^{-7}

The onsite recreational scenario is a potential future scenario, because there is no evidence that it is occurring today. It involves assumptions of representative concentrations, soil ingestion rates, and frequency and duration of visits.

The hazard indexes range from 0.0008 to 0.01 for the child and 0.0002 to 0.003 for the adult, with the major contribution from chromium concentrations (with the assumption of chromium VI) at all locations. At Well MW-2, 2,4-DNT is also a significant contributor. At Well MW-3, 2,4,6-TNT is a significant contributor. The chromium concentrations measured at OB/OD Pad are similar to reference values in surrounding non-contaminated areas. If chromium is excluded from the assessment, all hazard indexes decrease by different amounts, depending on the relative contribution of chromium to the hazard index.

In considering the value of the cancer risk, the EPA has used a cancer risk level of 1×10^{-6} or less as acceptable for hazardous waste sites. Under the recreational scenario at all sampling locations, the cancer risks in Table 9-5 are about 10^{-7}, which is less than the cancer risk criterion, and the noncancer hazard indexes also are considerably under their criterion of one.

Uncertainties are present in this assessment, including future human activities in the area, probability and magnitude of UXO detonation, environmental concentrations, appropriate exposure factors for the scenarios, and toxicity factors. Because the calculated hazard quotients are so small, it is unlikely that other reasonable combinations of exposure factors could result in a hazard quotient greater than 1 for the scenarios. It is likely that the greatest risk in the recreational scenarios come from potential explosions from UXO.

9.3.2 Ecological Risk Assessment

A number of inorganic and organic contaminants were detected in surface soils and groundwater at OB/OD Pad during the 1996 RI. The surface soil and groundwater contaminants were observed at relatively low levels in samples collected from the soil borings and installed monitoring wells on OB/OD Pad. All detected inorganic and organic contaminants were considerably below regulatory levels included in the 1996 Management Plan. Groundwater contaminants would be diluted even further as groundwater discharged into and mixed with surface waters of ERF. Therefore, none of the detected contaminants in groundwater was retained as a COPEC for OB/OD Pad.

Inorganic and organic surface soil contaminants were screened to determine whether any of these chemicals should be considered as a COPEC for OB/OD Pad. The maximum detected inorganic concentrations from recent soil samples were similar to or below corresponding background levels. Therefore, none of the inorganic chemicals was retained as a COPEC.

Additional risk to ecological receptors at OB/OD Pad was assessed by comparing maximum concentrations of detected organic chemicals to available data or derived critical toxicity values (CTVs). Organic chemicals were compared to soil CTVs derived for a small mammal, the deer mouse, considered to be representative of small rodents at OB/OD Pad (Table 9-6). None of the organic soil contaminants detected at the pad was retained as a COPEC.

Larger mammals were not expected to derive a significant proportion of their diet on the limited pad area. Risk to plants was estimated, but toxicity to plants and significant uptake and bioaccumulation of the detected explosive residues or semivolatile organic compounds was not expected to occur. Overall use of OB/OD Pad by ducks, as indicated by telemetry and lack of preferred feeding habitat, was very low (about 1 percent of all observations). Therefore, waterfowl were not evaluated as potential ecological receptors. Risk to terrestrial invertebrates was not evaluated because of the lack of applicable CTVs. None of the detected contaminants in the OB/OD Pad surface soil and groundwater samples were retained as a COPEC. Therefore, OB/OD Pad was not considered to be an area of potential ecological concern.

On the basis of results of the 1996 site investigation at OB/OD Pad and an evaluation of data collected during previous studies at this site, no further action is selected for OB/OD Pad for hazardous chemicals. Because of concerns regarding potential human exposure to UXO, existing institutional controls to monitor and control access to OU-C apply to OB/OD Pad.

9.4 OB/OD Pad Closure

This ROD selects the final remedial action for OU-C, as well as the EPA decision under RCRA regarding hazardous waste closure of the OB/OD Pad at this time. (The OB/OD Pad is being treated administratively as part of OU-C as agreed by the EPA, ADEC, and Army in the 1994 FFA.)

The EPA, ADEC, and Army are issuing this ROD as part of their public participation responsibilities under Section 117(a) of CERCLA. The EPA also is issuing this ROD pursuant to public notice and other requirements for closure of the OB/OD Pad, which is a

TABLE 9-6
Critical Toxicity Values for Organic Soil Contamination at OB/OD Pad[a]

Organic	Maximum Reported OB/OD Pad Value (µg/g)	Deer Mouse[b] Soil CTV	COPEC[c]
2,4,6-TNT	0.36	2	No
2,4-DNT	39	10	No[e]
2,6-DNT	3.9U	199	No
2-amino-4,6-DNT	0.47	103	No
4-amino-2,6-DNT	0.45	103	No
Di-n-butylpthalate[d]	14	3,718	No
N-nitrosodiphenylamine	4.2	251	No

Notes:
µg/g = micrograms per gram. This metric unit of measurement is commonly used for soil concentrations. It is equivalent to parts per million.
TNT = Trinitrotoluene
U = Flagged by laboratory as estimated value.
[a] CTV derived as described in Toxicological Benchmarks for Wildlife, Electronic Database VI.5, U.S. Department of Energy, 1996, and *Wildlife Exposure Factors Handbook*, EPA, 1993.
[b] Deer mouse considered to represent small mammal receptors at site.
[c] Chemical of potential ecological concern
[d] *Toxicological Benchmarks for Screening Potential Contaminants of Concern for Effects on Terrestrial Plants* (Suter et al., Oak Ridge National Laboratory, 1993) estimates a no observed effect concentration for plants at 200 µg/g that represents a soil CTV for plants.
[e] CTV is a conservative extrapolation that assumes plant concentration in mouse diet is equal to soil concentration. The deer mouse soil CTV is derived from data from dog toxicity studies that increases uncertainty in the value.

hazardous waste regulated unit under the authority of Sections 3004(a) and 3005(e) of RCRA, as amended, and its implementing regulations codified in 40 CFR 264 and 265.

The EPA, ADEC, and Army recognize the similarities between RCRA corrective action and CERCLA remedial action processes and their common objective of protecting human health and the environment from potential releases of hazardous substances, wastes, or constituents. Actions taken to remediate OU-C will comply with the provisions of both CERCLA and RCRA.

The EPA, ADEC, and Army are electing to combine response actions under RCRA and CERCLA remedial action primarily because the OB/OD Pad is administratively subject to RCRA closure authority; however, the OB/OD Pad also is in the same physical location as the rest of OU-C, which is subject to CERCLA authority. Thus, regardless of regulatory authority, it is only natural that the investigation and, if necessary, any remedial physical response be applied to these adjacent OU-C areas. In addition, there were similar, but not identical, historical actions that took place at the OB/OD Pad (destruction of explosives) in comparison to the rest of OU-C (use as a firing range with residuals of explosives remaining). By applying CERCLA authority concurrently with RCRA closure and corrective

action requirements through this integrated plan, the EPA, ADEC, and Army intend to minimize response costs as much as possible while remaining fully protective.

This ROD for OU-C fulfills the RCRA corrective action and the CERCLA remedial action processes for describing and analyzing closure and remedial alternatives. (The 1996 RI was functionally equivalent to a RCRA facility investigation.) To fulfill the requirements for the RCRA closure process, the Army will submit a closure plan in accordance with procedures described in Section 9.4.1

9.4.1 Closure Process

The OB/OD Pad was identified in the 1991 Federal Facility Compliance Agreement (FFCA), signed by the Army and EPA, as a RCRA-regulated, land-based unit. As such, the OB/OD Pad is subject to the interim status standards codified in 40 CFR 265. Under the 1991 FFCA, the Army was required to submit a closure plan for this unit that had to comply with the requirements for closure codified in 40 CFR 265, Subparts G and P. In addition, pursuant to the terms of the 1994 CERCLA FFA, the Army, ADEC, and EPA agreed that where feasible, any RCRA corrective actions required at solid waste management units at Fort Richardson would be integrated with any ongoing CERCLA response actions so that duplication of effort would not occur and the Army could realize cost savings as a result. However, the 1994 FFA also specified that such integration efforts would not obviate the need for the Army to meet its RCRA closure obligations under the 1991 FFCA.

Although the OB/OD Pad is not currently active, EPA believes that it is prudent to allow final RCRA closure of the OB/OD Pad concurrently with final clearance of the operating range. Because the OB/OD Pad is physically part of the operating range, RCRA closure at this time would be technically complex, with little, if any, demonstrable environmental benefit. In addition, as part of the RCRA/CERCLA integration effort under the 1994 FFA, the Army has completed some investigatory work and sampling efforts at and near the OB/OD Pad. The result of these activities indicate levels of organic and metal contaminants below any health-based action levels and RCRA "clean closure" requirements. For these reasons, the EPA is approving a delay of closure of the OB/OD Pad in accordance with 40 CFR 265.113(b)(1)(i). Delay of closure under this provision is subject the requirements of 40 CFR 265.113(b), which states, among other things, that final closure, by necessity, will take longer than 180 days to complete.

Additionally, the facility must take, and continue to take, all steps to prevent threats to human health and the environment from the unclosed, but not operating, hazardous waste management unit or facility, including compliance with applicable interim status requirements, 40 CFR 265.113(b)(2). The Army has indicated, and the EPA agrees through the signing of this ROD, that the OB/OD Pad meets the requirement for extension of time for closure specified in 40 CFR 265.113(b)(1)(i), provided that an interim closure plan acceptable to EPA is completed by the Army as specified below.

According to the requirement specified in the 1991 FFCA and in 40 CFR 265.112(a) for compliance with RCRA interim status standards, the Army will submit, within 150 days from the date the ROD for OU-C becomes final, a draft interim closure plan for the OB/OD Pad that meets the requirements specified in 40 CFR 265, Subparts G and P. The draft interim closure plan will be developed and completed in accordance with the procedures for submittal and review of primary documents specified in Paragraphs 20.12 through 21.13

of the 1994 FFA. Final closure will occur under the authority of the 1991 FFCA, RCRA, and its implementing regulations.

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

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

The findings of this evaluation will be submitted to EPA for review and approval. If either the EPA or the Army believe that delay of closure is no longer viable, the OB/OD Pad will be closed under the substantive and procedural RCRA closure requirements in effect at that time, and at that time, the Army will revise and resubmit the interim closure plan for the OB/OD Pad to the EPA for review and approval. Upon approval of the final closure plan, the Army will close the OB/OD Pad in accordance with the terms and conditions of that final closure plan.

In addition, the Army may elect to close the site under 40 CFR 265, Subparts G and P, at any earlier time. This closure will also require compliance with all substantive and administrative closure requirements, including EPA approval.

SECTION 10

Documentation of Significant Changes

The selected remedy for the ERF portion of OU-C is the same as the preferred alternative described in the Proposed Plan.

In the Proposed Plan, the OB/OD Pad was not identified as a RCRA unit subject to closure. Subsequent review of the Administrative Record indicated that it is necessary to close the OB/OD Pad in accordance with the administrative and substantive requirements in 40 CFR 265, Subparts G and P, and the 1991 FFCA. Section 9.4 of this ROD outlines the procedures that the Army will follow to close the OB/OD Pad.

Appendix A
Fort Richardson Administrative Record Index Update

Administrative Record Index
Fort Richardson, Alaska

September 1998

Fort Richardson, Alaska Administrative Record Index Update for 1998

Page Numbers	OU	Cat No	Date	Title	Abstract	Author	Recipient
06888 06897 OU-C Book 2	C	1.1	2/15/88	Memorandum of Understanding	Contained within the EA for the resumption of firing in the Eagle River Flats Impact Area; provides for formalization of the Eagle River Flats Task Force among the key agencies.	None Given	None Given
06163 06163 OU-C Book 1	C	1.1	3/10/92	Eagle River Flats Task Force Administrator Heads	Eagle River Flats Task Force administrative heads.	None Given	None Given
06162 06162 OU-C Book 1	C	1.1	3/10/92	Eagle River Flats Task Force Agencies	Eagle River Flats Task Force agencies.	None Given	None Given
06164 06167 OU-C Book 1	C	1.1	3/10/92	Eagle River Flats Task Force Participants	Eagle River Flats Task Force participants.	None Given	None Given
06168 06175 OU-C Book 1	C	1.1	7/31/92	Memorandum of Agreement Between the Army Toxic and Hazardous Materials Agency and the 6th Infantry Division (Light) and Army Garrison, Alaska	Establishes the respective responsibilities of the parties for delivering technical assistance, procurement, contract management, and related services.	None Given	None Given
06176 06179 OU-C Book 1	C	1.1	4/26/93	Draft Memorandum of Understanding Between CRREL and Fort Richardson, Alaska	Establishes roles of CRREL in environmental studies conducted at Eagle River Flats.	None Given	None Given

Page Numbers	OU	Cat No	Date	Title	Abstract	Author	Recipient
06180 06191 OU-C Book 1	C	1.1	8/15/93	Distribution of White phosphorus Residues from the Detonation of 81-mm Mortar WP Smoke Rounds at an Upland Site	Determination of the spatial distribution and persistence of white phosphorus residues following detonation of 81 mm mortar rounds.	CRREL	USAED Alaska
06192 06192 OU-C Book 1	C	1.1	6/30/94	Eagle River Flats: An Army Environmental Rescue Operation	Describes the events leading to the decision to evaluate human health and ecological risks from exposure to white phosphorus at Eagle River Flats.	William Gossweiler DPW	None Given
06193 06273 OU-C Book 1	C	1.2.2	8/15/89	Eagle River Flats Waterfowl Mortality Investigation, Progress Report	Progress report for the 1989 Eagle River Flats waterfowl mortality investigation.	Randy Tweten ESE	None Given
06274 06300 OU-C Book 1	C	1.2.3	3/15/88	Eagle River Flats General Study Plan	Development of the study approach to be followed by the Eagle River Flats Task Force.	None Given	None Given
06301 06406 OU-C Book 1	C	1.2.3	7/14/89	Eagle River Flats Expanded Site Investigation, Fort Richardson, Alaska, Final Sampling Design Plan	Presents the sampling and analysis plan, schedule, and health and safety plan for the 1989 Eagle River Flats waterfowl mortality study.	ESE	ATHAMA
06407 06426 OU-C Book 1	C	1.2.4	2/7/86	Water Quality Biological Study No. 32-24-1371-86, Waterfowl Die-Off Investigation, Eagle River Flats, Fort Richardson, Alaska	Surface water investigation of potential contaminants responsible for waterfowl die-offs	AEHA	USAED Alaska

Fort Richardson, Alaska Administrative Record Index Update for 1998

Page Numbers	OU	Cat No	Date	Title	Abstract	Author	Recipient
06427 06441 OU-C Book 1	C	1.2.4	7/15/86	Cooperative Agreement for Management of Fish and Wildlife Resources on Army Lands in Alaska	Agreement for ADFG, USFWS, and the Army to work together to manage the Army lands.	None Given	None Given
06442 06450 OU-C Book 1	C	1.2.4	2/13/87	Eagle River Flats Waterfowl Die-Off	Summary of work done to date on the Eagle River Flats bird kill problem.	USFWS	None Given
06451 06458 OU-C Book 1	C	1.2.4	2/4/88	Investigation of Waterfowl Mortality, Eagle River Flats, Alaska, Draft	Review of 1983 through 1985 study results and proposed field and laboratory research.	USFWS	None Given
06459 06886 OU-C Book 2	C	1.2.4	6/15/90	Eagle River Flats, Expanded Site Investigation, Fort Richardson, Alaska, Final Technical Report	Presents the results of the 1989 investigation of the causes of waterfowl mortality at Eagle River Flats.	ESE	ATHAMA
06899 06900 OU-C Book 2	C	1.2.4	11/12/91	Finding of No Significant Impact for Resumption of Firing into the Eagle River Flats	Contained within the EA for the resumption of firing in the Eagle River Flats Impact Area; describes the FONSI for the resumption of firing into Eagle River Flats.	William Bolt Army	None Given
06887 07068 OU-C Books 2 & 3	C	1.2.4	12/15/91	Environmental Documents: Public Notice, Finding of No Significant Impact, and Environmental Assessment for Resumption of Firing in the Eagle River Flats Impact Area	A report containing the following documents: A memorandum of understanding; a notice of availability and public comment period; the FONSI for resumption of firing in Eagle River Flats; and the EA for the resumption of firing in the Eagle River Flats Impact Area. These documents also are listed separately in this index.	None Given	None Given

Fort Richardson, Alaska Administrative Record Index Update for 1998

Page Numbers	OU	Cat No	Date	Title	Abstract	Author	Recipient
06901 07068 OU-C Book 3	C	1.2.4	12/31/91	Environmental Assessment for Resumption of Firing into the Eagle River Flats Impact Area, Fort Richardson, Alaska	EA to address the resumption of live-fire artillery training in Eagle River Flats.	William Quirk DPW	None Given
07069 07073 OU-C Book 3	C	1.2.5	6/2/89	Comments, Eagle River Flats Expanded Site Investigation--Draft Sampling Plan	Comments on the 1989 Eagle River Flats waterfowl mortality study draft sampling plan.	Edwin Ruff DEH	Douglas Reagan ESE
07074 07076 OU-C Book 3	C	1.2.5	6/6/89	Comments, Eagle River Flats Expanded Site Investigation--Draft Sampling Plan	Comments on the 1989 Eagle River Flats waterfowl mortality study draft sampling plan.	USFWS	ESE
07077 07079 OU-C Book 3	C	1.2.5	6/7/89	Comments, Eagle River Flats Expanded Site Investigation--Draft Sampling Plan	Comments on the 1989 Eagle River Flats waterfowl mortality study draft sampling plan.	Dan Rosenberg ADFG	Douglas Reagan ESE
07080 07082 OU-C Book 3	C	1.2.5	6/9/89	Comments, Eagle River Flats Expanded Site Investigation--Draft Sampling Plan	Comments on the 1989 Eagle River Flats waterfowl mortality study draft sampling plan.	Rob Lipkin EPA	Wayne Rush Army
07083 07095 OU-C Book 3	C	1.3.3	4/15/93	EPA Closure Plan Comments, Demolition Area #1 (OB/OD Area) at Fort Richardson, Alaska	EPA review comments on the second draft of Closure/Post--Closure Plan for Demolition Area #1 (OB/OD Area).	EPA	None Given

Page Numbers	OU	Cat No	Date	Title	Abstract	Author	Recipient
07096 07115 OU-C Book 3	C	1.3.3	4/15/93	Secondary Hazards of White phosphorus to Bald Eagles, Draft Study Protocol	A study plan to determine the secondary hazards posed by white phosphorus-exposed ducks that are scavenged by bald eagles.	John Cummings DWRC	USAED Alaska
07116 07122 OU-C Book 3	C	1.3.3	4/29/93	Comments, DERP OEW Ft. Richardson OB/OD Closure Plan Draft #4-145	Comments from several USAED Alaska reviewers on the second draft of Closure/Post-Closure Plan for Demolition Area #1 (OB/OD Area).	Wilson Walters USAED Alaska	None Given
07123 07201 OU-C Book 3	C	1.3.3	12/15/93	Demolition Area Number One Closure Guidelines, Fort Richardson, Alaska	Report discussing guidelines for closure of Demolition Area #1 at Eagle River Flats in compliance with the Federal Facility Agreement and RCRA regulations.	EMCON	Army
07202 07217 OU-C Book 3	C	1.3.3	12/20/93	Response to EPA and COE Comments, Demolition Area Number One Closure Guidelines, Fort Richardson, Alaska	Provides responses to EPA and USAED Alaska comments on the second draft of Closure/Post-Closure Plan for Demolition Area #1 (OB/OD Area).	EMCON	Army
07218 07230 OU-C Book 3	C	1.3.4	1/22/93	Hazardous Waste Management Consultation No. 37-66-JR11-92, Soil Sampling Results, Fort Richardson, Alaska	Discusses results from soil samples collected from the explosive ordnance disposal burning grounds adjacent to Eagle River Flats in order to identify any potential soil surface contamination from explosives and propellants destruction operations.	USAEHA	USAED Alaska
07056 07056 OU-C Book 3	C	1.3.5	12/20/91	Review Comments on the Environmental Assessment for Eagle River Flats	Contained as an appendix to the EA for the resumption of firing in the Eagle River Flats Impact Area; comments on the EA for Eagle River Flats.	Marilyn Twitchell Sierra Club Legal Defense Fund	Chuck Canterbury PAO

Fort Richardson, Alaska Administrative Record Index Update for 1998

Page Numbers	OU	Cat No	Date	Title	Abstract	Author	Recipient
07057 07060 OU-C Book 3	C	1.3.5	12/20/91	Review Comments on the Environmental Assessment for Eagle River Flats	Contained as an appendix to the EA for the resumption of firing in the Eagle River Flats Impact Area; comments on the EA for Eagle River Flats.	Dave Cline National Audubon Society	Chuck Canterbury PAO
07055 07055 OU-C Book 3	C	1.3.5	12/20/91	Review Comments on the Environmental Assessment for Eagle River Flats	Contained as an appendix to the EA for the resumption of firing in the Eagle River Flats Impact Area; comments on the EA for Eagle River Flats.	Ruth Wood Alaska Center for the Environment	Chuck Canterbury PAO
23922 23929 OU-C Book 16 **'97 Update**	C	1.4.1	3/7/96	Proposed Approach to the Site Investigation at the OB/OD Pad	This memorandum outlines the estimated minimal level of effort required to delineate the site characteristics identified in the draft-final management plan.	Jacques Gusmano CH2M Hill	Bill Gossweiler DPW
23930 23932 OU-C Book 16 **'97 Update**	C	1.4.1	6/27/96	OU-C, Eagle River Flats, EPA Comments on OB/OD Pad Site Investigation Work Plan	Review comments	Howard Orlean EPA	Bill Gossweiler
29057 29160 OU-C Book 20 **'98 Update**	C	1.4.1	7/15/97	Interagency Expanded Site Investigation, Evaluation of White phosphorus Contamination and Potential Treatability at Eagle River Flats, Alaska	A summary of work conducted at Eagle River Flats during 1996. Includes three RA reports, four treatability studies, and a discussion of the Eagle River Flats spatial database.	CRREL	William Gossweiler USAED Alaska
23933 24323 OU-C Book 16 **'97 Update**	C	1.4.2	2/6/96	Interagency Expanded Site Investigation, FY 95 Final Report	The sixth annual report describing results of white phosphorus contamination studies at Eagle River Flats.	CRREL	DPW

Fort Richardson, Alaska Administrative Record Index Update for 1998

Page Numbers	OU	Cat No	Date	Title	Abstract	Author	Recipient
24324 24328 OU-C Book 17 '97 Update	C	1.4.3	6/27/96	OU-C, Eagle River Flats EPA comments on Interagency Expanded Site Investigation	Review comments.	Howard Orlean EPA	Bill Gossweiler DPW
07231 07238 OU-C Book 3	C	1.7	6/28/49	phosphorus Poisoning in Waterfowl	Results of an investigation on the effects of poisoning from white phosphorus.	Don Coburn et.al. USFWS	APA
07239 07264 OU-C Book 3	C	1.7	3/3/93	Laboratory Evaluation of a Methyl Anthranilate Bead Formulation on Mallard Feeding Behavior, Draft Study Protocol	Assesses the effectiveness of a methyl anthranilate bead formulation for reducing feeding by mallards.	John Cummings DWRC	None Given
07265 07268 OU-C Book 3	C	1.7	12/8/93	White phosphorus Contamination of Wetlands: Effects and Options for Restoration	Presents the biogeochemical cycling of, waterfowl exposure to, and possible remediation options for white phosphorus contamination in wetlands.	Susan Richardson	None Given
07269 07274 OU-C Book 3	C	1.7	3/11/94	Predation of Ducks Poisoned by White phosphorus: Exposure and Risk to Predators	Evaluation of P4 uptake at Eagle River Flats by species that prey on poisoned ducks.	Bill Roebuck Dartmouth Medical School	None Given
07399 07400 OU-C Book 3	C	2.1.2	6/17/93	On-Going and Planned 1993 Activities for Investigations on White phosphorus at Eagle River Flats	Summary results for identification of biomarkers and histopathological effects in birds, white phosphorus in food chains, and physiological effects in waterfowl.	Donald Sparling DWRC	None Given

Fort Richardson, Alaska Administrative Record Index Update for 1998

Page Numbers	OU	Cat No	Date	Title	Abstract	Author	Recipient
29161 29166 OU-C Book 20 **'98 Update**	C	2.3	3/18/97	Decision Document for a Removal Action at Eagle River Flats Racine Island Pond	Describes a time-critical removal action to be conducted at Racine Pond within Eagle River Flats. The proposed action is to drain Racine Island pond to remove white phosphorus contamination.	William Gossweiler DPW	Kenneth Simpson CG
29167 29167 OU-C Book 20 **'98 Update**	C	2.5	3/12/97	Comments, Eagle River Flats Draft Decision Document	Comments on the draft decision document for Eagle River Flats.	Gene Kubecka DCSENG	Cristal Fosbrook DPW
07275 07277 OU-C Book 3	C	3.1.1	4/12/90	Preliminary Brief of Proposed FY90 Eagle River Flats Study	Summary of objectives and initial strategies for FY 1990 Eagle River Flats study as developed by ATHAMA and the Eagle River Flats Task Force during the April 10, 1990, meeting.	Edwin Ruff DEH	Army
07278 07285 OU-C Book 3	C	3.1.1	3/3/93	Baseline Risk Assessment and FS for Eagle River Flats, Fort Richardson, Anchorage, Alaska	SOW to conduct a baseline RA and FS for the 2,500-acre Eagle River Flats Impact Area.	None Given	None Given
07286 07302 OU-C Book 3	C	3.1.1	3/3/93	Mission Statement for the 6th Infantry Division/Eagle River Flats Task Force	Goals for the Eagle River Flats investigation, responsibilities of each task force member, and plans to achieve desired goals.	None Given	None Given
07303 07335 OU-C Book 3	C	3.1.1	4/15/93	Eagle River Flats Task Force Briefing	Goals and responsibilities for the Eagle River Flats Task Force.	EPA	None Given

Fort Richardson, Alaska Administrative Record Index Update for 1998

Page Numbers	OU	Cat No	Date	Title	Abstract	Author	Recipient
07336 07370 OU-C Book 4	C	3.1.1	4/14/94	Continued Evaluation of White phosphorus Effects on the Aquatic Ecosystem, Eagle River Flats, Fort Richardson, Alaska, Revised Scope of Work	Revised SOW for continued evaluation of white phosphorus effects on the aquatic ecosystem, Eagle River Flats.	David Smart AEHA	Charles Racine CRREL
07371 07388 OU-C Book 4	C	3.1.1	3/16/95	Scope of Work for Pilot Study of Dredging to Remove White phosphorus Contaminated Sediments from a Limited Area in Eagle River Flats, Alaska	Plans to confirm the feasibility of operating a small dredge in an area of Eagle River Flats with unexploded ordnance.	Michael Walsh CRREL	William Gossweiler DPW
07389 07398 OU-C Book 4	C	3.1.2	11/20/90	Summary of 1990 Eagle River Flats Waterfowl Mortality Work	Overview of 1990 work completed for the Eagle River Flats waterfowl mortality study.	William Gossweiler DPW	None Given
07405 07422 OU-C Book 4	C	3.1.2	10/14/93	Progress Report for Fourth Quarter, 1993	Review of progress to date on CRREL studies at Eagle River Flats.	Charles Racine CRREL	Army
07401 07404 OU-C Book 4	C	3.1.2	10/14/93	Protecting Waterfowl from Ingesting White phosphorus, Progress Report	Presents progress regarding waterfowl management techniques, responses of waterfowl to Concover and Bara-kade (brand names), and waterfowl distribution and movements in Eagle River Flats.	John Cummings DWRC	William Gossweiler DPW
07423 07467 OU-C Book 4	C	3.1.2	12/6/93	Eagle River Flats, Project Review Meeting, December 6-9, 1993	Summary report of previous investigations conducted at Eagle River Flats.	None Given	None Given

Page Numbers	OU	Cat No	Date	Title	Abstract	Author	Recipient
07468 07471 OU-C Book 4	C	3.1.2	6/15/94	Waterfowl Mortality at Eagle River Flats, Progress Report	Includes a comparison of 1994 mortality rates of ducks to those of previous years at Eagle River Flats.	NEILE	None Given
07472 07474 OU-C Book 4	C	3.1.2	6/15/95	Eagle River Flats Drilling/Coring Project, Progress Report	Progress report regarding the explosive ordnance disposal pad drilling and coring project and test bed machine.	Michael Walsh CRREL	None Given
07475 07475 OU-C Book 4	C	3.1.2	7/12/95	DWRC Progress Report	Summary of activities conducted during spring 1995.	DWRC	None Given
07476 07478 OU-C Book 4	C	3.1.2	7/15/95	Eagle River Flats Dredge Project, Progress Report	Progress report on dredging operations at Eagle River Flats.	Michael Walsh CRREL	None Given
07479 07490 OU-C Book 4	C	3.1.3	2/2/90	Eagle River Flats Study Proposal, Fiscal Year 1990	Draft plan for the 1990 field season at Eagle River Flats.	Walter Stieglitz USFWS	Kenneth Northamer USAED Alaska
07491 07500 OU-C Book 4	C	3.1.3	5/8/91	Proposed FY91 Eagle River Flats Remedial Investigations, Draft	Summary of proposed projects for investigating Eagle River Flats.	Charles Racine CRREL	ATHAMA

Fort Richardson, Alaska Administrative Record Index Update for 1998

Page Numbers	OU	Cat No	Date	Title	Abstract	Author	Recipient
07501 07514 OU-C Book 4	C	3.1.3	6/11/91	Elemental phosphorus as the Cause of Waterfowl Mortality in an Alaskan Salt Marsh, Draft	Results of investigation linking white phosphorus to waterfowl mortality at Eagle River Flats.	Charles Racine CRREL	None Given
07515 07518 OU-C Book 4	C	3.1.3	9/27/91	Action Plan for the Eagle River Flats Environmental Restoration Program	Action plan for assessment of the avian repellent methyl anthranilate and geotextile capping at Eagle River Flats.	None Given	None Given
07519 07519 OU-C Book 4	C	3.1.3	10/31/91	Eagle River Flats Management Plan	Suggestion to Fort Richardson that the Eagle River Flats management plan may be facilitated best if the project is completed locally.	Kurt Eilo EPA	Robert Wrentmore DEH
07520 07529 OU-C Book 4	C	3.1.3	12/10/91	Acute Toxicity Tests of Methyl Anthranilate for Aquatic Vertebrates	Plans for investigation of the effects of methyl anthranilate on waterfowl.	Larry Clark DWRC	None Given
07530 07545 OU-C Book 4	C	3.1.3	12/15/91	Eagle River Flats Management Plan Outline	Discusses the technical and managerial approach to be used to accomplish the Eagle River Flats Installation Restoration Program.	ATHAMA	None Given
07546 07582 OU-C Book 4	C	3.1.3	1/2/92	Twenty-Ninth Report of the Interagency Testing Committee to the Administrator, Environmental Protection Agency, November 1991	Toxic Substances Control Act Interagency Testing Committee proposes that white phosphorus be tested because of the problems at Eagle River Flats.	Walter Stieglitz USFWS	Robert Wrentmore DEH

Fort Richardson, Alaska Administrative Record Index Update for 1998

Page Numbers	OU	Cat No	Date	Title	Abstract	Author	Recipient
07583 07607 OU-C Book 4	C	3.1.3	2/10/92	Effects of Methyl Anthranilate Bead Formulation on Mallard Feeding Behavior in an Aqueous Environment, Study Protocol	Plans for investigation of methyl anthranilate effects on feeding behavior.	John Cummings DWRC	None Given
07608 07610 OU-C Book 4	C	3.1.3	2/15/92	1992/1993 Comprehensive Work Plan for Eagle River Flats	Outlines plans for investigation of Eagle River Flats.	Steven Bird IRD	Robert Wrentmore DPW
07611 07647 OU-C Book 4	C	3.1.3	2/15/92	Management Plan for the Eagle River Flats Remediation and Restoration Program, Fort Richardson, Alaska	Reviews the history of studies of Eagle River Flats and outlines the objectives and structure for long-term management of the remediation and restoration of Eagle River Flats.	Army	Army
07648 07673 OU-C Book 4	C	3.1.3	3/10/92	Field Test of Formulated Methyl Anthranilate: Risk Reduction for White phosphorus Toxicity, Study Protocol	Determines the effectiveness of methyl anthranilate for reducing mortality of ducks exposed to white phosphorus in marsh sediment.	Larry Clark DWRC	None Given
07674 07690 OU-C Book 4	C	3.1.3	4/15/92	Study Protocols for FY92, Eagle River Flats Remediation Study	List and brief descriptions of planned investigations for Eagle River Flats.	Charles Racine CRREL	None Given
07691 07724 OU-C Book 4	C	3.1.3	3/3/93	Evaluation of a Formulated Methyl Anthranilate Bird Repellent at Eagle River Flats, Alaska, Draft Study Protocol	Determines effectiveness of a beaded formulation of methyl anthranilate at reducing foraging activity and area use by waterfowl at Eagle River Flats.	Larry Clark DWRC	None Given

Fort Richardson, Alaska Administrative Record Index Update for 1998

Page Numbers	OU	Cat No	Date	Title	Abstract	Author	Recipient
07725 07732 OU-C Book 4	C	3.1.3	3/3/93	Management Plan Elements and Criteria for Eagle River Flats Management Plan	Management Plan Elements and Criteria for Eagle River Flats Management Plan as desired by ADEC.	Louis Howard ADEC	Wendy Fuller Army
07733 07741 OU-C Book 5	C	3.1.3	3/3/93	Proposal to Monitor Environmental Conditions of Eagle River Flats, Alaska, Prior to Remediation of White phosphorus Contamination and Determine the Toxicological Hazards of White phosphorus	Plan to measure preremediation environmental conditions in sites targeted for remediation within Eagle River Flats and to produce toxicity data necessary to determine cleanup criteria.	USFWS	Army
07742 07761 OU-C Book 5	C	3.1.3	3/3/93	Secondary Hazards of White phosphorus to Bald Eagles, Draft Study Protocol	Determines the secondary hazards of white phosphorus-exposed ducks scavanged by bald eagles on Eagle River Flats.	John Cummings DWRC	None Given
07762 07766 OU-C Book 5	C	3.1.3	3/3/93	Sedimentation, Erosion, and Sediment Transport in the Remediation and Treatment of White phosphorus Contamination in Eagle River Flats	Plan to conduct an analysis of rates of erosion, deposition, sediment transport, and white phosphorus particle transport within Eagle River Flats.	Daniel Lawson CRREL	None Given
07767 07801 OU-C Book 5	C	3.1.3	3/15/93	Draft Work Plan, Eagle River Flats, Fort Richardson, Alaska, Toxicological and Ecological Evaluation	Eagle River Flats work plan describing the history, cause, and plan to determine cleanup goals for major contaminant source areas and risks posed by white phosphorus.	AEHA	None Given
07802 07804 OU-C Book 5	C	3.1.3	4/2/93	Continuing Investigation of Waterfowl Mortality on Eagle River Flats, Fort Richardson, Alaska	Plan to continue and expand the index of waterfowl mortality on Eagle River Flats.	USAED Alaska	None Given

Page Numbers	OU	Cat No	Date	Title	Abstract	Author	Recipient
07805 07847 OU-C Book 5	C	3.1.3	7/23/93	Receiving Water Biological Study No. 32-24-H1ZV-93, Water, Sediment, Macroinvertebrate and Fish Sampling, Eagle River Flats, Protocol	Provides an overview of contractor plans for an investigation of contamination in Eagle River Flats.	AEHA	Army
07848 07849 OU-C Book 5	C	3.1.3	11/18/93	Draft Proposal for USDA-APHIS-ADC Activities on Eagle River Flats in 1994	Requests permission for a waterfowl hazing program.	Paul O'Neil USDA ADC	Daniel Lawson CRREL
07850 07851 OU-C Book 5	C	3.1.3	12/15/93	Field Study for Placement and Use of Geocomposite to Reduce Waterfowl Mortality in Eagle River Flats	Determines whether placement of geocomposite products over a contaminated area will reduce waterfowl mortality.	Karen Henry CRREL	None Given
07852 07859 OU-C Book 5	C	3.1.3	12/15/93	Report of USDA/APHIS/Animal Damage Control Activities for the Army at Eagle River Flats	Damage control activities for migratory waterfowl at Eagle River Flats.	Paul O'Neil USDA ADC	None Given
07860 07860 OU-C Book 5	C	3.1.3	12/15/93	White phosphorus Absorption in Ducks: Rate, Extent, and Completeness of Absorption of Particles in Relation to Development of Toxicity	Determines the location of white phosphorus absorption and factors controlling dissolution of white phosphorus from particles.	Bill Roebuck Dartmouth Medical School	None Given
07861 07862 OU-C Book 5	C	3.1.3	12/15/93	White phosphorus in Herring Gull (Larus argentatus) Eggs: Strategy for Monitoring the Effectiveness of Remediation at Eagle River Flats	Evaluation of distribution and bioaccumulation of white phosphorus in herring gull eggs.	Bill Roebuck Dartmouth Medical School	None Given

Page Numbers	OU	Cat No	Date	Title	Abstract	Author	Recipient
07863 07877 OU-C Book 5	C	3.1.3	3/31/94	Development and Analysis of the Eagle River Flats Spatial Database, Scope of Work	Presents the tasks, sampling and analysis plan, health and safety plan, QA/QC plan, and schedule for reviewing, refining, and updating the geographic information system database for Eagle River Flats.	Charles Racine CRREL	William Gossweiler DPW
07878 07912 OU-C Book 5	C	3.1.3	3/31/94	Evaluation of White phosphorus Effects on the Aquatic Ecosystem, Eagle River Flats, Fort Richardson, Alaska, Scope of Work	Presents the tasks, study plan, health and safety plan, QA/QC plan, and schedule for an investigation of the aquatic effects of white phosphorus at Eagle River Flats.	Carl Bouwkamp AEHA	William Gossweiler DPW
07913 07929 OU-C Book 5	C	3.1.3	3/31/94	Index of Waterfowl, Eagle, and Shorebird Use and Mortality on Eagle River Flats, Fort Richardson, Anchorage, Alaska, Scope of Work	Presents the tasks, sampling and analysis plan, health and safety plan, QA/QC plan, and schedule for investigation of waterfowl, eagle, and shorebird use and mortality on Eagle River Flats.	Lenard Reitsma NEILE	None Given
07930 07959 OU-C Book 5	C	3.1.3	3/31/94	Investigation of Natural Size Reduction of White phosphorus Particles in Eagle River Flats Sediments, Scope of Work	Presents the tasks, sampling and analysis plan, health and safety plan, QA/QC plan, and schedule for investigation of the natural size reduction process for white phosphorus at Eagle River Flats.	Marianne Walsh CRREL	William Gossweiler DPW
07960 07980 OU-C Book 5	C	3.1.3	3/31/94	Physical System Dynamics, WP Fate and Transport, Remediation and Restoration, Scope of Work	Presents the tasks, sampling and analysis plan, health and safety plan, QA/QC plan, and schedule for investigation of the transport and fate of white phosphorus in Eagle River Flats sediments.	Daniel Lawson CRREL	William Gossweiler DPW
07981 08000 OU-C Book 5	C	3.1.3	3/31/94	Pilot Study of Dredging to Remove White phosphorus Contaminated Sediments from a Limited Area in Eagle River Flats, AK, Scope of Work	Presents the tasks, sampling and analysis plan, health and safety plan, QA/QC plan, and schedule for a pilot study to assess the functionality of dredging sediments in Eagle River Flats to remove white phosphorus.	Michael Walsh CRREL	William Gossweiler DPW

Page Numbers	OU	Cat No	Date	Title	Abstract	Author	Recipient
08001 08022 OU-C Book 5	C	3.1.3	3/31/94	Pond Draining Treatability Study, Scope of Work	Presents the tasks, sampling and analysis plan, health and safety plan, QA/QC plan, and schedule to assess pond drainage as a viable remedial alternative of white phosphorus-contaminated areas at Eagle River Flats.	Charles Collins CRREL	William Gossweiler DPW
08023 08045 OU-C Book 5	C	3.1.3	3/31/94	Screening Study of Barriers to Immobilize White phosphorus and Prevent Poisoning of Waterfowl in Eagle River Flats, Alaska, Scope of Work	Presents the tasks, sampling and analysis plan, health and safety plan, QA/QC plan, and schedule to evaluate the ability of physical barriers to limit the transport of white phosphorus particles in Eagle River Flats sediment.	Karen Henry CRREL	William Gossweiler DPW
08046 08058 OU-C Book 5	C	3.1.3	3/31/94	White phosphorus Toxicity and Risk Assessment, Scope of Work	Presents the tasks, sampling and analysis plan, health and safety plan, and QA/QC plan to determine the extent of white phosphorus in waterfowl gastrointestinal tracts and test treatments for white phosphorus waterfowl toxicity.	Bill Roebuck Dartmouth Medical School	William Gossweiler DPW
08059 08066 OU-C Book 5	C	3.1.3	4/1/94	Protecting Waterfowl from Ingesting White phosphorus, Scope of Work	Presents the tasks, sampling and analysis plan, health and safety plan, QA/QC plan, and schedule to frighten waterfowl from hazardous areas of Eagle River Flats.	John Cummings DWRC	None Given
08067 08106 OU-C Book 5	C	3.1.3	4/1/94	Toxicological Studies on White phosphorus and Identification of Bioindicators, Scope of Work	Presents the tasks, sampling and analysis plan, health and safety plan, and QA/QC plan for toxicological studies on the effects of white phosphorus at Eagle River Flats.	Donald Sparling DWRC	None Given
08107 08138 OU-C Book 5	C	3.1.3	4/7/94	Scope of Work, Denver Wildlife Research Center	Presents the schedule, objectives, description of tasks, sampling and analysis plan, health and safety plan, and QA/QC plan for development of potential remediation measures to reduce the ingestion of white phosphorus by waterfowl.	John Cummings DWRC	William Gossweiler DPW

Page Numbers	OU	Cat No	Date	Title	Abstract	Author	Recipient
08139 08152 OU-C Book 5	C	3.1.3	10/4/94	Safety Plan for Pilot Study of Dredging to Remove White phosphorus Contaminated Sediments from a Limited Area in Eagle River Flats, Alaska	Includes the sampling and analysis plan and minimal health, safety, and emergency response activities involved with the Eagle River Flats site investigation.	Michael Walsh CRREL	William Gossweiler DPW
08153 08175 OU-C Book 5	C	3.1.3	2/27/95	Draft Technology Assessment of a Remotely Controlled Drill for Drilling Cased Water Sample Wells and a Remotely Controlled Sampler for Obtaining 1 m x 5 cm-Diameter Cores in Contaminated Areas at Eagle River Flats, Alaska, Sampling and Analysis Plan	Includes methods and procedures to drill monitoring wells safely and effectively on the explosive ordnance disposal pad in Eagle River Flats.	CRREL	None Given
08176 08200 OU-C Book 6	C	3.1.3	2/27/95	Dredging Treatability Study in Eagle River Flats, Sampling and Analysis Plan, Draft	Includes methods and procedures for removal of sediments from large, permanently flooded areas of Eagle River Flats that potentially contain lethal amounts of white phosphorus.	CRREL	None Given
08201 08210 OU-C Book 6	C	3.1.3	3/10/95	Eagle River Flats Spatial Database, Draft Workplan	Includes methods and procedures to develop a spatial database containing white phosphorus data, and information regarding fate and transport, monitoring sites, remediation sites, and ecological conditions in relation to physical, biological, and hydraulic site features at Eagle River Flats.	Charles Racine CRREL	None Given
08211 08285 OU-C Book 6	C	3.1.3	3/15/95	Remedial and Treatability Investigations of Physical System Dynamics and White phosphorus Fate and Transport, FY95 Workplan	The FY95 work plan includes remedial investigation and treatability study objectives for Eagle River Flats, a description of tasks, a detailed analysis plan, a health and safety plan, a QA plan, and a schedule.	None Given	Laurie Angell DPW
08286 08319 OU-C Book 6	C	3.1.3	3/16/95	Attenuation of White phosphorus Particles in Eagle River Flats Sediments, Sampling and Analysis Plan, Revised Draft	Includes methods and procedures to monitor attenuation of white phosphorus particles in sediments at Eagle River Flats under natural and altered conditions.	CRREL	None Given

Fort Richardson, Alaska Administrative Record Index Update for 1998

Page Numbers	OU	Cat No	Date	Title	Abstract	Author	Recipient
08320 08335 OU-C Book 6	C	3.1.3	3/16/95	Scope of Work for Pilot Study of Dredging to Remove White phosphorus Contaminated Sediments from a Limited Area in Eagle River Flats, Alaska	Includes the sampling and analysis plan and minimal health, safety, and emergency response activities involved with the Eagle River Flats site investigation.	Michael Walsh CRREL	William Gossweiler DPW
08336 08510 OU-C Book 6	C	3.1.3	3/20/95	Evaluation of AquaBlok on Contaminated Sediments to Reduce Mortality of Foraging Waterfowl, Proposed Remedial Investigation/FS Workplan	Includes a plan to continue to evaluate the effectiveness of AquaBlok (trademark) application on contaminated sediments to provide a physical barrier to feeding waterfowl at Eagle River Flats.	Patricia Pochop et al. DWRC	Army
08511 08679 OU-C Book 7	C	3.1.3	3/20/95	Movements, Distribution and Relative Risk of Waterfowl and Bald Eagles Using Eagle River Flats, Fort Richardson, Alaska, Proposed Remedial Investigation/FS Workplan	Includes a plan to determine daily and seasonal movements of waterfowl at Eagle River Flats and to determine hazards that waterfowl poisoned by white phosphorus pose to bald eagles.	John Cummings DWRC	None Given
08680 08691 OU-C Book 7	C	3.1.3	4/7/95	Proposal for 1995 ERF Field Season, Workplan, Draft	Includes methods and procedures for monitoring and measuring waterfowl mortality at Eagle River Flats.	Lenard Reitsma NEILE	William Gossweiler DPW
08692 08734 OU-C Book 7	C	3.1.3	4/10/95	Sampling and Analysis Plan, Pond Draining Treatability Study in Eagle River Flats	Sampling and analysis plan for samples to be collected during the pond draining treatability study in Eagle River Flats.	CRREL	None Given
08735 08736 OU-C Book 7	C	3.1.3	5/23/95	Program Plan, Drill and Core Project, Eagle River Flats, Alaska	Includes a revision in the original plan for deploying the drill rig and drilling wells on the explosive ordnance disposal pad.	Michael Walsh CRREL	William Gossweiler DPW

Fort Richardson, Alaska Administrative Record Index Update for 1998

Page Numbers	OU	Cat No	Date	Title	Abstract	Author	Recipient
08737 09285 OU-C Books 7 & 8	C	3.1.3	6/15/95	Eagle River Flats Final 1995 Work Plan, Fort Richardson, Alaska	Includes the sampling and analysis plan, QA/QC plan, and site health and safety plan to identify data gaps to support key CERCLA decisions.	CH2M Hill	William Gossweiler DPW
09296 09363 OU-C Book 8	C	3.1.3	6/15/95	Final QA Program Plan for 1995 Fieldwork, Eagle River Flats, Fort Richardson, Alaska	Describes the planned objectives of the 1995 field investigations, the data required to meet these objectives, and the procedures that will be followed to obtain the data.	CH2M Hill	William Gossweiler DPW
09364 09411 OU-C Book 9	C	3.1.3	6/15/95	Sampling and Analysis Plan, Remedial and Treatability Investigations of Physical System Dynamics and White phosphorus Fate and Transport	Includes a plan to conduct RIs on the Eagle River Flats physical system, examining the hydrology, sedimentology and hydraulic processes controlling the erosion, transport, deposition, and burial of white phosphorus-bearing sediments.	USAED Alaska	None Given
09412 09417 OU-C Book 9	C	3.1.3	7/14/95	Eagle River Flats Decision Document	Describes the selected interim remedial action for the Eagle River Flats site in accordance with CERCLA.	None Given	None Given
24329 24494 OU-C Book 17 **'97 Update**	C	3.1.3	9/1/96	OU-C OB/OD Pad, Fort Richardson, Alaska, Site Investigation Work Plan	Sampling and QA procedures are presented for investigating potentially contaminated soil and groundwater at the OB/OD Pad.	CH2M Hill	USAED Alaska
09418 09422 OU-C Book 9	C	3.1.4	8/3/90	Ingestion of Munitions Compounds, Hypothesis for Waterfowl Mortality in Eagle River Flats, Alaska, Draft Interim Report	Hypothesis for waterfowl mortality in Eagle River Flats.	CRREL	None Given

Page Numbers	OU	Cat No	Date	Title	Abstract	Author	Recipient
09423 09425 OU-C Book 9	C	3.1.4	9/10/90	Waterfowl Mortality in Eagle River Flats Impact Area, Anchorage, Alaska	Includes a summary of field investigations at Eagle River Flats for the 1990 field season and recommendations for future studies.	Charles Racine CRREL	None Given
09426 09543 OU-C Book 9	C	3.1.4	1/15/91	Waterfowl Mortality in Eagle River Flats, Alaska: The Role of Munition Compounds	Presents investigation results regarding the presence of white phosphorus in Eagle River Flats sediments, and the effects on local waterfowl.	Charles Racine CRREL	ATHAMA
06993 06994 OU-C Book 3	C	3.1.4	6/28/91	Waterfowl Deaths at Eagle River Flats (ERF): Possible Human Health Hazard, Preliminary Evaluation	Contained as an appendix to the EA for the resumption of firing in the Eagle River Flats Impact Area; summary of the potential for human health effects and recommendations for further study.	Maurice Weeks Army Toxicology Division	None Given
09544 09551 OU-C Book 9	C	3.1.4	9/15/91	Eagle River Flats Waterfowl Mortality Studies, 1991	Radio telemetry study of the fall use of Eagle River Flats by mallards and pintails.	Laurel Bennett DPW	William Gossweiler DPW
09552 09565 OU-C Book 9	C	3.1.4	11/13/91	Waterfowl Mortality in Eagle River Flats, Alaska: The Role of Munition Compounds	Presents investigation results regarding the presence of white phosphorus in sediments, and the effects of white phosphorus on waterfowl at Eagle River Flats, including human health RA information.	Charles Racine CRREL	None Given
09566 09571 OU-C Book 9	C	3.1.4	3/10/92	Preliminary Report, Ecological Assessment of Methyl Anthranilate	Preliminary report regarding ecological assessment of methyl anthranilate	Larry Clark DWRC	None Given

Fort Richardson, Alaska Administrative Record Index Update for 1998

Page Numbers	OU	Cat No	Date	Title	Abstract	Author	Recipient
09572 09777 OU-C Book 9	C	3.1.4	3/15/92	Remedial Investigation Report: White phosphorus Contamination of Salt Marsh Sediments at Eagle River Flats, Alaska, Final	Presents the results of the 1991 Eagle River Flats studies and investigation into the presence of white phosphorus in Eagle River Flats sediments and verification of white phosphorus' effects on waterfowl.	Charles Racine CRREL	ATHAMA
09778 09821 OU-C Book 9	C	3.1.4	5/15/92	Waterfowl Mortality in Eagle River Flats, Alaska: The Role of Munition Residues	Presents results of investigation of white phosphorus in Eagle River Flats sediment and effects of phosphorus on waterfowl.	Charles Racine CRREL	None Given
09822 09923 OU-C Book 10	C	3.1.4	1/15/93	Army Eagle River Flats: Protecting Waterfowl from Ingesting White phosphorus, Technical Report 93-1	Contains three reports from 1992 studies regarding the effectiveness and toxicity of methyl anthranilate.	John Cummings DWRC	ATHAMA
09924 09948 OU-C Book 10	C	3.1.4	3/3/93	Responses of Waterfowl to Concover and Bara-kade, Draft Study Protocol	Evaluates feasibility of applying Concover and Bara-kade on contaminated sediments to provide a physical barrier to feeding waterfowl.	Patricia Pochop DWRC	None Given
09949 10181 OU-C Book 10	C	3.1.4	6/15/93	Phase II Remedial Investigation Report: White phosphorus Contamination of Salt Marsh Sediments at Eagle River Flats, Alaska, Fiscal Year 1992, Final	Final 1992 report regarding the investigation into the cause and extent of annual waterfowl die-offs.	Charles Racine CRREL	Army
10182 10211 OU-C Book 10	C	3.1.4	12/15/93	Preliminary Assessment of Sedimentation and Erosion in Eagle River Flats, South-Central Alaska, Report 93-23	Evaluation of the physical processes of sedimentation and erosion within tidal mud flats and salt marshes at Eagle River Flats.	Daniel Lawson CRREL	None Given

Page Numbers	OU	Cat No	Date	Title	Abstract	Author	Recipient
10212 10246 OU-C Book 10	C	3.1.4	12/21/93	Nature and Extent of White phosphorus Contamination in Eagle River Flats Sediments, Draft	Presents the results of three years of sampling and analysis to determine the nature and extent of white phosphorus contamination at Eagle River Flats.	Charles Racine CRREL	None Given
10247 10293 OU-C Book 10	C	3.1.4	1/10/94	Toxicological Studies of White phosphorus in Waterfowl and Its Presence in Food Chain Organisms, Draft	Presents a summary of waterfowl research conducted during 1993 at Eagle River Flats.	Donald Sparling DWRC	None Given
10294 10373 OU-C Book 11	C	3.1.4	4/15/94	Receiving Water Biological Study No. 32-24-H1ZV-93, Water, Sediment, Macroinvertebrate and Fish Sampling, Eagle River Flats, Fort Richardson, Alaska, Final Report	Presents the results of the 1993 field study to determine the effects of Eagle River Flats contaminants on aquatic species.	AEHA	Army
10706 10713 OU-C Book 11	C	3.1.4	5/15/94	A Preliminary Literature List and Review for Salt Marsh Restoration as Applied to Eagle River Flats, Alaska	Contained in the Interagency Expanded Site Investigation FY93 Final Report; a review of a literature base on salt marshes to determine whether methods and techniques for restoration exist and how other salt marshes have responded to major alterations such as draining or dredging.	Charles Racine CRREL	None Given
10734 10742 OU-C Book 11	C	3.1.4	5/15/94	Analytical Method for White phosphorus in Water	Contained in the Interagency Expanded Site Investigation FY93 Final Report; a description of the analytical method for detecting white phosphorus in water.	Marianne Walsh CRREL	None Given
10471 10496 OU-C Book 11	C	3.1.4	5/15/94	Contaminant Inventory	Contained in the Interagency Expanded Site Investigation FY93 Final Report; provides the results of the analysis of sediment and water samples collected from 18 sites in Eagle River Flats and analyzed for multiple parameters.	Carl Bouwkamp AEHA	None Given

Fort Richardson, Alaska Administrative Record Index Update for 1998

Page Numbers	OU	Cat No	Date	Title	Abstract	Author	Recipient
10680 10687 OU-C Book 11	C	3.1.4	5/15/94	Evaluation of Concover and Bentoballs on Contaminated Sediments to Reduce Mortality of Foraging Waterfowl	Contained in the Interagency Expanded Site Investigation FY93 Final Report; the results of Laboratory and field trials to evaluate the feasibility and performance of materials to provide a physical barrier between feeding waterfowl and contaminated sediments.	Patricia Pochop et al. USDA ADC	None Given
10656 10669 OU-C Book 11	C	3.1.4	5/15/94	Field Behavioral Response and Bead Formulations for Methyl Anthranilate Encapsulated Bird Repellents	Contained in the Interagency Expanded Site Investigation FY93 Final Report; a report on field tests using a bird repellent on waterfowl from study areas.	Larry Clark et al. USDA ADC	None Given
10670 10673 OU-C Book 11	C	3.1.4	5/15/94	Field Evaluation: Mortality of Mallards Feeding in Areas Treated with Methyl Anthranilate	Contained in the Interagency Expanded Site Investigation FY93 Final Report; results of a test study to determine the mortality of mallards feeding in pens treated with a modified methyl anthranilate formulation.	John Cummings et al. USDA ADC	None Given
10688 10696 OU-C Book 11	C	3.1.4	5/15/94	Field Study of Air-Drying Contaminated Sediment	Contained in the Interagency Expanded Site Investigation FY93 Final Report; results of tests to air-dry contaminated sediments under field conditions to reduce the concentrations of white phosphorus.	Michael Walsh CRREL	None Given
10620 10636 OU-C Book 11	C	3.1.4	5/15/94	Food Chain Invertebrates and Fish: Sediment Bioassay	Contained in the Interagency Expanded Site Investigation FY93 Final Report; discusses the results of sediment samples and Laboratory studies to determine the effect of white phosphorus on benthic invertebrates and fish.	Carl Bouwkamp AEHA	None Given
10674 10679 OU-C Book 11	C	3.1.4	5/15/94	Geosynthetic Covering of Contaminated Sediment	Contained in the Interagency Expanded Site Investigation FY93 Final Report; conclusions from pilot field testing of four geosynthetic products to limit exposure of dabbling ducks to white phosphorus in Eagle River Flats.	Karen Henry CRREL	None Given

Page Numbers	OU	Cat No	Date	Title	Abstract	Author	Recipient
10393 10411 OU-C Book 11	C	3.1.4	5/15/94	Habitat and Vegetation	Contained in the Interagency Expanded Site Investigation FY93 Final Report; summarizes the zones of habitat and vegetation types occurring within Eagle River Flats.	Charles Racine CRREL	None Given
10644 10650 OU-C Book 11	C	3.1.4	5/15/94	Hazing Waterfowl in Eagle River Flats	Contained in the Interagency Expanded Site Investigation FY93 Final Report; discusses the methods and results of hazing waterfowl at Eagle River Flats to prevent white phosphorus poisoning.	Paul O'Neil USDA ADC	None Given
10374 10768 OU-C Book 11	C	3.1.4	5/15/94	Interagency Expanded Site Investigation: Evaluation of White phosphorus Contamination and Potential Treatability at Eagle River Flats, Alaska, Fiscal Year 1993, Final Report	A compilation of reports detailing 1993 field and laboratory work, performed by several groups, on white phosphorus at Eagle River Flats.	CRREL	William Gossweiler DPW
10637 10640 OU-C Book 11	C	3.1.4	5/15/94	Invertebrates and Fish	Contained in the Interagency Expanded Site Investigation FY93 Final Report; sampling analysis results of white phosphorus in macroinvertebrates collected from ponded areas of Eagle River Flats.	Donald Sparling DWRC	None Given
10651 10655 OU-C Book 11	C	3.1.4	5/15/94	Laboratory Evaluation of a Methyl Anthranilate Bead Formulation for Reducing Mallard Mortality and Feeding Behavior	Contained in the Interagency Expanded Site Investigation FY93 Final Report; results of a test to apply a bird repellent to bottom sediment in a simulated pond to determine effectiveness.	John Cummings et al. DWRC	None Given
10714 10720 OU-C Book 11	C	3.1.4	5/15/94	Method Documentation in USATHAMA (1990) Format: Analytical Method for White phosphorus in Soil or Sediment	Contained in the Interagency Expanded Site Investigation FY93 Final Report; details the analytical method suitable for determining white phosphorus in wet soil or sediment.	Michael Walsh CRREL	None Given

Fort Richardson, Alaska Administrative Record Index Update for 1998

Page Numbers	OU	Cat No	Date	Title	Abstract	Author	Recipient
10412 10470 OU-C Book 11	C	3.1.4	5/15/94	Physical System Dynamics	Contained in the Interagency Expanded Site Investigation FY93 Final Report; discusses the progressive, physical environment changes at Eagle River Flats from the interaction and response of various physical processes.	Daniel Lawson et al. CRREL	None Given
10697 10705 OU-C Book 11	C	3.1.4	5/15/94	Pond Draining Treatability Study	Contained in the Interagency Expanded Site Investigation FY93 Final Report; results of a field test to determine the insitu conditions of pond bottom sediments under drying conditions as a remediation option.	Charles Collins CRREL	None Given
10721 10733 OU-C Book 11	C	3.1.4	5/15/94	Preliminary Evaluation of the Analytical Holding Time for White phosphorus in Surface Water	Contained in the Interagency Expanded Site Investigation FY93 Final Report; information regarding determination of a suitable holding time under the analysis of white phosphorus dissolved in water.	Michael Walsh et al. CRREL	None Given
10497 10517 OU-C Book 11	C	3.1.4	5/15/94	Review of Chemical and Physical Properties of White phosphorus	Contained in the Interagency Expanded Site Investigation FY93 Final Report; a review of literature regarding the properties of white phosphorus to determine the factors that influence the persistence of white phosphorus in the environment.	Michael Walsh CRREL	None Given
10743 10768 OU-C Book 11	C	3.1.4	5/15/94	Sediment Samples Collected and Analyzed from Eight Areas on Eagle River Flats, 1991 to 1993	Contained in the Interagency Expanded Site Investigation FY93 Final Report; a summary of sample results from Eagle River Flats from 1991 to 1993.	None Given	None Given
10518 10536 OU-C Book 11	C	3.1.4	5/15/94	Toxicological Studies of White phosphorus in Waterfowl	Contained in the Interagency Expanded Site Investigation FY93 Final Report; discusses the findings of studies to determine lethal dose and lowest observed effect level concentrations for waterfowl and related effects.	Donald Sparling DWRC	None Given

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10568 10572 OU-C Book 11	C	3.1.4	5/15/94	Water Sampling	Contained in the Interagency Expanded Site Investigation FY93 Final Report; discusses the results of water samples collected from Eagle River Flats in relation to the presence or absence of white phosphorus in sediment.	Michael Walsh CRREL	None Given
10573 10585 OU-C Book 11	C	3.1.4	5/15/94	Waterbird Utilization of Eagle River Flats: April to October 1993	Contained in the Interagency Expanded Site Investigation FY93 Final Report; provides the results of a bird census taken at Eagle River Flats.	W.D. Eldridge USFWS	None Given
10607 10613 OU-C Book 11	C	3.1.4	5/15/94	Waterfowl Distribution and Movements in Eagle River Flats	Contained in the Interagency Expanded Site Investigation FY93 Final Report; discusses the movement, distribution, turnover rate, and site-specific exposure of waterfowl species most susceptible to white phosphorus poisoning at Eagle River Flats during fall migration.	John Cummings et al. DWRC	None Given
10586 10606 OU-C Book 11	C	3.1.4	5/15/94	Waterfowl Mortality at Eagle River Flats	Contained in the Interagency Expanded Site Investigation FY93 Final Report; results of a study conducted to assess the relative amount of waterfowl mortality in order to detect year-to-year changes as white phosphorus exposure decreases because of remediation efforts.	Lenard Reitsma NEILE	None Given
10641 10643 OU-C Book 11	C	3.1.4	5/15/94	White phosphorus in Plants at Eagle River Flats	Contained in the Interagency Expanded Site Investigation FY93 Final Report; provides the results of analyzing for white phosphorus in plants collected from sites where white phosphorus was detected previously in the sediment.	Michael Walsh CRREL	None Given
10537 10567 OU-C Book 11	C	3.1.4	5/15/94	White phosphorus in Sediments	Contained in the Interagency Expanded Site Investigation FY93 Final Report; summarizes the results of sampling efforts to determine the distribution and concentrations of white phosphorus in Eagle River Flats.	Charles Racine CRREL	None Given

Fort Richardson, Alaska Administrative Record Index Update for 1998

Page Numbers	OU	Cat No	Date	Title	Abstract	Author	Recipient
10614 10619 OU-C Book 11	C	3.1.4	5/15/94	White phosphorus Poisoning of Waterfowl in Eagle River Flats	Contained in the Interagency Expanded Site Investigation FY93 Final Report; the results of necropsies performed on waterfowl found dead at Eagle River Flats and a comparison of conditions between birds found dead in the flats and those that died from laboratory experiments with white phosphorus.	Donald Sparling et al. DWRC	None Given
10769 10797 OU-C Book 12	C	3.1.4	7/14/94	Eagle River Flats Potential ARARs Evaluation	Review of ARARs for Eagle River Flats in preparation of future CERCLA remedial activities.	CH2M Hill	None Given
10798 11028 OU-C Book 12	C	3.1.4	7/15/94	Eagle River Flats Comprehensive Evaluation Report, Fort Richardson, Alaska	Summarizes information obtained from Eagle River Flats investigations and is designed to determine practical, implementable, and effective remedial actions.	CH2M Hill	Army
11029 11032 OU-C Book 12	C	3.1.4	2/17/95	Report of USDA/APHIS/Animal Damage Control for the Army at Eagle River Flats, May to October, 1994	Includes damage control activities for migratory waterfowl at Eagle River Flats from May through October 1994.	USDA ADC	None Given
11033 11078 OU-C Book 12	C	3.1.4	3/15/95	Initial Analysis of Eagle River Flats Hydrology and Sedimentology, Fort Richardson, Alaska, Report 95-5	Presents the initial analysis of the physical system of Eagle River Flats, focusing on the inter-relationships of the hydrological and sedimentological processes.	Daniel Lawson CRREL	None Given
11079 11091 OU-C Book 12	C	3.1.4	4/25/95	Fort Richardson Multi-Agency Site Investigation	Includes background information and a summary of past investigations for Eagle River Flats.	William Gossweiler DPW	None Given

Page Numbers	OU	Cat No	Date	Title	Abstract	Author	Recipient
11347 11368 OU-C Book 13	C	3.1.4	5/15/95	Analysis of the Eagle River Flats White phosphorus Concentration Database	Contained in Volume 1 of the Interagency Expanded Site Investigation FY94 Final Report; presents results of the white phosphorus concentration database for sediment and water at Eagle River Flats.	Charles Racine CRREL	None Given
11728 11793 OU-C Book 14	C	3.1.4	5/15/95	Appendix A, Eagle River Flats Map Atlas	Contained in Volume 2 of the Interagency Expanded Site Investigation FY94 Final Report; a compilation of maps documenting all sampling, monitoring, and remediation test sites during studies from 1991 to 1994.	Charles Racine et al. CRREL	None Given
11506 11517 OU-C Book 13	C	3.1.4	5/15/95	Chemical Hazing of Free-Ranging Ducks in Eagle River Flats: Field Evaluation of Rejex-It W1-05	Contained in Volume 2 of the Interagency Expanded Site Investigation FY94 Final Report; discusses the results of field testing of a chemical waterfowl repellent at Eagle River Flats.	Larry Clark et al. DWRC	None Given
11280 11293 OU-C Book 13	C	3.1.4	5/15/95	Climate and Tides	Contained in Volume 1 of the Interagency Expanded Site Investigation FY94 Final Report; describes the results of meteorological studies and tide predictions for Eagle River Flats.	Richard Haugen CRREL	None Given
11658 11727 OU-C Book 14	C	3.1.4	5/15/95	Dredging as a Remediation Strategy for White phosphorus-Contaminated Sediments at Eagle River Flats, Alaska	Contained in Volume 2 of the Interagency Expanded Site Investigation FY94 Final Report; a discussion of the preparation and initiation of the dredging operations as part of the study of remediation strategies.	Michael Walsh et al. CRREL	None Given
11121 11148 OU-C Book 13	C	3.1.4	5/15/95	Ecological Inventory of Eagle River Flats, Alaska	Contained in Volume 1 of the Interagency Expanded Site Investigation FY94 Final Report; provides the results of an ecological evaluation of Eagle River Flats to characterize the ecosystem; to help evaluate white phosphorus distribution, persistence and ecological risk; and to provide a Baseline for evaluating and predicting the future effects of remediation.	Charles Racine et al. CRREL	None Given

Fort Richardson, Alaska Administrative Record Index Update for 1998

Page Numbers	OU	Cat No	Date	Title	Abstract	Author	Recipient
11524 11539 OU-C Book 13	C	3.1.4	5/15/95	Evaluation of AquaBlok on Contaminated Sediments to Reduce Mortality of Foraging Waterfowl	Contained in Volume 2 of the Interagency Expanded Site Investigation FY94 Final Report; results of a study of the AquaBlok barrier system in preventing waterfowl exposure to white phosphorus.	Patricia Pochop et al. DWRC	None Given
11426 11493 OU-C Book 13	C	3.1.4	5/15/95	Evaluation of White phosphorus Effects on the Aquatic Ecosystem, Eagle River Flats, Fort Richardson, Alaska	Contained in Volume 1 of the Interagency Expanded Site Investigation FY94 Final Report; discusses the results of studies to determine whether white phosphorus has an adverse impact on the aquatic biota or is bioaccumulating in the food chain, and to determine a no observed effect level concentration for white phosphorus in sediment.	Carl Bouwkamp AEHA	None Given
11518 11523 OU-C Book 13	C	3.1.4	5/15/95	Hazing at Eagle River Flats	Contained in Volume 2 of the Interagency Expanded Site Investigation FY94 Final Report; discusses the results of various hazing methods applied at Eagle River Flats to keep migratory waterfowl from being poisoned by white phosphorus.	Corey Rossi USDA ADC	None Given
11494 11501 OU-C Book 13	C	3.1.4	5/15/95	Integrated Risk Assessment Model (IRAM) for Determining White phosphorus Encounter Rate by Waterfowl	Contained in Volume 1 of the Interagency Expanded Site Investigation FY94 Final Report; includes a model that provides a method for RA for the white phosphorus encounter rate by waterfowl feeding at Eagle River Flats.	Larry Clark DWRC	William Gossweiler DPW
11092 11793 OU-C Books 13 & 14	C	3.1.4	5/15/95	Interagency Expanded Site Investigation, Evaluation of White phosphorus Contamination and Potential Treatability at Eagle River Flats, Alaska, Fiscal Year 1994, Final Report, Volumes 1 and 2	Two-volume compilation of reports detailing FY94 CRREL studies of Eagle River Flats.	CRREL	William Gossweiler DPW
11566 11623 OU-C Book 13	C	3.1.4	5/15/95	Investigation of Natural Size Reduction of White phosphorus Particles in Eagle River Flats Sediments	Contained in Volume 2 of the Interagency Expanded Site Investigation FY94 Final Report; includes an investigation of natural decontamination of Eagle River Flats sediments.	Marianne Walsh et al. CRREL	None Given

Page Numbers	OU	Cat No	Date	Title	Abstract	Author	Recipient
11412 11425 OU-C Book 13	C	3.1.4	5/15/95	Movements, Distribution and Relative Risk of Waterfowl, Bald Eagles and Dowitchers Using Eagle River Flats	Contained in Volume 1 of the Interagency Expanded Site Investigation FY94 Final Report; provides results of daily and seasonal movements of waterfowl at Eagle River Flats.	John Cummings et al. DWRC	None Given
11149 11279 OU-C Book 13	C	3.1.4	5/15/95	Physical System Dynamics, WP Fate and Transport, Remediation and Restoration, Eagle River Flats, Alaska	Contained in Volume 1 of the Interagency Expanded Site Investigation FY94 Final Report; presents the results of an analysis of the physical processes of erosion, sedimentation and sediment transport, and fate and transport of white phosphorus within Eagle River Flats.	Daniel Lawson CRREL	None Given
11624 11657 OU-C Book 13	C	3.1.4	5/15/95	Pond Draining Treatability Study	Contained in Volume 2 of the Interagency Expanded Site Investigation FY94 Final Report; presents results of the pond draining study conducted at Eagle River Flats.	Charles Collins CRREL	None Given
11540 11565 OU-C Book 13	C	3.1.4	5/15/95	Screening Study of Barriers to Prevent Poisoning of Waterfowl in Eagle River Flats, Alaska	Contained in Volume 2 of the Interagency Expanded Site Investigation FY94 Final Report; describes procedures and results of the use of barriers to prevent waterfowl from eating white phosphorus at Eagle River Flats.	Karen Henry CRREL	None Given
11327 11346 OU-C Book 13	C	3.1.4	5/15/95	Toxicological Properties of White phosphorus: Comparison of Particle Sizes on Acute Toxicity and the Biotransfer of White phosphorus from Hen to Eggs	Contained in Volume 1 of the Interagency Expanded Site Investigation FY94 Final Report; provides results of the comparison of particle sizes of white phosphorus on acute toxicity in birds and transfer from hen to egg.	Bill Roebuck Dartmouth Medical School	William Gossweiler DPW
11369 11380 OU-C Book 13	C	3.1.4	5/15/95	Waterbird Utilization of Eagle River Flats: April-October 1994	Contained in Volume 1 of the Interagency Expanded Site Investigation FY94 Final Report; provides the results of a water bird survey for the reported period.	William Eldridge USFWS	None Given

Page Numbers	OU	Cat No	Date	Title	Abstract	Author	Recipient
11381 11411 OU-C Book 13	C	3.1.4	5/15/95	Waterfowl Use and Mortality at Eagle River Flats	Contained in Volume 1 of the Interagency Expanded Site Investigations FY94 Final Report. Presents results of waterfowl mortality studies at Eagle River Flats.	Lenard Reitsma et al. NEILE	None Given
11294 11326 OU-C Book 13	C	3.1.4	5/15/95	White phosphorus Toxicity and Bioindicators of Exposure in Waterfowl and Raptors	Contained in Volume 1 of the Interagency Expanded Site Investigation FY94 Final Report; presents results of efforts to identify indicators of white phosphorus exposure in waterfowl at Eagle River Flats.	Donald Sparling DWRC	None Given
11794 11803 OU-C Book 14	C	3.1.4	5/16/95	1995 Eagle River Flats Spatial Database Project	Includes types and locations of data to be input into the Eagle River Flats database.	Charles Racine CRREL	None Given
11804 11945 OU-C Book 14	C	3.1.4	6/5/95	Receiving Water Biological Study No. 32-24-H37Y-94, Evaluation of White phosphorus Effects on the Aquatic Ecosystem, Eagle River Flats, Fort Richardson, Alaska, Final Report	Provides results of white phosphorus movement in the aquatic food chain at Eagle River Flats and the derivation of a no observed effect level concentration of white phosphorus in sediment.	AEHA	None Given
11946 11976 OU-C Book 14	C	3.1.4	6/28/95	Potential Assessment and Measurement Endpoints for Eagle River Flats, Draft	Presents the selection of assessment and measurement endpoints for the ERA of Eagle River Flats.	CH2M Hill	Richard Jackson USAED Alaska
11977 11977 OU-C Book 14	C	3.1.4	7/12/95	Eagle River Flats Waterfowl Hazing, Spring 1995 Summary	Summarizes waterfowl hazing operations at Eagle River Flats for spring 1995.	Corey Rossi USDA ADC	William Gossweiler DPW

Fort Richardson, Alaska Administrative Record Index Update for 1998

Page Numbers	OU	Cat No	Date	Title	Abstract	Author	Recipient
11978 12086 OU-C Book 14	C	3.1.4	12/15/95	Army Eagle River Flats: Protecting Waterfowl from Ingesting White phosphorus, Final, Technical Report 95-1	Final report on Eagle River Flats 1995 studies; contains two reports.	John Cummings DWRC	William Gossweiler DPW
12037 12086 OU-C Book 14	C	3.1.4	12/15/95	Evaluation of AquaBlok on Contaminated Sediment to Reduce Mortality of Foraging Waterfowl	Contained in Army Eagle River Flats: Protecting Waterfowl from Ingesting White phosphorus, Final, Technical Report 95-1; describes tests on the performance of a physical barrier material to prevent waterfowl from accessing contaminated sediment.	Patricia Pochop et al. DWRC	None Given
11980 12036 OU-C Book 14	C	3.1.4	12/15/95	Movement, Distribution and Relative Risk of Waterfowl and Bald Eagles Using Eagle River Flats	Contained in Army Eagle River Flats: Protecting Waterfowl from Ingesting White phosphorus, Final, Technical Report 95-1; summarizes the dynamics of the waterfowl population in Eagle River Flats and the estimated risk of exposure to white phosphorus and mortality.	John Cummings et al. DWRC	None Given
12087 12110 OU-C Book 14	C	3.1.4	12/16/95	Waterfowl Use and Mortality at Eagle River Flats, FY 1995	Summary of FY95 activities and findings.	Benjamin Steele NEILE	None Given
24495 24656 OU-C Book 17 **'97 Update**	C	3.1.4	7/1/96	Draft Risk Assessment Report, OU-C, Fort Richardson, Alaska	An analysis of current and potential future adverse environmental and human health effects caused by release of and exposure to OU-C-related chemicals.	CH2M Hill	USAED Alaska
24657 24880 OU-C Book 18 **'97 Update**	C	3.1.4	7/11/96	Draft Remedial Investigation Report, Fort Richardson, Alaska	Presents the results of the OU-C RI.	CH2M Hill	Army

Fort Richardson, Alaska Administrative Record Index Update for 1998

Page Numbers	OU	Cat No	Date	Title	Abstract	Author	Recipient
24881 24908 OU-C Book 18 **'97 Update**	C	3.1.4	7/15/96	Draft Natural Resources Appraisal of Damage on Eagle River Flats, OU-C, Fort Richardson, Alaska	Evaluation of level of the natural resource damage for determining natural resource compensation.	CH2M Hill	USAED Alaska
29168 29242 OU-C Book 20 **'98 Update**	C	3.1.4	12/15/96	Physical Processes and Natural Attenuation Alternatives for Remediation of White phosphorus Contamination, Eagle River Flats, Fort Richardson, Alaska	Describes the results of a study on the role of tidal flat physical systems in the natural attenuation of white phosphorus.	CRREL	DPW
29243 29278 OU-C Book 20 **'98 Update**	C	3.1.4	1/15/97	Movement, Distribution and Relative Risk of Waterfowl and Bald Eagles Using Eagle River Flats	Results of a study to determine daily and seasonal movement, distribution, turnover, and mortality rates of mallards. Determines the hazard that a mallard poisoned by white phosphorus poses to bald eagles. Establishes baseline mallard and bald eagle data with respect to proposed remediation.	John Cummings et al. DWRC	William Gossweiler DPW
29279 29829 OU-C Book 20 & 21 **'98 Update**	C	3.1.4	5/15/97	Final Remedial Investigation Report, OU-C, Fort Richardson, Alaska	Presents the results of the RI of OU-C, including the primary ordnance impact area at Eagle River Flats and the adjacent gravel pad used for open burning and open detonation (OB/OD Pad).	CH2M Hill	Joann Walls USAED Alaska
12111 12115 OU-C Book 14	C	3.1.5	6/5/89	Eagle River Flats Expanded Site Investigation--Draft Sampling Plan, Comments	Comments on the Hunter/ESE sampling design plan for Eagle River Flats.	Edwin Ruff DEH	Douglas Reagan ESE
12116 12117 OU-C Book 14	C	3.1.5	4/9/90	Eagle River Flats Expanded Site Investigation, Comments	Review comments on the Eagle River Flats expanded site investigation draft technical report.	Douglas Johnson EPA	Edwin Ruff DEH

Page Numbers	OU	Cat No	Date	Title	Abstract	Author	Recipient
12118 12122 OU-C Book 14	C	3.1.5	4/27/90	Eagle River Flats Expanded Site Investigation Fort Richardson, Alaska Draft Technical Report, Comments	Review comments on the Eagle River Flats expanded site investigation draft technical report, data item A011.	Bill Lamoreaux ADEC	Edwin Ruff DEH
12123 12128 OU-C Book 14	C	3.1.5	4/30/90	Eagle River Flats Expanded Site Investigation, Draft Technical Report, Fort Richardson, Alaska, Comments	Review comments on the Eagle River Flats expanded site investigation draft technical report.	Walter Stieglitz USFWS	Edwin Ruff DEH
12129 12131 OU-C Book 14	C	3.1.5	5/1/90	Eagle River Flats Expanded Site Investigation, Comments	Review comments on the Eagle River Flats expanded site investigation draft technical report.	Douglas Johnson EPA	Edwin Ruff DEH
12132 12134 OU-C Book 14	C	3.1.5	5/2/90	Eagle River Flats Expanded Site Investigation and Scope of Work, Comments	Review comments on the Eagle River Flats expanded site investigation draft technical report and SOW.	Bruce Duncan EPA	Douglas Johnson EPA
12135 12141 OU-C Book 15	C	3.1.5	5/17/90	Eagle River Flats Expanded Site Investigation, Fort Richardson, Alaska Draft Technical Report, Comments	Review comments on the Eagle River Flats expanded site investigation draft technical report, data item A011.	Dan Rosenberg ADFG	Edwin Ruff DEH
12142 12143 OU-C Book 15	C	3.1.5	12/27/90	Waterfowl Mortality in Eagle River Flats, Alaska: The Role of Munitions Compounds, Comments	Review comments on Waterfowl Mortality in Eagle River Flats, Alaska: The Role of Munitions Compounds.	Dan Rosenberg ADFG	Edwin Ruff DEH

Page Numbers	OU	Cat No	Date	Title	Abstract	Author	Recipient
12144 12145 OU-C Book 15	C	3.1.5	12/28/90	Waterfowl Mortality in Eagle River Flats, Alaska: The Role of Munitions Compounds, Draft Report, Comments	Includes recommendations for the 1991 proposed SOW.	Jennifer Roberts ADEC	Edwin Ruff DEH
12146 12148 OU-C Book 15	C	3.1.5	1/4/91	Waterfowl Mortality in Eagle River Flats, Alaska: The Role of Munitions Compounds, Comments	Review comments on the draft Waterfowl Mortality in Eagle River Flats, Alaska: The Role of Munitions Compounds.	Walter Steiglitz USFWS	Edwin Ruff DEH
12149 12150 OU-C Book 15	C	3.1.5	3/19/91	Waterfowl Mortality Study, Comments	USFWS comments on the proposed 1991 fieldwork for the Eagle River Flats waterfowl mortality study.	Walter Steiglitz USFWS	Edwin Ruff DEH
12151 12153 OU-C Book 15	C	3.1.5	1/31/92	Review Comments on the Remedial Investigation Report: White phosphorus Contamination of Salt Marsh Sediments at Eagle River Flats, Alaska, January 14, 1992, Draft Report	Review comments on Remedial Investigation Report: White phosphorus Contamination of Salt Marsh Sediments at Eagle River Flats, Alaska, January 14, 1992, Draft Report.	Jennifer Roberts ADEC	Robert Wrentmore DPW
12154 12155 OU-C Book 15	C	3.1.5	2/4/92	Review Comments on the Remedial Investigation Report: White phosphorus Contamination of Salt Marsh Sediments at Eagle River Flats, Alaska, January 14, 1992, Draft Report	Review comments on Remedial Investigation Report: White phosphorus Contamination of Salt Marsh Sediments at Eagle River Flats, Alaska, January 14, 1992, Draft Report.	Daryl Calkins USFWS	Robert Wrentmore DPW
12156 12163 OU-C Book 15	C	3.1.5	3/9/92	Review Comments on the 1992/1993 Comprehensive Workplan for Eagle River Flats	Review comments on 1992/1993 Comprehensive Workplan for Eagle River Flats.	Kurt Eilo EPA	Robert Wrentmore DPW

Page Numbers	OU	Cat No	Date	Title	Abstract	Author	Recipient
12164 12165 OU-C Book 15	C	3.1.5	3/9/92	Review Comments on the Remedial Investigation Report: White phosphorus Contamination of Salt Marsh Sediments at Eagle River Flats, Alaska, January 14, 1992, Draft Report	Review comments on Remedial Investigation Report: White phosphorus Contamination of Salt Marsh Sediments at Eagle River Flats, Alaska, January 14, 1992, Draft Report.	Kurt Eilo EPA	Robert Wrentmore DPW
12166 12170 OU-C Book 15	C	3.1.5	3/10/92	Eagle River Flats 1992/1993 Comprehensive Workplan	Review comments on Eagle River Flats 1992/1993 Comprehensive Workplan.	ADEC	Robert Wrentmore DPW
12171 12175 OU-C Book 15	C	3.1.5	4/2/92	Comprehensive Work Plan for Eagle River Flats, Response to Comments	Responses to EPA, Region X, comments on the comprehensive work plan for Eagle River Flats.	Robert York ATHAMA	Douglas Johnson EPA
12176 12178 OU-C Book 15	C	3.1.5	4/19/92	Comprehensive Work Plan for Eagle River Flats, Comments	USFWS comments on the comprehensive work plan for Eagle River Flats.	Daniel Allen USFWS	None Given
12179 12180 OU-C Book 15	C	3.1.5	2/22/93	Response to Comments on the Draft Scope of Work for Baseline Risk Assessment and FS	Responses to comments on the draft baseline RA and FS for Eagle River Flats.	Robert York AEC	Douglas Johnson EPA
12181 12182 OU-C Book 15	C	3.1.5	2/22/93	Responses to Eagle River Flats Task Force Comments and Concerns in Regard to CERCLA	Responses to Eagle River Flats Task Force comments and concerns in regard to CERCLA.	None Given	None Given

Page Numbers	OU	Cat No	Date	Title	Abstract	Author	Recipient
12183 12187 OU-C Book 15	C	3.1.5	2/22/93	Responses to Eagle River Flats Task Force Conference Call	Responses to Eagle River Flats Task Force conference call.	Robert York AEC	Douglas Johnson EPA
12188 12191 OU-C Book 15	C	3.1.5	4/14/93	Comments and Recommendations, Draft Remedial Investigations for Eagle River Flats, Report I	Review comments and recommendations on draft Report I, RIs for Eagle River Flats.	Robert York AEC	Larry Gatto CRREL
12192 12192 OU-C Book 15	C	3.1.5	4/14/93	Comments and Recommendations, Draft Remedial Investigations for Eagle River Flats, Report II	Review comments on the report II, treatability studies for Eagle River Flats.	Robert York AEC	Larry Gatto CRREL
12193 12197 OU-C Book 15	C	3.1.5	4/14/93	Comments on the Draft Phase II Remedial Investigation Report for Eagle River Flats	Review comments on the draft phase II RI report for Eagle River Flats.	Robert York AEC	Larry Gatto CRREL
12198 12199 OU-C Book 15	C	3.1.5	5/15/94	USCOE Review of the draft-final Comprehensive Evaluation Report for Eagle River Flats, Fort Richardson, Alaska	Review comments on the comprehensive evaluation report for Eagle River Flats.	USAED Alaska	William Gossweiler DPW
12200 12203 OU-C Book 15	C	3.1.5	5/31/94	Comprehensive Evaluation Report and Potential ARARs Evaluation for Eagle River Flats, draft-final	Review comments on the draft-final comprehensive evaluation report and potential ARARs evaluation for Eagle River Flats.	Jennifer Roberts ADEC	William Gossweiler DPW

Page Numbers	OU	Cat No	Date	Title	Abstract	Author	Recipient
12204 12208 OU-C Book 15	C	3.1.5	6/6/94	Description of Items Not Addressed in ERF Fieldwork QAPP	Includes a description of items not addressed in the Eagle River Flats fieldwork QA project plan.	CH2M Hill	USAED Alaska
12209 12210 OU-C Book 15	C	3.1.5	6/21/94	Comments on ERF Comprehensive Evaluation Report and ARARs Evaluation	Review comments on the Eagle River Flats draft-final comprehensive evaluation report and ARARs evaluation.	Ann Rappaport USFWS	William Gossweiler DPW
12211 12217 OU-C Book 15	C	3.1.5	6/21/94	Review of the draft-final Comprehensive Evaluation Report for Eagle River Flats, Fort Richardson, Alaska	Review comments on the draft-final comprehensive evaluation report for Eagle River Flats.	Arthur Lee AEHA	William Gossweiler DPW
12218 12224 OU-C Book 15	C	3.1.5	2/8/95	Draft 1994 Project Meeting Summary for Eagle River Flats	Recommended changes for Donald Sparling's portion of the draft 1994 project meeting summary for Eagle River Flats.	Donald Sparling DWRC	Richard Jackson USAED Alaska
12225 12235 OU-C Book 15	C	3.1.5	3/28/95	Eagle River Flats 1995 Field Work Proposals	Recommendations from the Biological Technical Assistance Group for Eagle River Flats regarding 1995 fieldwork proposals.	Sonce de Vries USFWS	William Gossweiler DPW
12236 12237 OU-C Book 15	C	3.1.5	5/24/95	Review Comments on the Draft 1995 QAPP	Review comments on the draft 1995 QA program plan.	Michael Walsh CRREL	Richard Jackson USAED Alaska

Fort Richardson, Alaska Administrative Record Index Update for 1998

Page Numbers	OU	Cat No	Date	Title	Abstract	Author	Recipient
12238 12240 OU-C Book 15	C	3.1.5	7/23/95	Comments on "Potential Assessment and Measurement Endpoints for Eagle River Flats"	ADFG comments on the technical memorandum Potential Assessment and Measurement Endpoints for Eagle River Flats.	Daniel Rosenberg ADFG	Sonce de Vries USFWS
12244 12246 OU-C Book 15	C	3.1.5	7/26/95	Comments on "Potential Assessment and Measurement Endpoints for Eagle River Flats"	CRREL comments on the technical memorandum Potential Assessment and Measurement Endpoints for Eagle River Flats.	Charles Racine CRREL	William Gossweiler DPW
12241 12243 OU-C Book 15	C	3.1.5	7/26/95	Comments on "Potential Assessment and Measurement Endpoints for Eagle River Flats"	Biological Technical Assistance Group comments on the technical memorandum, Potential Assessment and Measurement Endpoints for Eagle River Flats.	Sonce de Vries USFWS	William Gossweiler DPW
24909 24922 OU-C Book 18 **'97 Update**	C	3.1.5	1/1/96	Response to November 1995 Comments on Draft RI/FS Documents, OU-C, Eagle River Flats	CH2M Hill's response to comments made by EPA, the New England Institute for Landscape Ecology, USFWS, CRREL, the USDA Animal and Plant Health Inspection Service, USAED Alaska, and Dartmouth-Hitchcock Medical Center.	None Given	None Given
24923 24941 OU-C Book 18 **'97 Update**	C	3.1.5	1/30/96	Response to January 1996 Comments on Draft RI/FS Documents, OU-C, Eagle River Flats	CH2M Hill's response to comments made by USAED Alaska, CRREL, EPA and CHPPM.	None Given	None Given
24942 24949 OU-C Book 18 **'97 Update**	C	3.1.5	3/18/96	Review of CH2M Hill Documents	Response to January 1996 comments on the draft-final RI/FS management plan.	Michael Walsh CRREL	Laurie Angell DPW

Fort Richardson, Alaska Administrative Record Index Update for 1998

Page Numbers	OU	Cat No	Date	Title	Abstract	Author	Recipient
24950 24953 OU-C Book 18 **'97 Update**	C	3.1.5	8/19/96	Eagle River Flats Draft RI	Review comments.	Matthew Wilkening EPA	Bill Gossweiler DPW
24954 24955 OU-C Book 18 **'97 Update**	C	3.1.5	8/23/96	ADEC comments on ARAR's and RI	Review comments.	Jennifer Roberts ADEC	Richard Jackson USAED Alaska
24956 24960 OU-C Book 18 **'97 Update**	C	3.1.5	8/23/96	CHPPM Comments on Draft RI and RA, OU-C, July 1996	Review comments.	Arthur Lee CHPPM	Richard Jackson USAED Alaska
29830 29834 OU-C Book 21 **'98 Update**	C	3.1.5	8/23/96	Comments on Draft RI and RA, OU-C	Comments by the Army CHPPM.	Arthur Lee CHPPM	Richard Jackson USAED Alaska
24961 24974 OU-C Book 18 **'97 Update**	C	3.1.5	8/29/96	EPA Comments on Draft RI and Baseline RA	Review comments.	Howard Orlean EPA	Bill Gossweiler DPW
29835 29868 OU-C Book 21 & 22 **'98 Update**	C	3.1.5	3/25/97	Comments, draft-final Remedial Investigation Report, OU-C	Review comments.	Army	CH2M Hill

Fort Richardson, Alaska Administrative Record Index Update for 1998

Page Numbers	OU	Cat No	Date	Title	Abstract	Author	Recipient
12247 12247 OU-C Book 15	C	3.2	3/3/93	Guidelines for Remediation Experiments on Eagle River Flats, 1993	USFWS encourages the most expeditious means to resolve the water bird mortality problem at Eagle River Flats without compromising the long-term health of the wetlands.	USFWS	None Given
12248 12248 OU-C Book 15	C	3.2	3/11/93	Eagle River Flats Remediation Alternatives	ADEC supports implementation of the treatability analysis of the remediation measures for Eagle River Flats discussed at Hanover, New Hampshire, December 1992.	Jennifer Roberts ADEC	Robert Wrentmore DPW
24975 27979 OU-C Book 18 **'97 Update**	C	3.2	2/23/96	Revised SOW, Hydraulic Dredging, Eagle River Flats	An SOW to perform remote-controlled hydraulic dredging of Eagle River Flats for removal of white phosphorus-contaminated sediments.	Steven Russell Army	Bill Gossweiler DPW
29869 29919 OU-C Book 22 **'98 Update**	C	3.2	9/15/96	Dredging in an Active Artillery Impact Area, Eagle River Flats, Alaska	A study to investigate the feasibility of using a small, remote-controlled dredge to remove white phosphorus-contaminated sediments from ponded areas and to treat the spoils in an open retention basin.	CRREL	USAED Alaska
29920 29962 OU-C Book 22 **'98 Update**	C	3.2	1/15/97	Eagle River Flats Technology Screening	An evaluation of all potential treatment technologies on the basis of implementability, effectiveness, and cost. Also identifies which retained technologies may be applicable to ponds presenting the greatest threat of white phosphorus acute toxicity to water birds.	CH2M Hill	USAED Alaska
12249 12251 OU-C Book 15	C	3.3	12/4/89	Eagle River Flats Task Force Study	Request, on behalf of the Eagle River Flats Task Force, for ATHAMA's action, comments, and assistance on issues from the FY89 study and direction for the FY90 study.	Kenneth Northamer USAED Alaska	ATHAMA

Page Numbers	OU	Cat No	Date	Title	Abstract	Author	Recipient
12252 12256 OU-C Book 15	C	3.3	1/29/90	Eagle River Flats Task Force Study	Includes information addressing concerns expressed by Fort Richardson on behalf of the Eagle River Flats Task Force.	Louis Jackson ATHAMA	Kenneth Northamer USAED Alaska
12257 12268 OU-C Book 15	C	3.3	2/8/90	Eagle River Flats Task Force Meeting Minutes	Eagle River Flats Task Force meeting minutes, February 8, 1990.	None Given	None Given
12269 12295 OU-C Book 15	C	3.3	4/9/90	Eagle River Flats Task Force Meeting Minutes	Eagle River Flats Task Force meeting minutes, April 9, 1990.	None Given	None Given
12296 12296 OU-C Book 15	C	3.3	8/24/90	Reply to Senator Frank Murkowski's Letter Concerning Eagle River Flats Dated August 14, 1990	Reply to Senator Frank Murkowski's letter concerning Eagle River Flats.	William Kakel USAED Alaska	Frank Murkowski U.S. Senate
12297 12312 OU-C Book 15	C	3.3	12/10/90	Minutes of the 10 December 1990 Eagle River Flats Task Force Meeting	Eagle River Flats Task Force meeting minutes, December 10, 1990.	William Gossweiler DPW	None Given
12313 12313 OU-C Book 15	C	3.3	12/18/90	Eagle River Flats Waterfowl Mortality Study at Fort Richardson, Alaska	Summary of findings in the draft report, waterfowl Mortality on the Eagle River Flats Impact Area: The Role of Munitions Compounds.	Charles Nichols CRREL	Edwin Ruff DEH

Fort Richardson, Alaska Administrative Record Index Update for 1998

Page Numbers	OU	Cat No	Date	Title	Abstract	Author	Recipient
12314 12315 OU-C Book 15	C	3.3	3/21/91	Eagle River Flats Remedial Investigation	Concerns that need to be considered in the proposed FY91 Eagle River Flats RI.	Kurt Eilo EPA	Edwin Ruff DEH
12316 12316 OU-C Book 15	C	3.3	10/8/91	Concurrence on Environmental Assessment for the Resumption of Firing into the Eagle River Flats, Memorandum for Record	Office of the Assistant Secretary of the Army concurs with the EA for Eagle River Flats and offers no comments.	Bill Quirk Army	None Given
12317 12317 OU-C Book 15	C	3.3	11/12/91	Comprehensive Management Plan for Remediation of Eagle River Flats	Endorses the strategy of developing a comprehensive management plan for remediation of Eagle River Flats.	Walter Stieglitz USFWS	Robert Wrentmore DPW
12318 12318 OU-C Book 15	C	3.3	12/15/91	Eagle River Flats Waterfowl Die-Off Abstract, Memorandum for Record	Memorandum describing 1991 fieldwork regarding waterfowl die-offs and white phosphorus.	William Gossweiler DPW	None Given
12319 12321 OU-C Book 15	C	3.3	1/13/92	Eagle River Flats Update	Update on past, current, and future field investigations at Eagle River Flats.	William Gossweiler DPW	None Given
12322 12322 OU-C Book 15	C	3.3	3/19/92	Fiscal Year 1992 Eagle River Flats Study of Bird Hazing Activities	Reaffirms the position of the Eagle River Flats Task Force and the 6th Infantry Division regarding the integration of bird hazing and repellent operations in the FY92 study.	Robert Wrentmore DPW	ATHAMA

Fort Richardson, Alaska Administrative Record Index Update for 1998

Page Numbers	OU	Cat No	Date	Title	Abstract	Author	Recipient
12323 12324 OU-C Book 15	C	3.3	2/10/93	ERF	Request that the project to investigate and remediate white phosphorus contamination at Eagle River Flats be transferred from AEC to the Army Garrison, Alaska.	Robert Wrentmore DPW	Gerald Brown AEC
12325 12325 OU-C Book 15	C	3.3	2/11/93	Performance of AEC at Eagle River Flats	Concern that the AEC has not performed satisfactorily in executing studies needed for remediation at Eagle River Flats.	Walter Stieglitz USFWS	Robert Wrentmore DPW
12326 12328 OU-C Book 15	C	3.3	3/8/93	Remediation Measures at Eagle River Flats in Regards to Intertidal Wetlands	ADFG supports proceeding with remediation measures at Eagle River Flats as long as intertidal wetlands are unaffected.	Daniel Rosenberg ADFG	Robert Wrentmore DPW
12329 12330 OU-C Book 15	C	3.3	3/17/93	Eagle River Flats Alternatives	USFWS supports implementation of treatability studies of potential remediation measures for Eagle River Flats in FY93.	Walter Stieglitz USFWS	Gerald Brown AEC
12331 12332 OU-C Book 15	C	3.3	3/19/93	Eagle River Flats Project Management	Response to a request by Fort Richardson that management of Eagle River Flats be transferred from AEC to USAED Alaska.	Gerald Brown AEC	Robert Wrentmore DPW
12333 12335 OU-C Book 15	C	3.3	3/25/93	Eagle River Flats Environmental Cleanup	Concern about AEC's interpretation of the State of Alaska's legal requirements relating to the investigation and cleanup of contamination at Eagle River Flats.	Charles Cole ADOL	Gerald Brown AEC

Fort Richardson, Alaska Administrative Record Index Update for 1998

Page Numbers	OU	Cat No	Date	Title	Abstract	Author	Recipient
12336 12339 OU-C Book 15	C	3.3	4/21/93	Comments, Eagle River Flats Draft Workplan, Fort Richardson, Alaska	Review comments on the Eagle River Flats draft work plan.	David Charters EPA	Roy Metkar AEHA
12340 12342 OU-C Book 15	C	3.3	4/28/93	White phosphorus Lowest Observed Effect Level	Review of waterfowl toxicity data for white phosphorus.	Jack Dacre Geo-Centers, Inc.	William Burrows
12343 12346 OU-C Book 15	C	3.3	8/18/93	Eagle River Flats Task Force Meeting Minutes	Eagle River Flats Task Force meeting minutes.	None Given	None Given
12347 12347 OU-C Book 15	C	3.3	3/29/94	Telephone Conversation with State Historic Preservation Office	Contact report regarding the need for State Historic Preservation Office review of work to be conducted at Eagle River Flats.	William Gossweiler DPW	Ted Rockwell USAED Alaska
12348 12350 OU-C Book 15	C	3.3	8/1/94	Eagle River Flats FY94, Memorandum for Public AFederal Facilities Agreementirs Office	Describes how FY94 fieldwork for Eagle River Flats relates to remedial treatability studies and the development of an RA.	William Gossweiler DPW	Charles Canterbury PAO
12351 12352 OU-C Book 15	C	3.3	3/7/95	Eagle River Flats, Roles of Remedial Project Managers and the Biological Technical Assistance Group at Eagle River Flats	Letter explaining the roles of remedial project managers and the Biological Technical Assistance Group for Eagle River Flats.	Daniel Rosenberg ADFG	Albert Kraus DPW

Page Numbers	OU	Cat No	Date	Title	Abstract	Author	Recipient
12353 12353 OU-C Book 15	C	3.3	3/29/95	Eagle River Flats, Role of the Biological Technical Assistance Group at Eagle River Flats	Letter explaining the role of the Biological Technical Assistance Group at Eagle River Flats.	Albert Kraus DPW	Daniel Rosenberg ADFG
12354 12355 OU-C Book 15	C	3.3	4/4/95	Eagle River Flats, Roles of Remedial Project Managers and the Biological Technical Assistance Group at Eagle River Flats	Letter explaining the roles of remedial project managers and the Biological Technical Assistance Group for Eagle River Flats.	Sonce de Vries USFWS	Albert Kraus DPW
12356 12357 OU-C Book 15	C	3.3	4/15/95	Eagle River Flats, Role of the Biological Technical Assistance Group at Eagle River Flats	Letter explaining the role of the Biological Technical Assistance Group at Eagle River Flats.	Albert Kraus Army	Sonce de Vries USFWS
12358 12471 OU-C Book 15	C	3.3	12/15/95	Eagle River Flats, Final 1994 Project Meeting Summary	Eagle River Flats meeting minutes--December 12 through 14, 1994	CH2M Hill	William Gossweiler DPW
24980 25007 OU-C Book 18 **'97 Update**	C	3.3	3/1/96	Eagle River Flats GIS Database Review and Evaluation of Assessment End Points Approach	This technical memorandum summarizes CH2M Hill's efforts to obtain, quality check, and test the Army CRREL Eagle River Flats geographic information system. A summary of the QC review status on the geographic information system and a trial application for the identification of hot spots are included.	CH2M Hill	Army
29963 29965 OU-C Book 22 **'98 Update**	C	3.3	2/20/97	Endpoint for Eagle River Flats	Discusses activities of the Biological Technical Assistance Group with regard to endpoints, and preparation of the technical screening of remedial alternatives for Eagle River Flats.	Sonce de Vries USFWS	William Gossweiler DPW

Fort Richardson, Alaska Administrative Record Index Update for 1998

Page Numbers	OU	Cat No	Date	Title	Abstract	Author	Recipient
12472 12472 OU-C Book 15	C	4.2	7/31/95	Pilot Study of Dredging to Remove White phosphorus Contaminants from Sediments in a Limited Area of Eagle River Flats, Alaska	Discussion of preliminary test results from the use of an experimental remote-controlled dredging system in Eagle River Flats.	CRREL	None Given
25008 25364 OU-C Book 19 **'97 Update**	C	4.2	4/1/96	Final Remedial Investigation/FS Management Plan	The management plan documents the approach and methodologies used to conduct the RI for OU-C.	CH2M Hill	DPW
29966 30302 OU-C Book 22 & 23 **'98 Update**	C	4.2	9/15/97	Final FS Report, OU-C, Fort Richardson, Alaska	Presents the results of the FS for OU-C. The FS is intended to provide remedial project managers and the public with an assessment of remedial alternatives.	CH2M Hill	USAED Alaska
12473 12480 OU-C Book 15	C	4.3	8/31/95	Eagle River Flats (OU-C) Decision Document	Describes the treatment alternatives being evaluated by the Army to select a removal action for Eagle River Flats in accordance with CERCLA.	None Given	None Given
25365 25392 OU-C Book 19 **'97 Update**	C	4.3	4/1/96	Evaluation of Field Studies to Support Assessment Endpoints Approach	This technical memorandum summarizes the results of an evaluation of ongoing avian studies conducted at Eagle River Flats to determine whether endpoints have been reached. The objective of the evaluation was to assess the adequacy of studies performed to document attainment of sitewide remediation goals.	CH2M Hill	Army
30303 30320 OU-C Book 23 **'98 Update**	C	4.3	12/24/97	Final Proposed Plan, OU-C	Presents cleanup alternatives considered by the Army, EPA, and ADEC to the public.	Army	Public

Page Numbers	OU	Cat No	Date	Title	Abstract	Author	Recipient
25393 25402 OU-C Book 19 **'97 Update**	C	4.4	2/23/96	SOW Modification to the OU-C RI/FS Management Plan	A modification to perform an RI, HHRA, ERA, and Natural Resources Damage Assessment Plan.	None Given	None Given
25403 25403 OU-C Book 19 **'97 Update**	C	4.5	3/15/96	Comments on OU-C RI/FS Management Plan	Review comments.	Marianne Walsh CRREL	Richard Jackson USAED Alaska
25404 25407 OU-C Book 19 **'97 Update**	C	4.5	10/30/96	OU-C FS Schedule	Presents an outline of dates for documents to be prepared by CH2M Hill. Presents data gaps in the FS.	Colleen Burgh CH2M Hill	Richard Jackson USAED Alaska
25408 25412 OU-C Book 19 **'97 Update**	C	4.5	10/30/96	OU-C Technical Memo, Draft FS Data Needs	Summary of current information available and remaining data needed for researchers and principal investigators.	Colleen Burgh CH2M Hill	Richard Jackson USAED Alaska
30321 30328 OU-C Book 23 **'98 Update**	C	4.5	1/15/97	Hot Pond Screening, Draft Method	Discussion of a method for identifying the hot areas and ponds at Eagle River Flats.	David Lincoln CH2M Hill	Bill Gossweiler DPW
30329 30334 OU-C Book 23 **'98 Update**	C	4.5	1/30/97	Meeting Minutes: Eagle River Flats Technology Screening	A memorandum presenting the minutes from a January 22, 1997, meeting to discuss the results of the Eagle River Flats technology screening for the upcoming draft OU-C FS.	Colleen Burgh CH2M Hill	Joann Walls USAED Alaska

Fort Richardson, Alaska Administrative Record Index Update for 1998

Page Numbers	OU	Cat No	Date	Title	Abstract	Author	Recipient
30335 30337 OU-C Book 23 **'98 Update**	C	4.5	5/27/97	Comments, ERF Draft FS, April 1997	EPA comments on the draft FS for Eagle River Flats.	Howard Orlean EPA	Bill Gossweiler DPW
30338 30347 OU-C Book 23 **'98 Update**	C	4.5	5/30/97	Comments, OU-C Draft FS	Review comments.	Howard Orlean EPA	William Gossweiler DPW
30348 30395 OU-C Book 23 **'98 Update**	C	4.5	10/15/97	Response to Comments on Draft Proposed Plan, OU-C	A response to comments presented by EPA, CRREL, CHPPM, USFWS, ADFG, and USAED Alaska. The original comments are attached.	CH2M Hill	USAED Alaska
30396 30396 OU-C Book 23 **'98 Update**	C	5.5	3/11/97	Review of Decision Document, Eagle River Flats	Comments on the decision document for Eagle River Flats' Racine Island Pond. CHPPM has no comments and concurs with the remedial action.	Dennis Druck CHPPM	William Gossweiler DPW
30397 30397 OU-C Book 23 **'98 Update**	C	5.5	3/28/97	Review and Comments to Draft Decision Document	Review comments on the Draft Decision Document for Eagle River Flats' Racine Island Pond.	Michael Harada Army	Kevin Gardner DPW
25413 25414 OU-C Book 19 **'97 Update**	C	6.1	3/15/96	Memorandum of Agreement Between the USDA Animal Damage Control, Animal and Plant Health Inspection Service and the USAED Alaska	USAED Alaska entered an MOA to acquire waterfowl mortality reduction services.	None Given	None Given

Fort Richardson, Alaska Administrative Record Index Update for 1998

Page Numbers	OU	Cat No	Date	Title	Abstract	Author	Recipient
25415 25415 OU-C Book 19 '97 Update	C	9.0	12/16/96	Review of Draft Natural Resources Appraisal of Damage on ERF, July 1996	Review comments	Dennis Druck CHPPM	Joann Walls USAED Alaska
12482 12485 OU-C Book 15	C	10.6	10/5/88	Current Status of Eagle River Flats	Description of current, past, and planned activities for the Eagle River Flats investigation.	William Gossweiler DPW	None Given
12486 12488 OU-C Book 15	C	10.6	1/30/89	Current Status of Eagle River Flats Waterfowl Investigation	Summary of progress, action taken, and action required for Eagle River Flats investigations.	William Gossweiler DPW	None Given
12489 12492 OU-C Book 15	C	10.6	7/31/89	Current Status of Eagle River Flats Investigation	Presents the status of the 1989 Eagle River Flats waterfowl mortality investigation and lists actions taken and required.	Alan Bennett Army	None Given
12493 12496 OU-C Book 15	C	10.6	2/6/90	Update on Eagle River Flats/Poleline Road Contaminated Site Studies	Summary of progress, action taken, and action required for Eagle River Flats FY89 investigations.	William Gossweiler DPW	None Given
12497 12498 OU-C Book 15	C	10.6	6/29/90	Eagle River Flats Waterfowl Investigation Update	Review and update of the waterfowl investigation at Eagle River Flats.	William Gossweiler DPW	None Given

Fort Richardson, Alaska Administrative Record Index Update for 1998

Page Numbers	OU	Cat No	Date	Title	Abstract	Author	Recipient
12499 12500 OU-C Book 15	C	10.6	11/5/90	Eagle River Flats Waterfowl Investigation, Fact Sheet	Fact sheet about the Eagle River Flats waterfowl investigation.	Edwin Ruff DEH	William Gossweiler DPW
12501 12503 OU-C Book 15	C	10.6	1/9/91	Eagle River Flats Waterfowl Investigation	Review of historical waterfowl investigations at Eagle River Flats.	William Gossweiler DPW	None Given
12504 12506 OU-C Book 15	C	10.6	2/7/91	Eagle River Flats Waterfowl Investigation	Review of historical waterfowl investigations at Eagle River Flats.	William Gossweiler DPW	None Given
06933 06935 OU-C Book 3	C	10.6	2/21/91	Press Release: Eagle River Flats Report Released	Contained as an appendix to the EA for resumption of firing in the Eagle River Flats Impact Area. Release of the results of the report, Waterfowl Mortality in Eagle River Flats, Alaska: The Role of Munitions Compounds.	PAO	None Given
12481 12481 OU-C Book 15	C	10.6	3/15/91	Fact Sheet: Eagle River Flats Waterfowl Mortality	Information about waterfowl mortality at Eagle River Flats and investigations to date.	None Given	None Given
12507 12508 OU-C Book 15	C	10.6	3/21/91	Eagle River Flats Study-Progress Report	Assessment of 1990 study and discussion about resumption of firing at Eagle River Flats.	William Gossweiler DPW	None Given

Fort Richardson, Alaska Administrative Record Index Update for 1998

Page Numbers	OU	Cat No	Date	Title	Abstract	Author	Recipient
06940 06944 OU-C Book 3	C	10.6	9/25/91	Press Release: Eagle River Flats Studies Continue	Contained as an appendix to the EA for resumption of firing in the Eagle River Flats Impact Area; describes earlier and ongoing investigation results at Eagle River Flats.	PAO	None Given
06898 06898 OU-C Book 2	C	10.6	11/12/91	Notice of Availability and Public Comment Period	A notice of the availability of the EA and FONSI for the resumption of live-fire artillery and mortar training in Eagle River Flats.	William Bolt Army	None Given
12509 12510 OU-C Book 15	C	10.6	12/19/91	Eagle River Flats Update	Summarizes 1991 fieldwork, projections for 1992 fieldwork, and preparation of an EA to evaluate the resumption of firing into Eagle River Flats.	William Gossweiler DPW	None Given
12511 12512 OU-C Book 15	C	10.6	1/3/92	Press Release; FONSI Signed, Firing Resumes on Eagle River Flats	General information concerning the signing of the FONSI for the resumption of firing into Eagle River Flats.	Army	None Given
12513 12514 OU-C Book 15	C	10.6	1/9/92	Press Release: Eagle River Flats Test Results	Provides preliminary results of test firing munitions in Eagle River Flats.	Army	None Given
12515 12515 OU-C Book 15	C	10.6	5/13/92	Eagle River Flats Update	Brief summary of Army actions and plans to date.	Robert Wrentmore DPW	None Given

Fort Richardson, Alaska Administrative Record Index Update for 1998

Page Numbers	OU	Cat No	Date	Title	Abstract	Author	Recipient
12516 12516 OU-C Book 15	C	10.6	3/23/94	Eagle River Flats Waterfowl Mortality	Brief explanation of past, current, and future research at Eagle River Flats.	William Gossweiler DPW	None Given
12517 12517 OU-C Book 15	C	10.6	5/18/95	Fact Sheet: White phosphorus Contamination of Eagle River Flats, Fort Richardson, Alaska	Brief summary of historical findings at Eagle River Flats.	Charles Collins CRREL	Laurie Angell DPW
25416 25419 OU-C Book 19 **'97 Update**	C	10.6	2/27/96	Fact Sheet: Eagle River Flats Remediation Project	A fact sheet presenting a brief history of waterfowl deaths at Eagle River Flats.	William Gossweiler DPW	None Given
12518 12518 OU-C Book 15	C	10.9	8/14/90	Letter from Senator Frank Murkowski Concerning Eagle River Flats	Letter from Senator Frank Murkowski expressing concern about contamination at Eagle River Flats.	Frank Murkowski U.S. Senate	William Kakel USAED Alaska
18216 18239 FTR Book 1	FTR	1.1	10/28/83	Evaluation of Solid Waste Disposal Practices, Fort Richardson and Wainwright, Alaska	Evaluation of solid waste disposal practices and facilities with regard to protection of environmental quality and compliance with current regulations as they relate to sanitary landfill permitting and groundwater monitoring.	AEHA	None Given
18240 18241 FTR Book 1	FTR	1.1	7/6/90	DERP Program Review, Army Installation Restoration Program, FTW-D-001, Ft. Richardson Landfill Plume Investigation	Description, history, list of contaminants, mode of cleanup, status, issues and concerns, milestones, and fund status of an unlined landfill at Fort Richardson.	None Given	None Given

Fort Richardson, Alaska Administrative Record Index Update for 1998

Page Numbers	OU	Cat No	Date	Title	Abstract	Author	Recipient
18242 18243 FTR Book 1	FTR	1.1	7/6/90	DERP Program Review, Army Installation Restoration Program, WN-D-008, All Fort Assessment, GW Monitoring, and All Well Installation	Description, history, list of contaminants, mode of cleanup, status, issues and concerns, milestones, and fund status of the existing monitoring wells at Fort Richardson.	None Given	None Given
18244 18257 FTR Book 1	FTR	1.1	1/15/92	Installation Action Plan for Fort Richardson	Review of each OU's condition and funding.	USAED Alaska	None Given
20281 20281 FTR Book 1	FTR	1.1	7/14/92	Closure of Solid Waste Landfill at Ft. Richardson	Discussion of current situation at the landfill.	Karen Klocke DPW	None Given
18258 18328 FTR Book 1	FTR	1.1	4/8/94	Sampling and Analysis Plan, Groundwater Monitoring, Fort Richardson, Alaska	Outlines the procedures for chemical contamination monitoring in the groundwater of Fort Richardson.	USAED Alaska	Army
26984 27086 FTR Book 5 **'97 Update**	FTR	1.1	11/6/96	Final Landfill Closure Baseline Study, June-July 1996	Analytical results of groundwater sampling performed in June and July 1996	USAED Alaska	DPW
18329 18336 FTR Book 1	FTR	1.2	7/8/93	Fort Richardson Landfill, June 17, 1993 Inspection	Summary of site conditions reported by ADEC after its inspection of the landfill.	Kevin Kleweno ADEC	Robert Wrentmore DPW

Fort Richardson, Alaska Administrative Record Index Update for 1998

Page Numbers	OU	Cat No	Date	Title	Abstract	Author	Recipient
18337 18400 FTR Book 1	FTR	1.2.3	2/15/90	Sampling, Analysis, & QA/QC Plan for Groundwater Monitoring at Fort Richardson, Alaska	Sampling and data quality procedures to be used in the assessment of groundwater from existing supply wells, monitor wells, and piezometers at Fort Richardson.	USAED Alaska	None Given
18401 18571 FTR Book 1	FTR	1.2.3	4/3/90	Fort Richardson Landfill Work Plan, Part I & II	Methods to be employed for completion of the Fort Richardson landfill hydrogeological investigation; includes the sampling and analysis plan, site safety and health plan, and subsurface exploration plan.	E & E	USAED Alaska
18572 18580 FTR Book 1	FTR	1.2.4	12/1/89	Results of Chemical Analyses, Fort Richardson Landfill, Groundwater Monitoring	QA report and groundwater results, a report from USAED Alaska, cooler receipts and chain-of-custody forms, and diskettes with all reported data for the landfill wells at Fort Richardson.	James Paxton USAED Alaska	USAED Alaska
18581 18712 FTR Book 1	FTR	1.2.4	8/15/90	Draft of the Fort Richardson Landfill Geophysical Surveys Report	The principal goal of the geophysical surveys is to help select the location and number of monitoring wells needed to efficiently characterize the groundwater in the landfill area.	E & E	David Williams USAED Alaska
18713 18784 FTR Book 2	FTR	1.2.4	6/28/91	Geotechnical Report for Groundwater Monitoring Network, Fort Richardson, Alaska	1990 chemical and hydrogeological data from two sampling events during spring and fall 1990.	USAED Alaska	USAED Alaska
18785 18792 FTR Book 2	FTR	1.2.4	8/13/91	Basewide Groundwater Monitoring Study and Landfill, Chemical QA Data Report	Chemical QA report for the Fort Richardson basewide groundwater study and landfill data.	Tim Seeman USAED Alaska	Lynn Fischer E & E

Page Numbers	OU	Cat No	Date	Title	Abstract	Author	Recipient
18793 18947 FTR Book 2	FTR	1.2.4	2/20/92	Fort Richardson Landfill Report	An investigation and report on the hydrogeology of, and leaching from, the landfill at Fort Richardson.	E & E	USAED Alaska
18948 19118 FTR Book 2	FTR	1.2.4	7/16/92	Geotechnical Report for Groundwater Monitoring Network, Fort Richardson, Alaska	1991 chemical and hydrogeological data from two sampling events in May and November 1991.	USAED Alaska	Army
19119 19128 FTR Book 2	FTR	1.2.4	1/27/93	Fort Richardson and Fort Greely Groundwater Monitoring Well Network Sampling Results	Results of groundwater sampling conducted at Fort Richardson in October and November 1992.	Bob Wilson ENSR	Jane Smith DEH
19129 19197 FTR Book 2	FTR	1.2.4	4/15/94	Geotechnical Report for Groundwater Monitoring Network, Fort Richardson, Alaska	Number and state of groundwater wells present at Fort Richardson in 1994 and recommendations for new wells; boring logs are provided.	USAED Alaska	Army
19198 19330 FTR Book 3	FTR	1.2.4	7/19/94	Chemical Data Report, Groundwater Study (Spring 1994)	Results of a groundwater quality investigation for Fort Richardson.	USAED Alaska	None Given
19331 19484 FTR Book 3	FTR	1.2.4	5/15/95	Final Addendum to the Fort Richardson Landfill Report, Anchorage, Alaska	As a result of the recommendations presented in the 1992 Fort Richardson landfill report, USAED Alaska directs E & E to sample, log, and monitor the installation of three additional monitoring wells at the Fort Richardson landfill and to complete a report documenting the activities.	E & E	USAED Alaska

Page Numbers	OU	Cat No	Date	Title	Abstract	Author	Recipient
19485 19508 FTR Book 3	FTR	1.4.2	10/9/90	Final Phase, Results of the Analysis of Solid Waste Samples, Hazardous Waste Study No. 37-26-0474-91	Summary of the sampling and analysis of more than 200 containers of potentially hazardous waste located at four sites on Fort Richardson.	AEHA	None Given
19509 19564 FTR Book 3	FTR	1.4.2	10/9/90	Phase I, Results of the Analysis of Solid Waste Samples, Hazardous Waste Study No. 37-26-0474-91	Summary of the sampling and analysis of more than 200 containers of potentially hazardous waste located at four sites on Fort Richardson.	AEHA	None Given
19565 19595 FTR Book 3	FTR	1.4.2	10/9/90	Phase II, Results of the Analysis of Solid Waste Samples, Hazardous Waste Study No. 37-26-0474-91	Summary of the sampling and analysis of more than 200 containers of potentially hazardous waste located at four sites on Fort Richardson.	AEHA	None Given
19596 19635 FTR Book 3	FTR	2.1.4	1/15/94	Sampling Report for Groundwater Monitoring Network at Fort Richardson, Alaska	Summarizes new groundwater data collected from the monitoring well network on the main containment as well as water supply wells located on various training ranges.	ENSR	Army
19636 19717 FTR Book 3	FTR	3.1.3	4/15/95	Areawide Community Relations Plan, Fort Richardson, Anchorage, Alaska	Identifies current issues of community concern regarding known and potential contamination at Fort Richardson and includes proposals for community involvement activities to address these concerns.	E & E	USAED Alaska
27087 27341 FTR Book 5 **'97 Update**	FTR	3.1.3	4/18/96	Final Environmental Staging Facility Work Plan, Fort Richardson, Alaska	The work plan describes the design and operation of a contractor staging facility for support of environmental investigations and restoration at Fort Richardson. The proposed facility includes an equipment decontamination area and a liquid IDW treatment system.	ENSR	USAED Alaska

Fort Richardson, Alaska Administrative Record Index Update for 1998

Page Numbers	OU	Cat No	Date	Title	Abstract	Author	Recipient
31293 31319 FTR Book 8 '98 Update	FTR	3.1.3	9/23/97	Work Plan and Site Safety and Health Plan, Fort Richardson Methane Gas Survey	A work plan to perform a methane gas survey to meet the requirements of the landfill closure plan. A general overview of known site conditions, a description of the sampling equipment and methods to be used, and a description of the survey approach are presented.	Hart Crowser	USAED Alaska
19718 19731 FTR Book 4	FTR	3.1.4	7/16/92	Groundwater Monitoring Network, Fort Richardson	As part of the Fort Richardson basewide groundwater monitoring program begun in 1990, groundwater samples are collected and analyzed twice a year; this report summarizes the 1991 data.	Delwyn Thomas USAED Alaska	None Given
19732 19744 FTR Book 4	FTR	3.1.4	4/15/94	Installation Restoration Program FY94 Second Quarter Update	Includes FY94 second quarter updates for the OU-A RI/FS management plan, OU-D, groundwater monitoring, Poleline Road Disposal Area, and Eagle River Flats Impact Area.	Army	None Given
19751 19751 FTR Book 4	FTR	3.1.4	5/10/94	Compliance of Containerized Purge Water with AWWU Discharge Limitations	Containerized purge water resulting from the fall 1991 groundwater study is cleared for disposal in the Fort Richardson sewer system without violating the Fort's Anchorage Water and Waste Water Utility permit.	Delwyn Thomas USAED Alaska	None Given
19752 19763 FTR Book 4	FTR	3.1.4	6/15/94	Installation Restoration Program, FY94, Fourth Quarter Update	Project summaries for each OU at Fort Richardson.	Army	None Given
19746 19750 FTR Book 4	FTR	3.1.4	9/15/94	Installation Restoration Program FY94 Third Quarter Update	Includes FY94 third quarter updates for the Poleline Road Disposal Area, USTs, and Eagle River Flats.	Army	None Given

Fort Richardson, Alaska Administrative Record Index Update for 1998

Page Numbers	OU	Cat No	Date	Title	Abstract	Author	Recipient
19764 19769 FTR Book 4	FTR	3.1.4	12/15/94	Installation Restoration Program FY94 Third Quarter Update	Includes FY94 third quarter updates for the OU-A RI/FS management plan, OU-D groundwater monitoring, Poleline Road Disposal Area, and Eagle River Flats Impact Area.	Army	None Given
19770 19782 FTR Book 4	FTR	3.1.4	6/15/95	Installation Restoration Program FY95 Second Quarter Update	Includes FY94 second quarter updates for the OU-A management plan, OU-D groundwater monitoring, Poleline Road Disposal Area, and Eagle River Flats Impact Area.	Army	None Given
19783 19845 FTR Book 4	FTR	3.1.4	10/15/95	Draft Background Data Analysis Report	A study performed to determine the background concentrations of various chemicals at Fort Richardson, using previously existing data for soil and groundwater.	E & E	USAED Alaska
19846 20036 FTR Book 4	FTR	3.1.4	11/15/95	Chemical Data Report, Groundwater Study, Fall 1994 and Spring 1995	Data results from two sampling events conducted to continue a basewide groundwater quality study.	USAED Alaska	None Given
27342 27463 FTR Book 6 **'97 Update**	FTR	3.1.4	4/1/96	Final Background Data Analysis Report, Fort Richardson, Alaska	An analysis of analytical data at Fort Richardson to determine background levels of various inorganic compounds and pesticides in soil and groundwater.	E & E	USAED Alaska
31320 31359 FTR Book 8 **'98 Update**	FTR	3.1.4	5/15/97	Landfill Closure Study, Fort Richardson, Alaska	Presents analytical results for groundwater sampling performed by the Technical Engineering Section of USAED Alaska. Water samples were collected from nine of 13 monitoring wells located around the landfill.	Brian D. West USAED Alaska	DPW

Fort Richardson, Alaska Administrative Record Index Update for 1998

Page Numbers	OU	Cat No	Date	Title	Abstract	Author	Recipient
31360 31371 FTR Book 8 **'98 Update**	FTR	3.1.4	12/15/97	Installation Restoration Program FY97 Fourth Quarter Update	Presents a summary of environmental restoration projects at Fort Richardson.	Army	Public
20037 20037 FTR Book 4	FTR	3.1.5	11/16/95	Comments, Background Data Analysis Report, October 1995	Comments on the background data analysis report.	Louis Howard ADEC	Kevin Gardner DPW
20038 20041 FTR Book 4	FTR	3.1.5	12/7/95	Comments on the Background Study for Fort Richardson	Comments on the background data analysis report.	Matthew Wilkening EPA	Kevin Gardner DPW
27464 27476 FTR Book 6 **'97 Update**	FTR	3.1.5	1/1/97	Installation Restoration Program, FY 96, Third and Fourth Quarter Updates	Includes FY96 third and fourth quarter updates for OU-A, OU-B, OU-C, and OU-D; UST; and community relations plan.	USAED Alaska	None Given
27477 27841 FTR Book 6 **'97 Update**	FTR	3.2	2/1/96	Geotechnical Report for Groundwater Monitoring Network, Fort Richardson, Alaska	A study to provide additional information and understanding of the groundwater regime at Fort Richardson.	USAED Alaska	USAED Alaska
27842 28204 FTR Book 6 **'97 Update**	FTR	3.2	5/10/96	Chemical Data Report, Groundwater Study, Fall 1995, Fort Richardson, Alaska	Presents sample results for 60 wells sampled during October 1995 as part of the biannual postwide groundwater study.	USAED Alaska	None Given

Fort Richardson, Alaska Administrative Record Index Update for 1998

Page Numbers	OU	Cat No	Date	Title	Abstract	Author	Recipient
28205 28212 FTR Book 7 **'97 Update**	FTR	3.3	5/23/96	Memorandum: Final Background Data Analysis Report, Fort Richardson, Alaska	Minor errors were found on a few pages of the final Background Data Analysis Report, Fort Richardson, Alaska. The errata sheets have the correct information and should be included in the report.	Elaine Hourigan USAED Alaska	Kevin Gardner DPW
28213 28242 FTR Book 7 **'97 Update**	FTR	4.3	12/24/96	Draft Approach Document, Postwide Risk Assessment	Presents a proposed methodology for generating a basewide RA based on RAs conducted for all OUs and sites addressed under the Federal Facilities Agreement.	Army	None Given
20042 20066 FTR Book 4	FTR	6.1	3/28/94	Fort Richardson Environmental Restoration Agreement	Executed Two-Party Agreement between the Army and ADEC.	Breck Tostevin Alaska Attorney General	Thomas Cook CofS
20067 20144 FTR Book 4	FTR	7.4	12/20/94	Federal Facility Agreement Under CERCLA	Presents the EPA requirements for hazardous waste site investigation and remediation work to be completed at Fort Richardson.	Dean Ingemansen EPA	Thomas Cook CofS
20145 20152 FTR Book 4	FTR	8.1	2/1/95	ATSDR Site Summary and Site Ranking	ATSDR site summary and site ranking for Fort Richardson.	Sandra Isaacs PHS	Thomas Needham CG
28243 28272 FTR Book 7 **'97 Update**	FTR	8.1	7/23/96	Public Health Assessment for Fort Richardson, CERCLIS No. AK6214522157	A Public health assessment was conducted for each site within each OU. The public health assessment compiles and analyzes relevant health and environmental data, community health concerns, and contaminant exposure pathways.	Max Hawie Army Toxicology Division	Kevin Gardner DPW

Fort Richardson, Alaska Administrative Record Index Update for 1998

Page Numbers	OU	Cat No	Date	Title	Abstract	Author	Recipient
20153 20154 FTR Book 4	FTR	10.0	7/13/95	Administrative Record Review Meeting Minutes	Meeting minutes concerning the approach for the administrative record for Fort Richardson.	Louise Flynn E & E	None Given
20159 20161 FTR Book 4	FTR	10.1	3/3/95	Comments, Community Relations Plan, Fort Richardson	Review comments on the Fort Richardson community relations plan.	Matthew Wilkening EPA	Kevin Gardner DPW
20155 20155 FTR Book 4	FTR	10.1	9/21/95	Comments, Administrative Record	ADEC comments concerning documents in the administrative record for Fort Richardson.	Louis Howard ADEC	Kevin Gardner DPW
20156 20158 FTR Book 4	FTR	10.1	10/10/95	Comments, Administrative Record	EPA comments concerning documents in the administrative record.	Matthew Wilkening EPA	Kevin Gardner DPW
20162 20162 FTR Book 4	FTR	10.2	10/25/94	Fort Richardson Community Relations Plan Interview Questions, Draft	Interview questions for the public regarding the CERCLA/Superfund process at Fort Richardson.	Janet Kaps E & E	None Given
20166 20166 FTR Book 4	FTR	10.3	5/15/94	National Priorities List, Fort Richardson, Anchorage, Alaska	Brief summary of proposed sites for the NPL.	EPA	None Given

Fort Richardson, Alaska Administrative Record Index Update for 1998

Page Numbers	OU	Cat No	Date	Title	Abstract	Author	Recipient
20170 20259 FTR Book 4	FTR	10.4	7/15/95	Summary Report of the Fort Richardson Information Meeting Held June 29, 1995, Anchorage, Alaska	Summary of the public meeting regarding the status of environmental cleanup at Fort Richardson.	E & E	USAED Alaska
28280 28357 FTR Book 7 **'97 Update**	FTR	10.4	3/14/96	Summary Report, Fort Richardson Public Meeting, March 14, 1996, Anchorage, Alaska	Summarizes the March 14, 1996, public meeting to inform citizens of Anchorage and Fort Richardson about the progress at the four OUs at Fort Richardson.	E & E	USAED Alaska
31372 31448 FTR Book 8 **'98 Update**	FTR	10.4	3/19/97	Meeting Minutes, Fort Richardson Restoration Advisory Board Public Information Meeting	Meeting minutes and support documents from a March 19, 1997 public meeting held at Russian Jack Chalet.	Army	Public
31449 31465 FTR Book 8 **'98 Update**	FTR	10.4	10/9/97	Restoration Advisory Board Meeting Minutes	Minutes from the October 9, 1997, meeting of the Fort Richardson Restoration Advisory Board.	Thomas Reed USAED Alaska	Kevin Gardner DPW
31466 31482 FTR Book 8 **'98 Update**	FTR	10.4	11/19/97	Draft Meeting Minutes from October 9, 1997 Restoration Advisory Board Meeting.	Contains meeting minutes and other documentation from the October 9, 1997, Restoration Advisory Board meeting conducted at the Russian Jack Chalet.	David Brown DPW	Restoration Advisor
20163 20165 FTR Book 4	FTR	10.6	6/18/93	EPA News: National Priorities List Proposal	Press release reporting the proposal of Fort Richardson on the NPL.	EPA	None Given

Page Numbers	OU	Cat No	Date	Title	Abstract	Author	Recipient
20260 20263 FTR Book 4	FTR	10.6	6/1/94	Draft Press Release: Fort Richardson on the National Priorities List	Fort Richardson is placed on the NPL.	Army	None Given
20167 20167 FTR Book 4	FTR	10.6	6/1/94	EPA News Release: Fort Richardson on the National Priorities List	Fort Richardson is placed on the NPL.	EPA	None Given
20168 20168 FTR Book 4	FTR	10.6	10/30/94	Fort Richardson Schedule for Superfund Investigation	List of OUs and due dates for associated RI/FS management plans.	Matthew Wilkening EPA	None Given
20169 20169 FTR Book 4	FTR	10.6	6/5/95	Public Meeting Notice for Fort Richardson, in Environmental Restoration News	Public meeting notice for Fort Richardson.	Kevin Gardner DPW	None Given
20264 20264 FTR Book 4	FTR	10.6	6/6/95	Fort Richardson Public Meeting	Background, action taken, and action required for a public meeting to describe the Fort Richardson Federal Facilities Agreement.	Kevin Gardner DPW	None Given
20265 20272 FTR Book 4	FTR	10.6	6/15/95	Environmental Restoration News, Vol. 1, No. 1	Review of the Superfund process at Fort Richardson and announcement of the public meeting.	Army	Public

Fort Richardson, Alaska Administrative Record Index Update for 1998

Page Numbers	OU	Cat No	Date	Title	Abstract	Author	Recipient
20273 20280 FTR Book 4	FTR	10.6	10/15/95	Environmental Restoration News, Vol. 1, No. 2	Provides the status of the OUs, and discusses the June 29, 1995, public meeting and remediation technologies.	Army	Public
31483 31488 FTR Book 8 **'98 Update**	FTR	10.6	1/15/96	Environmental Restoration News, Vol. 2, No.1	This document provides an update on OU-A, OU-B, OU-C, and OU-D. Includes a questionnaire to determine public interest regarding formation of a Restoration Advisory Board. Defines what a PSE is.	Army	Public
28273 28273 FTR Book 7 **'97 Update**	FTR	10.6	4/1/96	Public Notice, Establishment of Administrative Record	The notice announces the establishment of the Fort Richardson administrative record at Fort Richardson and the information repositories.	USAED Alaska	Public
31489 31492 FTR Book 8 **'98 Update**	FTR	10.6	4/15/96	Environmental Restoration News, Vol. 2, No. 2	This document provides an update on OU-A, OU-B, OU-C, and OU-D. Presents results of the Restoration Advisory Board questionnaire. Also discusses the Fort Richardson background data analysis study; the UST restoration compliance agreement; and information about a public meeting on March 14, 1997, at the Russian Jack Chalet.	Army	Public
28274 28274 FTR Book 7 **'97 Update**	FTR	10.6	5/1/96	Public Notice: Public Health Assessment for Fort Richardson	The notice announces availability of the public health assessment for Fort Richardson as completed by the ATSDR.	ATSDR	Public
28275 28278 FTR Book 7 **'97 Update**	FTR	10.6	7/1/96	Environmental Restoration News, Vol. 2, No. 3	This document provides an update on the Restoration Advisory Board and information about the Two-Party Agreement sites at Fort Richardson. Also, explains the Superfund process and provides updates on OU-A, OU-B, OU-C, and OU-D.	Army	Public

Fort Richardson, Alaska Administrative Record Index Update for 1998

Page Numbers	OU	Cat No	Date	Title	Abstract	Author	Recipient
28279 28279 FTR Book 7 **'97 Update**	FTR	10.6	9/22/96	Public Notice: Fort Richardson Advisory Board Membership	The Army invites the public to participate in the decision-making process for the environmental cleanup of Fort Richardson by completing and mailing Restoration Advisory Board interest forms. All names received will be added to the Fort Richardson Restoration Advisory Board mailing list.	Army	Public
31493 31496 FTR Book 8 **'98 Update**	FTR	10.6	10/15/96	Environmental Restoration News, Vol. 2, No. 4	This document provides an update on OU-A, OU-B, OU-C, OU-D, and the Restoration Advisory Board.	Army	Public
31497 31500 FTR Book 8 **'98 Update**	FTR	10.6	3/7/97	Fact Sheet: Establishment of Restoration Advisory Board	An information packet to invite the Fort Richardson and Anchorage communities to participate in the decision-making process during environmental investigation and cleanup activities at Fort Richardson.	Army	Public
31501 31506 FTR Book 8 **'98 Update**	FTR	10.6	3/15/97	Environmental Restoration News, Vol. 3, No. 4	This document provides an update on OU-A, OU-B, OU-C, and OU-D, and information about a public meeting on January 29, 1997, at the Russian Jack Chalet. Also defines the Superfund process and what a proposed plan is.	Army	Public
31507 31510 FTR Book 8 **'98 Update**	FTR	10.6	3/19/97	Public Notice: Establishment of a Restoration Advisory Board	Public notice placed in the Anchorage Daily News and Alaska Star concerning a public meeting to establish a Restoration Advisory Board.	DPW	Public
31511 31514 FTR Book 8 **'98 Update**	FTR	10.6	9/15/97	Environmental Restoration News, Vol. 3, No. 2	This document provides an update on the Restoration Advisory Board and information about a public meeting on March 19, 1997, at the Russian Jack Chalet. Also defines the Superfund process and provides updates on OU-A, OU-B, OU-C, and OU-D.	Army	Public

Fort Richardson, Alaska Administrative Record Index Update for 1998

Page Numbers	OU	Cat No	Date	Title	Abstract	Author	Recipient
31515 31515 FTR Book 8 **'98 Update**	FTR	10.6	10/4/97	You Are Invited to Discuss Fort Richardson Environmental Cleanup Issues	A public notice that appeared in the Anchorage Daily News inviting the public to a Restoration Advisory Board meeting at the Russian Jack Chalet on Thursday, October 9, 1997.	Army	Public

Appendix B
Responsiveness Summary

APPENDIX B

Responsiveness Summary

Overview

The U.S. Army Alaska (Army), U.S. Environmental Protection Agency (EPA), and Alaska Department of Environmental Conservation (ADEC), collectively referred to as the Agencies, distributed a Proposed Plan for remedial action at Operable Unit C (OU-C), Fort Richardson, Alaska. OU-C consists of two source areas: the Eagle River Flats (ERF), an ordnance impact area, and the former Open Burning/Open Detonation (OB/OD) Pad.

The Proposed Plan identified the preferred remedial alternative for ERF. No cleanup action was recommended for the former OB/OD Pad. Institutional controls that control access to the OB/OD Pad will continue. The major components of the remedial alternative for ERF are as follows:

- Treatment of white phosphorus-contaminated sediment by draining ponds with pumps and allowing sediments to dry and the white phosphorus to sublimate and oxidize
- Application of cap-and-fill material to areas of ponds that do not drain and dry sufficiently to enable the white phosphorus to sublimate and oxidize
- Long-term monitoring of waterfowl use, waterfowl mortality, and white phosphorus in sediment
- Sitewide institutional controls

Four written comments and one verbal comment about the Proposed Plan for OU-C were received during the public comment period. The comments consisted of from one to several specific questions or statements from each commenter. The comments are summarized and presented in this Responsiveness Summary.

Background of Community Involvement

The public was encouraged to participate in selection of the final remedy for OU-C during a public comment period from February 5 to March 6, 1998. The *Proposed Plan for Cleanup Action at Operable Unit C, Fort Richardson, Alaska,* presents four options considered by the Agencies to address contamination in sediments at ERF. The Proposed Plan was released to the public on February 4, and copies were sent to all known interested parties, including elected officials and concerned citizens. Informational Fact Sheets, prepared quarterly since July 1995, provided information about the Army's entire cleanup program at Fort Richardson and were mailed to the addresses on the same mailing list.

The Proposed Plan summarizes available information about OU-C. Additional information was placed into three information repositories: the University of Alaska Anchorage Consortium Library, Alaska Resources Library, and Fort Richardson Post Library. An Administrative Record, including all items placed into the information repositories and other documents used in the selection of the remedial action, was established in

Building 724 on Fort Richardson. The public was encouraged to inspect materials available in the Administrative Record and the information repositories during business hours.

Interested citizens were invited to comment on the Proposed Plan and the remedy selection process by mailing comments to the Fort Richardson project manager, by calling a toll-free telephone number to record a comment, or by attending and commenting at a public meeting conducted on February 12, 1998 at the Russian Jack Springs Chalet in Anchorage. The proceedings of the meeting were recorded by a court reporter, and the transcript became a part of the Administrative Record for OU-C.

Basewide community relations activities conducted for Fort Richardson, which include OU-C, have consisted of the following:

- December 1994—community interviews with local officials and interested parties
- April 1995—preparation of the Community Relations Plan
- June 1995—distribution of an informational Fact Sheet covering all OUs at Fort Richardson
- June 29, 1995—an informational public meeting covering all OUs
- October 1995—distribution of an informational Fact Sheet covering all OUs at Fort Richardson
- January 1996—distribution of an informational Fact Sheet covering all OUs at Fort Richardson
- March 1996—establishment of informational repositories at the University of Alaska Anchorage Consortium Library, Alaska Resources Library, Fort Richardson Post Library, and Administrative Record at Building 724 on Fort Richardson
- March 14, 1996—an informational public meeting covering all OUs
- April 1996—distribution of an informational Fact Sheet covering all OUs at Fort Richardson
- July 1996—distribution of an informational Fact Sheet covering all OUs at Fort Richardson
- October 1996—distribution of an informational Fact Sheet covering all OUs at Fort Richardson
- March 1997—distribution of a Fact Sheet soliciting interest from the community for the formation of a Restoration Advisory Board (RAB) to support Fort Richardson
- September 1997—distribution of an informational Fact Sheet covering all OUs at Fort Richardson
- October 1997—first Fort Richardson RAB meeting convened
- February 1998—second Fort Richardson RAB meeting convened

Community relations activities specifically conducted for OU-C included the following:

- February 8, 9, 10, 11, and 12, 1998–display advertisement announcing the public comment period and public meeting in the *Anchorage Daily News*
- February 5, 1998–display advertisement announcing the public comment period and public meeting in the *Alaska Star*
- February 5, 1998–distribution of the Proposed Plan for final remedial action at OU-C
- February 5 to March 6, 1998–30-day public comment period for final remedial action at OU-C
- February 5 to March 6, 1998–availability of a toll-free number for citizens to provide comments during the public comment period. The toll-free number was advertised in the Proposed Plan and the newspaper display advertisement that announced the public review period.
- February 12, 1998–public meeting at the Russian Jack Springs Chalet to provide information, a forum for questions and answers, and an opportunity for public comment about OU-C

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

Verbal Comment from the Public Meeting

Comment: My name is John Schoen and I'm representing the Alaska Audubon Society. I certainly commend the Army for going ahead and trying to resolve this problem. It's a very serious problem. And we support Alternative Three with minimal capping and filling. In other words, we would like to see the wetlands and waterfowl habitat maintained as much as we can, as long as there's no poison out there in the environment. But seems like Alternative 3 is the best solution to us in terms of maintaining habitat and getting rid of the white phosphorus. So thanks for the good work. We'd like to see the effort continue so that we can reduce the problem as best we can in the long run.

Response: The Agencies appreciate input from community members.

Comment: I'm George Matz, president of Anchorage Audubon Society. And just reviewing the material on this, it is tremendously important work that they're doing. I hope to see it continue.

Response: The Agencies appreciate input from community members.

Written Comments

Comment: I [George Matz, Anchorage Audubon Society] was at the meeting last night and I gave some comments during the break commending Fort Rich for this effort. . . . One thing I forgot to mention is that Anchorage Audubon endorses the Alternative 3 that you have in your plan. It looks like the most, not only effective in terms of rehabilitation but most cost effective. I just wanted to have that on the record.

Response: The Agencies appreciate input from community members.

Comment: We [the Anchorage Waterways Council, Eric Paule, President] are pleased to learn that the cleanup of the Eagle River Flats is proceeding. After reviewing the Proposed Plan for Cleanup Action at Operable Unit C, Fort Richardson, Alaska we have the following questions:

Question 1: During the pumping process utilized in Alternative 3, what is the possibility that some of the white phosphorus could become suspended in the water column and be transported to the pumping location?

Response: In the sediment and surface water at ERF, white phosphorus generally exists in two sizes: smaller colloids (microgram-sized) and larger particles (milligram-sized). Both sizes have persisted over time in the sediment. Laboratory and field experiments indicate that the colloids are readily suspended, but there is no evidence that the larger particles can be resuspended or transported. The smaller colloids can remain suspended for long periods (approximately 40 seconds), whereas the larger particles settle in less than 1 second. The larger particles are the ones of concern in relation to dabbling ducks and lethal white phosphorus doses. More information regarding the fate and transport of white phosphorus is provided in Section 5.4 of the May 1997 *Operable Unit C Final Remedial Investigation* (RI) *Report*.

Question 2: In the documentation, it is not clear where the pond water will end up; please clarify.

Response: Pumped water will be transported from white phosphorus-contaminated ponds to neighboring gullies through an 8-inch, a 10-inch, or a 12-inch pipeline. These gullies feed to the Eagle River, which leads to the Knik Arm. More information about Alternative 3 is presented in Appendix C of the September 1997 *Operable Unit C Final Feasibility Study* (FS) *Report*. Itemized components are listed in the cost estimate (Appendix E of that report).

Question 3: Where has the AquaBlok™ been used before and with what success rate?

Response: The use of AquaBlok™ as a cap for contaminated pond bottoms has been evaluated first by bench-scale testing (1993) and then by treatability testing (1-acre in 1994) at ERF. Results show that AquaBlok™ will not destroy habitat, but it may alter it. Applications of AquaBlok™ will be limited to deeper portions of ponds. The feeding habitat represented by the covered bottom sediments will be reduced until habitat is reestablished. Sedimentation and plant establishment of the top of the AquaBlok™ are expected to restore these areas for waterfowl feeding; however, the pond depth will be permanently altered. It has been demonstrated that within 1 year of initial application, vegetative growth over the barrier becomes lush and is inhibited only in areas where the AquaBlok™ was the thickest. Fish and invertebrates also were observed in ponded areas treated with AquaBlok™. The new vegetation provides areas where waterfowl can hide or loaf. Additional information about the performance of AquaBlok™ at ERF can be found in Appendix C of the September 1997 final FS report. In addition, it has been reported that, on a separate project, AquaBlok™ was planned for use in covering a section of the Ottawa River to prevent polychlorinated biphenyls from flowing into Lake Erie.

Question 4: Has AquaBlok™ been used in cold regions before?

Response: Yes, as mentioned in the previous response, AquaBlok™ has been tested at ERF. Ice-plucking is a concern in areas close to Eagle River. However, none of the contaminated ponds that may be capped and filled are located close to the river.

Question 5: The documentation does not specify the thickness of AquaBlok™ barrier; please clarify.

Response: Approximately 5 to 10 centimeters (cm) of AquaBlok™ will be applied. The material is expected to swell to 20 to 30 cm. Changes in AquaBlok™ thickness through time (of material installed in 1994) are as follows:

	1994	1995	1996
Center of AquaBlok™ drop	approx. 30 cm	20.3 cm	20.0 cm
Level ground	6.2 cm	5.2 cm	9.8 cm
Craters	16.0 cm	14.5 cm	7.4 cm

The thickness of AquaBlok™ decreases over time in the craters as the material sloughs from the sides of the craters. A thicker layer of AquaBlok™ may be applied over craters. Areas with craters will be closely monitored. More detailed information is provided in Appendix C of the September 1997 final FS report.

Question 6: If the AquaBlok™ material supports vegetative growth, over time, would the integrity of the barrier be compromised? What is the life span of the barrier?

Response: The reestablishment of vegetative habitat will improve the barrier effectiveness of the material. The primary intent of AquaBlok™ is to prevent waterfowl from feeding in contaminated sediment. Therefore, the barrier is not intended to be hydraulically impermeable. The AquaBlok™ installed in 1994 is still performing to specifications. Through time, the performance of the cover material is expected to continue to improve with vegetative regrowth and sedimentation.

Question 7: If the AquaBlok™ will not be immediately available for revegetation, is a thin layer of soil being considered to facilitate revegetation?

Response: Vegetation rebound is expected to occur within 1 to 2 years of application. A thin layer of soil is not expected to be necessary to reestablish regrowth.

Question 8: Alternatives 1, 2, and 4 are the least desirable remediation methods. We would tend to agree with the documentation that 1 and 2 would not be the most proactive method for remediating the problem and Alternative 4, permanent removal of the duck habitat, is not an acceptable option to AWC.

Response: The Agencies appreciate input from community members.

Question 9: In the documentation, it is unclear if Alternative 3 will be carried out consecutively or concurrently. If consecutively, would there be hazing on the ponds where there is no remediation activity?

Response: Alternative 3 will likely be carried out consecutively. Therefore, hazing will be performed in contaminated areas that are awaiting treatment.

The following five comments are from Alaska Community Action on Toxics, a project of the Alaska Conservation Foundation, Pamela Miller, Project Director.

Comment 1: We are concerned about the level of damage and alteration of the Eagle River flats wetlands caused by past and present detonation and burning of munitions within and around the salt marsh and riparian habitat. The Eagle River riparian zone and delta are ecologically significant and sensitive areas that must not be subjected to further abuse. Munitions and explosives testing must stop immediately to prevent additional damage and disruption of the hydrology and ecology of the Eagle River wetlands. Computer simulations should be used instead of testing in such a fragile environment, if weapons must be "tested."

Response: The issue being addressed by this Proposed Plan is remedial action at OU-C for contamination from white phosphorus. Military uses of the ERF Impact Area not related to remedial actions for white phosphorus contamination are not within the focus of this plan.

Comment 2: The Army should intensively focus on the hydrological and ecological restoration of the Eagle River wetlands. The Army should strive to remove UXO, spent munitions, and white phosphorus to minimize continuing and long-term damage to the environment, wildlife, human health and safety. While it is commendable that the Army has ceased testing of white phosphorus in the Eagle River wetlands, all explosives testing should also cease to prevent further environmental damage and human health and safety hazards.

Response: The Army is presenting remedial action methodologies in the Proposed Plan that are least disruptive to the hydrology and ecology of the ecosystem. Issues related to military uses of the ERF Impact Area to fulfill its national security training mission that are not related to the remedial action for white phosphorus contamination are not relevant to this plan.

Comment 3: We question the assertion in the Proposed Plan that sampling during the RI "found that all contaminants identified at OB/OD Pad were at levels low enough that cleanup is not required." Recent studies demonstrate widespread contamination from munitions at such bases as the Massachusetts Military Reserve Camp Edwards, the Army Grafenwohr Training Area in Germany, and Fallon NAS. Large quantities of heavy metals such as lead, copper, zinc, cadmium, as well as arsenic were deposited within and around the weapons ranges. At the Grafenwohr Training Area, surface soils contaminated with heavy metals had to be classified as hazardous waste (measured through toxic characterization leaching procedures). The vegetation was contaminated with heavy metals. At other sites, toxic components of the explosives/propellants contaminate ground and surface waters with such chemicals as RDX, nitrobenzene, nitrotoluene, and trinitrobenzene. Open detonation and burning could result in the formation of persistent and toxic chemicals such as dioxins and furans. We are not convinced that an adequate sampling program has been undertaken which identifies the nature and extent of contamination and exposure pathways.

Response: An RI sampling program was conducted in 1996 to estimate the extent of contamination at OB/OD Pad. The RI considered the past use of OB/OD Pad related to the specific types and amounts of munitions that were disposed, the length of time the disposal occurred, and the physical features of the pad that would determine the fate and transport of suspected contamination. The RI also included a risk assessment that considered the representativeness and validity of the samples collected within the pad to ensure they represented the current conditions at the site, both from a contamination perspective as well as from a geological, hydrogeological, and biological perspective. A direct comparison of site-specific data needed for OB/OD Pad with data needed at other munitions bases would not be helpful in determining site risks at OB/OD Pad and future action that may be needed, because of the differences in chemicals used, time period of use, and the physical features of the site that determine the fate and transport of suspected chemicals. Detailed information about detected concentrations and extent of contamination can be found in Section 6 of the May 1997 final RI report.

Comment 4: Action should be taken to oxidize the white phosphorus and render it harmless to waterfowl. This should be done with as little damage to the hydrology and ecology of the wetlands as possible. Alternative 3, with an emphasis on pond draining by pumping, should be used in lieu of additional breaching with explosives. We prefer that additional filling and capping be minimized to prevent further alteration to the habitat.

Response: White phosphorus will oxidize and sublimate under Alternative 3 with little damage to the hydrology and ecology of the wetlands. No large-scale pond breaching will be conducted; only limited localized explosives work will be performed to improve drainage between ponds. Use of explosives is only anticipated in small areas to provide a place for the pump to be located.

Comment 5: One alternative that the Army has not explored in the Proposed Plan is oxidation through enhanced aeration, microbial activity, a workable form of bioremediation. We understand that the white phosphorus will not break down in an anaerobic environment, but it might be possible to enhance degradation using a combination of aeration and oxidizing bacteria. The EPA Profile on White Phosphorus states that polyphosphates are hydrolyzed by water and soil microorganisms indigenous to the area.

Response: The Army has performed several studies on enhanced sublimation and oxidation technologies. Air sparging was tested at a bench-scale level to determine whether introducing air into white phosphorus-contaminated sediment would oxidize white phosphorus. Laboratory scale tests also were performed to determine whether hydrogen peroxide could be used to oxidize white phosphorus. Both technologies were ruled out because of low effectiveness as well as implementability and/or safety issues. A field-scale test of enhanced biodegradation with the use of sediment warming also was implemented. Although sediment temperatures did increase, the increase was not sufficient to overcome saturated conditions to foster white phosphorus sublimation.

The following two comments are from (b) (6)

Comment 1: If I understand the proposal correctly, the ultimate goal is to lose no more than 50 birds per year. Currently, 1000 birds are lost, and the plan is to spend upwards of $6M-$9.2M over the next 15 years to save 950 birds. That puts a value on the birds of $6.3K-

$9.7K each. I find those figures ludicrous. Over the next 15 years, hunters will actually pay the state for the joy of shooting the birds, while the Federal government is proposing spending severely restricted Federal dollars to save many of the same birds.

Response: By using the assumptions presented in the Proposed Plan and in the above comment, the cost per duck under Alternative 3 over 15 years would be $421. Alternative 3 is estimated to cost approximately $6 million. 950 birds are estimated to be saved per year. The cost per duck decreases if one considers that remedial action objectives are expected to be maintained for many years after the 20-year monitoring time frame. Over 50 years and 100 years, the costs per duck are $126 and $63, respectively.

Comment 2: I recommend that signs posted on the Eagle River Flats read: "Don't eat what you shoot on the Eagle River Flats." I would also submit to you that, should the Federal government move ahead with this proposal, a letter will go to the Fraud, Waste and Abuse hotline. As a taxpayer, I deeply resent that a proposal of this type has reached the stage it obviously has without some voice of reason saying, "enough!". Although I applaud efforts to clean up the environment, I strongly feel that simply having Federal fenced dollars available does not suggest that those dollars must be spent. I believe that there should be a stated value to the taxpayer. I do not find a rational value stated in this proposal.

Response: The human health risk assessment included an offsite hunter exposure scenario and concluded that there is a very low risk to human health from consumption of contaminated ducks. The low risk was due primarily to the amount of white phosphorus potentially contained in a harvested duck and the number of ducks that would need to be consumed for a human to receive a harmful dose of white phosphorus. Although hunting is banned at Eagle River Flats, the risk assessment acknowledged that ducks may reside temporarily in the area prior to being hunted in other parts of Cook Inlet. The percentage of ducks hunted in the Cook Inlet area that have resided in ERF is very small, however, further reducing the likelihood of white phosphorus exposure to humans from eating contaminated harvested duck. On the basis of hunting statistics compiled by the Alaska Department of Fish and Game and the risk assessment results, the Agencies concluded that warning signs for consuming ducks are not warranted.

Appendix C
Baseline Cost Estimates for Remedial Alternatives, Operable Unit C Source Area, Fort Richardson

APPENDIX C

Baseline Cost Estimates for Remedial Alternatives

The following cost estimate spread sheets are included in this appendix:

- ERF-wide monitoring and Alternative 2 costs (presented by pond group), pages C-2 to C-12
- Alternative 3 (Preferred Alternative) costs, page C-13
- Alternative 4 costs, page C-14
- Alternative 5 costs, page C-15

Costs were based on assumptions presented in the Final Operable Unit C Feasibility Study, as well as capital and operation and maintenance costs for treatability studies performed in 1996, 1997, and 1998.

A table summarizing the cost estimates is provided below.

Cost Estimates for Cleanup Action Alternatives

Location	Capital Cost ($000)	Average Annual O&M[1] Present Worth ($000)	20 Year O&M Present Worth[2] ($000)	Total Cost– 20 Year O&M[3] ($000)
Alternative 1–No Action	0	0	0	0
Alternative 2–Detailed Monitoring	150	286	5,700	5,850
Alternative 3–Pumping with Capping and Filling	251	272	5,434	5,685
Alternative 4–Breaching and Pumping with Capping and Filling	2,064	353	7,068	9,132
Alternative 5–Capping and Filling	2,694	174	3,471	6,165

Notes:

[1] O&M = Operation and maintenance

[2] Present worth means costs are expressed as U.S. dollars in 1998. The amount indicates monies needed in 1998 to complete the project over 20 years. The majority of these costs will be used to achieve the 5-year cleanup goal. A discount rate of 5 percent is used.

[3] Costs include ERF-wide long-term monitoring.

Cost Estimate
Eagle River Flats

ERF-Wide Monitoring

6/25/97

Description	Quantity	Unit	Unit Cost	Frequency	Cost
			Incorporated into Alternative 2		
Annual O&M Costs					
Telemetry					$ 177,500
Aerial bird population surveys					
Aerial bird population survey of ERF	40	survey	$400 /survey		$ 16,000
Aerial bird population survey of Upper Cook Inlet	25	survey	$1,240 /survey		$ 31,000
Aerial photography	2	annually	$12,900 ea		$ 25,800
ERF Remediation database maintenance					$ 114,000
Hazing					$ 30,000
O&M Subtotals					
Year 0					$ 394,300
Year 1					$ 394,300
Year 2					$ 394,300
Year 3					$ 394,300
Year 4					$ 394,300
Year 5					$ 364,300
Year 6					$ 364,300
Year 7					$ 364,300
Year 8					$ 364,300
Year 9					$ 364,300
Year 10					$ 364,300
Year 11					$ 364,300
Year 12					$ 364,300
Year 13					$ 364,300
Year 14					$ 364,300
Year 15					$ 364,300
Year 16					$ 364,300
Year 17					$ 364,300
Year 18					$ 364,300
Year 19					$ 364,300
Present Worth ERF-wide monitoring cost (10-years, i=5%)					**$2,942,912**
Present Worth ERF-wide monitoring cost (20-years, i=5%)					**$4,669,868**

Cost Estimate
Eagle River Flats

Alternative 2 - Detailed Monitoring
Northern A Ponds

6/25/97

Description	Quantity	Unit	Unit Cost	Frequency	Cost	Subtotal
Capital Costs						
Pond Survey						
CRREL Engineer, field	12	hr	$86.91 /staff-hr	1 staff	$1,043	
CRREL Jr. Engineer, field	12	hr	$64.65 /staff-hr	1 staff	$776	
CRREL Technician, field	12	hr	$30.66 /staff-hr	1 staff	$368	
UXO clearance technician	8	hr	$80.00 /staff-hr	1 staff	$640	
UH-1 helicoptor	4	hr	$547 /hr		$2,188	
						$5,015
Baseline WP Sampling	16	site	$870.38 /site		$13,926	
						$ 13,926
Sublimation Conditions Monitoring Equipment						
Monitoring syst., data logger, sensors, w.l. indicator	2	ea	$4,000 ea		$8,000	
Monitoring syst., data logger, sensors	0	ea	$3,000 ea		$0	
Monitoring syst., sensors	0	ea	$1,000 ea		$0	
						$ 8,000
Direct Cost					**$26,941**	
Bid Contingencies	15	percent			$4,041	
Scope Contingencies	20	percent			$5,388	
Subtotal					$36,370	
COE Administration	10	percent			$3,637	
Reporting	5	percent			$1,819	
Permitting and Legal	5	percent			$1,819	
Bonding and Insurance	3	percent			$1,091	
Subtotal					$8,365	
Total Capital Costs					**$44,735**	
O&M Costs						
Annual sedimentation monitoring					$13,200	
						$ 13,200
Annual setup of monitoring equipment						
Number of monitoring system installations	2	system				
CRREL Engineer, field	4	hr/system	$86.91 /hr	2 systems	$695	
CRREL Engineer, field	4	hr/system	$86.91 /hr	2 systems	$695	
CRREL Jr. engineer, field	4	hr/system	$64.65 /hr	2 systems	$517	
CRREL staff per diem	2	staff	$339.06 /staff-day	2 day	$1,356	
UH-1 helicoptor	0.25	hr/system	$547 /hr	2 systems	$274	
						$ 3,538

Cost Estimate
Eagle River Flats

Alternative 2 - Detailed Monitoring
Northern A Ponds

6/25/97

Annual removal of monitoring equipment					
Number of monitoring system removals	2 system				
CRREL Engineer, field	4 hr/system	$86.91 /hr	2 systems	$695	
CRREL Engineer, field	4 hr/system	$86.91 /hr	2 systems	$695	
CRREL Jr. engineer, field	4 hr/system	$64.65 /hr	2 systems	$517	
CRREL staff per diem	2 staff	$339.06 /staff-day	2 day	$1,356	
UH-1 helicoptor	0.25 hr/system	$547 /hr	2 systems	$274	
					$ 3,538
Verification Sampling during Year 5	16 sites	$2,534 /site			$ 40,544

O&M Subtotals	
Year 0	$20,275
Year 1	$20,275
Year 2	$20,275
Year 3	$20,275
Year 4	$20,275
Year 5	$53,744
Year 6	$13,200
Year 7	$13,200
Year 8	$13,200
Year 9	$13,200
Year 10	$13,200
Year 11	$13,200
Year 12	$13,200
Year 13	$13,200
Year 14	$13,200
Year 15	$13,200
Year 16	$13,200
Year 17	$13,200
Year 18	$13,200
Year 19	$13,200
Net Present Worth 10-year O&M (I=5%)	**$162,813**
Net Present Worth 20-year O&M (I=5%)	**$225,387**
Alternative Cost (10-year O&M)	**$207,548**
Alternative Cost (20-year O&M)	**$270,123**

Cost Estimate
Eagle River Flats

Alternative 2 - Detailed Monitoring
Pond 290

6/25/97

Description	Quantity	Unit	Unit Cost	Frequency	Cost	
Capital Costs						
Pond Survey						
CRREL Engineer, field	6	hr	$86.91 /staff-hr	1 staff	$521	
CRREL Jr. Engineer, field	6	hr	$64.65 /staff-hr	1 staff	$388	
CRREL Technician, field	6	hr	$30.66 /staff-hr	1 staff	$184	
UXO clearance technician	8	hr	$80.00 /staff-hr	1 staff	$640	
UH-1 helicoptor	2	hr	$547 /hr		$1,094	
						$2,827
Baseline WP Sampling	4	site	$870.38 /site		$3,482	
						$ 3,482
Sublimation Conditions Monitoring Equipment						
Monitoring syst., data logger, sensors, w.l. indicator	1	ea	$4,000 ea		$4,000	
Monitoring syst., data logger, sensors	0	ea	$3,000 ea		$0	
Monitoring syst., sensors	0	ea	$1,000 ea		$0	
						$ 4,000
Direct Cost					**$10,309**	
Bid Contingencies	15	percent			$1,546	
Scope Contingencies	20	percent			$2,062	
Subtotal					$13,917	
COE Administration	10	percent			$1,392	
Reporting	5	percent			$696	
Permitting and Legal	5	percent			$696	
Bonding and Insurance	3	percent			$418	
Subtotal					$3,201	
Total Capital Costs					**$17,118**	
O&M Costs						
Annual sedimentation monitoring					$6,600	
						$ 6,600
Annual setup of monitoring equipment						
Number of monitoring system installations	1	system				
CRREL Engineer, field	4	hr/system	$86.91 /hr	1 systems	$348	
CRREL Engineer, field	4	hr/system	$86.91 /hr	1 systems	$348	
CRREL Jr. engineer, field	4	hr/system	$64.65 /hr	1 systems	$259	
CRREL staff per diem	2	staff	$339.06 /staff-day	1 day	$678	

Cost Estimate
Eagle River Flats

Alternative 2 - Detailed Monitoring
Pond 290

6/25/97

UH-1 helicoptor	0.25 hr/system	$547 /hr	1 systems	$137	
					$ 1,769
Annual removal of monitoring equipment					
Number of monitoring system removals	1 system				
CRREL Engineer, field	4 hr/system	$86.91 /hr	1 systems	$348	
CRREL Engineer, field	4 hr/system	$86.91 /hr	1 systems	$348	
CRREL Jr. engineer, field	4 hr/system	$64.65 /hr	1 systems	$259	
CRREL staff per diem	2 staff	$339.06 /staff-day	1 day	$678	
UH-1 helicoptor	0.25 hr/system	$547 /hr	1 systems	$137	
					$ 1,769
Verification Sampling during Year 5	4 sites	$2,534 /site			$ 10,136

O&M Subtotals	
Year 0	$10,138
Year 1	$10,138
Year 2	$10,138
Year 3	$10,138
Year 4	$10,138
Year 5	$16,736
Year 6	$6,600
Year 7	$6,600
Year 8	$6,600
Year 9	$6,600
Year 10	$6,600
Year 11	$6,600
Year 12	$6,600
Year 13	$6,600
Year 14	$6,600
Year 15	$6,600
Year 16	$6,600
Year 17	$6,600
Year 18	$6,600
Year 19	$6,600
Net Present Worth 10-year O&M (I=5%)	**$73,843**
Net Present Worth 20-year O&M (I=5%)	**$105,130**
Alternative Cost (10-year O&M)	**$90,961**
Alternative Cost (20-year O&M)	**$122,248**

Cost Estimate
Eagle River Flats

Alternative 2 - Detailed Monitoring
Northern C and C/D Ponds

6/25/97

Description	Quantity	Unit	Unit Cost	Frequency	Cost	
Capital Costs						
Pond Survey						
CRREL Engineer, field	20	hr	$86.91 /staff-hr	1 staff	$1,738	
CRREL Jr. Engineer, field	20	hr	$64.65 /staff-hr	1 staff	$1,293	
CRREL Technician, field	20	hr	$30.66 /staff-hr	1 staff	$613	
UXO clearance technician	8	hr	$80.00 /staff-hr	1 staff	$640	
UH-1 helicoptor	8	hr	$547 /hr		$4,376	
						$8,661
Baseline WP Sampling	17	site	$870.38 /site		$14,796	
						$ 14,796
Sublimation Conditions Monitoring Equipment						
Monitoring syst., data logger, sensors, w.l. indicator	2	ea	$4,000 ea		$8,000	
Monitoring syst., data logger, sensors	0	ea	$3,000 ea		$0	
Monitoring syst., sensors	0	ea	$1,000 ea		$0	
						$ 8,000
Direct Cost					**$31,457**	
Bid Contingencies	15	percent			$4,719	
Scope Contingencies	20	percent			$6,291	
Subtotal					$42,467	
COE Administration	10	percent			$4,247	
Reporting	5	percent			$2,123	
Permitting and Legal	5	percent			$2,123	
Bonding and Insurance	3	percent			$1,274	
Subtotal					$9,767	
Total Capital Costs					**$52,234**	
O&M Costs						
Annual sedimentation monitoring					$19,800	
						$ 19,800
Annual setup of monitoring equipment						
Number of monitoring system installations	2	system				
CRREL Engineer, field	4	hr/system	$86.91 /hr	2 systems	$695	
CRREL Engineer, field	4	hr/system	$86.91 /hr	2 systems	$695	

Cost Estimate
Eagle River Flats

Alternative 2 - Detailed Monitoring
Northern C and C/D Ponds

6/25/97

CRREL Jr. engineer, field	4 hr/system	$64.65 /hr	2 systems	$517	
CRREL staff per diem	2 staff	$339.06 /staff-day	2 day	$1,356	
UH-1 helicoptor	0.25 hr/system	$547 /hr	2 systems	$274	
					$ 3,538
Annual removal of monitoring equipment					
Number of monitoring system removals	2 system				
CRREL Engineer, field	4 hr/system	$86.91 /hr	2 systems	$695	
CRREL Engineer, field	4 hr/system	$86.91 /hr	2 systems	$695	
CRREL Jr. engineer, field	4 hr/system	$64.65 /hr	2 systems	$517	
CRREL staff per diem	2 staff	$339.06 /staff-day	2 day	$1,356	
UH-1 helicoptor	0.25 hr/system	$547 /hr	2 systems	$274	
					$ 3,538
Verification Sampling during Year 5	17 sites	$2,534 /site			$ 43,078
Year 0				$26,875	
Year 1				$26,875	
Year 2				$26,875	
Year 3				$26,875	
Year 4				$26,875	
Year 5				$62,878	
Year 6				$19,800	
Year 7				$19,800	
Year 8				$19,800	
Year 9				$19,800	
Year 10				$19,800	
Year 11				$19,800	
Year 12				$19,800	
Year 13				$19,800	
Year 14				$19,800	
Year 15				$19,800	
Year 16				$19,800	
Year 17				$19,800	
Year 18				$19,800	
Year 19				$19,800	
Net Present Worth 10-year O&M (I=5%)				**$215,667**	
Net Present Worth 20-year O&M (I=5%)				**$309,529**	
Alternative Cost (10-year O&M)				**$267,902**	
Alternative Cost (20-year O&M)				**$361,763**	

Cost Estimate
Eagle River Flats

Alternative 2 - Detailed Monitoring
Pond 146

6/25/97

Description	Quantity	Unit	Unit Cost	Frequency	Cost	
Capital Costs						
Pond Survey						
CRREL Engineer, field	6	hr	$86.91 /staff-hr	1 staff	$521	
CRREL Jr. Engineer, field	6	hr	$64.65 /staff-hr	1 staff	$388	
CRREL Technician, field	6	hr	$30.66 /staff-hr	1 staff	$184	
UXO clearance technician	8	hr	$80.00 /staff-hr	1 staff	$640	
UH-1 helicoptor	2	hr	$547 /hr		$1,094	
						$2,827
Baseline WP Sampling	8	site	$870.38 /site		$6,963	
						$ 6,963
Sublimation Conditions Monitoring Equipment						
Monitoring syst., data logger, sensors, w.l. indicator	1	ea	$4,000 ea		$4,000	
Monitoring syst., data logger, sensors	0	ea	$3,000 ea		$0	
Monitoring syst., sensors	0	ea	$1,000 ea		$0	
						$ 4,000
Direct Cost					**$13,790**	
Bid Contingencies	15	percent			$2,069	
Scope Contingencies	20	percent			$2,758	
Subtotal					$18,617	
COE Administration	10	percent			$1,862	
Reporting	5	percent			$931	
Permitting and Legal	5	percent			$931	
Bonding and Insurance	3	percent			$559	
Subtotal					$4,282	
Total Capital Costs					**$22,899**	
O&M Costs						
Annual sedimentation monitoring					$13,200	
						$ 13,200
Annual setup of monitoring equipment						
Number of monitoring system installations	1	system				
CRREL Engineer, field	4	hr/system	$86.91 /hr	1 systems	$348	
CRREL Engineer, field	4	hr/system	$86.91 /hr	1 systems	$348	

Cost Estimate
Eagle River Flats

Alternative 2 - Detailed Monitoring
Pond 146

6/25/97

CRREL Jr. engineer, field	4 hr/system	$64.65 /hr	1 systems	$259	
CRREL staff per diem	2 staff	$339.06 /staff-day	1 day	$678	
UH-1 helicoptor	0.25 hr/system	$547 /hr	1 systems	$137	
					$ 1,769
Annual removal of monitoring equipment					
Number of monitoring system removals	1 system				
CRREL Engineer, field	4 hr/system	$86.91 /hr	1 systems	$348	
CRREL Engineer, field	4 hr/system	$86.91 /hr	1 systems	$348	
CRREL Jr. engineer, field	4 hr/system	$64.65 /hr	1 systems	$259	
CRREL staff per diem	2 staff	$339.06 /staff-day	1 day	$678	
UH-1 helicoptor	0.25 hr/system	$547 /hr	1 systems	$137	
					$ 1,769
Verification Sampling during Year 5	8 sites	$2,534 /site			$ 20,272

O&M Subtotals

Year 0	$16,738
Year 1	$16,738
Year 2	$16,738
Year 3	$16,738
Year 4	$16,738
Year 5	$33,472
Year 6	$13,200
Year 7	$13,200
Year 8	$13,200
Year 9	$13,200
Year 10	$13,200
Year 11	$13,200
Year 12	$13,200
Year 13	$13,200
Year 14	$13,200
Year 15	$13,200
Year 16	$13,200
Year 17	$13,200
Year 18	$13,200
Year 19	$13,200
Net Present Worth 10-year O&M (I=5%)	**$132,370**
Net Present Worth 20-year O&M (I=5%)	**$194,944**
Alternative Cost (10-year O&M)	**$155,269**
Alternative Cost (20-year O&M)	**$217,843**

Cost Estimate
Eagle River Flats

Alternative 2 - Detailed Monitoring
Pond 183

6/25/97

Description	Quantity	Unit	Unit Cost	Frequency	Cost	
Capital Costs						
Pond Survey						
CRREL Engineer, field	6	hr	$86.91 /staff-hr	1 staff	$521	
CRREL Jr. Engineer, field	6	hr	$64.65 /staff-hr	1 staff	$388	
CRREL Technician, field	6	hr	$30.66 /staff-hr	1 staff	$184	
UXO clearance technician	8	hr	$80.00 /staff-hr	1 staff	$640	
UH-1 helicoptor	2	hr	$547 /hr		$1,094	
						$2,827
Baseline WP Sampling	7	site	$870.38 /site		$6,093	
						$ 6,093
Sublimation Conditions Monitoring Equipment						
Monitoring syst., data logger, sensors, w.l. indicator	1	ea	$4,000 ea		$4,000	
Monitoring syst., data logger, sensors	0	ea	$3,000 ea		$0	
Monitoring syst., sensors	0	ea	$1,000 ea		$0	
						$ 4,000
Direct Cost					**$12,920**	
Bid Contingencies	15	percent			$1,938	
Scope Contingencies	20	percent			$2,584	
Subtotal					$17,442	
COE Administration	10	percent			$1,744	
Reporting	5	percent			$872	
Permitting and Legal	5	percent			$872	
Bonding and Insurance	3	percent			$523	
Subtotal					$4,012	
Total Capital Costs					**$21,454**	
O&M Costs						
Annual sedimentation monitoring					$13,200	
						$ 13,200
Annual setup of monitoring equipment						
Number of monitoring system installations	1	system				
CRREL Engineer, field	4	hr/system	$86.91 /hr	1 systems	$348	
CRREL Engineer, field	4	hr/system	$86.91 /hr	1 systems	$348	

Cost Estimate
Eagle River Flats

Alternative 2 - Detailed Monitoring
Pond 183

6/25/97

CRREL Jr. engineer, field	4 hr/system	$64.65 /hr	1 systems	$259	
CRREL staff per diem	2 staff	$339.06 /staff-day	1 day	$678	
UH-1 helicoptor	0.25 hr/system	$547 /hr	1 systems	$137	
					$ 1,769
Annual removal of monitoring equipment					
Number of monitoring system removals	1 system				
CRREL Engineer, field	4 hr/system	$86.91 /hr	1 systems	$348	
CRREL Engineer, field	4 hr/system	$86.91 /hr	1 systems	$348	
CRREL Jr. engineer, field	4 hr/system	$64.65 /hr	1 systems	$259	
CRREL staff per diem	2 staff	$339.06 /staff-day	1 day	$678	
UH-1 helicoptor	0.25 hr/system	$547 /hr	1 systems	$137	
					$ 1,769
Verification Sampling during Year 5	7 sites	$2,534 /site			$ 17,738

O&M Subtotals

Year 0	$16,738
Year 1	$16,738
Year 2	$16,738
Year 3	$16,738
Year 4	$16,738
Year 5	$30,938
Year 6	$13,200
Year 7	$13,200
Year 8	$13,200
Year 9	$13,200
Year 10	$13,200
Year 11	$13,200
Year 12	$13,200
Year 13	$13,200
Year 14	$13,200
Year 15	$13,200
Year 16	$13,200
Year 17	$13,200
Year 18	$13,200
Year 19	$13,200
Net Present Worth 10-year O&M (I=5%)	**$130,479**
Net Present Worth 20-year O&M (I=5%)	**$193,053**
Alternative Cost (10-year O&M)	**$151,933**
Alternative Cost (20-year O&M)	**$214,507**

Alternative 3, Pumping with Capping and Filling

Capital Costs	Unit Costs	Quantity	Sub-total
Pump and generator on floating platform	100,000.00	2 pumps	200,000
8-in Flexible Hose	27.33	60 ft	1,640
8-in Rigid piping	15.75	1000 ft	15,750
Monitoring Stations	2,500.00	4 stations	10,000
Subtotal			227,390
Total (includes 10% Contractor Profit)			250,129

Operations and Maintenance

	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20
	FY1999	FY2000	FY2001	FY2002	FY2003	FY2004	FY2005	FY2006	FY2007	FY2008	FY2009	FY2010	FY2011	FY2012	FY2013	FY2014	FY2015	FY2016	FY2017	FY2018
Tide Predictions:	Wet	Wet	Dry	Dry	Dry	Wet	Dry	Dry	Dry	Wet	Wet	Dry	Dry	Wet	Wet	Wet				
Progress	*Mortality and WP concentrations decrease consistently each year. Trend established. Short term RAO met at end of Year 5.*					*Continue Mortality and WP monitoring to ensure RAOs are maintained.*			*Mortality monitoring performed at Year 10, Year 15 and Year 20 to ensure that RAOs are maintained. Limited aerial and land surveys conducted during years during years that mortality monitoring is not being performed.*											*Long term RAOs met.*
	Pumping performed. More activity during dry years; less during wet years. Only small, isolated amounts of WP detected.					*Natural processes like sedimentation continue.*														
					Cap and fill applied to areas that do not dry.															

Monitoring																				
Waterfowl Telemetry and Mortality Study	150,000	150,000	150,000	150,000	150,000	150,000	150,000	150,000		150,000					150,000					150,000
Aerial waterfowl surveys	30,000	30,000	30,000	30,000	30,000	30,000	30,000	30,000		30,000					30,000					30,000
WP monitoring of treated ponds	50,000	50,000	100,000	100,000	100,000															
WP composite sampling in untreated areas	60,000	60,000	45,000	45,000	45,000															
GIS database management	30,000	30,000	25,000	25,000	25,000	20,000	20,000	20,000		20,000					20,000					20,000
Pond/Land/Air Survey	15,000								20,000	5,000	20,000	20,000	20,000	20,000	5,000	20,000	20,000	20,000	20,000	5,000
Aerial photography and interpretation	10,000		10,000		10,000		10,000		10,000											
Habitat changes monitoring	5,000			5,000				5,000				5,000				5,000				5,000
UXO clearance (also for treatment activities)	35,000	35,000	35,000	35,000	35,000	10,000	10,000	10,000	2,500	10,000	2,500	2,500	2,500	2,500	10,000	2,500	2,500	2,500	2,500	10,000
DPW support (logistics, supplies, labor)	25,000	25,000	25,000	25,000	25,000	15,000	15,000	15,000	2,000	20,000	2,000	2,000	2,000	2,000	20,000	2,000	2,000	2,000	2,000	20,000
DPW helicopter support	70,000	70,000	70,000	70,000	70,000	40,000	40,000	40,000	2,500	40,000	2,500	2,500	2,500	2,500	40,000	2,500	2,500	2,500	2,500	40,000
Treatment																				
Pond Pumping Treatment	180,000	180,000	300,000	300,000	300,000															
Cap and Fill Application					125,000															
Cap and Fill Integrity Inspection					2,000	2,000	2,000	2,000		2,000					2,000					2,000
DPW Cap and Fill Oversight					25,000															
Contractor refueling and support	65,000	65,000	85,000	85,000	85,000															
DPW support (logistics, supplies, labor)	25,000	25,000	35,000	35,000	35,000															
DPW helicopter support	50,000	50,000	180,000	180,000	180,000															
Hazing (Contingency)	10,000	10,000	10,000	10,000	10,000															
O&M Subtotal per year	810,000	780,000	1,100,000	1,095,000	1,252,000	267,000	277,000	272,000	37,000	277,000	27,000	32,000	27,000	27,000	277,000	32,000	27,000	27,000	27,000	282,000
Net Present Worth 20-year O&M (I=5%)	$5,434,499		average:	$271,725																

Total Cost for Alternative 3 **$5,684,627**

Assumptions:

1. Active remediation will be performed until Year 5. Treatment progress and monitoring technique will be evaluated during the 5-year review.
2. Waterfowl mortality will decline after each year of treatment. A trend will be established to justify that reaching the short-term mortality goal is the result of treatment (WP removal), and not just limited dataset.
3. Cap and fill material will be applied to 0.88 ha of pond bottoms at Year 5. It is assumed that 5% of Pond 146, 5% of Pond 155 and 10% of Northern A ponds will not dry.
4. Telemetry and mortality studies, aerial waterfowl surveys, reduced WP sampling, limited GIS database management, and studies of habitat rebound will be performed for an additional 3 years after active pumping is complete. This additional monitoring is to ensure that cleanup objectives are not only reached, but also maintained.
5. Telemetry and mortality studies, aerial waterfowl surveys, limited GIS database management, and limited studies of habitat rebound will be performed at Year10, 15, and 20 to ensure that cleanup objectives are maintained.
6. Limited site visits to inspect mortality and habitat rebound will be performed during years that telemetry and mortality studies are not performed. Assessment will be performed visually on foot and by air.
7. UH-1 helicopters or their equivalent will be available to support treatment and monitoring activities.
8. Costs also assume that the C/D ponds will not be pumped, but will be sampled for WP.
9. Level of accuracy: -30% to +50% ; performance from the Summer 1997 pond pumping treatability study was used to prepare this estimate.

Estimate of Alternative 4 Costs

Capital Costs (new pumps, explosives, limited cap and fill)			
Cost presented in the PP and FS		$4,990,000	
To baseline Alternative 4 against Alternative 3, the following indirects were removed:		-$1,618,378	
Bid Contingencies	-15%		
Scope Contingencies	-20%		
Reporting	-5%		
Permitting and Legal	-5%		
Bonding and Insurance	-3%		
Subtract the cost of the six pumps systems already owned by the Army (@$100K/pump)		-$600,000	
Subtract out the cost of Cap and Fill Material orginally priced in FS (5.965 ha @$140k?ha)		-$835,100	
AquaBlok Application (summer helicopter delivery)			
Application of Cap and Fill Material (assume 0.88 ha @ $140/K)		$125,466	
Cap and Fill Integrity Testing (@$2275/ha)		$2,000	
Capital Costs Subtotal		**$2,063,988**	
Net Present Worth 20-year O&M (I=5%)		**$7,068,440**	
	average:		$353,422
Total Alternative Cost		**$9,132,428**	

Note: It is still assumed at C/D area may be drained.The capital costs for Alt 4 is higher than Alt 3 because of explosives costs and less understanding about how some ponds may respond to breaching therefore may need those extra pumps.
Active treatment is expected to be 2 years longer because of frequent reflooding.
Costs are based on estimates in the Final OU C FS.

Alternative 4: Annual O&M and monitoring activities.

ID	Activity	Year	Yearly O&M	Comments
1	Telemetry, Aerial Surveys, WP sampling, Treatment @183, 290, 136, 155	1999	$800,000	wet year
2	Telemetry, Aerial Surveys, WP sampling, Treatment @183, 290, 136, 155; Sampling @ C/D	2000	$800,000	wet year
3	Telemetry, Aerial Surveys, WP sampling, Treatment @183, 290, 136, 155; Sampling @ C/D	2001	$1,000,000	dry year
4	Telemetry, Aerial Surveys, WP sampling, Treatment @183, 290, 136, 155; Sampling @ C/D	2002	$1,000,000	dry year
5	Telemetry, Aerial Surveys, WP sampling, Treatment @ A Ponds; Sampling @ C/D Ponds	2003	$1,000,000	dry year
6	Telemetry, Aerial Surveys, WP sampling, Treatment @ A Ponds; Sampling @ C/D Ponds	2004	$1,000,000	wet year
7	Telemetry, Aerial Surveys, WP sampling, Treatment @ A Ponds; AquaBlok Application	2005	$1,000,000	dry year
8	Telemetry, Aerial Surveys, WP sampling	2006	$1,200,000	dry year
9	Telemetry, Aerial Surveys, WP sampling	2007	$275,000	dry year
10	Telemetry, Aerial Surveys, WP sampling	2008	$275,000	wet year
11	Limited site visits	2009	$275,000	wet year
12	Limited site visits	2010	$30,000	dry year
13	No Activity	2011	$30,000	dry year
14	No Activity	2012	$30,000	wet year
15	Telemetry, Aerial Surveys, WP sampling	2013	$275,000	wet year
16	Limited site visits	2014	$30,000	wet year
17	No Activity	2015	$30,000	
18	No Activity	2016	$30,000	
19	No Activity	2017	$30,000	
20	Telemetry, Aerial Surveys, WP sampling	2018	$275,000	

Estimate of Alternative 5 Costs

Capital Costs (new pumps, explosives, limited cap and fill)			
Application of Cap and Fill Material (assume 18.7 ha @ $140/K)		2,619,000	
AquaBlok Integrity and Depth Testing (@$4000/ha)		75,000	
Capital Costs Subtotal		**2,694,000**	
Net Present Worth 20-year O&M (I=5%)		**3,470,976**	
	average:		$173,549
Total Alternative Cost		**6,164,976**	

Note: It is assumed Cap and Fill Material will be applied to all the hot ponds.
Costs are based on estimates in the Final OUC FS.

Alternative 5: Annual O&M and monitoring activities.

ID	Activity	Year	Yearly O&M	Comments
1	Monitor Cap and Fill application and integrity, perform telemetry and aerial surveys, GIS management, Project Management	1999	1,000,000	wet year
2	Monitor Cap and Fill application and integrity, perform telemetry and aerial surveys, GIS management, Project Management	2000	320,000	wet year
3	Monitor Cap and Fill application and integrity, perform telemetry and aerial surveys, GIS management, Project Management	2001	320,000	dry year
4	Monitor Cap and Fill application and integrity, perform telemetry and aerial surveys, GIS management, Project Management	2002	320,000	dry year
5	Monitor Cap and Fill application and integrity, perform telemetry and aerial surveys, GIS management, Project Management	2003	320,000	dry year
6	Monitor Cap and Fill application and integrity, perform telemetry and aerial surveys, GIS management, Project Management	2004	320,000	wet year
7	Monitor Cap and Fill application and integrity, perform telemetry and aerial surveys, GIS management, Project Management	2005	320,000	dry year
8	Monitor Cap and Fill application and integrity, perform telemetry and aerial surveys, GIS management, Project Management	2006	320,000	dry year
9	Monitor Cap and Fill application and integrity, perform telemetry and aerial surveys, GIS management, Project Management	2007	320,000	dry year
10	Monitor Cap and Fill application and integrity, perform telemetry and aerial surveys, GIS management, Project Management	2008	320,000	wet year
11	Limited site visits	2009	30,000	wet year
12	Limited site visits	2010	30,000	dry year
13	Limited site visits	2011	30,000	dry year
14	Limited site visits	2012	30,000	wet year
15	Telemetry, Aerial Surveys, cap and fill material integrity	2013	275,000	wet year
16	Limited site visits	2014	30,000	wet year
17	Limited site visits	2015	30,000	
18	Limited site visits	2016	30,000	
19	Limited site visits	2017	30,000	
20	Telemetry, Aerial Surveys, cap and fill material integrity	2018	275,000	