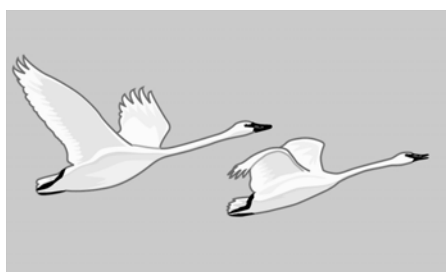
U.S. Army
Fort Richardson, Alaska

UPDATED
Interim Remedial Action Report
Operable Unit C – Eagle River Flats



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ACRONYM LIST

AAC	Alaska Administrative Code
ADEC	Alaska Department of Environmental Conservation
ADFG	Alaska Department of Fish and Game
AR	Army Regulation
ARAR	Applicable or Relevant and Appropriate Requirements
CERCLA	Comprehensive Environmental Restoration, Compensation, and Liability Act
CFR	*Code of Federal Regulations*
CRREL	Cold Regions Research and Engineering Laboratory
CWA	Clean Water Act
DPW	Directorate of Public Works
ERF	Eagle River Flats
EOD	Explosive ordnance disposal
FFA	Federal Facility Agreement
FS	Feasibility Study
GIS	Geographical Information System
HE	High Explosive
IC	Institutional Controls
IRAR	Interim Remedial Action Report
NCP	National Contingency Plan
NPL	National Priorities List
OB/OD	Open Burn/Open Detonation
O&M	Operations and Maintenance
OU	Operable Unit
QA/QC	Quality Assurance/Quality Control
QAPP	Quality Assurance Program Plan
RA	Remedial Action
RAB	Restoration Advisory Board
RAO	Remedial Action Objectives
RAR	Remedial Action Report
RAT	Remedial Action Team
RAWP	Remedial Action Work Plan
RCRA	Resource Conservation and Recovery Act
RI	Remedial Investigation
ROD	Record of Decision
SOPs	Standard Operating Procedures
USACE	U.S. Army Corps of Engineers
USEPA	U.S. Environmental Protection Agency
USFWS	U.S. Fish and Wildlife Service
UXO	Unexploded Ordnance
WP	White phosphorus

1.0 INTRODUCTION

This document presents the 2004 Updated Interim Remedial Action Report (IRAR) for the U.S. Army at Eagle River Flats (ERF), Operable Unit C (OU-C), Fort Richardson, Alaska. Eagle River Flats is one of two OU-C source areas. The objectives of the remedial action at ERF are designed to ensure the protection of human health and the environment by:

- Reducing the white phosphorus present in ponds that are utilized by waterfowl for feeding.
- Reducing waterfowl mortality due to the ingestion of white phosphorus.

The major components of the remedy are:

- Pumping permanent ponds dry to allow for the sublimation and oxidation of the white phosphorus present in the pond.
- Sampling of ponds under treatment to determine that white phosphorus concentrations are being reduced.
- Conducting waterfowl mortality studies to determine quantity and location of ducks that are dying due to white phosphorus.

This remedy, as outlined in the Comprehensive Environmental Restoration, Compensation, and Liability Act (CERCLA) Record of Decision (ROD) (dated September 1998), was chosen to reduce the concentration of white phosphorus and thereby reduce the waterfowl mortality.

The remedial action began the summer of 1999 and pond pumping continued through the summer of 2003. During the 5-year review, the remedial action and the monitoring activities outlined in the ROD were evaluated. The review concluded that it appeared that the short-term objective for waterfowl mortality was being successfully met. It also concluded that the monitoring activities outlined in the ROD would continue through 2018. The 5-year review also discussed the difficulty in utilizing the waterfowl telemetry study and model to measure waterfowl mortality to the accuracy required to meet the long-term objective, but noted that the sampling program along with the mortality data indicates that the cleanup goals are being met In 2004, ground-based transects was introduced as the method for determining waterfowl mortality. This method is currently under evaluation to determine its use in meeting the long-term mortality objective. Also, monitoring activities in 2004 indicated that an area in Northern C still contained white phosphorus and that bird mortality continued in this area due to its presence. Therefore, it was determined that pumping activities in this area would be performed in the summer of 2005.

1.1 Fort Richardson Background

Fort Richardson was established in 1940 as a military staging and supply center during World War II. It now occupies approximately 62,000 acres bounded to the north by Knik Arm, to the west by Elmendorf Air Force Base, and to the south by the Municipality of Anchorage. Appendix B includes a location map of Eagle River Flats and Fort Richardson. The current mission of Fort Richardson is to support the rapid deployment of Army forces from Alaska to the Pacific Theater.

In June 1994, the U.S. Environmental Protection Agency (USEPA) included Fort Richardson on the National Priorities List (NPL). Following negotiations, the Army, USEPA, and the Alaska Department of Environmental Conservation (ADEC) signed a Federal Facility Agreement (FFA) for Fort Richardson on December 5, 1994. The FFA outlines the approach for a thorough investigation of suspected historical hazardous-substance sources. It also calls for cleanup activities that will protect public health and welfare and the environment in accordance with state and federal laws.

The FFA divided Fort Richardson into four Operable Units (OUs, named with letters A through D) to represent the potential source areas for hazardous substances. The OUs were created based on the amount of existing information, the similarity of contamination, and the level of effort required to complete a Remedial Investigation (RI). In 2000, an additional Operable Unit, OU-E, was added. This Remedial Action (RA) report focuses on OU-C.

1.2 Operable Unit C Background

OU-C consists of a 2,160-acre salt marsh that makes up ERF and an 8-acre gravel open burn/open detonation (OB/OD) ordnance disposal pad on the eastern edge of ERF. Appendix B includes a map showing these areas.

1.2.1 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.

The ERF area has been used for artillery training since 1949 and contains numerous targets and craters created by artillery shells in the wetlands and associated mud flats. However, observations made during the on-going remedial action suggest that the numbers of Unexploded Ordnance (UXO) in ERF is a small percentage of the overall number of UXO indicated in the Remedial Investigation/Feasibility Study (RI/FS). Extensive pumping and draining of ponds have revealed only a few dozen UXO on the pond bottoms. This number is a rough estimate based on input from UXO technicians working on the project, and recollections of an average of less than six UXOs found each season. The corrosive salt marsh environment has rusted and destroyed many potential UXOs. Once a projectile casing is corroded and the explosive filler exposed, the extreme reducing conditions of the salt marsh will prevent migration of any dissolved explosives from the filler. Since 1990 all

UXOs (approximately 100) found on the surface in Eagle River Flats in the course of the remedial investigation and the remediation phases of the project have been destroyed in place. These are destroyed by Fort Richardson EOD personnel per their standard procedure of using an explosive charge of C-4 and detonating in place.

ERF serves as an important staging ground for migrating waterfowl during spring and fall migrations due to its wetland status. It supports local populations of fish, birds, mammals, and macro invertebrates (primarily insects, snails, and crustaceans). In addition, the many small-interconnected ponds provide excellent habitat for dabbling ducks and other waterfowl.

1.2.2 OB/OD Pad

The former OB/OD Pad, also referred to as Demolition Area One or Demo 1, is an 8-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.

An RI at the 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, the OB/OD Pad is restricted from 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, the OB/OD Pad is not available for future development. Institutional Controls (IC) at OU-C have been implemented. (See paragraph 6.3).

The OB/OD Pad, which was designated a Resource Conservation and Recovery Act (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 the ROD for OUC.

1.3 Operable Unit C Site Investigation and Remedial Action History

1.3.1 1980s

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 and recommend remedial alternatives. The ERF Task Force consisted of representatives from the U.S. Army Alaska, USEPA, USFWS, ADFG, and ADEC. 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.

Based on the initial bird utilization and mortality studies results, ERF was originally 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. Appendix B shows the locations and approximate boundaries for the ERF areas.

1.3.2 1990 - 1993

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, based on 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.

Waterfowl 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 following 1990 field season focused on finding 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 residual matter, 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 only allowing firing during winter months after a thick ice cover is formed, preventing disturbance of underlying contaminated sediments. 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 is indicative of heavy use for firing. White phosphorus was often used to mark targets for firing and therefore cratered areas were considered to be an indicator of the extent of white phosphorus. In 1993, waterfowl telemetry studies were initiated.

1.3.3 1994 - 1998

In June 1994, USEPA added Fort Richardson to the NPL. Then, on December 5, 1994, the Army, ADEC, and USEPA signed a Federal Facility Agreement, which outlined 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), RCRA, and applicable state laws.

During 1994 and 1995, Cold Regions Research and Engineering Laboratory (CRREL) completed several field investigations of the ERF physical system and laboratory studies of white phosphorus's potential to bioaccumulate.

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 residual matter in sediments. Priority cleanup areas were evaluated by using data from white phosphorus sampling, waterfowl telemetry, carcass transects, physical system dynamics, and mapping of land covers (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 (>15°C). 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 1994 through 1998 to determine potential technologies that could be used in ERF to result in pond draining and drying of sediments so that degradation would occur.

In 1994, Pond 285 (0.9 acres) on Racine Island was capped and filled as part of a treatability study. In 1995 and 1996, small areas of contaminated sediments (<1.5 acres total) were removed from Pond 146 by a remote-controlled dredge during another treatability study. In 1996, Pond 109 (8.2 acres) was drained by a blasted ditch. In 1997, Pond 293 (1.5 acres) on Racine Island was drained by a blasted ditch. A single pump system was also used in 1997 to temporarily drain Pond 183 in Area C as part of an initial treatability study. In 1998, a full-scale pump system treatability study was conducted using six pump systems. Pumps were deployed in Ponds 183, 155, and 146 in Area C, and Ponds 290, 256, and 258 in Area A. After the 1998 season, Pond 290, a small isolated pond in Area A with limited WP residual matter, was successfully remediated after only one season. This success was encouraging but not thought to be the norm for other ponds. A rough time estimate, based on good remediation conditions (soil type, precipitation, tidal flooding, and temperature) is three years.

Based on the results of these feasibility studies, pond draining by pumping was chosen as the preferred alternative for remediating the areas impacted by residual matter of ERF. The Record of Decision describing this selected remedy was signed in September 1998.

1.4 Community Relations

The public has been encouraged to participate in the remedy selection process. Interested citizens were encouraged to comment on the Proposed Plan and remedy selection process following publication of the Proposed Plan in February 1998, during a public meeting held at the Russian Jack Springs Chalet on February 12, 1998, and throughout the comment period ending March 6, 1998. Information on OU-C was made available in the administrative record and information repositories at the following locations: Fort Richardson Public Works Building 724; University of Anchorage Consortium Library; Alaska Resources Library & Information Services (ARLIS); and Fort Richardson Post Library.

Community relation activities for OU-C include:

- Conducting community interviews and developing a Community Relations Plan in 1994;
- Formation of the Biological Technical Advisory Group (BTAG) in December 1995 prior to starting the RAB;
- Initial Environmental Restoration Newsletter (CERCLA Fact Sheets) was published in June 1995 and quarterly publication has continued (with some exceptions);
- CERCLA oriented Public Meeting held in June 1995 at the Russian Jack Springs Chalet and held quarterly until the RAB was formed;

- Army solicited interest in the RAB starting in January 1996 with a questionnaire published in the Environmental News Letter;

- RAB membership solicited in March 1997 through public notices in Environmental News Letter and local newspapers;

- First RAB meeting held on October 9, 1997 and held quarterly since that time; and

- RAB meetings included site visits and presentations on remediation progress.

The public has been encouraged to stay informed and to participate in ongoing remedial actions. Updates on the effectiveness of the remedial action, informational fact sheets, and public notices continue to be made available for the public. The Restoration Advisory Board (RAB) continues to meet quarterly in Anchorage, and interested citizens are invited to participate.

The Community Relations Plan is in the process of being updated. The current version is available in the information repositories located at the University of Alaska Anchorage Consortium Library, Alaska Resources Library and Information Services, Fort Richardson Post Library, and the Administrative Record at Building 724 on Fort Richardson.

2.0 OPERABLE UNIT C

2.1 Record of Decision Requirements

2.1.1 Selected Remedy for OU-C

The major components of the preferred remedy for OU-C are listed below. Pond remediation treatment occurred between 1999 and 2003, and is being followed by long-term monitoring from 2004 to 2018. Monitoring activities in the summer of 2004 indicated that WP and bird mortality exists in the Northern C area, and in 2005 pumping activities are planned for this area.

- Treated white phosphorus-contaminated sediment by draining ponds with pumps for five summers beginning in 1999. Pumping allowed the sediments to dry and the white phosphorus to sublime and oxidize. The treatment season began in May and ended in August or September. A pond elevation survey was conducted to determine the optimal pump placement. To enhance drainage, explosives were used to make sumps for the pumps and shallow drainage channels. These shallow drainage channels enhanced the hydraulic connectivity between ponds to encourage drainage. In 2004, pumping occurred only in Pond 146 to reduce water levels for sampling and monitoring activities.
- Implemented 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
  - Minimized the use of equipment and 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
- Sampled pond bottoms for white phosphorus prior to treatment to confirm or determine that the pond or area requires remediation. If it was determined that the pond or area did require remediation, this initial sampling established a white phosphorus baseline. As new areas were suspected of being contaminated, this baseline sampling was performed. Additional sampling in the spring was done to

further locate and refine areas of known contamination (every year starting in 1999).

- Sampled pond bottoms for white phosphorus after treatment to determine effectiveness of the treatment system. This verification sampling was performed at the end of each field pumping season (every year that a pond was treated, starting in 1999).

- Collected surface and subsurface discrete samples from locations that had high concentrations of white phosphorus prior to pumping. This sampling was repeated annually until white phosphorus was not detected in the surface sediment.

- Planted WP particles at various locations every year to confirm extent that sublimation/oxidation activities were occurring (every year, starting in 1999).

- Performed composite sampling each year at ponds identified in the ROD as potentially hot ponds to confirm if they were contaminated and in pond/marsh areas where waterfowl mortality appeared to be occurring. This sampling was conducted every year, starting in 1999, to further locate and refine areas of known contamination.

- Performed monitoring of moisture and temperature by placing sensors in the sediments, which are linked to dataloggers. This provides information on when and if conditions were favorable for decontamination by sublimation/ oxidation (every year, starting in 1999).

- Performed telemetry monitoring in years 1999, 2001, and 2002 and aerial surveys every year beginning in 1999 concurrently with pumping activities to determine bird populations, usage, and mortality. Due to helicopter availability and contracting issues, the telemetry monitoring was not performed in 2000 and 2003. In 2003, it was determined that instead of utilizing telemetry and the mortality model to estimate overall mortality rates, that a weight of evidence approach would be used in the future. This approach would integrate sediment sampling for white phosphorus, aerial surveys of dabbling duck populations, and dabbling duck mortality (including necropsy) using ground transects to assess mortality attributable to white phosphorus contamination. Therefore, in 2004, ground–based waterfowl mortality surveys were utilized instead. The ground-based mortality survey will continue for at least 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.

- Performed aerial surveys every year to determine waterfowl census data. Ground-based photos and photos from helicopters have been taken each year to document vegetation and habitat changes in the treated ponds. Ground-based searches for waterfowl carcasses have been conducted incidental to the remediation and sediment sampling efforts. These were in addition to the efforts of the telemetry crew to document waterfowl mortality. Limited aerial surveys and ground truthing will be conducted through Year 20 to continue to evaluate waterfowl mortality, physical habitat changes, and vegetation rebound.

- Vertical false color IR aerial photography (scale of 1"=600') has been acquired every year to document changes from pond pumping and channel construction.

They have not been analyzed yet to document year-to-year changes in habitat and vegetation. Continue to perform aerial photography every other year through 2008 to monitor habitat changes resulting from remedial actions. Changes in drainage, topography, and vegetation would be evaluated.

- Habitat mapping has not been updated recently, but habitat changes were documented in 2004 and habitat maps were updated. Habitat mapping will continue once every 4 years for 20 years to continue to evaluate impacts to habitat as a result of remedial actions, as well as to observe habitat rebound after pumping is discontinued.
- Limited hazing (planned only as a contingency) during first 5 years starting in 1999 was not performed as incidental hazing from pumping operations and other fieldwork activities deterred bird usage.
- After remedial action objectives are achieved and pumping is discontinued, cap-and-fill material was to be applied in ponded areas that did not drain and dry sufficiently to enable the white phosphorus to sublime and oxidize. However, in 2003 it was determined that this capping action was not a reasonable solution at this time, and no placement has occurred.
- Monitor cap and fill material integrity every year for 4 years if the material is placed.
- Data from white phosphorus sampling has been incorporated in the REMOTE database for each year through 2003. Telemetry, aerial survey, habitat, and physical landform data is maintained in a separate GIS database. GIS management has been performed every year for the first 6 years, starting in 1999, and will continue for each year that data is collected for the site.
- 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 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.

2.1.2 RA Objectives

As part of the RI/FS process, remedial action objectives (RAOs) were developed in accordance with the NCP and USEPA 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 thus reducing waterfowl 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.

2.1.3 Applicable or Relevant and Appropriate Requirements (ARAR)

2.1.3.1 Chemical-Specific Requirements

- 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.

2.1.3.2 Location-Specific Requirements

- Clean Water Act (CWA), Section 404: Section 404 of the CWA, which is implemented by the USEPA 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 U.S. Army Corps of Engineers (USACE) 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 USEPA and USACE (*Federal Register*, 58:45008) on August 25, 1993. Under the newly defined "discharge of dredged material," USACE 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.

2.1.3.3 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.

2.1.3.4 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 USEPA 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.

- Army Regulation (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 standard operating procedures (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 unexploded ordnance (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 high explosive (HE) ammunition and explosives and the resulting fragments, debris, and components. The regulation also requires that all impact areas be 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.

2.2 Remedial Design Summary

The objective of this remedial action is to temporarily drain ponds to allow the pond sediments to dry and allow white phosphorus to sublime and oxidize. This action consists of draining ponds using mechanical pumps 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.

In the summer of 1997, this technology was tested through a pond pumping treatability study. Baseline and verification sampling was performed before and after pumping and the results 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 is installed annually after spring breakup and is removed before the winter freeze. The typical useful drying season is mid-May to mid-September with the emphasis on the earlier, normally drier months. Pumped water is discharged to an adjacent unconnected pond, river, gully, or open area. Mounted on floats, each pump system is completely automated to start and stop at established elevations of pond surface. Scheduled maintenance service and refueling is required.

Typically, explosives are used to create sump holes for placement of the pumps, and to create short ditches for drainage to the pumps. The affected areas are small, and impacts are minimal and temporary.

The pump systems are expected to operate for 5 consecutive years, based largely on tide predictions. Tidal fluctuations affect the ability to effectively dry the sediments. This alternative includes baseline (before the pumping season) sampling of white phosphorus to confirm which ponds require 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.

After pumping and monitoring, those pond systems where white phosphorus exposure remains a concern could be capped and filled. 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 would provide a barrier between the dabbling waterfowl and the sediment contaminated with white phosphorus.

3.0 CONSTRUCTION ACTIVITIES

The following presents a step-by-step summary description of the construction activities for ERF.

3.1 Mobilization and Site Preparatory Work

3.1.1 UXO Clearance

Before workers can enter an area at ERF, the area must be cleared for UXO. After a visual inspection of the ground surface, the UXO contractor uses a magnetometer to scan the area for buried ferrous metal objects. If an object is detected, the spot is marked and flagged. Walking paths and helicopter landing areas used throughout the season are cleared and marked during system installation in the spring.

The RI/FS included an estimate of total number of rounds of UXO that might be in Eagle River Flats. This estimate was based strictly on an estimate of total rounds fired over the years and an assumed dud rate of 5 – 10%. However, experience in the field during the remediation phase of the project indicates that the original estimate may be far too high and that the actual numbers of UXOs may only be a small percentage of the estimated number of UXO given in the RI/FS. Extensive pumping and draining of ponds have revealed only a few dozen UXO on the pond bottoms. The corrosive salt marsh environment may have rusted and destroyed many UXOs. Since 1990, all UXOs (approximately 100) found on the surface have been destroyed in place by Fort Richardson EOD personnel by a standard procedure of detonating an explosive charge of C-4.

3.1.2 Sump and Ditch Blasting

Before deployment of the pumping systems, the location for the pump is determined. The pumps are typically placed in the deepest point in the pond. If necessary, sumps and drainage ditches are blasted. Military engineers blast the sumps and drainage ditches. Shape and cratering charges are used to blast the sumps. Bangalore torpedoes and detonation cord are used to blast the drainage ditches.

3.1.3 Helicopter Transport of Equipment

Heavy lift military helicopters, such as the UH-60L Blackhawk and CH-47D Chinook are used for transporting the heavy pumps and generators to the remote pond locations. The pumps are placed in the deepest part of the pond, generally a blasted sump, and the generators and fuel tanks are placed approximately 230 feet away from the pump.

3.1.4 Helicopter Transport of Piping

Commercial helicopters, such as an Aerospatiale A-Star, are used for sling-loading the piping, check valves and supplemental materials to the flats at the beginning of the season.

Piping is located to run from the pump to an appropriate drainage area on the flats. The piping is clamped together by hand in the field as it is placed on site.

3.1.5 Fueling

Helicopter support is used for fueling activities on site. Large-capacity double-wall fuel tanks (250 – 300 gallons) for onsite refueling are transported to the pumping sites with the heavy equipment at the beginning of the season. Lightweight fuel tanks are used for transporting fuel to the pump systems once they are in place at the ponds. Refueling operations are kept to a minimum to reduce the opportunity of spillage during fuel transportation and transfer.

3.2 Construction of Treatment System

Once the pump systems and piping are transported to the ponds and the generators have been fueled, the system is put into operation. Field startup / shutdown testing of the systems is conducted before full operation.

3.3 Associated Site Work

3.3.1 Check Valves

A check valve is installed for each system. These check valves prevent draining of water from the discharge line back into the sump when the system shuts down. By preventing this backflow, less cycling of the pumps is necessary, which results in less fuel consumption and fewer refueling operations. It also enables the connection of more than one pump into a single discharge line.

3.3.2 Tide Gates

Tide gates are like check valves, allowing water to flow out of a pond system but not in. The tide gates are placed in natural drainage gullies to lessen the inflow to pond systems from tidal activity. Sandbags and bentonite are used to hold the tide gate in place. Use of tide gates at the heads of tidal gullies have been very successful in assisting in the pond pumping remediation and enhancing its effectiveness. High tides in the range of 31.1 to 32.0 ft (Anchorage Tide Datum) that would have normally spilled over into the pond basins have been kept out by the tide gates, thus greatly extending the drying season. Tides over about 32.0 ft still flood into the pond basins. However, the frequency of these tides are much less than the lower range high tides. The tidal gates have played a crucial role in the remediation efforts to date. Without these devices, remediation results would be less successful. In 2002, a large soil and rock "tide gate" was installed at Bread Truck to close the breach in the pond that was blasted in 1998. This tide gate has prevented tide flow in the upper C and C/D area during flooding tides and is allowing this area to continue to dry.

3.3.3 Additional Ditching

After the pumping systems are installed and operational, some areas of the pond may not be draining as intended. If possible, some additional ditching is performed using explosives such as bangelore torpedoes or detonation cord. These small additional ditches allow additional contaminated areas to drain sufficiently to allow drying of the white phosphorus-contaminated sediments.

3.4 System Operation

Once the systems are installed in the ponds, they run autonomously to lower the human exposure to the UXO hazards in the flats. However, general maintenance such as refueling, oil changes, and checking the condition of the system must be done during the treatment season.

3.5 Sampling Activities

White phosphorus (WP) concentrations in sediment are measured to identify areas where remediation is necessary and to test the effectiveness of pond draining on WP concentrations. Three sampling methods are used:

- Composite sampling, used to identify "hot spots" and to verify the success of the remedy
- Discrete surface and subsurface sampling, used to compare WP concentrations over time
- Measuring the amount of sublimation/oxidation from planted WP particles

3.6 Monitoring Sediment Temperature and Moisture

Sediment temperature and moisture are monitored to determine how conducive conditions are for sublimation/oxidation of WP. Twenty-eight (28) accumulated drying days in a season with sediment temperatures above 15 degrees Celsius (°C) has proven to reduce WP particle mass. Monitoring systems equipped with a data logger and monitoring devices are positioned at each pond system. Several systems are connected through the Internet to enable daily monitoring of remediation conditions from remote sites.

3.7 Waterfowl Mortality Studys and Aerial Surveys

3.7.1 Telemetry

Radio telemetry was planned to be performed each season from 1999 to 2004 to monitor waterfowl movements and mortality. However, due to problems with helicopter availability and contracting issues this did not occur in 2000 and 2003. In 1999, 2001, and 2002, radio telemetry was used to monitor waterfowl movements and mortality. Approximately 100 – 125 ducks were captured and transmitters were attached. Aerial Surveys were also performed each year to determine bird populations. The mortality and population data was incorporated into a site-specific model to develop overall annual waterfowl mortality data. This method and model were successful in showing that the short-term goal of 50% reduction in waterfowl mortality was met. However, the model lacks the sensitivity to estimate the more stringent long-term RAO of 1% mortality of the population. This issue along with difficulties and expenses of procuring a helicopter to capture the ducks led to the decision to utilize other methods for estimating waterfowl mortality.

3.7.2 Ground-based Mortality Transect Method

From 1991 – 1995, mortality studies using ground transects were successfully conducted, including two years of ground-based mortality data in 1994 and 1995 that overlapped with the telemetry mortality studies (CRREL 1992, 1993; Reitsma and Steele 1994, 1995, 1996.) Transects used for those studies included edge transects that covered the perimeters of each of the major contaminated ponds, grid transects in the C/D area that traversed a variety of salt marsh habitats, and forest-edge transects to count feather piles from the many carcasses removed from Eagle River Flats to the forest edge by eagles. It was decided in 2003 to use this method for estimating waterfowl mortality.

During 2004 ground-based mortality transect surveys were successfully established and carried out to determine waterfowl mortality. Ground-based mortality surveys consisted of three types. The first type consisted of a core group of transects covering areas with known remaining white phosphorus contamination and areas most highly used by waterfowl. This core group of transects was surveyed at least twice a week over the full 6-week fall migration period. The transects covered the marshes of northern Area C and eastern BT Area and the major waterfowl feeding ponds in Area C that have been remediated.

The second type of surveys consisted of additional transects covering areas of waterfowl use that have been remediated or have no known contamination. These transects were covered on a less frequent basis than the Core transects, generally on a weekly or bi-weekly basis. These included transects in Area A that cover ponds that have undergone remediation, a canoe transect of Pond 40 in the C/D area, and a grid transect covering much of the remaining area of C/D.

A third type of surveys was only conducted once or twice each season. This type consisted of forest-edge transect surveys to the east of Eagle River Flats to check for feather piles.

A waterfowl population for Fall 2004 will be determined using the census numbers from the aerial surveys and average turnover rates from past studies. Using that population estimate, a mortality rate as a percentage of waterfowl population will be determined. In 2005 ground-based mortality transect surveys would again be used to inventory and collect waterfowl carcasses during the fall migration periods and to provide estimates of waterfowl mortality rates using nearly the same design as used in 2004.

3.7.3 Transect Survey Procedure

Wherever possible, ground-based transect lines established in 2004 for the survey replicated the transect lines used in the 1991-1995 studies. This would allow better comparison of the mortality data collected in those studies with the new data. In some instances transect lines were in new locations or modified to fit current conditions or current understanding of contaminated areas.

Ground-based transect lines for the first type of the survey were established through areas where remaining pockets of white phosphorus contamination are known to still exist and areas where there is intensive waterfowl use. These includes the small pools in the Northern C marsh area where a system of ditches were excavated for pumping remediation and the small ponds in the eastern BT area (the Duck Ponds), just recently drained with a small ditch system installed in July 2004. Transects were also laid around the perimeter of the large, previously contaminated waterfowl feeding ponds that have been remediated, such as Pond 183 in Area C and Pond 730 in western C/D Area. The four transects included in the first segment of surveys include:

Northern C Marsh Ditch transect	1040 meters
Pond 183 Transect	900 meters
Pond 730 and Duck Pond Transect	2360 meters combined length

Total lane length of the four transects is approximately 4,300 meters. The total length is such that a pair of observers can walk the entire lengths of lanes in 4 to 5 hours. This method set-up transects in the flats that are then monitored once or twice a week for waterfowl mortality.

The second type of transects, the transects that will be done on a less frequent basis, consist of

Area A	2,600 m plus 4,250 m round-trip walking access
Canoe Transect of Pond 40	1,440 m plus 2,400-m round-trip walking access
C/D grid transect	1,500 m

The Area A transect will take approximately 5 hours to conduct, including the walking time to access the area from Lower Cole Point. An access trail has been marked and cleared from Lower Cole Point, the nearest point where a vehicle can be driven to, along Otter Creek and the western edge of Eagle River Flats to the start of the transect at the south end of Pond 290. The transect follows the east side of Pond 290, then along the east side of the Northern A pond complex and back, returning along the west side of Pond 290.

The Canoe Transect starts along the east shore of C/D. The starting point is accessed by walking north approximately 1.2 km along the trail from the EOD pad. A canoe is used to follow along the entire edge of Pond 140. The C/D grid transect follows a 250 x 500-m grid laid out through the C/D marsh. The two transects together will take about six hours to complete.

All transects will be surveyed similarly. The two person observation team will walk each of the transect lanes in turn, visually scanning for waterfowl carcasses or feather pile remains of carcasses. When a carcass or feather pile is found, the team will record the date, location (UTM coordinate using GPS system or estimated from UTM-gridded photo maps of areas), the species, and an estimate of freshness of carcass. A unique sequential sample identification number will be assigned (e.g. MORT 001, MORT 002, etc.) to all carcasses and feather piles. The gizzard of the carcass will be collected for later white phosphorus analysis. The location of the carcass will be marked with a PVC pin flag with the identification number.

If a feather pile is found rather than a carcass, similar information will also be recorded, including date, location, the identification number, and species if it can be determined from the feathers. The feather pile location will be marked with a PVC pin flag with an identification number and date so that the feather pile will not be recounted on future surveys.

If a waterfowl carcass or feather pile is seen outside the cleared lane, the approximate location should be noted in field notes but the carcass gizzard should not be collected if it is in an area not cleared by the UXO technician.

3.7.4 Period of observations

The phase one or Core mortality transects will be surveyed twice a week (Tuesday and Friday) over at least a 6-week period from mid-August through September.

The phase two transects will be surveyed weekly on Wednesdays from mid-August through September, alternating each week between the Area A transect and the Canoe & C/D transects.

3.8 Aerial Photography and Habitat Mapping

Aerial photography of the ERF area is performed every other year to monitor habitat changes. Habitat mapping was performed in 1994 to evaluate impacts to habitat as a result of remedial actions. These maps were updated in 2004 based on documentation and survey of habitat changes.

4.0 CHRONOLOGY OF EVENTS

4.1 Summary of Events at OU-C

The Eagle River Flats area (OU-C) has been the subject of environmental investigations since the 1980s. Section 1.3 of this report contains a brief history of the site investigations and remedial action history

A chronological summary of significant events and reports since the signing of the ROD is provided below in Table 1.

Table 1. Chronological Summary of Significant Events at OU-C

DATE	EVENT
September 30, 1998	ROD for OU-C signed
April, 1999	Remedial Action Work Plan and Final Design
May 1999	Installation of Equipment for 1st Post ROD season
May – Sept 1999	First Remediation Season
July 2000	CRREL 1999 Final Report
May – Sept 2000	Second Remediation Season
August 2001	CRREL 2000 Final Report
May – Sept 2001	Third Remediation Season
April 2002	CRREL 2001 Draft Report
May – Sept 2002	Fourth Remediation Season
Completed September 2003	Continuation of active remediation for 5th season
September 2003	Met short term clean-up goal
Feb 2004	Five Year Review
Ongoing	Continuation of monitoring activities
2018	Meet long term clean-up goals

5.0 PERFORMANCE STANDARDS AND CONSTRUCTION QUALITY CONTROL

5.1 Comparison to Cleanup Goals

The major components of the preferred remedy for OU-C were previously outlined in Section 2.1.1. The components scheduled to occur from 1999 – 2004 have all been instituted with two exceptions. The telemetry monitoring scheduled to occur every year for the first five years, did not occur in 2000 and 2003. This was due to a contracting problem as well as low availability of a helicopter at the time due to the high occurrences of forest fires in other areas of Alaska. In 2004, ground-based transect surveys were utilized to determine mortality instead of the telemetry monitoring.

The short term RAO is to reduce the dabbling duck mortality rate attributable to white phosphorus to 50 percent of the 1996 mortality rate attributable to white phosphorus within 5 years of the ROD being signed (e.g. 2003). Radio tracking and aerial surveys calculated that about 1,000 birds (waterfowl or ducks) died from white phosphorus at ERF in 1996. Therefore, to meet the short-term RAO, the number of duck deaths from white phosphorus would need to be less than 500. Further refinement of the mortality model has reduced the calculated 1996 overall duck mortality to 655 ducks. Therefore, the allowable number of duck deaths by 2003 is 327. As shown in Table 3, below, duck mortalities in 1999, 2001, and 2002 were below this target number and it appears that the short-term objective is being successfully met. However, duck usage of the flats has also been decreasing due to the activities at the site.

The long term RAO, within 20 years of the ROD being signed, is to reduce the mortality attributable to white phosphorus to no more than 1 percent of the total annual fall population of dabbling ERF ducks. In 1996, that population was about 5,000. Therefore, the allowable number of duck deaths from white phosphorus would be approximately 50. However, the duck population has decreased significantly due to the active remediation activities occurring during the time period that the ducks would be utilizing the flats.

5.2 Waterfowl Study

Table. 3. Summary of calculated waterfowl deaths each year since 1996.

	1996	1997	1998	1999	2000	2001	2002	2003	2004
Calculated Deaths	655	240	355	198	N.A.	87	203	N.A.	111?

Because the mortality data, are obtained concurrently with or immediately after pond pumping remediation and sampling activities that can cause bird hazing, the true mortality will not be known until after remediation is completed and waterfowl usage of ERF is uninhibited by remedial activities.

There is also imprecision when trying to model a larger population with a small subset, as is being done with the radio-collared birds. The mortality model is an attempt to predict what is happening in a transient population of waterfowl in ERF by monitoring a small subset. The model is continually being refined to improve its accuracy. Mortality rates that are being derived from the telemetry data and the mortality model show a decreasing rate of mortality in ERF. This reduction is strengthened by the sediment-sampling program, which is showing a large decrease in the amount of white phosphorus residual matter. The combination of the results of the sampling program with the morality data indicates that cleanup goals are being met. Based on the model, sampling program, and other monitoring activities, the short term RAO appears to have been met.

However, the model lacks the sensitivity to estimate the more stringent long-term RAO of 1% mortality of the population. Because of the lack of sensitivity of the model as well as the expenses and uncertainty involved with radio telemetry, especially the uses of helicopters to capture the mallards, alternative methods of evaluating mortality were considered. It was determined that a weight of evidence approach would be used in the future. This approach would integrate sediment sampling for white phosphorus, aerial surveys of dabbling duck populations, and dabbling duck mortality (including necropsy) using ground transects to assess mortality attributable to white phosphorus contamination.

Therefore, in 2004, a ground based mortality transect study was utilized. Mortality studies using ground transects were successfully conducted from 1991-1995, including two years of ground-based mortality data in 1994 and 1995 that overlapped with the telemetry mortality studies. Wherever possible, ground-based transect lines established in 2004 for the survey replicated the transect lines used in the 1991-1995 studies. This would allow better comparison of the mortality data collected in those studies with the new data. In some instances transect lines were in new locations or modified to fit current conditions or current understanding of contaminated areas.

Ground-based mortality surveys consisted of three types. The first type consisted of a core group of transects covering areas with known remaining white phosphorus contamination and areas most highly used by waterfowl. This core group of transects was surveyed at least twice a week over the full 6-week fall migration period. The transects covered the marshes of northern Area C and eastern BT Area and the major waterfowl feeding ponds in Area C that have been remediated.

The second type of surveys consisted of additional transects covering areas of waterfowl use that have been remediated or have no known contamination. These transects were covered on a less frequent basis than the Core transects, generally on a weekly or bi-weekly basis. These included transects in Area A that cover ponds that have undergone remediation, a canoe transect of Pond 40 in the C/D area, and a grid transect covering much of the remaining area of C/D.

A third type of surveys was only conducted once or twice each season. This type consisted of forest-edge transect surveys to the east of Eagle River Flats to check for feather piles.

5.3 Analysis of Mortality Data

Waterfowl carcass data collected from the ground transect surveys will be compiled and used to estimate a percentage mortality rate for the total fall dabbling duck population of Eagle River Flats, similar to the estimated mortality previously determined from the telemetry data and the model. The periodic aerial census data collected by U.S. Fish & Wildlife Service over the fall will be used along with the long-term average turnover rate determined from the previous radio-collar studies by NWRC to estimate the total fall dabbling duck population. The total numbers of duck carcasses counted on the mortality transects will then be used to determine a percent mortality rate for the estimated total fall duck population. This will indicate how close the project is coming to meeting the long-term remedial action objectives for Eagle River.

The uncertainties in determining the percentage mortality estimate are several. They include the error in counting numbers of waterfowl from the air; the periodic nature of the aerial census flights which might miss major peaks of waterfowl populations moving in or out of Eagle River Flats; applying an average turn-over rate for estimating the total population; and using actual counted carcasses in a portion of Eagle River Flats to represent mortality for the entire Flats.

Both the aerial census data and the ground-based mortality transects will provide data on an area-by-area basis. It is unclear yet whether an estimate of mortality for each area can be made based on number of carcasses counted along the transects within an area and numbers of total waterfowl using that area during that timeframe or if only an estimate can be made for the entire Eagle River Flats. An estimate of mortality by area would be very useful in showing the success of remediation in an area or indicating presence of still unremediated white phosphorus contamination within an area. In the previous ground-based mortality surveys, Reitsma and Steele (1994, 1995, 1996) were able to determine a mortality rate as well as numbers of carcasses per unit area of portions of Eagle River Flats. The ideal goal for this study would be to determine a total mortality estimate for each of the major areas and for Eagle River Flats as a whole. It remains to be seen if that goal can be achieved. In any case, the data on mortality, in conjunction with the other data from sediment sampling and aerial surveys, will provide a weight-of-evidence approach to evaluating the effectiveness of the remediation effort in Eagle River Flats.

5.4 Pond Acreage Treated

Although pond acreage treated is not a specific RAO for this project, it is a good indicator that the WP residual matter is being remediated and therefore duck mortality should decrease as a result.

Table 4. Summary of contaminated pond acreage in Eagle River Flats, acreage remediated, and acreage undergoing remediation at the end of 2004.

Total Acreage identified in ROD as contaminated or potentially contaminated	**57.6**
Contaminated Acreage deleted due to successful remediation pre ROD	**-2.2**
Contaminated Acreage deleted due to additional sampling	
1999	**-7.4**
2000	**-2.0**
2001	**-3.6**
2002	**-0.0**
2003	**-0.5**
2004	**??**
Contaminated Acreage added due to additional sampling	
1999	**+1.1**
2000	**+1.4**
2001	**+0.2**
2002	**+0.0**
2003	**+0.1**
2004	**??**
New Estimated Total Contaminated Area	**44.7?**
Total Area Remediated during 1999 and 2000	**-5.2**
Total Area Remediated during 2001	**-15.2**
Total Area Remediated during 2002	**-17.2**
Total Area Remediated during 2003	**-1.7**
Total Area Remediated during 2004	**??**
Total Area still undergoing remediation at end of 2004	**5.3?**
Total Area yet to undergo any remediation at end of 2004	**0.1?**

5.5 Sampling Strategy

Sampling for white phosphorus at OU-C has occurred as described in Section 2.1.1. Results for each year are compared to previous years to determine the progress of remediation. Table 4, above, shows the pond acreage remediated, which is in direct correlation with sampling results for these areas.

Maps in Appendix C shows the pond status for each year since the signing of the ROD, including identifying contaminated ponds, confirmed uncontaminated ponds, ponds undergoing remediation, and ponds that are remediated.

A summary of pond sampling results:

Pond 183 and Pond 146 are the major (largest) permanent ponds in Area C. These ponds are now connected.

- Pond 183 is clean. A small, contaminated area was found beneath some geotextile fabric left on site from previous actions. CRREL removed the geotextile in 2002 and the favorable sublimation/oxidation conditions in 2003 reduced the white phosphorus concentration found at depth to trace levels.

- Pond 146 is also clean. For example, composite sample 146-2 had WP concentration of 7.31 micrograms per gram (μg/g) in June 1999 and this was reduced to 0.0002 μg/g in September 2002. (This is the reportable detection limit.)

- Resampling in 2003 confirmed that no white phosphorus is detectable in the surface sediments of the large ponds (146 and 183) in Area C.

Area C/D ponds are considered clean.

- Bread Truck pond (Pond 109) samples both discrete and composite, are below the detection limit.

- Pond 730 (Area C/D) is considered clean. No WP was ever detected in the sampling at this pond. Pumping was performed based on waterfowl mortality in the area.

All Area A ponds are considered clean/remediated.

- Pond 290 is considered clean. No WP was ever detected in the sampling at this pond. Pumping was performed based on waterfowl mortality in the area.

- White phosphorus residual matter in Ponds 226, 256 and 258 (Area A) is no longer detectable and so these ponds are determined to be clean.

- Replicate composite sampling was conducted in 2004 in Area A Ponds 290, 258, 246 and 226 and no white phosphorus was found.

All Racine Island ponds are drained or clean.

- Pond 293 on Racine Island was drained by explosively excavating a ditch as part of the treatability studies performed prior to the ROD. These areas were resampled in 2002 and white phosphorus was still detectable at levels of 0.01 μg/g in pond 287 and 0.04 μg/g in pond 297. However, the drained pond areas have grown up with vegetation and are no longer waterfowl habitat. The area will continue to be monitored in the future to ensure no waterfowl mortality is occurring.

- Pond 285 on Racine Island was covered by AquaBlok in a treatability study in 1994-1995. Very high levels of white phosphorus were still present in the surface sediment in 2000, posing danger to feeding waterfowl. The pond was drained by ditching in 2001 and in 2003 additional shallow ditching was done to remove some remaining standing water areas with contaminated sediment. Presently the drained pond area is starting to overgrow with vegetation and is no longer waterfowl habitat. The area will continue to be monitored in the future to ensure no waterfowl mortality is occurring.

Pond 155 and 171 and neighboring smaller ponds are grouped as "Northern C marsh ponds." These ponds need further remediation.

- Pond 155 still needs further remediation. White phosphorus concentrations in the composite samples were reduced from 0.45 µg/g in 1999 to 0.005 µg/g in 2001. However, some discrete sampling taken in 2002 show that WP was still present. Drainage channels in the pond area were further improved in 2002 and additional pumping undertaken in the adjacent marsh in 2002 and 2003. The percentage of discrete samples taken on a grid pattern in the pond that has detectable white phosphorus declined from 77% in 2002 to 3% in 2003. White phosphorus particles could still be present in the surface sediments in two small zones within Pond 155.

- As identified through composite and discrete sampling, the small pools in the marsh in the northern Area C and the small pools of Pond 141 on the boundary of Areas BT and C are the remaining locations in ERF where white phosphorus is present in the surface sediment and may be ingested by feeding waterfowl.

5.6 Assessment of Data Quality

5.6.1 QAPP

A Quality Assurance Program Plan (QAPP) was developed for Eagle River Flats as part of the Remedial Action Work Plan (RAWP). This QAPP details procedures and issues relating primarily to the fieldwork to be conducted at ERF, including the collection of measurement data, potential field laboratory analyses conducted at ERF and Fort Richardson, and the handling and shipping of samples to offsite laboratories. These procedures are being followed in implementing the remedial action for OU-C.

5.6.2 Quality Assurance/Quality Control (QA/QC) Procedures

QA/QC procedures were outlined in the QAPP of the RAWP. The overall objective of the QA program is to establish procedures for obtaining data of known and acceptable quality. These procedures have been followed for this project.

The QAPP did not cover analytical QA/QC at offsite laboratories for the analysis of the white phosphorus. The method used was SW-7580. This method was developed by CRREL as part of the OUC project. This method includes generation of a daily calibration (five standards) curve with check standards run every 10 samples. Spike recovery samples are also analyzed.

6.0 FINAL INSPECTION AND CERTIFICATIONS

6.1 Remedial Action Contract Inspections

No official pre- or final inspections for OU-C have been conducted. However, representatives of USEPA, ADEC, and the Army have inspected the remediation activities at various times since the fieldwork began and have noted no significant operational problems with the treatment system. Initiation of the treatment system was authorized through review of work plans and health and safety plans.

6.2 Health and Safety

A Health and Safety Plan is included in the Remedial Action Work Plan and an updated plan is developed prior to each field season. No health and safety problems have been encountered during construction or operation. All personnel requiring access to the site are required to have a current HAZWOPER certification, and attend both a Range Control and Explosive Ordnance Disposal (EOD) briefing each season. Daily safety briefings are held, and additional helicopter briefings are held on days when helicopter operations are required. An UXO technician is used for providing safe pathways when accessing the site.

6.3 Institutional Controls

Institutional controls (ICs) at OU-C have been implemented. Fort Richardson has established a post wide IC policy at all known or suspected contaminated sites. Further details regarding the Army/Fort Richardson IC policy can be found in the OU-D ROD, the U.S. Army Institutional Controls Standard Operating Procedures [APVR-RPW (200-1)], and a Memorandum on Institutional Controls [APVR-RPW-EV (200-1c)], from Major General James J. Lovelace – Fort Richardson, Alaska. This policy is reviewed annually and revised every two years.

This policy ensures that there are limitations on access, water use, excavations, and property transfers as appropriate for the site. At OU-C, controls include a locked gate limiting access, fences and signs around the perimeter of the area, and large signs at access points to Eagle River.

One component of the IC policy involves obtaining an Excavation Clearance Request (USARAK Form 81 a – 1 Mar 02) to prevent undertaking work inconsistent with established ICs at a particular site.

The Directorate of Public Works (DPW) maintains a Geographic Information System database with information on all of the contaminated sites on post. The DPW is responsible for ensuring ICs on Fort Richardson. ICs will remain in place as long as hazardous substances remain on site at levels that preclude unrestricted use.

6.4 Confirmation that Remedy is Operational and Functional

Components of the preferred remedy as described in Section 2.1.1 of this document that were scheduled to occur from 1999 to 2002 have been implemented as planned with two exceptions. The telemetry monitoring for duck mortality did not occur in 2000 and 2003. Therefore, the remedy is operational and functional.

7.0 OPERATION & MAINTENANCE ACTIVITIES

7.1 Monitoring/Closure Activities

A methodology to determine exit strategies is currently being developed. The exit strategy will rely heavily on documented need and allow the Army, EPA, and ADEC to determine a strategy for monitoring that fits current and anticipated future data needs.

The project managers will evaluate the planned monitoring on an annual basis until RAOs are achieved. They will review the results from the monitoring to determine if conditions are progressing towards achieving the RAOs. Based on the results of the annual evaluation, the project managers will set the operating and monitoring parameters for the next year. The Army will then operate the systems, or perform monitoring as agreed over the coming year, making adjustments as they consider reasonable and in accordance with agreements made during the last annual evaluation. If the project managers can not reach concurrence on the operating or monitoring parameters of the systems, then previously agreed to parameters will be followed until the issue is resolved in accordance with the dispute resolution procedures incorporated in the Federal Facility Agreement.

8.0 SUMMARY OF PROJECT COSTS

Table 5. Project Cost Summary for 1999-2002

Cost Item	ROD Estimate (1998 $$)	ROD Estimate (2002 $$) [1]	Actual Costs (2002 $$)
RA Capital Cost [2]	**$250,129**	**$271,800**	**$50,000** [3]
RA Operating Cost	**$3,594,000**	**$3,905,000**	**4,965,000**
Total RA Cost	**$3,844,129**	**4,176,800**	**5,015,000**
Projected O&M			
Difference between total project cost and total ROD estimate		**838,200**	**+20%**

1 – ROD costs were adjusted for inflation from 1998 to 2002 using inflation calculator
2 – RA Capital Costs were based on addition of 2 pumps to the six that had already been purchased prior to the ROD. Capital cost for the initial six pumps systems was approximately $600,000.
3 – Actual RA Capital Costs were incurred for additional piping, connexes, and supplemental fuel tanks.

8.1 Comparison of Actual vs. ROD Costs

Actual costs for the first four years of operation are approximately 20% higher than estimated in the Record of Decision. The additional costs are due to the following:

- Costs estimated in ROD for 1999 and 2000 did not include placement of 6 pumps for pumping. It was anticipated that high flooding tides in those years would not be ideal for pumping conditions. However, due to innovations with small tides gates, it was determined that many of the flooding tides would be held back. Therefore, all 6 pumps were placed for pumping in these years.

- Helicopter costs have increased significantly since the ROD costs were estimated. This has primarily impacted the costs of the telemetry work.

- The costs in the ROD did not include costs for the Corps of Engineers support. The costs for this IRAR and the Five Year Review were also not included in the ROD costs.

- Telemetry costs for 2000 were significantly less than estimated in the ROD. Due to difficulties in procuring a helicopter to support this work, the telemetry study was not completed that year. However, some costs were incurred.

9.0 OBSERVATIONS AND LESSONS LEARNED

9.1 Successes

9.1.1 Tide Gates

Tide gates as described in Section 3.3.2 have been successful in optimizing the pond pumping remediation and enhancing its effectiveness. The drying season has been extended, and the efficiency and cost-effectiveness of the pumping action has been increased.

9.1.2 Remediation Operations

Logistics for this unique remediation project have been under constant development. Installation and removal of the remediation equipment has been streamlined each season as the equipment and procedures are modified. More efficient use of helicopters and better planning and coordination of ground crews have been achieved each season. This greater efficiency has resulted in cost savings as helicopter time required to deploy and retrieve the equipment has been reduced. It has also extended the remediation season by allowing the rapid deployment, retrieval, and startup of the equipment.

The use of a qualified construction contractor has been essential in the success of the remediation since the signing of the ROD. In 1997 and 1998, equipment was allowed to run out of fuel during crucial periods, resulting in flooding of treatment areas during prime remediation windows. Even small problems crippled operations. Since Weldin Construction took over as the O&M contractor in 1999, operations have been smooth and reliable, with all problems addressed within a matter of days.

The UXO contractor has also been instrumental in the success of the remediation effort, especially since the Army explosive ordnance disposal (EOD) detachment withdrew their support in 1996. However, it is important to have UXO technicians familiar with conditions in Eagle River Flats.

9.2 Problems Encountered and Solutions

9.2.1 Capping

The ROD calls for capping and filling of any remaining hot spots or small contaminated ponds at the end of the pumping remediation project. A Treatability Study testing a potential capping method was conducted in 1994 on Pond 285 on Racine Island. A bentonite and gravel mixture was transported by helicopter and dropped from air. Problems were encountered with getting complete coverage and uniform thickness of the cap material.

Subsequent sampling showed contaminated sediment still available to waterfowl. Also, the bentonite in the capping mixture prevents any possible drying of sediment even when water is drained off. This precludes any further in situ remediation of white phosphorus

If capping is needed in the future to cover any untreated hot spot or small contaminated pond, a bentonite-gravel mixture is not recommended. Rather, gravel alone should be used for any capping. Because of the difficulty of achieving uniform coverage when applying the cap from helicopters, application of a cap should be done from the surface if at all possible. Many areas of ERF are accessible during the winter by truck across the ice-covered surface. Gravel can be hauled directly to the particular site, dumped on the ice surface, spread out, and allowed to melt through and settle over the contaminated area during the spring. Other small areas are accessible during the summer using ATVs along cleared trails.

9.2.2 Helicopters

Helicopter support is a critical factor for all aspects of the remediation and monitoring efforts at ERF. Every year has been a challenge. In May of 1998, the use of military UH-1H aircraft was lost during spring deployment. A commercial helicopter contractor was brought on board for one season to provide the needed support. Starting in 1999, ERA Helicopters was contracted for helicopter support. The Army National Guard has been supplying heavy lift capability throughout the project with UH-60L Blackhawk helicopters. Rigging of the loads has always been a problem due to either a lack of rigging or a lack of qualified Army riggers. To alleviate this problem, rigging equipment was purchased for the project, and the ERF Remedial Action Team (RAT) performs the rigging. This has greatly increased the efficiency of the airlift operations. The Blackhawk helicopter's lift capacity does not allow the generator sets to be moved when filled with fuel. This has required additional time and helicopter cost in moving fuel out to the gensets after they are placed in the pond location. In September 2001, an Active Army CH-47D Chinook helicopter was used to airlift the heavy equipment. The heavier lift capacity of the Chinook allowed the lift of gensets without defueling them, thus increasing the efficiency of the operations.

In 2000, contracting problems were encountered in procuring a helicopter to provide support for the waterfowl telemetry study. Magnifying the problem was a very limited availability of helicopters during the season due to a high instance of forest fires. Also, pilots that are competent and experienced in net gun waterfowl capture work are in short supply. Due to the contracting issue and availability problem of helicopter and pilot, the waterfowl telemetry work was not performed in 2000. Contracting issues have been resolved; however, availability of helicopters and pilots continues to be a problem. In 2002, the waterfowl telemetry work started approximately 2 weeks late due to no availability of a helicopter. This resulted is less than 100 ducks being captured for the study. In 2003, again due to availability problems, the waterfowl telemetry work was not performed. Alternatives to helicopter capture were investigated but were not considered viable because of technical or regulatory issues. It was then decided to postpone mortality surveys for a year and to re-evaluate the method used to determine waterfowl mortality rates. In 2004, ground-based transect surveys were utilized for determining waterfowl mortality and so helicopter were not utilized for this part of the project.

10.0 OPERABLE UNIT CONTACT INFORMATION AND REFERENCES

10.1 OU Contact Information

10.1.1 USEPA Project Manager

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APPENDIX A – COST INFORMATION

Actual Final Costs (1999 – 2004) (in thousands 000)

	1999	2000	2001	2002	2003	2004
MONITORING ACTIVITIES:						
Telemetry – including aerial surveys, helicopter support	251	90	295	315		
WP sampling /monitoring – including data management and monitoring	163	185	185	185		
UXO support	32	25	25	35		
DPW Support	7	7	10	15		
COE Support	35	40	40	40		
TREATMENT ACTIVITIES:						
Pond Pumping – including helicopters	548	509	444	435		
Contractor support, fuel	120	145	175	150		
Cap and Fill/Bread Truck Gate	0	0	0	30		
DPW Support	5	10	11	15		
Reports	0	0	0	80		
COE Support	35	38	37	40		
Hazing (contingency)	0	0	0	0		
O&M PER YEAR	**1,196**	**1,049**	**1,222**	**1,340**		

Previously Estimated ROD Costs
Capital Cost: 250,129
Operations and Maintenance: ($000)

	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018
Monitoring Activities:																				
Telemetry – incl. aerial surveys, helicopter support	250	250	250	250	250	220	220	220	0	220	0	0	0	0	220	0	0	0	0	220
WP sampling /monitoring – incl. data management	170	140	180	175	180	20	30	25	32.5	25	22.5	27.5	22.5	22.5	25	27.5	22.5	22.5	22.5	30
UXO support	35	35	35	35	35	10	10	10	2.5	10	2.5	2.5	2.5	2.5	10	2.5	2.5	2.5	2.5	10
DPW Support	25	25	25	25	25	15	15	15	2	20	2	2	2	2	20	2	2	2	2	20
Treatment Activities:																				
Pond Pumping – incl. helicopters, contractor, fuel	295	295	565	565	565	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Cap and Fill	0	0	0	0	152	2	2	2	0	2	0	0	0	0	2	0	0	0	0	2
DPW Support	25	25	35	35	35	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Hazing contingency	10	10	10	10	10	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
O&M Per Year	810	780	1100	1095	1252	267	277	272	37	277	27	32	27	27	277	32	27	27	27	282

APPENDIX B – LOCATION MAPS FOR EAGLE RIVER FLATS

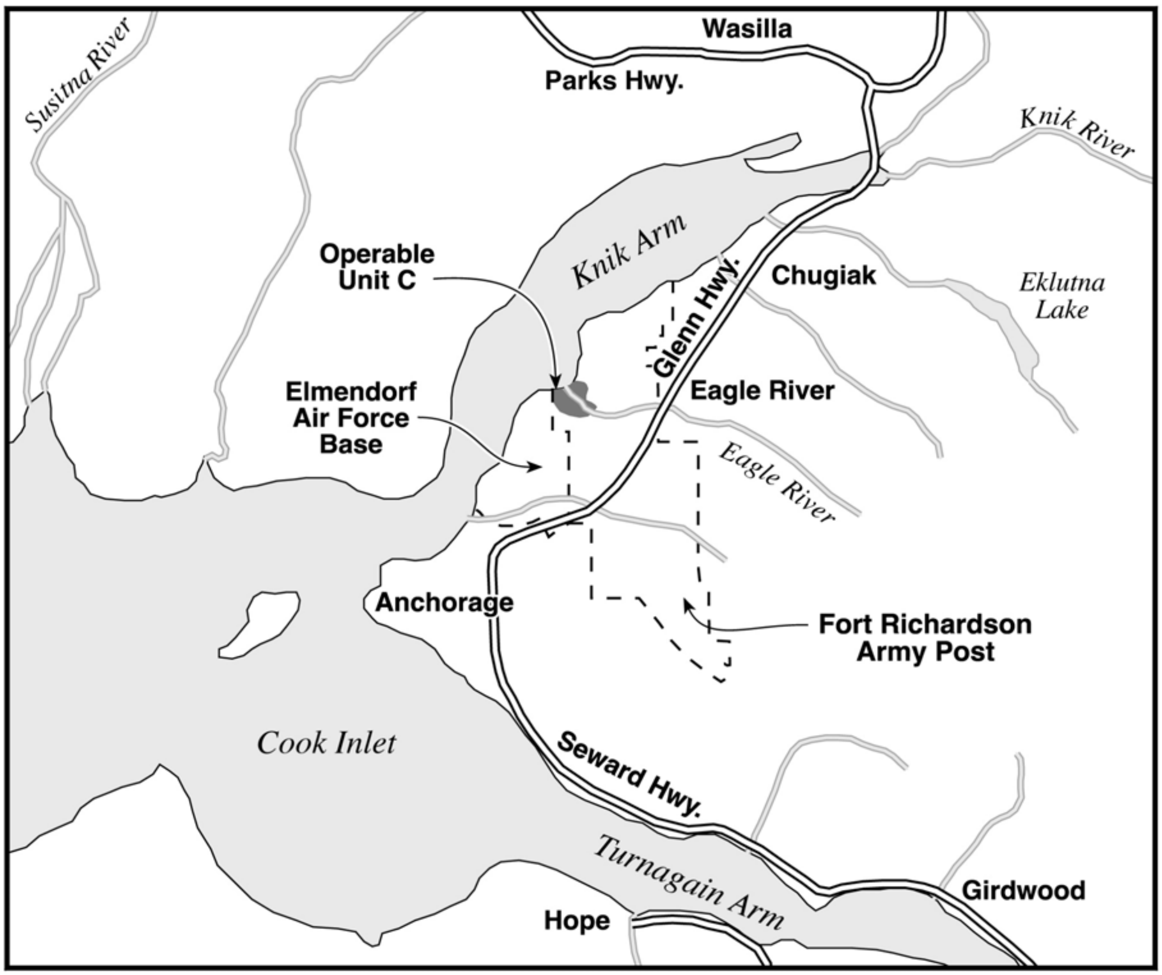


Figure 1
Location Map

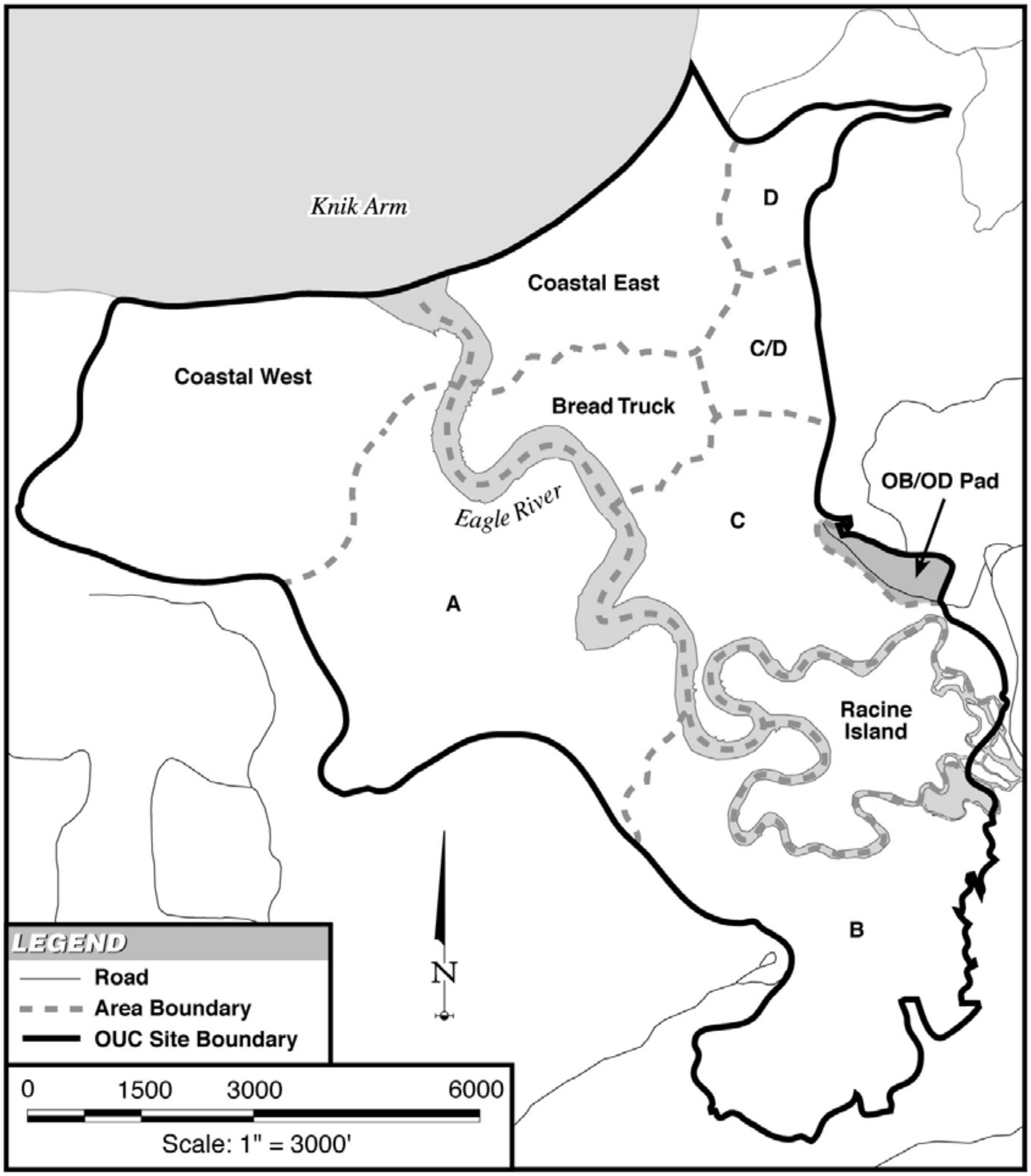


Figure 2
ERF Areas and OB/OD Pad
2000

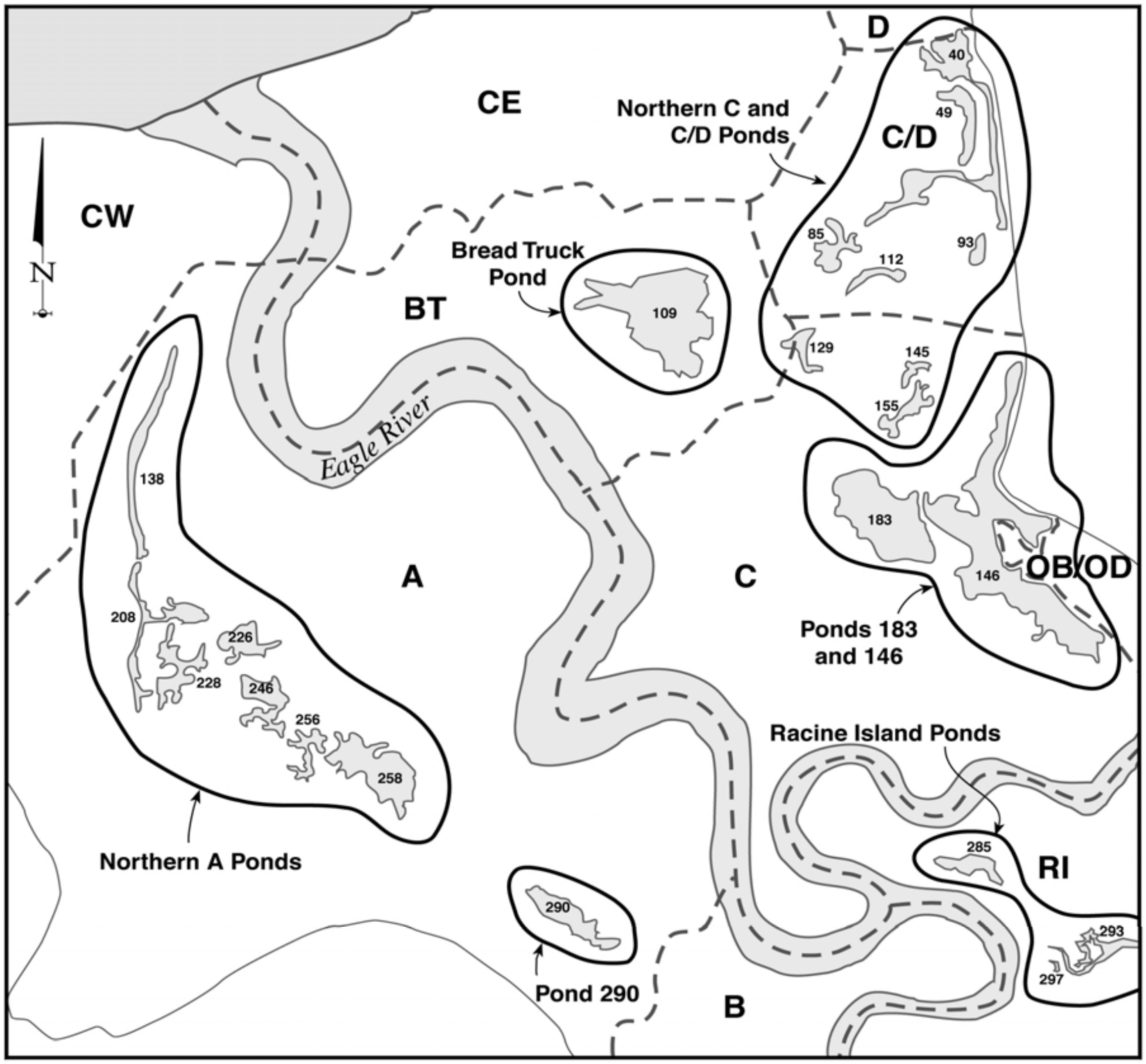
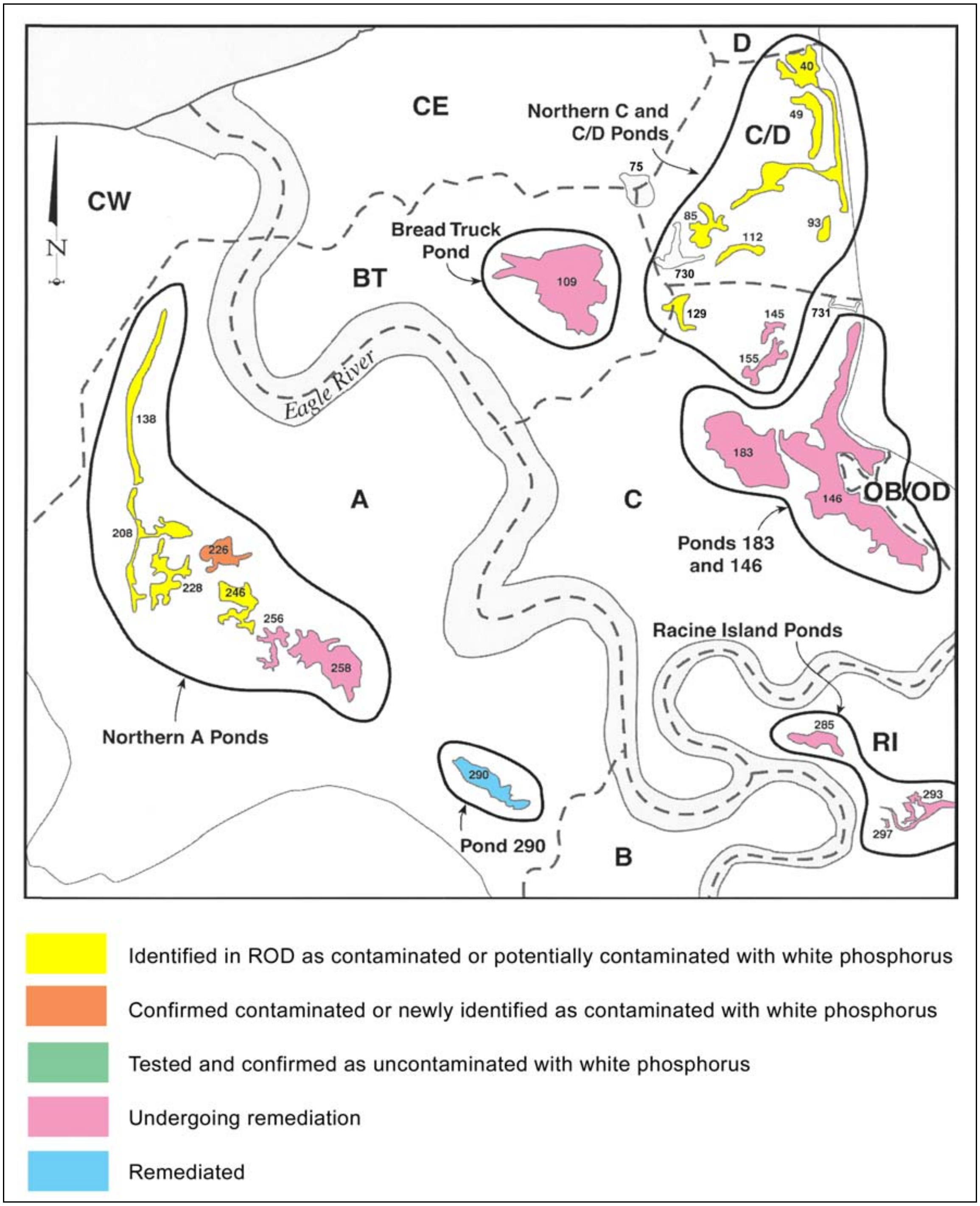
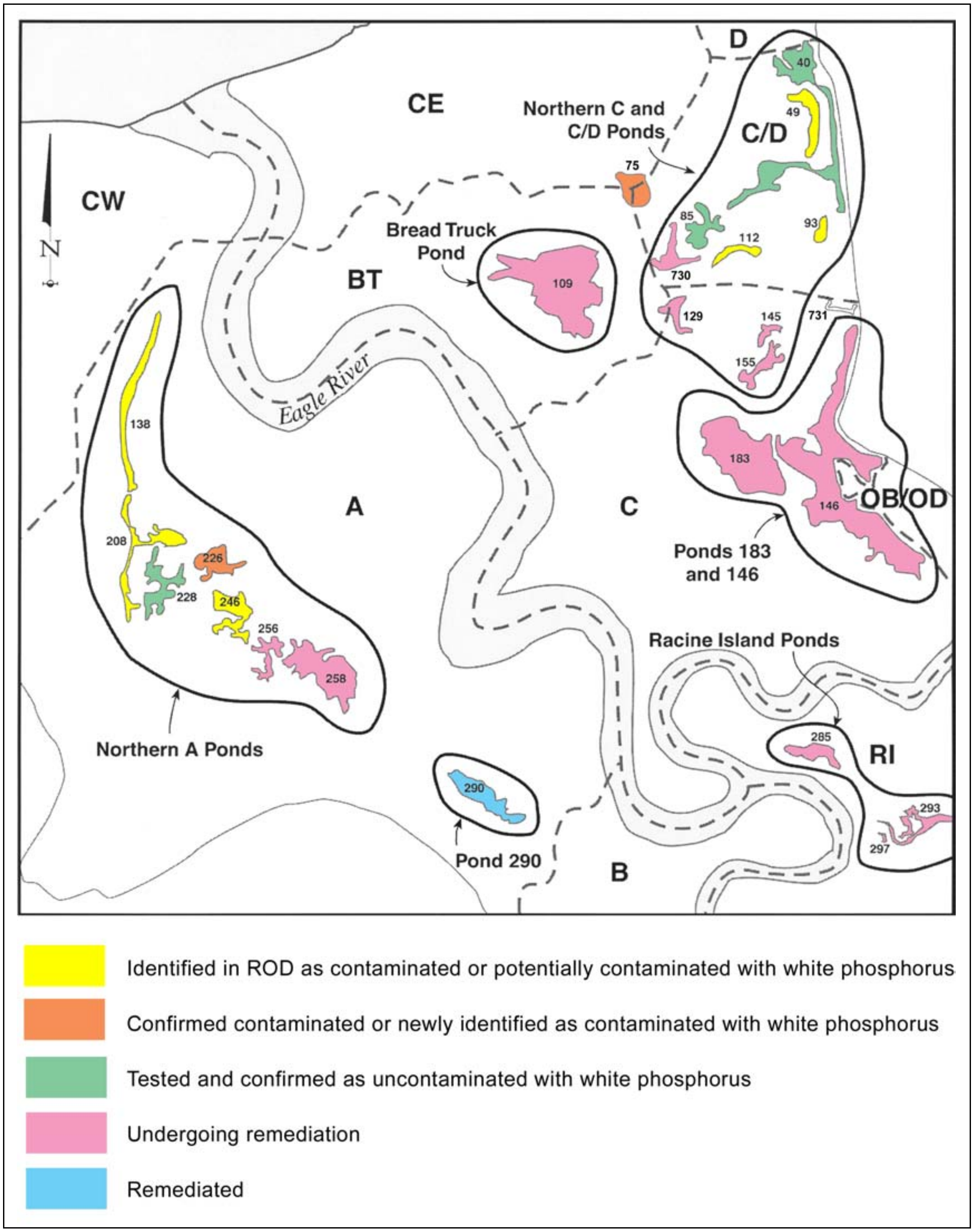


Figure 3
Pond Groups

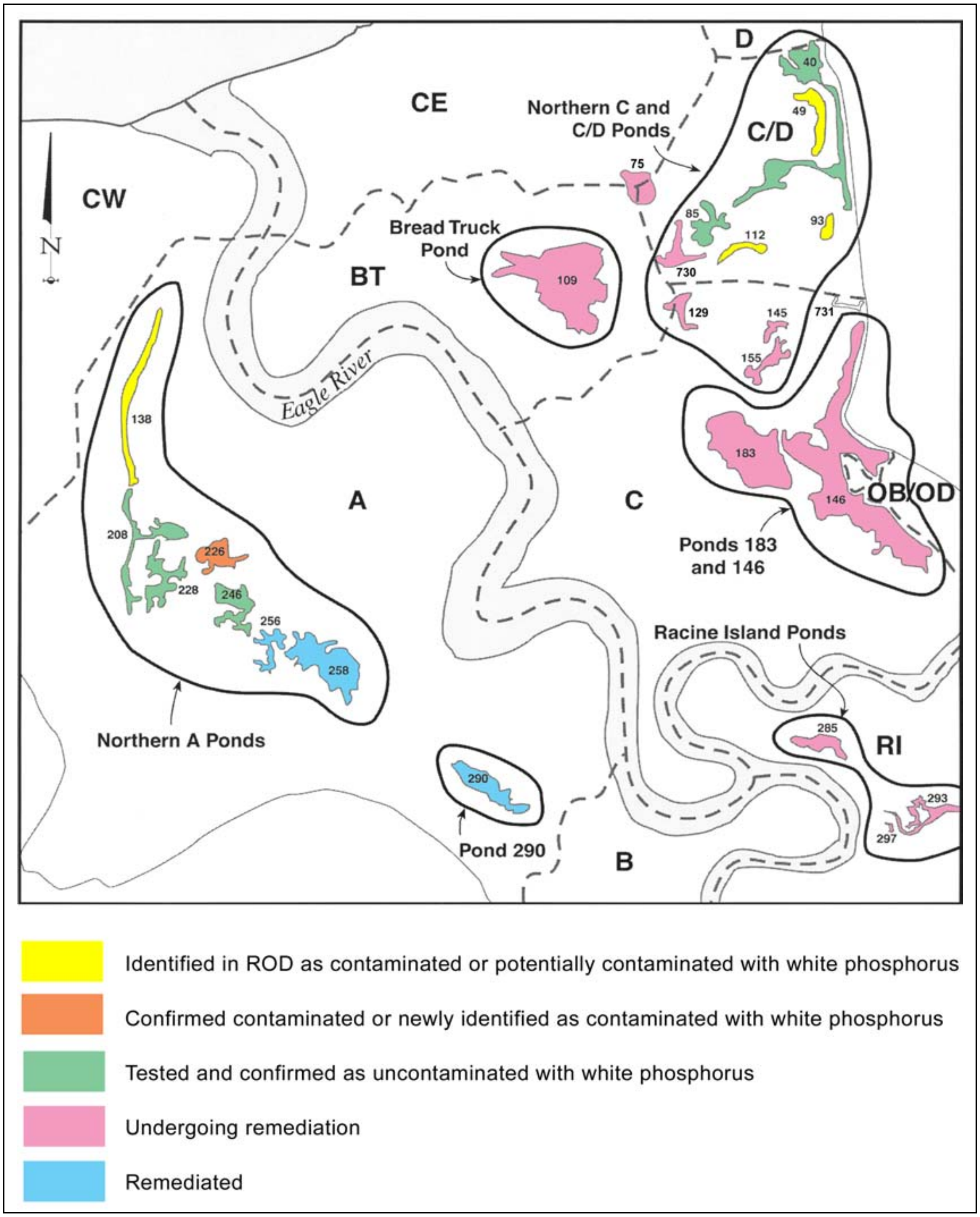
APPENDIX C – STATUS OF TREATED PONDS, 1998 – 2004



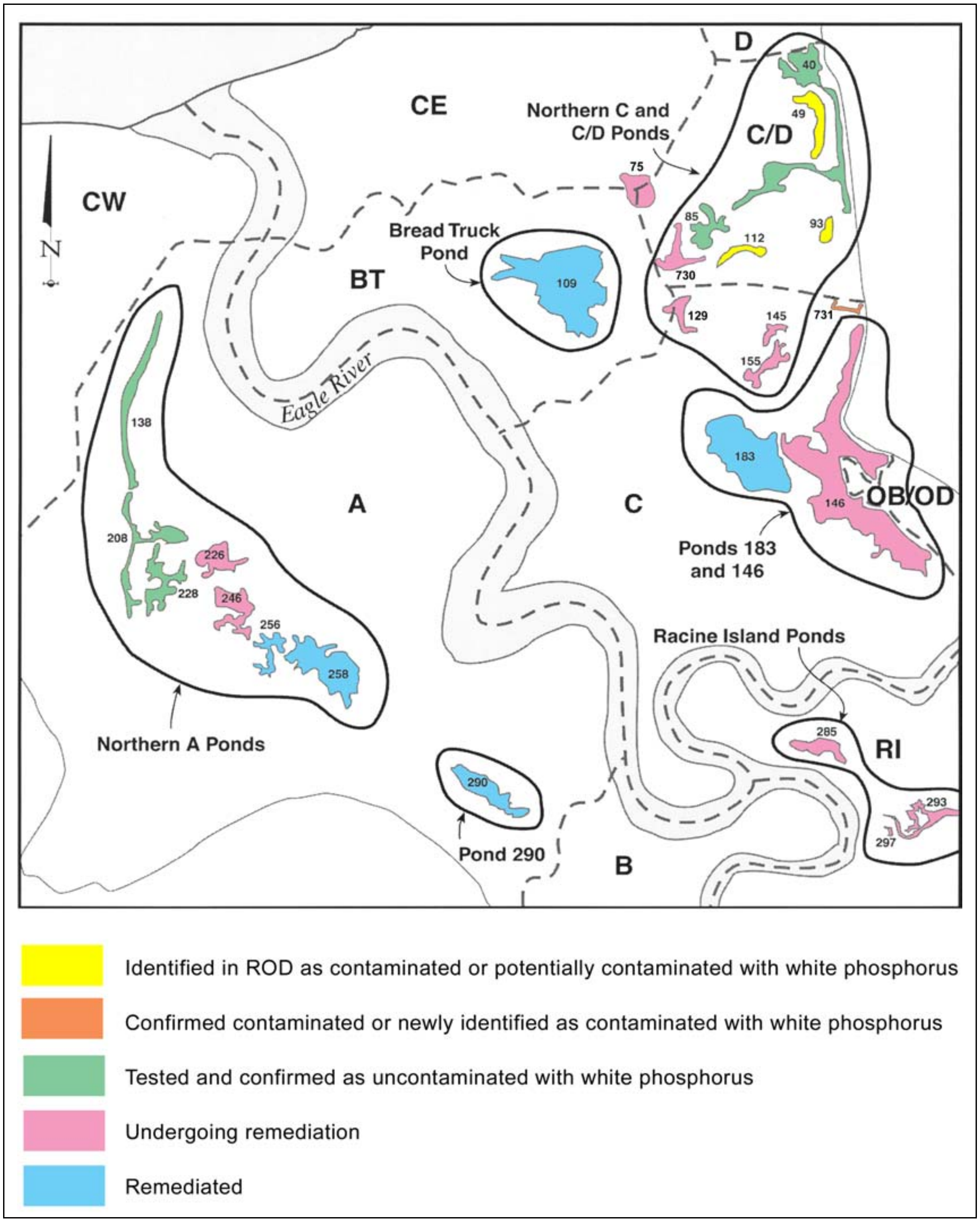
a. Pond status at the end of the 1998 season and the signing of the ROD.



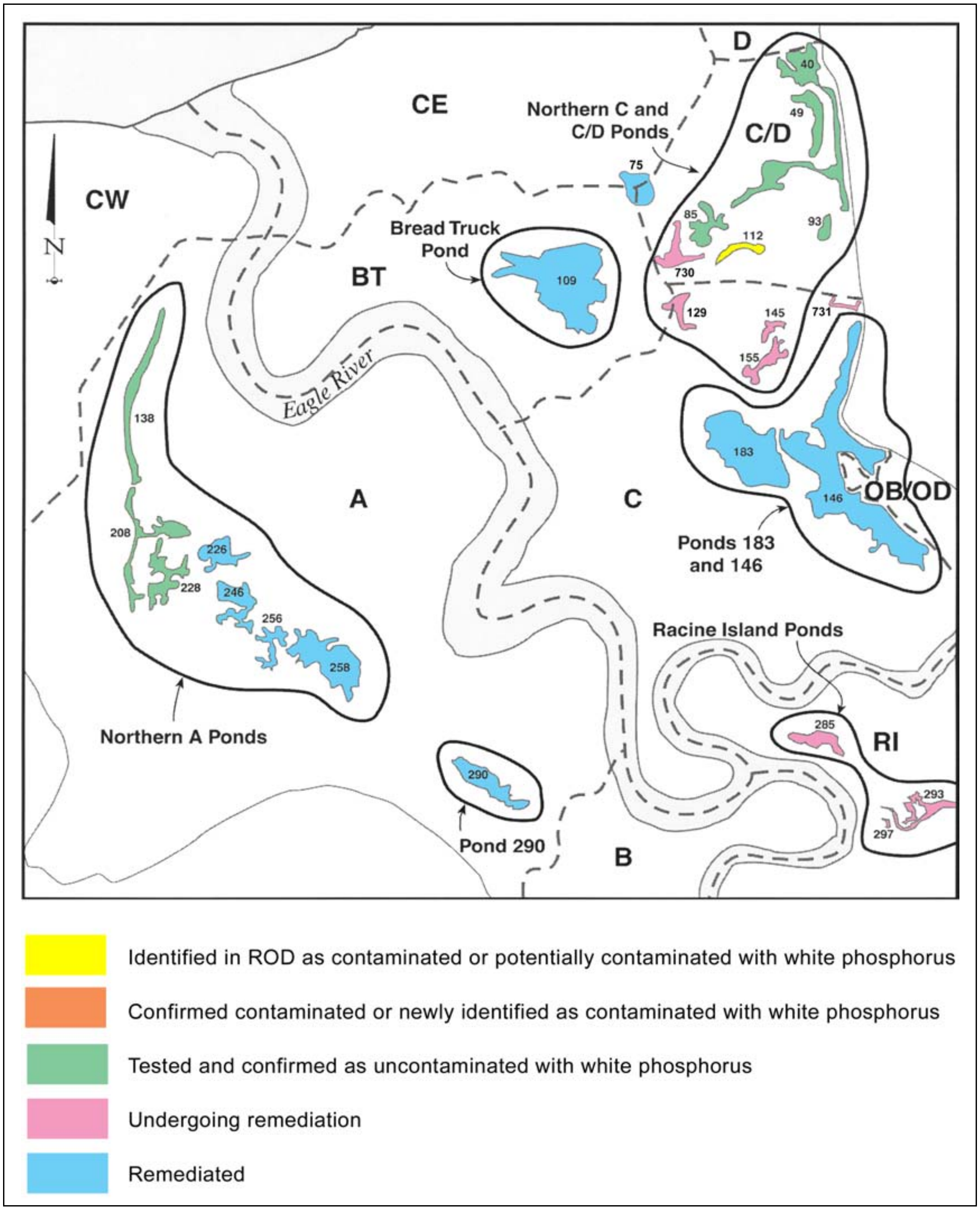
b. Pond status at the end of the 1999 season.



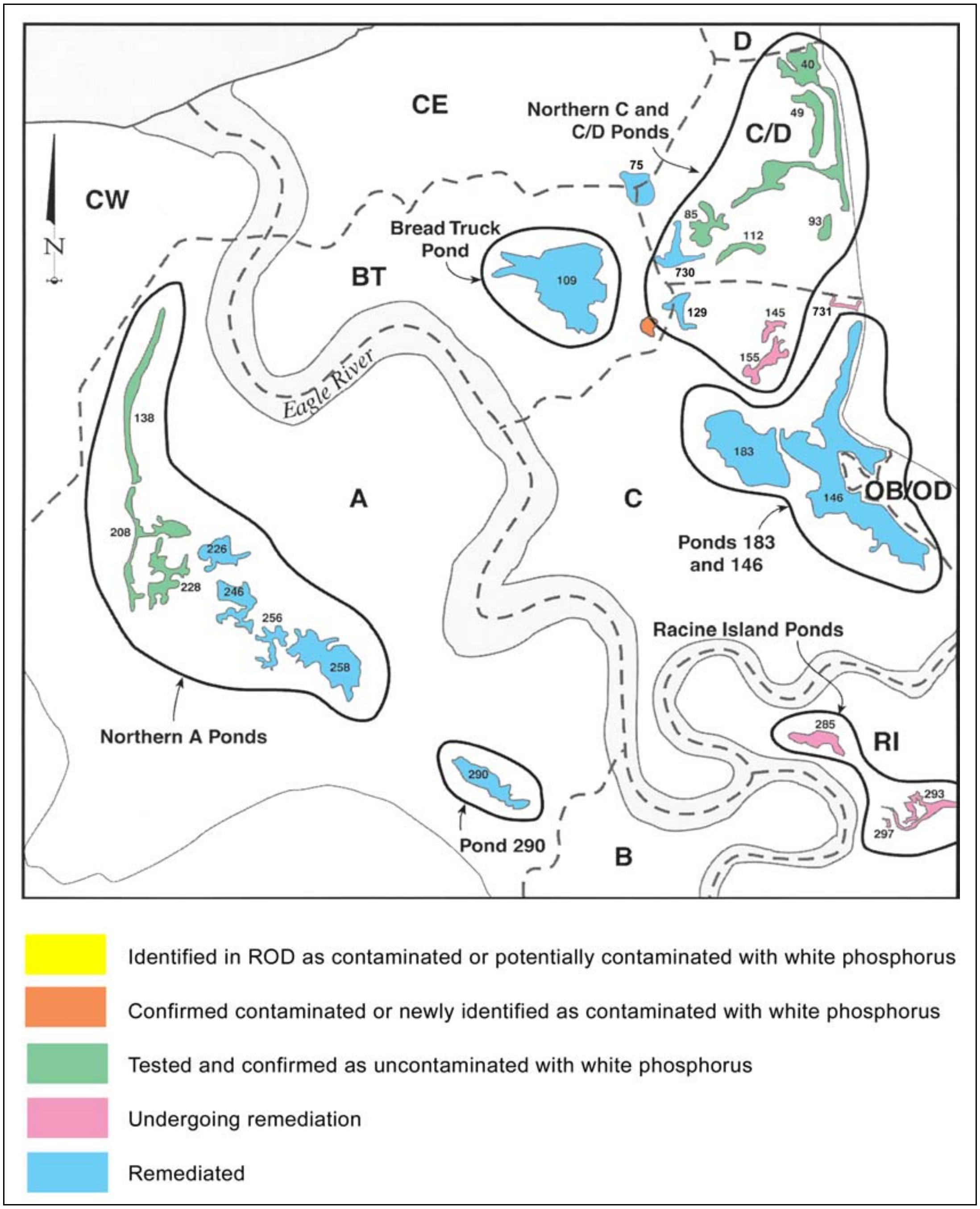
c. Pond status at the end of the 2000 season.



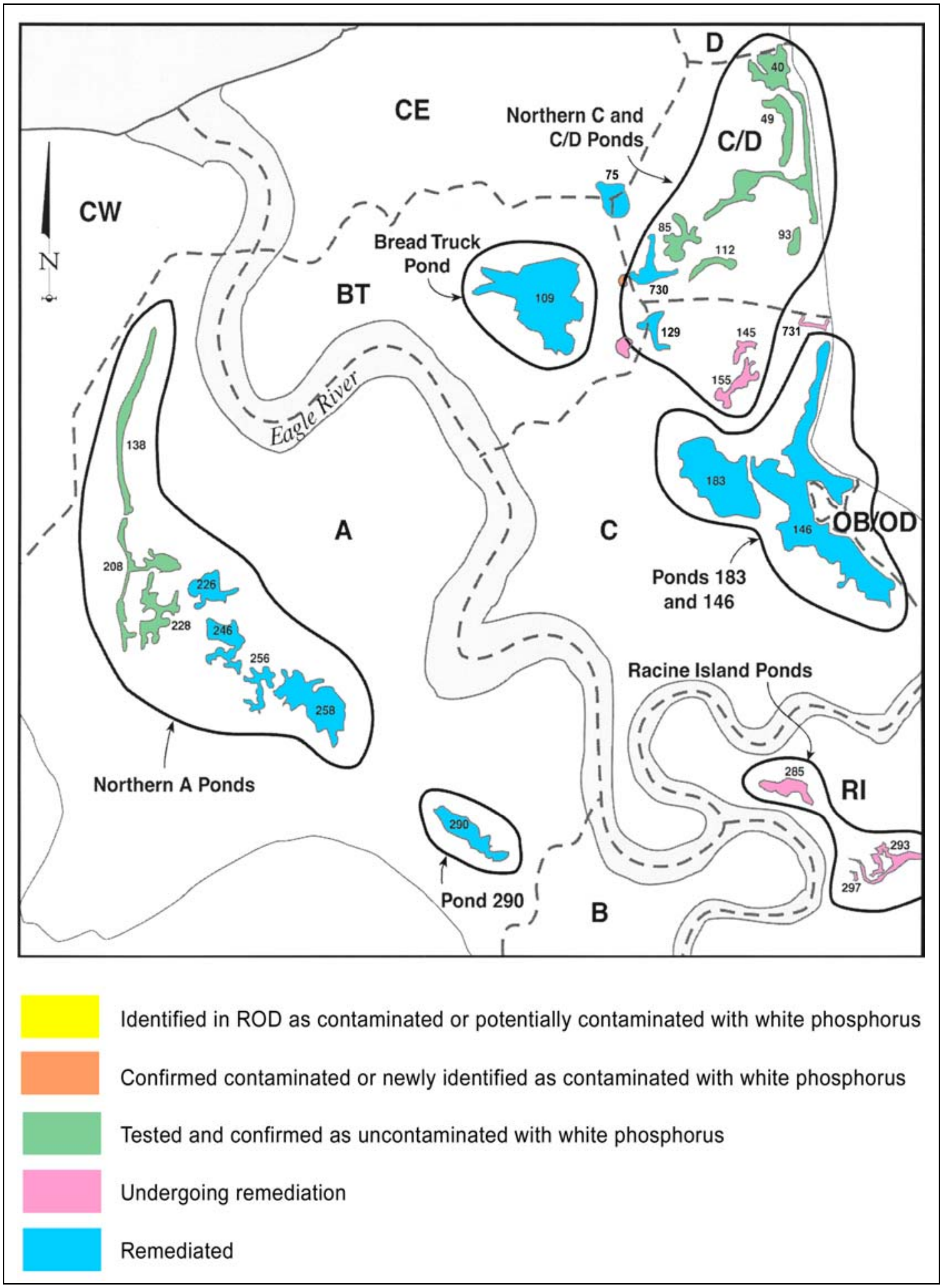
d. Pond status at the end of the 2001 season.



e. Pond status at the end of the 2002 season.



f. Pond status at the end of the 2003 season.



f. Pond status at the end of the 2004 season.

APPENDIX D – BIBLIOGRAPHY

Nam S.I., M.R. Walsh, C.M. Collins, and L. Thomas (1999) Eagle River Flats Remediation Project, Comprehensive Bibliography – 1950 to 1998, USA Cold Regions Research and Engineering Laboratory, Special Report 99-13.

Walsh, Michael R, (2003) Eagle River Flats Remediation Project, Comprehensive Bibliography – 1998 to 2003, USA Cold Regions Research and Engineering Laboratory, ERDC/CRREL TR-03-15.