FINAL
RECORD OF DECISION
for Operable Unit 3

NAS Whidbey Island
CTO-0074

March 29, 1995

NORTHWEST AREA

COMPREHENSIVE LONG-TERM ENVIRONMENTAL ACTION NAVY

ENGINEERING FIELD ACTIVITY
NORTHWEST, NAVAL FACILITIES
ENGINEERING COMMAND
CONTRACT #N62474-89-D-9295

THE URS TEAM

URS Consultants

Science Applications International Corp.

Shannon & Wilson, Inc.

FINAL

RECORD OF DECISION

FOR THE

COMPREHENSIVE LONGTERM ENVIRONMENTAL ACTION NAVY (CLEAN) NORTHWEST AREA

NAS WHIDBEY ISLAND
OPERABLE UNIT 3
CONTRACT TASK ORDER NO. 0074

PREPARED BY:

URS CONSULTANTS, INC.
SEATTLE, WASHINGTON

AND

SCIENCE APPLICATIONS INTERNATIONAL CORPORATION
BOTHELL, WASHINGTON

PREPARED FOR:

ENGINEERING FIELD ACTIVITY, NORTHWEST
SOUTHWEST DIVISION, NAVAL FACILITIES ENGINEERING COMMAND
POULSBO, WASHINGTON

March 29, 1995

DECLARATION OF THE RECORD OF DECISION

SITE NAME AND ADDRESS

Naval Air Station Whidbey Island, Ault Field
Operable Unit 3, Area 16
Oak Harbor, Washington

STATEMENT OF PURPOSE

This decision document presents the final remedial action for Operable Unit (OU) 3, one of four operable units at the Naval Air Station (NAS) Whidbey Island, Ault Field, Superfund site near Oak Harbor, Washington. The selected remedy in this decision document was chosen in accordance with the Comprehensive Environmental Response, Compensation, and Liability Act of 1980 (CERCLA), as amended by the Superfund Amendments and Reauthorization Act of 1986 (SARA), and, to the extent practicable, the National Oil and Hazardous Substances Pollution Contingency Plan (NCP). This decision is based on the administrative record for OU 3.

This document also finalizes the results of the Hazardous Waste Evaluation Study. The purpose of this study was to determine whether sufficient contamination existed at an additional 26 areas at NAS Whidbey Island to warrant either further investigation, some type of remedial action, or no further action. Those decisions are included in this Record of Decision.

The United States Navy (Navy) is the lead agency for this decision. The United States Environmental Protection Agency (EPA) approves of this decision and, along with the Washington State Department of Ecology (Ecology), has participated in the scoping of the site investigations and in the evaluation of remedial action alternatives. The State of Washington concurs with the selected remedy.

ASSESSMENT OF THE SITE

Actual or threatened releases of hazardous substances from OU 3, if not addressed by implementing the response action selected in this Record of Decision (ROD), may present an imminent and substantial endangerment to public health, welfare, or the environment.

DESCRIPTION OF THE REMEDY

OU 3 originally consisted of Area 16, the Runway Ditches, and Area 31, the Former Fire Training School. Because of the need for further evaluation. Area 31 is no longer part of OU 3, Area 31 will be addressed as part of OU 5.

The remedial action at Area 16 addresses ecological risks. Runway ditch sediments at several segments of the ditch system were found to contain chemicals that pose risks to animals, such as muskrats and benthic organisms, which come into contact with the sediments. Chemicals of concern in ditch sediment include polynuclear aromatic hydrocarbons (PAHs), total petroleum hydrocarbons (TPH), arsenic, and lead. There is no concern for human health risks in the runway ditch system. The purpose of the action is to reduce the ecological risk associated with contamination in the ditch sediments.

The selected remedy for the runway ditches is removal with on-site disposal. The action is to remove the sediment from the contaminated areas and haul it to the Area 6 landfill on the base. This landfill will be capped as part of the selected remedy for OU 1, and placement of these sediments under the cap will contain the contaminants. Because the concentrations of chemicals found in the sediments do not cause the sediment to be considered hazardous or dangerous waste, placement in the landfill will be permitted. The sediments will be analyzed prior to placement to verify this conclusion. After remedial action, the Navy can resume maintenance dredging to allow for better drainage along the flightline area.

STATUTORY DETERMINATIONS

The selected remedy is protective of human health and the environment, is in compliance with federal and state requirements that are legally applicable or relevant and appropriate to the remedial action, and is cost-effective. The remedy utilizes permanent solutions and alternative treatment (or resource recovery) technologies to the maximum extent practicable for this site. However, because treatment of the principal threats of the site was not found to be practicable, this remedy does not satisfy the statutory preference for treatment as a principal element. Hazardous substances will be left on site above risk-based levels; therefore, the five-year review will apply to this action.

Signature sheet for the foregoing Naval Air Station Whidbey Island, Ault Field, Operable Unit 3, final remedial action, Record of Decision, between the United States Navy and the United States Environmental Protection Agency, with concurrence by the Washington State Department of Ecology.

4/20/95

Captain John F. Schork
Commanding Officer, Naval Air Station Whidbey Island
United States Navy

Date

Signature sheet for the foregoing Naval Air Station Whidbey Island, Ault Field, Operable Unit 3, final remedial action, Record of Decision, between the United States Navy and the United States Environmental Protection Agency, with concurrence by the Washington State Department of Ecology.

Chuck Clarke

Chuck Clarke
Regional Administrator, Region 10
United States Environmental Protection Agency

APR 14 1995

Date

Signature sheet for the foregoing Naval Air Station **Whidbey** Island, **Ault** Field, Operable Unit 3, **final remedial** action, Record of Deeision, between the United States Navy and the United States Environmental Protection Agency, with concurrence by the Washington State Department of Ecology.

Mary E. Burg

Mary **E. Burg**
program Manager, **Toxics** Cleanup **Program**
Washington State Department of Ecology

11 April 1995
Date

CONTENTS

CONTENTS (Continued)

CONTENTS (Continued)

TABLES

FIGURES

ABBREVIATIONS AND ACRONYMS

AOC - area of contamination
ARAR - applicable or relevant and appropriate requirement
bgs - below ground surface
CERCLA - Comprehensive Environmental Response, Compensation, and Liability Act
CFR - Code of Federal Regulations
COPC - chemical of potential concern
CSL - cleanup screening level
DNAPL - dense non-aqueous phase liquids
DoD - Department of Defense
Ecology - Washington State Department of Ecology
EFA Northwest - Engineering Field Activity, Northwest
EPA - U.S. Environmental Protection Agency
FFA - Federal Facilities Agreement
FS - Feasibility Study
FWQC - Fresh Water Quality Criteria
FWQS - Fresh Water Quality Standard
HEAST - Health Effects Assessment Summary Tables
HI - hazard index
HPLC - high pressure liquid chromatography
HQ - hazard quotient
IR - Installation Restoration
IRIS - Integrated Risk Information System
LD_{50} - lethal dose for 50 percent of the exposed population
LOEL - lowest-observed-effects level
MCL - maximum contaminant level
MSL - mean sea level
MTCA - Model Toxics Control Act
NACIP - Navy Assessment and Control of Installation Pollutants
NOEL - no-observed-effects level
NPL - National Priorities List
NUWC - Naval Undersea Warfare Center
O&M - operation and maintenance
OU - Operable Unit
PAH - polynuclear aromatic hydrocarbon
PCB - polychlorinated biphenyl
PGDN - propylene glycol dinitrate
PSAPCA - Puget Sound Air Pollution Control Agency
PUD - public utility district

RAB - Restoration Advisory Board
RAO - remedial action objective
RCRA - Resource Conservation and Recovery Act
RfD - reference dose (mg/kg-day)
RI - Remedial Investigation
RME – reasonable maximum exposure
ROD - Record of Decision
SARA - Superfund Amendments and Reauthorization Act
SF - slope factor $(mg/kg\text{-}day)^{-1}$
SMS - Sediment Management Standards
SQS - sediment quality standard
SQV - sediment quality value
SVOC - semivolatile organic compound
TCLP – toxicity characteristic leaching procedure
TEC - toxicity equivalency concentration
TPH - total petroleum hydrocarbons
TRC - Technical Review Committee
TRV - toxicity reference value
UCL - upper confidence limit
VOC - volatile organic compound
WAC - Washington Administrative Code
WQC - water quality criteria

DECISION SUMMARY

1.0 INTRODUCTION

In accordance with Executive Order 12580, the Comprehensive Environmental Response, Compensation, and Liability Act of 1980 (CERCLA), as amended by the Superfund Amendments and Reauthorization Act of 1986 (SARA), and, to the extent practicable, the National Oil and Hazardous Substances Pollution Contingency Plan, the United States Navy (Navy) is addressing environmental contamination at Naval Air Station (NAS) Whidbey Island, Ault Field, by undertaking remedial action. The selected remedial action has the approval of the United States Environmental Protection Agency (EPA), the concurrence of the Washington State Department of Ecology (Ecology), and is responsive to the expressed concerns of the public. The selected remedial actions will comply with applicable or relevant and appropriate requirements (ARARs) promulgated by Ecology, EPA, and other state and federal agencies.

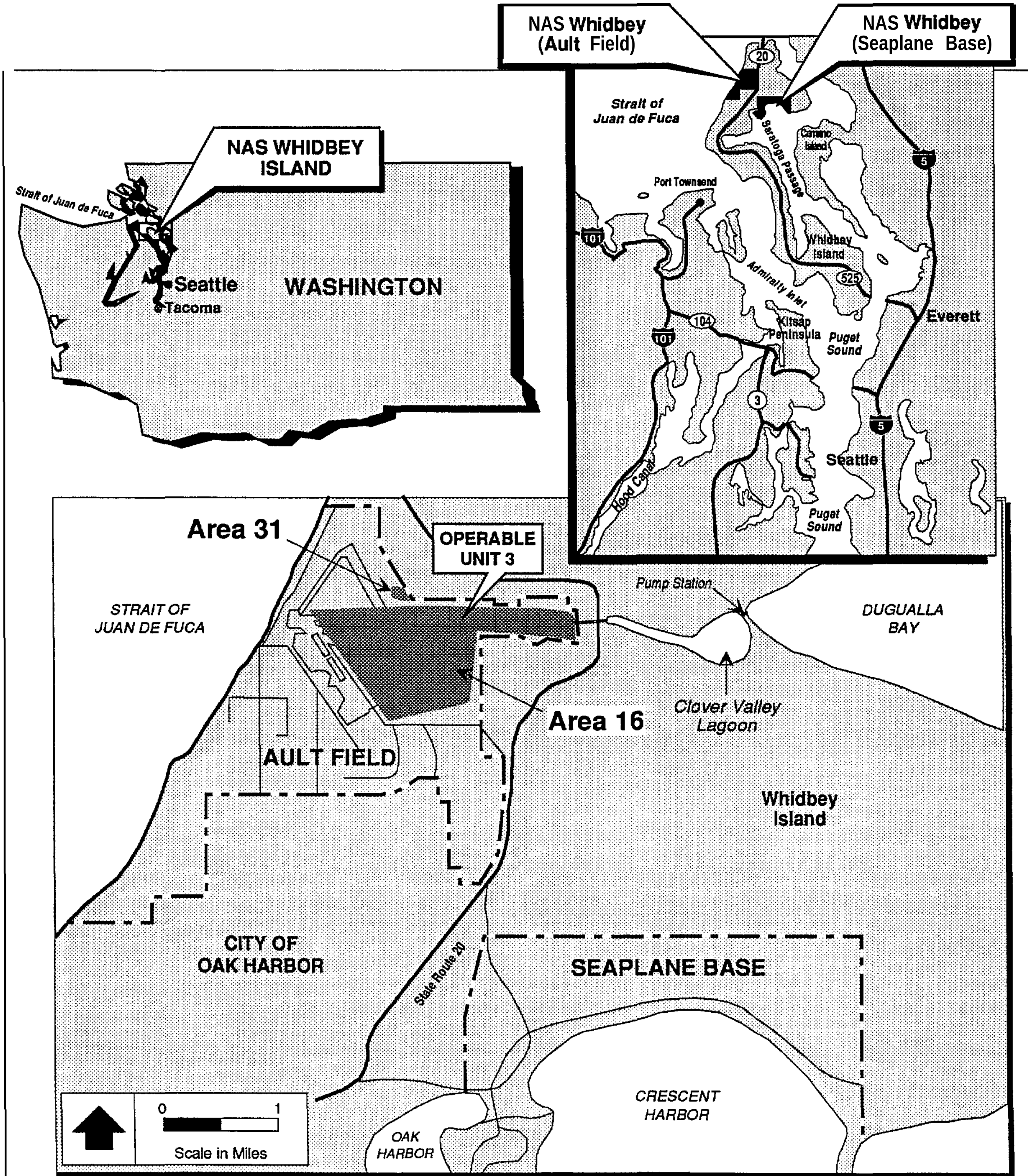
2.0 SITE NAME, LOCATION, AND DESCRIPTION

NAS Whidbey Island, Ault Field, is located on Whidbey Island in Island County, Washington, at the northern end of Puget Sound and the eastern end of the Strait of Juan de Fuca (Figure 2-1). The island is oriented north-south, with a length of almost 40 miles and a width varying from 1 to 10 miles. NAS Whidbey Island is located just north of the city of Oak Harbor (population 14,000) and has two separate operations: Ault Field and the Seaplane Base.

Ault Field is a Superfund site that has been divided into four separate operable units (OUs): 1, 2, 3, and 5. The Seaplane Base is a separately listed Superfund site and constitutes OU 4.

This record of decision (ROD) addresses OU 3, which now consists only of Area 16, the Runway Ditches. Area 31, the Former Runway Fire School, was initially included as part of OU 3. However, more information is needed and further evaluation is necessary before a remedial action decision can be made for Area 31. Therefore, Area 31 has been removed from OU 3 and will be addressed as part of OU 5.

This ROD also documents the decisions reached and the actions that will be taken as a result of the Hazardous Waste Evaluation Study. This study addressed twenty-six additional study



CLEAN COMPREHENSIVE LONG-TERM ENVIRONMENTAL ACTION NAVY	Figure 2-1 NAS Whidbey Island Location Map	CTO 0074 OPERABLE UNIT 3 NAS WHIDBEY, WA RECORD OF DECISION

CTO74\ROD\FIG2_1.DRW 1/31/95

areas that had been originally identified at both Ault Field and the Seaplane Base but were not included in OUS 1, 2, 3, or 4.

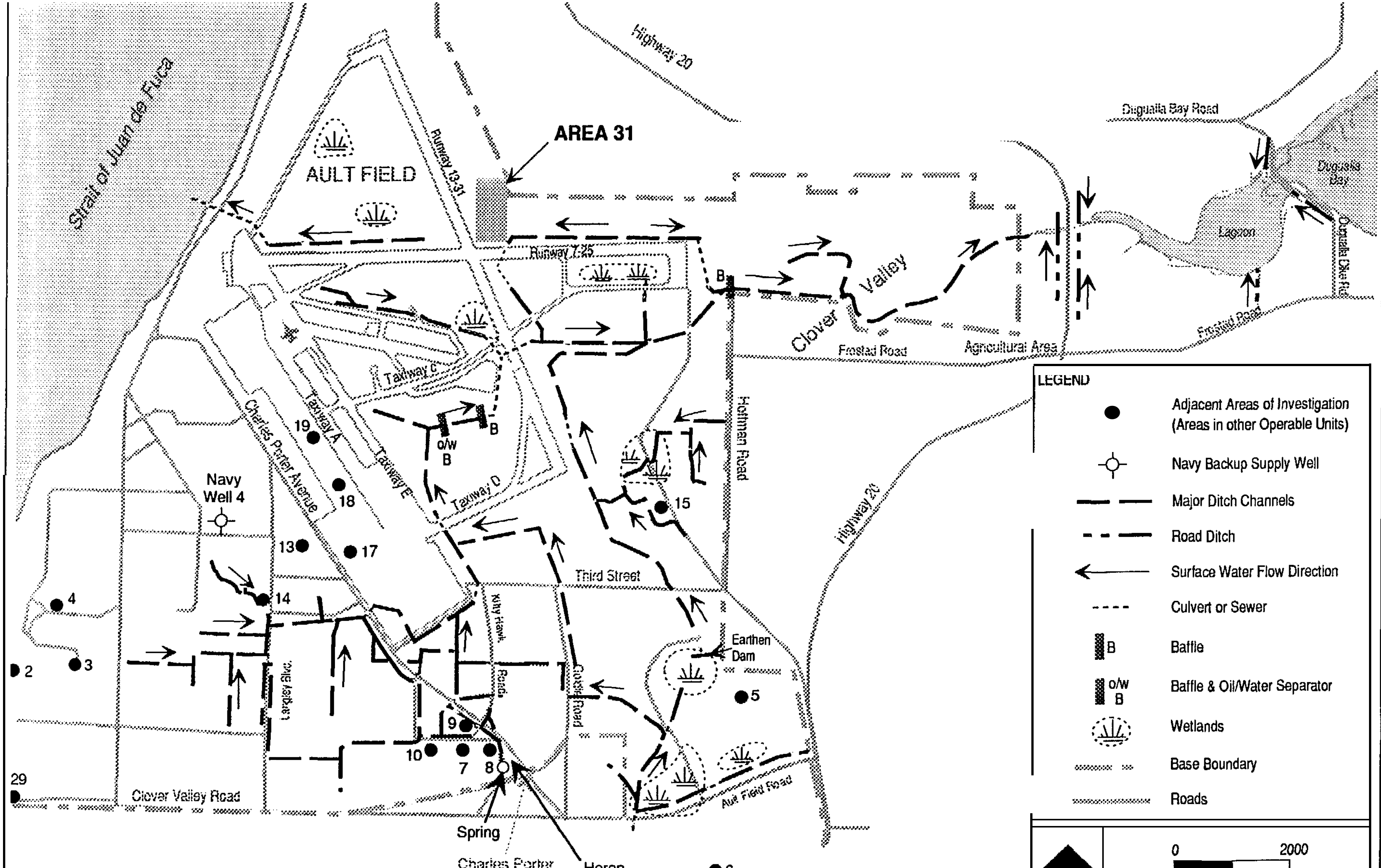
Area 16 comprises the eastern portion of Ault Field, including the flightline area and the on-site drainage areas through Clover Valley (Figure 2-2). Clover Valley Lagoon and Dugualla Bay, which are east of the base boundary, were also included in the investigation because they are downgradient of Area 16.

The Ault Field Runway Ditches consist of approximately 9 miles of connected ditches and 1 mile of culverts that drain the runway area and receive discharge from many of the station's storm drains. The majority of the ditches eventually connect with the Clover Valley stream, which flows east toward the Clover Valley Lagoon and Dugualla Bay (Figure 2-2). One ditch, located north of Runway 7-25, empties into the Strait of Juan de Fuca. This ditch only receives runoff from the runway, not discharge from other storm drains. Some of the ditches do not contain water during the dry season.

The bottoms of the ditches near the runway vary in width from approximately 2 to 10 feet and range in elevation from slightly below mean sea level (MSL) to 20 feet above MSL. The banks of the ditches typically have a 30- to 45-degree slope and rise to a height of 5 to 10 feet above the base of the ditch. Thick plant growth typical of wetlands is present in the base of the flowing ditches, except where the water is greater than 1 foot deep. Sediment buildup in the ditches is greater than 1 foot thick near storm drain discharges and is less than 6 inches in the ditches east of Runway 13-31. Until about 1981, the ditches were dredged with a dragline every 7 to 8 years. During dredging, sediment was removed from the ditch base and reportedly placed along the banks. Presently, there is little or no evidence of dredged piles and the area is thickly vegetated.

Three baffles have been installed along the runway ditches (Figure 2-2). The baffles are intended to retain sediment and keep culverts from becoming clogged. The upstream (westernmost) baffle, south of Taxiway C, is constructed of concrete; the two downstream baffles are constructed of wood. The upstream baffle is also constructed and operated to contain any floating petroleum product that may enter the ditches if a spill occurs on the flightline. The upstream baffle used to have an oil/water separator with an electric oil skimming recovery system that removed and containerized the floating product retained by the baffle. The oil skimmer unit is now inoperable. Current practice at the base is to immediately respond to spill events if and when they occur, with oil skimming performed as needed by a spill response contractor using a vacuum truck.

The Clover Valley Lagoon serves as a catchment basin for approximately 7,000 acres of land drained by the ditch network, which includes most of Ault Field and some surrounding areas.



NOTE: Operable Unit 1 includes Areas 5 and 6.
Operable Unit 2 includes Areas 2, 3, 4, 14, and 29

CLEAN
COMPREHENSIVE LONG-TERM ENVIRONMENTAL ACTION NAVY

Figure 2-2
Area 16 - Runway Ditches
(including adjacent areas of investigation)

CTO 0074
OPERABLE UNIT 3
NAS WHIDBEY, WA
RECORD OF DECISION

Discharge into the lagoon includes surface water from surrounding hills to the north and south, wetlands in the southeastern portion of the naval base, and surface water runoff collected from Ault Field by the runway ditches and carried off base by the Clover Valley stream. Water flow in this stream was measured at 4.6 cubic feet per second in June 1992. In the lower elevations of Clover Valley, the stream system may intersect the water table and receive groundwater input. The lagoon water surface is maintained at several feet below MSL by pumping water over a dike into Duguaila Bay. Water from the uppermost portion of the lagoon is reportedly used to irrigate the surrounding agricultural fields; runoff from these fields drains into the lagoon. Additional discussion about Clover Valley Lagoon and Bay is included in section 6.1.

Because the runway ditch network is designed to handle stormwater drainage for Ault Field and the surrounding area, and because much of the land next to the ditches is wetland, Area 16 is assumed to lie within the 100 year flood plain. There are no known buildings at Area 16 that are subject to historic preservation requirements.

Duguaila

3.0 SITE HISTORY & ENFORCEMENT ACTIVITIES

3.1 SITE HISTORY

NAS Whidbey Island was commissioned on September 21, 1942. The station was placed on reduced operating status at the end of the war. In December 1949, the Navy began a continuing program to increase the capabilities of the air station. The station's current mission is to maintain and operate Navy aircraft and aviation facilities and to provide associated support activities. Since the 1940s, operations at NAS Whidbey Island have generated a variety of hazardous wastes. Prior to the establishment of regulatory requirements, these wastes were disposed of using practices that were considered acceptable at that time.

In response to the requirements of CERCLA, the United States Department of Defense (DoD) established the Installation Restoration (IR) Program. The Navy, in turn, established a Navy IR program to meet the requirements of CERCLA and the DoD IR Program. From 1980 until early 1987, this program was called the Navy Assessment and Control of Installation Pollutants (NACIP) program. Under the NACIP program, a set of procedures and terminologies were developed which were different from those used by the EPA in administration of CERCLA. As a result of the implementation of SARA, the Navy has dropped NACIP and adopted the EPA CERCLA/SARA procedures and terminology. Responsibility for the implementation and administration of the IR program has been assigned to the Naval Facilities Engineering Command (NAVFACENGCOM). The Southwest Division of NAVFACENGCOM has responsibility for the western states. Engineering Field Activity, Northwest (EFA Northwest) has responsibility for investigations at NAS Whidbey Island and other naval installations in the Pacific Northwest and Alaska.

3.2 PREVIOUS INVESTIGATIONS AT NAS WHIDBEY ISLAND

The Navy conducted the Initial Assessment Study at NAS Whidbey Island under the NACIP program in 1984 (SCS Engineers 1984). A more focused follow-up investigation and report, the NAS Whidbey Island Current Situation Report, was completed in January 1988 (SCS Engineers 1988). After the Current Situation Report was completed, further investigations were proposed for areas where contamination was verified and where unverified conditions indicated further investigations were appropriate.

While the Current Situation Report was being prepared, EPA Region 10 performed preliminary assessments at NAS Whidbey Island, Ault Field, to evaluate risks to public health and the environment using the Hazard Ranking System.

In late 1985, EPA proposed that Ault Field be nominated for the National Priorities List (NPL). In February 1990, the site was officially listed as a Superfund site on the NPL. EPA's inclusion of Ault Field on the NPL was based on the number of waste disposal and spill sites discovered, types and quantities of hazardous constituents (such as petroleum products, solvents, paints, thinners, jet fuel, pesticides, and other wastes), and the potential for domestic wells and local shellfish beds to be affected by wastes originating from the site.

As a result of the NPL listing, the Navy, EPA, and Ecology entered into a federal facility agreement (FFA) in October 1990. The FFA established a procedural framework and schedule for developing, implementing, and monitoring appropriate response actions at NAS Whidbey Island.

Following CERCLA and SARA guidelines, various sites and areas at NAS Whidbey Island were later grouped into "operable units." The term "operable unit" (OU) is used to designate specific areas undergoing RI/FS investigations. The two areas at Ault Field (Areas 16 and 31) were collectively identified as OU 3. An RI/FS for OU 3 was conducted in 1992, with the Final RI report issued in January 1994 (URS 1994a) and the Final FS report issued in April 1994 (URS 1994b). The purpose of the RI/FS was to characterize the site, determine the nature and extent of contamination, assess human and ecological risks, and evaluate remedial alternatives. A proposed plan addressing the Navy's preference for remedial actions was published for public comment in July 1994 (URS 1994c).

4.0 COMMUNITY RELATIONS

The specific requirements for public participation pursuant to CERCLA Section 117(a), as amended by SARA, include releasing the proposed plan to the public. The proposed plan for OU 3 (both Areas 16 and 31) was issued on July 19, 1994, and an open house and public meeting were held on July 26, 1994. The public comment period expired on August 18, 1994. Approximately 30 comments were received on the proposed plan. The responsiveness summary, that includes responses to comments, is included in this ROD as Appendix A. As explained in Section 2, OU 3 no longer includes Area 31 (the Former Runway Fire School). Therefore, Appendix A provides comments and responses only for Area 16 and does not address public comments related to Area 31. Because Area 31 has been moved to OU 5, the comments and responses for this Area will be provided in the responsiveness summary section of the ROD for OU 5.

Documents pertaining to this investigation were placed in the following information repositories:

Oak Harbor Library
7030 70th N.E.
Oak Harbor, Washington 98277
Phone: (360) 675-5115

Sno-Isle Regional Library System
Coupeville Library
788 N.W. Alexander
Coupeville, Washington 98239
Phone: (360) 678-4911

NAS Whidbey Island Library (for those with base access)
1115 W. Lexington Street
Oak Harbor, Washington 98278-2700
Phone: (360) 257-2702

The Administrative Record is on file at the following location:

Engineering Field Activity, Northwest
Naval Facilities Engineering Command
19917 7th Avenue
Poulsbo, Washington 98370
Phone: (360) 396-0061

Community relations activities have established communication between the citizens living near the site, other interested organizations, the Navy, EPA, and Ecology. The actions taken to satisfy the statutory requirements also provided a forum for citizen involvement and input to the proposed plan and ROD. These have included:

- Creation of a community relations plan.
- Quarterly Technical Review Committee (TRC) meetings with representatives from the public and from other governmental agencies.
- Monthly Restoration Advisory Board (RAB) meetings beginning February 1994 that replaced the TRC and provided additional public involvement in Ou 3.
- A public availability session, held in February 1994, where information was presented to citizens about the ongoing environmental investigations and the Navy invited interested persons to tour OU 3.
- Issuance of a draft proposed plan for review and comment by the RAB committee on June 9, 1994, before the issuance of the final proposed plan.
- Newspaper advertisement for the proposed plan and public meeting.
- A public meeting on July 26, 1994, to present the findings of the OU 3 investigations and to receive comments on the proposed plan.

In the National Defense Authorization Act for Fiscal Year 1995 (Senate Bill 2182), Section 326(a), Assistance for Public Participation in Defense Environmental Restoration Activities, the Department of Defense was directed to establish Restoration Advisory Boards (RABs) in lieu of Technical Review Committees. In January 1994, NAS Whidbey Island became one of the first Navy facilities to establish a RAB.

The purposes of the RAB are to:

- Act as a forum for discussion and exchange of information between the Navy, regulatory agencies, and the community on environmental restoration topics.
- Provide an opportunity for stakeholders to review progress and participate in the decisionmaking process by reviewing and commenting on actions and proposed actions involving releases or threatened releases at the installation.

- Serve as an outgrowth of the TRC concept by providing a more comprehensive forum for discussing environmental cleanup issues and serving as a mechanism for RAB members to give advice as individuals.

The RAB members consist of representatives from the Navy and regulatory agencies as well as civic, private, city government, and environmental activist groups. The NAS Whidbey Island RAB, as currently staffed, has a substantial representation from interested environmental organizations (Whidbey Island Preservationists, Whidbey Islanders for a Sound Environment, Whidbey Island Audubon Society).

The RAB has participated in development of the OU 3 decision documents. Members were briefed on and reviewed two drafts of the proposed plan prior to the public meeting. The RAB has also received draft review copies of this ROD and their comments were evaluated for incorporation prior to this ROD being finalized.

5.0 SCOPE AND ROLE OF OPERABLE UNIT

Potential source areas at NAS Whidbey Island, Ault Field, have been grouped into separate OUS, for which different schedules have been established. Final cleanup actions for OUS 1 and 2 have been selected and RODS finalized. OU 5 is proceeding through a focused feasibility study with a ROD scheduled to be final in 1995. For OU 4 (at the Seaplane Base), the ROD was signed in 1993, and cleanup actions were completed in 1994.

The cleanup actions for OU 3 described in this ROD address only sediment contamination in the Area 16 Runway Ditches. Ditch sediment is the only environmental medium requiring active remediation. The cleanup actions described in this ROD address all known and current and potential risks to human health and the environment associated with OU 3.

6.0 SUMMARY OF SITE CHARACTERISTICS

This section summarizes site conditions, including a discussion of the geologic, hydrologic, and environmental setting of OU 3, and the nature and extent of contaminants of concern.

6.1 PHYSICAL AND ENVIRONMENTAL SETTING

The following subsections discuss the geology, hydrogeology, surface water, and ecological characteristics of OU 3.

6.1.1 Geology and Hydrogeology

Whidbey Island lies within the Puget Sound Lowland, a topographic and structural depression between the Olympic Mountains and the Cascade Range. During the Quaternary Period (last 2 million years), the l?uget Lowland was repeatedly covered by continental ice sheets advancing from the north. Characteristic sedimentary deposits were formed during the advance and retreat of these glaciers, as well as during interglacial periods. These glacial and nonglacial deposits are up to several thousand feet deep on the island, but tend to be thinner on the northern portion of the island, including Ault Field, where bedrock is locally exposed at the surface. The near-surface deposits on the island were deposited during the Fraser glaciation (20,000 to 10,000 years ago) and during the post-glacial period (10,000 years to the present).

Features of the glacial/interglacial stratigraphy on northern Whidbey Island and Ault Field have been described from surficial exposures and boreholes during regional geologic studies and site-specific environmental investigations. The geologic units that have been identified at OU 3 consist of the following, listed from youngest to oldest:

- Recent post glacial deposits: sand, silt, and clay with minor gravel and peat
- Everson glaciomarine drift: silt and clay with some sand and minor gravel
- Vashon recessional outwash: sand and gravel with some silt
- Vashon till: gravelly, sandy silt with some clay
- Vashon advance outwash: clean to silty sand with some gravel and minor silt
- Whidbey Formation: sand, silt, peat, and clay
- Double Bluff Drift: till, glaciomarine drift, and outwash

At Auk Field and surrounding areas, these geologic units locally rest on metamorphic bedrock. The stratigraphic units at Area 16 consist of recent deposits overlying glaciomarine drift, which in turn overlies Vashon advance outwash deposits. Deposits of the Whidbey Formation underlie the advance outwash. The Double Bluff Drift probably underlies the Whidbey Formation. The Whidbey Formation underlies the Vashon deposits.

The U.S. Geological Survey (USGS) has identified five major regional aquifers (hydrogeologic units) above bedrock on Whidbey Island, labeled A through E from bottom to top. Individual aquifers may consist of one or more geologic units, and often there is not a one-to-one correspondence between a particular aquifer and specific geological units over a regional scale. The aquifers are generally composed of sand, or sand and gravei; aquitards are composed mainly of nonglacial clay and silt, glacial till, or glaciomarine drift. The aquifer system at Whidbey Island is designated as a soie source aquifer, since it serves as the only supply of potable water for at least half of the residents, there is no viable alternative source of drinking water for those using groundwater, and the aquifer boundaries have been defined.

Two aquifers have been identified at OU 3. One is a local perched aquifer identified near the northeast portion of the runways (around Area 31), but not identified at the Area 16 wells in the southern portion of the runways. The other is the regional aquifer corresponding to USGS hydrogeologic units C and D, forming a combined single aquifer at OU 3 (USGS Units C-D). This aquifer is laterally continuous throughout OU 3 and much of Ault Field. The localized perched water-bearing zones north of the runways occur above silt-rich lenses of Vashon outwash and till. Measured water levels in these zones range from 0.5 to 4 feet below ground surface (bgs) or 30 to 35 feet above MSL. The saturated thickness is generally only a few feet. Flow direction and velocity for the perched zones are unknown.

The regional aquifer at OU 3 occurs within fine to medium sand with some silt, corresponding to the Vashon advance outwash and Whidbey Formation. No significant aquitards were identified during drilling within either unit. This aquifer is confined by the overlying Everson glaciomarine silt and clay throughout much of the area. The regional aquifer is at least 100 feet thick at OU 3. Potentiometric groundwater levels in the southern portion of Area 16 range from about 5 feet bgs to 4 feet above the ground surface (two flowing artesian wells are located in this area); these levels correspond to elevations of 8 to 11 feet above MSL.

Based on water level data from environmental investigations at NAS Whidbey Island and from regional studies, it appears that groundwater flow at Ault Field generally follows surface topography. The flow pattern for the uppermost regional aquifer at Ault Field (USGS Units C-D) is illustrated in Figure 6-1. Most of the groundwater underlying Ault Field converges in the central runway areas and likely discharges eastward to Dugualla Bay. Groundwater along the western side of Ault Field appears to discharge westward to the Strait of Juan de Fuca. Water levels in three shallow wells in the southern portion of Area 16 suggest a generally northeastward flow, with groundwater converging from the west and south (Figure 6-2). Groundwater in the northern portion of the runways flows south and southwest.

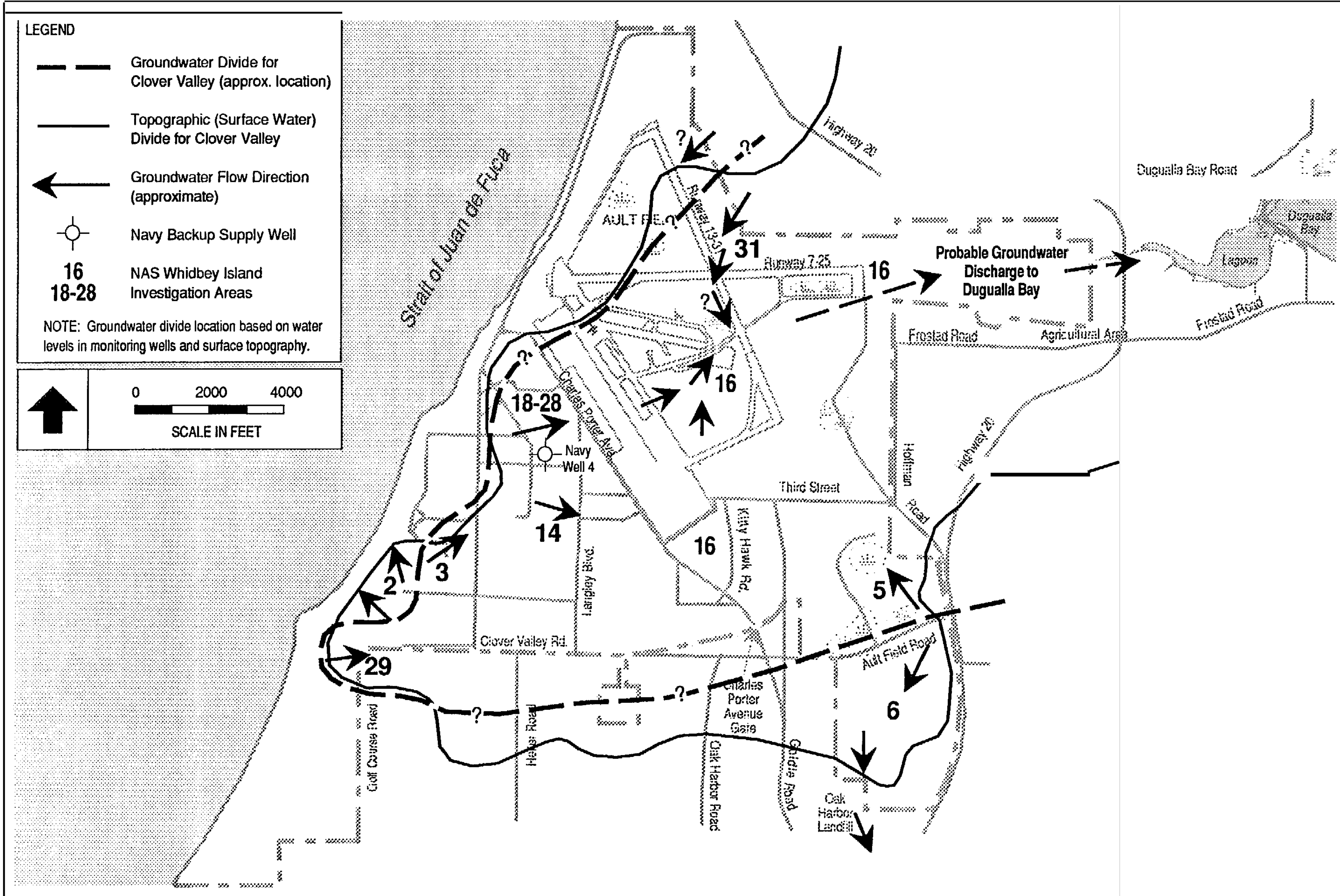
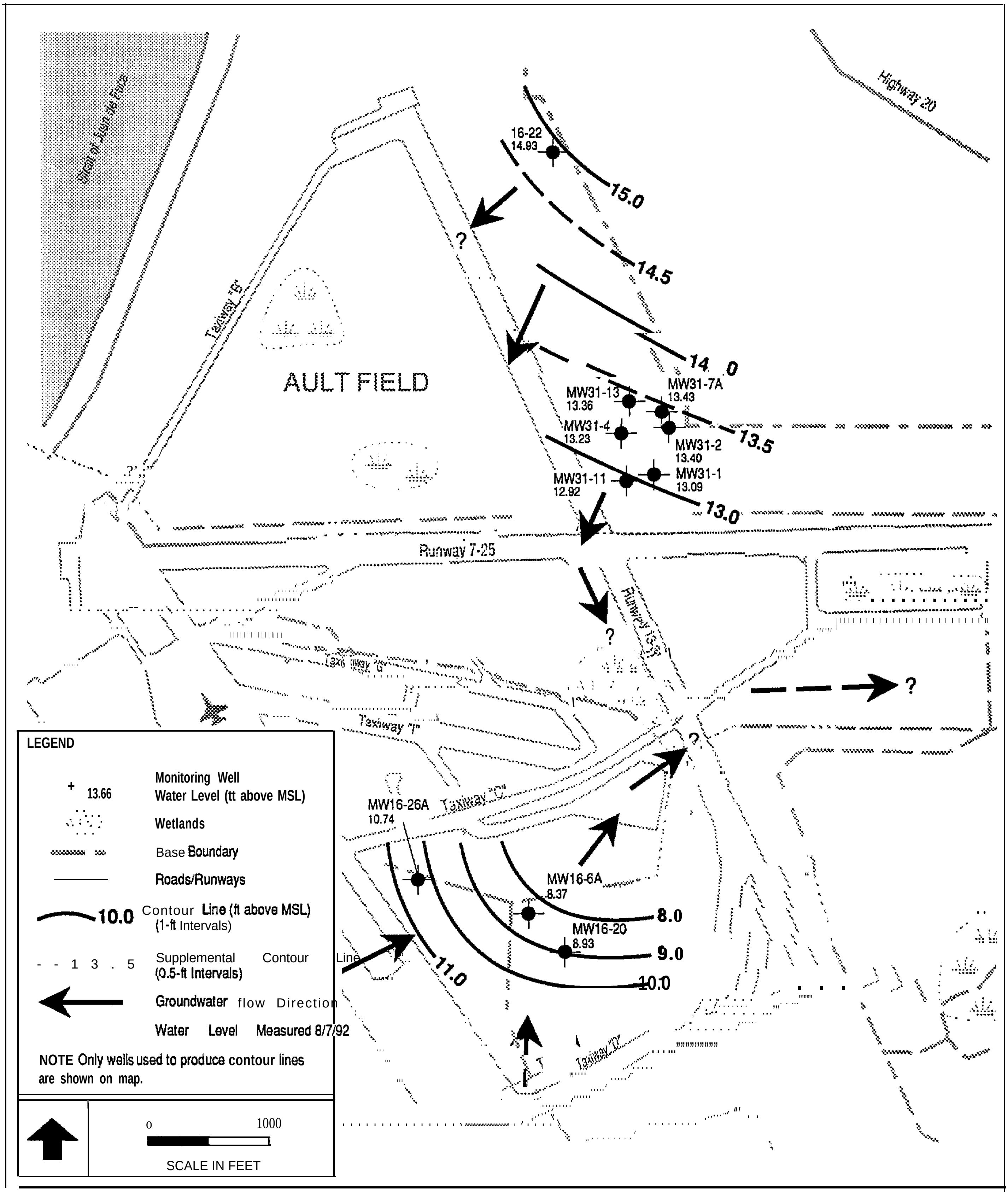


Figure 6-1
Groundwater Flow Directions at Ault Field

CLEAN
COMPREHENSIVE LONG-TERM ENVIRONMENTAL ACTION NAVY

CTO 0074
OPERABLE UNIT 3
NAS WHIDBEY, WA
RECORD OF DECISION

CTO74\ROD\FIG6_1.DRW 11/14/94



CLEAN
COMPREHENSIVE
LONG-TERM
ENVIRONMENTAL
ACTION NAVY

Figure **6-2**
Groundwater Potentiometric Surface Contour Map
Runway Area

CTO 0074
OPERABLE UNIT 3
NAS **WHIDBEY**, WA
RECORD OF DECISION

CTO74\ROD\FIG6_2.DRW 11/30/94

The calculated linear groundwater velocity for the southern part of Area 16 ranges from 13 to 300 feet per year, with an average of about 59 feet per year. Groundwater moving at this average rate would take about 100 years to flow off site.

6.1.2 Surface Water

The Clover Valley Lagoon was created when a dike was constructed on the western edge of Dugualla Bay in 1915. Prior to dike construction, the region was a marine estuary, forming the extreme western reach of Dugualla Bay. In the western, riverine portion of the lagoon, it appears that the agricultural fields were enlarged by partial filling of the estuarine headland. The source of the fill was most likely material dredged from the river-estuary system. After construction of the dike, runoff and sediment from the Clover Valley stream have collected in the newly formed lagoon rather than being discharged outward into Dugualla Bay.

Although the Navy did not build the dike, the base maintains a pumping station that constantly pumps water from the lagoon into Dugualla Bay, in order to prevent flooding of Ault Field and nearby lands. The water level in the lagoon area is reportedly maintained within a vertical range of 1 foot. However, the water level may be higher after heavy rains. The maximum tidal fluctuation of Dugualla Bay is roughly 15 feet.

There is an absence of aquatic life in the bottom portion of the lagoon. This condition was caused by physical changes that occurred when the lagoon was initially formed by construction of the dike, which interrupted the natural tidal flow in the original estuary. Without tidal action, the water in the lagoon has become relatively still, such that the deeper portions do not readily mix with the upper surface water. Because the bottom of the lagoon is below Dugualla Bay tide levels, salt water enters the lagoon by seeping underneath the dike and upward through the bottom sediments of the lagoon. The salinity of the lagoon water increases with depth, ranging up to 23 parts per thousand.

Fresh water enters the lagoon from stormwater drainage and stratifies on top of the salt water. As a result of the stillness of the lagoon and the fact that salt water is denser than fresh water, the salt water tends to stay at the bottom of the lagoon. Because the salt water in the deeper part of the lagoon does not mix with the fresh water above, oxygen levels have decreased in this deeper zone and in the bottom sediments, thus prohibiting the existence of oxygen-demanding organisms. Bottom sediments in the lagoon consist of layered, biologically undisturbed, dark gray to black silt and clay, which exhibit a hydrogen sulfide odor and are rich in gaseous methane. These sediment characteristics indicate anoxic (poorly oxygenated) bottom conditions with high inputs of organic materials. Even though anoxic conditions exist in this deeper zone, the upper fresh water portion is oxygenated and the lagoon is a functioning ecosystem that supports a large sticklebacks fish population, snails, and migratory birds.

6.1.3 Ecological Setting

A variety of habitat types exist at Ault Field, including mixed evergreen forests; brush and grasslands; freshwater wetlands; lagoon, beach, and coastal zones; and agricultural lands. The largest ecosystems, in areal extent, are brush-grasslands and coniferous forests (principally Douglas fir). Forested lands cover approximately 600 acres at Ault Field while brush-grasslands encompass roughly 2,500 acres. Approximately 750 acres of land on the Ault Field property are leased for agricultural use and cultivated primarily for hay and grain. The remainder of the base property is freshwater wetland or is covered by Navy structures.

Woodland and brush-grassland areas provide habitat for deer, red fox, coyote, weasel, rabbit, and smaller rodents. The wetlands support waterfowl and aquatic organisms and provide water for the larger upland animals. Birds are common, most notably raptors, upland game birds, waterfowl, and shore birds. Agricultural areas also provide feed and cover for many birds.

Biota using the runway ditch complex include waterfowl and shore birds, mammals, fish, invertebrates, and plants. Great blue herons are commonly observed foraging in the runway ditches. Ducks forage in the ditches and nest on the banks. Other species of water and shore birds are expected to periodically use the runway ditches for foraging. Small mammals (e.g., voles and shrews) periodically swim the ditches; muskrats have been observed in the ditches and presumably breed along the banks. Small fish (including three-spined sticklebacks) have been observed in the ditches. Invertebrate populations include snails, leeches, insects, and small crustaceans.

The riparian habitat along the runway ditches and Clover Valley Lagoon provides nesting to many bird species, including ducks, rails, coots, blackbirds, and kingfishers. Amphibians that live in the aquatic and riparian habitat of the runway ditches and lagoon include frogs and salamanders.

Dugualla Bay is home to many species of flora and fauna that are typical of other inlets in Puget Sound. Biological resources in Dugualla Bay include redrock and Dungeness crabs, softshell and bent-nose clams, and a variety of ducks, gulls, and other shore birds. Additional features in and near the bay that are important for biological resources include: the nesting site of a sensitive bird species at the north end of Dugualla Bay, seal and sea lion haul-out sites near the bay, spawning grounds for Pacific herring throughout the bay, and a spawning beach for surf smelt on the south side of the bay.

Sensitive wildlife species that inhabit NAS Whidbey Island include the bald eagle, osprey, great blue heron, peregrine falcon, and the Caspian tern. The bald eagle (a threatened species) and the peregrine falcon (an endangered species) occasionally hunt near OU 3. A bald eagle nest is located in the southwest area of Ault Field near Rocky Point. The bald eagle and osprey also frequent the area just east of the dike, attracted to the perched hunting habitat provided by pilings.

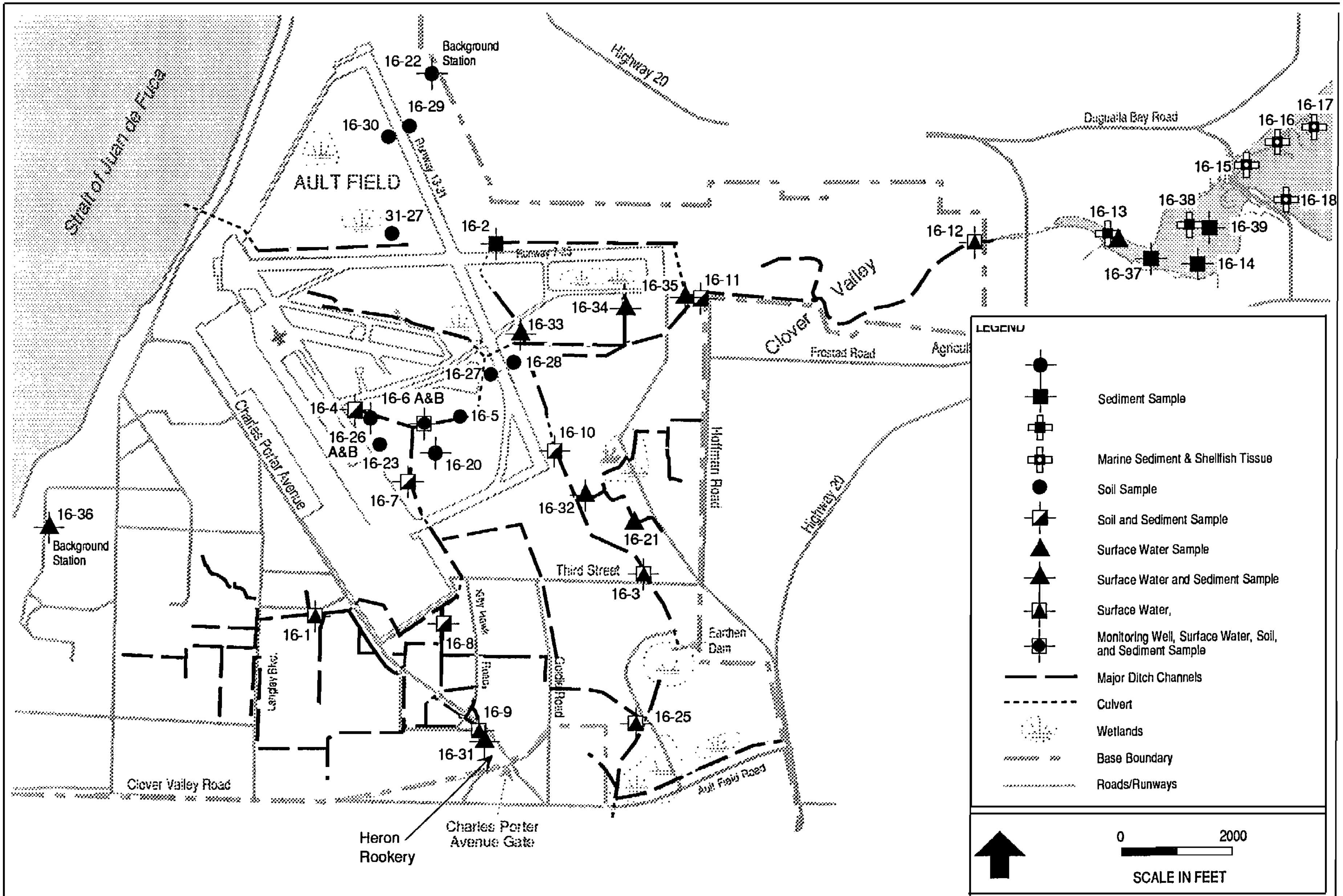
A great blue heron rookery with more than 30 nests is located on the southern border of Ault Field near the Charles Porter Avenue gate. Herons from the rookery heavily use the runway ditches, Clover Valley Lagoon, and Dugualla Bay as foraging sites for fish and frogs.

6.2 NATURE AND EXTENT OF CONTAMINANTS

Environmental media sampled during the OU 3 investigation include surface and subsurface soil, groundwater, ditch sediment, lagoon sediment, marine sediment, ditch surface water, lagoon surface water, marine surface water, and marine shellfish tissue. Locations of sample collection points are shown in Figure 6-3. In general, the samples were analyzed for volatile organic compounds (VOCs), semivolatile organic compounds (SVOCS), pesticides, polychlorinated biphenyls (PCBs), chlorinated herbicides, total petroleum hydrocarbons (TPH) and target analyte list (TAL) inorganic. VOCS and TPH analyses were not performed on the shellfish tissues. One of the soil samples and one of the ditch sediment samples were also analyzed for dibenzo-p-dioxins and dibenzo-p-furans. Dioxin/furan analyses were not part of sampling scope developed in the project work plans, but the laboratory inadvertently analyzed these two samples along with other samples from another site.

All of the chemicals detected at Area 16 were evaluated by a series of initial screening steps to identify chemicals of potential concern for each of the sampled media. Key steps in this screening process included data validation to eliminate chemical results of inadequate quality, comparison with risk-based screening values, and comparison with background concentrations. Details of the screening process are given in Section 7.1.1.

Chemicals not eliminated by the initial screening steps were further evaluated to determine chemicals of concern (COCs) for each sampled medium. COCS are defined as chemicals detected at concentrations that exceed human health and ecological risk threshold concentrations based on federal or state criteria. The COCS were determined from the



CLEAN
COMPREHENSIVE LONG-TERM ENVIRONMENTAL ACTION NAVY

Figure 6-3
Area 16 - Sampling Stations

CTO 0074
OPERABLE UNIT 3
NAS WHIDBEY, WA
RECORD OF DECISION

CTO74\ROD\FIG6_3.DRW 12/02/94

results of the baseline risk assessment (Section 7) and by comparing maximum detected concentrations to applicable or relevant and appropriate requirements (ARARs) of state and federal regulations (Table 6-1). Inorganic chemicals detected at or below background concentrations are not considered COCs. Background concentrations for inorganic were established from samples collected at locations outside suspected areas of contamination.

The following paragraphs describe the nature and extent of contamination for the COCS that were identified in soil, groundwater, surface water, sediment, and shellfish tissues for Area 16. Table 6-2 provides a summary of the COCs identified for Area 16, including the range of detected concentrations, the frequent y of detection, and the calculated background values for comparison.

6.2.1 Soil

Soil sampled at Area 16 included soil borings near the runway ditches and soil collected from the ditch banks. Both surface and subsurface samples were collected from the soil borings. Only surface soil samples were collected from the ditch bank. The ditch bank samples were taken from the crest of the bank, where dredged sediments may have been piled from past dredging activity, as well as midway up the bank slope. In addition, surface soil samples were taken at several locations away from the immediate vicinity of the ditch banks.

Arsenic, beryllium, and manganese were identified as COCS in both surface and subsurface soils at Area 16. However, they do not form any clear distribution pattern and are not associated with any obvious sources. These inorganic chemicals occur naturally in soil.

Dioxin (2,3 ,7, 8-TCDD), selenium, and total petroleum hydrocarbons were identified as COCS in surface soil. Dioxin was detected at the only station sampled (16-26), located in the central flightline area. Petroleum hydrocarbons were identified as COCS at three widely spaced stations, with the highest concentration near the flightline area (station 16-4). Although dioxin and selenium were identified as ecological risk contributors, the conclusion of the baseline risk assessment was that minimal impacts to ditch bank organisms from COCS are expected.

6.2.2 Groundwater

Arsenic and manganese were identified as COCs in groundwater based on several exceedances of drinking water ARARs. Concentrations of arsenic and manganese were above the Washington State Model Toxics Control Act (MTCA) Method B Cleanup Levels

Table 6-1
Chemical-Specific ARARs Pertaining to OU 3

Environmental Medium	Washington Sediment Management Standards: Sediment Quality Standards	Washington Sediment Management Standards: Cleanup Screening Levels	Washington Fresh Water Quality Standards (Acute & Chronic)	Federal Fresh Water Quality Criteria (Acute & Chronic)	Drinking Water Standards: Federal	Drinking Water Standards: Washington State	Washington Model Toxics Control Act Cleanup Levels: Method B Groundwater	Washington Model Toxics Control Act Cleanup Levels: Method B Surface Water	Washington Model Toxics Control Act Cleanup Levels: Method B Soil
Soil									●
Ditch Sediment									
Lagoon Sediment									
Dugualla Bay Sediment	●	●							
Ditch Water			●	●				●	
Lagoon Water			●	●				●	
Groundwater					●	●	●		
Dugualla Bay Shellfish Tissue									

ARAR = applicable, or relevant and appropriate requirement
● = requirement is considered an ARAR

CITATIONS:

1. Washington sediment management standards: 173 WAC 204.
2. Washington fresh water quality standards: Washington Water Pollution Control Act: 90.48 RCW; 173 WAC 201A.
3. Federal fresh water quality criteria: Clean Water Act (Federal Water Pollution Control Act, 33 USC 1251-1387; CWA 303-304).
4. Federal drinking water standards: Safe Drinking Water Act, 42 USC 300; 40 CFR 141, 143.
5. Washington drinking water standards: State Board of Health Drinking Water Regulations, 246 WAC 290.
6. Washington Model Toxics Control Act: 70.105D RCW; 173 WAC 340.

Table 6-2
Chemicals of Concern at OU 3

Chemical	Background Value	Frequency of Detections Above Background [a]	Range of Detections Above Background		Major Risk Contributors [b]		Exceeds ARAR
			Minimum	Maximum	Human	Ecological	
Soil, Surface (mg/kg)							
2,3,7,8-TCDD (TEC)		1/1	0.000000146	0.000000146		●	
Arsenic	7.5	13/33	8.1	60.9			MTCA
Beryllium	0.5	17/33	0.52	1.0			MTCA
Manganese	681	3/33	878	1,170			MTCA
Selenium	0.43	8/33	0.71	7.6		●	
TPH		18/33	57.7	391			MTCA
Soil, Subsurface (mg/kg)							
Arsenic	7.5	6/26	8.2	65.9			MTCA
Beryllium	0.5	17/26	0.53	0.87			MTCA
Manganese	681	7126	686	763			MTCA
Groundwater (µg/L)							
Arsenic		9/9	2.8	12.8			MTCA
Manganese		9/9	207	1,640			MTCA
Surface Water, Ditch (µg/L)							
Copper	10	3/24	15.4	24.5			EPA FWQC (C)
Lead	4	2/24	5.0	8.1			EPA FWQC (C)
Mercury		1/24	3.6	3.6			WA FWQS (A)
Silver		1124	11.8	11.8			EPA FWQC (A)
Sediment, Ditch (mg/kg)							
2-Methylnaphthalene		7/41	0.19	3.2		●	
4,4'-DDD		14/45	0.0049	0.61		●	
4,4' -DDT		4144	0.0048	0.095		●	
Acenaphthene		4/40	0.36	2.3		●	
Anthracene		7/40	0.14	12.0		●	
Aroclor-1254		6145	0.19	0.77		●	
Aroclor- 1260		6145	0.014	1.2		●	
Arsenic	3.4	37145	4.1	581		●	
Benzo(a)anthracene		8/41	0.63	15.0		●	
Benzo(b)fluoranthene		9/41	0.89	4.9		●	
Benzo(g,h,i)perylene		7140	0.38	3.3		●	
Benzo(k)fluoranthene		6141	0.72	23.0		●	

Table 6-2 (Continued)
Chemicals of Concern at OU 3

Chemical	Background Value	Frequency of Detections Above Background [a]	Range of Detections Above Background		Major Risk Contributors [b]		Exceeds ARAR
			Minimum	Maximum	Human	Ecological	
Sediment, Ditch (mg/kg) (Continued)							
Dibenz(a,h)anthracene		5/40	0.32	1.9		●	
Dimethvlohthalate		7/40	0.17	17.0		●	
Endosulfan I		2/45	0.0051	0.0073		●	
Fensulfothion		2/45	0.2	0.27		●	
Fluorene		7/45	0.077	5.4		●	
Lead	[8	21/45	24.0	942		●	
Methyl azinphos (Guthion)		7145	0.32	1.7		●	
Phenanthrene		8/41	0.33	20.0		I*	I
Pyrene		13f43	0.46	52.0		●	
TPH		26/45	27	123,000			MTCA [c]
Zinc	87	32145	91.0	2,100		●	
Sediment, Shallow Portion of Lagoon (mg/kg)							
Cadmium	1.8	6/6	4.1 "1""	7.6		●	
Nickel	63	6/6	133	233		●	
Selenium	1.0	1/6	1.4	1.4		●	
Thallium	0.3	4/6	0.32	1.5		●	
Vanadium	56	4/6	59.4	121		●	
Zinc	104	6/6	244	517		●	
Sediment, Deep Portion of Lagoon (mg/kg)							
Dieldrin		2/10	0.0032	0.0042		●	
Dimethoate		2/4	0.0023	0.0027		●	
Nickel	63	8/8	102	143		●	
Thallium	0.3	1./8	1.0	1.0		●	
Vanadium	56	7/8	63.4	85.9		●	

Table 6-2 (Continued)
Chemicals of Concern at OU 3

FOOTNOTES:

[a] The first number in each cell is the number of detections above background; for chemicals with no background value, the number of detections above background equals the total number of detections. The second number in each cell is the total number of samples analyzed.

[b] For human health risk. if combined cancer risk is greater than 10^{-4}, a major risk contributor is a chemical in a medium that contributes greater than 10^{-5} to the total risk. For noncancer risks with an HI greater than 1.0, a major risk contributor is a chemical in a medium that contributes an HQ greater than 0.1.
For ecological risk, a chemical that contributes an HQ greater than 1 is a major risk contributor.

[c] Exceeds the MTCA Method A value for soil, which is not deemed an ARAR for sediments but has been included here as guidance "to be considered" (TBC); for further discussion, see Section 8.1.3.

ABBREVIATIONS :

ARAR = applicable or relevant and appropriate requirement.
MCL = Federal Safe Drinking Water Act (42 USC 300) Maximum Contaminant Levels (40 CFR 141).
MTCA = Model Toxics Control Act cleanup levels.
EPA FWQC (A & C) = Clean Water Act (Federal Water Pollution Control Act, 33 USC 1251-1387; CWA 303-304), Fresh Water Quality Criteria (Acute and Chronic).
WA FWQS (A & C) = Washington Water Pollution Control Act (90.48 RCW), Fresh Water Quality Standards (Acute & Chronic) (WAC 173-201A).
TEC = Toxicity Equivalency Concentration (individual dioxins/furans concentrations were converted to equivalent 2,3,7,8-TCDD concentration using EPA's toxicity equivalency factors).
TPH = total petroleum hydrocarbons.

for all wells at Area 16, both shallow and deep. Arsenic and manganese occur naturally in groundwater at variable concentrations. Because these chemicals occur in background soils, and the groundwater samples used to establish background concentrations were silty, representative background concentrations for the site are not available. However, the results for the wells at Area 16 were not unusual compared with typical regional conditions.

In addition to the chemicals of concern listed in Table 6-2, two chlorinated herbicides (dinoseb and 2,4-D) were also detected in the Area 16 groundwater samples from Phase I of the investigation. These herbicides have apparently been used throughout the base and in other nearby agricultural areas. However, it is unlikely that chemicals have migrated from the Area 16 runway ditches into the groundwater because of the presence of a silt aquitard at the ground surface and upward hydraulic gradients from the confined aquifer just below the aquitard (the shallowest groundwater at Area 16 is in this confined aquifer).

The Phase I dinoseb results exceeded the drinking water standard for two shallow wells and one deep well. The Phase I results for 2,4-D also exceeded the drinking water standard for one of these shallow wells. However, these herbicides are not considered to be chemicals of concern for the following reasons. There were laboratory interferences associated with almost all of the Phase I dinoseb and 2,4-D results, particularly all the results that exceeded drinking water standards. The gas chromatograms (GC) for these analyses exhibited saturated peaks that interfered with the detection and quantitation of the target compounds (i.e., dinoseb and 2,4-D) and caused disagreement between the analytical results for the two GC columns. These interferences appear to be due to co-eluting compounds and make the results for the Phase I dinoseb and 2,4-D analyses suspect. Because of these interferences and questionable results, two of the wells were resampled and reanalyzed for herbicides in Phase II, including the well which exhibited the highest concentrations of dinoseb and 2,4-D in Phase I. Neither chemical was detected in the Phase II samples, with detection limits well below the drinking water standards. The interference problems experienced in Phase I did not occur in the Phase II analyses. Because of the questionable results for Phase I and the lack of detections with no interferences in Phase II, the Phase I results for dinoseb and 2,4-D are considered to be anomalous.

6.2.3 Surface Water

Copper, lead, mercury, and silver were identified as COCs in ditch surface water at some stations, but at a very low frequency (Table 6-2). Three of these metals were detected at one station located adjacent to the heron rookery (station 16-31). Two other stations with detections were upstream of the base industrial area. One of the metals was also detected at a station within the runway area.

6.2.4 Runway Ditch Sediment

No ARARs currently exist that apply to freshwater sediments. Numerous chemicals detected in the ditch sediments were identified as COCS because of their significant contributions to ecological risk. The following chemicals were identified as COCs in the runway ditches:

- Metals (arsenic, lead, zinc)
- Semivolatile organic compounds (SVOCs) including many polynuclear aromatic hydrocarbons (PAHs)
- Pesticides (DDD, DDT, endosulfan, fensulfothion, methyl azinphos)
- Polychlorinated biphenyls (PCBs [aroclors])

One or more of these COCS were found at a variety of the sample stations located throughout the runway ditch complex. Stations with the highest concentrations included three in the flightline core area (16-4, 16-6, and 16-7) and two at the eastern end of the runways in the ditches that lead to the Clover Valley stream (16-11 and 16-35). Stations 16-6 and 16-11 are located behind baffles, where sediment and chemical accumulations would be expected.

Most of the SVOCS and pesticides were identified at station 16-4, which is located directly downstream of a storm sewer outfall from the industrial part of the base along the flightline. A number of SVOCS were also identified at station 16-35 located at the east end of runways. Navy pilots perform "touch and go" flight training operations at this part of the runways, which may result in increased jet engine emissions and might affect this part of the base. Some stations where COCS were identified are upstream of the runway complex, such as station 16-31 near the southern boundary of the base.

In general, the concentrations of chemicals in ditch sediment were found to decrease with depth. The overall distribution pattern suggests that the runways and industrial part of the base were the sources of these chemicals, and they have reached the ditches via the storm sewers. In addition, an upstream source is suspected to explain detections in the ditch near the southern boundary of Ault Field. The pesticides found at many of the stations likely originated from past on- and off-site surface applications.

The RI data were evaluated to determine if the ditch sediments meet the criteria for designation as a hazardous waste as defined in hazardous waste regulations. Since the sediments do not display the characteristics of ignitability, corrosivity, or reactivity, the assessment of the toxicity characteristic was used determine whether or not the soil meets the hazardous waste criteria. Normally, this evaluation is done by analyzing samples for toxicity characteristic leaching procedure (TCLP) constituents (40 CFR 261.24). Because TCLP analyses were not performed on the RI sediment samples, the total concentrations of TCLP constituents detected in the sediment samples were compared with the TCLP criteria, with adjustment by a factor of 20 because a 20-fold dilution occurs in the TCLP test. In general, this evaluation showed that the concentrations of COPCs detected in the RI ditch sediment samples were below hazardous waste designation levels.

6.2.5 Clover Valley Lagoon Surface Water and Sediment

No metals or organic compounds exceeding federal or state surface water quality standards (acute and chronic criteria for freshwater aquatic organisms) were detected at any surface water sampling station in the Clover Valley Lagoon.

Several metals and organic compounds were identified as COCS in the shallow and deep sediments of the lagoon (Table 6-2), based on the muskrat exposure modeling and sediment quality value comparisons conducted in the ecological risk assessment. However, the hazard quotients were low, many of the COCS were inorganic that represent little risk compared with background conditions, and the ecological risk assessment concluded that adverse effects from the chemicals detected in the sediments are unlikely. The bioassay test results for lagoon sediments confirmed a low potential for ecological impacts, as all but one of the tests passed the state sediment quality standards and all the results met the state sediment cleanup screening levels.

In addition to the chemicals listed in Table 6-2, the ecological risk assessment also identified acetone in sediments as posing risk to organisms in the lagoon. However, the risk for acetone is likely a laboratory artifact because acetone is a common laboratory chemical and the risk estimate for acetone was elevated by inclusion of high detection limits in the risk calculations for samples where acetone was not detected. For samples in which acetone was actually detected, the concentrations were below levels of concern for ecological risk. Because of this, acetone in lagoon sediments is not considered to be a chemical of concern even though it was carried forward and included in the ecological risk calculations.

The chemicals detected in the lagoon probably came from the Navy's operations at Ault Field via the runway ditches, as well as from other non-Navy sources. The RI sampling stations were distributed throughout the ditch complex in order to define the contributions and interrelationships among the various segments to the overall chemical load carried through the system to the lagoon. This includes contributions from upgradient and off-base sources captured in the ditch complex and carried through the Clover Valley drainage system.

Surface water flow and sediment entrainment are the primary mechanisms by which COCS in the drainage ditches are transported toward the lagoon. Many of the COCS tend to adhere to fine-grained organic material in the sediment particles. During storm events when water flows increase in the ditches, these particulate can become temporarily suspended and move with the ditch water. When flows subside, the particulate can drop out of suspension and be deposited farther downstream in the ditch channel. Deposited material can be resuspended when more water is flowing in the ditch or can be covered by additional deposits, which prevent future mobilization.

If the particulates reach a quiet water body such as the Clover Valley Lagoon, the particulate will tend to settle to its bottom. Once deposited in the lagoon, the bottom sediments will not likely become resuspended because no tidal currents influence the lagoon and because wind-driven currents diminish with depth and become negligible near the bottom of the lagoon.

The RI data for sediments in the ditch network and the lagoon indicate that the majority of the sediment-bound contamination that originated from the Navy storm sewers has tended to remain relatively close to the flightline and runway source areas, rather than migrating far along the ditches and impacting the lagoon. These data show that, under current conditions, concentrations of chemicals found in the ditch sediments generally decrease as the sampling stations move away from the runways and downstream toward the lagoon. The baffles in the ditches appear to have impeded sediment transport and limited the potential for contaminants to migrate into the lagoon.

In addition, increased concentrations were observed at sample stations near roadways along the ditch, the Clover Valley stream, and/or the lagoon itself. These results indicate that sources other than Ault Field have probably also contributed to the chemicals found in the Clover Valley Lagoon. The lagoon is surrounded by agricultural fields and private landowners that may contribute to the hydrocarbon and pesticide concentrations found in the lagoon. Several off-site ditches also drain into the lagoon or the stream that feeds the lagoon (Figure 2-2). The roadway ditch along Hoffman Road discharges to the ditch at station 16-11, upstream of the lagoon, In addition, Highway 20 is located near the western border of the lagoon and its drainage goes into the lagoon. These roadways are suspected of having contributed to the chemicals in the lagoon (in addition to inputs from the Navy's activities) because the chemicals found in the lagoon are similar to the types found in urban runoff. Runoff from agricultural lands and roads are expected to remain as ongoing sources of chemical inputs to the lagoon.

Some of the chemicals detected in the ditch sediments were also detected in the lagoon sediments, but at much lower concentrations. All the organic chemicals detected in samples collected near the main flightline were significantly higher in concentration than they were in samples collected from the lagoon. Results for metals followed a more erratic pattern, but generaUy also decreased in concentration with distance from the central flightline area.

Section 7 of the RI Report presents a series of graphs illustrating these general trends. These graphs plot the chemical concentrations in sediment samples in the order of increasing distance from the main on-site source area at the sewer discharges near the flightline (i.e., station 16-4) through the remainder of the ditch network toward the lagoon. The following subsections summarize the trends depicted in the RI plots for different classes of chemicals.

- **Inorganic Chemicals**

The plots for cadmium, lead, nickel, and zinc showed decreasing concentrations with increasing distance from the main sewer discharge area (station 16-4). Each chemical also exhibited an expected high at stations 16-35 (east end of the runway) and 16-11 (roadway ditch and baffle). The current source of lead probably originates from automobile activity on Highway 20. Mercury was only detected in two samples of lagoon sediment. The concentrations detected were low, near the detection limits. Arsenic was fairly consistent in concentration along the ditches except for an abnormally high level at station 16-35; this is most likely due to NAS activities.

- **Semivolatile Organic Compounds**

Graphs of chemical concentration versus distance from the flightline sewer discharge for 2-methylnaphthalene, dimethylphthalate, and phenol showed that concentrations decreased markedly with distance from the central flightline area. Phenol concentration rose at station 16-12 (near the highway and downstream of the runways), indicating possible additional inputs from non-Navy sources.

- **Polynuclear Aromatic Hydrocarbons (PAHs)**

Graphs of chemical concentration versus distance from the flightline discharge points for PAHs (acenaphthene, anthracene, fluorene, and phenanthrene, benzo[a]anthracene, benzo[b]fluoranthene, benzo[g,h,i]perylene, benzo[k]fluoranthene, dibenz[a,h]anthracene, and pyrene) showed a general decreasing trend in concentration from the sewer discharge at the flightline to the lagoon. Several of these graphs also showed an expected spike in concentration at station 16-35, most likely due to NAS training exercises. There was a substantial decrease in concentration from station 16-35 to the lagoon stations.

- **Pesticides and Polychlorinated Biphenyls (PCBs)**

Graphs of chemical concentration versus distance from the flightline sewer area for pesticides (methyl azinphos, 4,4-DDD, 4,4-DDT, and Endosulfan I) and PCBS (Aroclor-1254 and Aroclor- 1260) showed a general trend of markedly decreasing concentration with distance from the flightline.

The Aroclor- 1254 plot also showed higher concentrations at stations 16-11 and 16-35, most likely due to NAS operations and the presence of the baffle. There was a substantial decrease in concentration from stations 16-11 and 16-35 to station 16-12 located upstream of the lagoon. The concentrations near the entrance to the lagoon showed a slight increase, possibly indicating an additional (non-Navy) source. The pesticide/PCB plots had the same characteristic shape as exhibited in the plots for PAHs.

- **Total Petroleum Hydrocarbons (TPH)**

TPH concentrations showed a decrease in concentration versus increased distance from the central flightline stations. The TPH plots showed a sharp spike at station 16-11, which may be due in part to runoff from Hoffman Road. This station is also located just upstream from a baffle, so hydrocarbons resulting from the naval flightline operations may also have accumulated at this point. TPH dropped to a very low concentration downstream of this baffle, at station 16-12 which is prior to Highway 20.

Relatively high concentrations of TPH were found in the surface sediments at stations 16-13 and 16-14. The TPH at these stations most likely resulted from Highway 20 runoff.

6.2.6 Dugualla Bay Sediment and Clam Tissue

No COCs were identified for sediment in Dugualla Bay. Some of the chemicals detected in sediment from the Clover Valley Lagoon were also detected in Dugualla Bay. Arsenic, cadmium, lead, and total petroleum hydrocarbons were detected in both Clover Valley Lagoon and Dugualla Bay sediments, but were at lower concentrations in the bay than in the lagoon sediments and showed no obvious distribution pattern in Dugualla Bay.

No COCS were identified in the clam tissue samples collected from Dugualla Bay.

7.0 SUMMARY OF SITE RISKS

A baseline risk assessment (RA) was conducted to analyze both current and potential future risks for OU 3. It serves as a baseline to indicate what risks could exist if no action were taken, taking into consideration possible risks if existing land use patterns were to shift in the future to other uses, such as residential or full-time industrial activity. The risk assessment results are used in evaluating whether remedial action is needed. The primary components of the risk assessment are chemical screening to identify chemicals of potential concern, exposure assessment, toxicity assessment, and risk characterization.

Both human health and ecological risk assessments were conducted as part of the investigation for OU 3 at NAS Whidbey Island. A summary of the RA procedures and findings is presented in this section.

7.1 HUMAN HEALTH RISK ASSESSMENT

The human health RA evaluated potential risks associated with exposure to chemical contaminants detected at OU 3. Risks were calculated for three exposure scenarios: current on-site workers, recreational visitors, and future residents.

7.1.1 Chemical Screening

The chemical results obtained for the RI samples at OU 3 were evaluated by a number of initial screening steps to identify chemicals of potential concern (COPCs). These COPCs were carried through the remainder of the risk assessment to quantify risks at OU 3 and determine the chemicals that contribute most significantly to overall site risks. The most significant risk-contributing chemicals are discussed as chemicals of concern (COCs) in Section 6.2.

The chemical screening steps used to establish COPCS included:

- *Sample grouping.* For each environmental medium, samples were selected that are most representative for a particular exposure pathway. For example, chemical results for soil samples collected in the upper 2 feet of soil were used for current human exposures, whereas samples from the upper 15 feet of soil were used for future exposures because deeper soil might be brought to the surface by future construction activities.

- *Data validation. The* quality of the data was evaluated, in accordance with EPA guidelines, to assess whether each chemical result was suitable for use in the risk assessment. Data rejected for inadequate quality were not carried forward in the quantitative risk assessment.

- *Nondetected chemicals.* If a chemical was not detected in any of the samples for a particular medium, the chemical was screened out of the risk assessment.

- *Essential nutrients. Certain* inorganic chemicals were not included in the risk calculations because they are essential nutrients that are either nontoxic or toxic only at high concentrations. This screening is in accord with EPA guidance which approves of eliminating such nutrients from the human health risk assessment.

- Tom-city. The maximum detected concentrations in each medium were compared with risk-based screening concentrations developed by EPA Region 10. For chemicals in water, the screening concentration designated by EPA represents a 10^{-6} risk level for cancer effects, and a hazard quotient (HQ) of 0.1 for noncartcer effects. For soil or sediment, the screening concentration was equivalent to a 10”[7] cancer risk and an HQ of 0.1. These screening concentrations represent conservative risk levels, so that significant risk-causing chemicals will not be screened out. (See Section 7.1.3 for explanations of hazard quotient and cancer risk levels.)

- *Background.* Inorganic chemicals that were not eliminated during the above screening steps were compared with background concentrations to determine if they are present on site at elevated levels. Background data for inorganic were used to screen on-site chemicals because inorganic are naturally occurring and ubiquitous. Background screening was not conducted for any organic chemicals. Several different methods were used for the background screening, depending on the number of sample results available for a given comparison; details are given in Section 6.2.1 of the RI Report.

All chemicals that still remained as COPCs following the chemical screening were evaluated in the quantitative risk assessment.

7.1.2 Exposure Assessment

The purpose of the exposure assessment was to quantify contact with chemicals of potential concern identified at the site. This was accomplished by identifying the exposure media, the potentially exposed populations (based on current and future land uses), and the routes of exposure; and by quantifying human intake of chemicals for these media, populations, and routes. A summary of the exposures that were evaluated is presented in Table 7-1.

Potentially exposed populations (receptors) and exposure routes (pathways) were identified for current and potential future land uses for each of three subareas evaluated in the human health risk assessment: the runway ditches, Clover Valley Lagoon, and Dugualla Bay. The populations that were considered include on-site workers, recreational visitors, and future residents. Pathways pertinent to each subarea, population, and medium are identified in Table 7-1.

In order to calculate human intake of chemicals, exposure point concentrations must be estimated. Exposure-point concentrations are those concentrations of each chemical to which an individual may potentially be exposed for each medium at the site. Exposure-point concentrations were developed from analytical data obtained during the investigation.

Exposure point concentrations were calculated for both an average exposure and a reasonable maximum exposure (RIME). The RME corresponds to the highest plausible degree of exposure that may be anticipated for a site. The RME concentration is designed to be higher than the concentration that will be experienced by most individuals in an exposed population. The RME concentration was calculated as the lesser of the maximum detected concentration or the 95 percent confidence limit on the arithmetic mean.

The average exposure scenario was evaluated to allow a comparison with the RME. The average scenario is intended to be more representative of likely human exposures at the site. The average exposure point concentrations were calculated as an arithmetic average of the chemical results for a particular medium.

In calculating exposure point concentrations, a value of one-half the sample quantitation limit was generally used for samples in which a particular chemical was not detected. This procedure is designed to avoid underestimating risks. To avoid overestimation, this procedure was not applied to samples with abnormally high quantitation limits. The approach used to screen unusually high detection limit data from the quantitative risk assessment consisted of first identifying detection limits that were elevated substantially above the typical detection limits for a given analyte and medium, and then eliminating those data with detection limits that exceeded the highest detected concentration by an order of magnitude or more. This approach eliminated few samples from the data set and provided more realistic exposure point concentrations.

Estimates of potential human intake of chemicals for each exposure pathway were calculated by combining exposure point concentrations with pathway-specific exposure assumptions (for

Table 7-1
Human Exposure Models Selected to Evaluate Potential Risks from Chemicals at OU 3

Environmental Medium	Runway Ditches						Clover Valley Lagoon			Dugualla Bay		
	Current On-Site Worker			Future Resident			Recreational Visitor			Recreational Visitor		
	ING	INH	DC	ING	INH	DC	ING	INH	DC	ING	INH	DC
Soil	●	●	●	●	●	●						
Sediment	●		●	●		●	●		●	●		●
Surface water			●			●	●		●			
Groundwater				●	●	●						
Fish/shellfish							●			●		

ING = ingestion
INH = inhalation
DC = dermal contact

parameters such as ingestion rate, body weight, exposure frequency, and exposure duration) for each medium of concern. Exposure parameters used in the risk assessment calculations were based on a combination of EPA Region 10 default values (U.S. EPA 1991) and site-specific exposure assumptions; specific values can be found in Table 6-25 of the RI Report. More conservative exposure parameters were used to calculate RME chemical intakes than were used to calculate average intakes.

7.1.3 Toxicity Assessment

A toxicity assessment was conducted for the COPCs identified at OU 3 to quantify the relationship between the magnitude of exposure and the likelihood or severity of adverse effects (i.e., dose-response assessment). The toxicity assessment also weighed the available evidence regarding the potential for chemicals to have adverse effects on exposed individuals (i.e., hazard identification).

Toxicity values are used to express the dose-response relationship, and are developed separately for carcinogenic (cancer) effects and noncarcinogenic (noncancer) health effects. Toxicity values are derived from either epidemiological or animal studies, to which uncertainty factors are applied. These factors account for variability among individuals, as well as for the use of animal data to predict effects on humans. The primary sources for toxicity values are EPA's Integrated Risk Information System (IRIS) database and Health Effects Assessment Summary Tables (HEAST). Both IRIS and HEAST were used to identify the toxicity values used in the OU 3 risk assessment.

Toxicity values for carcinogenic effects are referred to as cancer slope factors (SFs). SFS have been developed by EPA for estimating excess lifetime cancer risks associated with exposure to potential carcinogens (cancer-causing chemicals). SFS are expressed in units of $(mg/kg\text{-}day)^{-1}$ and are multiplied by the estimated daily intake rate of a potential carcinogen, to provide an upper-bound estimate of the excess lifetime cancer risk associated with exposure at that intake level. The upper bound reflects the conservative estimate of risks calculated from the SF. This approach makes underestimation of the actual cancer risk highly unlikely.

Toxicity values for noncancer effects are termed reference doses (RfDs). RfDs are expressed in units of kg/mg-day and are estimates of acceptable lifetime daily exposure levels for humans, including sensitive individuals. Estimated intakes of chemicals of potential concern (e.g., the amount of a chemical that might be ingested from contaminated drinking water) are compared with the RfD to assess risk.

Toxicity values are only available for the oral and inhalation pathways. EPA has not published toxicity values for dermal contact exposures, and recommends using the oral toxicity values to evaluate the dermal pathway. In calculating chemical intakes for dermal exposures, the oral toxicity values are adjusted by an absorption factor, which corrects for the percentage of the chemical that is absorbed through the skin (compared with direct oral ingestion).

Because of its unique toxicity characteristics, EPA does not currently provide a toxicity value for lead. As an alternative to the traditional risk assessment approach, EPA has published recommended acceptable levels for lead. At the time the baseline risk assessment was performed, these levels were: 500 to 1,000 mg/kg in soil, and 15 $\mu g/L$ in drinking water. Concentrations at the site were compared with these levels to determine lead risks at OU 3.

Total petroleum hydrocarbons (TPH) were detected in a number of the samples from OU 3. EPA has not published a toxicity value for TPH in IRIS or HEAST. Petroleum is a complex mixture of hydrocarbons, many of which can contribute to a detectable TPH concentration. TPH results are normally assumed to be related to contamination from petroleum-related fuels (e.g., jet fuel, gasoline, kerosene, or diesel). EPA has developed provisional RfDs for several fuels, including jet fuel (JP-5). The RfD for JP-5 was selected for use in estimating risks from exposure to TPH at OU 3. This RfD was selected because JP-5 is documented to have been the jet fuel most heavily used on site.

7.1.4 Risk Characterization

A risk characterization was performed to estimate the likelihood of adverse health effects occurring in potentially exposed populations. The risk characterization combines the information developed in the exposure assessment and toxicity assessment to calculate risks for cancer and noncancer health effects. Because of fundamental differences in the mechanisms through which carcinogens and noncarcinogens act, risks were characterized separately for cancer and noncancer effects.

- **Noncancer Effects**

The potential for adverse noncancer effects of a single contaminant in a single medium is expressed as a hazard quotient (HQ), which is calculated by dividing the average daily chemical intake derived from the contaminant concentration in the particular medium by the RfD for the contaminant. The RfD is a dose below which no adverse health effects are expected to occur.

By adding the HQs for all contaminants within a medium and across all media to which a given population may reasonably be exposed, a hazard index (HI) cart be calculated. The HI represents the combined effects of all the potential exposures that may occur for the exposure scenario being evaluated. To avoid overestimation of risk, an HI should be calculated by summing chemicals with a common toxicological endpoint (e. g., the liver). If the HI is less than 1.0, it indicates that noncancer health effects are unlikely. If the HI for a common endpoint is greater than 1.0, it indicates that adverse health effects are possible. An HI of less than 1.0 is EPA's acceptable risk level for CERCLA sites.

- **Cancer Risks**

The potential health risks associated with carcinogens is estimated by calculating the increased probability of an individual developing cancer during his or her lifetime as a result of exposure to a carcinogenic compound. Excess lifetime cancer risks are calculated by multiplying the cancer slope factor by the daily chemical intake averaged over a lifetime of 70 years.

These cancer risk estimates are probabilities that are expressed as a fraction less than 1.0. For example, an excess lifetime cancer risk of 0.000001 (or 10^{-6}) indicates that, as a plausible upper bound, an individual has a one-in-one-million chance of developing cancer as a result of site-related exposure to a carcinogen over a 70-year lifetime under the specific exposure conditions at the site. An excess lifetime cancer risk of 0.0001 (or 10^{-4}) represents a chance of one-in-ten-thousand. EPA recommends, in the National Contingency Plan (NCP), an acceptable target risk range for cancer of 0.000001 to 0.0001 (or 10^{-6} to 10^{-4}) for CERCLA sites.

- **Results**

Table 7-2 summarizes the risk characterization results for each exposure scenario evaluated for OU 3. Except for future residents, the human health risks were all below EPA's acceptable target levels (HI less than 1, excess lifetime cancer risk less than 10^{-4}).

Risk levels were acceptable for both cancer and noncancer effects for the following populations: current on-site workers, recreational visitors to Clover Valley Lagoon, and recreational visitors to Dugualla Bay. Estimated risks were also below EPA's acceptable level for noncancer effects for future (hypothetical) residents that may live near the runway ditches. Because the estimated risks for these scenarios were below EPA's target levels, a discussion of results for these exposures has not been included.

For hypothetical residents that might live next to the Area 16 runway ditches in the future, the estimated cumulative cancer risk was at the upper end of EPA's acceptable risk range

Table 7-2
Summary of Potential Human Health Risks at OU 3

Exposure Scenario	Cumulative Risk	Chemicals Contributing to Risk in Specific Media [a]				
		Soil	Sediment	Surface Water	Groundwater	Fish / Shellfish
Area 16 - Current Worker Exposure:						
RME	HI < 1	NR	NR	NR	NP	NP
	CR = 1×10^{-5}	NR	PAHs, As	NR	NP	NP
Average Exposure	HI < 1	NR	NR	NR	NP	NP
	CR = 7×10^{-6}	NR	PAHs, As	NR	NP	NP
Area I6- Future Resident Exposure:						
RME	HI < 1 [b]	NR	NR	NR	NR	NP
	CR = 1×10^{-4}	As, Be	As, PAHs	NR	NR	NP
Average Exposure	HI < 1	NR	NR	NR	NR	NP
	CR = 5×10^{-6}	As	NR	NR	NR	NP
Clover Valley Lagoon - Recreational Visitor Exposure:						
II!W	HI < 1	NP	NR	NR	NP	NS
	CR = 1 x I0-$	NP	As, Be	NR	NP	NS
Average Exposure	HI < 1	NP	NR	NR	NP	NS
	CR = 3×10^{-7}	NP	NR	NR	NP	NS
Dugualla Bay - Recreational Visitor Exposure:						
RME	HI < 1	NP	NR	NP	NP	NR
	CR = 1×10^{-5}	NP	As	NP	NP	As
Average Exposure	HI < 1	NP	NR	NP	NP	NR
	CR = 3×10^{-7}	NP	NR	NP	NP	NR

Table 7-2 (Continued)
Summary of Potential Human Health Risks at OU 3

FOOTNOTES:

[a] Each of the chemicals listed for a particular medium poses a cancer risk greater than 10^{-6} or has a noncancer hazard quotient of greater than 0.1 due to exposure pathways for that medium. Chemicals posing cancer risk of less than 10^{-6} or having a hazard quotient of less than 0.1 for a particular medium are not listed. No chemicals are listed for any medium for those exposure scenarios having a cumulative cancer risk less than 10^{-6} or a noncancer hazard index less than 1.

[b] Based on target organ.

CHEMICAL ABBREVIATIONS:

As = Arsenic
Be = Beryllium
Mn = Manganese
PAHs = Polycyclic aromatic hydrocarbons
PCBS = Polychlorinated biphenyls (Aroclors)

OTHER ABBREVIATIONS:

CR = Cancer risk
HI = Hazard index
NP = This pathway was not included in the human exposure model (see Table 7-l).
NR = No risk-contributing chemicals are listed for this medium, as explained in footnote a.
NS = Not sampled (various attempts were made to collect fish/shellfish samples from the lagoon, but no suitable samples were available because of the physical conditions of the lagoon).
RME = Reasonable maximum exposure

(i.e., 10^{-4}). The majority of the cumulative cancer risk to future residents is due to arsenic in soil and sediments, with more than 50 percent of the total risk attributable to arsenic via soil exposure pathways. The RME concentration of arsenic in soil for the future residents scenario is 15.5 mg/kg; this is about 2 times higher than the background value established in the RI (7.5 mg/kg), but is not unusual compared to normal arsenic concentrations found in the region. For example, the RME concentration is less than the MTCA Method A cleanup level for arsenic in soil which has been established at 20 mg/kg to account for typical background values in Washington. Because the RME soil arsenic concentration does not differ greatly from the RI background value and is not unusually elevated compared with typical regional values, it represents a low incremental risk above background conditions. The remaining overall risk to future residents posed by chemicals other than arsenic in soil is below EPA's acceptable risk level (the majority of the non-arsenic risk is due to PAHs in ditch sediments).

7.1.5 Uncertainty

The accuracy of the risk assessment depends on the quality and representativeness of the data and assumptions that are used. The main sources of uncertainty associated with the risk assessment are described in the subsections below. It is important to keep in mind that the baseline risk assessment is primarily a decision-making tool for use in assessing the need for remedial action. The results of a baseline risk assessment are presented in terms of the potential for adverse effects based on a number of very conservative assumptions. The tendency to be conservative is an effort to err on the side of protection of human health.

- **Toxicity Assessment**

The cancer slope factor (CSF) for benzo(a)pyrene was used as a surrogate for all PAH compounds that are classified as probable human carcinogens. Because benzo(a)pyrene may be the most potent PAH, this practice may overestimate risks. However, until more toxicity data are available on these compounds, it is not possible to conduct a more chemical-specific evaluation. EPA has developed toxic equivalency factors for PAHs, but at the time the risk assessment was performed, their use had not yet been adopted. Therefore, this approach was not used in this risk assessment.

A variety of chemicals were detected during the RI for which toxicity values are not available. For example, toxicity data (RfDs) are not available for lead or TPH, so they were excluded from the hazard index calculations. This may result in an underestimate of the noncancer risk at OU 3.

Arsenic is a COPC in many of the media on site.' The toxicological database has certain peculiarities that render the toxicity factors for arsenic more uncertain than for many other chemicals. Uncertainties discussed in IRIS concerning the oral CSF for arsenic imply that risks for arsenic may be overestimated by as much as an order of magnitude.

Risks associated with dermal contact with soil and sediment were not evaluated for VOCS because competition between volatilization and absorption is expected to make dermal absorption minimal. There is moderate to high uncertainty regarding the methodology and absorption rates used for the dermal pathway, especially for exposures to water. Dermal absorption values used for soil/sediment are not chemical-specific, but are based on chemical class. Further, the method of estimating dermal absorption from soil and sediment does not consider the time of contact. Hence, risk estimates from dermal absorption are highly uncertain.

- **Exposure Assessment**

Many of the exposure assumptions used in the risk assessment are default values in EPA Region 10 guidance (U.S. EPA 1991). The RME parameters used to evaluate exposures are intentionally conservative to ensure that site risks are not underestimated. In recognition of this, the EPA Region 10 guidance specifies that average exposures are also to be quantified. Exposures differed significantly between the average and RME scenario. Most exposure parameters used in the RME scenario were overestimates, whereas parameters for the average scenario are more representative of typical exposures.

A conservative approach was used to select potential current and future receptors and exposure pathways to be used in calculating risks. Current worker, recreational, and future residential receptors were evaluated. However, none of these exposures is very likely for the portions of OU 3 near the flightlines. Very little, if any, on-site worker exposure currently occurs, and recreational/residential exposures may never occur unless the base is closed and the area is developed for residential use.

Exposure point concentrations of chemicals at the site were assumed to remain constant for the entire exposure duration. No degradation or other natural losses of chemicals (e.g., migration, dilution) were assumed to occur. Assuming a static chemical concentration for the entire exposure duration introduces a conservative bias for chemicals that undergo environmental degradation, migration, or immobilization.

- **Risk Characterization**

Because the RME **scenario is** designed to represent the upper bound of probable exposure and is intentionally conservative, RME risk estimates are overestimates. Average risks are more realistic, but are still expected to represent conservative risk estimates for a typical receptor. Differences between average and RME risks were sometimes quite significant. For example, the RME risk from ingestion of shellfish from Dugualla Bay was approximately 40 times the average risk.

Cancer and noncancer risks are summed in the risk characterization process to estimate potential risks associated with the simultaneous exposure to multiple chemicals. In the case of carcinogens, this gives probable or possible human carcinogens the same weight as known human carcinogens. It also equally weights slope factors derived from animal data with those derived from human data. Uncertainties in the combined risks are also compounded because RfDs and cancer slope factors do not have equal accuracy or levels of confidence and are not based on the same severity of effect. These factors may result in an overestimation or underestimation of risk.

The assumption that risks from exposure to multiple chemicals are additive does not address potential synergistic (greater than additive) or antagonistic (less than additive) interactions. Slopes of chemical-specific dose-response curves may differ substantially (i.e., some chemicals may be more potent than others); hence, the respective HQs may not be directly comparable among different chemicals. RfDs for different chemicals have varying degrees of confidence associated with them because of variations in the amount and quality of toxicity information and the uncertainty and modifying factors used in developing them. For example, an HQ greater than 1 for a chemical with an RfD incorporating high uncertainty and modification factors and designated as “low confidence" may be of less concern than the same HQ for a chemical with a better-defined RfD.

Because CSFS typically correspond to the upper 95 percent confidence Limit on the mean probability of carcinogenic response (i.e., upper bound estimates), CSFS are inherently overly conservative. In addition, the assumption that any exposure to a carcinogen produces some degree of risk is unproven; hence, it is possible that low levels of some carcinogens may not actually produce any risk at all.

Several pathways were not included in the risk characterization and are discussed below. These include risks from dermal contact with groundwater while showering, risks from exposure to lead, and risks from TPH. Exclusion of these risks from the risk totals may cause overall risk to be underestimated.

Dermal exposure to COPCs in groundwater while showering was omitted from the total risk estimates because of the high degree of uncertainty associated with the exposure model. Risks were estimated separately for this pathway for future residents at Areas 16. All hazard indices were below the EPA target level. No cancer risks from this pathway exist because no carcinogenic COPCs were identified in the groundwater.

To semiquantitatively evaluate exposure to TPHs, a provisional reference dose for JP-5 was used to quantitate risks from exposure to TPH. This RfD is highly uncertain because it was necessary to use inhalation studies and route-to-route extrapolation to calculate provisional RfDs for oral exposure. In addition, the inhalation studies used were subchronic, rather than chronic, in duration, and no studies of developmental or reproductive toxicity were available. The uncertainties associated with the use of this provisional RfD are unknown.

Hazard indices were calculated separately for exposure to TPH, using a provisional RfD for JP-5. No hazard indices exceeded 1. These risks are highly uncertain because of the low detection frequency of TPH, the use of a provisional RfD for JP-5, and the unknown type of TPH on site.

Exposures to lead were characterized separately by comparing on-site concentrations to EPA's recommended screening levels for lead. The maximum detected concentration in Area 16 sediments exceeded the lead screening level of 500 mg/kg. However, the RME concentration (183 mg/kg) was well below 500 mg/kg. Furthermore, current and future exposures are expected to be minimal. Hence, evaluation with EPA's LEAD5 UBK model was deemed unwarranted.

In summary, the probability that risks are underestimated is low and the likelihood that risks are overestimated is high. Estimated future risks are highly uncertain for the following reasons: 1) future land use assumptions are hypothetical (i.e., exposure may never occur), and 2) the magnitude of future concentrations is unknown.

7.2 ECOLOGICAL RISK ASSESSMENT

This section summarizes the methods and major conclusions of the ecological risk assessment performed for OU 3. Because the runway ditches are extensive and drain all of Ault Field, this risk assessment addresses the ecological aspects of the site from a base-wide perspective.

A screening-level ecological risk assessment was conducted to evaluate potential toxicological threats to sensitive ecological receptors of chemicals released into the environment at OU 3. This evaluation was performed for both terrestrial and aquatic receptors. The overall methodology utilized four major approaches to evaluate potential risks: exposure modeling, comparison with benchmark values, bioassessments, and comparison with site-specific biological studies.

Exposure models use results of chemical analysis, chemical biotransfer factors, and exposure factors to provide conservative dose estimates for receptors. Estimated doses are compared with conservative toxicity reference values (TRVs) to evaluate potential risks. Benchmark values (regulatory criteria and guidelines) are available for some chemicals and media for assessing potential risks to ecological receptors. For example, the federal ambient water quality criteria (WQC) can be used to evaluate potential risks to aquatic biota associated with chemicals released in surface water. Bioassessments provide a direct measure of biological disturbance that can be used to validate the results of the exposure modeling and comparisons with benchmark values. Bioassessments do not identify specific chemicals causing adverse effects, but they add biological realism to the risk assessment. Two bioassessment techniques were used to assess potential ecological risks in the runway ditch and lagoon sediments: toxicity tests and in-situ invertebrate population studies.

The Institute of Wildlife and Environmental Toxicology (TIWET 1993) investigated the use of terrestrial wildlife populations as biomonitors at selected hazardous waste sites at NAS Whidbey Island (including Area 16). The results of this site-specific biomonitoring study were integrated to supplement and validate the screening-level ecological risk assessment for the terrestrial habitat.

7.2.1 Chemical Screening

The chemical results obtained for the RI samples at OU 3 were evaluated by a number of initial screening steps to identify chemicals of potential concern (COPCs). These COPCs were carried through the remainder of the risk assessment to quantify risks at OU 3 and determine the chemicals that contribute most significantly to overall site risks. The most significant risk-contributing chemicals are discussed as chemicals of concern (COCs) in Section 6.2.

The chemical screening steps used to establish COPCS were generally the same as those for the human health risk assessment described in Section 7.1.1, except for the following differences:

- The initial screening included elimination of chemicals that were detected at a frequency of less than 5 percent of the samples, except in cases where hot spots were identified. Frequency of detection was not used as a screening step in the human health risk assessment.

- Several different methods were used for background screening, depending on the number of sample results available for a given comparison; details are given in Section 6.3.2 of the RI Report.

7.2.2 Exposure Assessment

A diversity of aquatic and terrestrial habitats exist within OU 3. Four distinct environments exist at Area 16 and adjacent downstream areas: terrestrial habitat (predominantly grass-brushland), runway ditches aquatic habitat (freshwater stream, riparian habitat), Clover Valley Lagoon aquatic habitat (wetland, riparian habitat), and Dugualla Bay marine habitat (tide flats and subtidal areas). In addition, the runway ditches drain a large portion of Ault Field, and thereby collect runoff and any chemicals that may be transported from these other areas. These diverse habitats provide food and cover for a variety of terrestrial and aquatic species.

Wildlife populations frequenting the site include small mammals (deer mice, Townsend's vole, masked shrew), larger mammals (muskrat, raccoon, coyote, long-tailed weasel), avifauna (northern harrier, red-tailed hawk, California quail, great blue heron, and waterfowl), reptiles (garter snakes), fish, and a variety of invertebrates in Dugualla Bay. The ecological risk assessment was conducted to determine whether historical contamination at OU 3 constitutes a potential threat to wildlife. Because of the extensive area of the runway ditches, the large size of Area 16, and the diversity of habitat types, the ecological risk assessment is intended to represent most of Ault Field.

Species inhabiting the terrestrial habitat are primarily exposed to risks by: initial root uptake from soils by endemic grasses; ingestion by animals of soil, surface water, and vegetation; ingestion by carnivores of small mammals or soil invertebrates. In the aquatic habitat, species are exposed by ingestion of sediment, surface water, vegetation, fish, or shellfish.

7.2.3 Toxicity Assessment

The screening-level assessment of potential ecological risk compared concentrations of COPCs in sediment and surface water to respective quality criteria values. The toxicity of COPCs to specific ecological receptors and ecosystems was evaluated. Relevant toxicological information from the literature was used to provide a qualitative description of the potential toxicity of the COPCs. For terrestrial and aquatic habitats, quantitative TRVS were selected or derived for evaluating the potential for adverse effects that may be associated with a chronic, long-term exposure.

TRVS for avian and mammalian receptors were expressed as a dose and were obtained from a review of the pertinent literature. Freshwater TRVS for aquatic receptors were derived from either federal ambient WQC or from the aquatic toxicity literature. Freshwater sediment TRVS were either obtained from toxicological information compiled by Ecology or derived from ambient WQC using equilibrium partitioning for non-ionic organic chemicals. The sediment TRVS are also referred to as sediment quality values (SQVs).

Acute toxicity tests (bioassays) using several species were also conducted in the lab on runway ditch and lagoon sediments to provide biological validation of overall adverse effects predicted from other methods. In addition, population studies were performed to characterize the aquatic communities inhabiting the runway ditches and lagoon. This identified populations and habitats of ecological concern for evaluating potential ecological risks associated with chemical releases. It also acted as a confirmatory in-situ biological evaluation of impacts on aquatic organisms.

7.2.4 Risk Characterization

Four approaches were used to evaluate potential risks for the different environmental media, as shown in Table 7-3. Comparison with benchmark values utilized a quotient method to assess the relative magnitude of potential risk to aquatic populations. For each COPC, a hazard quotient (HQ) was determined; individual HQs greater than 1 indicate a potential stress to aquatic organisms. In addition, estimated chemical doses were compared to TRVS to predict potential risks to terrestrial organisms; an HQ greater than 1 indicate potential toxic effects on the target population.

Table 7-4 summarizes the exposure pathways and receptors that were modeled and evaluated for the risk assessment. Groundwater was not considered because it is not a significant ecological exposure pathway. The modeling estimated reasonable maximum exposures (RME) to several receptors having different foraging patterns.

. Runway Ditch Terrestrial Habitat -- Soil

Potential ecological risks from COPCs in soil were evaluated by exposure modeling applied to the vole (herbivorous small mammal), shrew (insectivorous small mammal), weasel (carnivorous small mammal), quail (herbivorous bird), and harrier (carnivorous bird). Modeling results predict that chemicals in the soil pose negligible risks to the vole, quail, and harrier, suggesting that risks to small herbivorous mammals, herbivorous birds, and raptors feeding along the ditches is minimal. Evaluation of uncertainty in soil ingestion rates for the weasel suggests that adverse risk to this species is unlikely. Potential risks to terrestrial receptors inhabiting the banks of the runway ditches are limited to exposure of the shrew to 2,3,7, 8-TCDD (dioxin) and selenium (Table 7-5). However, considerable uncertainty is associated with the potential risk from TCDD because data were limited to a single soil sample; the hazard quotient for TCDD was only 3 times higher than the acceptable level (HQ of 1). Risks associated with selenium were also highly uncertain and

Table 7-3
Overall Methodology for Ecological Risk Assessment

Location and Environmental Medium		Exposure Modeling[a]	Comparison with Benchmark Values[b]	Bioassessments[c]	Integration of Site-Specific Biological Studies[d]
Runway Ditches	Surface Soil (0 to 60 cm depth)	●			●
	Sediment (0 to 22 cm depth)	●	●	●	
	Surface Water	●	●		
Clover Valley Lagoon	Sediment (0 to 22 cm depth)	●	●	●	
	Surface Water	●	●		
Dugualla Bay	Sediment (0 to 22 cm depth)	●	●		
	Shellfish Tissue	●			

a Exposure modeling information is provided in Table 7-4.

b Comparison with benchmark values:
- For sediment, detected concentrations were compared with sediment quality values (SQVs)
- For surface water, detected concentrations were compared with water quality criteria (WQC)

c Bioassessments:
- For runway ditch sediment, toxicity tests and a benthic invertebrate survey were utilized
- For Clover Valley Lagoon sediment, toxicity tests were utilized

d The Institute of Wildlife and Environmental Toxicology (TIWET 1993) evaluated small mammal populations near the runway ditches during a biomonitoring study at NAS Whidbey Island.

Table 7-4
Ecological Exposure Models Used to Evaluate Potential Risks from Chemicals at OU 3

Species	Soil Contact	Soil Ingestion	Sediment Ingestion	Surface Water Ingestion	Vegetation Ingestion	Soil Invertebrate Ingestion	Small Mammal Ingestion	Fish Ingestion	Clam Ingestion
Terrestrial									
Earthworm[a]	●	●	●		●				
Townsend's vole		●		●	●				
California quail		●		●	●				
Masked shrew		●				●			
Long-tailed weasel		●		●			●		
Northern harrier							●		
Aquatic									
Great blue heron			●	●				●	
Muskrat			●	●	●				
Raccoon									●

NOTE: Small mammal ingestion applies to ingestion of Townsend's vole by masked shrew and northern harrier.

a · Earthworm exposure was used ordy for modeling soil invertebrate ingestion by the masked shrew.

Table 7-5
Summary of Ecological Risks in Soil

Chemical	RME Concentration mg/kg	RME Hazard Quotient for: Masked Shrew
Selenium	1.3	230
2,3,7,8-TCDD (TEC)	0.00000014 (1.4×10^{-7})	3.1

NOTE: Hazard quotient for masked shrew based upon results of exposure modeling.

RME = reasonable maximum exposure
TEc = Toxicity Equivalency Concentration (individual dioxins/furans concentrations were converted to equivalent 2,3,7, 8-TCDD concentration using EPA's toxicity equivalency factors).

may have been significantly overestimated because exposure was primarily through consumption of earthworms, and the bioconcentration factor (BCF) used for earthworms was the most conservative value found in the literature and possibly not representative of site-specific conditions (a BCF of 52.6 was used in the assessment; other published values range from 2.1 to 9.6). The RME concentration for selenium was marginally elevated compared with the RI background value (1.29 mg/kg vs background of 0.43 mg/kg).

Results of the TIWET biomonitoring study showed that voles at Area 16 have similar survival rates to those at the reference site, although some mortalities were caused by contact with petroleum hydrocarbons in the ditches. Abnormalities in liver weights (from unknown causes) were identified, but concentrations of common metals and organochlorine compounds were within background levels. In summary, TIWET results support the conclusion of minimal impact from COPCs to small mammal and raptor populations inhabiting the central core area.

- **Runway Ditch Aquatic Habitat -- Surface Water**

Potential ecological risks from COPCs in ditch surface water were evaluated by comparing COPC concentrations with WQC and by exposure modeling applied to the heron (a fish-eating bird). Both methods suggested that potential adverse impacts are unlikely, although WQCS and TRVS were unavailable for several COPCs.

- **Runway Ditch Aquatic Habitat -- Sediment**

Potential ecological risks from sediment-borne COPCs in the runway ditches were evaluated by comparing chemical concentrations with freshwater sediment quality values (SQVs) and by exposure modeling applied to the muskrat (aquatic herbivorous mammal). RME sediment concentrations of 22 COPCs exceeded their SQVS (Table 7-6), suggesting probable adverse impacts to benthic organisms. SQVS were unavailable for about one-third of the total COPCS, so risks are underestimated. Exposure modeling showed that three COPCs had RME HQs exceeding 1. Considering the uncertainty of sediment ingestion and the conservativeness of the model, only lead is predicted to present potential adverse risk to the muskrat.

The high potential for adverse impacts from sediment-borne chemicals was confiied by biological tests. Sediment toxicity tests showed significant epibenthic amphipod mortality in two central core stations. The bioassessment showed widespread biological impairment of benthic macroinvertebrate communities throughout the runway ditch system, which was primarily associated with organic enrichment. However, impairment was greatest in central core stations where sediment-borne chemicals were detected at uniformly high concentrations; upstream and downstream stations are in much better biological condition.

Table 7-6
Summary of Ecological Risks in Runway Ditch Sediments

Chemical	RME Concentration		RME Hazard Quotient for:	
	mg/kg	mg/kg C	Muskrat [a]	Benthic Invertebrate [b]
2-Methylnaphthalene	0.91		1.2	1.4
4,4'-DDD	0.057		0.000012	2.8
4,4'-DDT	0.012		0.0027	1.7
Acenaphthene	0.7'4		0.021	1.1
Anthracene	1.6		0.0042	1.7
Aroclor- 1254	0.15		0.0022	2.4
Aroclor- 1260	0.14		0.00032	29
Arsenic	63		3.9	0.74
Benzo(a)anthracene	2.0		0.0048	1.3
Benzo(b)fluoranthene	1.3	44	0.0030	1.4 [c]
Benzo(g,h,i)perylene	0.93	39	0.0021	3.1 [c]
Benzo(k)fluoranthene	2.5	64	0.00057	2.1 [c]
Dibenz(a,h)anthracene	0.71		0.67	2.7
Dimethylphthalate	1.7	41	0.0016	4.1 [c]
Endosulfan I	0.0036	0.10	0.00016	8.3 [c]
Fensulfothion	1.3	11	0.40	390 [c]
Fluorene	1.3		0.0035	2.0
Lead	180		14	1.7
Methyl azinphos	1.0	14	0.0076	8.4 [c]
Phenanthrene	3.0		0.23	2.1
Pyrene	5.3		0.0016	2.4
Zinc	460		—	1.7

[a] HQs for muskrat are based upon results of exposure modeling.
[b] HQs for benthic invertebrates are based upon comparison to freshwater sediment quaMy values (SQVS) (see Section 7.2.3).
[c] These hazard quotients (HQs) are based on SQVS that are normalized for carbon (i.e., carbon-normalized SQVS expressed as mg/kg organic carbon). The other HQs are based on non-normalized SQVS.

mg/kg C = milligram per kilogram total organic carbon (carbon-normalized)
RME = reasonable maximum exposure

NOTE: Although manganese, nickel, and vanadium had HQ > 1 for muskrat and/or benthic invertebrates, the incremental risks above background were considered low; these metals are not included in the risk summary.

• Clover Valley Lagoon Aquatic Habitat -- Surface Water

No COPCs were identified in surface water, indicating that potential adverse impacts are unlikely.

• Clover Valley Lagoon Aquatic Habitat -- Sediment

Potential ecological risks from sediment-borne COPCs in the lagoon were evaluated by comparing analytical results with SQVS, by exposure modeling applied to the muskrat (aquatic herbivorous mammal), and by sediment toxicity testing.

Based upon comparison with SQVs, potential aquatic risks to benthic invertebrates were predicted for seven chemicals having an HQ greater than 1; the maximum HQ was **6** for acetone (Table 7-7). As explained in Section 6.2.5, the HQ for acetone is likely an artifact of the laboratory. Considering the poorly oxygenated habitat in the deep portion of the lagoon (no ecologically significant receptors over a large area), the high acid volatile sulfide concentrations (which can reduce bioavailability of certain divalent metals including cadmium and zinc), and the lower HQs in the shallow portion of the lagoon, the potential for adverse impacts on the aquatic ecosystem in the lagoon is low.

Exposure modeling using the muskrat showed four chemicals with an HQ greater than 1; the maximum HQ was 5 for dimethoate mainly due to ingestion of vegetation. The other three chemicals were metals that had HQs close to 1 and represent low incremental risk above background concentrations. Dimethoate was only detected in the deep, poorly oxygenated portion of the lagoon, which is not where rooted aquatic plants grow.

Toxicity tests were conducted on sediments from Clover Valley Lagoon on two occasions: December 1992 and July 1993. For each event, two locations were sampled for amphipod bioassay tests. The two July 1993 samples were also assayed using a larval bivalve (mussel) as a test species.

AU of the bioassay results showed virtually no toxicity and consequently negligible risk, except for one of the mussel tests, which indicated some adverse effects (i. e., lower normal survivorship than the reference station). Because only one of the six tests showed impacts, the overall risk indicated by the bioassays is low.

To further interpret these results, the framework of the state Sediment Management Standards (SMS) was used. SMS describes two levels of toxicity: sediment quality standards (SQS), which establish goals that are protective of aquatic organisms in sediments, and cleanup screening levels (CSLs), which are used in remedial decisionmaking.

Table 7-7
Summary of Ecological Risks in Clover Valley Lagoon Sediments

Chemical	RME Concentration		RME Hazard Quotient for:		
				Benthic Invertebrate	
	mg/kg	mg/kg C	Muskrat	Shallow Portion of Lagoon	Deep Portion of Lagoon
Acetone	0.29		0.37	2.3	6.1
Cadmium	5.4		1.0	1.1	0.8
Dieldrin	0.0042		0.004399	2.4	4.1
Dimethoate		46	5.3[a]	—	—
Nickel	160		0.96	3.6	2.4
Selenium	1.4		0.079	1.1	1.9
Thallium	0.62		0.0047	1.7	1.5
Vanadium	79		1.7	1.3	1.2
Zinc	340		1.0	0.8	0.7

a · This hazard quotient (HQ) is based on the carbon-normalized sediment quality value (SQV) (i.e., mg/kg organic carbon). Other hazard quotienta are based on non-normalized SQVs.
RME · reasonable maximum exposure
mg/kg C = milligram per kilogram total organic carbon

Notes:
1. Hazard quotient for muskrat are based upon results of exposure modeling.
2. Hazard quotient for benthic invertebrates are based upon comparison to SQVS, preferentially using the state sediment management standards.

One of the tests (the mussel) failed to meet the SQS levels. All of the results for both the mussel and amphipod tests passed the CSL criteria, meaning that active sediment cleanup measures are not needed.

. Clover Valley Lagoon -- Bioassessment

Water quality measurements and sediment coring showed the Clover Valley Lagoon to be very poorly oxygenated below the 3-meter water depth. This anoxic condition and consequent diminished value of habitat quality extends over much of the lagoon bottom. Aquatic vertebrate sampling with a gillnet resulted in no captures in June 1992, and no macrobenthic invertebrates were found in any sediment cores during the sediment sampling. Raking the benthos of the east shore with a clam rake produced no clams. Given the high degree of stratification and resulting anoxic conditions, it appears that the deeper portions of the lagoon may not be suitable for most aquatic biota due to existing conditions.

• Dugualla Bay Marine Habitat -- Sediment

Potential ecological risks from sediment-borne COPCs in Dugualla Bay were evaluated by comparing chemical concentrations with SQVS. No COPCS had HQs greater than 1, suggesting that potential impacts on invertebrates inhabiting bay sediments are negligible.

• Dugualla Bay Marine Habitat -- Shellfish

Potential ecological risks from COPCS in shellfish tissue from Dugualla Bay were evaluated by exposure modeling applied to the raccoon (omnivorous mammal) through ingestion of clams (conservatively assumed to comprise half of the raccoon's diet). No COPCS had HQs greater than 1, suggesting that potential impacts on animals ingesting shellfish are negligible.

7.2.5 **Uncertainty**

This uncertainty analysis provides a qualitative evaluation of the assumptions and limitations inherent in the ecological risk assessment. The main sources of uncertainty associated with the risk assessment are described in the subsections below. The results of a baseline risk assessment are presented in terms of the potential for adverse effects based on a number of very conservative assumptions. The tendency to be conservative is an effort to err on the side of protection of the ecosystem.

- **Chemical Screening**

The screening methodology employed in the risk assessment used conservative input values and assumptions to establish risk-based screening values for selecting chemicals of potential concern. Because the input values and assumptions were conservatively selected, it is unlikely that potential ecological risks for any chemical were underestimated, unless an input value was not available. For example, there were cases where a toxicity reference value was not available for a particular chemical, and therefore, the potential risk due to the chemical could not be estimated. It is likely that the cumulative risks estimated for particular receptors may have been underestimated because of this, and it is possible that some chemicals were screened out that could be partly responsible for adverse effects observed in the non-chemical assessments (i.e., bioassays and bioassessment surveys). On the other hand, it is likely that the use of conservative input values and assumptions for the remaining chemicals led to overestimation of risk for the chemicals that could be included in the risk calculations.

. **Exposure Assessment**

Exposure models were based on receptor ingestion rates of water, forage, soil, and sediment. Water and forage ingestion rates were not site-specific. Soil and sediment ingestion rates were not site-specific and not species-specific.

Some of the factors needed to estimate exposure for all receptors were not available. In these cases, no exposure was estimated and overall risks were underestimated. Also, the use of conservative non-site-specific exposure factors probably overestimates exposure.

Biotransfer factors were used in the exposure models to estimate chemical tissue concentrations in prey species. These factors were based on a limited number of species and chemicals, and may not be representative of actual site conditions.

The exposure models include an assumption that receptors are continuously exposed to an environment with a uniform distribution of chemicals. Because many animals will not inhabit the contaminated area 100 percent of the time, exposure may be overestimated for many receptors.

Using the RME value instead of the average overestimates risk. RME values typically range from 1.2 to 1.4 times the average value. Hence, risks may be overestimated by 20 to 40 percent compared with average concentrations.

Many chemicals may exist in a state that is not readily bioavailable or is not the most toxic. Under some circumstances, virtually all of the chemical, even if measured at a substantial concentration, could be unavailable and then would pose little risk to biota. Bioavailability could have a moderate effect on overestimating risks as compared with the measured concentration of those chemicals.

● **Toxicity Assessment**

Typically, TRVS were not available for the receptor species. Therefore, values for species of similar taxonomic classification were used, often from laboratory studies using standard laboratory test organisms. The direction and magnitude of uncertainty is unknown.

Toxicity values were not found for all COPCs. Therefore, potential risks were not estimated for these COPCs and cumulative risks were underestimated.

In some cases, the toxicity values were extrapolated from one endpoint (e.g., LD_{50}) to the no-observed-effects level (NOEL) or lowest-observed-effects level (LOEL). This extrapolation was based on generalized published relationships that may not be pertinent to the organisms or chemicals in this study.

Results of the toxicity tests performed on sediments can be influenced by at least three factors that contribute to uncertainty: assessment endpoints affected by basic physical and chemical conditions that are not reflective of chemical contamination, uncertainties in counting test organisms or assessing their behavior, and variability in bioavailability of chemicals among samples.

● **Risk Characterization**

At least some chemicals, when acting in mixtures, may pose risks that are greater than the sum of the individual risks. Very little is known of such synergistic effects of toxicants. When synergistic effects occur, but have not been accounted for, the overall risk may be underestimated.

For at least some chemicals, adaptation by organisms may occur. After adapting to particular chemicals in their environment, or in some cases in their tissues, organisms may carry out life functions that would otherwise be impaired at those concentrations. In these cases, risks based on measured concentrations would be overestimated.

The interpretation of potential ecological risks based upon HQs calculated from exposure modeling is ill-defined. This ecological risk assessment has used an HQ of greater than 1 as an indicator of potential impacts to ecological receptors. However, some workers state that HQs ranging from 1 to 10 indicate a possibility for ecological impacts, while HQs greater than 10 indicate a probability that ecological impacts would occur. Many of the COPCs identified as potential risks in exposure models in this risk assessment had HQs below 10.

The macroinvertebrate bioassessment that was conducted on the runway ditches provided direct biological evidence of impacts on the benthic macroinvertebrate community. However, some uncertainties exist in its application. The macroinvertebrate bioassessment method was designed for use on relatively healthy stream systems with abundant and diverse benthic insect communities. The benthic macroinvertebrate communities inhabiting the runway ditches had poor diversity and abundance, and were devoid of many insect taxa used in assessing impairment. In addition, organic enrichment of the entire stream bed caused a substantial decline in habitat quality, which confounded the delineation of impact potential of COPCs.

As discussed at the beginning of Section 7.2, the ecological risk assessment employed several different approaches to evaluate risks, including comparison of chemical concentrations with toxicity reference values, bioassays and bioassessments. Using a variety of approaches was intended to help overcome some of the uncertainties inherent to each individual approach and produce a better overall understanding of the ecological risks at OU 3.

8.0 REMEDIAL ACTION OBJECTIVES

This section explains the basis for remedial action at OU 3, identifies the media for which action is needed, and describes the objectives that the remedial action is intended to achieve. Based on these remedial action objectives (RAOS), specific cleanup levels are defined for specific chemicals in the media of concern. Based on the cleanup levels, this section also identifies specific areas of 0U3 that have been selected for remedial action.

8.1 RUNWAY DITCHES

The following subsections discuss the need for remedial action, establish cleanup levels, and identify selected remediation areas for the runway ditch complex. The ditch complex includes all parts of Area 16 upstream of the Clover Valley Lagoon. Section 8,2 discusses the Clover Valley Lagoon and Dugualla Bay.

8.1.1 Need for Remedial Action

The baseline risk assessment evaluated exposures to current workers and hypothetical future residents applicable to the soil, groundwater, surface water, and sediments of the runway ditch complex. As discussed in Section 7.1.4, the estimated human health risks were below the CERCLA target levels for all the exposure scenarios except for cancer risks to future residents.

For hypothetical residents that may live next to the ditches in the future, the estimated cancer risks were at the upper end of EPA's acceptable risk range (i. e., RME cancer risk was 1 x 10^{-4}). Because the estimated risk is marginal compared with the acceptable target level, because the majority of this risk is due to arsenic in soil at concentrations similar to background levels and below MTCA Method A cleanup levels, and because RME risks reflect a number of conservative assumptions, the risk to future residents does not warrant cleanup actions.

Thus, the baseline risk assessment did not demonstrate a need to take remedial action at the runway ditches to protect human health. The following subsections discuss the need for remedial action in regards to the results of the ecological risk assessment and consideration of ARARs for the soil, groundwater, surface water, and sediments of the runway ditch complex.

- soil

The baseline risk assessment identified potential ecological risk, based on the masked shrew exposure model, for two chemicals in soil along or near the banks of the runway ditches: selenium and dioxin. State standards for soils (i.e., MTCA cleanup levels) were exceeded in some of the soil samples for arsenic, beryllium, manganese, and petroleum hydrocarbons.

None of these chemicals is considered to pose significant risks warranting remedial action because of the following reasons:

- Selenium, arsenic, and petroleum hydrocarbons were infrequently detected above the ARAR or risk level. The dioxin risk was based on analysis of only one sample.

- For selenium, arsenic, beryllium, manganese and petroleum hydrocarbons, the samples indicative of risk were distributed in widely spaced locations not indicative of an obvious source.

- For dioxin, arsenic, beryllium, manganese, and petroleum hydrocarbons, the ARAR or risk level was exceeded by only a marginal amount.

- For selenium, arsenic, beryllium, and manganese, the detected concentrations were similar to background concentrations.

For these reasons, no remedial actions are considered to be necessary for the soil at the runway ditches.

- **Groundwater**

Because there is no exposure route, groundwater does not pose an ecological risk. However, several chemicals were detected in the groundwater at concentrations above drinking water standards or state cleanup levels: arsenic, manganese, dinoseb, and 2,4-D. The latter two chemicals are herbicides.

Most of the groundwater results for arsenic were close to or below the MTCA Method A cleanup level. One of the wells had concentrations about 2 times the cleanup level, but the concentrations were not unusually elevated compared to typical regional background values, and were well below the federal drinking water standard. The manganese results were also not unusual compared with regional conditions. Hence, arsenic and manganese in the groundwater are not considered to pose a significant excess risk compared with naturally occurring background levels.

The detections of herbicides in the groundwater are considered to be laboratory anomalies. As explained in Section 6.2.2, the dinoseb and 2,4-D detections in the Phase I samples were associated with interferences making the results questionable. These detections were not confirmed by resampling in Phase II. The Phase II analyses had no interference problems and the detection limits were well below drinking water standards.

Because the herbicide exceedances are considered anomalous and the arsenic concentrations are considered typical of natural background levels, remedial actions are not necessary for the Area 16 groundwater.

- **Surface Water**

No significant ecological risks were identified in the baseline risk assessment for the surface water in the runway ditches. However, surface water ARARs (i.e., water quality criteria and MTCA cleanup levels) were exceeded in some of the ditch water samples for four metals: copper, lead, mercury, and silver.

None of these chemicals is considered to pose significant risks warranting remedial action because: 1) the chemicals were infrequently detected above background levels, 2) none of the results greatly exceeded the background concentrations, 3) only a few samples exceeded the ARAR concentrations, 3) the few results above ARARs were found in widely spaced locations not related to manmade sources, 4) the ARAR or risk level was exceeded by only a small amount, and 5) detected concentrations were often not confirmed by resampling. For these reasons, no remedial actions are considered to be necessary for the surface water in the runway ditches.

- **Sediments**

There are no federal or state ARARs for fresh water sediments. However, the baseline risk assessment identified significant ecological risk attributable to chemicals detected in the runway ditch sediments. The ecological risk was predicted based on the results of exposure modeling using the muskrat as a receptor, and the exceedance of sediment quality guidelines for protection of benthic organisms. The following types of chemicals were identified as contributing to the ecological risk in the sediments:

- metals (arsenic and lead)
- volatile organic compounds (VOCs)
- semivolatile organic compounds (SVOCs, including polynuclear aromatic hydrocarbons [PAHs])
- pesticides
- herbicides
- PCBs

In addition to these chemicals, high concentrations of petroleum hydrocarbons were detected at several of the sediment stations, which are a likely source of the SVOCs, PAHs, and lead that contribute to the overall ecological risk. The prediction of significant risk from the SQV and muskrat evaluations was confirmed by the results of sediment bioassays and benthic community assessments for selected stations.

The weight of evidence from the muskrat exposure modeling, the benthic assessments, and the sediment bioassays indicates that remedial actions are necessary in order to reduce the ecological risk posed by chemicals detected in the runway ditch sediments.

8.1.2 Remedial Action Objectives

For the reasons discussed in Section 8.1.1, remedial actions are needed to address contaminants in the sediments of the runway ditch complex. The objective of these remedial actions is to reduce ecological risks posed by the contaminated sediments, as identified in the baseline risk assessment.

In addition to this remedial action objective, the Navy desires to minimize future constraints on dredging of the runway ditches that are currently in effect because of the sediment contamination. The ditches must be periodically dredged to maintain free-flowing conditions because they serve as a major drainage network for Ault Field and the surrounding land. Without periodic dredging, flooding may eventually occur. In the past, the Navy has dredged the ditches as needed to prevent flooding and has disposed of the dredged material next to the ditch banks. Placement of the dredged material on the ditch banks is a practical and cost-effective means of disposal, especially for portions of the ditches where access is difficult or is limited by flight operations. Because of the potential for contaminants in the sediments, this disposal practice has been discontinued during the remedial investigation. In order to resume this cost-effective practice, the Navy desires to take cleanup actions that will minimize contaminants in the ditches that may need to be dredged in the future, so that dredging can be conducted for maintenance purposes without the restrictions that are currently in place.

Once cleanup actions have addressed contaminants in the ditch sediments, it is not likely that they would become recontaminated in the future. The Navy has instituted best management practices to reduce runoff from industrial areas into the ditch complex. It also has an emergency response plan that greatly reduces the chances of an accidental fuel spill reaching the ditches. If fuel did reach the ditches, it would be contained and pumped from the ditch at baffle number 1. The past practice of disposing waste into the ditches no longer occurs. Other Navy programs (recycling and waste minimization) have greatly reduced the amount of hazardous materials handled at the base. In addition, the Navy routinely monitors the ditch effluent that leaves the base as part of its National Pollutant Discharge Elimination System permit. All these programs and the spill response plan are designed and implemented to prevent recontamination of the ditch sediments or release of pollutants into the marine environment. For additional assurance, the Navy plans to install stormwater treatment at various locations, where needed, throughout NAS Whidbey Island; the runway ditches are being considered in these plans.

In order to minimize constraints on future dredging, risks that may be posed by the dredge spoils must be addressed. Ecological concerns for the dredge spoils would be addressed by remedial actions designed to achieve the principal objective of reducing ecological risk posed by the contaminated sediments themselves. In addition, there may be human health concerns related to the dredge spoils. Once the sediments are placed on the ditch banks, they will become soils that may pose human health risks via soil exposure routes. The baseline risk assessment did not evaluate this exposure scenario, because it is associated with future actions rather than baseline (no-action) conditions. However, in order to facilitate future dredging activities, prevention of unacceptable human health risks from this exposure scenario has been included as an objective of the remedial actions.

In summary, the remedial action objectives for the ditch sediments include:

- Reduction of current ecological risks posed by chemicals of concern in the ditch sediments.

- Reduction of future human health risks that may occur if contaminated sediments are dredged for ditch maintenance purposes and placed on the ditch banks, where the sediments will become soil and result in human exposures to chemicals of concern via soil exposure pathways.

8.1.3 Cleanup Levels

The RAOS defined in the previous section include reduction of both current ecological risks and potential future human health risks. Chemical-specific cleanup levels that correspond with these objectives were derived from the following:

- *Concentrations in the sediments that are equivalent to a hazard quotient of 1.0 based on the muskrat model used in the baseline risk assessment.* Cleanup to these concentrations would eliminate ecological risk predicted by the model for the muskrat as an indicator species. The muskrat model was selected for this purpose because risks to other indicator species modeled in the baseline risk assessment (i. e., heron) were found to be acceptable without remediation.

- *Concentrations in the sediments that exceed MTCA Method C cleanup levels for industrial soil.* Cleanup to these concentrations would minimize potential human health risks to workers that could be exposed to the sediments if they were dredged in the future for maintenance purposes and placed along the ditch banks. The soil cleanup levels are appropriate because, after placement on the ditch banks, the dredged sediments will become soil. MTCA Method B cleanup levels, which are based on human health risk for residential exposures, were not selected for this purpose because the land use at the ditches is not expected to be converted to residential use in the future. Future residential development is very unlikely because of the presence of the air field, which would probably remain as a non-military airport if the base were to close, and because the wetlands surrounding the ditches would make development unlikely. If future land use changes to non-industrial, this situation would be reevaluated.

- *Concentrations in the sediments that exceed the MTCA Method A industrial cleanup level for total petroleum hydrocarbons (TPH) in soil.* Cleanup to these concentrations would reduce potential human health risks to workers that could be exposed to the sediments if they were dredged in the future, as discussed above. The Method A cleanup level was included because there is no Method C cleanup level for TPH.

- *Concentrations in the sediments that exceed background levels.* In cases where the sediment background level is higher than any of the risk-based or ARAR-based cleanup levels described in the previous bullets, the background value will be the basis for remedial action decisions.

The cleanup levels described above were compared with the maximum concentrations of chemicals detected in the RI ditch sediment samples in order to determine target chemicals for remedial action. The results of this comparison are shown in Table 8-1, which lists the maximum detected concentrations, the cleanup levels based on the muskrat model, and the cleanup levels based on MTCA. Table 8-1 lists all the chemicals for which the maximum detected concentration exceeded the minimum cleanup level. Detected chemicals that did not exceed the minimum cleanup level in any of the sediment samples are not included in the table.

The cleanup levels listed in Table 8-1 differ from the preliminary remediation goals used to develop and evaluate alternatives in the feasibility study. As this record of decision was developed, the preliminary remediation goals were reevaluated and revised. Differences between the preliminary remediation goals and the final cleanup levels in Table 8-1 are due to the use of MTCA cleanup levels, sediment quality values, and TPH concentrations. Each of these differences is discussed in the following paragraphs.

MTCA cleanup levels for soil were included as final cleanup levels for the sediments to address a potential future human exposure pathway, as explained above in the second bullet. MTCA soil values had not been included in the preliminary remediation goals because the baseline risk assessment and feasibility study did not consider this potential pathway.

In addition to the muskrat and heron models, the ecological baseline risk assessment quantified risks in the ditch sediments by comparing sediment concentrations to sediment quality values (SQVs) such as those developed by the Ontario Ministry of the Environment. These SQVS were used as preliminary remediation goals in the FS, but have not been retained as final cleanup levels. The SQVS are concentrations at which adverse ecological effects may be expected to occur to benthic organisms, and were developed to protect ecosystems in surface water bodies such as trout streams and lakes. Because these SQVS are

Table 8-1
Cleanup Levels for Runway Ditch Sediments

Chemical	Maximum Detected Concentration mg/kg	Background Value mg/kg	Cleanup Levels, mg/kg			
			Based on MTCA for Soil		Based on Muskrat Model	Selected Cleanup Level
			Method A Industrial	Method C Industrial		
Arsenic	581	3.4		188	16	16
Lead	942	18		140	14	18
2-methylnaphthalene	3.2				0.8	0.8
Benzo(k)fluoranthene	23			18	450	18
Dibenz(a,h)anthracene	1.9			18	1.1	1.1
Phenanthrene	20				13	13
TPH	123,000		200			200

intended to protect prime water resources, they are overly conservative and not appropriate as cleanup levels for ditches. For this reason, and because the SQVS are not ARARs, cleanup levels based on the SQVS were not included in Table 8-1.

The MTCA soil cleanup level for TPH has been included as a final cleanup level for sediments, although it was not listed in the FS Report as a preliminary remediation goal because this ARAR applies to soils rather than sediments. In addition to the reasons given above in the third bullet, the cleanup level for TPH has been included as an indicator of ecological risk. Ecological risks attributable to TPH were not quantified in the ecological risk assessment, because of the lack of pertinent toxicity data. Nonetheless, the TPH data collected in the RI correlated well with ecological risk in the sediments. This is shown in Table 8-2, which compares TPH results for sediment stations where bioassay samples were analyzed or where benthic community assessments were performed. The data in Table 8-2 suggest that adverse ecological effects may occur in the sediments at concentrations on the order of 4,000 mg/kg and above. That is, no adverse ecological effects were found for station 16-11 which had a TPH concentration of 4,350 mg/kg, whereas community impairment was noted for station 16-7 having 3,860 mg/kg TPH. At much higher TPH concentrations (stations 16-4 and 16-6), adverse effects were observed in both the bioassay and community assessment results. These results suggest that TPH can serve as an indicator of ecological risk in the sediments and that a concentration of about 4,000 mg/kg may be an appropriate cleanup level for this purpose. Cleanup to the MTCA Method A cleanup level for TPH (which is 200 mg/kg) would therefore also address the ecological risk that appears to be associated with TPH.

8.1.4 Selection of Areas for Remediation

The highest concentrations of contaminants contributing to the ecological risk were found in the sediment stations located closest to the Ault Field runways and taxiways, where major storm sewers from the base discharge into the ditches. In the past, wastes were discharged into these sewers, contaminating the ditches. Lower contaminant concentrations were detected in the sediments farther from the runways, and concentrations were found to generaUy decrease along the ditches downgradient of the runways towards the Clover Valley Lagoon and Dugualla Bay.

In order to identify parts of the ditches that should be remediated to attain the remedial action objectives, the maximum concentrations detected at each station were compared to the cleanup levels listed in Table 8-1. Table 8-3 shows the maximum concentration detected at each station along with the cleanup level for each chemical of concern.

Table 8-2
Comparison of TPH Concentrations in Ditch Sediments With Bioassay and Benthic Community Assessment Results

Sediment Station Number	Benthic Assessment Station Number	Maximum Detected TPH Concentration mg/kg	Risk Indicated By Bioassay Testing?	Benthic Community Impairment Observed?
16-6	6	123,000	YES	YES
16-4	5	45,000	YES	YES
16-7	4	3,860	NT	YES
16-11	9	4,530	NO	NO
16-8	2	139 U	NT	NO

U = Not detected (the value listed is the detection limit).

NT = Not tested.

Table 8-3
Maximum Detected Concentrations at Runway Ditch Sediment Stations

Chemical	Cleanup Level mg/kg	Maximum Concentration Detected at Each RI Sampling Station, mg/kg																
		Station 16-1	Station 16-2	Station 16-3	Station 16-4	Station 16-6	Station 16-7	Station 16-8	Station 16-9	Station 16-10	Station 16-11	Station 16-12	Station 16-25	Station 16-31	Station 16-32	Station 16-33	Station 16-34	Station 16-35
Arsenic	16	6	6	87	13	13	14	13	20	5	30	28	9	13	4	44	31	581
Lead	18	13	42	6	942	831	160	6	17	4	147	77	17	27	15	15	16	379
2-methyl naphthalene	0.8				3.2	0.26								1.3				
Benzo(k) fluoranthene	18				23									4.1				
Dibenz(a,h) anthracene	1.1				1									1.9				0.57
Phenanthrene	13				20									0.7				0.81
TPH	200		446		45,000	123,000	3,860				4,530			269	213	117	170	4,200

NOTE: The cleanup levels shown above are taken from Table 8-1. The cleanup level for lead is based on the background value developed in the RI.

Table 8-4 presents the same information as Table 8-3, except the chemical results for each station are normalized by dividing the maximum concentration detected at the station by the corresponding cleanup level. When normalized in this manner, values greater than 1 indicate an exceedance of the cleanup level and thus identify stations where remediation should be considered. For purposes of clarity, values less than 1 have been omitted from Table 8-4. The normalized results in Table 8-4 are intended to distinguish which stations have the highest risk from those with lesser risk, relative to the cleanup levels. For example, an exceedance value of 20 in Table 8-4 means that the chemical exceeded the cleanup level at that station by a factor of 20, whereas an exceedance value of 2 means that the chemical concentration was only 2 times the cleanup level.

Based on the exceedances of cleanup levels illustrated in Table 8-4, the following stations were selected for remedial action: 16-4, 16-6, 16-7, 16-11, and 16-35. These stations are identified as shaded columns in Table 8-4, and their locations are shown in Figure 8-1. These stations were selected for remediation based on the following considerations:

- Stations exhibiting the highest risk, as indicated by the exceedance values in Table 8-4 much greater than 1, were selected for remediation. These stations were selected because they appear to represent areas of more serious contamination.

- Stations exhibiting high TPH concentrations (exceedance values of about 20 or more in Table 8-4) were selected for remediation. High TPH concentrations were used as an indicator of significant ecological risk, for the reasons discussed in Section 8.1.3.

Stations were not selected for remediation based on the following conditions:

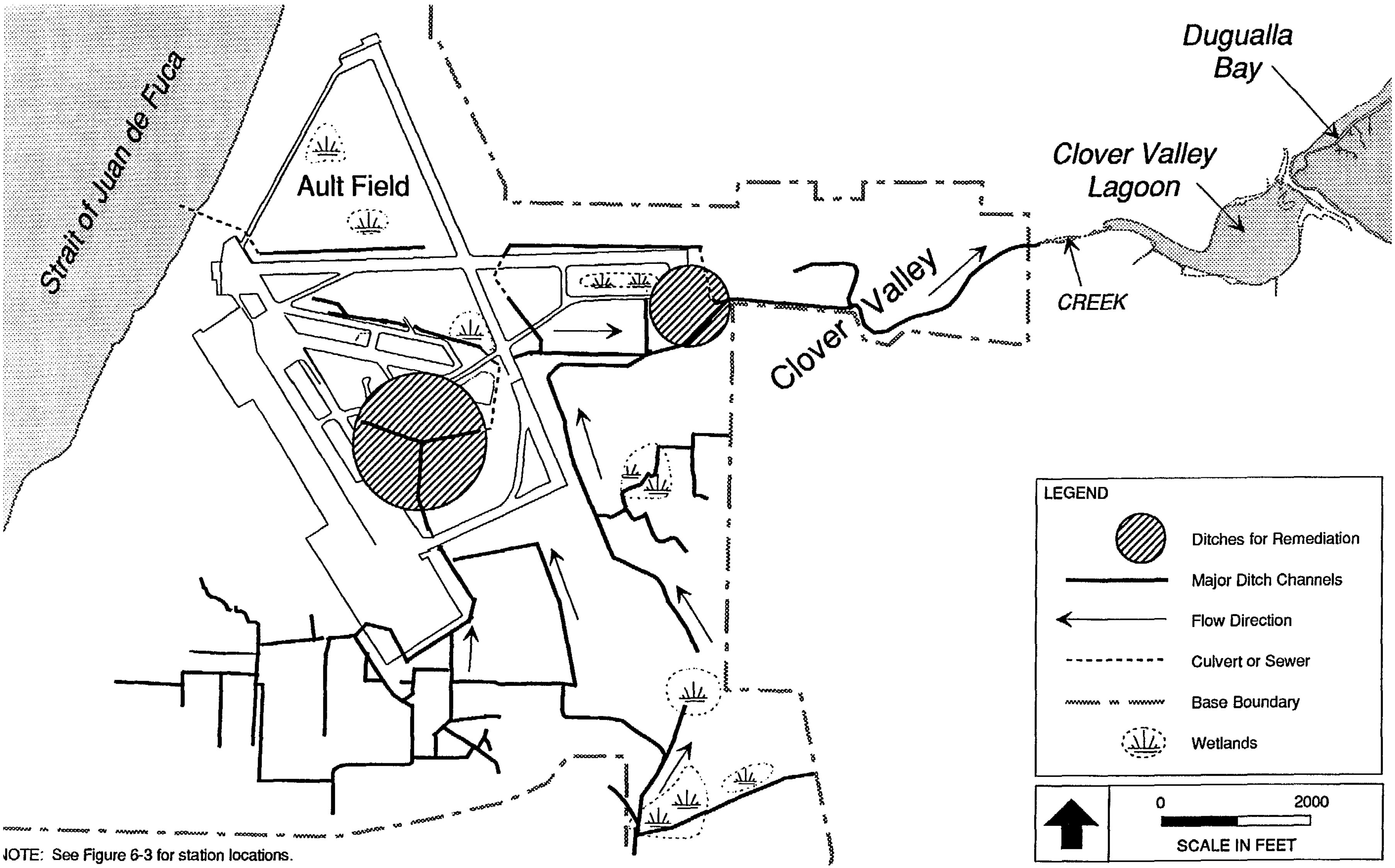
- Stations having only one or two chemicals with relatively small exceedance values were not selected for remediation.

- Stations 16-9 and 16-31 were not selected for remediation because of their proximity to the heron rookery in addition to the relatively low exceedance values associated with these stations. The ecological exposure assessment using the heron as a receptor did not show significant risk to these birds for chemicals detected in the sediments. Remedial actions at these stations would result in unavoidable disturbance of the rookery and destruction of part of its habitat. In view of the protected status of the great blue heron and the relatively low risk to other organisms posed by the sediments at these stations, it was decided that these particular stations should not be remediated.

Table 8-4
Exceedances of Cleanup Levels at Runway Ditch Sediment Stations

Chemical	Cleanup Level mg/kg	Exceedances of the Cleanup Levels at Each RI Sampling Station (Maximum Detected Concentration Divided by the Cleanup Level)																
		Station 16-1	Station 16-2	Station 16-3	Station 16-4	Station 16-6	Station 16-7	Station 16-8	Station 16-9	Station 16-10	Station 16-11	Station 16-12	Station 16-25	Station 16-31	Station 16-32	Station 16-33	Station 16-34	Station 16-35
Arsenic	16			5					1		2	2				3	2	36
Lead	18		2		52	46	9				8	4		2				21
2-methyl naphthalene	0.8				4									2				
Benzo(k) fluoranthene	18				1													
Dibenz(a,h) anthracene	1.1													2				
Phenanthrene	13				2													
TPH	200		2		225	615	19				23			1	1			21

Notes: 1. The shaded columns indicate those stations selected for remediation.
2. The cleanup levels shown above are taken from Table 8-1; the cleanup level for lead is based on the background value developed in the RI.



NOTE: See Figure 6-3 for station locations.

CLEAN
COMPREHENSIVE
LONG-TERM
ENVIRONMENTAL
ACTION NAVY

Figure 8-1
Ditch Segments Selected for Remediation

CTO 0074
OPERABLE UNIT 3
NAS WHIDBEY, WA
RECORD OF DECISION

CTO74\ROD\FIG8_1.DRW 3/22/95

Several of the ditch sediment stations not selected for remediation exhibited moderate exceedance values for arsenic and lead (e.g., Stations 16-3 and 16-12). Such stations were not selected for the following reasons:

- Except for a few of the sediment stations, the RI data showed arsenic and lead to be widespread, non-localized chemicals detected throughout the ditches at concentrations not substantially different from background values. Because of statistical variations in background concentrations for these chemicals, many of the moderate exceedances found in the ditches may not represent a significant contaminant source that is distinguishable from background levels.

- The estimated ecological risk posed by lead and arsenic at the nonselected stations is relatively small and represents an increment above background that may not be significant.

- Remediation of non-localized arsenic and lead concentrations would be impractical because of the large areas of the ditches and large volumes of sediments that would be involved.

- There is considerable uncertainty in modeling and quantifying human and ecological risks . To accommodate this, the assumptions and models used to evaluate chemicals of potential concern in baseline risk assessments are selected to be overly conservative, and thus tend to overstate actual risks. Because of this, some latitude in selecting areas for remediation is prudent in order to avoid excessive cleanup expenses that may not achieve significant benefits. The non-chemical bioassessments conducted for the ditch sediments support this idea. For example, the bioassay and bioassessment results showed no adverse effects or benthic impairment at station 16-11 (see Table 8-2) in spite of the moderate exceedances of cleanup levels at this station shown in Table 8-4 for arsenic, lead, and TPH. This evidence indicates that the lesser exceedances of cleanup levels for the unshaded columns of Table 8-4 do not likely represent significant risk.

Several of the stations have much higher concentrations of arsenic and lead that are abnormal compared with typical background values, and are associated with high concentrations of TPH. These stations have been selected for remediation, so that substantial risks attributable to arsenic and lead will not be ignored.

The sampling strategy employed in the remedial investigation was to select a reasonable but minimal number of ditch sediment sampling locations, based on ditch geometry and potential source inputs such as storm sewer discharge points, that would allow for cost-effective identification of those parts of the ditch network for which remedial action is needed. This has been accomplished, with the stations selected for remediation as described in the above paragraphs. As part of this strategy, further sampling of the ditches in the vicinity of these selected stations will need to be conducted during remedial design, in order to establish the full extent of the areas to be remediated.

8.2 CLOVER VALLEY LAGOON AND DUGUALLA BAY

In consideration of CERCLA requirements and the evaluation of risks associated with the Clover Valley Lagoon and Dugualla Bay, no remedial actions are deemed to be necessary for this portion of OU 3 to ensure adequate protection of human health and the environment. This decision is based on the following:

- No significant human health risks were identified for exposure to chemicals detected in either the lagoon or the bay.
- No ecological risks were identified for Dugualla Bay.
- No ecological risks were identified for the surface water in the lagoon.
- Some potential for adverse ecological effects was identified in the baseline risk assessment for chemicals detected in the lagoon sediments. However, the level of risk is low and does not warrant remedial actions, as explained below.

The ecological risk identified for the lagoon sediments is based on several exceedances of sediment quality values (SQVS), exposure modeling using the muskrat as a receptor, and the results of sediment bioassay testing. The SQV and muskrat assessments revealed several chemicals with hazard quotients greater than 1, with a maximum HQ of 6, indicating a relatively low potential for adverse effects. Most of the chemicals having HQs above 1 were metals detected at concentrations similar to background levels, and thus represent little incremental risk compared to background conditions. For non-metals, there were only three chemicals that had HQs greater than 2, two of which were only detected in the deep section of the lagoon. One of these (dimethoate) contributed to the risks predicted for the muskrat via ingestion of vegetation, but the pathway is not realistic because vegetation will not grow in the deep sediments. The highest HQ was for acetone, but this is likely a laboratory artifact as explained in Section 6.2.5. The mitigating factors discussed above for the chemicals with HQs greater than 1 suggest that the adverse effects indicated by the SQV and muskrat assessments are unlikely.

The lagoon sediment bioassay test results confirm a low potential for ecological impacts. The risks indicated by the bioassay tests were evaluated by comparison with the state sediment quality standards (SQS), which indicate no-effects levels, and the state sediment cleanup screening levels (CSLs), which are used to determine when cleanup actions are necessary. Only one of two test species in one of the six sediment samples failed to meet the SQS level. None of the tests failed the CSL criteria. Because all but one of the tests showed little or no impact, the overall risks measured by this approach are low. Because all of the tests passed the CSL criteria, the results indicate that no active cleanup measures are warranted for the lagoon sediments.

The remedial investigation determined that the absence of aquatic life in the bottom portion of the lagoon is due to the anoxic condition (i.e., lack of oxygen) in the deeper parts of the lagoon rather than chemical contamination. The anoxic condition was caused by construction of the dike that separates the lagoon from Dugualla Bay. The dike has interrupted the natural tidal action in the original estuary that formerly mixed the water in the estuary and provided oxygen to its deeper portions. The chemicals detected in the deep lagoon sediments are not believed to be the cause of the absence of aquatic life in the bottom of the lagoon. As discussed above, the risk associated with these chemicals is low and similar to background conditions. Furthermore, the HQ levels observed in the shallow sediments were similar to those in the deep sediments, whereas there is no life at the bottom but the upper part of the lagoon is a viable ecosystem that supports a large sticklebacks fish population, snails, and migratory birds. This comparison supports the conclusion that the absence of life at the bottom of the lagoon is due to its anoxic condition rather than contaminants.

Aquatic life will not flourish in the deeper part of the lagoon unless the anoxic condition is removed. The anoxic condition could be rectified by removing the dike, but such an action would not likely be supported by all citizens because the dike prevents flooding of the adjacent farm lands. With further study, it could be determined if other actions would be able to remove the anoxic condition. However, removal of the anoxic condition is not related to chemical contamination from past practices which CERCLA is intended to address, and such actions are therefore not within the scope of this ROD. Even if the anoxic condition were ameliorated, the low level of risk posed by the chemicals detected in the lagoon sediments would still not warrant remedial actions, for the reasons discussed earlier.

9.0 DESCRIPTION OF ALTERNATIVES

The feasibility study (FS) assessed a range of alternatives for remediation of Area 16 (URS 1994b). Based on the results of the risk assessment and the remedial action objectives discussed in Section 8, the alternatives were developed to address potential risks from contaminated sediments in the runway ditches. No alternatives were developed for remediation of other media because associated risks do no warrant remedial actions for media besides the ditch sediments.

A total of three alternatives were evaluated for possible implementation at Area 16:

- Alternative 1- No Action
- Alternative 2- Ditch Rerouting and Backfilling
- Alternative 3- Sediment Removal and Disposal

The following sections provide a brief description of each alternative evaluated in the FS, including the estimated capital cost and operating and maintenance (O&M) costs for implementation.

9.1 ALTERNATIVE 1- NO ACTION

The no-action alternative was included in the range of alternatives evaluated in the FS, as required by the National Contingency Plan. Alternative 1 includes no specific response actions to reduce contaminants at the site, control their migration, or prevent exposures. The no-action alternative serves as a baseline from which to judge the performance and cost of other action-oriented alternatives.

There is a need at the base for periodic dredging to assure that the ditches adequately carry stormwater away from the airfield operations area and runways. In the past, the Navy has placed the dredgings from such routine maintenance next to the ditch banks, and wants to continue this cost-effective practice. If sediments are placed on the banks, they will then become defined as soils, and be subject to state cleanup standards for soils. Because there is known contamination in the sediments that could lead to exceedances of these soil standards, this practice would not be allowed under this alternative.

Costs for Alternative 1 are:

Capital cost:	$0
Present value of O&M costs:	$0
Total present worth:	$0

9.2 ALTERNATIVE 2- DITCH REROUTING AND BACKFILLING

This alternative would involve rerouting the existing ditches in segments where contaminated sediment has been found, so that these sections of the existing ditch network would be covered and filled with earth. Covering the contaminated segments with earth would eliminate the ecological exposure pathway of concern for Area 16. Risk to ecological receptors is typically considered only to depths of 2 feet (depth of burrowing animals), and covering the sediment with more than 2 feet of earth would essentially eliminate the exposure route for animals such as voles, shrews, and muskrats.

Covering the sediments would convert them to soils that could pose a human health risk to future residents, or might pose ecological risks, if the soils were exposed by future excavation. Because of this, Alternative 2 would include institutional controls in the form of land use restrictions to prevent future excavation. The institutional controls would document the locations of the filled ditches and prevent land use or future activity that would disturb these locations.

Actions for this alternative would include additional in situ sampling of the ditch sediment near sample stations that showed evidence of contamination during the remedial investigation, construction of new ditches around the areas of contamination, and backfilling the existing ditches with excavated soil.

The sampling results would be used to verify the dimensions of existing ditch segments that would be filled and the length and configuration of new ditch segments needed to replace them. If contamination is detected at consecutive sampling points, all the sediments between those points would be remediated.

Segments of new drainage ditch would be constructed with conventional excavation equipment. The new ditch segments would mirror the existing ditch, and material excavated from the new ditches would be used as backfill for placement into the existing ditch sections.

In limited places where the ends of a new ditch segment would need to be tied into an existing ditch near a baffle or culvert, it may be necessary to remove contaminated sediments from the ends of the existing ditch segment rather than simply covering them with backfill. In such cases, the contaminated sediments would be dredged and placed in the center of the old ditch segment before it is backfilled with material from the new ditch.

Estimated costs for Alternative 2 are:

Capital cost:	**$0.6** million
Present value of O&M costs:	$0
Total present worth:	**$0.6** million

These costs were estimated based on remediation of the ditch segments selected for evaluation in the FS. These segments were selected by comparing the RI data for ditch sediments to the preliminary remediation goals developed in the FS, and identifying ditch locations of greatest ecological concern. Because the preliminary remediation goals in the FS were different from the final cleanup levels presented in Section 8, the FS costs were based on several additional ditch segments beyond those selected for final remediation in Section 8 and shown in Figure 8-1. The additional ditch segments included in the FS cost estimates were at stations 16-9, 16-31, and 16-32. Two of these stations are located near the heron rookery (Figure 6-3).

Because presently available data for estimating the extent of the ditch contaminants are limited, the actual scope of the remedial actions is unknown at this time. The actual length and configuration of ditch segments that would be filled and replaced would be determined based on the sampling described earlier.

9.3 ALTERNATIVE 3- SEDIMENT REMOVAL AND DISPOSAL

This alternative would involve removal and disposal of sediments in the runway ditches where contaminated sediment has been found. Removing the contaminated sediments would eliminate the ecological exposure pathway of concern for Area 16, and reduce possible human health risks that may occur if contaminated sediments were dredged in the future for maintenance reasons and placed on the ditch banks.

Actions for this alternative would include in situ sampling of the ditch sediment near the sample locations that showed evidence of contamination during the remedial investigation, excavation or dredging of sediments, and appropriate disposal of the dredged materials. It was assumed that sediment removal would be carried out for the same ditch segments selected for remedial action in Alternative 2 (Figure 8-1). The rationale for the selected ditch segments is the same as in Alternative 2. The in situ sampling would be performed during the design phase to verify the extent of dredging that would be required at each ditch segment. If contamination is detected at consecutive sampling points, all sediments between those points would be excavated.

It was assumed in the feasibility study that the in situ sampling would also be used to determine whether the removed material will be classified as a hazardous waste, and to select appropriate means for disposal (e. g., whether treatment or disposal in a Subtitle C landfill would be required). For hazardous waste profiling purposes, it was assumed that the samples would be analyzed for toxicity characteristic leaching procedure (TCLP) constituents (40 CFR 261 .24[b], Appendix II). Since the sediments are not expected to display the characteristics of ignitability, corrosivity, or reactivity, the assessment of the toxicity characteristic would therefore determine whether or not the soil meets the hazardous waste criteria.

Removal of Area 16 ditch sediments would be done by mechanical dredging. The total quantity of dredged material was estimated to be 3,700 cubic yards, with an average depth of about 2 feet. Dredging operations would be conducted during the dry season and would be scheduled to minimize impacts to the northern harrier population.

Depending on the results of the in situ sampling, the dredged sediments would be transported to either a hazardous waste landfill or a nonhazardous waste landfill for disposal. Based on RI sediment data, little or none of the dredged material is likely to be classified as a hazardous or dangerous waste. Accordingly, it was assumed for the purpose of this alternative that **95** percent of the dredged sediments would pass the hazardous waste criteria and thus could be disposed as nonhazardous waste. The nonhazardous waste would be placed at the Area 6 landfill and then covered by a cap, which is part of the selected remedy for the cleanup of OU 1. It was assumed that the other 5 percent of dredged sediments would need to be treated as a hazardous waste and be disposed at an approved off-site Subtitle C landfill. These assumed percentages have a significant effect on the estimated cost for this alternative. The in situ sampling during the design phase would verify these assumptions prior to implementation.

The estimated costs for Alternative 3 are:

Capital cost:	$0.6 to 1.2 million
Present value of O&M costs:	$0
Total present worth:	**$0.6** to 1.2 million

These costs were estimated based on remediation of the ditch segments selected for evaluation in the FS. This included several additional ditch segments beyond those shown in Figure 8-1, for the reasons explained earlier for Alternative 2.

The cost ranges shown above are dependent upon the extent of sampling and dredging effort that would be required. The lower range cost reflects optimistic assumptions for dredging and dewatering sediments, and a sampling effort equivalent to that assumed for Alternative 2.

If the in situ sampling indicates a significant portion of the sediments are hazardous wastes, additional sampling may be appropriate to better define the extent of the sediments that require hazardous waste management, to avoid unnecessary disposal costs. Such additional sampling and less optimistic sediment handling assumptions are reflected in the upper range cost .

10.0 COMPARATIVE ANALYSIS OF ALTERNATIVES

EPA has established nine criteria for the evaluation of remedial alternatives:

- Overall protection of human health and the environment
- Compliance with ARARs
- Long-term effectiveness and permanence
- Reduction of toxicity, mobility, and volume through treatment
- Short-term effectiveness
- Implementability
- cost
- State acceptance
- Community acceptance

The following sections summarize the detailed evaluation of alternatives presented in the feasibility study. Each remedial alternative is discussed relative to the evaluation criteria, to help identify a preferred alternative.

10.1 OVERALL PROTECTION OF HUMAN HEALTH AND THE ENVIRONMENT

Because there was no unacceptable risk to humans, all of the alternatives would be protective of human health. Adverse ecological risks were identified for muskrats and benthic organisms living in contact with contaminated sediments in the runway ditches.

Alternative 3 would provide the highest level of protection to the environment by removing the contaminated materials to a location that will contain the contaminated sediments and prevent exposures of concern. Because the RI data indicate the contaminants in the sediments are below hazardous waste levels, it is expected most of the dredged material can be readily and safely disposed at the on-site Area 6 landfill prior to its being capped as part of the remedial actions selected for OU 1. The sediments will be analyzed prior to dredging to determine if any are classified as hazardous waste which require treatment prior to disposal at a permitted off-site Subtitle C landfill. If such treatment is needed, it would provide additional protection compared with the other alternatives through reduction of toxicity, mobility or volume of contaminants.

Alternative 1 (the no-action alternative) would not prevent exposures of concern and is not protective of the environment. In addition, under this alternative, the Navy would be unable to perform necessary routine maintenance of the runway ditches in the future. Because Alternative 1 would not provide adequate overall protection of the environment and does not meet this threshold criterion, it is eliminated from further consideration and is not included in the following sections that discuss the remaining evaluation criteria.

Alternative 2 would eliminate ecological risks by covering the contaminated ditch sediments, thereby preventing organisms such as muskrats from being exposed to the contaminated sediments. However, the contaminated material would not be removed from the site, and these substances could be exposed if the covered areas were excavated in the future. This alternative would rely on institutional controls to prevent future excavation in places where sediments are covered.

10.2 COMPLIANCE WITH APPLICABLE OR RELEVANT AND APPROPRIATE REQUIREMEN TS (ARARS)

No chemical-specific ARARs were identified for the runway ditch sediments, so compliance with this criterion would be equally met by all of the alternatives. On the other hand, non-promulgated chemical criteria, which constitute guidance "to be considered" (TBC), were identified in the baseline risk assessment and were considered in the development of preliminary remediation goals for evaluating alternatives in the FS. The TBCs would be met to an equivalent degree by Alternatives 2 and 3, either by covering the material of concern so that it no longer is present as sediment, or by dredging to remove the material from the site. Although these TBCs were used to develop cleanup levels, they are unenforceable guidelines, and compliance with them is not mandatory.

Although under Alternative 2 the contaminants would be covered with soil, they would be left at the site. However, once the sediments are covered, they become soils, and some of the contaminants would then exceed state cleanup levels for soils. Although state cleanup levels would be exceeded, state requirements could be met because the soil cover and institutional controls would control the potential human exposures on which the cleanup levels are based.

It is anticipated that compliance with location- and action-specific ARARs could be achieved for all of the alternatives. Consultation with a number of regulatory agencies (wetlands, floodplains, wildlife) would be necessary under Alternatives 2 and 3 to assure that substantive elements of location- and action-specific ARARs were met. On-site construction equipment and activities would be very similar for Alternatives 2 and 3. Alternative 2, however, might be viewed less favorably by these regulatory agencies, because it would involve filling as well as dredging and because it may involve more extensive clearing than Alternative 3 in order to construct the new ditches.

10.3 LONGTERM EFFECTIVENESS

Alternative 2 would be effective over the long-term in preventing ecological exposures of concern, provided that the soil cover is not disturbed by future construction activity. Alternative 2 would not provide as permanent a remedy as Alternative 3 because the contaminants would be left at the site rather than removed, and institutional controls would be relied on to prevent disturbance of the cover.

Alternative 3 offers better long-term effectiveness because it would permanently remove the contaminated sediments to another location. These sediments would be covered with an impermeable cap during closure of the Area 6 landfill (or an off-site landfill if one is used).

10.4 REDUCTION OF TOXICITY, MOBILITY, OR VOLUME THROUGH TREATMENT

The need for treatment was considered for the contaminated sediments. However, based on the chemical concentrations detected in the RI sediment samples, it is believed that testing during remedial design will not result in the contaminated sediment being designated as a dangerous or hazardous waste. If this is so, treatment will not be required for disposal. The need for and degree of required treatment depends on whether the material to be disposed has acceptable concentrations of chemicals compared with criteria defined in hazardous and dangerous waste regulations. The RI results for the ditch sediments were compared to these criteria, and it was determined that no treatment would be required prior to disposal and that concentrations are low enough that treatment is not necessary for overall protection of human health and the environment. Therefore, there was no reason to evaluate treatment alternatives and none of the alternatives satisfy this evaluation criterion.

10.5 SHORT-TERM EFFECTIVENESS

None of the alternatives would likely pose health risks during impiementation. Workers and nearby residents would be protected during construction by engineering and safety controls. Short-term environmental impacts would be mitigated by isolating the ditch being remediated and diverting stormwater during construction activities, in order to confine impacts to the segments being remediated. Alternatives 2 and 3 would both achieve remedial action objectives in a similar time frame. This may take up to a year, because work around the ditches could only be accomplished during the dry season. Remedial action objectives would be met in Alternative 2 by containment and institutional controls, although contaminants would remain at Area 16. For Alternative 3, cleanup levels would be achieved in the ditches because contaminated sediments would be removed and disposed in a controlled landfill. Unavoidable short-term ecological impacts would occur to a similar degree under both Alternative 2 and Alternative 3; these include temporary disruption of habitat and destruction of existing benthic organisms. In either case, it is expected that the benthic organisms would repopulate aud establish a healthier community.

10.6 IMPLEMENTABILITY

Alternative 3 would present some Navy flightline operational concerns at Ault Field as a result of work in the ditches around the runways and taxiways. Rocks or dirt could fall onto the taxiways from trucks hauling excavated sediments to the disposal site; this would present severe safety hazards to aircraft and pilots because debris could be sucked into the aircraft engines. Therefore, coordination with airfield operations staff would be required. For example, the flight operations would have to be suspended while dredged material is hauled out of the infield area as trucks cross the taxiways and runways. Because the infield area is completely surrounded by taxiways and runways, there is no alternative route for removing the material that would avoid temporary suspension of flight operations.

These flightline concerns would be less important for Alternative 2. There would be less risk to aircraft and crew from foreign objects or debris being picked up by the aircraft engines, because Alternative 2 does not involve hauling sediments across the runways.

Another consideration for Alternative 3 is that the timing of the dredging and disposal of sediments must be coordinated with the Area 6 landfill capping to ensure that the sediments are disposed before the final cap is constructed. A delay in the schedule for the OU 3 could cause a delay in the schedule for capping the landfill. Coordination with the Area 6 landfill closure is important because the costs for Alternative 3 would be substantially higher if an off-site landfill must be used.

Alternatives 2 and 3 would both be easy to implement from a construction standpoint. Both alternatives involve straightforward application of common construction equipment. However, the other factors described above would make Alternative 3 harder to implement than Alternative 2. Alternatives 2 and 3 would both require an environmental protection plan to prevent degradation of water quality during construction.

10.7 COST

The estimated present worth cost of Alternative 2 is $0.6 million. The estimated present worth cost for Alternative 3 ranges between $0.6 and $1.2 million, depending on the extent of sampling and dredging effort that would be required for implementation. The cost of Alternative 3 could be substantially higher if design phase sampling shows the sediments must be treated or disposed as a hazardous waste. However, if the design phase sampling confirms the findings of the RI, the sediments will not need to be treated or disposed off site, and the cost of Alternative 3 would be comparable to that of Alternative 2.

The cost estimates were prepared using costing techniques that typically achieve an accuracy of +50 percent to - 30 percent for a specified scope of actions. Additional uncertainty in the costs is introduced by variations in the volumes and other quantities assumed for the estimates.

10.8 STATE ACCEPTANCE

Ecology has been involved with the oversight and review of the remedial investigation (URS 1994a), feasibility study (URS 1994b), and proposed plan (URS 1994c). Ecology comments have resulted in substantive changes to these documents.

10.9 COMMUNITY ACCEPTANCE

On July 26, 1994, the Navy held an open house and a public meeting to discuss the proposed plan for final action at OU 3. The proposed plan identified Alternative 3 as the preferred alternative for OU 3, and discussed the other alternatives being considered. The results of the public meeting indicated that community members generally supported the Navy's preferred alternative for remediating the runway ditches. However, some community members submitted comments that did not support the proposed plan. One commenter wanted the Navy to take no action, while another felt the Navy should do more than any of the alternatives presented in the proposed plan.

A responsiveness summary, which addresses questions and comments received during the public meeting and the public comment period is attached to this ROD (Appendix A).

11.0 THE SELECTED REMEDY

The Navy has chosen Alternative 3 (sediment removal and disposal) as the selected remedy to mitigate current ecological risks associated with the runway ditch sediments and hypothetical human health risks if they are dredged in the future for maintenance. Removing sediments from those segments of the ditch where contaminants have been found that contribute to unacceptable risk and placing the dredged sediments under the cover of the Area 6 landfill (or in an off-site Subtitle C landfill) will accomplish the objective of protecting human health and the environment.

The major components of the selected remedy include the following actions:

- Sample and analyze sediments in the ditch segments identified as contaminated during the remedial investigation, to determine the extent of contamination that needs to be removed.

- Compare the sample results to RCRA criteria for toxicity characteristic wastes (i.e., TCLP criteria in 40 CFR 261.24) to determine whether the sediments to be dredged will need to be treated and disposed as a hazardous waste or dangerous waste. Initially, this comparison will be done using the total concentrations detected in the sediment samples (rather than leachate concentrations), divided by a factor of 20 to account for the 20-fold dilution that occurs in the TCLP test. If any sample fails the TCLP criteria based on this initial approach, resampling and reanalysis using the TCLP test will be considered to obtain actual leachate results for comparison with the TCLP criteria.

- Dredge the sediments from those portions of the ditch segments determined by the sampling to be contaminated in comparison with the selected cleanup levels shown in Table 8-1.

- For those sediments determined to be non-hazardous waste, haul the dredged sediments to the Area 6 landfill and place them so they will be under the final cover system when it is completed.

- For any sediments determined to be hazardous waste, haul the dredged sediments to a permitted off-site facility for appropriate treatment and disposal.

The above actions will be carried out for those segments of the runway ditches identified in Section 8 (Figure 8-1). These actions will require an environmental protection plan to prevent degradation of water quality during remediation. The actions are based on the cleanup levels described in Section 8.1.3, which include MTCA C industrial soil cleanup levels with the assumption that land use at the ditches will remain industrial (non-residential) in the future. If future land use changes to non-industrial activity, these cleanup levels and actions will be reevaluated.

The Navy sampled the ditches in January 1995. Based on preliminary results, the entire length of the ditch segments identified in this ROD for potential remedial action will require cleanup . Confirmation of these results will be made in consultation with EPA.

12.0 STATUTORY DETERMINATIONS

Under CERCLA Section 121, selected remedies must be protective of human health and the environment, comply with ARARs, be cost-effective, and use permanent solutions and alternative treatment technologies to the maximum extent practical. In addition, CERCLA includes a preference for remedies that use treatment that significantly reduces volume, toxicity, or mobility of hazardous wastes as their principal element. How the selected remedy for Area 16 meets these statutory requirements is discussed in the following sections.

12.1 PROTECTION OF HUMAN HEALTH AND THE ENVIRONMENT

The selected remedial action for Area 16 will protect human health and the environment through sediment removal and disposal actions. Implementation of these remedial actions will not pose unacceptable short-term risks to site workers or nearby residents. Placement of the dredged sediments under the cap of the Area 6 landfill (or an off-site hazardous waste landfill) will prevent direct exposure to contaminants by ecological receptors.

The selected remedy corresponds with Alternative 3 of the feasibility study. This alternative is preferred over the other alternatives that were evaluated because it will result in a more permanent solution for OU 3. Unlike the other alternatives, the selected remedy will remove the contaminants of concern from Area 16 and provide effective, long-term containment of the contaminated material in a capped, controlled landfill.

12.2 COMPLIANCE WITH ARARS

The selected remedy for area 16 will comply with federal and state ARARs that have been identified. No waiver of any ARAR is being sought or invoked for any component of the selected remedies. The ARARs identified for OU 3 are discussed in the following sections.

12.2.1 Chemical-Specific ARARs

There are no chemical-specific standards that are considered ARARs for the freshwater sediments in the Area 16 runway ditches.

12.2.2 Location-Specific ARARs

- Federal Executive Order 11990, 40 CFR Part 6, Appendix A is applicable to the actions that may affect the wetlands at Area 16.

- The Endangered Species Act (16 USC §1531 promulgated by 33 CFR $$320-330) is relevant and appropriate to Ault Field in general because several birds and plants listed as sensitive or threatened species are known to inhabit the base. However, the actions of the selected remedy at Area 16 will not affect critical habitat of these species.

12.2.3 Action-Specific ARARs

- Section 404 of the Clean Water Act (Federal Water Pollution Control Act, 33 USC §§1344 promulgated by 33 CFR $$320-330 and 40 CFR §230), which requires the minimization and mitigation of impacts due to unavoidable dredging or filling activities in navigable waters including wetlands, is applicable to the dredging activities of the selected remedy at Area 16.

- Federal Resource Conservation and Recovery Act (regulations set forth in 40 CFR §§261, 262, 263, and 268), which specifies waste identification, storage, manifest, transport, treatment, and disposal requirements for solid waste that may contain hazardous substances, is applicable to the ditch sediments that will be dredged during remediation of Area 16.

- State of Washington Dangerous Waste Regulations (WAC 173-303), which specify waste identification, storage, manifest, transport, treatment, and disposal requirements for solid waste that may contain hazardous substances, is applicable to the ditch sediments that will be dredged during remediation of Area 16.

- Federal Clean Air Act General Provisions (40 CFR §52) and Puget Sound Air Pollution Control Authority (PSAPCA) Regulation 1, Section 9.15 for the control of fugitive dust during construction activities, is applicable to the ditch sediment removal and disposal actions of the selected remedy.

12.2.4 Other Criteria, Advisories, or Guidance

This section discusses other criteria, advisories, or guidances that are considered to be appropriate for the remedial actions of the selected remedy for Area 16.

If any of the ditch sediments dredged during remediation of Area 16 are determined to be hazardous wastes that must be disposed in an off-site RCRA Subtitle C landfill, the NCP off-site disposal rule (40 CFR $300.440) must be followed. This will require that the Navy obtain prior certification from EPA that any off-site landfill to be used for this purpose is in compliance with RCRA regulations stipulated by the off-site disposal rule.

As discussed in Section 8.1.3, industrial soil cleanup levels of the State of Washington Model Toxics Control Act (MTCA; Chapter 70. 105D RCW) as codified in Chapter 173-340 WAC were used as guidance for developing cleanup levels for the ditch sediments at Area 16. These cleanup levels are considered to be guidance rather than ARARs because they apply to remediation of soil rather than sediments under MTCA.

12.3 COST-EFFECTIVENESS

The selected remedy for Area 16 is cost-effective because it has been determined to provide overall effectiveness proportional to its cost, with an estimated present worth cost of $0.6 to $1.2 million. This range in cost reflects different assumptions regarding the extent of sampling and dredging effort that will be needed. If remedial design phase sampling confirms the findings of the RI, it is anticipated that the cost of the selected alternative would be comparable to that of Alternative 2, which was estimated to have a present worth cost of $0.6 million.

Although the upper range of the estimated cost for the selected remedy indicates that it could be twice as expensive as Alternative 2, it would provide a solution with much better long-term effectiveness, because the contaminants of concern would be permanently removed from the runway ditches and contained in a controlled landfill rather than just being covered and left in place and covered with soil to prevent exposures.

Although the selected remedy has a number of implementation difficulties associated with flightline operations that would be avoided in Alternative 2, the Navy has determined that these difficulties are not critical constraints, and they can be accommodated in the interest of achieving a more protective and permanent remedial action.

The cost of the selected remedy could be substantially higher if the remedial design phase sampling shows that a significant portion of the sediments must be treated or disposed as a hazardous waste. Should this occur, the cost-effectiveness of the selected remedy could be reevaluated. As discussed earlier, the RI sediment data suggest that this is not very likely.

12.4 UTILIZATION OF PERMANENT SOLUTIONS AND TREATMENT TECHNOLOGIES TO THE MAXIMUM EXTENT PRACTICAL

The selected remedy represents the maximum extent to which permanent solutions and treatment technologies can be utilized in a cost-effective manner for Area 16. It is protective of human health and the environment, complies with ARARs, and provides the best balance of tradeoffs in terms of long-term effectiveness, permanence, short-term effectiveness, implementability, cost, and reductions in toxicity, mobility, or volume achieved through treatment. The selected remedy meets the statutory requirement to use permanent solutions to the maximum practical extent. The dredged sediments will be placed in a controlled on-site landfill (Area 6) and will be covered by an impermeable liner when the landfill is capped. This will provide for practical, permanent containment of the contaminated sediments; because the contaminants in sediments are relatively immobile chemicals (i.e., strongly sorbed), additional measures to reduce mobility would not be cost-effective.

In selecting the preferred remedy from the alternatives evaluated, long-term effectiveness was the most important non-threshold (balancing) criterion. By removing the contaminants from the runway ditches, the selected remedy will provide a much more permanent solution for OU 3 than would Alternative 2. Sediment removal and disposal in the Area 6 landfill (or an off-site hazardous waste landfill if needed for the more contaminated sediments) will provide more effective, long-term containment of the contaminated material than leaving the sediments in place and covering them with soil.

12.5 PREFERENCE FOR TREATMENT AS A PRINCIPAL ELEMENT

The selected remedy is not expected to meet the statutory preference for selecting remedial actions that employ treatment technologies to permanently and significantly reduce the toxicity, mobility, or volume of the hazardous substances as a principal element. Although the selected remedy will include off-site treatment of dredged sediments if this is necessary to bring chemical concentrations into compliance with hazardous waste disposal regulations, this treatment is not expected to be needed for the majority of the sediments and it would not reduce the mobility, toxicity, or volume of hazardous residuals left at the site.

Because of the wide range of chemical types detected in the sediments, and their relatively low concentrations in comparison with hazardous waste designation criteria, treatment processes are not expected to be cost-effective for the bulk of the sediments that will be remediated. It is anticipated that a small portion of the sediments may have high concentrations of contaminants for which treatment may be required and effective. Off-site treatment, as included in the selected remedy, will be the most cost-effective approach for the small quantities that are expected.

13.0 DOCUMENTATION OF SIGNIFICANT CHANGES

The proposed plan, released for public comment in July 1994, discussed remedial action alternatives for both Area 16 and Area 31. The proposed plan identified Alternative 3 as the preferred alternative for Area 16. The Navy reviewed all written and verbal comments submitted during the public comment period for Area 16. Upon review of these comments, it was determined that no significant changes to the remedy for Area 16, as it was originally identified in the proposed plan, were necessary to satisfy public concerns. However, the preferred alternative has been slightly modified for a different reason. Although the overall concept of the preferred alternative and the remedial technologies to be used have remained the same, one of the ditch sediment stations identified for remediation in the proposed plan has not been retained for remediation in the selected remedy.

The sediment station that has been deleted from the remedial action is station 16-32. **This** station had been included among the ditch segments to be remediated in the proposed plan, based on the preliminary remediation goals listed in the FS Report. Based on the final cleanup levels presented in Section 8, remediation of station 16-32 is no longer considered to be necessary. The rationale for this decision is detailed in Section 8. Removing station 16-32 represents a change to a component of the preferred alternative. Because trees and shrubs would have to be removed to gain access for remediating this station, this would cause significant environmental damage compared with the small reduction in risk that would be achieved by removing the sediments.

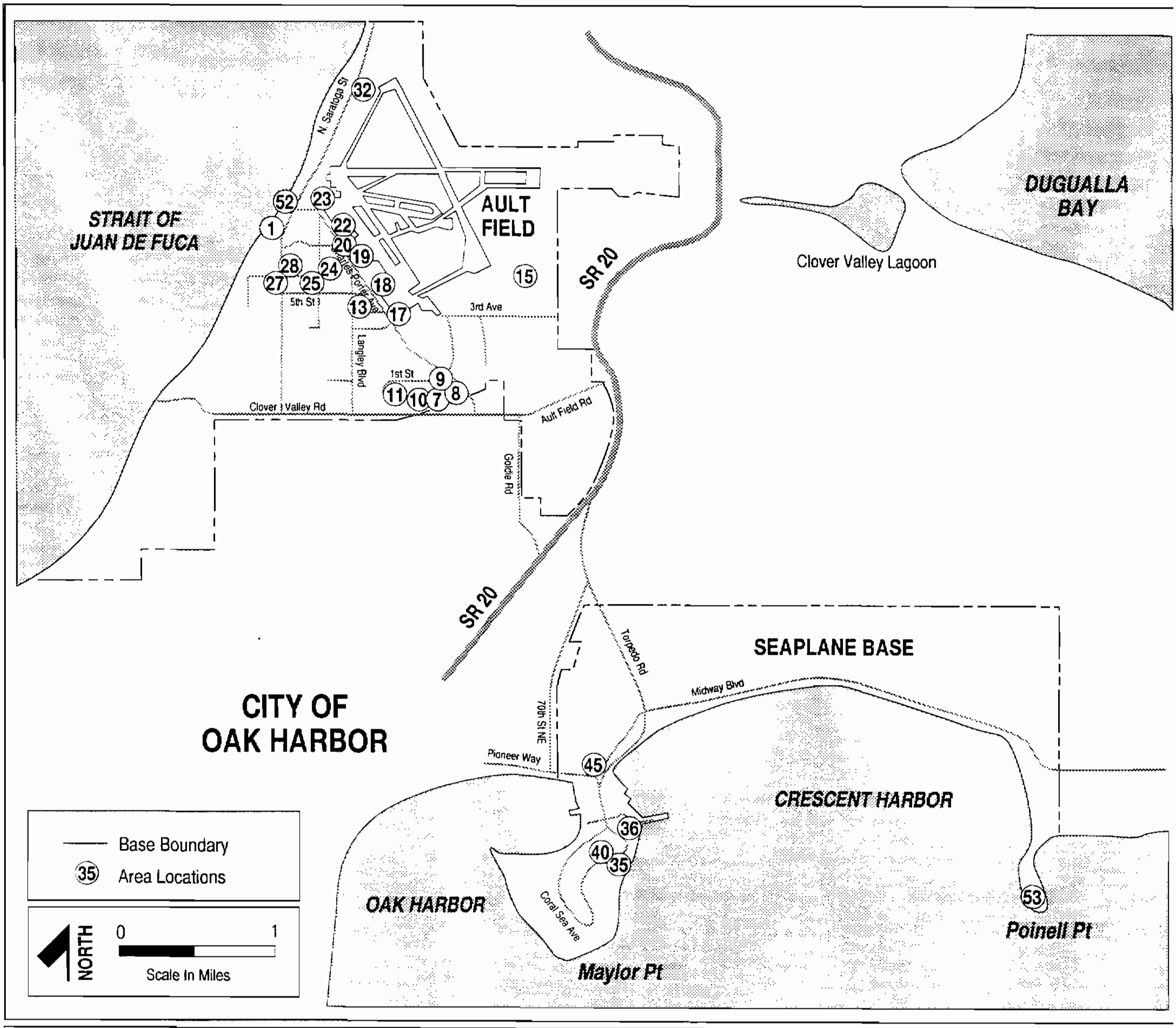
In response to public comments, the need for remedial action at Area 31 will be reevaluated based on further characterization of the site. In order to allow more time for the reevaluation of Area 31 while proceeding with a decision for Area 16, Area 31 has been removed from OU 3. Area 31 will be incorporated into the decision process and the ROD for OU 5. Removing Area 31 from OU 3 represents a significant change compared with the proposed plan. At the present time, the Navy has not formulated a revised preferred alternative for Area 31, so it is premature to evaluate the significance of changes that may occur to the remedy for Area 31.

14.0 RESULTS OF THE HAZARDOUS WASTE EVALUATION STUDY

Operable units for NAS Whidbey Island were created when the Navy entered into a federal facility agreement (FFA) with the Washington Department of Ecology and EPA in September, 1990. At that time, 26 areas scattered throughout NAS Whidbey Island (both Ault Field and the Seaplane Base) that were not included in the operable units were identified as possible areas of contamination. However, very little was known about these areas. As part of the FFA, the Navy agreed to perform a screening-level investigation known as the "Hazardous Waste Evaluation Study. " This study was designed to determine whether sufficient contamination existed to warrant further investigation, some type of remedial action, or no action at any or all of the 26 study areas. The locations of these areas are shown in Figure 14-1.

Table 14-1 shows the results of the Hazardous Waste Evaluation Study. This table lists the areas that were investigated, the results of the investigation, and the decision made for each study area. For each of the areas, soil and groundwater samples were collected. The results of the sampling were evaluated against standard Superfund exposure assumptions for residential use at a 10^{-6} or lower cancer risk level, state cleanup levels (MTCA Method B), and background levels to determine if cleanup actions were necessary.

Results of the study indicated that two of the areas require further investigation and potential remedial action. Therefore, the Navy created a new operable unit (OU 5) that consists of the Area 1 Beach Landfill and the Area 52 Jet Engine Test Cell. In addition, in 8 of the study areas, the Navy will conduct limited removal actions ranging from removal of site structures to extraction of floating oil in groundwater. The remaining 16 study areas were found to be clean and require no further action. None of the 26 study areas is a RCRA-related unit. The actions planned for each area are listed in Table 14-1.



CLEAN COMPREHENSIVE LONG-TERM ENVIRONMENTAL ACTION NAVY	**Figure 14-1** **Locations of Hazardous Waste Evaluation Study Areas**	CTO 0074 NAS WHIDBEY ISLAND, WA RECORD OF DECISION

Table 14-1
Disposition of Hazardous Waste Evaluation Study Areas

Study Area	Reason for Potential Concern	Media Sampled/Potential Contaminants	Results	Decisions
Area 1 - Beach Landfill	Contaminated Soils/Sediments Eroding into Marine Environment	Soil, Sediment, GW/VOCs, PAHs, Pesticides, Metals	DDT, PCBs in Sed. < MTCA, Metals in GW > MTCA	Investigate Under OU5
Area 7 - Old Waste Storage Tank Spills	Contaminated Soil and GW from Past Spills	Soil, GW/VOCs, SVOCs, Inorganics	GW Inorganics Comparable to Background Levels	No Further Action
Area 8 - Sewage Sludge Disposal Area	Soils Contaminated by inorganics Concentrated in Sludges	Soil/Inorganics	Soil Inorganics Comparable to Background	No Further Action
Area 9 - Asphalt Plant Disposal Area	Contaminated Soils	Soil, Sediment, Surface Water/VOCs, SVOCs	Inorganics at Background, Phthalates Attributed to Lab	No Further Action
Area 10 - Bldg. 2536, PCP Dip Tank	Contaminated Soils from Spills	Soil/SVOCs, PCBs	No Detection	No Further Action
Area 11 - Fuel Farm 4	Soils and GW Contaminated by Tank Cleaning Byproducts	Soil, GW/Inorganics, VOCs, SVOCs, Pesticides, PCBs	VOCs In Soil, GW < MTCA Inorganics = Background	Removal Action - Close Drywells to Prevent Future Contamination
Area 13 - Fuel Farm 3	Soils and GW Contaminated by Tank Cleaning Byproducts	Soil, GW/Inorganics, VOCs, SVOCs, Pesticides, PCBs	VOCs in Soil < MTCA, Lead >RBSCs, Free Product Present	Removal Action - Remove Free Product, Close Drywells
Area 15 - PD-680 Spill	Spill, Leaks from HW Storage Tank	Soil, Sediment/VOCs, SVOCs	PAHs, DDE in Sed. < RBSCs	Removal Action - Remove Abandoned HW Storage Tank
Area 17 - Old Ault Field Coal Pile	Soil and GW Contaminated by Pile Leachate	Soil/SVOCs, Inorganics	Inorganics Comparable to Background, SVOCs < RBSCs	No Further Action

Table 14-1 (Continued)
Disposition of Hazardous Waste Evaluation Study Areas

Study Area	Reason for Potential Concern	Media Sampled/Potential Contaminants	Results	Decisions
Area 18- Ault Field Nose Hangar	Soils and GW Contaminated by Aircraft Maintenance Operationa	Soil, GW/ VOCs, SVOCs, PCBs, Pesticides, Inorganic	Inorganic Comparable to Background, VOCa < RBSCs	No Further Action
Ares 19- Fuel Truck Depot	Petroleum Contaminated Soils	Soil/Total Petroleum Hydro.	TPH Below MTCA Levels	No Further Action
Area 20- Ault Field Sewage Clarifier	Soils and GW Contaminated by Wastewater Tank Leakage	Soil/VOCs, SVOCs, Inorganic	Organics < MTCA, Inorganic Comparable to Background	Removal Action - Remove Abandoned HW Storage Tank
Area 22- Hangar 5	Soil and GW Contaminated by Aircraft Maintenance Operations	Soil, GW/ VOCs, SVOCs, PCBs, Pesticides, Inorganic, TPH	VOCa < MTCA, Inorganics Comparable to Background	No Further Action
Area 23 -Northwest Apron Ares	Contaminated Soila/Sedimenta Eroding into Marine Environment	Soil, Sediment, GW/VOCs, PAHs, Pesticides, Metals	VOCS Detected < RBSCs	No Further Action
Area 24- Bldg. 283, PCP Dip	Contaminated Soil from Paat Spills	Soil / SVOCs, TPH	No PCP, TPH < MTCA	No Further Action
Area 25- Bldg. 120, Xforrner Area	Soils Contaminated by PCBS	Soil/PCBs	No Detections	No Further Action
Area 27-1966 Fire School	Soils and GW Contaminated with Unburned Fuels and Solvents	Soil/VOCs, SVOCs	BTEX < MTCA, RBSCS	No Further Action
Area 28- Chapel Fire School	Soils and GW Contaminated with Unburned Fuels and Solvents	Soil/VOCs, SVOCS, Pesticides, PCBs, Inorganic	Organics < MTCA, RBSCs, GW Inorganic Compare to Background	No Further Action
Area 32- Bldg. 889, Transformer Service Ares	Migration of PCB Contaminated Sediment to Strait	Soil, Sediment/ PCBa	No Detections	No Further Action

Table 14-1 (Continued)
Disposition of Hazardous Waste Evaluation Study Areas

Study Area	Reason for Potential Concern	Media Sampled/Potential Contaminants	Results	Decisions
Area 34 - Machine Gun Range Berms	**Soils and Sediments Contaminated by Gun Cleaning Solvents**	**Soil/VOCs**	**Organics** < MTCA, **RBSCs**	No Further Action
Area 35- Fuel Farm 2	Soils and **GW** Contaminated by Tank Cleaning Byproducts	Soil, **GW/Inorganics, VOCs, SVOCs,** Pesticides, PCBS	**Soil Organics** < MTCA GW BTEX > **RBSCs**	Removal Action - Close **Drywells** to Prevent Future Contamination
Ares 36- Fuel Farm 1	Soils and GW Contaminated by Tank Cleaning Byproducts	Soil, **GW/Inorganics,** VOCS, SVOCS, Pesticides, PCBS	Soil **Organics** < **RBSCs** **GW** BTEX > **RBSCs**	Removal Action - Close **Drywells** to Prevent Future Contamination
Area 40- Seaplane Base Coal Pile	**Soil** and **GW Contaminated by Pile Leachate**	**Soil/SVOCs,** Inorganic	Soil SVOCa < **RBSCs,** MTCA Inorganic Compare to Background	No Further Action
Area 45- TCE Tank	Soils and GW Contaminated by Tank **Leaks**	Soil, **GW/VOCs, SVOCs,** Pesticides, PCBS, Inorganic	**Organics** < **RBSCs,** MTCA **GW** Inorganic Compare to Background	Removal Action - Remove Abandoned TCE Tanka
Area 52- Jet Engine Test Cell	Soils and GW Contaminated by Fuel Leaka and **Maint.** Activities	Soil, **GW/VOCs,** SVOCS, TPH	**GW Organics > RBSCs, MTCA** **Free Product Present**	**Investigate Under OU 5**
Area 53 -**Polnell** Point Ordnance Area	Soil Contaminated by Ordnance	Soil/ Ordnance	**No Detections**	**No Further Action**

RBSC EPA **Risk** Based Screening Concentrations
TPH - Total Petroleum Hydrocarbons
SVOC - **Semivolatile** Organic Compounds
PCB - **Polychlorinated Biphenyls**
PAH **Polynuclear** Aromatic Hydrocarbons
BTEX - Benzene, **Toluene, Ethylbenzene, Xylene**
VOC - Volatile Organic Compounds
MTCA - Model **Toxics** Control Act

NOTE: BTEX are common fuel constituents.

The planned actions for these 26 study areas are included in this ROD to formally document the results of the Hazardous Waste Evaluation Study. Detailed information on the sampling plan and sampling results can be found in the "Final Hazardous Waste Evaluation Study Report, " which is part of the Administrative Record. The results of the study were presented in the proposed plan for OU 3 and no public comments were received. The Washington Department of Ecology was involved in the scoping and review of the study and concurs with the decisions presented in Table 14-1.

APPENDIX A
RESPONSIVENESS SUMMARY

This responsiveness summary addresses public comments on the proposed plan for remedial action at Naval Air Station (NAS) Whidbey Island, Operable Unit 3 (OU 3). The proposed plan was reviewed by the public members of the Restoration Advisory Board (RAB), and their comments were incorporated into the proposed plan. The public comment period on the proposed plan was held from July 19, 1994, to August 18, 1994.

A public meeting was held on July 26, 1994, to present and explain the proposed plan and solicit public comments. Members of the public and the RAB attended the meeting. During the meeting all questions and comments were recorded by a court reporter. The transcript of this meeting was provided to all attendees of the public meeting and is available in the Administrative Record. Questions raised and answers given during the public meeting have been summarized and are grouped below in the following categories: off-site properties, harrier study, Clover Valley Lagoon, jet fuel residue, ditch dredging, cleanup actions, and Area 31. Only two written comments were received on the remedial investigation, feasibility study, or proposed plan during the public comment period. The responses to these two comments are included in this summary.

AREA 31—FORMER RUNWAY FIRE SCHOOL

Comment 1: The Navy received several comments questioning the need for expensive cleanup actions at Area 31, the Former Runway Fire School. Comments indicated that there was a concern about the cost of cleaning up Area 31 when weighed against the actual risks posed by the contamination in this area.

Response 1: The Navy conducted the remedial investigation to determine the nature and extent of contamination at the site. However, upon the discovery office product in the groundwater, the Navy did not continue to fully define the exact extent of contamination. In general, EPA has encouraged the Navy not to waste money and time on further site evaluation once it knows there is likely to be a cleanup action in a given area. The theory is that additional sampling to define the extent of contamination always takes place during the remedial design phase of a project. Therefore, there is no need to spend money on additional sampling during the remedial investigation if it looks like there is enough contamination to warrant a remedial action. The risk in this approach is that sometimes the lack of data makes it difficult to arrive at good decisions about the type of cleanup action that is necessary. That is exactly what has happened in the case of Area 31.

When alternatives for action were developed for Area 31, the Navy had to make "worst case" assumptions about the amount of contamination in the soils and groundwater. Costs for the alternatives presented in the proposed plan were based on these worst case assumptions because the Navy did not know the full extent of contamination. In addition, after the risk assessment was completed, it became clear that while there is contamination in the area, there are no real current risks to human health, and only some minor to moderate risks for small burrowing mammals. However, whereas the risks were not very great, the estimated costs of cleanup were quite high because they were based on assumptions and unknowns.

In response to public concerns, EPA and the Navy have decided that additional information is needed before a cleanup decision that makes sense can be issued for Area 31. Therefore, Area 31 will no longer be included in OU 3 and will not be included in this ROD. The Navy plans to do further sampling in Area 31 to determine more precisely the amount of contamination that exists (this additional sampling would have been done after the ROD, during the design of the remedial action). Once the additional data become available, EPA and the Navy will be able to re-evaluate Area 31, using more extensive data to make a decision.

Area 31 will be included in the OU 5 ROD, which is scheduled for the summer of 1995. Responses to the comments on the OU 3 proposed plan pertaining to Area 31 will be addressed in the OU 5 ROD. If the Navy recommends a different preferred alternative for Area 31 based on the new data that will be collected, the public will have a chance to comment on any new cleanup alternatives during the public comment period for OU 5.

Comment 2: Because Area 31 was included in the proposed plan for OU 3, the Navy received a number of comments and questions on the proposed cleanup action for Area 31 and on the specific conditions at this site. The comments focused on the status of the oil plume (i.e., whether it was migrating), any current or future threats to human health, the cost of the preferred alternative, and specific questions about the effects of the preferred alternative.

Response 2: The *Navy does not plan to provide responses to all the comments received on Area 31 at this time. It is not the Navy's intention to ignore the comments that were received during the public comment period on Area 31. However, as previously explained in both the text of the ROD and in this responsiveness summary, Area 31 is no longer included in OU 3 and therefore, it is not appropriate to address all the previous Area 31 comments and responses to those comments in this decision document. For some comments, the Navy simply does not know the answers because more data are needed before they can be answered. In addition, it is premature to answer specific comments about the preferred alternative, since a cleanup decision has been put on hold pending the results of additional sampling and evaluation. The known conditions and the cleanup alternatives for this site* *may change as a result of the additional sampling. Whatever happens, there will be another opportunity for public review and comment on the cleanup alternatives for Area 31. The Navy woul like to emphasize that there is no current human health threat posed by the contamination at Area 31.*

AREA 16—RUNWAY DITCHES

Off-site Properties

Comment 1: Why were the homes and farms on Frostad and Hoffman Roads, south of the Area 16 runway ditches, not tested for chemical contamination?

Response 1: *The remedial investigation focused on the flightline and other areas at Ault Field that could have been contaminated with industrial chemicals or waste products released into the ditch complex as a result of past practices by the Navy. Surface water flows from the houses and farms on Frostad and Hoffman Roads toward the ditch complex Therefore, surface water and sediments from the ditches could not have contaminated these properties. Chemical concentrations in the ditch sediments decrease with distance from the flightline. No chemicals were detected at elevated concentrations in sediment samples collected where the ditches exit Navy property. The sediment samples collected near the intersection of the Hoffman Road ditches and the runway ditches indicate that Hoffman Road is a source of chemical contamination typical of urban runoff from car exhaust residues, oil, etc. Laboratory results show that State Highway 20 is also a source of PAH contamination to the lagoon sediment.*

Comment 2: Do the homes and farms on Frostad and Hoffman Roads receive runoff from Navy property?

Response 2: *The homes and farms on Frostad and Hoffman Roads do not receive runoff from Navy property. The Navy met with the homeowners and farm owners on Monday, August 1, 1994, to walk along Whiskey Creek and follow the surface drainage features at Hoffman and Frostad Roads. Whiskey Creek originates on the east side of Hoffman Road, east of the Navy property boundary, and does not receive runoff from Navy property. Surface water runoff from a small wetland exits Navy property and runs in the westernmost drainage ditch along Hoffman Road, and then re-enters Navy property just south of Frostad Road.*

Comment 3: Are the Hoffman Road ditches contaminated and is Hoffman Road included in the cleanup actions?

Response 3: *It is not known if the Hoffman Road ditches are contaminated and Hoffman Road is not included in the cleanup action. The remedial investigation was conducted on the Navy base to examine the sources of contamination that are attributable to the Navy. The Hoffman Road ditches were not tested for contamination except where they meet the runway ditches. Contaminant levels in samples collected where the urban runoff enters the runway ditches are typical of road runoff and urban pollution. However, testing the Hoffman Road ditches was neither required nor performed during the remedial investigation. Therefore, no statement as to whether the Hoffman Road ditches are contaminated can be supported by the analytical data.*

Comment 4: We live on the east and north sides of Area 16. How can we get our properties tested?

Response 4: *The Navy met with the homeowners and tested seven residential wells. The Navy attended a meeting on Monday, August 1, 1994, at the homeowners' residences to discuss the testing of their wells. The sampling and analysis was performed by the Washington State Department of Health on September 14, 1994. The Department of Health has discussed the test results with all of the well users. The results showed no evidence of volatile organic compounds, herbicides, or pesticides. However, the results indicated that levels of naturally occurring inorganic (metals) are present in the water from all seven wells. The specific metals detected were iron, manganese, and arsenic. The Department of Health has stated that the levels of these metals are within the range found in other drinking water wells it has tested in Island County. One of the seven wells, however, had a detection of aluminum that is not thought to be naturally occurring. This well is one of the farthest from the NAS boundary. The property owner has been notified of this fact by the Department of Health. The results also indicated the presence of low levels of phthalates in water from many of the wells. Phthalates are commonly associated with plastics. The Department of Health attributes the presence of phthalates to sample collection activities and laboratory procedures, both of which involve plastic materials.*

Harrier Study

Comment 1: I am concerned with the potential impacts on the Northern Harrier posed by the preferred remedial alternative-dredging (Alternative 3). More data should be collected to evaluate the relationship between the Northern Harrier, its prey (the vole), and the runway ditch complex before the ditches are excavated.

***Response 1:** The Navy commissioned The Institute of Wildlife and Environmental Toxicology (TIWET) at Clemson University to study the harrier-vole interrelationship on the runway ditches in 1992. The results of this study showed a very healthy and vital harrier population at Ault Field and the Seaplane Base, most likely due to the large population of voles on base. If voles are driven out of a small area like the 2,(X70 feet of runway ditches to be dredged, they will recolonize the disturbed area very quickly. Voles are such voracious small mammals, they will actually run other small species out. The voles breed extensively and continuously in very early spring until the late fall and their population declines to fairly small numbers annually in late summer. The harrier breeding season runs from early March through June, and they are finished raising their young by early August. The area to be dredged is less than 0.01 percent of the total acreage available to the harrier and the vole. If dredging occurs in late summer or early fall, there will be no significant impacts on the harrier or vole populations. The Navy believes that based on this information, any remedial action in the ditches will be protective of the harrier.*

The Navy is continuing its study of the harriers at NAS Whidbey Island. It is the Navy's policy to protect valuable natural resources on Federal land and in support of this policy will continue to study the vitality of the harrier population. This research mull take several years to complete and remedial action as well as maintenance of the ditch complex needs to be completed as soon as possible.

Comment 2: During the **TIWET** study, did you **find** toxic substances in the vole and harrier eggs and their new fledglings?

***Response 2:** No chemical testing was performed on the eggs or the flesh of the fledglings as part of the TIWET study. However, blood samples were collected from the young just before they fledged and analyzed for organochloride pesticides and metals. The levels were similar to those detected by other researchers on fledglings in the northern forests of Canada. Lead and cadmium were also detected, but not at levels that would prove harmful to this specie.*

Comment *3:* Do voles prefer colonizing in ditches?

***Response 3:** They may colonize the ditch banks because the dredged soil on the banks may be softer than the surrounding areas and there is a close source of water.*

Comment *4:* Have you performed any studies on the harrier nests at the Seaplane Base and how do they compare to nests at other sites?

***Response 4:** The TIWET study investigated harriers at the Seaplane Base, Ault Field, and a site southwest of Heller Road. The results were fairly similar. The breeding success rates were about the same. There are no other sites studied which can be used for comparison.*

Comment 5: Is 1 year enough time to establish a trend for the harriers?

Response 5: ***No,*** *it is not and actually two years is still insufficient time to establish a trend. The Navy is continuing to research the harrier population at NAS Whidbey Island. The Navy is studying a few of the nesting sites and have fledgling counts for this year. The Navy also has a member of Falcon Research doing bird banding and is planning to collect blood and fecal samples for testing.*

Comment 6: How did the nesting harriers this year compare with the findings of the 1992 TIWET study?

Response 6: *The current success rates for harriers, based on the number of nests and number of fledglings, are similar to the 1992 TIWET study results. The report from the 1992 TIWET study indicated that the harrier populations have hatching success and nesting survival rates that are higher than normal. The harrier population at NAS Whidbey Island has the highest known density of northern harriers breeding in western Washington.*

Clover Valley Lagoon

Comment 1: Clover Valley Lagoon should be cleaned up and restored to its former thriving habitat for salmon, steelhead, and cutthroat.

Response 1: *According to information obtained from interviews with members of the dike commission and local farmers who have lived for more than 50 years on Clover Valley Lagoon, and from the Washington State fisheries, Clover Valley Lagoon was never a trout or salmon run. The hydrology and sediment characteristics of the ditches and the lagoon preclude it from providing an adequate habitat for salmon and trout. The surface water does not run fast or cold enough for an effective fish hatchery nor are the ditch sediments coarse enough (gravel or sand.) for salmon to spawn. The state fishery department used to release hatchery-raised fish on the ocean side of the dike. One year there was an accidental release of the fish into Clover Valley Lagoon and the ditch complex. The discovery of these fish, which were fished out of the ditches, resulted in a newspaper article reporting fish in the ditch complex.*

The chemicals detected in Clover Valley Lagoon surface water and sediments are not a threat to aquatic life. Within the upper 9 feet of the lagoon, there is a healthy ecosystem. Snails, sticklebacks, frogs, and salamanders are prevalent. The shoreline of the lagoon also provides nesting areas for many species of birds, such as the mallard, teal, red-winged blackbird, and belted kingfisher. The ecosystem in the upper portion of the lagoon and along the shoreline is typical of the existing habitat.

The lack of similar living organisms below a depth of approximately 9 feet is caused by an oxygen-deficient (anoxic) layer of seawater underlying the freshwater layer. Seawater seeps through the dike and up from the bottom of the lagoon. Because of the difference in densities between the lighter fresh water and the heavier salt water and the low energy flow of the freshwater ditches into the lagoon, no mixing of the waters occurs and hence an anoxic layer is formed.

Comment 2: What about just making the lagoon shallow?

Response 2: *There is no reason to fill the lagoon for cleanup purposes. Filling the lagoon with sediments would most likely cause considerable harm to the vibrant sticklebacks population and would have to be evaluated with other environmental impacts that are beyond the scope of the remedial investigation/feasibility study.*

The Navy has requested monies from the Legacy program, which funds cultural and natural resource projects. If funding is provided by this program, the feasibility of upgrading the dike system will be investigated.

Jet Fuel Residue

Comment 1: [When at home] I can smell JP-5 and have noticed residue on my car and garden. Does the Navy test for jet fuel residue and what are the health effects from JP-5?

Response 1: *There is a program at the base to test for jet fuel residues at locations on and off base. The Navy has performed residue testing as far as La Conner, Washington. There is no air testing for fuel residue or exhaust. If you feel you have a fuel residue on your car or windows, contact the Officer of the Day at (206) 257-2631. Because jets burn fuel most efficiently at 30,000 feet, not all of the fuel is burned at lower elevations. Particularly on take offs, there is often unburned fuel in the exhaust. You may be able to detect the smell of jet fuel, or JP-5, in the exhaust.*

A large short-term exposure to a high concentration of jet fuel can irritate skin, eyes, and the respiratory system and result in headache, dizziness, or nausea.

Ditch Dredging

Comment 1: Do the concentrations of metals in the runway ditch sediments pose a risk to human health or the environment?

Response 1: *Metals concentrations detected in the ditch were evaluated in the human health and ecological risk assessment. There was no unacceptable risk identified for humans from metal concentrations in the ditch. There was, however, a potential risk identified for the muskrat caused by arsenic and lead in the runway ditch sediments. When cleanup actions begin, the amounts of arsenic and lead will be reduced to levels that will not be a threat to the environment or to the muskrat. The highest levels of arsenic and lead detected in ditch sediments were 581 and 942 parts per million, respectively.*

As shown in Table 8-1 in the ROD, the remediation goal for arsenic is 16 mg/kg (based on the muskrat model) and the remediation goal for lead is 18 mg/kg (based on the background concentration).

Comment 2: If the ditches were routinely dredged in the past, where did the contamination that we are now seeing come from?

Response 2: *The ditches have not been dredged for approximately 14 years. Therefore, the contamination we have observed is a result of past practices such as petroleum dumping in the ditches that stopped around 1986.*

Comment *3:* When are you going to determine whether the sediments dredged from the Area 16 ditches are suitable for disposal under the Area 6 landfill cap?

Response 3: *A sampling and analysis program in support of the remedial design will be conducted in January/February 1995 to determine the proper disposal method.*

Comment *4: Are* you going to dig new ditches?

Response 4: *The Navy is not planning to dig new ditches. This alternative was evaluated in the feasibility study and the proposed plan.*

Comment *5:* Do you expect the ditches ever to become contaminated again, after they are dredged?

Response 5: *No, the Navy does not expect the ditches to become contaminated again. The Navy is instituting best management practices to reduce runoff from industrial areas into the ditch complex. It also has an emergency spill response plan that greatly reduces the chances* *of an accidental fuel spill reaching the ditches. Fuel that reaches the ditches would be contained and pumped from the ditch at Baffle 1. Disposal of waste in the ditches no longer occurs. Other efforts (recycling and waste minimization) over the past 5 years have greatly reduced the amount of hazardous materials handled at the base.*

Comment 6: Is there a monitoring device that could be installed to continually filter and recheck for contamination?

Response 6: *The Navy does have a program in place that monitors the ditch effluent as part of its National Pollutant Discharge Elimination System (NPDES) permit. The hazardous waste minimization program, the stormwater management program, and the spill response plan make the recontamination of the ditches unlikely. The Navy plans to install stormwater treatment at various locations, where needed, at NAS Whidbey Island. One location being considered is in the runway ditches.*

Comment 7: There really is no difference between maintenance dredging and the preferred alternative. If the Navy performs maintenance dredging instead of the preferred alternative, would the excavation be deeper?

Response 7: *There is a difference between maintenance dredging and the preferred alternative. Specifically, the differences are in the method of disposing of the dredged materials and chemical analysis of the materials. The depths to which sediment would be dredged for maintenance versus the preferred alternative are established using different criteria. In the preferred alternative, the contaminated sediment will be removed to the extent necessary to meet remediation goals and the removed materials will be placed under the cap of the Area 6 landfill. In some areas, the contaminated sediment may be anywhere from a few inches to a few feet deep. As part of maintenance dredging, sediments would be dredged to create a sufficient slope and an unclogged ditch allowing water to flow freely and the dredged materials will be placed on the banks of the ditches. The depth of dredging for maintenance purposes may be from a few inches to a few feet.*

Comment 8: Why is the Navy hiring a contractor to excavate the ditches—why not use the SEABEES?

Response 8: *The Navy's Construction Battalion (CB 's) are committed to other types of construction work and typically have not received the hazardous waste worker training required by federal regulations for individuals who work on hazardous waste cleanup at Superfund sites.*

Comment 9: ***Who is*** choosing the contractors for the remedial actions and is the creation of jobs in the community being given any consideration?

Response 9: The **Navy has** *competitively selected a contractor to conduct cleanup actions at Navy bases in the Puget Sound area. In order to accomplish this contract award, the Navy followed a federally mandated procurement process which is intended to maximize competition by giving firms a fair chance at winning the contract. This includes giving small and disadvantaged businesses an opportunity to receive work through subcontracts. The cleanup contractor can and does utilize local subcontractors to help perform the work. The Navy has also recently used a local contractor for the OU 1 water hookups.*

Evaluation of Alternatives

Comment 1: Alternatives 2 and 3 have significant differences only in cost. Since either Alternative 2 or Alternative 3 would ensure maintenance of the ditches to prevent flooding, it seems imprudent to select the most expensive solution.

Response 1: *The higher cost for Alternative 3 is on account of a contingency if the materials dredged from the ditches cannot be disposed of in the Area 6 landfill. Alternatives 2 and 3 include different types of action, which contributes to the difference in cost. Alternative 2 includes the construction of new ditches to bypass the current areas of contamination. Soil removed for construction of the new ditches would be used to cover the existing ditches, thus leaving contamination in place. Alternative 3 involves characterization of the contaminated sediments and then dredging of these sediments with ultimate disposal of the removed materials under the cap of the landfill at Area 6. Under this described alternative, all contaminated sediments are removed from the ditch network.*

Alternative 2 would disturb more of the habitat around the ditch complex than Alternative 3. Alternative 2 involves excavating a new ditch (10 feet wide by 15 feet by 3, 000 feet long) and filling in the old ditch, which is approximately the same dimensions. Compared to Alternative 3, Alternative 2 would disturb twice the area and volume. Alternative 3 will remove the sediments only on the bottom of the ditch (5 feet wide by 2 feet deep by 3,000 feet long). The bottom sediments are not a habitat for the voles. The vole habitat that would be disturbed by Alternative 3 is the area adjacent to the ditch banks and this disruption would be limited to that caused by a trackmounted backhoe and dump trucks. The costs for Alternative 2 and Alternative 3 are estimated to be comparable at the low end ($0.6 million). All costs associated with these alternatives are approximate and are considered to be accurate only to -30 to +50 percent.

Comment *2:* Sediments from specific segments of the runway ditches where contaminated sediments have been found should be removed and disposed of. This should include sampling the ditch sediments near particular sampling stations that showed evidence of contamination during the remedial investigation, excavating or dredging the sediments from the areas upstream and downstream of these locations, and managing the removed material. If contaminant concentrations in the dredged material are below the state standards for classification as hazardous materials, the material could be placed in the Area 6 landfill and covered. This should, of course, include the runway ditches outside the main flightline area, as well as within the flightline area.

Once the ditches have been cleaned of contaminated sediments, they should be filled and capped. New runway ditches should be excavated and lined with a nonporous material and a drainage pipe should be laid within the ditches and covered. A treatment/decontamination station should be placed at Baffle 1.

Response 2: *The suggestion to remove contaminated sediments and properly dispose of them in the Area 6 landfill is the preferred alternative, Alternative 3. The one exception to this approach is the sediments in the area of the heron rookery. Dredging these sediments would damage the trees and habitat in the area. Installing a piped stormwater system in the drainage ditch complex would not be the best management practice for the stormwater processes at NAS Whidbey Island. In the Fall of 1994, EPA inspected the ditches and stated that the existing design of the ditches is adequate. No inspection report has been received. An open-flowing channel with vegetation is considered one of the best natural pollution control systems, especially for the type of contamination that could accidentally spill into the ditch system from a fuel release. The open ditch will allow for rapid and easy spill containment and cleanup by providing direct access to the entire spill. The spill can be contained by Baffle 1 or oil booms and can be removed using vacuum trucks and oil absorbent materials.*

The open ditch system will also provide a habitat for various animal species. The reason for taking any environmental action at Area 16 is the ecological risk to the muskrat. Encasing the ditch in concrete would eliminate the habitat for these animals and, therefore, pose more environmental risk for the muskrat and other animals. The costs of installing an enclosed system is very prohibitive and would not ensure that contamination would not migrate into the subsurface or directly into Clover Valley Lagoon.

The Navy is installing stormwater treatment units at the base and possibly in the runway ditch complex These systems will be installed as part of the continuing efforts by NAS Whidbey Island to upgrade its pollution prevention program. The units are expected to be installed within the year but this schedule is contingent on the receipt of funding.