OU 1 SITES 101, 101A, 103, 110: DECLARATION OF RECORD OF DECISION (ROD)

08/08/2000

Author Affiliation Unknown

DECLARATION OF THE RECORD OF DECISION

SITE NAME AND ADDRESS

Jackson Park Housing Complex/Naval Hospital Bremerton
Operable Unit 1, Sites 101, 101-A, 103, and 110
Bremerton, Washington

STATEMENT OF PURPOSE

This decision document presents the final remedial action for Operable Unit (OU) 1, one of three operable units at the Jackson Park Housing Complex/Naval Hospital Bremerton (JPHC/NHB), Superfund site near Bremerton, Washington. This ROD for OU 1 addresses the terrestrial portions of the site and all human health risks. OU 2 addresses marine sediments in Ostrich Bay and any associated ecological risks to the marine environment. OU 3 addresses unexploded ordnance/ordnance explosive waste that may be present on JPHC/NHB property or in Ostrich Bay. Separate RODs will be issued for OU 2 and OU 3.The selected remedy in this decision document was chosen in accordance with the Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA), as amended, 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 1.

The U.S. Navy (Navy) is the lead agency for this decision. The Washington State Department of Ecology (WDOE) is the lead regulatory agency. The U.S. Environmental Protection Agency (EPA) is the support regulatory agency. WDOE and EPA concur with the selected remedy.

ASSESSMENT OF THE SITE

The response action selected in this Record of Decision is necessary to protect the public health or welfare or the environment from actual or threatened releases of hazardous substances into the environment. Such a release or threat of release may present an imminent and substantial endangerment to public health, welfare, or the environment.

DESCRIPTION OF THE SELECTED REMEDIES

The selected remedy for soil addresses human health risks posed by ingestion of soil, and potential environmental risks posed by erosion of fill material into the marine environment. Surface soils containing inorganic and organic chemicals at concentrations greater than established cleanup levels will be covered with a clean soil cover to minimize the potential for human exposure. Shoreline areas will be stabilized to minimize the potential for erosion of fill material into the marine environment. The selected remedy also includes land use restrictions to prevent uncontrolled disturbance of subsurface soils containing inorganic and organic chemicals at concentrations greater than established cleanup levels, and to prevent residential development at Site 103.

The selected remedy for groundwater addresses potential environmental and human health risks. Groundwater in lowland portions of OU 1 (Sites 101, 101-A, and 103), although not a potential source of drinking water, discharges to marine water. The groundwater was found to contain organic and inorganic chemicals at the point of discharge at concentrations exceeding marine surface water standards for protection of human health and the environment. The objective of the groundwater remedy at these sites is to attain established surface water standards at the point of discharge, but not to clean up groundwater to drinking water standards. The selected remedy includes investigating and removing potential sources of chlorinated volatile organics in groundwater at Site 103. The selected remedy includes treating benzene in groundwater at Sites 101 and 110. The selected remedy also includes restrictions to prevent future construction of drinking water wells and monitoring to ensure that chemicals that may remain in groundwater are not adversely affecting the marine environment.

Groundwater in the upland portions of OU 1 (Site 110) is potentially a future source of drinking water. The selected remedy for groundwater at Site 110 includes additional sampling to verify that inorganics are not present above drinking water standards. If the monitoring should show that the inorganics in Site 110 groundwater are present above drinking water standards and background levels, then restrictions will be placed to prevent future construction of drinking water wells.

The selected remedy for marine tissue addresses potential human health risks posed by consumption of clams and crabs from Ostrich Bay. The selected remedy includes removing wooden pilings that are a potential source of chemicals found in marine tissue, and restricting shellfish harvesting as needed to limit human exposure to chemicals in shellfish. The selected remedy also includes monitoring of marine tissue to determine the need for continued shellfish harvest restrictions.

This ROD encompasses all issues at Jackson Park Housing Complex/Naval Hospital Bremerton except for marine and terrestrial unexploded ordnance and subtidal ecological risk from possible contaminated sediments.

STATUTORY DETERMINATIONS

The selected remedies are protective of human health and the environment, are in compliance with federal and state requirements that are legally applicable or relevant and appropriate to the remedial action, and are cost-effective. The remedies utilize permanent solutions and alternative treatment (or resource recovery) technologies to the maximum extent practicable.

The selected remedies satisfy the statutory preference for treatment as a principal element of the remedy. Treatment was found to be practicable only for benzene in groundwater at Sites 101 and 110. There are no principal threat wastes at the site, as that term is defined in EPA guidance. Because this remedy will result in hazardous substances, pollutants, or contaminants remaining on site above levels that allow for unlimited use and unrestricted exposure, a statutory review will be conducted within 5 years after initiation of remedial action to ensure that the remedy continues to be protective of human health and the environment.

DATA CERTIFICATION CHECKLIST

The following information is included in the Decision Summary section of this ROD. Additional information can be found in the Administrative Record file for this site.

- Chemicals of concern and their respective concentrations (pages 7-23 through 7-26)
- Baseline risk represented by the chemicals of concern (pages 7-28 through 7-30)
- Cleanup levels established for chemicals of concern and the basis for these levels (pages 8-12 through 8-15)
- How source materials constituting principal threats are addressed (pages 12-6, 12-12, 12-16, and 12-20)
- Current and reasonably anticipated future land use assumptions and current and potential future beneficial uses of groundwater used in the baseline risk assessment and ROD (pages 6-21 through 6-22)
- Potential land and groundwater use that will be available at the site as a result of the Selected Remedy pages (11-15 through 11-16)
- Estimated capital, annual operation and maintenance (O&M) and total present worth costs, discount rate, and the number of years over which the remedy cost estimates are projected (pages 11-19 through 11-24)
- Key factor(s) that led to selecting the remedy pages (11-1, 11-5, 11-8, and 11-11)

Signature sheet for the foregoing Jackson Park Housing Complex /Naval Hospital Bremerton Operable Unit 1 Record of Decision between the U.S. Navy, the Washington State Department of Ecology, and the U.S. Environmental Protection Agency.

J.A. Holden
Captain, U.S. Navy
Commanding Officer, Naval Station Bremerton

08 August 00
Date

Signature sheet for the foregoing Jackson Park Housing Complex/Naval Hospital Bremerton Operable Unit 1 Record of Decision between the U.S. Navy, the Washington State Department of Ecology, and the U.S. Environmental Protection Agency.

G. Parker
Captain, U.S. Navy
Commanding Officer, Naval Hospital Bremerton

16 Aug 00
Date

Signature sheet for the foregoing Jackson Park Housing Complex/Naval Hospital Bremerton Operable Unit 1 Record of Decision between the U.S. Navy, the Washington State Department of Ecology, and the U.S. Environmental Protection Agency.

Jim Pendowski
Program Manager, Toxics Cleanup Program
Washington State Department of Ecology

Date 8/09/00

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Signature sheet for the foregoing Jackson Park Housing Complex/Naval Hospital Bremerton Operable Unit 1 Record of Decision between the U.S. Navy, the Washington State Department of Ecology, and the U.S. Environmental Protection Agency.

Charles E. Findley
Acting Regional Administrator, Region 10
U.S. Environmental Protection Agency

8/9/00
Date

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FIGURES

ABBREVIATIONS AND ACRONYMS

ARAR	applicable or relevant and appropriate requirement
bgs	below ground surface
BRAC	Base Closure and Realignment Act
CERCLA	Comprehensive Environmental Response, Compensation, and Liability Act
CFR	Code of Federal Regulations
CLEAN	Comprehensive Long-Term Environmental Action Navy
COC	chemical of concern
COPC	chemical of potential concern
cPAH	carcinogenic polycyclic aromatic hydrocarbon
CSF	cancer slope factor
CTO	Contract Task Order
CWA	Clean Water Act
DoD	Department of Defense
EFA NW	Engineering Field Activity, Northwest
EOD	Explosive Ordnance Disposal
EPA	U.S. Environmental Protection Agency
EPC	exposure point concentration
FS	feasibility study
GAC	granular activated carbon
GPR	ground-penetrating radar
GSA	General Services Administration
HHRA	human health risk assessment
HI	hazard index
IAS	in situ air sparging
ICP	institutional controls plan
IR	Installation Restoration
IRIS	Integrated Risk Information System
JPHC/NHB	Jackson Park Housing Complex and Naval Hospital Bremerton
MCL	maximum contaminant level
MFS	minimum functional standards
msl	mean sea level
MTCA	Washington State Model Toxics Control Act
NACIP	Navy Assessment and Control of Installation Pollutants
NAD	U.S. Naval Ammunition Depot

ABBREVIATIONS AND ACRONYMS (Continued)

NAVFACENGCOM	Naval Facilities Engineering Command
Navy	U.S. Navy
NCP	National Oil and Hazardous Substances Pollution Contingency Plan
NEESA	Naval Energy and Environmental Support Activity
NEX	Navy Exchange
NPL	National Priorities List
ORC	a proprietary formulation of magnesium peroxide
OEW	ordnance explosives waste
OU	operable unit
PA	preliminary assessment
PAH	polycyclic aromatic hydrocarbon
PCB	polychlorinated biphenyl
PCP	pentachlorophenol
POTW	publicly-owned treatment works
PSNS	Puget Sound Naval Shipyard
RAB	Restoration Advisory Board
RAO	remedial action objective
RCRA	Resource Conservation and Recovery Act
RCW	Revised Code of Washington
RDX	hexahydro-1,3,5-trinitro-1,3,5-triazine (Royal Demolition Explosive)
RfC	reference concentration
RfD	reference doses
RI	remedial investigation
RI/FS	remedial investigation/feasibility study
RME	reasonable maximum exposure
ROD	record of decision
SARA	Superfund Amendments and Reauthorization Act
SI	site inspection
SOP	standard operating procedure
SQS	sediment quality standards
SVE	soil vapor extraction
SVOC	semivolatile organic compound
TAL	target analyte list
TCL	target compound list
TEF	toxicity equivalency factor
TPH	total petroleum hydrocarbons

ABBREVIATIONS AND ACRONYMS (Continued)

TRC	Technical Review Committee
UCL95	95 percent upper confidence level
USC	United States Code
UST	underground storage tank
UXO	unexploded ordnance
VOC	volatile organic compound
WAC	State of Washington Administrative Code
WQC	water quality criteria
WQS	water quality standards
WDOE	Washington State Department of Ecology

UNITS OF MEASURE

cm	centimeter
kg	kilogram
kgOC	kilogram organic carbon
L	liter
m^3	cubic meter
µg	microgram
mg	milligram

DECISION SUMMARY

1.0 INTRODUCTION

In accordance with Executive Order 12580, the Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA) as amended and, to the extent practicable, the National Oil and Hazardous Substances Pollution Contingency Plan (NCP), the U.S. Navy (Navy) is addressing environmental contamination at Jackson Park Housing Complex and Naval Hospital Bremerton (JPHC/NHB) by undertaking remedial action. The selected remedial actions have the approval of the U.S. Environmental Protection Agency (EPA) and the concurrence of the Washington State Department of Ecology (WDOE) and are responsive to the expressed concerns of the public. The selected remedial actions will comply with applicable or relevant and appropriate requirements (ARARs) promulgated by WDOE, EPA, and other state and federal agencies.

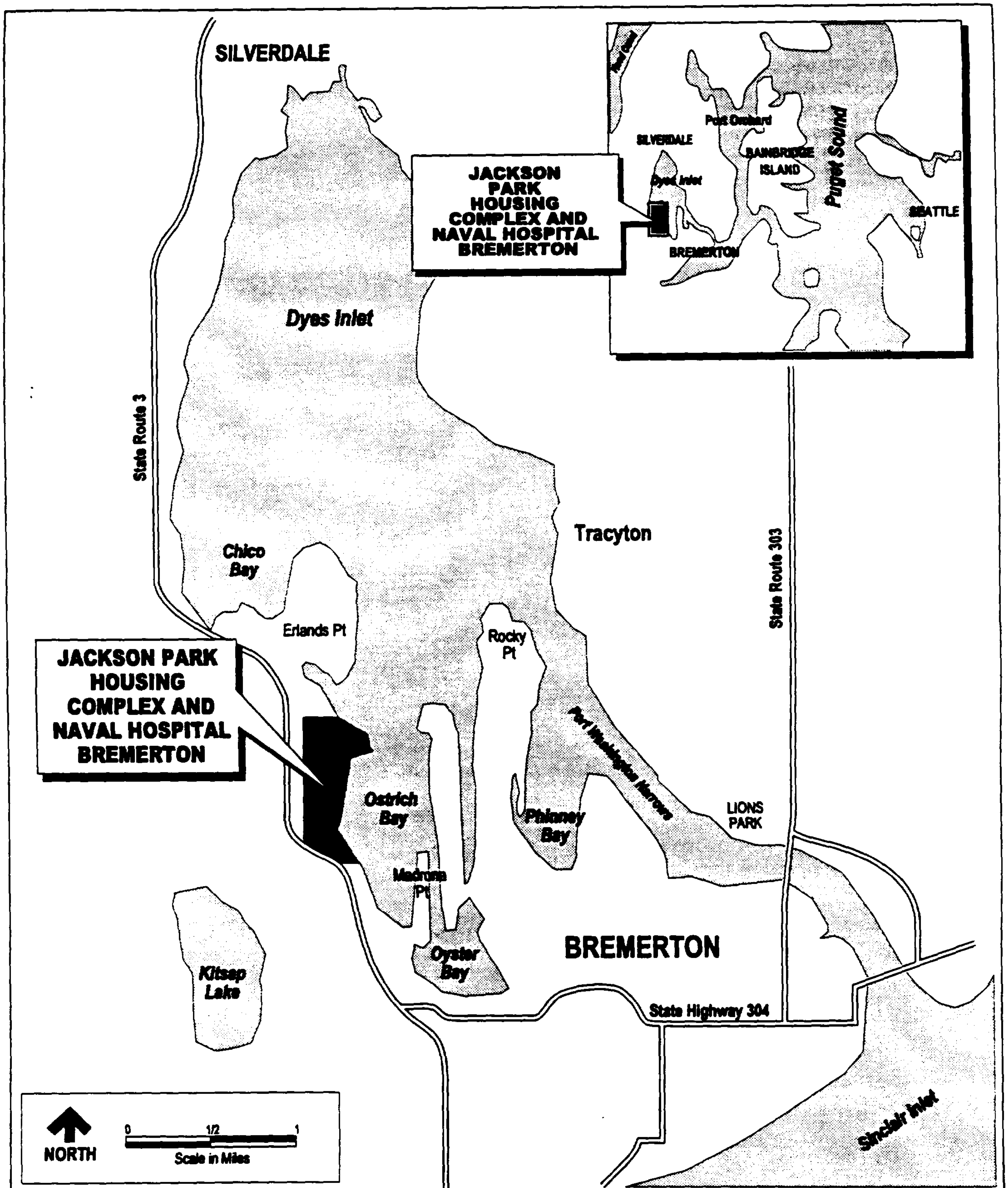
2.0 SITE NAME, LOCATION, AND DESCRIPTION

The JPHC/NHB site is located in eastern Kitsap County, approximately 2 miles northwest of Bremerton, Washington (Figure 2-1). The JPHC/NHB properties occupy a total of approximately 206 acres on a sloping hillside bordering Ostrich Bay. Ostrich Bay is part of the Puget Sound marine environment. The JPHC/NHB properties are bounded to the north by the community of Erlands Point, to the west by State Route 3, and to the south by an undeveloped wooded area. The topography slopes from a maximum elevation of 180 feet above mean sea level at the west edge down to a relatively flat shoreline area along Ostrich Bay.

JPHC/NHB is a Superfund site (CERCLIS identification number WA3170090044) that has been divided into three separate operable units (OUs): OU 1, OU 2, and OU 3. This Record of Decision (ROD) addresses OU 1, which consists of the terrestrial portion of the site, and addresses human health risks from terrestrial sources and ingestion of shellfish from Ostrich Bay. A terrestrial ecological risk assessment was not conducted for OU 1. OU 2 consists of marine sediments in Ostrich Bay and any associated ecological risks to the marine environment. OU 3 addresses unexploded ordnance/ordnance explosive waste that may be present on JPHC/NHB property or in Ostrich Bay. Separate RODs will be issued for OU 2 and OU 3.

OU 1 comprises four sites: Sites 101, 101-A, 103, and 110 (Figure 2-2). Much of JPHC/NHB is developed as high-density residential housing for Navy personnel and dependents. Drinking water for OU 1 is supplied by the City of Bremerton public water system.

The U.S. Navy is the lead agency for this decision. WDOE is the lead regulatory agency. EPA is the support regulatory agency.



CLEAN COMPREHENSIVE LONG-TERM ENVIRONMENTAL ACTION NAVY	Figure 2-1 Jackson Park Housing Complex/Naval Hospital Bremerton Vicinity Map	CTO 0031 JPHC/NHB Bremerton, WA OU 1 ROD

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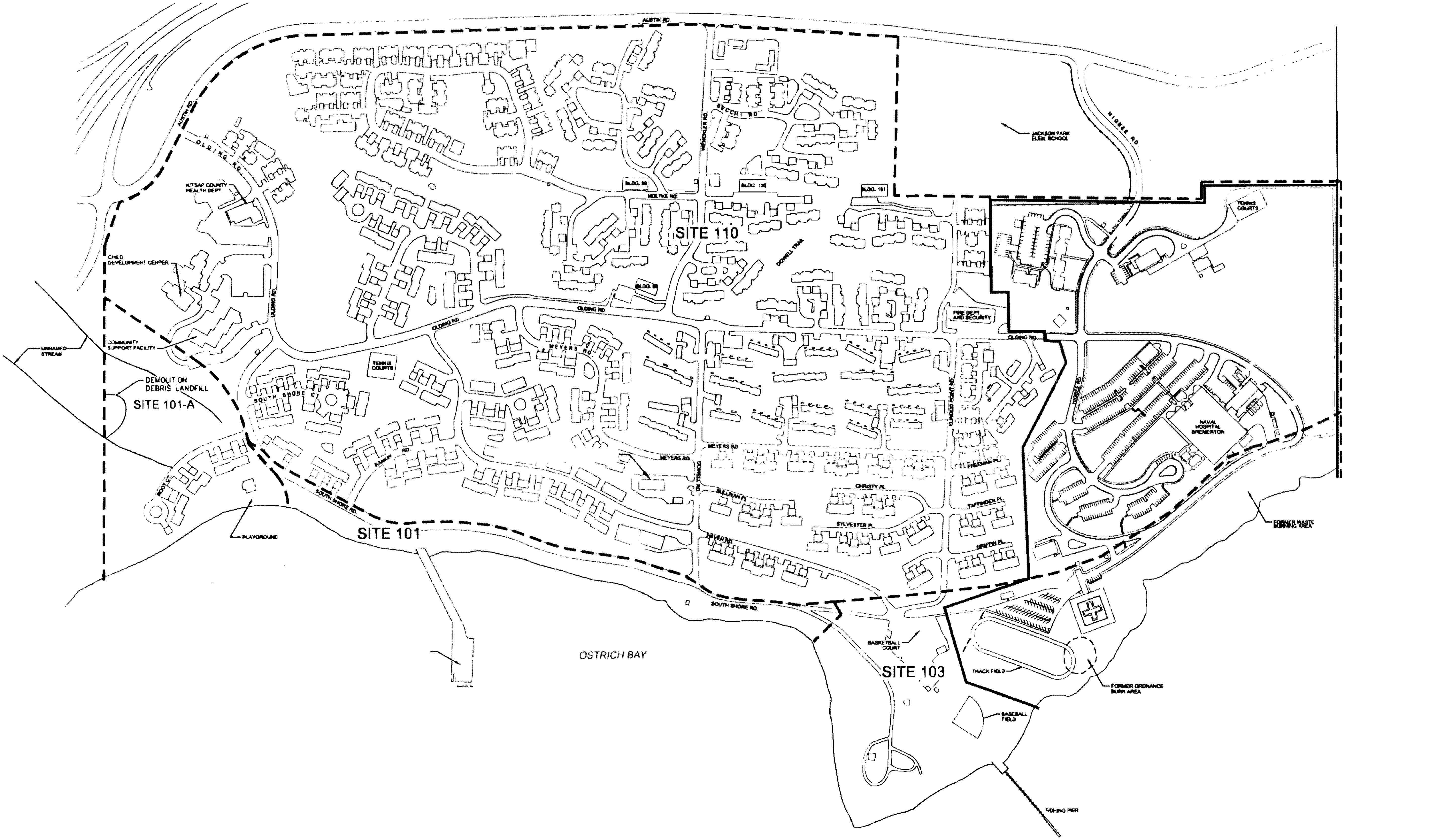

LEGEND

- - - - SITE BOUNDARY LINE

——— NAVAL HOSPITAL BREMERTON PROPERTY LINE

CLEAN COMPREHENSIVE LONG-TERM ENVIRONMENTAL ACTION NAVY	CTO 0031 JPHC/NHB Bremerton, WA OU 1 ROD	0 100 200 400 SCALE IN FEET	Figure 2-2 Site Plan

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3.0 SITE HISTORY AND ENFORCEMENT ACTIVITIES

3.1 SITE HISTORY

JPHC/NHB is on the site of the former Naval Magazine Puget Sound (Naval Magazine), which was established in 1904 as an ammunition depot to store ordnance. Operations expanded during World War I to include ordnance manufacturing and processing, projectile loading and cleaning, and ordnance demilitarization.

The Naval Magazine became the U.S. Naval Ammunition Depot (NAD) Puget Sound around 1916. After World War I, the name was changed to NAD Bremerton. Operations at NAD Bremerton were stepped up during World War II. After the end of World War II the facility's primary role shifted to ordnance demilitarization.

In 1948, command of NAD Bremerton was transferred to Bangor, and NAD Bremerton was renamed the Bremerton Annex. By 1959, the ammunition depot was no longer needed at the property and the area was placed under caretaker status. The annex was closed but remained Navy property. Portions of the former depot property were then conveyed to Kitsap County, the City of Bremerton, and the State of Washington. Beginning around 1965, a portion of the remaining property was converted to military housing and renamed the Jackson Park Housing Complex. As housing construction continued in the early 1970s, the Navy demolished most of the remaining depot structures at the site. Around 1981, a gas station was added to the NEX convenience store located within the Jackson Park Housing Complex (Figure 2-2). Construction of additional housing at the site continued into the 1990s. Naval Station Bremerton is the current owner of Jackson Park Housing Complex.

In 1977, during initial planning for construction of the hospital, the Navy began to transfer claimancy of approximately 50 acres at the north end of the former Bremerton Annex to the Naval Regional Medical Center. The claimancy transfer was completed just prior to the hospital's opening in 1980. The Naval Hospital Bremerton property lies within Sites 103 and 110, with approximately 85 percent of the hospital property in Site 110 and the remaining 15 percent in Site 103 (see Figure 2-2).

In response to CERCLA requirements, the U.S. 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, procedures and terminologies were developed that were different from those used by EPA in administrating CERCLA. As a result of the implementation of the Superfund Amendments and Reauthorization Act (SARA), the Navy has dropped NACIP and adopted EPA CERCLA/SARA procedures and terminology.

The following sections summarize historical activities at the four sites that make up OU 1.

3.1.1 Site 101

Historical industrial processes at Site 101 included ordnance production and destruction (demilitarization), storage of ordnance, and recycling and disposal of ordnance wastes. Waste ordnance (explosive dry powders) was produced daily in the loading and sifting buildings. The rooms in the loading and sifting buildings were rinsed with water daily to prevent the explosive powders from accumulating and forming an explosive atmosphere. Most liquid wastes were flushed into tile drains and discharged directly to Ostrich Bay. Some waste liquids were removed from the waste stream and transported by truck to a recycling processing area on site.

The shoreline area was backfilled during the construction of the original ordnance facility (the Naval Magazine) and/or construction of the housing units. Fill areas at Site 101 are shown in Figure 3-1. The materials used for backfilling were sands, gravels, and artificial materials such as concrete and metal debris, which are now being exposed along the shoreline by erosion.

3.1.2 Site 101-A

Historical industrial processes associated with Site 101-A include ordnance production and demilitarization and ordnance sifting and loading. An incinerator and a boiler house were also present at Site 101-A. Demilitarization used high temperature and steam. As described for Site 101, rooms in the loading and sifting buildings were rinsed with water daily to prevent accumulation of explosive materials. The liquid wastes were flushed into tile drains and discharged directly to Ostrich Bay. The shoreline area was backfilled during the construction of the Naval Magazine and/or housing units. Fill areas at Site 101-A are shown in Figure 3-1. Backfill materials were sands, gravels, and artificial materials such as concrete and metal debris, which are now being exposed along the shoreline by erosion.

3.1.3 Site 103

The historical industrial processes and facilities associated with Site 103 were maintenance of locomotives, sand-blasting, military and civilian housing, barracks, a cafeteria, latrines, paint and oil storage, and a railroad transfer bridge. Ordnance wastes were burned on a concrete slab on the north side of Elwood Point; trash was burned in an area farther north along the shoreline of the site (Figure 3-1). An incinerator was also present at Site 103. Landfilling took place from 1910 to 1959 and included sands, gravels, and artificial materials such as concrete and metal debris. As shown in Figure 2-2, the northern portion of Site 103 is owned by Naval Hospital Bremerton and the southern portion is part of the Jackson Park Housing Complex property.

3.1.4 Site 110

Historic activities at Site 110 primarily consisted of ordnance production and storage of ordnance and inert materials. Three bunkers previously used for ordnance storage continue to be used as warehouses by JPHC/NHB, and a fourth is being used as a chapel. Ordnance wastes were found in at least 13 of the structures that were removed during the early 1970s demolitions. Buildings most heavily used for ordnance were steam-cleaned prior to demolition. The structural debris from these buildings was disposed of in a debris fill area south of Root Court in Site 101-A (Figure 3-1). Visibly contaminated wastes were transported to Subase Bangor for disposal. As shown in Figure 2-2, the northern portion of Site 110 is owned by Naval Hospital Bremerton and the southern portion is part of the Jackson Park Housing Complex property.

3.2 PREVIOUS INVESTIGATIONS AT JPHC/NHB

3.2.1 RI/FS Investigations (1983 to 1997)

The Navy initiated the remedial investigation/feasibility study (RI/FS) process at JPHC/NHB after conducting preliminary assessments (PAs) (NEESA 1983, Hart Crowser 1988).

In February 1992, Enforcement Order DEC92TC-005 was issued by the Washington State Department of Ecology (WDOE) in accordance with the Washington State Model Toxics Control Act (MTCA). This enforcement order encompasses the entire JPHC/NHB property.

In 1994, EPA placed JPHC/NHB on the National Priorities List (NPL). The NPL is designed to categorize, rank, and expedite investigation and cleanup of the nation's primary hazardous waste sites.

A site inspection (SI) was conducted at Site 110 and the results documented in the site's final SI report (U.S. Navy 1993). The Navy used the results of this report to conduct several removal actions at Site 110; see Section 3.3. Based on the results of the SI and the removal actions that have taken place, the Navy and the State of Washington determined that a formal RI report and a risk assessment were not warranted at Site 110.

The Navy and the State of Washington determined that RI work was warranted at Sites 101, 101-A, and 103. Three phases of field work were conducted. Phase I was documented in the JPHC/NHB final Phase I RI report (U.S. Navy 1994a), which presents the findings from the Phase I terrestrial and marine investigations. The Phase I RI concluded with specific recommendations to collect additional data for the terrestrial and marine environments. The additional data collection is considered Phase II and was performed in two separate tasks. The Phase II terrestrial data collection was performed in December 1993 and the Phase II marine data collection in July 1994.

To expedite remedial actions, in May 1995 the Navy administratively separated the site into OU 1, which addresses the terrestrial environment, and OU 2, which addresses the marine environment. Human health risks, including terrestrial and marine exposures, are addressed in OU 1. The final Phase II OU I supplemental RI report (U.S. Navy 1995) summarized the terrestrial findings from the Phase I RI and the findings from the Phase II terrestrial investigation.

After completion of the final Phase II Supplemental RI report, additional field work was conducted in August 1996, and is referred to as Phase III. The Phase III investigation was designed to address specific data gaps associated with surface water seeps and outfalls along the Ostrich Bay shoreline and with a former waste burning area near Naval Hospital Bremerton. The final feasibility study (FS) for JPHC/NHB was issued in April 1998 (U.S. Navy 1998a). The final FS incorporated all data collected through 1997 (Phases I, II, and III).

3.2.2 Post-FS Investigations (1997 to 1999)

Phase III field work and data analysis continued after publication of the final FS. As summarized below, several additional studies were conducted at OU 1 between 1997 and 1999.

Jackson Park / Erlands Point Clam and Sediment Sampling

In December 1997, WDOE and the Washington State Department of Health (WDOH) collected samples of manila clams and intertidal sediment from Dyes Inlet. The samples were collected from shoreline areas between the north portion of Elwood Point and the south portion of Erlands Point. Manila clam samples were also collected from a reference area, Twanoh State Park on Hood Canal. The samples were analyzed for the following chemicals of interest as determined by WDOE: arsenic, antimony, mercury, thallium, vanadium, pentachlorophenol, bis(2-ethylhexyl)phthalate, and 3,3'-dichlorobenzidine.

The results of this investigation indicated that concentrations of arsenic, vanadium, and thallium in the Elwood Point/Erlands Point clam samples were consistent with, or less than, concentrations in the reference area samples. Mercury concentrations in the Elwood Point/Erlands Point clam samples were greater than concentrations in the reference area samples, but below WDOH health risk values. Antimony, pentachlorophenol, bis(2-ethylhexyl)phthalate, and 3,3'-dichlorobenzidine were not detected in any of the Elwood Point/Erlands Point clam samples or reference area clam samples. The results of this sampling are reported in the *Data Report on Jackson Park/Erlands Point Clam and Sediment Samples* (WDOE 1998).

Additional Seep and Outfall Sampling

To determine if there were any seasonal effects on chemical concentrations in water discharging from shoreline seeps and outfalls, an additional round of seep and outfall sampling was conducted in June 1998. The results were reported in the *Letter Report for 1998 Seep and Outfall Sampling* (U.S. Navy 1998b).

Benzene Release Investigations

Phase III seep sampling at Site 101 identified one shoreline outfall that was discharging water containing benzene and petroleum above state cleanup levels. In 1996, WDOE conducted an independent investigation of seeps and groundwater in this area. In 1997 and 1998, a second investigation was conducted by the Navy in an attempt to determine the source and extent of benzene and petroleum contamination in upgradient soil and groundwater. The upgradient area includes portions of Site 101 and 110. The results of these investigations were reported in the *Draft Report, Benzene Release Investigation* (Hart Crowser 1998); however, no source of contamination was defined. In November 1999, additional field work was conducted. This third benzene release investigation identified a source of the benzene and petroleum contamination near the fuel dispenser island at the Navy Exchange (NEX) gas station located at Dowell Road and Sullivan Place in Site 110. The results of this sampling are reported in the *Draft Data Summary Report for Benzene Source and Initial Conditions Investigation* (U.S. Navy 1999c).

Groundwater Background Investigation

The FS concluded that the groundwater background samples that were collected during the RI were from a different aquifer than the one sampled at OU 1. To allow an accurate estimate of area background concentrations of inorganics in groundwater, two monitoring wells were installed off site and crossgradient from Site 101-A. The wells were installed and sampled in August 1998, and sampled again in November 1998. The results of this sampling are reported in the *Background Groundwater Letter Report* (U.S. Navy 1999a). Additional sampling of these wells is continuing on a quarterly basis. (The ongoing background sampling is a component of the selected remedy for groundwater at OU 1.) A total of 10 sampling events are planned to allow a large enough sample population to statistically determine the area groundwater background concentrations. The results of the background investigation will be available before the first 5-year review of the remedy for OU 1.

3.3 REMOVAL ACTIONS

Removal actions at JPHC/NHB are summarized below.

3.3.1 Underground Storage Tank Removal—Site 101-A

As discussed below, six underground storage tanks (USTs) and some associated pipes and fuel distribution lines were removed from Site 101-A.

In September 1993, three 500-gallon USTs and one 3,000-gallon UST were removed. Confirmation soil samples from these tank excavations reported no detections of petroleum hydrocarbons remaining in the soils (Severson 1993). There were no records of installation date, cathodic protection, or tank tightness for any of the four USTs.

In 1993, two 100,000-gallon concrete USTs were removed. Soils and groundwater beneath these tanks were found to be contaminated with petroleum hydrocarbons. One of these tanks was removed entirely. To protect an existing structure, the other one was left partially in place and filled with concrete. Petroleum-contaminated soils above groundwater were removed from the excavation but soils beneath groundwater containing petroleum hydrocarbons above the MTCA Method A cleanup level were not removed. An engineered backfill on top of geotextile fabric was designed to contain any remaining contamination by decreasing the permeability of the soil. After the excavation was complete, samples of downgradient wells indicated no migration of petroleum hydrocarbons through the groundwater (U.S. Navy 1994b).

3.3.2 Underground Storage Tank Removal—Site 110

Four USTs were removed from Site 110 in 1996. The tanks probably stored fuel oil and diesel fuel. There were no records of installation date, cathodic protection, or tank tightness for any of the USTs. All four tanks were found in good condition with little corrosion and no holes or damage. The tanks and all petroleum-contaminated soil were removed (Severson 1996a, 1996b, 1996c, 1996d).

3.3.3 Soil Removal at the Upland Bunker Area—Site 110

The Upland Bunker Area at Site 110 includes six formerly used bunkers. These are known as buildings 98, 99, 100, 101, 103, and 104. In 1959, all explosives were moved from the bunkers to the Naval Ammunitions Depot Bangor.

Levels of lead, arsenic, and carcinogenic polycyclic aromatic hydrocarbons (cPAHs) exceeded the MTCA Method A cleanup levels for residential surface soil in soil near four of the five bunkers (U.S. Navy 1993). The affected bunkers were buildings 100, 101, 103, and 104.

Between August 1994 and June 1995, the soils containing contamination above MTCA Method A cleanup levels for residential surface soil, including an area within the Jackson Park Elementary School yard, were excavated and properly disposed of. However, arsenic concentrations above the MTCA Method A cleanup level of 20 milligrams per kilogram (mg/kg) remain in soil underneath paved areas in front of two of the bunkers (buildings 100 and 101) (Ebasco 1995a). The highest remaining arsenic concentration beneath the pavement is 273 mg/kg. The pavement serves as a barrier to prevent human exposure to these soils.

Building 98 currently serves as a chapel. Buildings 99, 100, and 101 are currently used as warehouses. Buildings 103 and 104 were demolished subsequent to the removal action discussed in this section.

3.3.4 Debris and Drum Disposal Area Removal—Site 110

During construction of new homes at JPHC in 1995, a disposal site was discovered at the northeast corner of Olding Road and Elwood Point Road (Figure 3-1). Drums uncovered by the housing construction contractor were sampled and the contents determined to be petroleum products and lime wastes. Samples of materials removed from the disposal site confirmed the presence of asbestos in pipe insulation, petroleum products and lime waste in the drums, petroleum contamination in soils, and creosote-PAH compounds in timber. In March 1995, all waste and contaminated soil were removed and disposed of. Confirmation samples collected from the excavation prior to backfilling reported no petroleum detections above MTCA Method A soil cleanup levels (Ebasco 1995b).

3.3.5 Petroleum-Contaminated Soil Removal—Site 101/101-A

Investigations conducted in 1992 revealed diesel and motor oil contamination in subsurface soils immediately east of Building 91, along South Shore Road. Building 91 (since renamed Building 575) is a housing unit located in Site 110, along the Site 101/Site 110 border. The area of contaminated soil extended across the site borders to include portions of Site 110, 101, and 101-A. The petroleum contamination in the soil was likely caused by releases from former NAD Building 67 (an industrial building) and/or former NAD Building 122 (a boiler house/fuel pumping facility). Buildings 67 and 122 were demolished prior to construction of the housing units. Removal was conducted September 1993 through February 1994. The area of soil excavation was east of Building 91 (a.k.a. Building 575) in portions of Site 101 and 101-A. The excavation included removal of the buried foundation of former NAD Building 122. Confirmation sampling conducted in the excavation indicated levels of total petroleum hydrocarbons (TPH) below the MTCA cleanup level in two of six sample locations (OHM 1994). Contaminated soils were left in place beneath Building 91 to ensure the structural stability of the building. Engineered backfill designed for low permeability was used to fill the excavation. This design, along with the natural underlying glacial till, will decrease the probability that the small amounts of remaining contamination will migrate to groundwater.

3.3.6 Street Waste Disposal Area Removal—Site 110

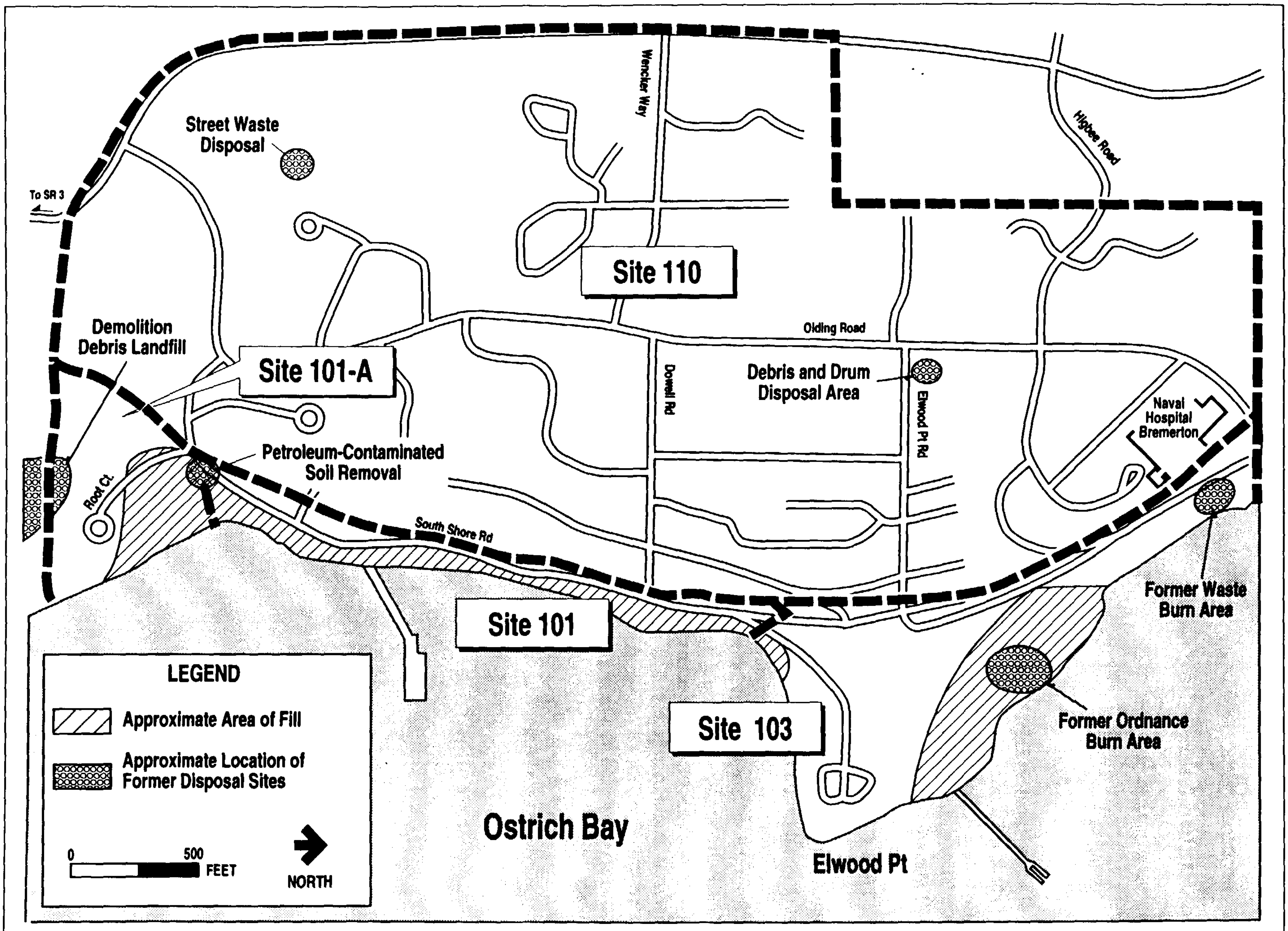
In 1995, housing construction contractors found a section of soils at Site 110 that failed to meet compactability requirements. Investigation revealed that maintenance crews had been placing street waste at the edge of the ravine to compost (Figure 3-1). Results from two samples showed TPH levels above MTCA Method A levels (CAS 1995, WDOE 1995a). To minimize surface water infiltration into the compost, the site was covered with 3 feet of clean soil and sloped to promote rapid drainage.

3.3.7 Time-Critical Removal—Erosion Control at Site 103

In 1998, significant erosion was occurring along the north shore of Site 103, near the helipad. The erosion threatened a potential release into the marine environment of contaminants present in fill material. A removal action was conducted to temporarily prevent further erosion along approximately 75 feet of shoreline. The removal action included excavating the bank back to a slope of approximately 3H:1V, armoring the slope with rock, and covering the area with a gravel mix to act as a sacrificial material during storm events. If required prior to final remedial construction, additional sacrificial material may be added periodically depending on the rate of erosion. This area will be addressed with a more permanent solution as a component of the selected remedy for OU 1.

3.3.8 Time-Critical Removal Action—Ordnance Removal OU 3

In conjunction with the actions taken as part of the OU 1 ROD, the Navy is planning a time-critical removal action for OU 3, per 40 CFR 300.415. OU 3 consists of the media ordnance items. The Removal Action would consist of cutting a minimum one-foot thick layer of soil and debris from the surface of about 19 acres, which are included in the area to be covered as part of the OU 1 ROD action. Soil would be collected and transported to a mechanical screening plant where it would be screened for ordnance related items, construction debris, and garbage. The screened soil would then be returned to the site as a structural fill without additional testing. The vegetated soil cover, for OU 1, would be placed on top of the returned structural fill. Abandoned ordnance surveys would be accomplished prior to and after the one-foot thick soil cutting action takes place.



CLEAN COMPREHENSIVE LONG-TERM ENVIRONMENTAL ACTION NAVY	**Figure 3-1** **Jackson Park Housing Complex/Naval Hospital Bremerton** **Known Historic Fill and Disposal Areas**	CTO 0031 JPHC/NHB Bremerton, WA OU 1 ROD

4.0 COMMUNITY RELATIONS

The specific requirements for public participation pursuant to CERCLA Section 117(a), as amended, include releasing the Proposed Plan to the public. The Proposed Plan for JPHC/NHB OU 1 was issued in October 1999 and mailed to all residences at JPHC and other members of the public. An open house and public meeting were held on October 20, 1999. The public comment period expired on November 4, 1999. Comments received on the Proposed Plan included verbal comments at the public meeting and written comments.

A response to the comments received during the public comment period is included in the Responsiveness Summary, which is part of this ROD. This decision document presents the selected remedial action for OU 1 at JPHC/NHB, chosen in accordance with CERCLA, as amended, and, to the extent practicable, the NCP. The decision for this site is based on the Administrative Record.

Documents pertaining to this investigation are available in the following information centers:

Central Library
1301 Sylvan Way
Bremerton, Washington
(360) 377-7601

Silverdale Branch Library
3450 NW Carlton St.
Silverdale, Washington
(360) 692-2779

Grand Central Station
Jackson Park Housing Complex
(Reserved for Jackson Park residents)

Washington State Department of Ecology
Toxics Cleanup Program
300 Desmond Drive
Lacey, Washington

The Administrative Record is on file at the following location:

Engineering Field Activity, Northwest
Naval Facilities Engineering Command
19917 Seventh Avenue Northeast
Poulsbo, Washington 98370-7570
(360) 396-0214

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

- Creation of a community relations plan
- Quarterly meetings of the Technical Review Committee (TRC), which included representatives from the public and from other governmental agencies
- Conversion of the TRC to a Restoration Advisory Board (RAB), which has met periodically since 1995 (the function of a RAB is discussed below)
- Newspaper advertisements for the Proposed Plan and public meetings
- An open house and public meeting on October 20, 1999, to present the findings of JPHC/NHB OU 1 investigations and to receive comments on the Proposed Plan

In accordance with 10 USC 2.705(a), the purposes of the RAB are as follows:

- To act as a forum for the discussion and exchange of information between the Navy, regulatory agencies, and the community on environmental restoration topics
- To 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

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

The RAB members have included citizens and representatives from the Navy, regulatory agencies, the Suquamish Tribe, city and county governments, and environmental activist groups. The RAB has been involved in the review and comment process of all project documents. In particular, this group participated in development of the JPHC/NHB OU 1 decision documents. Members were briefed on the proposed remedy prior to issuance of the Proposed Plan, and were provided the Proposed Plan for review and comment.

5.0 SCOPE AND ROLE OF OPERABLE UNITS

Impacted areas at JPHC/NHB have been grouped into three separate OUs, for which different schedules have been established. Operable Unit 1, which addresses the terrestrial portions of the site as well as all human health risks, is the subject of this ROD. OU 2 consists of marine sediments in Ostrich Bay and any associated ecological risks to the marine environment. OU 3 addresses unexploded ordnance/ordnance explosive waste that may be present on JPHC/NHB property or in Ostrich Bay. Separate RODs will be issued for OU 2 and OU 3.

6.0 SUMMARY OF SITE CHARACTERISTICS

This section summarizes the physical characteristics and the nature and extent of chemicals detected at JPHC/NHB OU 1 and documents the current and potential future land and resource uses.

6.1 CONCEPTUAL SITE MODEL

A Conceptual Site Model (CSM) was developed for OU 1 to provide a basis for planning the site investigations, conducting the risk assessment, and developing appropriate response actions. The CSM identifies the potential contaminant sources, migration pathways, exposure routes, and potential receptors. Figure 6-1 is a graphical depiction of the CSM.

6.2 PHYSICAL CHARACTERISTICS

The surface features, surface water hydrology, geology, and hydrogeology of the four sites in OU 1 are described in the following subsections.

6.2.1 Surface Features

JPHC occupies approximately 158 acres on a sloping hillside west of Ostrich Bay. Naval Hospital Bremerton occupies approximately 48 acres north of JPHC on terrain similar to that of JPHC. Land surface elevations range from 180 feet above mean sea level (msl) in the western portions to sea level along the Ostrich Bay shoreline. The shoreline along the northern portion of the site consists of low-bank bluffs (2 to 8 feet high) that descend to a beach consisting of fine to coarse sand and cobbles. The shoreline bluff height increases to the south, with a maximum relief of approximately 20 feet at Site 101-A. The majority of the property is paved or landscaped, and developed with residential housing, recreational areas, and community and hospital facilities.

6.2.2 Surface Water Hydrology

The land surface at JPHC/NHB slopes downward from Site 110 in the uplands area toward Ostrich Bay. Surface water at JPHC/NHB occurs primarily as runoff from precipitation and lawn watering. Water that does not infiltrate the land surface and enter the groundwater system runs off as overland flow or enters the JPHC/NHB storm sewer system, which discharges to Ostrich

Bay. Two ephemeral streams in the southwestern portion of Site 101-A discharge to Ostrich Bay following rainfall events; another stream traverses Site 110 and enters Ostrich Bay north of Site 103.

At low tide, a number of seeps are visible along the shoreline at JPHC/NHB. Groundwater, which flows along the top of the low-permeability till layer that underlies much of the lower portion of JPHC/NHB, discharges as surface water in the intertidal zone along the beach. Discharge from outfalls also occurs along the shoreline below high tide level. Many of these outfalls are not part of the storm sewer system, but rather are associated with former structures that have been removed. The outfalls now serve as a conduit to direct infiltrating precipitation and groundwater to specific discharge areas.

6.2.3 Geology

The generalized stratigraphy beneath JPHC/NHB consists of a thin surface layer of fill or recent geologic deposits overlying a thick sequence of silt, sand, and coarser material deposited as glacial drift over the last 50,000 years. Much of the area surrounding JPHC/NHB is underlain by glacial till capped discontinuously with recessional outwash from the most recent glaciation associated with the Vashon Stade.

The Vashon Recessional Outwash deposits occur at the surface in the lower portions of JPHC/NHB and make up the uppermost water-bearing unit. These deposits are composed of silty sands and gravels deposited by glacial meltwaters. The deposits generally range in thickness from less than 5 feet to about 30 feet. The underlying Vashon Till consists of a dense, fine-grained, low-permeability matrix of silt containing gravel and cobbles that restricts the vertical movement of groundwater. Thickness of the till in the lowland areas is unknown because no wells were installed through this unit at Site 101, 101-A, or 103. In the upland areas, the till is approximately 10 to 20 feet thick. The Vashon Advance Outwash deposits beneath the till consist principally of slightly silty to silty fine-grained sand. This unit occurs regionally at elevations ranging from 100 to 350 feet above msl (Hart Crowser 1988) and has a thickness of 20 to 250 feet. Depth to bedrock at JPHC/NHB is unknown.

Soils at the site belong to the Alderwood series developed on the recessional deposits and consist of silty sands with varying amounts of organic material. The silty sands grade to coarse sand and gravel beach deposits along the shoreline of Ostrich Bay.

Figure 6-2 shows the locations of cross sections depicting site geology. Figure 6-3 shows the geologic cross sections.

6.2.4 Hydrogeology

Groundwater occurs at JPHC/NHB as perched groundwater in the recessional outwash above the Vashon Till, within localized permeable zones in the Vashon Till, and regionally in the Vashon Advance Outwash deposits below the Vashon Till. Groundwater movement in all water-bearing units at the site is generally toward Ostrich Bay.

The Vashon Advance Outwash deposits below the Vashon Till are a regionally important aquifer. Groundwater within this unit is reportedly potable and provides an important domestic source of drinking water. However, because of the depth and a readily available public water system, no domestic wells are screened in the Vashon Advance Outwash deposits within about 0.75 mile of JPHC/NHB. Numerous domestic wells and two municipal water supply wells are present in the Vashon Advance Outwash at depths greater than 200 feet and at distances greater than about 0.75 mile from JPHC/NHB. Because groundwater movement at JPHC/NHB is toward Ostrich Bay, none of these wells are hydrogeologically downgradient of JPHC/NHB. The City of Bremerton is the current and most likely future source of drinking water for the JPHC/NHB area.

Key characteristics of site hydrogeology in regard to the sea-level aquifer in the recessional outwash are:

- Groundwater flows generally to the east from the upland areas and discharges to Ostrich Bay. At low tide, the groundwater discharges as surface water in the intertidal zone and is visible as seeps along the shoreline.
- Hydraulic gradients of 0.011 to 0.033 foot/foot were measured.
- Hydraulic conductivities in the recessional outwash and beach sands, calculated from slug tests, ranged from 1.2×10^{-4} to 6.5×10^{-4} centimeters per second (cm/s). Hydraulic conductivity in the underlying till was calculated at 2.4×10^{-5} cm/s, indicating that the till restricts vertical groundwater movement.
- No significant salinity concentration and no freshwater/saltwater interface was detected in any site monitoring wells. Water level measurements indicated no significant gradient reversal at high tide and minimal intrusion of salt water at high tide.
- Average groundwater seepage velocity at Site 103 is approximately 0.13 feet/day.

- Average daily discharges of groundwater to Ostrich Bay from Sites 101, 101-A, and 103 are calculated at approximately 23,065 gallons/day, 7,600 gallons/day, and 50,750 gallons/day, respectively.

Figure 6-4 is a conceptual model of site hydrogeology in nearshore areas, showing groundwater (fresh water) discharging to a saltwater body. A saltwater wedge, formed by the higher density seawater, directs the flow of groundwater to the intertidal zone. Little or no discharge of groundwater occurs in the subtidal zone. The region in Figure 6-4 labeled "brackish water" will have temporally varying salinities depending on the tidal cycle and potential seasonal variations in groundwater discharge rate. At low tide, much of this region would have very low salinity, as discharging fresh water flushes the salt water out. Seep and outfall samples were collected using sampling procedures specifically designed to avoid any effects of dilution by marine water, in order to obtain samples that are representative of actual groundwater quality at the point of discharge. Seep samples were collected during low tide, when all salt water had been flushed out. Salinity measurements confirmed that saltwater dilution of the seep and outfall samples was negligible.

Groundwater in the nearshore portions of OU 1 (Sites 101, 101-A, and 103) occurs in the Vashon Recessional Outwash and is not a potential source of drinking water, based on the requirements of Washington Administrative Code (WAC) 173-340-720(1)(a)(i-iii). Groundwater at these sites is not a current source of drinking water; groundwater quantities are insufficient to yield greater than 0.5 gallons per minute (gpm) on a sustainable basis; and it is unlikely that hazardous substances could be transported to other groundwater sources of drinking water. Based on these WAC requirements, groundwater at these sites is not considered a viable source of potable water, and groundwater quality was evaluated for its potential impacts to adjacent marine surface water. This approach is also consistent with federal requirements. Based on the federal guidelines (U.S. EPA 1986), groundwater in these areas is also considered nonpotable, or "Class III," because a well could not yield more than 150 gallons per day on a sustained basis. The federal guidelines stipulate that restoration of Class III groundwaters should consider any surface water bodies to which the groundwater discharges.

In upland portions of OU 1 (portions of Site 110), the uppermost groundwater occurs in the Vashon Advance Outwash deposits. Because groundwater from some portions of Site 110 could potentially be used as a drinking water resource in the future, the groundwater results for Site 110 were evaluated against drinking water criteria.

6.3 NATURE AND EXTENT OF CONTAMINATION

6.3.1 Media Sampled

Environmental media sampled during the OU 1 investigation include surface and subsurface soil, groundwater, surface water from an ephemeral stream, surface water from seeps and outfalls (where groundwater discharges along the shoreline), intertidal marine sediments, and marine tissue from clams and crabs. Samples were analyzed for target analyte list (TAL) inorganics and target compound list (TCL) pesticides/polychlorinated biphenyls (PCBs), volatile organic compounds (VOCs), semivolatile organic compounds (SVOCs), total petroleum hydrocarbons (TPH), and ordnance compounds.

Figure 6-5 shows the locations of sampling stations at Sites 101, 101-A, and 103. Figure 6-6 shows the location of sampling stations at the benzene release area within Sites 101 and 110.

During the RI, groundwater samples were collected from three deep wells located upgradient of OU 1 in an effort to determine background concentrations of inorganics. However, the FS concluded that the groundwater background samples that were collected during the RI were from a different aquifer than the one sampled at OU 1. To allow an accurate estimate of area background concentrations of inorganics in groundwater, two monitoring wells were installed off site and crossgradient from Site 101-A (Figure 6-7). The wells were installed and sampled in August 1998, and sampled again in November 1998. The results of this sampling are presented in a letter report (U.S. Navy 1999a). Additional sampling of these wells is continuing on a quarterly basis. A total of 10 sampling events are planned to allow a large enough sample population to statistically determine the area groundwater background concentrations. The results of the background investigation will be available before the first 5-year review of the remedy for OU 1.

6.3.2 Data Evaluation

Detected concentrations of chemicals were compared against evaluation criteria to eliminate from consideration chemicals that are not expected to pose significant risk to human health or the environment. The chemicals that exceed the evaluation criteria in one or more samples are defined as chemicals of concern (COCs). The evaluation criteria include background concentrations of inorganics and chemical-specific regulatory criteria (Table 6-1). Section 8 contains tables showing the chemical-specific ARARs, background concentrations, and selected cleanup levels for each COC.

The process for selection of chemical-specific evaluation criteria is summarized below:

- For soil, MTCA Method B soil cleanup levels are used for the residential areas at Sites 101, 101-A, and 110, and MTCA Method C soil cleanup levels are used for the recreational area at Site 103. (MTCA Method B soil cleanup levels are based on a lifetime excess cancer risk of 1E-06 or a Hazard Index (HI) of 1. MTCA Method C soil cleanup levels are based on a lifetime excess cancer risk of 1E-05 or a Hazard Index (HI) of 1.) For petroleum hydrocarbons and lead in soil, MTCA Method B or C cleanup levels were not available, and the Method A cleanup levels were used. If naturally occurring background concentrations of inorganics in soil are greater than the MTCA soil cleanup levels, the background concentrations are used as the evaluation criteria. Background soil concentrations were reported in the RI and were calculated by WDOE (U.S. Navy 1994a).

- For groundwater and surface water, MTCA Method B surface water cleanup levels are used. As described in WAC 173-340-730, the Method B surface water cleanup levels are determined by selecting the most stringent of the following:

    - National Toxics Rule (40 CFR 131.36) criteria for protection of human health based on ingestion of organisms

    - Washington State water quality standards (WQS) (Chapter 173-201A WAC)

    - For those chemicals for which there are no promulgated state criteria, federal water quality criteria (WQC) (40 CFR 131) may be used

    - For those chemicals for which sufficiently protective health-based standards are not promulgated, the risk-based cleanup levels from the formulas in WAC 173-340-730 are used; these are summarized in the *CLARC II* database (WDOE 1996)

  For petroleum hydrocarbons in groundwater and surface water, none of the above regulations have promulgated criteria, and therefore the MTCA Method A groundwater cleanup level was used.

If naturally occurring background concentrations of inorganics in groundwater are greater than the most stringent of these surface water cleanup levels, the groundwater background concentrations are used as the evaluation criteria. Groundwater background concentrations were reported in the RI based on samples from upgradient wells. As stated in Section 6.3.1, the FS concluded that the RI groundwater background samples were from a different aquifer from the one sampled at OU 1. Area background concentrations of inorganics in groundwater are being determined by the Navy (using WDOE statistical guidance) and will be available before the first 5-year review of the remedy for OU 1.

- For intertidal sediments, Washington State sediment quality standards (SQS) chemical criteria are used as the evaluation criteria.

In addition to the COCs identified by comparisons against the numeric evaluation criteria, all detected chemicals were evaluated in a site-specific baseline human health risk assessment. Actual exposure scenarios that could occur at each site were used to develop numeric risk estimates, and any chemical presenting an excess cancer risk of 1 in 1,000,000 (1.0E-06) or a hazard quotient of 1 for noncancer effects was considered a COC. The specific methods used in the baseline risk assessment are discussed in detail in Section 7. The following subsections describe the nature and extent of the COCs found at each site.

6.3.3 Site 101

Table 6-2 summarizes the COCs identified for Site 101, including the selected evaluation criteria used for comparison, the frequency of detections above the evaluation criteria, and the range of detected concentrations above the evaluation criteria.

Soil

A total of 25 surface and subsurface soil samples were collected at Site 101 from six soil borings and four surface locations. Carcinogenic PAH compounds and arsenic were identified as COCs in Site 101 soils.

Carcinogenic PAH compounds exceeded the MTCA Method B cleanup level of 0.137 mg/kg in four surface soil samples collected from Site 101 from upland surface soil at location USS-2, monitoring wells MW-5 and MW-4, and soil boring SB-22 (sampling locations are shown in Figure 6-5). The cPAH exceedances are generally associated with shoulders or ditches along South Shore Road, with the exception of the exceedance at USS-2. Arsenic exceeded the natural soil background concentration of 8.6 mg/kg in five surface soil samples collected at MW-4, MW-5, USS-2, and surface soil locations SS-1 and SS-2.

One ordnance compound (picric acid) was detected in 1 of 22 soil samples at Site 101, at location SS-2. No MTCA soil cleanup levels have been calculated for picric acid. Picric acid was not retained as a COC.

The human health risk assessment identified arsenic and cPAHs as COCs, based on carcinogenic risk greater than 1.0E-06.

Groundwater

During the RI, a total of 16 groundwater samples were collected from 5 monitoring wells within Site 101. Groundwater discharges to marine surface water in the intertidal zone. Because groundwater at Site 101 is not a current or potential future source of drinking water, groundwater quality was evaluated based on the protection of nearby marine surface water.

State marine WQS for the following inorganics are based on the dissolved form: cadmium, copper, lead, nickel, silver, and zinc. No inorganics exceeded the evaluation criteria in the dissolved analyses. For all other chemicals, total concentrations are used. Arsenic, beryllium, mercury, and thallium were identified as COCs in Site 101 groundwater based on exceedances of the evaluation criteria in the total inorganics analysis.

The groundwater samples for total inorganics contained turbidity introduced by the sample collection methods. This turbidity causes a high bias in the total inorganics analyses, and therefore the total inorganics data from these sampling events are not considered to represent actual groundwater quality. Filtered groundwater samples were also collected to minimize sample turbidity. In the filtered samples, no inorganics exceeded the evaluation criteria.

No ordnance compounds were detected in Site 101 groundwater.

Based on a 1996 detection of benzene in a shoreline outfall (OF-712) at Site 101, WDOE independently sampled shoreline seeps and groundwater from selected monitoring wells at Site 101 in 1996. The Navy subsequently conducted investigations of soil, groundwater, and seeps in an area that has been designated the benzene release area. The benzene release area is located within portions of Sites 101 and 110 and is discussed separately. The results of the WDOE and Navy investigations at the benzene release area are summarized in Section 6.3.7.

Exceedances of the screening criteria in inland monitoring wells does not necessarily indicate a risk to the marine environment. The potential for risk to the marine environment is evaluated based on seep and outfall data, discussed below.

Surface Water—Seeps and Outfalls

Groundwater at Site 101 discharges to marine water in the intertidal zone, in a series of seeps and outfalls. A total of 18 surface water samples were collected from seeps and outfalls at Site 101. Salinity measurements were used to confirm that measured concentrations of chemicals in the seeps and outfalls were not diluted by seawater. Total and dissolved arsenic, dissolved mercury, and dissolved nickel were identified as COCs in Site 101 seeps and outfalls. Total arsenic exceeded the calculated groundwater background concentration of 3.3 µg/L in 5 of 18 samples, with a maximum concentration of 6.5 µg/L. Dissolved arsenic exceeded the calculated background concentration of 3.3 µg/L in 1 of 12 samples, with a maximum concentration of 5 µg/L. Total mercury exceeded the state marine WQS of 0.025 µg/L in 2 of 12 samples, with a maximum concentration of 0.2 µg/L. Dissolved nickel exceeded the state marine WQS of 7.9 µg/L in 1 of 12 samples. In the three seep sampling events at Site 101, the mercury and nickel detections occurred in one event and have not been reproducible. Background concentrations of total mercury and dissolved nickel were not determined.

The calculated groundwater background concentrations from the RI are questionable because the wells used to determine background are not screened in the same groundwater unit as the shallow groundwater unit at JPHC/NHB. It is suspected that the inorganics concentrations in the seeps and outfalls are attributable to background. To eliminate the uncertainty associated with groundwater background, groundwater background concentrations are being redetermined as a component of the selected remedy in this ROD. At the 5-year review, the new background data will be used to verify that the inorganic COCs in seeps and outfalls are not affecting the marine environment.

Five ordnance compounds—1,3,5-trinitrobenzene, 2,4-dinitrotoluene, hexahydro-1,3,5-trinitro-1,3,5-triazine (also called Royal Demolition Explosive or RDX), tetryl, and nitrobenzene—were detected in surface water samples at Site 101. No ordnance compounds exceeded chemical-specific surface water evaluation criteria. However, published or calculated regulatory criteria were not available for tetryl in surface water. In the two most recent surface water sampling rounds (1996 and 1998 Phase III sampling), no ordnance compounds were detected in surface water samples. No ordnance compounds were retained as COCs.

Benzene was detected in two seep samples at OF-712 (shown in Figure 6-5) at 290 and 230 µg/L, exceeding the MTCA Method B surface water cleanup level of 43 µg/L. Based on the first benzene detection at OF-712, WDOE independently sampled shoreline seeps and groundwater from selected monitoring wells at Site 101 in 1996. The Navy subsequently conducted investigations of soil, groundwater, and seeps in an area that has been designated the benzene release area. The benzene release area is located within portions of Sites 101 and 110, and is discussed separately. The results of the WDOE and Navy investigations at the benzene release area are summarized in Section 6.3.7.

Intertidal Sediments

Six intertidal sediment samples were collected at Site 101 at the same locations as six of the seep/outfall surface water samples. No detected concentrations of chemicals in these samples exceeded the state SQS. No COCs were identified in the sediment samples.

6.3.4 Site 101-A

Table 6-3 summarizes the COCs identified for Site 101-A, including the selected evaluation criteria used for comparison, the frequency of detections above the evaluation criteria, and the range of detected concentrations above the evaluation criteria.

Soil

A total of 35 surface and subsurface soil samples were collected at Site 101-A from 12 soil borings and 3 surface locations. Carcinogenic PAH compounds, antimony, arsenic, and beryllium were identified as COCs in Site 101-A soils.

Carcinogenic PAH compounds exceeded the MTCA Method B cleanup level of 0.137 mg/kg in one surface soil sample from MW-A8 and in three subsurface soil samples from SB-03 and MW-A5 (Figure 6-5). Arsenic exceeded the natural soil background concentration of 8.6 mg/kg in one surface soil sample collected at MW-A1 and in three subsurface soil samples collected at MW-A5 and SB-03. Antimony exceeded the MTCA Method B cleanup level of 32 mg/kg in one surface soil sample from SB-05. Beryllium exceeded the natural soil background concentration of 1.5 mg/kg in one surface soil sample collected at SB-05 and one subsurface soil sample collected at SB-03.

No ordnance compounds were detected in Site 101-A soils.

The human health risk assessment identified cPAHs and beryllium as COCs, based on carcinogenic risk greater than 1.0E-06.

Groundwater

A total of 20 groundwater samples were collected from 10 monitoring wells within Site 101-A. Groundwater discharges to marine surface water in the intertidal zone. Because groundwater at Site 101-A is not a current or potential future source of drinking water, groundwater quality was evaluated based on the protection of nearby marine surface water.

State marine WQS for the following inorganics are based on the dissolved form: cadmium, copper, lead, nickel, silver, and zinc. Because no dissolved inorganics analyses were done on Site 101-A groundwater samples, total inorganics results were used.

Petroleum hydrocarbons, 1,1-dichloroethene, and the inorganics arsenic, beryllium, copper, cyanide, lead, nickel, thallium, and zinc were identified as COCs in Site 101-A groundwater. The inorganic COCs were identified based on exceedances of the evaluation criteria in the total inorganics analysis.

The VOC 1,1-dichloroethene was detected in 1 of 20 samples at a concentration of 2 μg/L, slightly exceeding the MTCA Method B surface water cleanup level of 1.93 μg/L. TPH exceeded the MTCA Method A groundwater cleanup level of 1,000 μg/L in 1 sample of 20. Cyanide was detected in 1 of 20 samples at a concentration of 2 μg/L, exceeding the state marine WQS of 1 μg/L. Seven inorganics (arsenic, beryllium, copper, lead, nickel, thallium, and zinc) exceeded the evaluation criteria in one or more samples analyzed for total inorganics.

The petroleum compounds were detected before the removal of underground storage tanks and were not detected in a second round of sampling. The detections of 1,1-dichloroethene and cyanide may have been anomalous—each was found at low concentrations and was not detected in a second round of sampling. There were no detected concentrations of any of these three chemicals at measured points of discharge of groundwater into Ostrich Bay at Site 101-A.

The groundwater samples for total inorganics analysis contained turbidity introduced by the sample collection methods. This turbidity causes a high bias in the total inorganics analyses, and therefore the total inorganics data from these sampling events are not considered representative of actual groundwater quality. No groundwater samples were collected at Site 101-A that represent actual inorganics concentrations, and many of the inorganic COCs may not be present in Site 101-A groundwater at concentrations exceeding surface water regulatory criteria.

Four ordnance compounds (1,3-dinitrobenzene, 2,4,6-trinitrotoluene, 2,6-dinitrotoluene, and RDX) were detected in groundwater samples at Site 101-A. No ordnance compounds exceeded chemical-specific surface water evaluation criteria. However, published or calculated surface water regulatory criteria were not available for 1,3-dinitrobenzene. No ordnance compounds were retained as COCs.

Exceedances of the screening criteria in inland monitoring wells does not necessarily indicate a risk to the marine environment. The potential for risk to the marine environment is evaluated based on seep and outfall data, discussed below.

Surface Water—Seeps and Outfalls

Groundwater at Site 101-A discharges to marine water in the intertidal zone, in a series of seeps and outfalls. Nine surface water samples were collected from seeps and outfalls at Site 101-A. Salinity measurements were used to confirm that measured concentrations of chemicals in the seeps and outfalls were not diluted by seawater. Total and dissolved arsenic and total mercury were identified as COCs in Site 101-A seeps and outfalls. Total arsenic exceeded the calculated groundwater background concentration of 3.3 µg/L in two of nine samples, with a maximum concentration of 6 µg/L. Dissolved arsenic exceeded the calculated background concentration of 3.3 µg/L in one of four samples, with a maximum concentration of 4.4 µg/L. Total mercury exceeded the state marine WQS of 0.025 µg/L in one of nine samples, with a maximum concentration of 0.1 µg/L. In the three seep sampling events at Site 101-A, the mercury detection occurred once and has not been reproducible.

The calculated groundwater background concentrations from the RI are questionable because the wells used to determine background are not screened in the same groundwater unit as the shallow groundwater unit at JPHC/NHB. It is suspected that the inorganic concentrations in the seeps and outfalls are attributable to background. To eliminate the uncertainty associated with groundwater background, groundwater background concentrations are being re-determined as a component of the selected remedy in this ROD. At the 5-year review, the new background data will be used to verify that the inorganic COCs in seeps and outfalls are not affecting the marine environment.

Four ordnance compounds—1,3,5-trinitrobenzene, RDX, tetryl, and nitrobenzene—were detected in seep and outfall surface water samples at Site 101-A. No ordnance compounds exceeded chemical-specific evaluation criteria. However, published or calculated regulatory criteria were not available for tetryl in surface water. In the two most recent surface water sampling rounds (1996 and 1998 Phase III sampling), no ordnance compounds were detected in surface water samples. No ordnance compounds were retained as COCs.

Intertidal Sediments

Two intertidal sediment samples were collected at Site 101-A at the same locations as two of the seep/outfall samples. No detected concentrations of chemicals in these samples exceeded the state SQS. No COCs were identified in the sediment samples.

Stream Surface Water

Two stream surface water samples were collected from an ephemeral stream that runs through Site 101-A. No COCs were identified in these samples. No ordnance compounds were detected in these samples.

6.3.5 Site 103

Table 6-4 summarizes the COCs identified for Site 103, including the selected evaluation criteria used for comparison, the frequency of detections above the evaluation criteria, and the range of detected concentrations above the evaluation criteria.

Soil

A total of 107 surface and subsurface soil samples were collected at Site 103 from 24 soil borings, 9 test pits, and 7 surface locations. Petroleum hydrocarbons, the PCB Aroclor 1254, cPAH compounds, antimony, arsenic, and lead were identified as COCs in Site 103 soils.

Carcinogenic PAH compounds exceeded the MTCA Method C cleanup level of 5.48 mg/kg in one surface soil sample from SB-16 and in two subsurface soil samples from TP-4 and MW-8 (Figure 6-4). PCBs exceeded the MTCA Method C cleanup level of 5.19 mg/kg in one subsurface soil sample from MW-18. Lead exceeded the MTCA Method A cleanup level of 250 mg/kg in two surface soil samples from SB-16 and MW-29 and in five subsurface soil samples from TP-4, MW-8, MW-18, and TP-7. Antimony exceeded the MTCA Method C cleanup level of 128 mg/kg in one subsurface soil sample from TP-4. Total petroleum hydrocarbons exceeded the MTCA Method A cleanup level of 200 mg/kg in two subsurface soil samples from MW-29. The highest concentrations of COCs in Site 103 soils occurred near the former ordnance burn area.

Four ordnance compounds—picric acid, picramic acid, RDX, and tetryl—were detected in soil samples at Site 103. No ordnance compounds exceeded chemical-specific evaluation criteria. However, published or calculated regulatory criteria were not available for picric acid, picramic acid, or tetryl in soil. No ordnance compounds were retained as COCs.

The human health risk assessment identified arsenic, Aroclor 1254, and cPAHs as COCs, based on carcinogenic risk greater than 1.0E-06. Lead was also considered a human health COC, although numeric risk estimates were not calculated for lead.

Groundwater

A total of 29 groundwater samples were collected from 12 monitoring wells within Site 103. Groundwater discharges to marine surface water in the intertidal zone. Because groundwater at Site 103 is not a current or potential future source of drinking water, groundwater quality was evaluated based on the protection of nearby marine surface water.

State marine WQS for the following inorganics are based on the dissolved form: cadmium, copper, lead, nickel, silver, and zinc. For all other chemicals, total concentrations are used.

Chlordane, arsenic, beryllium, mercury, nickel, thallium, and zinc were identified as COCs in Site 103 groundwater. Chlordane exceeded the National Toxics Rule criterion of 0.0022 µg/L in 1 of 20 samples. Total arsenic exceeded the groundwater background concentration of 3.3 µg/L in 17 of 29 samples. Total beryllium exceeded the MTCA Method B cleanup level of 0.0793 µg/L in 9 of 29 samples. Total mercury exceeded the state marine WQS of 0.025 µg/L in 7 of 29 samples. Dissolved nickel exceeded the state marine WQS of 7.9 µg/L in 2 of 21 samples. Total thallium exceeded the MTCA Method B cleanup level of 1.56 µg/L in 1 of 29 samples. Dissolved zinc exceeded the groundwater background concentration of 104 µg/L in 2 of 21 samples.

There were no detected concentrations of chlordane at measured points of discharge of groundwater into Ostrich Bay at Site 103. The chlordane detection may have been anomalous, and it appears that the chlordane concentrations are below cleanup levels at the conditional point of compliance.

The groundwater samples collected for total inorganics analysis contained turbidity introduced by the sample collection methods. This turbidity causes a high bias in the total inorganics analyses, and therefore the total inorganics data from these sampling events are not considered representative of actual groundwater quality. Three groundwater samples were collected at

Site 103 using a low-flow method that minimized sample turbidity. In the low-flow samples, arsenic, beryllium, and mercury exceeded the evaluation criteria in the total inorganics analyses; however, these exceedances were limited to one sample collected at MW-20 (Figure 6-5). Even though low-flow sampling techniques were used, turbidity measurements at MW-20 were still high at the time of sampling. The sample from MW-20 is not considered to be representative of actual groundwater quality.

Five ordnance compounds—2,4,6-trinitrotoluene, 2,4-dinitrotoluene, 2,6-dinitrotoluene, RDX, and picric acid—were detected in groundwater samples at Site 103. No ordnance compounds exceeded chemical-specific evaluation criteria. However, published or calculated regulatory criteria were not available for picric acid in surface water, to which the groundwater discharges. No ordnance compounds were retained as COCs.

Exceedances of the screening criteria in inland monitoring wells does not necessarily indicate a risk to the marine environment. The potential for risk to the marine environment is evaluated based on seep and outfall data, discussed below.

Surface Water—Seeps and Outfalls

Groundwater at Site 103 discharges to marine water in the intertidal zone, in a series of seeps and outfalls. A total of 30 surface water samples were collected from seeps and outfalls at Site 103. Salinity measurements were used to confirm that measured concentrations of chemicals in the seeps and outfalls were not diluted by seawater.

Chemicals identified as COCs in Site 103 seeps and outfalls were 1,1-dichloroethene, trichloroethene, vinyl chloride, total and dissolved arsenic, dissolved mercury, and dissolved silver. Concentrations of 1,1-dichloroethene exceeded the MTCA Method B cleanup level of 1.93 μg/L in 1 of 30 samples. Trichloroethene exceeded the MTCA Method B cleanup level of 55.6 μg/L in 1 of 30 samples. Vinyl chloride exceeded the MTCA Method B cleanup level of 2.92 μg/L in 5 of 30 samples. Total arsenic exceeded the calculated groundwater background concentration of 3.3 μg/L in 13 of 27 samples, with a maximum concentration of 17 μg/L. Dissolved arsenic exceeded the calculated background concentration of 3.3 μg/L in 4 of 18 samples, with a maximum concentration of 3.8 μg/L. Dissolved mercury exceeded the state marine WQS of 0.025 μg/L in 2 of 18 samples, with a maximum concentration of 0.16 μg/L. Dissolved silver exceeded the state marine WQS of 1.2 μg/L in one of nine samples.

The VOCs 1,1-dichloroethene, trichloroethene, and vinyl chloride were present in seeps and outfalls downgradient of the former ordnance burn area. Concentrations of the VOCs have been declining over time and in the last (1998) round of sampling only vinyl chloride exceeded the surface water standards. The inorganic exceedances (arsenic, mercury, and silver) occurred in an apparently random distribution. In three seep sampling events at Site 103, the mercury and silver detections occurred in one sampling event and have not been reproducible.

The calculated groundwater background concentrations from the RI are questionable because the wells used to determine background are not screened in the same groundwater unit as the shallow groundwater unit at JPHC/NHB. It is suspected that the inorganics concentrations in the seeps and outfalls are attributable to background. To eliminate the uncertainty associated with groundwater background, groundwater background concentrations are being re-determined as a component of the selected remedy in this ROD. At the 5-year review, the new background data will be used to verify that the inorganic COCs in seeps and outfalls are not affecting the marine environment.

Six ordnance compounds (1,3,5-trinitrobenzene, 2,4-dinitrotoluene, 2,6-dinitrotoluene, RDX, tetryl, and nitrobenzene) were detected in seep and outfall surface water samples at Site 103. No ordnance compounds exceeded chemical-specific evaluation criteria. However, published or calculated regulatory criteria were not available for tetryl in surface water. In the two most recent surface water sampling rounds (1996 and 1998 Phase III sampling), no ordnance compounds were detected in surface water samples. No ordnance compounds were retained as COCs.

Intertidal Sediments

Nine intertidal sediment samples were collected at Site 103 at the same locations as nine of the seep/outfall samples. Bis(2-ethylhexyl)phthalate was identified as a COC in the sediment samples. Bis(2-ethylhexyl)phthalate was detected in one of nine samples at a concentration exceeding the state SQS of 47 milligrams per kilogram organic carbon (mg/kgOC). This chemical was also found in soil at Site 103, at concentrations below the soil evaluation criterion. Erosion of soil along the Site 103 shoreline is the suspected cause of the exceedance in the intertidal sediments.

6.3.6 Site 110

The nature and extent of contamination at Site 110 was largely determined in an SI (U.S. Navy 1993). Table 6-5 summarizes the COCs identified for Site 110, including the selected evaluation criteria used for comparison, the frequency of detections above the evaluation criteria, and the range of detected concentrations above the evaluation criteria.

Soil

A total of 137 surface and subsurface soil samples were collected for the SI at Site 110 from 27 soil borings and 77 surface locations. Arsenic and cPAH compounds were identified as COCs in Site 110 soils. Based on the SI results, removal actions were conducted at the identified areas of contamination. At the time of the removal actions, MTCA Method A soil cleanup levels were used as the remedial goals. Following the removal actions, two locations (SS-51 and MW-13) remain where arsenic exceeds the MTCA Method A soil cleanup level of 20 mg/kg, and two locations remain (SB-13 and SS-67) where cPAHs exceed the MTCA Method A soil cleanup level of 1 mg/kg. Additionally, soil beneath paved areas in front of Bunkers 100 and 101 contain arsenic and cPAHs above the MTCA Method A soil cleanup levels.

Because the primary areas of contamination have been addressed by removal actions, the human health risk assessment did not include an evaluation of risks from COCs in soil at Site 110.

Groundwater

A total of eight groundwater samples were collected from four monitoring wells within Site 110. Because groundwater from some portions of Site 110 could potentially be used as a drinking water resource in the future, the groundwater results were evaluated against drinking water criteria. Groundwater flows from Site 110 into Sites 101, 101-A, and 103, eventually discharging to marine surface water in the intertidal zone. Any effects of Site 110 groundwater on marine surface water are evaluated using the seep and outfall results from Sites 101, 101-A, and 103.

Although five inorganics (arsenic, beryllium, manganese, nickel, and vanadium) exceeded the drinking water evaluation criteria in one or more groundwater samples, the samples contained turbidity introduced by the sample collection methods. This turbidity causes a high bias in the total inorganics analysis, and therefore these data are not considered to represent actual groundwater quality. All of the inorganics exceedances at Site 110 occurred in the totals analysis. Two groundwater samples at Site 110 were collected and analyzed for dissolved inorganics. No inorganics exceeded the evaluation criteria in the dissolved analyses. Nevertheless, these inorganics were retained as COCs in Site 110 groundwater.

Based on a 1996 detection of benzene in a shoreline outfall (OF-712) at Site 101, WDOE independently sampled shoreline seeps and groundwater from selected monitoring wells at Site 101 in 1996. The Navy subsequently conducted investigations of soil, groundwater, and seeps in an area that has been designated the benzene release area. The benzene release area is located within portions of Sites 101 and 110 and is discussed separately. The results of the WDOE and Navy investigations at the benzene release area are summarized in Section 6.3.7.

6.3.7 Benzene Release Area (Sites 101 and 110)

The benzene release area is located within portions of Sites 101 and 110 at OU 1 (Figure 6-5). The area is defined by two seeps that discharge through two pipes along the shoreline of Ostrich Bay, and an area of benzene and petroleum contamination in soil and groundwater that extends approximately 450 feet upgradient of the seeps (Figure 6-6). The NEX gas station, constructed around 1981, is the upgradient limit of known contamination. The NEX gas station is located at the corner of Dowell Road and Sullivan Place in Site 110. In three separate sampling events in 1996, WDOE collected seep and groundwater samples from this area. In 1997 and 1998, the Navy conducted a separate investigation in an attempt to determine the source and extent of benzene and petroleum contamination in upgradient soil and groundwater. No source was found in the 1997/1998 investigation (Hart Crowser 1998). Another investigation in 1999 identified petroleum-contaminated soil beneath the NEX fuel dispenser island as the source of groundwater contamination (U.S. Navy 1999c).

Results of Investigations Through 1998

Table 6-6 summarizes the COCs identified for the benzene release area, including data from investigations through 1998. Table 6-6 shows the selected evaluation criteria used for comparison, the frequency of detections above the evaluation criteria, and the range of detected concentrations above the evaluation criteria.

- ***Soil***

A total of 25 subsurface soil samples were collected from 16 boreholes. Gasoline-range petroleum hydrocarbons were identified as a COC in soil in the benzene release area.

In soil borings, only two samples (both located at the downgradient edge of the gas station) contained gasoline-range petroleum hydrocarbons above the MTCA Method A cleanup level of 100 mg/kg. Gasoline-range petroleum hydrocarbons were detected in soil at HC-4 at 300 mg/kg at a depth of 22.5 to 24 feet below ground surface (bgs); and at the adjacent Strataprobe boring 11 at 440 mg/kg at a depth of 8 to 11 feet bgs.

- ***Groundwater***

A total of 37 groundwater samples were collected from 9 monitoring wells and 16 direct-push groundwater sampling locations. Because groundwater in the benzene release area is not a current or potential future source of drinking water, groundwater quality was evaluated based on the protection of nearby marine surface water.

Gasoline-range petroleum hydrocarbons and benzene were identified as COCs in groundwater in the benzene release area based on exceedances of the evaluation criteria. Gasoline-range petroleum hydrocarbons exceeded the MTCA Method A groundwater cleanup level of 1,000 µg/L in 2 of 34 samples from wells HC-4 and MW-4. Benzene exceeded the MTCA Method B surface water cleanup level of 43 µg/L in 7 of 37 samples from wells BH-2, MW-3, MW-4, and HC-4.

- ***Surface Water – Seeps and Outfalls***

A total of 12 surface water samples were collected from two seeps (designated SEEP-R and SEEP-L) in 1996 through 1998. (SEEP-L is the same location that was designated OF-712 in the RI/FS seep sampling at Site 101.)

Benzene was identified as a COC in the seep samples based on exceedances of the evaluation criteria. Benzene exceeded the MTCA Method B surface water cleanup level of 43 µg/L in 9 of 12 samples, with a maximum detection of 1,070 µg/L.

Results of 1999 Investigation

Additional soil and groundwater samples were collected in 1999 to identify the source of groundwater and seep contamination at the Benzene Release Area. Table 6-7 summarizes the COCs identified in the 1999 investigation. Figure 6-6 shows the approximate limits of soil and groundwater contamination found in the 1999 investigation.

- ***Soil***

A total of 22 subsurface soil samples were collected from 12 boreholes. Gasoline-range petroleum hydrocarbons were identified as a COC in soil in the benzene release area. Petroleum contamination in soil extended laterally approximately 180 feet downgradient from the fuel dispenser island at the NEX gas station. The petroleum contamination extended to depths of approximately 25 feet bgs. The maximum detected concentration of gasoline-range petroleum hydrocarbons was 3,500 mg/kg, exceeding the MTCA Method A cleanup level of 100 mg/kg. The petroleum-contaminated soil was confirmed to be the source of groundwater and seep contamination.

- ***Groundwater***

A total of 12 groundwater samples were collected from newly-installed boreholes and existing wells. Because groundwater in the benzene release area is not a current or potential future source of drinking water, groundwater quality was evaluated based on the protection of nearby marine surface water.

Gasoline-range petroleum hydrocarbons and benzene were identified as COCs in groundwater in the benzene release area based on exceedances of the evaluation criteria. The area of petroleum/benzene contamination in groundwater corresponds to the location of the source area soil contamination, as shown in Figure 6-6. An additional groundwater plume fragment is present near the shoreline, indicating changes in plume shape over time and/or preferential groundwater flow pathways.

- ***Surface Water – Seeps and Outfalls***

A total of two surface water samples were collected from SEEP-R and SEEP-L in 1999. Benzene was identified as a COC in the seep samples based on exceedances of the evaluation criteria. Benzene exceeded the MTCA Method B surface water cleanup level of 43 μg/L in one of two samples, with a maximum detection of 260 μg/L.

6.3.8 Marine Tissue

A total of 80 marine tissue (clam and crab) samples were collected from Ostrich Bay and analyzed for inorganics, VOCs, SVOCs, pesticides/PCBs, and ordnance compounds. No chemical-specific regulatory criteria exist for acceptable concentrations of these chemicals in marine tissue. The human health risk assessment identified four COCs in marine tissue: antimony, vanadium, pentachlorophenol (PCP), and 3,3′-dichlorobenzidine. The incremental noncancer risks (i.e., actual risk above background) posed by antimony and vanadium could not be evaluated because background concentrations of these elements in marine tissue were not established. However, the excess lifetime cancer risk associated with PCP and 3,3'-dichlorobenzidine in marine tissue exceeds 1E-04, and therefore action is warranted regardless of antimony and vanadium background concentrations. The selected remedy in this ROD includes determining tissue background concentrations to eliminate this uncertainty. At the 5-year review, the new background data will be used to refine the risk estimates.

Analytical results from terrestrial media (soil, groundwater, and seeps/outfalls) were evaluated to determine whether terrestrial sources may be affecting concentrations of COCs in marine tissue. No terrestrial sources of vanadium, PCP, and 3,3'-dichlorobenzidine were found. Erosion of soils along the Site 103 shoreline is one potential source of antimony in marine tissue. Wooden pilings in Ostrich Bay are a potential source of PCP detected in marine tissue. Testing, however, has not been conducted to determine whether or not the pilings are a source.

6.4 CURRENT AND POTENTIAL FUTURE LAND AND RESOURCE USES

6.4.1 Land Uses

Land uses on site at OU 1 include residential housing, recreational areas, and a military hospital. Sites 101, 101-A, and 110 include developed residential and recreational areas. The northern portion of Site 110 is developed as a military hospital. Site 103 is a recreational area for Jackson Park Housing Complex, and includes a ballfield, a running track, a park, a picnic area, easily accessible beachfront areas, and other recreational facilities. A helipad serving Naval Hospital Bremerton is also located at Site 103.

Land uses in areas surrounding OU 1 are as follows. The site is bounded to the east by the marine environment of Ostrich Bay, which is state-owned aquatic land. A wooded park used for recreation bounds the site to the south. The site is bounded to the west by State Route 3 and the Jackson Park Elementary School. The site is bounded to the north by the residential community of Erlands Point.

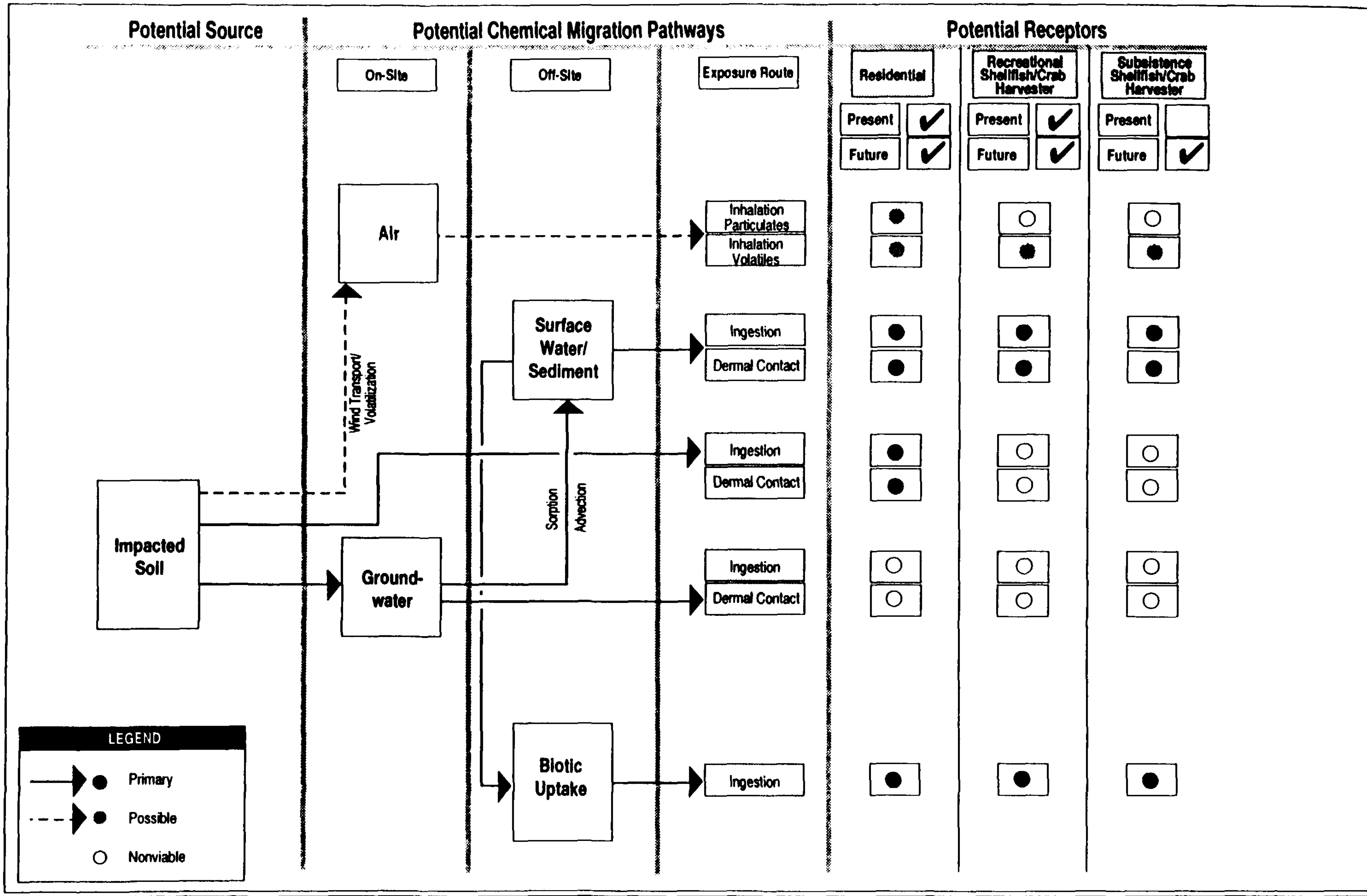
The Navy has no plans to modify existing land use at OU 1. The Navy's intent is to maintain Site 103 as recreational in the future. The Navy is planning a major recreational project at Sites 101 and 103 to provide additional recreational facilities and improve shoreline access in existing recreational areas. No major changes can reasonably be anticipated in the future land uses of surrounding properties.

6.4.2 Groundwater Uses

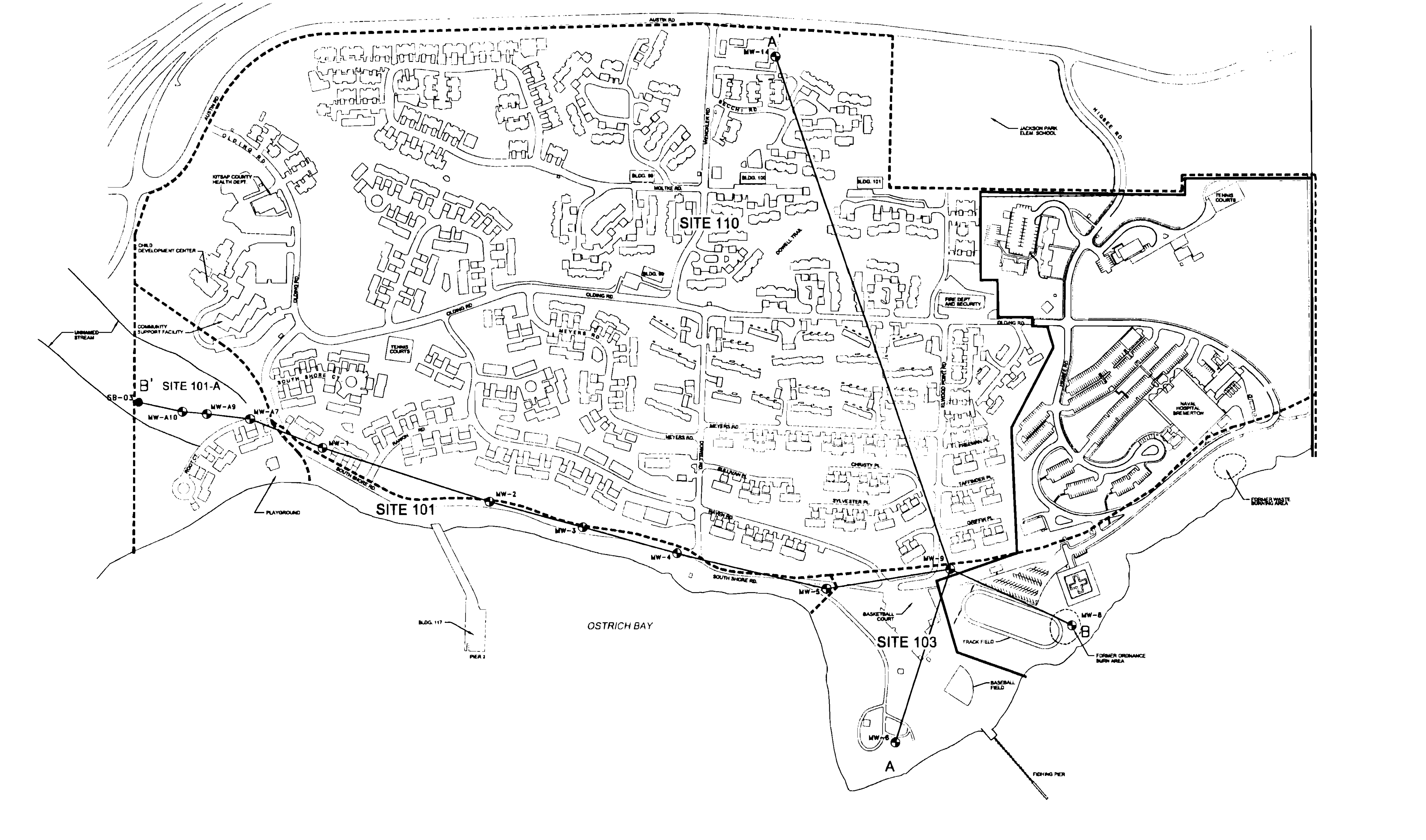
Groundwater at OU 1 is not a current source of drinking water. Drinking water for OU 1 is supplied by the City of Bremerton public water system. Groundwater at OU1 discharges to marine surface water in the intertidal zone, as a series of seeps and outfalls along the Ostrich Bay shoreline. Groundwater in the immediate vicinity of OU 1 is not used as a source of drinking water. Numerous domestic wells and two municipal water supply wells are present in the Vashon Advance Outwash at depths greater than 200 feet and at distances greater than about 0.75 mile from OU 1. Because groundwater movement at OU 1 is toward Ostrich Bay, none of these wells are hydrogeologically downgradient of the site.

The City of Bremerton public water system is the most likely future source of drinking water for OU 1. As discussed in Section 6.2.4, groundwater in the nearshore portions of OU 1 (Sites 101, 101-A, and 103) occurs in the Vashon Recessional Outwash and is not a potential future source of drinking water, based on the requirements of WAC 173-340-720(1)(a)(i-iii) and EPA groundwater classification guidelines. In upland portions of OU 1 (portions of Site 110), the uppermost groundwater occurs in the Vashon Advance Outwash deposits. Groundwater from some portions of Site 110 could potentially be used as a drinking water resource in the future, although such use is considered to be highly unlikely given the ready availability of the existing public water supply system.

Because groundwater movement at OU 1 is toward Ostrich Bay, with discharge to surface water, any groundwater contamination that may exist on site is not expected to affect any off-site groundwater resources. Groundwater at OU 1 was evaluated for its potential impact to adjacent marine surface water.



CLEAN Comprehensive Long-Term Environmental Action Navy	**Figure 6-1** **Conceptual Site Model for OU 1**	CTO 0031 JPHC/NHB Bremerton, WA OU 1 ROD



LEGEND

- - - - - Site Boundary Line

——— Naval Hospital Bremerton Property Line

MW-2 ● Monitoring Well

SB-03 ● Soil Boring

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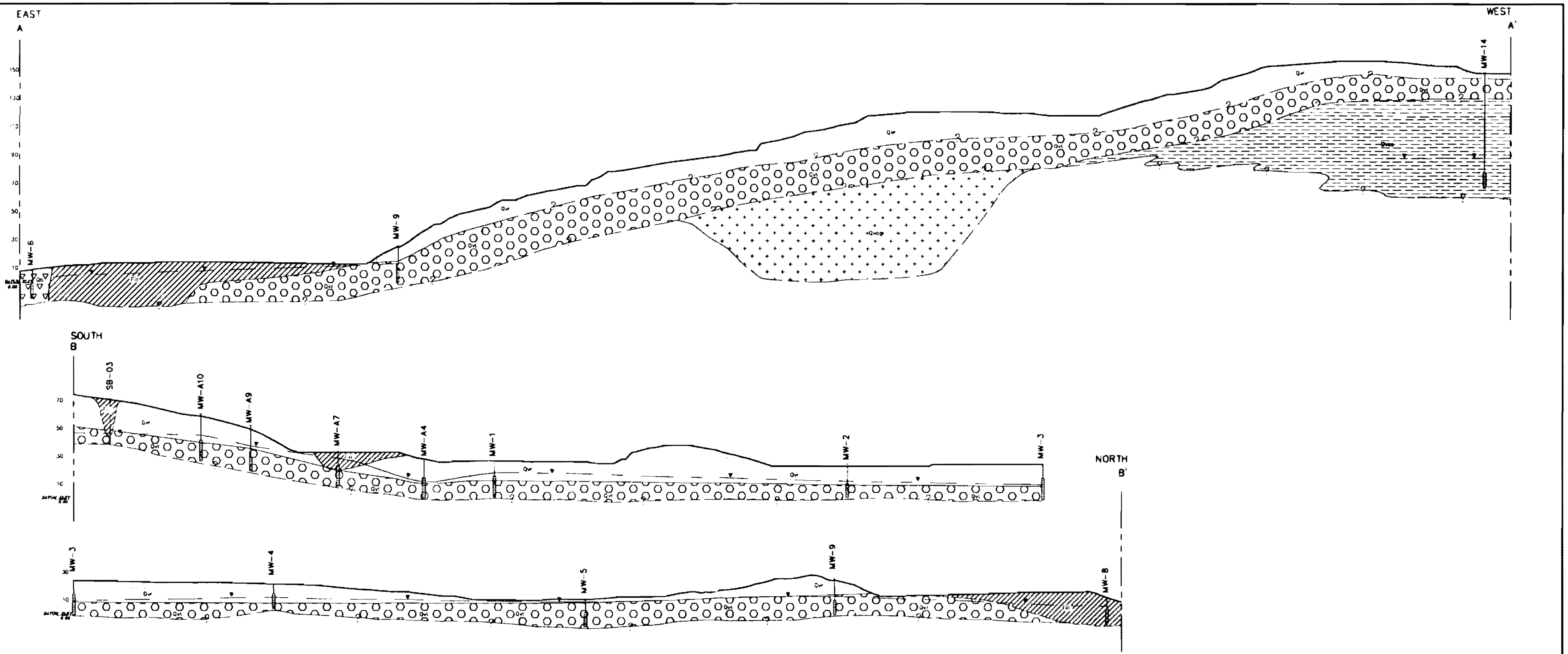
CTO 0031
JPHC/NHB
Bremerton, WA
OU 1 ROD

N

0 100 200 400
SCALE IN FEET

Figure 6-2
Cross Sections Locations Map



LEGEND

ARTIFICIAL FILL – COMPOSITION VARIES FROM PLACE TO PLACE – MAY BE DIFFICULT TO DISTINGUISH FROM THE NATURAL SOILS & GLACIAL OUTWASH; THE FILL IS OFTEN MARKED BY ANTHROPOGENIC DEBRIS RANGING FROM SMALL TRASH (I.E. PLASTICS, WIRES) TO LARGE CONCRETE SLABS & CONSTRUCTION RUBBLE.

BEACH DEPOSITS – ASSORTED SANDS AND GRAVELS, POORLY SORTED AND OFTEN SATURATED.

Vashon Recessional Outwash Deposits

Qvr — GLACIAL OUTWASH DEPOSITS – YELLOW-BROWN, SILTY MEDIUM TO FINE SAND, MINOR AMOUNTS OF GRAVEL.

Vashon Till Deposits

Qvt — GLACIAL TILL – GREY, POORLY SORTED, SILTY SANDS, SILTY GRAVELS, COARSE SANDS AND SILTY CLAY, GRAVELY CLAYS; THE TILL IS OFTEN WELL INDURATED AND NOT PLASTIC WHEN WET.

Vashon Advance Outwash Deposits

Qvas — SILTS & SANDS – BROWN SILTS AND MEDIUM TO FINE SANDS, OFTEN INTERBEDDED

Qvag — SANDS & GRAVELS – COARSE SANDS AND GRAVELS, POORLY SORTED.

DEFINED CONTACT

SUSPECTED CONTACT

EXACT CONTACT UNDEFINED.

GROUND WATER LEVEL

MW-4 — MONITORING WELL WITH SCREENED INTERVAL. (SOIL SAMPLE INTERVAL EVERY 5 FEET)

SB-03 — SOIL BORING (SOIL SAMPLE INTERVAL EVERY 5 FEET)

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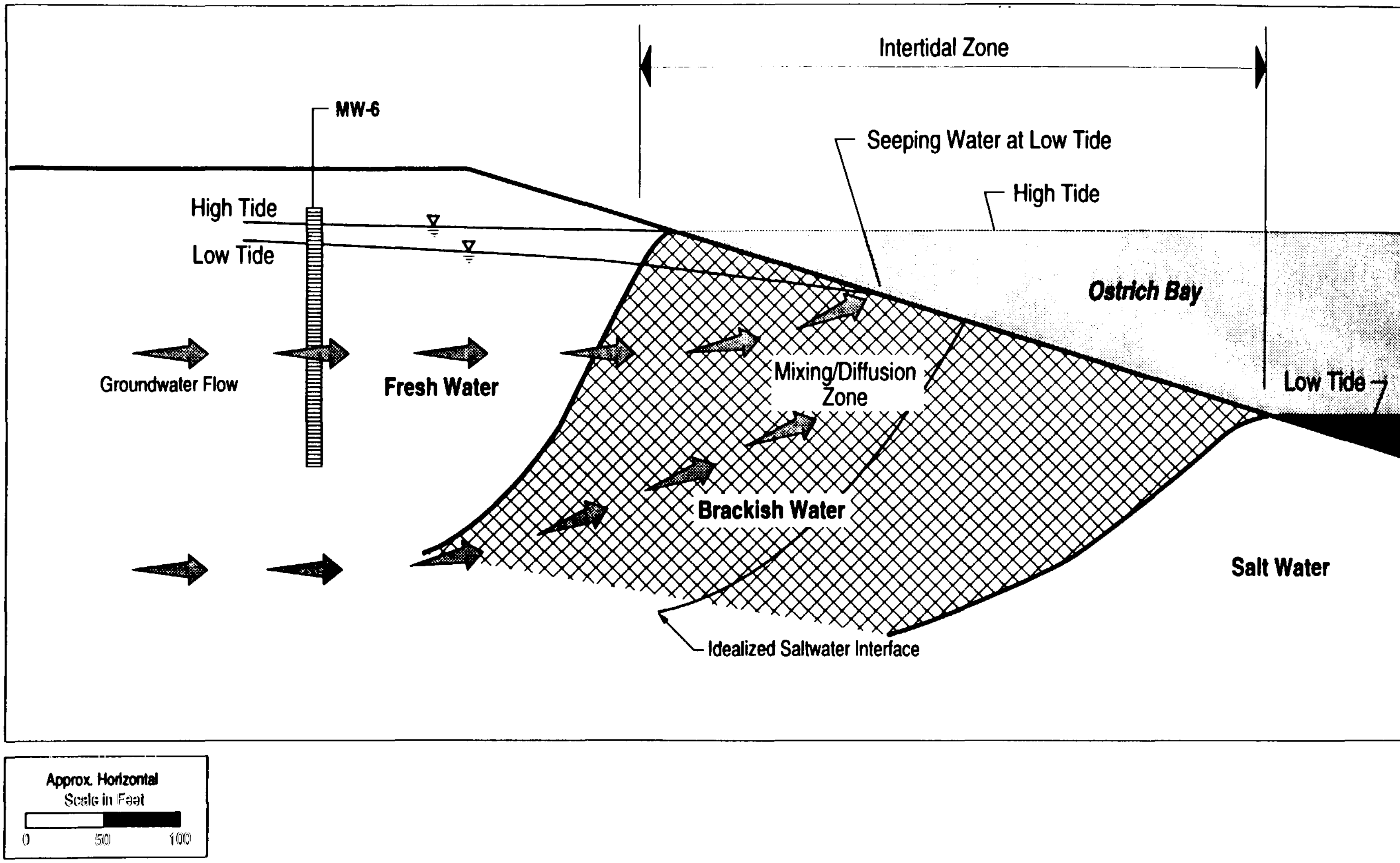
CLEAN COMPREHENSIVE LONG-TERM ENVIRONMENTAL ACTION NAVY	CTO 0031 JPHC/NHB Bremerton, WA OU 1 ROD	0 55 110 220 SCALE IN FEET	**Figure 6-3 Generalized Cross Sections (A-A' & B-B')**



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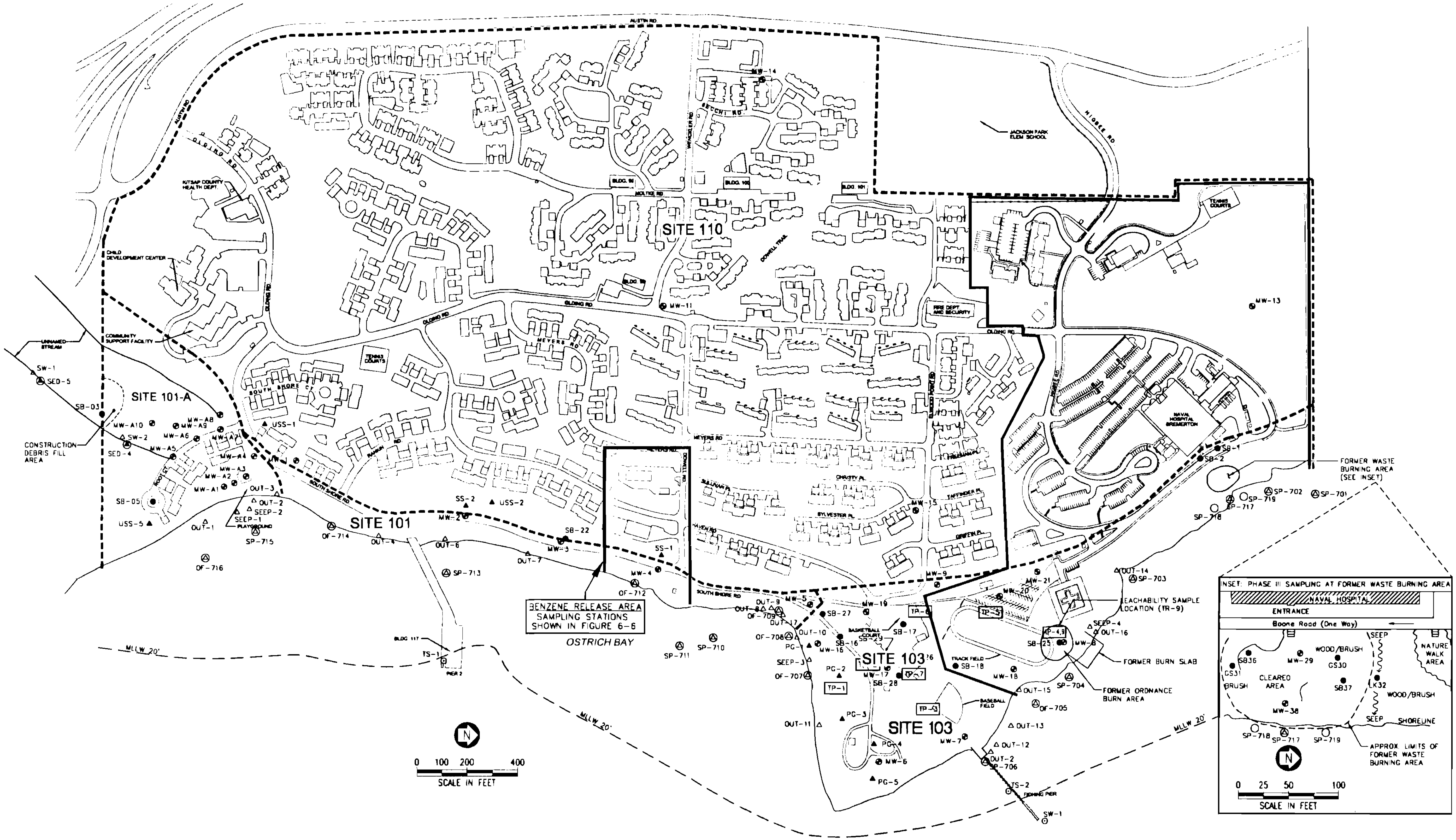
COMPREHENSIVE LONG-TERM ENVIRONMENTAL ACTION NAVY

Figure 6-4
Tidal Study Conceptual Model

CTO 0031
JPHC/NHB
Bremerton, WA
OU 1 ROD

533153006-36a-120799



Legend

- TIDAL STATION MEASURING POINT
- GROUND WATER MONITORING WELL LOCATION
- SOIL BORING LOCATION
- SURFACE SOIL SAMPLING LOCATION
- SURFACE WATER SAMPLING LOCATION
- MARINE SEDIMENT SAMPLING LOCATION (PHASE III)
- SURFACE WATER AND MARINE SEDIMENT SAMPLING LOCATION (PHASE II)
- FRESH WATER SEDIMENT SAMPLING LOCATION
- TP-6 BACKHOE TEST PIT
- SITE BOUNDARY LINE
- NAVAL HOSPITAL PROPERTY LINE
- MLLW 20' 20' MEAN LOW LOW WATER (MLLW) CONTOUR (APPROXIMATE)

NOTE: SITE 110 SURFACE AND SUBSURFACE SOIL SAMPLING LOCATIONS NOT SHOWN.

CLEAN COMPREHENSIVE LONG-TERM ENVIRONMENTAL ACTION NAVY	CTO 0031 JPHC/NHB Bremerton, WA OU 1 ROD	SCALE AS SHOWN	Figure 6-5 Sampling Locations Sites 101, 101-A, and 103

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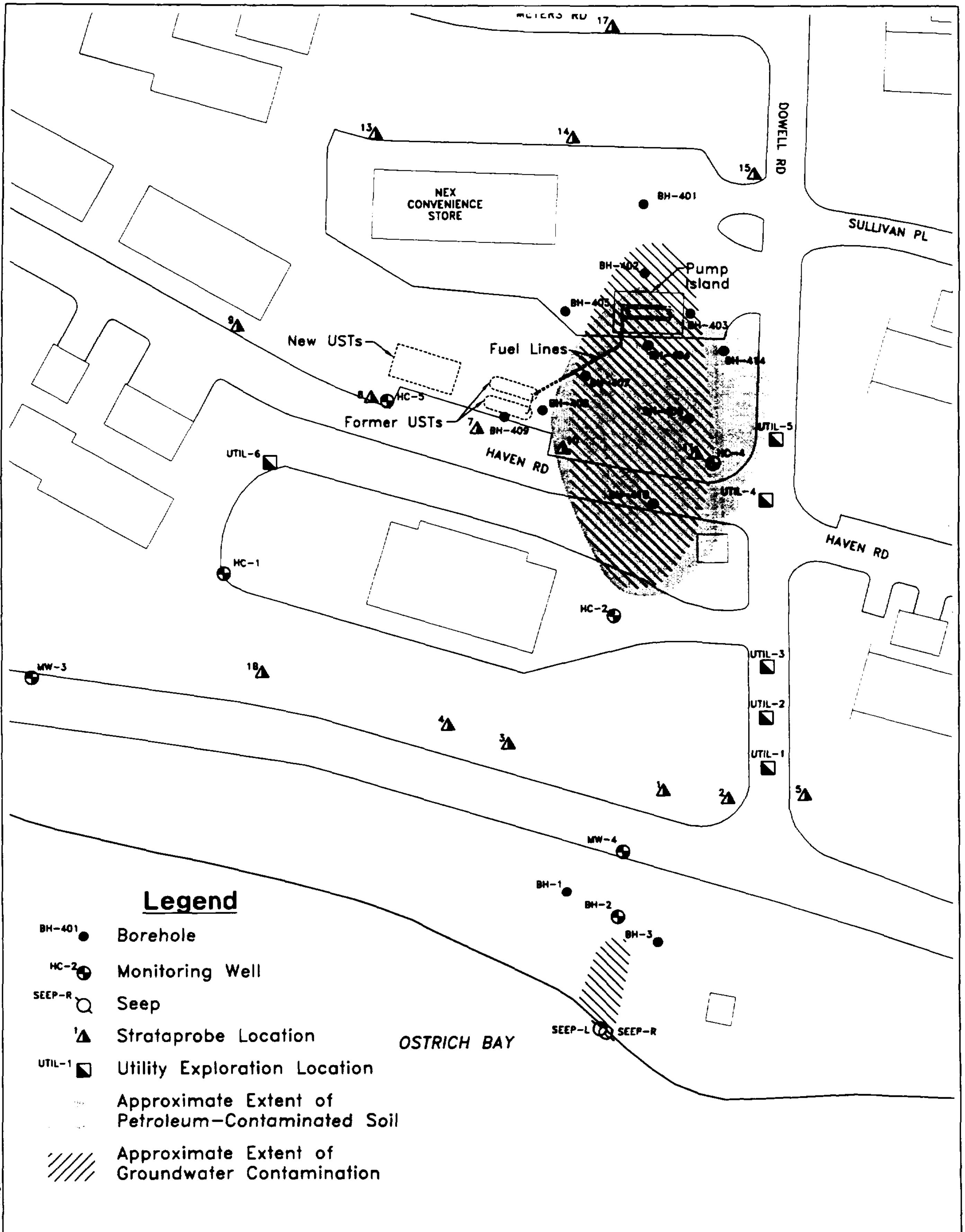

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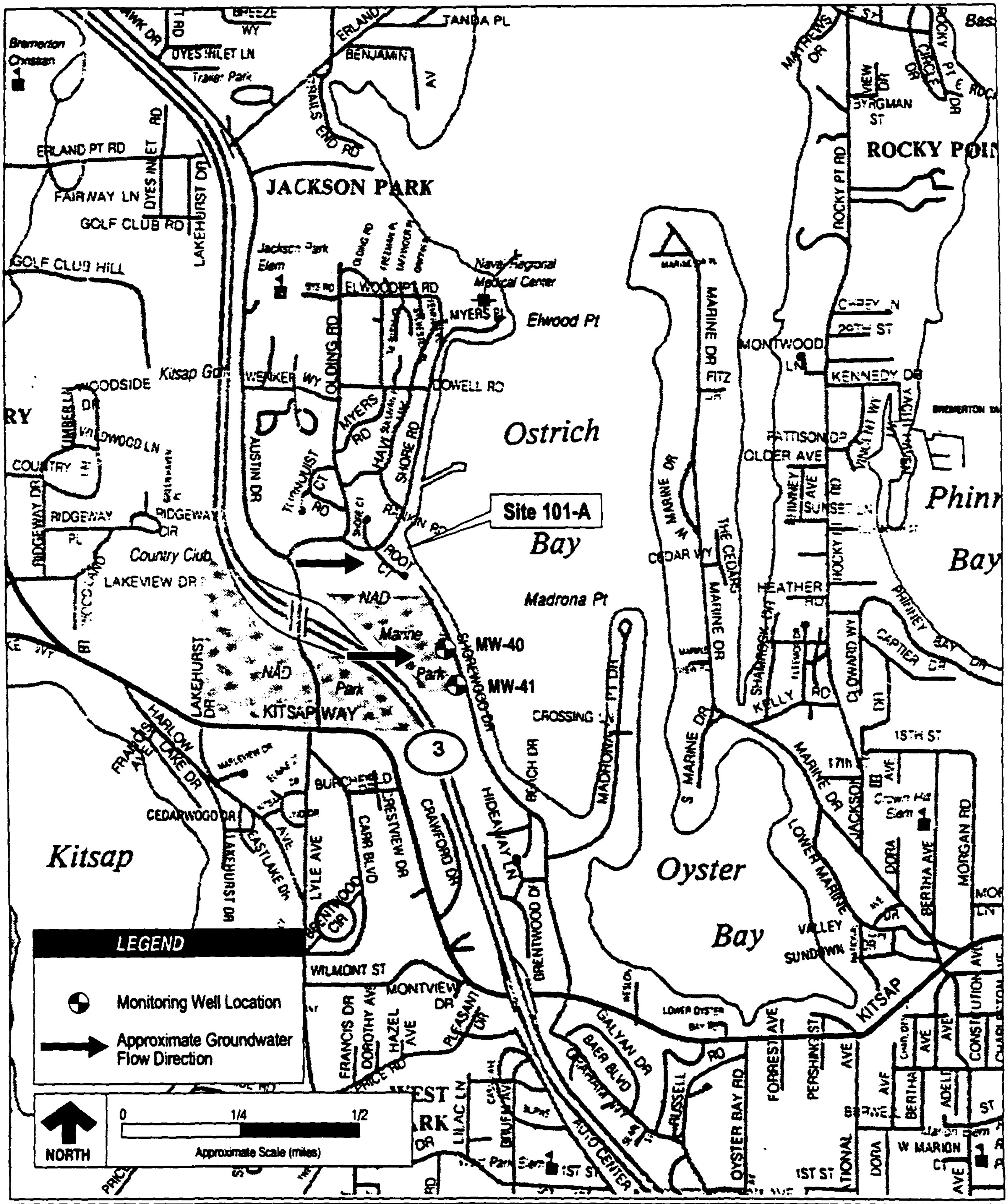
CLEAN COMPREHENSIVE LONG-TERM ENVIRONMENTAL ACTION NAVY	N — 0 20 40 80 SCALE IN FEET	**Figure 6-6 Benzene Release Area Sampling Locations**	CTO 0031 JPHC/NHB Bremerton, WA OU1 ROD



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COMPREHENSIVE LONG-TERM ENVIRONMENTAL ACTION NAVY

Figure 6-7
Background Monitoring Well Locations

CTO 0031
JPHC/NHB
Bremerton, WA
OU1 ROD

533031206-101-120799

Table 6-1
Chemical-Specific Evaluation Criteria at Operable Unit 1

Evaluation Criteria Used	Source
Soil	
MTCA Method B soil cleanup levels (Sites 101, 101-A, and 110)	MTCA (Chapter 70.105D RCW; Chapter 173-340 WAC)
MTCA Method C soil cleanup levels (Site 103)	MTCA (Chapter 70.105D RCW; Chapter 173-340 WAC)
MTCA Method A soil cleanup levels (all sites, for petroleum and lead only)	MTCA (Chapter 70.105D RCW; Chapter 173-340 WAC)
Background soil concentrations	Site-specific (U.S. Navy 1994a)[a]
Groundwater and Surface Water (Includes Intertidal Seeps/Outfalls and Ephemeral Stream Surface Water)	
MTCA Method B surface water cleanup levels	MTCA (Chapter 70.105D RCW; Chapter 173-340 WAC)
Washington State water quality standards (WQS) for marine water (acute and chronic)	Washington Water Pollution Control Act (Chapter 90.48 RCW; Chapter 173-201A WAC)
Federal marine water quality criteria (WQC) including the National Toxics Rule, for consumption of organisms only	Clean Water Act (33 USC 1313-1314, Sections 303 and 304; 40 CFR Part 131)
MTCA Method A groundwater cleanup level (for petroleum only)	MTCA (Chapter 70.105D RCW; Chapter 173-340 WAC)
Background groundwater concentrations	Site-specific (U.S. Navy 1994a)[a,b]
Intertidal Marine Sediments	
Washington State sediment quality standards (SQS)	Washington Water Pollution Control Act (Chapter 90.48 RCW; Chapter 174-204 WAC)

[a]The site-specific area background concentrations for inorganics in soil and groundwater were determined by WDOE (U.S. Navy 1994a).
[b]The groundwater background concentrations are being re-determined as a component of the selected remedy.

Notes:
Applicable regulatory criteria are used. Background concentrations are used if they are higher than the applicable regulatory criteria.
CWA - Clean Water Act
MTCA - Model Toxics Control Act
RCW - Revised Codes of Washington
USC - United States Code
WAC - Washington Administrative Code

Table 6-2
Chemicals of Concern at Site 101

Chemical	Evaluation Criteria Concentration	Evaluation Criteria Source	Frequency of Detections Above Evaluation Criteria[a]	Range of Detections Above Evaluation Criteria		Reasons for Selection as a COC		
				Minimum	Maximum	Major Risk Contributors[b]		Evaluation Criteria Exceedance
						Human	Ecological	
Soil (mg/kg)								
Arsenic	8.6	Background	5/25	9.3	56.2	•		•
Benzo(a) anthracene	0.137	MTCA B	1/22	0.52	0.52			•
Benzo(a) pyrene	0.137	MTCA B	3/22	0.14	0.48	•		•
Benzo(b) flouranthene	0.137	MTCA B	3/22	0.18	1.1			•
Chrysene	0.137	MTCA B	2/22	0.35	1.1			•
Indeno(1,2,3-cd)pyrene	0.137	MTCA B	2/22	0.22	0.26			•
Groundwater (μg/L)[d]								
Arsenic (total)	3.3	Background	9/16	3.4	8.1			•
Beryllium (total)	0.0793	MTCA B	5/16	0.74	5.8			•
Mercury (total)	0.025	WA MWQS	2/16	0.27	0.28			•
Thallium	1.56	MTCA B	1/16	1.9	1.9			•
Surface Water—Seeps and Outfalls (μg/L)								
Benzene[c]	43	MTCA B	2/18	230	290			•
Arsenic (total)	3.3	Background	5/18	3.4	6.5			•
Arsenic (dissolved)	3.3	Background	1/12	5	5			•
Mercury (total)	0.025	WA MWQS	2/18	0.1	0.2		•	•
Nickel (dissolved)	7.9	WA MWQS	1/12	15.6	15.6		•	•

[a]The first number is the number of detections above the evaluation criterion. The second number is the total number of samples analyzed.
[b]For human health risk, a major risk contributor is a chemical whose concentration results in an excess cancer risk of 1 in 1,000,000 or a hazard index greater than 1. For ecological risk, no credible pathways of exposure exist for soil and groundwater. Ecological risk contributors in surface water at the seeps and outfalls are those chemicals whose concentration exceeds standards for protection of marine life.
[c]Benzene exceedances occurred at OF-712. This outfall and upgradient soil and groundwater were further investigated in a separate benzene release investigation; results are summarized in Table 6-6.
[d]Total inorganics results for groundwater are from unfiltered samples. These results are believed to be biased high due to sample turbidity.

Notes:
COC - chemical of concern
MTCA - Model Toxics Control Act cleanup levels
WA MWQS - Washington Water Pollution Control Act (Chapter 90.48 RCW), marine water quality standards, acute and chronic (Chapter 173-201A WAC)

Table 6-3
Chemicals of Concern at Site 101-A

Chemical	Evaluation Criteria Concentration	Evaluation Criteria Source	Frequency of Detections Above Evaluation Criteria[a]	Range of Detections Above Evaluation Criteria		Reasons for Selection as a COC		
						Major Risk Contributors[b]		
				Minimum	Maximum	Human	Ecological	Evaluation Criteria Exceedance
Soil (mg/kg)								
Arsenic	8.6	Background	4/35	8.9	13.5			•
Antimony	32	MTCA B	1/35	69.9	69.9			•
Beryllium	1.5	Background	2/35	1.6	11	•		•
Benzo(a) anthracene	0.137	MTCA B	2/35	0.2	3.6			•
Benzo(a) pyrene	0.137	MTCA B	3/35	0.22	1.3	•		•
Benzo(b) flouranthene	0.137	MTCA B	3/35	0.15	2.3			•
Chrysene	0.137	MTCA B	3/35	0.19	3.3			•
Dibenz(a,h) anthracene	0.137	MTCA B	1/35	0.19	0.19			•
Indeno(1,2,3-cd) pyrene	0.137	MTCA B	1/35	0.63	0.63			•
Groundwater (µg/L)[c]								
Arsenic (total)	3.3	Background	11/20	4.1	41.8			•
Beryllium (total)	0.0793	MTCA B	9/20	0.12	1.2			•
Copper (total)	58	Background	1/20	121	121			•
Cyanide	1	WA MWQS	1/20	2	2			•
Lead (total)	6	Background	8/20	7	62.1			•
Nickel (total)	7.9	WA MWQS	18/20	9.2	389			•
Thallium (total)	1.56	MTCA B	1/20	1.6	1.6			•
Zinc (total)	104	Background	5/20	114	476			•
1,1-dichloroethene	1.93	MTCA B	1/20	2	2			•
TPH	1,000	MTCA A	1/20	1200	1200			•
Surface Water—Seeps and Outfalls (µg/L)								
Arsenic (total)	3.3	Background	2/9	5.9	6			•
Arsenic (dissolved)	3.3	Background	1/4	4.4	4.4			•
Mercury (total)	0.025	WA MWQS	1/9	0.1	0.1		•	•

[a]The first number is the number of detections above the evaluation criterion. The second number is the total number of samples analyzed.
[b]For human health risk, a major risk contributor is a chemical whose concentration results in an excess cancer risk of 1 in 1,000,000 or a hazard index greater than 1. For ecological risk, no credible pathways of exposure exist for soil and groundwater. Ecological risk contributors in surface water at the seeps and outfalls are those chemicals whose concentrations exceed standards for protection of marine life.
[c]Total inorganics results for groundwater are from unfiltered samples. These results are believed to be biased high due to sample turbidity.

Notes:
COC - chemical of concern
MTCA - Model Toxic Control Act cleanup levels
TPH - total petroleum hydrocarbons
WA MWQS - Washington Water Pollution Control Act (Chapter 90.48 RCW), marine water quality standards, acute and chronic (Chapter 173-201A WAC)

Table 6-4
Chemicals of Concern at Site 103

Chemical	Evaluation Criteria Concentration	Evaluation Criteria Source	Frequency of Detections Above Evaluation Criteria[a]	Range of Detections Above Evaluation Criteria		Reasons for Selection as a COC		
						Major Risk Contributors[b]		Evaluation Criteria Exceedance
				Minimum	Maximum	Human	Ecological	
Soil (mg/kg)								
Arsenic	66.7	MTCA C	0/107			•		
Antimony	128	MTCA C	1/91	175	175			•
Lead	250	MTCA A	7/107	287	1,960	•		•
TPH	200	MTCA A	2/12	260	380			•
Aroclor-1254	5.19	MTCA C	1/76	8.2	8.2	•		•
cPAHs (total)	5.48	MTCA C	3/105	11.1	19.1	•		
Groundwater (µg/L)[d]								
Chlordane	0.0022	NTR-ORG	1/20	0.031	0.031			•
Arsenic (total)	3.3	Background	17/29	4.6	74.6			•
Beryllium (total)	0.0793	MTCA B	9/29	0.4	14.7			•
Mercury (total)	0.025	WA MWQS	7/29	0.28	0.79			•
Nickel (dissolved)	7.9	WA MWQS	2/21	29.5	30.7			•
Thallium (total)	1.56	MTCA B	1/29	2.1	2.1			•
Zinc (dissolved)	104	Background	2/21	117	539			•
Surface Water—Seeps and Outfalls (µg/L)								
Arsenic (total)	3.3	Background	13/27	3.5	17[c]			•
Arsenic (dissolved)	3.3	Background	4/18	3.4	3.8[c]			•
Mercury (dissolved)	0.025	WA MWQS	2/18	0.12	0.16[c]		•	•
Silver (dissolved)	1.2	WA MWQS	1/18	2.4	2.4		•	•
1,1-Dichloroethene	1.93	MTCA B	1/30	2	2			•
Trichloroethene	55.6	MTCA B	1/30	60	60			•
Vinyl chloride	2.92	MTCA B	5/30	6	24			•
Intertidal Marine Sediments (mg/kgOC)								
bis(2-Ethylhexyl)-phthalate	47	WA SQS	1/9	94.9	94.9		•	

[a]The first number is the number of detections above the evaluation criterion. The second number is the total number of samples analyzed.
[b]For human health risk, a major risk contributor is a chemical whose concentrations results in an excess cancer risk of 1 in 1,000,000 or a hazard index greater than 1. For ecological risk, no credible pathways of exposure exist for soil and groundwater. Ecological risk contributors in marine sediments and surface water at the seeps and outfalls are those chemicals whose concentrations exceed standards for protection of marine life.
[c]The highest detected value is from a seep sample collected at SP-701 in 1998. This was not a flowing seep, and this sample is not believed to be representative of groundwater quality at the point of discharge.
[d]Total inorganics results for groundwater are from unfiltered samples. These results are believed to be biased high due to sample turbidity.

Notes:
COC - chemical of concern
cPAHs - carcinogenic polycyclic aromatic hydrocarbons
mg/kgOC - milligrams per kilogram organic carbon
MTCA - Model Toxic Control Act cleanup levels
NTR-ORG - National Toxics Rule for consumption of organisms
TPH - total petroleum hydrocarbons
WA MWQS - Washington Water Pollution Control Act (Chapter 90.48 RCW), marine water quality standards, acute and chronic (Chapter 173-201A WAC)
WA SQS - Washington Water Pollution Control Act (Chapter 90.48 RCW); sediment quality standards (Chapter 173-204 WAC)

Table 6-5
Chemicals of Concern at Site 110

Chemical	Evaluation Criteria Concentration	Evaluation Criteria Source	Frequency of Detections Above Evaluation Criteria[a]	Range of Detections Above Evaluation Criteria		Reasons for Selection as a COC		
						Major Risk Contributors[b]		Evaluation Criteria Exceedance
				Minimum	Maximum	Human	Ecological	
Soil (mg/kg)								
Arsenic	20	MTCA A	2/137	22.1	25.2			•
cPAHs (total)	1	MTCA A	2/137	10.93	17.4			•
Groundwater (µg/L)[c]								
Arsenic (total)	3.3	Background	3/8	5	25.2			•
Beryllium (total)	0.0203	MTCA B	1/8	6.1	6.1			•
Manganese (total)	2,240	MTCA B	1/8	14,400	14,400			•
Nickel (total)	100	SDWA MCL	1/8	606	606			•
Vanadium (total)	112	MTCA B	2/8	126	420			•

[a]The first number is the number of detections above the evaluation criterion. The second number is the total number of samples analyzed.
[b]Human health risks were not evaluated at Site 110, based on the results of removal actions. For ecological risk, no credible pathways of exposure exist for soil or groundwater.
[c]Total inorganics results for groundwater are from unfiltered samples. These results are believed to be biased high due to sample turbidity.

Notes:
COC - chemical of concern
cPAHs - carcinogenic polycyclic aromatic hydrocarbons
MTCA - Model Toxics Control Act cleanup level
SDWA MCL - Safe Drinking Water Act maximum contaminant level

Table 6-6
Chemicals of Concern at the Benzene Release Area (Data Through 1998)

Chemical	Evaluation Criteria Concentration	Evaluation Criteria Source	Frequency of Detections Above Evaluation Criteria[a]	Range of Detections Above Evaluation Criteria		Reasons for Selection as a COC		
						Major Risk Contributors[b]		Evaluation Criteria Exceedance
				Minimum	Maximum	Human	Ecological	
Soil (mg/kg)								
TPH (gasoline)	100	MTCA A	2/25	300	440			•
Groundwater (µg/L)								
TPH (gasoline)	1,000	MTCA A	2/34	1,100	80,000			•
Benzene	43	MTCA B	7/37	59	1,480			•
Surface Water—Seeps and Outfalls (µg/L)								
Benzene	43	MTCA B	9/12	100	1,070			•

[a]The first number is the number of detections above the evaluation criterion. The second number is the total number of samples analyzed.
[b]For human health risk, a major risk contributor is a chemical whose concentration results in an excess cancer risk of 1 in 1,000,000 or a hazard index greater than 1. For ecological risk, no credible pathways of exposure exist for soil and groundwater. Ecological risk contributors in surface water at the seeps and outfalls are those chemicals whose concentration exceeds standards for protection of marine life.

Notes:
Data presented are from investigations through 1998.
MTCA - Model Toxics Control Act cleanup levels
TPH - total petroleum hydrocarbons

Table 6-7
Chemicals of Concern at the Benzene Release Area (1999)

Chemical	Evaluation Criteria Concentration	Evaluation Criteria Source	Frequency of Detections Above Evaluation Criteria[a]	Range of Detections Above Evaluation Criteria		Reasons for Selection as a COC		
						Major Risk Contributors[b]		Evaluation Criteria Exceedance
				Minimum	Maximum	Human	Ecological	
Soil (mg/kg)								
TPH (gasoline)	100	MTCA A	7/22	210	3,500			•
Groundwater (µg/L)								
TPH (gasoline)	1,000	MTCA A	6/12	51,630	9,348,750			•
Benzene	43	MTCA B	5/12	420	96,000			•
Surface Water—Seeps and Outfalls (µg/L)								
Benzene	43	MTCA B	1/2	260	260			•

[a]The first number is the number of detections above the evaluation criterion. The second number is the total number of samples analyzed.
[b]For human health risk, a major risk contributor is a chemical whose concentration results in an excess cancer risk of 1 in 1,000,000 or a hazard index greater than 1. For ecological risk, no credible pathways of exposure exist for soil and groundwater. Ecological risk contributors in surface water at the seeps and outfalls are those chemicals whose concentration exceeds standards for protection of marine life.

Notes:
Data presented are from 1999 investigation.
MTCA - Model Toxics Control Act cleanup levels
TPH - total petroleum hydrocarbons

7.0 SUMMARY OF SITE RISKS

A baseline human health risk assessment (HHRA) was conducted as part of the RI/FS for OU 1 (U.S. Navy 1996). The HHRA estimates the risks that could exist if no remedial actions were taken, considering both current and potential future land uses. The HHRA evaluated risks for Sites 101, 101-A, and 103. As noted in Section 3.2, a risk assessment was not conducted at Site 110, based on the results of the SI and removal actions. The HHRA is summarized in Section 7.1. The potential for terrestrial ecological risks was also considered and is discussed in Section 7.2. The results of these risk assessments were used to evaluate the need for remedial action at OU 1.

Ecological risks in the marine environment are being addressed in OU 2.

7.1 HUMAN HEALTH RISK ASSESSMENT

The baseline HHRA presents a quantitative and qualitative analysis of risk relating to potential exposure to chemicals identified at the JPHC/NHB. Data from chemical analyses/environmental samples collected during the Phase I RI and additional data from sampling conducted subsequently were used to evaluate potential threats to human health. This HHRA follows the Superfund (U.S. EPA 1989) and EPA Region 10 guidance (U.S. EPA 1991a).

The scope of the HHRA included combining the Phase I RI data (U.S. Navy 1994a) and Phase II marine sediment and soil data (U.S. Navy 1994c) to evaluate both terrestrial and marine exposures for current residents (who use the site for residential purposes), future residents (who would use the site for residential purposes), and subsistence harvesters of clams and crabs. Terrestrial and marine exposures were also evaluated for off-site visitors who might use the site for recreational and subsistence harvesting of clams and crabs. Specific methods for each risk assessment step (chemical screening, toxicity assessment, exposure assessment, risk characterization) are discussed in Sections 7.1.1 through 7.1.4.

7.1.1 Identification of Chemicals of Potential Concern

A number of chemicals were identified as chemicals of potential concern (COPCs) in the HHRA, based on comparison of the maximum concentrations detected at each site with the corresponding risk-based screening concentrations (RBSCs), background concentrations, or (in the case of lead) MTCA cleanup levels. These COPCs were carried through the remainder of the risk assessment to quantify risks and to determine the chemicals that contribute most significantly to overall site risks. The chemical screening steps used to establish COPCs included the following:

- ***Sample grouping.*** For each environmental medium, samples were selected that were most representative for a particular exposure pathway. For example, analytical results for chemicals in soil samples from 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 guidance, to assess whether each chemical result was suitable for use in the risk assessment. Data rejected because of 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 eliminated from further consideration in the risk assessment.

- ***Essential nutrients.*** Certain inorganic chemicals (aluminum, calcium, iron, magnesium, potassium, and sodium) were not included in the risk calculations because they are essential nutrients that are either nontoxic or toxic at only high concentrations. This screening was in accordance with EPA guidance, which approves of eliminating such nutrients from the HHRA.

- ***Toxicity.*** The maximum detected concentrations in each medium were compared with RBSCs for residential use developed by EPA Region 10. For chemicals in water, the RBSC designated by EPA corresponds to a 1.0E-06 risk level for carcinogenic effects and a hazard quotient (HQ) of 0.1 for noncarcinogenic effects. (Note: HQs are discussed in more detail in Section 7.1.4.) For soil and sediment, the RBSC is equivalent to a 1.0E-07 cancer risk and an HQ of 0.1. These RBSCs represent conservative risk levels so that significant risk-causing chemicals will not be screened out.

- ***Background.*** Inorganic chemical concentrations that were not eliminated by comparison to RBSCs were compared with background concentrations to determine whether they were present on site at elevated levels. Background screening was not conducted for organic chemicals because most of these chemicals are not normally found in environmental media.

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

7.1.2 Exposure Assessment

The purpose of the exposure assessment was to identify receptors at risk and estimate the type and magnitude of exposures to the COPCs identified at the sites. The results of the exposure assessment are then combined with the chemical-specific toxicity information to characterize potential risks.

Four steps are involved in the exposure assessment process: (1) characterizing the exposure setting, (2) identifying the exposure pathways, (3) calculating exposure point concentrations (EPCs), and (4) quantifying exposure in the form of chemical intakes.

The exposure setting characterized in this section is based on the current and potential future land uses that have been developed for JPHC/NHB. The potentially exposed populations were identified based on these land uses and are summarized in Table 7-1.

Because groundwater is not a current or likely future drinking water resource at JPHC/NHB, no complete exposure pathway for groundwater exists or is anticipated. Thus, the HHRA did not calculate risks from ingestion of groundwater. Groundwater in portions of Site 110 could potentially be used as a drinking water resource in the future, although such use is considered unlikely. The selected remedy includes additional sampling of Site 110 groundwater, and if needed, institutional controls will be implemented to prevent future use of Site 110 groundwater as a drinking water resource.

Exposure point concentrations are concentrations of a specific chemical that an individual may potentially be exposed to for each specific medium at each site. EPCs were developed in a manner consistent with EPA guidance (U.S. EPA 1989). Average EPCs and reasonable maximum exposure (RME) point concentrations are calculated for sample data sets for each medium and site. Average EPCs are intended to be more representative of likely human exposures. RME point concentrations represent the highest EPCs reasonably expected to occur at the site. The RME point concentration was obtained by calculating the 95 percent upper confidence limit (UCL95) on the mean. However, for small sample populations (i.e., three or fewer), the large variability in the measured concentrations often yields a UCL95 greater than the maximum detected value. In these instances, the maximum concentration has been used to represent the RME point concentration. The EPCs for the COPCs are shown in Tables 7-2 through 7-5.

Because it was not possible to accurately determine the presence or absence of ordnance compounds in marine sediment and tissue (due to inadequacies in the analytical methods), ordnance compounds from the Phase I RI were rejected from use in the HHRA. Ordnance compounds collected during the Phase II marine sediment study were analyzed to fill the ordnance data gap from the Phase I RI. However, marine tissues were not resampled during Phase II; therefore, sediment concentrations were used to model the uptake of ordnance compounds by clams and crabs.

Based on a risk assessment of chemical contamination in Puget Sound (Tetra Tech, Inc. 1988), arsenic EPCs for the evaluation of ingestion of crabs and clams were adjusted to equal 1 percent of the total arsenic concentration. This adjustment was made because the arsenic potency factor is based on ingestion of inorganic arsenic. Arsenic in seafood occurs primarily as a methylated or organic chemical species that is less toxic and more readily excreted than inorganic arsenic. Research on arsenic speciation in seafood indicates that approximately 1 percent of the total arsenic is in the inorganic state. Hence, 1 percent of the concentration of total arsenic was used to estimate risks associated with seafood.

Following EPA guidance (U.S. EPA 1991a and 1991b), both average exposure and RME scenarios were evaluated for current and future residential populations across all pathways (with the exception of clam and crab ingestion). The RME is characterized as the highest exposure that is reasonably expected to occur at a site. The intent of the RME concept is to provide a conservative estimate of exposure that is well above average, yet still expected to be within the possible range of exposures. The values of various exposure factors are selected so that the combination of all factors results in an exposure estimate that reflects a reasonable maximum case, not the worst possible case. By design, to provide for this intended level of protectiveness, the estimated RMEs are higher than those expected to be experienced by most of an exposed population.

An average exposure scenario is also presented to allow a comparison with the RME. This scenario, although conservative, is intended to be more representative of likely human exposures. Exposure parameters are presented in Table 7-6.

7.1.3 Toxicity Assessment

A toxicity assessment was conducted for the COPCs with two goals: (1) to weigh the available evidence regarding the potential for chemicals to have adverse effects on exposed individuals (i.e., hazard identification) and (2) to provide a quantitative estimate of the relationship between the magnitude of exposure and the likelihood or severity of adverse effects (i.e., dose-response assessment) (U.S. EPA 1989).

Generally, dose-response estimates are presented as reference doses (RfDs) for noncarcinogenic effects and cancer slope factors (CSFs) for carcinogenic effects, although carcinogens may also have an RfD. These values (i.e., RfDs or CSFs) are most frequently available for the oral route of exposure, although inhalation values have been developed for some chemicals. In order of preference, sources of toxicity values were: (1) EPA's *Integrated Risk Information System (IRIS)* (U.S. EPA 1995a) and (2) EPA's *Health Effects Assessment Summary Tables (HEAST)* (U.S. EPA 1995b).

Noncarcinogenic toxicity data for the inhalation pathway are provided in the form of reference concentrations (RfC), which are expressed in units of milligrams per cubic meter (mg/m^3) or micrograms per cubic meter ($\mu g/m^3$). RfC (mg/m^3) was converted to an inhalation RfD (mg/kg-day) by assuming the standard adult inhalation rate of 20 m^3/day and a body weight of 70 kg.

CFSs are expressed in units of $(mg/kg\text{-}d)^{-1}$ or 1/(mg/kg-d). Carcinogenic toxicity data for the inhalation pathway are provided in the form of unit concentrations expressed in $(mg/m^3)^{-1}$ or $(\mu g/m^3)^{-1}$ [$1/(mg/m^3)$ or $1/(\mu g/m^3)$]. Unit concentrations were converted to CFSs by assuming an inhalation rate of 20 m^3/day and a body weight of 70 kg.

Carcinogenic toxicity data are not available for the majority of polycyclic aromatic hydrocarbons (PAHs). For those PAHs exhibiting carcinogenic effects, toxicity equivalency factors (TEFs) developed by EPA were applied to the detected cPAHs, relating their cancer potencies to the CSF of benzo(a)pyrene (U.S. EPA 1993).

Toxicity values were lacking for copper, lead, thallium, Endrinaldehyde, Endosulfan I, Endosulfan II and trichloroethene. The toxicity value for copper was calculated from the maximum contaminant level (MCL) of 1.3 mg/L, and the toxicity value for thallium chloride was used as the surrogate for thallium. The toxicity value for trichloroethene was withdrawn by EPA at the time of the risk assessment and non-cancer effects of trichloroethene were not evaluated.

At the time that the HHRA was conducted, EPA's database did not provide toxicity data for lead because of unique considerations related to the toxicology of this element (U.S. EPA 1995a).

As an alternative to the traditional risk assessment approach, EPA guidance recommends (for some hazardous waste sites) modeling blood-lead levels and comparing them to acceptable blood-lead concentrations (U.S. EPA 1994). However, the modeling approach is not appropriate if limited data are available on the environmental concentrations of lead. In such cases, lead concentrations in soil and surface water can be compared to acceptable levels recommended by EPA (action level of 400 mg/kg) (U.S. EPA 1994) or WDOE (MTCA Method A cleanup level of 250 mg/kg) (WDOE 1996). In order to be conservative and protective of sensitive populations, lead concentrations were compared with the MTCA Method A cleanup level of 250 mg/kg. Lead concentrations in surface water were compared with EPA's action level of 15 μg/L (U.S. EPA 1994). Comparison of surface water concentrations to levels recommended for drinking water is very conservative (i.e., protective), since surface water is not used for drinking water at JPHC/NHB. EPA has not developed a lead screening value for ingestion of crabs and clams.

Noncarcinogenic and carcinogenic values for dermal toxicity are currently not available. Dermal RfDs and CSFs were estimated using the oral RfDs and oral CSFs, which is consistent with EPA guidelines (U.S. EPA 1989, 1992a).

It was assumed that metals would not be absorbed well through the skin; therefore, they were not evaluated for dermal exposure (U.S. EPA 1989, 1992b). Because toxicity testing has shown that cPAHs such as benzo(a)pyrene cause skin cancer through a direct action at the point of application, it is considered inappropriate to use oral slope factors to evaluate risks associated with dermal exposure to this group of chemicals (U.S. EPA 1989). In addition, experimental results indicate a wide range of absorption factors for PAHs (U.S. EPA 1992a). Therefore, risks from dermal exposure to PAHs are not evaluated quantitatively in this document.

7.1.4 Risk Characterization

Risk characterization integrates the results of the exposure and toxicity assessments into a quantitative description of potential carcinogenic and noncarcinogenic risks. Because of the fundamental differences in the development of carcinogenic and noncarcinogenic effects, risks are characterized separately for these health endpoints.

Carcinogenic Risks

The risk of cancer from exposure to a chemical is described in terms of the incremental probability that an individual will develop cancer in his or her lifetime as a result of exposure to a potential carcinogen. The resulting probabilities are expressed in numbers that indicate how many excess cancer cases are likely for a specified population. For instance, 1 additional cancer case in a population of 1,000,000 is expressed as an excess cancer risk of 1.0E-06. Excess cancer risks are summed across all COPCs and all exposure pathways that contribute to exposure of an individual in a given population. Typically, remedial action is warranted when total excess cancer risks to any population exceed EPA's acceptable risk range of 1 in 1,000,000 to 1 in 10,000 (1.0E-06 to 1.0E-04).

Noncarcinogenic Hazards

The potential for noncancer health effects from exposure to a chemical is evaluated by comparing the estimated intake of a chemical over a specific time period with the RfD for that chemical derived for a similar exposure period. This comparison results in a noncancer hazard quotient (HQ). Since exposure may occur simultaneously by more than one exposure pathway, HQ values are summed to obtain a hazard index (HI). If the total HI is equal to or less than 1, it is believed that there is no appreciable risk of adverse noncancer health effects. If an HI exceeds 1, there is some possibility that adverse noncancer effects could occur, although an HI above 1 does not indicate an effect will definitely occur.

Methods for Computing Risks

The approach used for computing risks is based on EPA guidance (U.S. EPA 1989). In this assessment, carcinogenic risks were calculated for adult exposure, child exposure, and integrated adult and child exposure (i.e., lifetime exposure). Risks were calculated separately to account for differences in potential exposure between adults and children (e.g., children ingest soil at a higher rate).

Average exposure and RME risks were calculated for current and future residents. However, only RME risks were calculated for the clam and crab harvester; current RME risks were calculated for the recreational harvester, and future RME risks were calculated for the subsistence harvester. In addition, the total risk for both recreational and subsistence clam and crab harvesters as off-site visitors was also calculated.

7.1.5 Results

Site 101

Noncarcinogenic HIs and carcinogenic risks for Site 101 are summarized in Table 7-7.

Estimated Noncarcinogenic Hazard Quotients. Under current land use conditions, the total HI across all COPCs and pathways was only 0.05 for the average exposure scenario. Therefore, typical residents are not being adversely impacted by noncarcinogenic COPCs. For the RME scenario, HIs for residents who do not eat clams and crabs totaled 0.17 for adults, 1.57 for young children, and 1.21 for an integrated adult and child exposure. Exposure to arsenic via surface soil ingestion is the primary pathway contributing to these HIs. The HI for adults who consume clams and crabs obtained through recreational harvesting is 2.80. (Antimony in clams and crabs is the primary contributor to this HI.) Exposure to antimony may affect the circulatory system and arsenic may affect the kidneys and liver. Because antimony and arsenic target different physiological systems, the toxicity may not be directly additive. EPA has medium confidence in the RfD, indicating that strong arguments can be made for RfD values within a factor of 2 or 3 of the current recommended value. Thus, under RME conditions, both children and adults may experience negative effects from exposure to arsenic.

Under future land use conditions, the total HI across all COPCs and pathways was only 0.03 for the average exposure scenario. Therefore, it is unlikely that the typical future resident will be impacted by noncarcinogenic COPCs. For the RME scenario, the HIs for residents who do not consume clams and crabs totaled 0.09 for adults, 1.02 for young children, and 0.24 for an integrated adult and child exposure. The total HI for adult residents who consume clams and crabs obtained through subsistence harvesting is 13.5. Under likely future conditions, noncarcinogenic COPCs will not pose a threat to adult or child residents who do not eat clams or crabs. However, antimony and vanadium in clams and crabs may adversely affect residents who eat clams and crabs obtained from subsistence harvesting. As the HI for chemicals other than vanadium and antimony in clams is 1.6, it is possible that the combined effect may be significant. However, antimony generally causes impacts to the circulatory system, while exposure to vanadium via the oral pathway causes changes in the protein structure of hair and gastrointestinal, renal, and central nervous system effects. Thus, the toxic effects of these two chemicals may not be additive. The types of effects for these chemicals were not evaluated to determine whether summation of HQs is appropriate since the HQs for antimony and vanadium already exceed 1.

Estimated Carcinogenic Risks. Under current land use conditions, total risks are less than 1.0E-06 for the average exposure scenario. Under the RME scenario, the risk for an adult who does not eat clams and crabs is 2.4E-06, and the risk for an adult who does eat clams and crabs is 1.32E-05. The total risk for a child is 6.93E-05. For the RME scenario, 69 percent of the risk is associated with ingestion of arsenic in surface soil. Benzo(a)pyrene in surface soil also contributes slightly to the total risk. Ingestion of clams and crabs and ingestion of marine sediment each contribute 13 percent to the total risk. For clams and crabs, this risk is primarily associated with 3,3'-dichlorobenzidine in clams and PCP in crabs. These two chemicals were not detected in soil, sediment, or surface water on site. Arsenic is the primary contributor to the risk from ingestion of marine sediment.

Under future land use conditions, total risks are 2.93E-06 for the average exposure scenario. Under the RME scenario, the risk for an adult who does not eat clams and crabs is 1.5E-05, and the risk for an adult who does eat clams and crabs is 8.2E-04. The total risk for a child is 3.48E-05. For the average exposure scenario, this risk is primarily from ingestion of arsenic in subsurface soil and sediment. For the RME scenario, ingestion of clams and crabs is the most significant exposure pathway, contributing 95 percent of the total risk. This risk is primarily associated with 3,3'-dichlorobenzidine in clams and PCP in crabs. These chemicals were not detected in soil, sediment, or surface water on site. Thus, it appears that the predominant risk drivers may not be site-related. To a lesser extent, arsenic and bis(2-ethylhexyl)phthalate in clams and crabs, and beryllium, benzo(a)anthracene, and benzo(b)fluoranthene in crabs, are also contributors to the risk from marine tissue ingestion. In addition, arsenic in subsurface soil and marine sediment—and to a lesser extent, benzo(a)pyrene in subsurface soil—contributes most of the remaining 5 percent to the total risk at Site 101.

Arsenic was identified as a COC in intertidal sediments based on a carcinogenic risk of 9.34E-06 for a reasonable maximum exposure scenario for a child. The magnitude of this risk was overestimated because naturally occurring concentrations of arsenic in sediments were not accounted for in the risk estimate.

Site 101-A

Noncarcinogenic HIs and carcinogenic risks for Site 101-A are summarized in Table 7-8.

Estimated Noncarcinogenic Hazard Quotients. Under current land use conditions, the total HI across all COPCs and pathways was only 0.03 for the average exposure scenario. Therefore, it is unlikely that the typical resident is currently being impacted by noncarcinogenic COPCs. For the RME scenario, HIs for residents who do not eat clams or crabs totaled 0.13 for adults, 1.17 for young children, and 0.91 for the integrated adult and child exposure. The total HI for an adult resident who also eats clams and crabs obtained through recreational harvesting is 2.76. Although the total HI for young children who do not eat clams exceeds 1, the HQs for each of the contributing chemicals (antimony and arsenic) are below 1. Exposure to antimony may affect the circulatory system and arsenic may affect the kidneys and liver. Because antimony and arsenic target different physiological systems, the toxicity may not be directly additive. Therefore, noncarcinogenic COPCs do not currently pose a threat to adult or child residents who do not eat clams and crabs. However, antimony in clams and crabs may adversely affect residents who eat clams and crabs.

Under future land use conditions, the total HI across all COPCs and pathways was only 0.03 for the average exposure scenario. Therefore, it is unlikely that the typical resident will be impacted by noncarcinogenic COPCs. For the RME scenario, HIs for residents who do not consume clams or crabs totaled 0.09 for adults, 0.85 for young children, and 0.24 for the integrated adult and child exposure. The total HI for adult residents who consume clams and crabs obtained through subsistence harvesting is 13.5. Under likely future conditions, noncarcinogenic COPCs will not pose a threat to adult or child residents who do not eat clams and crabs. However, antimony in clams and crabs, and vanadium in clams, may adversely affect residents who eat clams and crabs. Antimony generally impacts the circulatory system, while exposure to vanadium via the oral pathway causes changes in the protein structure of hair and gastrointestinal, renal, and central nervous system effects. Thus, the toxic effects of these two chemicals may not be additive. As the HI for chemicals other than vanadium and antimony in clams is 1.6, it is possible that the combined effects of these chemicals may cause health effects. The types of effects for these chemicals were not evaluated to determine whether the summation of HQs is appropriate since the HQs for antimony and vanadium already exceed 1.

Estimated Carcinogenic Risks. Under current land use conditions, total risks are below 1.0E-06 for the average exposure scenario and are 3.78E-05 for the integrated adult and child RME scenario (for those adults and children who do not eat clams or crabs). Under the RME scenario, the risk for adults who do not eat clams and crabs is 1.0E-06, and the risk for adults who do eat clams and crabs is 1.21E-05. The total risk for a child is 3.64E-05. Exposure via ingestion of arsenic and beryllium in soil and marine sediment contributes 77 percent of this risk. Exposure via ingestion of 3,3′-dichlorobenzidine in clams, PCP in crabs, and benzo(a)pyrene in surface soil are other substantial contributors to current risks.

Under potential future land use conditions, total risks are 3.14E-06 for the average exposure scenario. Under the RME scenario, the risk for adults who do not eat clams and crabs is 1.4E-05, and the risk for an adult who does eat clams and crabs is 8.34E-04. The total risk for a child is 3.23E-05. For the average exposure scenario, total risks exceed 1.0E-06 for the soil ingestion pathway. Arsenic, (and to a lesser extent) beryllium, benzo(a)pyrene, and dibenz(a,h)anthracene, are the major contributors to this risk. For the RME scenario, ingestion of clams and crabs is the most significant exposure pathway (contributing 95 percent of the total risk). This risk is primarily associated with 3,3'-dichlorobenzidine in clams and PCP in crabs. These two chemicals were not detected in soil, sediment, or surface water on site. Thus, it appears that the predominant risk drivers may not be site-related. To a lesser extent, arsenic and bis(2-ethylhexyl)phthalate in clams and crabs, and beryllium, benzo(a)anthracene, and benzo(b)fluoranthene in crabs only, are also contributors to the risk from ingestion of marine tissue. In addition, arsenic in subsurface soil and marine sediment, and beryllium, benzo(a)pyrene, and dibenz(a,h)anthracene in subsurface soil contribute most of the remaining 5 percent to the total cancer risk at Site 101-A.

Arsenic was identified as a COC in intertidal sediments based on a carcinogenic risk of 9.34E-06 for a reasonable maximum exposure scenario for a child. The magnitude of this risk was overestimated because naturally occurring concentrations of arsenic in sediments were not accounted for in the risk estimate.

Carcinogenic risk estimates for arsenic and beryllium in soil do not account for naturally occurring background concentrations. At Site 101-A, the average and RME exposure point concentrations for arsenic in soil are less than the naturally occurring soil background concentration. Therefore, arsenic is not considered a human health COC in soil at Site 101-A.

Site 103

Noncarcinogenic HIs and carcinogenic risks for Site 103 are summarized in Table 7-9.

Estimated Noncarcinogenic Hazard Quotients. Under current land use conditions, the total HI across all COPCs and pathways was only 0.04 for the average exposure scenario, indicating that typical adult residents are not being impacted by noncarcinogenic COPCs. For the RME scenario, the HIs for residents who do not consume clams and crabs are 0.17 for adults, 1.25 for young children, and 1.14 for an integrated adult and child exposure. Thus, noncarcinogenic COPCs are unlikely to adversely affect adult residents who do not eat clams and crabs. Although the total HI for children exceeds 1, the HQs for each of the contributing chemicals (antimony, Aroclor 1254, and arsenic) are each below 1. Because antimony impacts the circulatory system, arsenic impacts the renal and hepatic systems, and Aroclor 1254 impacts the immune system, the effects from arsenic are unlikely to be additive to those from antimony and Aroclor 1254. Thus, it is unlikely that children who do not eat clams and crabs are currently being impacted. The HI for adults who consume clams and crabs is 2.8. Adults who eat clams and crabs obtained through recreational harvesting may experience noncancer effects primarily as a result of antimony in crabs and clams.

Under future land use conditions, the total HI across all COPCs and pathways was only 0.22, indicating that the typical adult resident is not being impacted by noncarcinogens. However, the RME for both adults and children may result in noncancer effects because of dermal exposure to Aroclor 1254 in subsurface soil. Residents who eat crabs and clams obtained through subsistence harvesting may also be adversely affected by exposure to antimony and vanadium. The total HI for adult residents who consume clams and crabs obtained through subsistence harvesting is 13.6. As the HI for chemicals other than vanadium and antimony in clams and crabs is 1.6, it is possible that the combined effect may be significant. The types of effects for these chemicals were not evaluated to determine whether summation of HQs is appropriate since the HQs for antimony and vanadium already exceed 1.

Estimated Carcinogenic Risks. Under current land use conditions, cancer risks are less than 1.0E-06 for the average exposure scenario. Under the RME scenario, the risk for an adult who does not eat clams and crab is 1.4E-06, and the risk for an adult who does eat clams and crabs is 1.09E-05. The total risk for a child is 4.38E-05. For the RME scenario, 52 percent of the risk is associated with ingestion of arsenic in surface soil. Benzo(a)pyrene and dibenz(a,h)anthracene in surface soil also contribute slightly to the total risk. Ingestion of clams, crabs, and marine sediment each contributes 19 percent to the total risk. This risk is primarily associated with 3,3′-dichlorobenzidine and PCP in clams and crabs, respectively. These two chemicals were not detected in soil, sediment, or surface water on site. Arsenic is the primary contributor to the risk from ingestion of marine sediment.

Under future land use conditions, cancer risks are 3.13E-06 for the average exposure scenario. Under the RME scenario, the risk for an adult who does not eat clams and crabs is 2.3E-05, and the risk for an adult who does eat clams and crabs is 8.43E-04. The total risk for a child is 3.2E-05. For the average exposure scenario, this risk is primarily from ingestion of arsenic in subsurface soil and marine sediment. For the RME scenario, ingestion of clams and crabs is the most significant exposure pathway, contributing 95 percent of the total risk. This risk is primarily associated with 3,3′-dichlorobenzidine in clams and PCP in crabs. These chemicals were not detected in soil, sediment, or surface water on site. Thus, it appears that the predominant risk drivers may not be site-related. To a lesser extent, arsenic and bis(2-ethylhexyl)phthalate in clams and crabs, and beryllium, benzo(a)anthracene, and benzo(b)fluoranthene in crabs only, are also contributors to the risk from marine tissue ingestion. In addition, arsenic in subsurface soil and marine sediment (and to a lesser extent, benzo(a)pyrene and dibenz(a,h)anthracene in subsurface soil) contribute most of the remaining 5 percent to the total risk at Site 103.

Arsenic was identified as a COC in intertidal sediments based on a carcinogenic risk of 9.34E-06 for a reasonable maximum exposure scenario for a child. The magnitude of this risk was overestimated because naturally occurring concentrations of arsenic in sediments were not accounted for in the risk estimate.

7.1.6 Trends Across All Sites

Noncarcinogenic Trends

Under current and future land use conditions, noncarcinogenic COPCs are not impacting typical (i.e., average) residents. Even under RME conditions, current and future residents who do not eat clams and crabs are not expected to be impacted by noncarcinogenic COPCs. (The exceptions to this are current child residents at Site 101 exposed to antimony via incidental soil and sediment ingestion, and future child and adult residents exposed to Aroclor 1254 through dermal contact with soil at Site 103.) Residents consuming clams and crabs obtained from recreational or subsistence harvesters may experience noncancer effects associated primarily with antimony and vanadium. However, most HIs that exceed 1 are not higher than 2, which indicates that exceedances are not great. Section 7.1.8 discusses the uncertainty associated with interpreting HIs close to 1. Although only the clam and crab pathways pose a noncancer threat, additional exposure via other pathways may increase the likelihood or severity of noncancer effects associated with ingestion of clams and crabs.

Carcinogenic Trends

Ingestion of marine tissue (clams and crabs) was the most important exposure pathway, although ingestion of soil and sediment also posed significant risks. Dermal exposure to surface water and sediment did not pose a risk because the only COPCs in these media were metals, PAHs, and VOCs, for which dermal exposure is not generally evaluated. The inhalation of particulates pathway was found to be insignificant.

Cancer risks at all three sites are below 1.0E-06 for average residential exposure under current land use conditions. However, under RME conditions, each site poses an estimated cancer risk to current residents that approaches the upper end of the CERCLA risk range (1.0E-06 to 1.0E-04). The highest risk estimate was associated with Site 101. The risk drivers at all three sites are arsenic, beryllium (Site 101-A), and cPAHs in surface soil, and arsenic in marine sediment, although organic compounds in clams and crabs also contributed to the total risk. Because a portion of the risk associated with arsenic and beryllium is attributable to naturally occurring levels, the excess cancer risks actually posed by elevated levels of these chemicals are less than those reported in the risk summary tables.

Future residents exposed under average (as well as reasonable maximum) conditions may be at risk. For the average receptors, however, estimated risks are just slightly above the low end of the CERCLA risk range (1.0E-06 to 1.0E-04). For RME receptors, total risk estimates exceed the upper end of this range. The predominant risk drivers are 3,3′-dichlorobenzidine and PCP in marine tissue. These chemicals were not detected in any other medium and therefore may not be site-related. Risks from all other pathways fall within or below the NCP range.

7.1.7 Risk Evaluation for Lead

Lead concentrations in soil and marine sediment were compared to the MTCA Method A cleanup level of 250 mg/kg; surface water lead concentrations were compared to the EPA drinking water action level of 15 µg/L. Screening values for clam and crab tissue are not available.

Only one soil sampling location at Site 103 contained lead at concentrations exceeding the MTCA Method A cleanup level. (The sample from location TP-4, near the track field, contained 334 mg/kg in surface soil and 1,960 mg/kg in subsurface soil.) All other surface and subsurface soil samples contained lead concentrations below the MTCA Method A cleanup level. The lead concentrations in subsurface soil at TP-4 are just below EPA's proposed action level of 2,000 mg/kg, but above EPA's proposed 400 mg/kg "level of concern." Lead concentrations in surface soil (0 to 2 feet below ground surface) may pose a health risk to children who play on or near the track field area. Lead concentrations in subsurface soil (2 to 15 feet below ground surface) would pose a significant health risk if the subsurface soil is disturbed as a result of construction or excavation. All other soil, sediment, and surface water sample concentrations were below the MTCA screening levels.

Lead was also detected in clam and crab tissues (at 0.18 mg/kg and 7.0 mg/kg, respectively). However, EPA has not yet established a criterion for lead in clams. Because children are most susceptible to the ingestion of lead, the ingestion of marine tissue could pose a health risk as a result of the low lead concentrations.

7.1.8 Uncertainty Analysis

The uncertainties associated with each step of the risk assessment process—data evaluation, exposure assessment, toxicity assessment, and risk characterization—are described in the following subsections.

Uncertainty Associated With Data Evaluation

Background comparisons are intended to screen out chemicals present at naturally occurring levels in the environment that have not been influenced by human activity, or chemicals that are present in the area of the site but are not due to site-related activity. These comparisons were not made for marine sediment. Therefore, a number of chemicals (i.e., arsenic or lead) were retained in the HHRA that may have been screened out if background samples were available. This conservative approach is likely to overestimate risks associated with marine sediment and marine tissue.

Low frequencies of detections were observed for most of the COPCs in clam and crab tissue. Noncarcinogenic risk is driven by antimony in the future RME scenario. Antimony was detected in 5 of 38 clam samples (13 percent) and 8 of 47 crab samples (17 percent). The RBSC was exceeded in two of five clam samples with detectable concentrations and five out of eight crab samples with detectable concentrations. Thus, noncarcinogenic risk estimates are based on a very small number of detections and RBSC exceedances and, therefore, may be overestimated.

Carcinogenic risks in the future RME crab and clam ingestion pathways are also driven by chemicals with low detection frequencies. Risks from clam ingestion are driven by 3,3'-dichlorobenzidine, which was detected in 3 of 57 tissue samples. This chemical was not detected in sediment, surface water, or soil. It is likely that the chemical may not be site-related and that risks are overestimated.

In the future RME crab ingestion scenario, the greatest contributor to carcinogenic risk is PCP, which was detected in 1 of 47 tissue samples. Thus, it is highly likely that risks are overestimated for this chemical.

The effect of differing analytical detection limits introduces considerable uncertainty into the HHRA. This is true because detection limits are often used for development of EPCs for chemicals that are intermittently detected. In addition, many detection limits in marine tissue for organic chemicals exceeded the screening criteria as a result of technical limits of the analytical methods. This may lead to an underestimation of risk because of chemicals that could not be detected due to the high detection limits.

Uncertainty Associated With Exposure Assessment

A number of uncertainties are also associated with assumptions made for the exposure assessment. Areas of uncertainty include calculation of EPCs, use of data below the detection limits, elimination of undetected values because of high detection limits, development of the average exposure RME and scenarios, and selection of exposure parameters for these scenarios.

Considerable uncertainty is introduced into the HHRA through the inclusion in the EPCs of data that are below detection limits. If a chemical was detected at least once at one site, a value one-half the detection limit for nondetected samples was used to calculate EPCs. This provides a conservative representation of the concentration of chemicals that were intermittently detected. Assuming that nondetected chemicals are actually present introduces a conservative bias into the HHRA, particularly for chemicals that have a very low frequency of detection. This effect was partially mitigated by eliminating any nondetects that were greater than 10 times the maximum detected concentration. For some COPCs (such as PAHs in surface and subsurface soils), calculation of EPCs—including data based on one-half the detection limit—resulted in RME concentrations equal to or greater than the maximum detected concentration.

For inorganics in soil and sediments, calculated EPCs include the naturally occurring background concentrations. Calculated risks are therefore the total risk, not the incremental risk posed by site conditions. This results in an artificially high risk estimate for some inorganics, particularly arsenic and beryllium.

Concentrations of ordnance compounds in crabs and clams were not measured. Rather, they were modeled from sediment concentrations using a steady-state bioaccumulation model. It is likely that concentrations of ordnance compounds in clams may be slightly overestimated due to the use of a steady-state model. However, no ordnance concentrations exceeded the conservative site-specific RBSCs.

The EPCs for nonordnance compounds calculated for crab, which were based on muscle samples, are applicable for the majority of consumers (who eat only the muscle). However, some consumers also eat the hepatopancreas, which was not included in the samples. This may lead to an underestimation or overestimation of risk for some people.

EPCs in crabs, clams, and soil were often developed using data sets having very low frequencies of detections. Therefore, uncertainty is introduced because it is likely that EPCs were overestimated as a result of the use of one-half the detection limit.

Uncertainties Associated With Exposure Scenarios and Parameters

A number of uncertainties are associated with the exposure scenarios that were developed for the HHRA. The RME parameters used to evaluate exposures to residents and recreational visitors are intentionally conservative (following EPA guidance) and will probably result in highly conservative risks. In recognition of this uncertainty, EPA Region 10 guidance (U.S. EPA 1991a) specifies that average exposures also be quantified (where data permit). Average cancer and noncancer risks are presented along with the RME estimates. The difference between the risks calculated for the average exposure and RME scenarios can be significant. The RME scenario is designed to represent the upper bounds of probable exposure and is intentionally conservative. The actual exposures and subsequent risks of a typical individual are likely to be significantly lower.

Because seafood ingestion rates for children were not available, children were not included in the harvesting scenarios. This may lead to an underestimation of risk, since a child may have a greater sensitivity to potential contaminants.

EPCs 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. This assumes a static chemical concentration for the entire exposure duration, which results in a conservative bias for those chemicals that would undergo environmental degradation, migration, or immobilization. It is highly likely that risks are overestimated because of this assumption. In addition, crabs may migrate off site or on site from other locations, which would impact tissue concentrations.

Uncertainties Associated With Toxicity Assessment

For carcinogens, CSFs for probable or possible human carcinogens are given the same weight as known human carcinogens. CSFs derived from animal data are equally weighted with those derived from human data. Uncertainties in the combined risks are also compounded because CSFs for various chemicals 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. Because CSFs typically correspond to the UCL95 of 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 poses some degree of risk is unproven, and it is possible that low levels of some carcinogens may not actually pose any risk at all.

Most RfDs developed by EPA are for chronic (i.e., greater than 7 years) and subchronic (i.e., less than 7 years) oral exposures. While exposures at JPHC/NHB are both chronic and subchronic, only chronic toxicity values were used because those values were available for most of the identified COPCs while subchronic values were not. Because chronic toxicity values are more conservative than subchronic values, this approach may overestimate the potential risks at JPHC/NHB. Subchronic exposures occur in the current residential and clam and crab harvester scenarios in both the average and RME cases.

Uncertainty factors for the majority of the RfD values are in the range of a hundred or a thousand, which indicates considerable uncertainty regarding the actual values of the RfDs for these chemicals. The uncertainty factors for nitrobenzene and 1,3,5-trinitrobenzene are particularly high (10,000), indicating even more uncertainty for these chemicals. On the other hand, the uncertainty factors for the oral RfDs for arsenic and manganese are less than 10. This indicates very little uncertainty regarding the actual values for these RfDs.

Since toxicity data are not available for lead, concentrations found on site were compared to cleanup or action levels recommended by EPA (U.S. EPA 1994) and WDOE under MTCA Method A. This does not allow calculation of a risk result in the traditional sense nor does it allow summation of risks for lead with the rest of the COPCs. This approach may cause underestimation of total risk for those sites where lead concentrations appear to be of concern.

In addition, toxicity values for Endosulfan I, Endosulfan II, trichloroethene Endrin aldehyde, lead, copper, and thallium were not available from accredited sources. The lack of toxicity values for these chemicals raises the uncertainty concerning the risk assessment results. However, these chemicals were detected in only 5 percent to 16 percent of all samples at JPHC/NHB, indicating that the potential exposure will be limited.

Risks associated with dermal contact with soil, sediment, and water were evaluated only for nonvolatile organic chemicals. Because most metals are not absorbed easily through the skin, the dermal route is not expected to contribute substantially to total risks for metals. Volatile chemicals were assumed to volatilize prior to absorption. At the time that the original HHRA was conducted, EPA was still in the process of revising its approach for evaluating exposure through dermal contact (U.S. EPA 1992a). A great deal of uncertainty exists regarding the methodology and the actual absorption rates used for the dermal pathway.

Uncertainties Associated With Risk Characterization

When summing risks for all COPCs and relevant exposure pathways, the standard assumption is that the chemical-specific risks are independent and additive. In actuality, these risks may interact to produce an effect that is less than additive (antagonism) or more than additive (synergism). Unfortunately, data on chemical interactions are lacking for most chemical mixtures. In the absence of mixture-specific toxicity data, assuming that the risks are additive is the standard approach recommended by EPA (U.S. EPA 1989). It is not known how this assumption affects the overall risk estimate.

7.2 TERRESTRIAL ECOLOGICAL RISK ASSESSMENT

A terrestrial ecological risk assessment was not conducted for OU 1. OU 2 consists of marine sediments in Ostrich Bay and any associated ecological risks to the marine environment. OU 3 addresses unexploded ordnance/ordnance explosive waste that may be present on JPHC/NHB property or in Ostrich Bay. Separate RODs will be issued for OU 2 and OU 3. Chemicals detected on land at JPHC/NHB pose no significant risks to terrestrial ecological receptors because no credible current or future exposure scenarios to site chemicals exist. The conceptual site model developed for JPHC/NHB (U.S. Navy 1991) and its associated text does not show surface soil or water as a primary potential route of exposure to on-shore site contaminants for terrestrial flora and fauna. Erosion of fill material along the shoreline, and discharge of groundwater to marine surface water, could potentially affect sediments in the marine environment. Any potential marine ecological risks associated with marine sediments are being assessed as part of OU 2. The terrestrial actions that are part of the selected remedy for OU 1 will minimize these transport pathways from the terrestrial to the marine environment.

Consistent with the conclusion that there are no significant terrestrial ecological risks, it is noted that detections of benzene in surface water seeps (in the Benzene Seep area) and VOCs in surface water seeps (at Site 103) exceeded human health risk-based cleanup levels, but did not exceed any ecological-based criteria.

A determination of no significant risk at a site is justifiable if one or more of the following criteria outlined in EPA's *Framework for Ecological Risk Assessment* (U.S. EPA 1992b) are met:

Criterion 1. Toxic chemicals are not present at a site

Criterion 2. Toxic chemicals are found at a site, but only at concentrations below those that elicit a toxicological response in biota

Criterion 3. No credible exposure scenario exists that would result in biota becoming exposed to site chemicals for the length of time necessary to elicit a toxic response

Toxic chemicals are found in subsurface (but not surface) soil at JPHC/NHB at concentrations that would pose risks to ecological receptors if a viable exposure pathway were present; therefore, Criteria 1 and 2 cannot be used to justify a conclusion of no significant risk. However, an examination of the possible exposure pathways for terrestrial biota indicates that such a pathway does not exist under current conditions at JPHC/NHB.

Vegetative cover at JPHC/NHB consists primarily of maintained lawns and landscaping plants. Trees at the site include Douglas fir and numerous introduced ornamental trees. Urban development in areas adjacent to JPHC/NHB has eliminated much of the native forest community that was once present at the site. Development at JPHC/NHB has also eliminated natural vegetation. Natural vegetation has been replaced with landscaped grounds that, if maintenance continues, preclude reversion of the site to any type of natural plant association.

Wildlife living at the site primarily includes those species that can adapt to urbanized, developed settings. Endangered or threatened species known to exist in the vicinity of the site include the Chinook salmon and the bald eagle. Any existing ecological risk to Chinook salmon would be addressed as part of OU 2. A bald eagle has been sighted several times at JPHC/NHB and is known to nest at the site.

The absence of natural vegetative cover makes it extremely unlikely that terrestrial fauna would make extensive use of the site, as it contains no food resources and no habitat except for those species that can make use of developed areas. As the site is nearly completely paved over, built up, or contains maintained landscaped grounds, direct contact with and ingestion of soil contaminants is no longer possible (as long as the pavement, buildings, and landscaping remain intact). Current land uses also limit the potential for dust formation from site soil and subsequent exposure to airborne contaminants bound to particulates.

Except for small, temporary puddles of water that appear on site after storm events, only one body of water (surface freshwater) exists on site. Two small intermittent streams are located near the southern end of OU 1. A survey of the streams found no fish present. The relatively flat or gently sloping nature of the site makes it unlikely that extensive areas of permanent standing water could exist. Although contaminants of concern were identified in one stream at OU 1, the stream's intermittent nature makes it improbable that either aquatic or terrestrial biota would be exposed to stream contaminants for a sufficient period of time to result in a toxicological impact.

The concept of *de minimus* risk implies that even though all risks cannot be completely eliminated, certain levels of risk are considered to be so low or so unlikely that it is not worth the time, effort, and cost to minimize or eliminate them (Suter 1993). While all potential risks to all potential ecological receptors at JPHC/NHB cannot be eliminated, the lack of a viable exposure pathway warrants the conclusion that the onshore portions of JPHC/NHB pose no significant risks to terrestrial biota.

7.3 ASSESSMENT OF THE SITE

Actual or threatened releases of hazardous substances from OU 1, if not addressed by implementing the response action selected in this ROD, may present an imminent and substantial endangerment to public health, welfare, or the environment.

Table 7-1
Exposure Pathways by Site, Scenario, and Medium

Medium	Exposure Route	Terrestrial Scenarios (Residential)						Marine Scenarios (Off-Site Visitors)	
		Site 101		Site 101-A		Site 103			
		Current	Future	Current	Future	Current	Future	Current	Future
Soil	Ingestion	●	●	●	●	●	●		
	Inhalation of Particulates	●	●	●	●	●	●		
	Dermal Contact	●	●	●	●	●	●		
Surface Water from Outfalls and Seeps	Dermal Contact	●	●	●	●	●	●		
Marine Sediment (intertidal)	Ingestion	●	●	●	●	●	●	●	●
	Dermal Contact	●	●	●	●	●	●	●	●
Clams/Crabs	Ingestion	●[a]	●[b]	●[a]	●[b]	●[a]	●[b]	●[a]	●[b]

[a]Recreational shellfish harvesting
[b]Subsistence shellfish harvesting

Table 7-2
Summary of COPCs and Exposure Point Concentrations at Site 101

Chemical	Matrix	Average (ppm)	RME (ppm)
Arsenic	Surface Soil	14.8	28.8
Benzo(a)anthracene	Surface Soil	0.184	0.297
Benzo(a)pyrene	Surface Soil	0.195	0.292
Benzo(b)fluoranthene	Surface Soil	0.32	0.592
Chrysene	Surface Soil	0.301	0.569
Dibenz(a,h)anthracene	Surface Soil	0.115	0.078
Indeno(1,2,3-cd)pyrene	Surface Soil	0.163	0.213
Arsenic	Subsurface Soil	6.64	11.2
Benzo(a)anthracene	Subsurface Soil	0.192	0.237
Benzo(a)pyrene	Subsurface Soil	0.182	0.227
Benzo(b)fluoranthene	Subsurface Soil	0.241	0.334
Chrysene	Subsurface Soil	0.229	0.321
Dibenz(a,h)anthracene	Subsurface Soil	0.155	0.078
Indeno(1,2,3-cd)pyrene	Subsurface Soil	0.189	0.221

Notes:
ppm - parts per million
RME - reasonable maximum exposure (the minimum of the 95 percent upper confidence limit or maximum detected concentration)

Table 7-3
Summary of COPCs and Exposure Point Concentrations at Site 101A

Chemical	Matrix	Average (ppm)	RME (ppm)
Antimony	Surface Soil	7.94	19.2
Arsenic	Surface Soil	3.24	5.17
Beryllium	Surface Soil	1.38	3.13
Benzo(a)pyrene	Surface Soil	0.27	0.18
Benzo(a)anthracene	Subsurface Soil	0.4	0.612
Benzo(a)pyrene	Subsurface Soil	0.308	0.38
Benzo(b)fluoranthene	Subsurface Soil	0.355	0.486
Chrysene	Subsurface Soil	0.389	0.582
Dibenz(a,h)anthracene	Subsurface Soil	0.269	0.19
Indeno(1,2,3-cd)pyrene	Subsurface Soil	0.286	0.325
Aluminum	Subsurface Soil	18,000	20,300
Antimony	Subsurface Soil	4.81	9.28
Arsenic	Subsurface Soil	3.86	5.01
Beryllium	Subsurface Soil	0.793	1.47

Notes:
ppm - parts per million
RME - reasonable maximum exposure (the minimum of the 95 percent upper confidence limit or maximum detected concentration)

Table 7-4
Summary of COPCs and Exposure Point Concentrations at Site 103

Chemical	Matrix	Average (ppm)	RME (ppm)
Aroclor 1254	Surface Soil	0.209	0.22
Arsenic	Surface Soil	10.7	14.8
Benzo(a)anthracene	Surface Soil	0.209	0.267
Benzo(a)pyrene	Surface Soil	0.237	0.324
Benzo(b)fluoranthene	Surface Soil	0.355	0.541
Chrysene	Surface Soil	0.304	0.406
Dibenz(a,h)anthracene	Surface Soil	0.187	0.223
Indeno(1,2,3-cd)pyrene	Surface Soil	0.239	0.331
Lead	Surface Soil	36.4	56
Antimony	Subsurface Soil	7.06	10.9
Aroclor 1254	Subsurface Soil	0.252	0.504
Aroclor 1260	Subsurface Soil	0.011	0.0087
Lead	Subsurface Soil	68.8	112
Arsenic	Subsurface Soil	7.06	8.8
Benzo(a)anthracene	Subsurface Soil	0.274	0.379
Benzo(a)pyrene	Subsurface Soil	0.246	0.316
Benzo(b)fluoranthene	Subsurface Soil	0.342	0.469
Benzo(k)fluoranthene	Subsurface Soil	0.203	0.235
Chrysene	Subsurface Soil	0.299	0.401
Dibenz(a,h)anthracene	Subsurface Soil	0.165	0.18
Indeno(1,2,3-cd)pyrene	Subsurface Soil	0.214	0.257
Lead	Subsurface Soil	68.8	112
1,1-Dichloroethene	Surface Water from Outfalls and Seeps	0.000875	0.0011
2,4-Dinitrotoluene	Surface Water from Outfalls and Seeps	0.0000448	8.89E-05
Trichloroethene	Surface Water from Outfalls and Seeps	0.0158	0.027
Vinyl chloride	Surface Water from Outfalls and Seeps	0.00563	0.0103

Notes:
ppm - parts per million
RME - reasonable maximum exposure (the minimum of the 95 percent upper confidence limit or maximum detected concentration)

Table 7-5
Summary of COPCs and Exposure Point Concentrations for Marine Sediment and Clam and Crab Tissue

Chemical	Sediment Average Exposure (mg/kg)	Sediment RME (mg/kg)	Clam RME (mg/kg)	Crab RME (mg/kg)
Antimony	11.3	14.2	5.87	6.74
Arsenic	15.4	17.4	0.00216	19.7
Beryllium	0.371	0.411	7.5	0.08
Cadmium	4.37	5.15	0.341	0.458
Chromium	32.7	36.3	0.749	1.4
Copper	17.6	21.3	1.63	12.1
Cyanide	0.891	1	1.46	0.472
Lead	16.6	20.6	0.125	0.818
Manganese	171	191	1.39	1.41
Mercury	0.218	0.325	0.0557	0.144
Nickel	28.8	31.8	2.61	4.31
Selenium	1.91	2.48	0.539	1.41
Silver	2.27	2.72	0.125	1.82
Thallium	0.117	0.125	0.03	ND
Vanadium	23.1	25.7	50.7	1.24
Zinc	57.3	67.2	13.6	72.2
Benzo(a)anthracene	0.339	0.11	8.3	0.18
Benzo(a)pyrene	0.422	0.15	ND	ND
Benzo(b)fluoranthene	0.491	0.21	8.3	0.21
Benzo(g,h,i)perylene	0.305	0.091	ND	ND
Benzo(k)fluoranthene	0.466	0.18	ND	ND
Chrysene	0.481	0.23	8.3	0.17
3,3-Dichlorobenzidine	ND	ND	4.3	9.1
Fluoranthene	0.404	0.15	ND	ND
Indeno(1,2,3-cd)pyrene	0.319	0.096	ND	ND
Pentachlorophenol	ND	ND	38.4	26
Phenol	0.57	0.632	7.5	13.2
Pyrene	0.489	0.22	0.22	ND

Note:
ND - not detected
RME - reasonable maximum exposure

Table 7-6
Summary of Pathway-Specific Exposure Assumptions

Exposure Pathway	Parameter	Units	Age Group	Season	Current Scenario Avg	Current Scenario RME	Future Scenario Avg	Future Scenario RME
Dermal Contact with Soil	Exp. Freq.	days	—	—	275	350	275	350
	Contact Rate	mg/cm^2	—	—	0.6	1	0.6	1
	Skin Surface Area	cm^2	child	—	—	3,900	—	3,900
			adult	summer	1,900	5,000	1,900	5,000
				winter	1,900	1,900	1,900	1,900
Soil Ingestion	Exp. Freq.	days/yr	—	—	275	350	275	350
	Ingestion Rate	mg/day	child	—	—	200	—	200
			adult	—	100	100	100	100
Marine Sediment Ingestion	Exp. Freq.	days/yr	—	—	20	98	52	980
	Ingestion Rate	mg/day	child	—	—	200	—	200
			adult	—	100	100	100	100
Soil Particulate Inhalation	TSP	µg/m^3	—	—	24	24	24	24
	Exp. Freq.	days/yr	—	—	275	350	275	350
Dermal Contact with Surface Water from Outfalls and Seeps	Exp. Freq.	days/yr	—	—	20[a]	98	52[a]	98
	Contact Rate	hrs/day	—	—	2.6	2.6	2.6	2.6
	Skin Surface Area	cm^2	—	—	20,000	20,000	20,000	20,000
Dermal Contact with Marine Sediment	Exp. Freq.	days/yr	—	—	20[a]	98[a]	52[a]	98[a]
	Contact Rate	mg/cm^2	—	—	0.6	1	0.6	1
	Skin Surface Area	cm^2	child	summer	—	3,900	—	3,900
			adult	summer	1,900	5,000	1,900	5,000
Shellfish Ingestion	Exp. Freq.	days/yr	—	—	—	365[a]	—	135
	Intake Rate	g/day	—	—	—	8.6[b]	—	117
Averaging Time for Cancer Effects	Years	—	—	—	70	70	70	70
Averaging Time for Noncancer Effects	Years	—	—	—	Same as Exp. Dur.	Same as Exp. Dur.	Same as Exp. Dur.	Same as Exp. Dur.
All Pathways	Exposure Duration	yr	child	—	—	6[a]	—	6
			adult	—	2[a]	2[a]	9	24
	Body Weight	kg	child	—	—	15	—	15
			adult	—	70	70	70	70

[a]Site-specific assumption
[b]Recreational shellfish harvesting

Notes:
All values taken from EPA (U.S. EPA 1991a) unless otherwise indicated
RME - reasonable maximum exposure
TSP - total suspended particulates
— - not applicable

Table 7-7
Summary of Potential Human Health Risks and COCs at Site 101

Exposure Scenario	Cumulative Risk		Chemical of Concern in Specified Media[a]			
			Soil	Marine Tissue	Surface Water	Sediment
Current Resident						
RME—Noncancer	Adult Child Lifetime	2.80 1.57 1.21	Arsenic	Antimony	None	None
RME—Cancer	Adult Child Lifetime	1.32E-05 6.93E-05 7.18E-05	Arsenic cPAHs	3,3'-dichlorobenzidine PCP	None	Arsenic
Average Exposure—Noncancer	Adult	0.05	None	None	None	None
Average Exposure—Cancer	Adult	9.87E-07	None	None	None	None
Future Resident						
RME—Noncancer	Adult Child Lifetime	13.5 1.02 0.24	None	Antimony Vanadium	None	None
RME—Cancer	Adult Child Lifetime	8.2E-04 3.48E-05 4.97E-05	Arsenic cPAHs	3,3'-dichlorobenzidine PCP	None	Arsenic
Average Exposure—Noncancer	Adult	0.03	None	None	None	None
Average Exposure—Cancer	Adult	2.93E-06	Arsenic cPAHs	None	None	None

[a]Groundwater was not evaluated as an exposure pathway.

Notes:
cPAH - carcinogenic polycyclic aromatic hydrocarbon
NA - not applicable; no chemicals in this medium pose significant risk
PCP - pentachlorophenol
RME - reasonable maximum exposure

Table 7-8
Summary of Potential Human Health Risks and COCs at Site 101-A

Exposure Scenario	Cumulative Risk		Chemical of Concern in Specified Media[a]			
			Soil	Marine Tissue	Surface Water	Sediment
Current Resident						
RME—Noncancer	Adult Child Lifetime	2.76 1.17 0.91	None	Antimony	None	None
RME—Cancer	Adult Child Lifetime	1.21E-05 3.64E-05 3.78E-05	cPAHs Beryllium	3,3'-dichlorobenzidine PCP	None	Arsenic
Average Exposure—Noncancer	Adult	0.03	None	None	None	None
Average Exposure—Cancer	Adult	4.98E-07	None	None	None	None
Future Resident						
RME—Noncancer	Adult Child Lifetime	13.5 0.85 0.24	None	Antimony Vanadium	None	None
RME—Cancer	Adult Child Lifetime	8.34E-04 3.23E-05 4.65E-05	cPAHs	3,3'-dichlorobenzidine PCP	None	Arsenic
Average Exposure—Noncancer	Adult	0.03	None	None	None	None
Average Exposure—Cancer	Adult	3.14E-06	cPAHs	None	None	None

[a]Groundwater was not evaluated as an exposure pathway.

Notes:
cPAH - carcinogenic polycyclic aromatic hydrocarbon
NA - not applicable; no chemicals in this medium pose significant risk
PCP - pentachlorophenol
RME - reasonable maximum exposure

Table 7-9
Summary of Potential Human Health Risks and COCs at Site 103

Exposure Scenario	Cumulative Risk		Chemical of Concern in Specified Media[a]			
			Soil	Marine Tissue	Surface Water	Sediment
Current Resident						
RME—Noncancer	Adult Child Lifetime	2.8 1.25 1.14	None	Antimony	None	None
RME—Cancer	Adult Child Lifetime	1.09E-05 4.38E-05 4.53E-05	Arsenic cPAHs	3,3'-dichlorobenzidine PCP	None	Arsenic
Average Exposure—Noncancer	Adult	0.04	None	None	None	None
Average Exposure—Cancer	Adult	7.82E-07	None	None	None	None
Future Resident						
RME—Noncancer	Adult Child Lifetime	13.6 7.61 2.58	PCBs	Antimony Vanadium	None	None
RME—Cancer	Adult Child Lifetime	8.43E-04 3.20E-05 4.58E-05	Arsenic cPAHs	3,3'-dichlorobenzidine PCP	None	Arsenic
Average Exposure—Noncancer	Adult	0.22	None	None	None	None
Average Exposure—Cancer	Adult	3.13E-06	cPAHs	None	None	None

[a]Groundwater was not evaluated as an exposure pathway.

Notes:
cPAHs - carcinogenic polycyclic aromatic hydrocarbons
NA - not applicable; no chemicals in this medium pose significant risk
PCBs - polychlorinated biphenyls
PCP - pentachlorophenol
RME - reasonable maximum exposure

8.0 REMEDIAL ACTION OBJECTIVES

Actual or threatened releases from OU 1, if not addressed by implementing the response action selected in this ROD, may present an imminent and substantial endangerment to human health and the environment.

This section explains the basis for remedial action at OU 1, identifies the media for which action is needed, and describes the objectives that the remedial action is intended to achieve. Specific remedial action objectives (RAOs) are based on the results of the HHRA and consideration of ARARs for soil, groundwater (including groundwater discharging to surface water), intertidal sediments, and marine tissue at OU 1. The ARARs considered include established health-based or ecological risk-based thresholds. To achieve the RAOs, specific cleanup levels and/or risk targets are defined for specific chemicals in the media of concern.

8.1 SOIL

8.1.1 RAOs for Soil

The human health risk assessment evaluated the exposure of current and future residents to chemicals in soil at Sites 101, 101-A, and 103. Excess carcinogenic risks exceeding 1.0E-06 and excess noncarcinogenic hazard indexes exceeding 1.0 were associated with the COCs arsenic, cPAH compounds, and PCBs.

The COCs antimony and beryllium exceeded state cleanup levels in a well-defined area of surface soil at Site 101-A. Arsenic and cPAH compounds exceeded state cleanup levels in several areas of surface soil at Sites 101, 101-A, and 103. The COCs antimony, lead, and PCBs exceeded state cleanup levels in a well-defined area of subsurface soils near the former ordnance burn area at Site 103. In addition, fill material that may contain COCs is eroding into Ostrich Bay along portions of the Site 101 and 103 shoreline.

To address potential human health or ecological risks associated with these chemicals, the following RAOs were identified for soil:

- Prevent dermal contact or ingestion of soil containing concentrations of antimony, arsenic, beryllium, lead, cPAH compounds, and PCBs above state cleanup levels.

The point of compliance for attaining the state cleanup levels is from the ground surface down to 15 feet below ground surface.

- Reduce the potential for erosional transport of chemicals in soil to the marine environment.

No RAOs were developed for Site 110 soils. With few exceptions, the soil removal actions at Site 110 addressed all known or suspected areas of contamination. Soil containing arsenic and cPAHs above cleanup levels remains beneath paved areas in front of bunkers 100 and 101. Land use restrictions are included in the soil alternatives to address maintenance of the asphalt cover and procedures for controlling activities that involve digging or construction that could cause exposure to contaminants in soil.

Surface soil exceeding MTCA Method A cleanup levels was removed at the Jackson Park Elementary School yard (Ebasco 1995a). Although the tree/hill area at the school yard was left undisturbed, a statistical analysis indicated that the arsenic cleanup level was attained (Ebasco 1995a).

At the time of the removal actions at Site 110, MTCA Method A soil cleanup levels were used as the remedial goals. The MTCA Method A cleanup levels are slightly higher than the MTCA Method B soil cleanup levels. Thus, limited areas of soil in the vicinity of the removal actions at Site 110 still contain chemicals above the MTCA Method B soil cleanup levels. No further action is needed to address these residual concentrations.

8.1.2 Remedial Goals for Soil

Land Use Assumptions

In developing the remedial goals for soils, consideration was given to the current and potential future land use at the individual sites. The default land use assumption in MTCA cleanup level calculations is residential, which is the most conservative (i.e., highest exposure) assumption. This assumption is valid for Sites 101, 101-A, and 110. However, at Site 103, recreational land use is the historical, current, and planned future land use. The following three criteria are set forth in WAC 173-340-740(a)(i-iii) to determine if cleanup levels for a site can be calculated based on nonresidential land use:

(i) The property does not serve as a current residential area

(ii) The property does not have the potential to serve as a future residential area based on the consideration of zoning, statutory and regulatory restrictions, comprehensive plans, historical use, adjacent land use, and other relevant factors

(iii) Appropriate site use restrictions are implemented

Since the 1970s, Site 103 has served as a recreational area for Jackson Park Housing Complex. Included in the site are a ballfield, a running track, a park, a picnic area, easily accessible beachfront areas, and other recreational facilities. Adjacent land use includes residential housing and Naval Hospital Bremerton.

In addition to the existing recreational features, the Navy is planning a major recreational project at Sites 101 and 103 to provide additional recreational facilities and improve shoreline access. The Navy's intent is to maintain Site 103 as recreational in nature. Continued use of Site 103 as recreational will be accomplished with land use restrictions. However, deed restrictions cannot be placed on the property until transfer of the property, in which case transfer of the property would be required to meet the requirements of CERCLA Section 120(h).

Based on the consideration of historical use, current recreational use and zoning, the existing Master Plan for future land use, and adjacent land use, WDOE has determined that Site 103 does not meet the requirements set forth in WAC 173-340-740(1)(a)(i-iii). WDOE made this determination because of the potential for future residential development of Site 103. Accordingly, MTCA Method B cleanup levels are applicable to Site 103. However, the need for active remediation at Site 103 is being based on a recreational scenario, with site-specific *remediation levels* derived using recreational exposure parameters, as described below.

Soil Cleanup Level Calculations—Sites 101, 101-A, and 110

At Sites 101, 101-A, and 110, land use is residential and therefore MTCA Method B soil cleanup levels are appropriate. Standard exposure parameters are used to calculate the Method B soil cleanup levels (Table 8-1). Background concentrations of inorganics in soil were also considered in determining the soil cleanup levels at these sites. Based on WAC 173-340-706(1)(a), in cases where area background concentrations are higher than the MTCA Method B cleanup levels, MTCA Method C cleanup levels are established at a concentration equal to the background concentration. For petroleum hydrocarbons and lead in soil, MTCA Method B or C cleanup levels were not available, and the Method A cleanup levels were used.

Soil Remediation Level Calculations—Site 103

At Site 103, the need for active remediation is based on site-specific *remediation levels* derived using recreational exposure parameters. These parameters are shown in Table 8-1. These parameters are identical to the MTCA Method C exposure parameters, and the derived remediation levels for Site 103 are identical to the MTCA Method C soil cleanup levels. For petroleum hydrocarbons and lead in soil, MTCA Method C cleanup levels were not available, and the Method A cleanup levels were used as the remediation level.

Summary of Soil Cleanup Levels and Remediation Levels

Table 8-2 presents the background concentrations, chemical-specific ARARs, and selected cleanup and remediation levels for COCs in soil at OU 1. Table 8-3 summarizes the excess cancer risk and HI that is associated with the soil cleanup and remediation levels. These residual risks were calculated using MTCA risk equations and parameters specified in WAC 173-340-740 (3) and (-4), and using the soil cleanup and remediation levels as exposure point concentrations. Taking action to achieve the cleanup and remediation levels will result in residual risks lower than those shown in Table 8-3, because the RME exposure point concentrations will be less than the cleanup levels.

8.2 GROUNDWATER

8.2.1 RAOs for Groundwater

RAOs for Groundwater at Sites 101, 101-A, and 103

Drinking water is not considered the highest beneficial use for groundwater at Sites 101, 101-A, and 103 under Washington State regulations. Therefore, no human health risks were defined for groundwater ingestion in the HHRA because groundwater was not considered as a potential source of drinking water. Groundwater discharges to marine surface water in the intertidal zone, as a series of seeps and outfalls along the Ostrich Bay shoreline. The HHRA evaluated dermal contact with groundwater discharging through seeps and outfalls as a potential exposure pathway. Human health risks from exposure to the seeps and outfalls are below the CERCLA threshold criteria.

In the absence of potential future use of groundwater for drinking water, MTCA allows groundwater cleanup levels that are based on protecting beneficial uses of adjacent surface water. This approach is also consistent with federal requirements. Based on the federal guidelines (U.S.

EPA 1986), groundwater in these areas is also considered nonpotable, or "Class III," because a well could not yield more than 150 gallons per day on a sustained basis. The federal guidelines stipulate that restoration of Class III groundwaters should consider any surface water bodies to which the groundwater discharges.

MTCA requires that groundwater entering surface waters not exceed surface water cleanup levels at the point of entry or at any downstream location where it is reasonable to believe that hazardous substances may accumulate (WAC 173-340-720[1][c][iii]). MTCA also requires that the groundwater meet the most stringent of the following surface water ARARs: Washington State marine WQS (acute and chronic); federal marine WQC for protection of aquatic organisms (acute and chronic) and human health; and, for those chemicals for which sufficiently protective health-based standards are not promulgated, the MTCA Method B surface water cleanup levels calculated using the risk-based equations under WAC 173-340-730(3)(a)(iii). (The MTCA Method B surface water cleanup levels calculated using the risk-based equations are designed for protection of humans eating aquatic organisms. These cleanup levels are not necessarily protective of aquatic life.) These criteria must be met at a conditional point of compliance located as close as technically possible to the point where groundwater discharges to surface water. The conditional point of compliance for groundwater at JPHC/NHB is located at the seeps and outfalls.

WDOE allows the use of a conditional point of compliance only under certain conditions, specified in WAC 173-340-720 (6)(d). These conditions are (1) that no dilution zone be used to measure actual concentrations in sea water; (2) that all known available and reasonable methods of treatment be used; (3) that discharging groundwater not contaminate sediments; and (4) that groundwater be monitored to estimate the rate at which contaminants flow into surface water. The FS report discussed how Sites 101, 101-A, and 103 meet WDOE criteria. Thus, at these sites the need for groundwater cleanup actions is based on the seep and outfall water results.

According to this approach, eight COCs (arsenic, mercury, nickel, silver, benzene, 1,1-dichloroethene, trichloroethene, and vinyl chloride) have been identified whose concentrations in groundwater at the seeps and outfalls exceed human health or ecological risk-based regulatory criteria for surface water. To address potential human health or ecological risks associated with these chemicals, the following RAO was identified for groundwater at Sites 101, 101-A, 103, and the benzene release area:

- Protect ecological receptors in the marine environment and human health by attaining compliance with water quality standards for marine surface water at the point of groundwater discharge

RAOs for Groundwater at Site 110

Groundwater from some portions of Site 110 could potentially be used as a drinking water resource in the future. Although five inorganics (arsenic, beryllium, manganese, nickel, and vanadium) were detected in Site 110 groundwater at concentrations above drinking water regulatory criteria, these results are believed to be an artifact of sampling procedures. However, to verify protection of human health for potential future residents who may consume groundwater, the following RAO was identified:

- Verify that concentrations of inorganics in Site 110 groundwater are below background levels or state and federal drinking water ARARs

8.2.2 Approach for Achieving Groundwater RAOs

The following subsections describe the specific approaches for addressing the various COCs identified in various portions of OU 1 groundwater.

Approach for Inorganics Found in Seeps and Outfalls

Arsenic frequently exceeded the evaluation criterion in groundwater at the seeps and outfalls; most such arsenic exceedances were less than two times the calculated groundwater background concentration of 3.3 µg/L. The arsenic exceedances occurred in an apparently random pattern and were not reproducible in multiple sampling events. The highest concentration of arsenic found in groundwater at the seeps and outfalls was 17 µg/L, approximately five times the calculated groundwater background concentration. However, this detection (at location SP-701 in 1998) is not considered to be representative because groundwater was not flowing from the seep location at the time of sample collection. It is suspected that the arsenic concentrations at the seeps are attributable to background. However, the calculated groundwater background concentrations are suspect because the wells used in the RI to determine background are not screened in the same groundwater unit.

Dissolved nickel and dissolved silver each exceeded evaluation criteria in 1 seep sample in a total of 34. The detected concentrations of nickel and silver were approximately two times the state WQS for marine water. Total and dissolved mercury were detected in 3 of 54 seep samples and 2 of 34 seep samples, respectively. The mercury detections exceeded the state WQS for marine water. The mercury, nickel, and silver detections each occurred in one sampling event and have not been reproducible. For these inorganics, the low frequency of detection and relatively low concentration indicate that it is extremely unlikely that environmental receptors in the marine environment would be affected. These inorganics may also be attributable to background.

To eliminate the uncertainty associated with groundwater background, the Navy is redetermining background concentrations by installing and sampling new background wells. The results of the new background data will be used to verify protectiveness of the final remedial action at the time of the 5-year review. Therefore, no cleanup actions are presently considered to detect arsenic, mercury, nickel, or silver in seeps or outfalls.

Approach for VOCs at Site 103

The VOCs 1,1-dichloroethene, trichloroethene, and vinyl chloride have been detected consistently in seep samples in the general vicinity of the former ordnance burn area. The concentrations of these analytes have been steadily decreasing over time, as measured in four sampling events from 1991 through 1998. In the 1998 sampling event, only vinyl chloride exceeded the regulatory criterion. A range of cleanup actions is considered to address the continued presence of vinyl chloride.

Approach for COCs in Inland Monitoring Wells—Sites 101, 101-A, and 103

Additional COCs were identified whose concentrations in inland monitoring wells at the nearshore sites exceed regulatory criteria for surface water. These COCs are arsenic, beryllium, copper, cyanide, lead, mercury, nickel, thallium, zinc, benzene, chlordane, 1,1-dichloroethene, and TPH. The results for inorganics from the monitoring wells were biased high as a result of sample turbidity, and many of the inorganics may not be present in the groundwater above the regulatory criteria. These exceedances in monitoring wells do not indicate actual exceedances at the point of entry into the marine environment. No cleanup actions are considered for these inland detections, but future monitoring of seeps and outfalls will include analyses for these COCs to ensure that the RAO for groundwater is achieved at the seeps and outfalls (the conditional point of compliance).

Approach for Groundwater Impacts on Marine Sediments

The data were also evaluated to determine whether groundwater discharging through seeps and outfalls is affecting marine sediment quality. In no instances did the COCs identified in OU 2 marine sediments correspond to the COCs found in seeps and outfalls. Therefore, no cleanup actions are needed for groundwater discharging through seeps and outfalls to protect marine sediments.

Approach for COCs in Inland Monitoring Wells—Site 110

Because groundwater from some portions of Site 110 could potentially be used as a drinking water resource in the future, the groundwater results were evaluated against drinking water criteria. Five inorganics (arsenic, beryllium, manganese, nickel, and vanadium) were detected in Site 110 groundwater at concentrations above drinking water regulatory criteria. However, the total inorganics data for Site 110 groundwater are not considered to be representative of actual groundwater quality due to the sampling methods used. All of the inorganics exceedances at Site 110 occurred in the totals analysis. Two groundwater samples at Site 110 were collected and analyzed for dissolved inorganics. No inorganics exceeded the evaluation criteria in the dissolved analyses. These inorganics may also be attributable to background.

To eliminate the uncertainty associated with the presence of inorganics in Site 110 groundwater, the Navy is resampling Site 110 groundwater using low-stress sampling methods. The Navy is also redetermining groundwater background concentrations by installing and sampling new background wells. The results of the groundwater background sampling and Site 110 groundwater resampling will be used to verify protectiveness of the final remedial action at the time of the 5-year review. Therefore, no cleanup actions are considered for Site 110 groundwater.

Approach for Benzene Release Area

Benzene and gasoline-range petroleum hydrocarbons are present in two seeps at Site 101 and an area of upgradient groundwater in Sites 101 and 110. The concentrations of these chemicals have remained above cleanup levels in several sampling events from 1996 through 1998. A range of cleanup actions is considered to address the continued presence of these COCs.

8.2.3 Remedial Goals for Groundwater

Sites 101, 101-A, and 103

The RAO for groundwater involves complying with chemical-specific ARARs for protection of marine surface water. Chemical-specific ARARs for groundwater at Sites 101, 101-A, and 103 that correspond with the RAO are presented in Table 8-4. The selected criteria are used to evaluate groundwater quality at the conditional point of compliance (the seeps and outfalls) and assess the protection of ecological receptors in the marine environment.

Site 110

The RAO for groundwater at Site 110 involves complying with chemical-specific ARARs for drinking water. The chemical-specific ARARs for groundwater at Site 110 that correspond to this RAO are presented in Table 8-5. The selected criteria are used to evaluate groundwater quality measured in Site 110 monitoring wells.

8.3 INTERTIDAL SEDIMENTS

The HHRA concluded that there are no noncarcinogenic human health risks from intertidal sediments at JPHC/NHB. The HHRA identified arsenic as a COC in sediments, based on a carcinogenic risk of 9.34E-06 for an RME child scenario. The magnitude of this risk was overestimated because naturally occurring concentrations of arsenic in sediments were not accounted for in the risk estimate; that is, calculated risks represent the total risk, not the incremental risk posed by site conditions. The estimated carcinogenic risk falls with the CERCLA target risk range of 1.0E-04 to 1.0E-06, and thus no unacceptable human health risks are associated with sediments.

Sampling of seeps, outfalls, and intertidal sediments has shown that the sediments are not being impacted by groundwater discharging through seeps and outfalls. In intertidal sediment samples, the following COCs were identified, based on exceedances of Washington State Sediment Management Standards (SMS) Chemical Criteria (SQS): phenol, bis(2-ethylhexyl)phthalate, cadmium, silver, and mercury. One COC in sediment—bis(2-ethylhexyl)phthalate—has a potential terrestrial source. The erosion prevention RAO that was developed for soil addresses this potential source. Based on these results, no further terrestrial action is needed to protect intertidal sediments, and no RAOs were developed. The SQS chemical criteria are designed to protect aquatic organisms. Actions to address potential ecological risk in the marine environment caused by the COCs in sediments will be addressed in the OU 2 ROD.

8.4 MARINE TISSUE

8.4.1 RAOs for Marine Tissue

The HHRA determined the potential carcinogenic human health risks from PCP and 3,3′-dichlorobenzidine in clams and crabs to be above the carcinogenic risk level of 1.0E-04, and the potential noncarcinogenic HI from antimony and vanadium in clams and crabs to be above 1.

Neither PCP nor 3,3′-dichlorobenzidine were detected in terrestrial media or intertidal sediments. One possible source of the PCP is pilings in Ostrich Bay.

Antimony and vanadium were detected in terrestrial media. The only potential mechanism for transport of these inorganics from the terrestrial to the marine environment is erosion of fill material at Site 103. Vanadium was never detected in soil at concentrations above MTCA Method B soil cleanup levels. Some detections of antimony in soil exceeded MTCA Method B soil cleanup levels, but these exceedances occurred in locations that are already being addressed under the soil RAOs. Also, there is much uncertainty about the true incremental risks posed by antimony and vanadium in tissue because no tissue background values were available and detection frequencies were low.

To address potential human health risks associated with PCP, 3,3′-dichlorobenzidine, antimony, and vanadium, the following RAO was identified for marine tissue at OU 1:

- Reduce risks from subsistence-level ingestion of shellfish from Ostrich Bay to less than 1E-05 excess carcinogenic risk or noncarcinogenic hazard index of 1

Treated wood pilings in Ostrich Bay may be a source of PCP, although testing has not confirmed this. Removal of pilings could be effective in eliminating the source of PCP in marine tissue. Piling removals may result in decreased human health risks resulting from shellfish consumption in the long term.

Antimony in fill material at Site 103 may be eroding into the marine environment. Erosion control measures are being considered under the soil RAOs to reduce the potential for erosional transport. Any effects of erosion control measures on marine tissue concentrations are unknown.

Because of the lack of terrestrial sources for the other COCs in marine tissue, additional terrestrial response actions in soil, surface water, or groundwater would have no effect on marine tissue. Sediment removal or capping are not considered to be viable or effective options for reducing human health risks, because sediments were not shown to be a source of chemicals in marine tissue, and because these actions would destroy existing shellfish populations.

In addition to erosion control and piling removal, institutional controls consisting of marine tissue monitoring and possible shellfish harvest restrictions may be necessary to protect human health. The monitoring program would also include determining background concentrations of antimony and vanadium in marine tissue to better define actual risks.

8.4.2 Remedial Goals for Marine Tissue

For clam and crab tissue in Ostrich Bay, chemical-specific cleanup levels were not developed. Actions to satisfy the soil RAO of reducing erosion of fill material may reduce concentrations of antimony in marine tissue. The true incremental risk of antimony and vanadium in marine tissue have not been calculated, because background concentrations were not determined. Determining the background concentrations of these inorganics in marine tissue may result in a downward-revised risk estimate. Background concentrations of these inorganics will be determined as a part of the marine tissue monitoring program, and will be available at the time of the 5-year review.

The marine tissue monitoring program will also allow a better estimate of risk from 3,3'-dichlorobenzidine and pentachlorophenol. The Washington State Department of Health, using the results of the marine tissue monitoring program, will determine whether it is safe to eat shellfish from Ostrich Bay.

Table 8-1
Exposure Parameters Used in Calculating Soil Cleanup Levels and Soil Remediation Levels

Exposure Parameters	MTCA Method B Soil Cleanup Level Default Parameters (Sites 101, 101-A, and 110)	MTCA Method C Soil Cleanup Level Default Parameters	Site-Specific Recreational Parameters (Site 103)
Acceptable Cancer Risk	1.0E-06	1.0E-05	1.0E-05
Average Body Weight (kg)	16 (child)	16 (child)	16 (child)
Soil Ingestion Rate (mg/day)	200	100	100
Duration of Exposure (years)	6	6	6
Frequency of Contact (days/year)	365	182.5	182.5

Note:
MTCA - Model Toxics Control Act

Table 8-2
Chemical-Specific ARARs for Soil

Chemical	Background Concentration (mg/kg)	MTCA Method B Soil Cleanup Level (mg/kg)	MTCA Method C Soil Cleanup Level (mg/kg)	Selected Cleanup Level for Sites 101, 101-A, and 110 (mg/kg)	Selected Remediation Level for Site 103 (mg/kg)
Antimony	N/C	32	128	32	128
Arsenic	8.6	1.67	66.7	8.6	66.7
Beryllium	1.5	0.233	9.3	1.5	9.3
Lead	95	250[a]	250[a]	250	250
cPAHs	0	0.137	5.48	0.137	5.48
PCBs	0	0.130	5.19	0.130	5.19
TPH-G	0	100[a]	100[a]	100	100

[a]Model Toxics Control Act Method A soil cleanup level is used for lead and gasoline-range petroleum hydrocarbons because no Method B value is available.

Notes:
cPAHs - carcinogenic polycyclic aromatic hydrocarbons
MTCA - Model Toxics Control Act
N/C – Not Calculated
PCBs - polychlorinated biphenyls
TPH-G – gasoline-range petroleum hydrocarbons

Table 8-3
Residual Risks[a] Associated With Soil Cleanup Levels

Chemical	Sites 101, 101-A, and 110		Site 103	
	Excess Cancer Risk at Cleanup Level[b]	Hazard Index at Cleanup Level	Excess Cancer Risk at Remediation Level	Hazard Index at Remediation Level
Antimony	N/C	1	N/C	1
Arsenic	0	0.14	8.7E-06	0.28
Beryllium	0	0.004	8.4E-06	0.006
Lead	N/C	N/C	N/C	N/C
cPAHs	1E-06	N/C	1E-05	N/C
PCBs	1E-06	N/C	1E-05	N/C

[a]Risks are calculated by using MTCA risk equations and parameters specified in WAC 173-340-740 (3) and (-4), and using soil cleanup levels/remediation levels as the exposure point concentration.
[b]Excess cancer risks for arsenic and beryllium are calculated by subtracting the natural background concentrations of arsenic and beryllium from the soil cleanup levels.

Notes:
cPAHs - carcinogenic polycyclic aromatic hydrocarbons
PCBs - polychlorinated biphenyls
N/C - not calculated

Table 8-4
Chemical-Specific ARARs for Groundwater—Sites 101, 101-A, and 103

Chemical	Background Concentration (µg/L)[a]	Chemical-Specific ARARs (µg/L)				Selected Cleanup Level (µg/L)
		Washington Marine WQS[b]	Federal Marine WQC[b]	MTCA Method B (Surface Water)[c]	Federal NTR[c]	
Arsenic (total)	3.3	36[d]	36[d]	0.0982	0.14	3.3
Beryllium (total)[e]	NA	NA	NA	0.0793	NA	0.0793
Copper (dissolved)[e]	58	2.5[f]	2.9[f]	2,660	NA	58
Cyanide[e]	0	1[f]	1[f]	51,900	220,000	1
Lead (dissolved)[e]	6	5.8[d]	8.5[d]	NA	NA	6
Mercury (total)	NA	0.025[d]	0.025[d]	NA	0.15	0.025
Nickel (dissolved)	NA	7.9[d]	8.3[d]	1,100	4,600	7.9
Silver (dissolved)	NA	1.2[f]	2.3[f]	25,900	NA	1.2
Thallium (total)[e]	NA	NA	NA	1.56	6.3	1.56
Zinc (dissolved)[e]	104	76.6[d]	86[d]	16,500	NA	104
Benzene	0	NA	NA	43	71	43
Chlordane[e]	0	0.004[d]	0.004[d]	0.000354	0.0022	0.0022
1,1-Dichloroethene	0	NA	NA	1.93	3.2	1.93
TPH[e]	0	NA	NA	1,000[g]	NA	1,000
Trichloroethene	0	NA	NA	55.6	81	55.6
Vinyl chloride	0	NA	NA	2.92	525	2.92

[a]Background concentrations are being redetermined as a component of the monitoring program.
[b]Based on protection of aquatic life.
[c]MTCA Method B groundwater cleanup level and National Toxics Rule (NTR) values are based on protection of human health from human consumption of organisms from adjacent surface water.
[d]Based on chronic exposure.
[e]These chemicals were found in inland groundwater but not at the seeps and outfalls, which are the conditional point of compliance.
[f]Based on acute exposure.
[g]MTCA Method A groundwater cleanup level used.

Notes:
MTCA - Model Toxics Control Act
NA - no available value
TPH - total petroleum hydrocarbons
WQC - water quality criteria
WQS - water quality standard

Table 8-5
Chemical-Specific ARARs for Groundwater—Site 110

Chemical	Background Concentration (µg/L)[a]	Chemical-Specific ARARs: MTCA Method B Groundwater Cleanup Level (µg/L)	Federal MCL (µg/L)	State MCL (µg/L)	Selected Cleanup Level for Site 110 Groundwater (µg/L)
Arsenic	3.3	0.0583	50	50	3.3
Beryllium	NA	0.0793	4	NA	0.0793
Manganese	257	2,240	NA	NA	2,240
Nickel	NA	320	100	NA	100
Vanadium	24	112	NA	NA	112

[a]Background concentrations are being redetermined as a component of the monitoring program.

Notes:
ARARs - applicable or relevant and appropriate requirements
MCL - maximum contaminant level
MTCA - Model Toxics Control Act
NA - not applicable

9.0 DESCRIPTION OF ALTERNATIVES

The feasibility study assessed a range of alternatives for remediation of soil, groundwater, and marine tissue of OU 1. A separate set of alternatives was assembled to address groundwater contamination in the benzene release area. These alternatives did not appear in the FS, but were presented in a technical memorandum (U.S. Navy 1999b). Based on the results of the risk assessment and the RAOs discussed in Section 8, the remedial alternatives were developed to address potential risks at OU 1. The following sections provide a brief description of each alternative evaluated for soil, groundwater, marine tissue, and the benzene area, including the estimated capital cost and operation and maintenance (O&M) costs for implementation.

9.1 SOIL ALTERNATIVES

Four remedial alternatives were considered for soil at OU 1.

9.1.1 Soil Alternative 1—No Action

The no-action alternative was included in the range of alternatives evaluated in the feasibility study, as required by the NCP. Soil Alternative 1 includes no specific response actions to reduce contaminant concentrations 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.

Costs for Soil Alternative 1 are the following:

Capital cost:	$0
Total present value O&M costs:	$12,900
Total present worth:	$12,900

9.1.2 Soil Alternative 2—Institutional Controls and Shoreline Stabilization

Soil Alternative 2 includes measures to limit access to areas of surface soil exceedances; land use restrictions to ensure ongoing implementation of the access restrictions, maintain recreational land use at Site 103, and allow excavation of contaminated fill only under controlled conditions; shoreline stabilization measures; and periodic reviews. A description of the scope of these components follows.

Access Limitations

Signage on the periphery of the affected areas of surface soil exceedances would be provided and maintained to discourage access.

Shoreline Stabilization

Shoreline stabilization measures would be targeted to those areas where erosion of potentially contaminated fill is occurring. An estimated 2,700 feet of shoreline at Sites 101, 101-A, and 103 would be affected. Process options for this technology type include seawalls, vegetated shoreline protection, and removal of fill material to create new intertidal areas. Figure 9-1 presents the conceptual approaches for application of each of these stabilization process options along the OU 1 shoreline.

Shoreline stabilization would be designed to meet the following performance criteria, to the maximum extent practicable:

- Withstand a 25-year storm event
- Minimize human and ecological exposure to fill materials
- Provide for future site uses
- Protect the shoreline and intertidal area from erosion
- Provide slope for surface drainage
- Support vegetation
- Provide access for operation and maintenance
- Limit the amount of beach habitat encroachment
- Protect existing improvements at the site
- Protect and improve fishery habitat
- Offset any loss of productive habitat by expansion of existing onsite beaches

The shoreline stabilization would extend approximately 2,700 feet along the shoreline of Sites 101, 101-A, and 103 as shown in Figure 9-1. The precise configurations and locations would be determined in the remedial design. The following is a description of the conceptual approach for shoreline stabilization, starting at the southern end of the shoreline:

- Along approximately 750 feet of the southern portion of the shoreline, a vegetated low rock shelf would be installed to help control bluff erosion. The vegetated low rock shelf consists of a row of approximately 2,000- to 3,000-pound stones placed in a single row at approximately mean higher high water level. Salt-tolerant vegetation would be planted behind the stones and continuing into the upland area. The plantings would develop dense root masses that would be resistant to erosion. The conceptual design for the low rock shelf is based on a successful section of shoreline on the southern boundary of Elwood Point.

- Damaged portions of the existing concrete seawall would be repaired.

- From the north end of the seawall to the south corner of Elwood Point (a distance of approximately 600 feet), a combination of armor stone revetment and vegetated shoreline protection would be used. This approach would protect the existing sewer pumphouse and buried utilities within the bank, and would require minimal cutback of fill material along the shoreline. North of the pumphouse, vegetated areas would be installed above the stone revetment to control erosion. Along this segment of shoreline, a layer of gravel mix with appropriate particle sizes for habitat enhancement would be placed in intertidal areas.

- Along approximately 450 feet of shoreline on the south side of Elwood Point, fill removal and beach extension would be used. Removal of fill material to create new intertidal areas and beach areas would require removing existing bank and fill materials and regrading approximately 20 to 50 feet inland to match existing beach slopes. A layer of gravel mix with appropriate particle sizes for habitat enhancement would be placed in intertidal areas, and adjacent uplands would be revegetated. The newly created "pocket beach" formed by the fill removal actions would be designed to ensure continuity with the existing beach habitat and provide maximum habitat benefit for species such as surf smelt. The newly created intertidal areas would offset any filling of intertidal areas that may be required along other portions of the shoreline.

- Along approximately 350 feet of shoreline on the north side of Elwood Point, a vegetated low rock shelf would be installed to help control bluff erosion. The design of the vegetated low rock shelf would be generally as described for the southernmost segment of the shoreline. A layer of gravel mix with appropriate particle sizes for habitat enhancement would be placed in intertidal areas.

- Along approximately 600 feet of shoreline on the north side of Elwood Point, a rock seawall would be installed. In this area, the presence of the helipad prevents the regrading necessary to implement the other shoreline stabilization techniques. Protection of the helipad is critical to the mission of the hospital. A layer of gravel mix with appropriate particle sizes for habitat enhancement would be placed in intertidal areas.

- Along the entire shoreline and intertidal zone at JPHC/NHB, anthropogenic debris would be removed as a mitigation measure to offset any adverse habitat impacts with positive ones.

Excess material removed during grading would require disposal, at a Resource Conservation and Recovery Act (RCRA) Subtitle D (sanitary) landfill, or at a RCRA Subtitle C (hazardous waste) landfill. Chemical sampling and analysis of the excavated material would be conducted to determine disposal requirements.

Any live ordnance encountered during the remedial action would be handled and destroyed by Navy EOD. Any OEW encountered during the remedial action would be treated onsite in a thermal treatment unit to destroy any ordnance residue. The thermal treatment unit would be a propane-fueled, single burner ammunition and fireworks disposal unit. Treated OEW would be properly disposed of off site or recycled.

The design specifics of the shoreline stabilization would comply with the substantive requirements of the Washington Hydraulic Code (RCW 75.20.100-140 and WAC 220-110) and Clean Water Act Section 404. A State Hydraulic Project Approval permit would not be required, but the substantive requirements of WAC 220-110 would be applicable. The construction schedule for the shoreline protection system would observe "fish windows" set forth in WAC 220-110, during which time intertidal areas would not be disturbed. Implementation of the shoreline stabilization measures would require consultation with natural resource agencies to fulfill the requirements of the Endangered Species Act. Remedial design specifics may be modified as a result of this consultation.

Compared to the no-action alternative, shoreline stabilization is expected to improve the natural resource values (including recreation for humans and habitat for various marine, terrestrial, and avian species) of the upland, intertidal, and subtidal areas. The effect of implementing the shoreline stabilization measures was estimated to be a net gain in habitat within the intertidal area. Existing surf smelt spawning habitat may be improved in the fill removal/beach extension areas and vegetated shoreline areas and may be adversely affected in the portions of shoreline where a hard structure is needed. The specific locations and extent of the seawall portion of these measures is being developed as part of the remedial design. The intent of the remedial design will be to offset any adverse habitat impacts with positive ones.

A shoreline stabilization alternative with 100 percent fill removal and beach extension along the shoreline was not considered for several reasons. Upland structures such as the helipad and utility lines would have to be demolished and rebuilt further inland. Besides being infeasible, the costs of such actions would be substantial and disproportionate to any potential incremental benefits to habitat. Compared to the proposed shoreline stabilization measures, complete removal of the fill would not offer significantly greater long-term protection of human health or the environment with regard to chemicals of concern in the fill material. Finally, greater short-term risks to construction workers, the community, and the marine environment would be associated with the massive excavations that would be required to remove and dispose of all fill in shoreline areas.

The excavation and construction activities under this action may affect the cultural resources of Native American tribes. Although the presumed location of archaeological resources is outside the area of shoreline restoration, the extent of cultural resources is unknown because an archaeological survey has not been conducted at this site. Archaeological finds may affect the final design or delay implementation of this alternative.

Inspection and Maintenance

Annual inspection and maintenance of the shoreline stabilization measures would be required to ensure long-term effectiveness of this alternative. Activities that would disturb the shoreline would be restricted, and periodic visual inspections would be conducted and documented. Physical maintenance of the shoreline protection would be provided as needed. In some locations, beach material and vegetation may require periodic replacement after storm events. Therefore, a monitoring plan and contingency measures would be developed in the remedial design to ensure continued long-term protection of the intertidal and marine habitat. The effectiveness of the inspection and maintenance program would be reviewed and evaluated during the periodic reviews, discussed below.

Land Use Restrictions

Land use restrictions would be placed on the property by the Navy. Absent further cleanup, these restrictions would include:

- Preventing housing construction or residential land use at Site 103.

- Placing special controls on activities that may disturb areas of subsurface contamination (e.g., the former ordnance burn area at Site 103). The requirements may include health and safety plans, waste management plans, and environmental protection plans.

- Requirements for monitoring and maintaining the integrity of the shoreline stabilization measures.

The Navy would administer the land use restrictions, using base instructions, for as long as it owns the property. Future cleanup, if undertaken, could reduce the need for, or scope of, the land use restrictions.

Absent further cleanup, in the event of transfer of the property, it would be necessary to include deed or use restrictions. Deed restrictions cannot be placed on the property until transfer of the property. Upon such transfer, notification of the history of the site would be attached to any property transfer and the property transfer would have to meet the requirements of CERCLA Section 120(h).

Periodic Reviews

Because this alternative would result in some exceedances of state cleanup levels remaining in soils, a periodic review of the environmental data would be required no less frequently than every 5 years. The environmental data would be used by EPA, WDOE, and the Navy to ensure that the alternative remains protective of human health and the environment.

Estimated costs for Soil Alternative 2 are the following, assuming 5 years of operation and a 5 percent discount factor:

Capital cost:	$1,021,000
Total present value O&M costs:	$104,000
Total present worth:	$1,130,000

9.1.3 Soil Alternative 3—Soil Cover, Institutional Controls, and Shoreline Stabilization

Soil Alternative 3 includes installing and maintaining a vegetated soil cover in areas where concentrations of COCs in surface soil exceed remedial goals; limited excavation of surface soil in residential backyards where COCs are present; shoreline stabilization measures as described in Alternative 2; land use restrictions to maintain recreational land use at Site 103 and to allow excavation of contaminated fill only under controlled conditions; and periodic reviews. A description of the scope of these components follows.

Soil Cover

A vegetated soil cover would be installed over the identified areas where COCs in surface soils exceed the remedial goals. The soil cover would be a containment action to prevent dermal contact and ingestion of COCs. The results of the RI indicated that COCs in soil are not leaching to groundwater and were not found in marine tissue at levels that pose human health risks. Containment options, such as caps, that meet the requirements of RCRA or Washington State minimum functional standards (MFS), which are designed to prevent infiltration of precipitation, are therefore not warranted.

The soil covers would be required over portions of Sites 101, 103, and 101-A (Figures 9-2, 9-3, and 9-4, respectively) which represents a total area of approximately 280,000 square feet. The actual extent of the soil covers would be greater than the areas shown in Figures 9-2, 9-3, and 9-4 because of specific design considerations, discussed below.

The Navy is currently planning a shoreline recreation project at Sites 101 and 103. Under this alternative, much of the required soil cover would be provided by the grading activities already scoped as part of the shoreline recreation project. Also, to provide proper drainage and to match grades, the soil cover at Site 103 would extend inland to cover portions of Elwood Point where surface soils are not contaminated. Therefore, as a result of coordinated design of the shoreline recreation project and the CERCLA remedial action, the installed soil cover would extend over most of Sites 101 and 103. Figure 9-5 shows the extent of the soil covers that would be provided by the shoreline recreation project and the remedial action under Alternative 3. The costs for this alternative include the portions of the soil cover outside the areas covered by the shoreline recreation project.

The soil covers would consist of a compacted layer of clean fill, overlain by a compacted layer of topsoil. Installation of the soil cover is expected to involve construction of recreation facilities (e.g., a baseball field and running track). For the portion of the soil cover included in the costs for this alternative (i.e., all areas outside the limits of the recreation project), approximately 10,000 cubic yards of fill and 5,000 cubic yards of topsoil would be required. The soil covers would be vegetated with grass and landscaping. The final design may include additional features designed for recreational purposes, such as paved pathways.

Soil Excavation in Backyard Areas

Results from one RI sampling station at Site 101 (USS-2) indicate that arsenic and cPAHs may be present in a limited area of residential backyards. Additional soil sampling in residential areas throughout Site 110 was conducted as part of the SI. A total of 137 soil samples were collected in locations near former NAD structures. The results of the SI sampling, combined with the RI sampling and results of removal actions, indicate that the remaining exceedance at USS-2 is an isolated occurrence. To address the area around USS-2, removal of the affected soil is preferred over a soil cover for two reasons. First, a soil cover may disturb drainage patterns. Second, because this area is residential, there is a greater chance that a soil cover could be disturbed by residential activities.

The affected backyard area(s) would be excavated to a maximum 2-foot depth to remove the contaminated soil, backfilled with clean fill, and revegetated (Figures 9-2 and 9-5). For cost estimating purposes, the volume of soil requiring excavation was conservatively estimated at 2,600 cubic yards (the actual volume may be considerably less). The remedial design would include a sampling program to characterize the exact extent of soils exceeding the cleanup levels.

Following excavation, confirmation sampling would be conducted to verify that all contaminated soils exceeding remedial goals are removed. Appropriate statistical methods would be used to determine the number of confirmation samples required. The actual number of samples would vary with field conditions.

The existing chemical information indicates that excavated soils would not be classified as dangerous wastes under Chapter 173-303 WAC and may be disposed of in a RCRA Subtitle D sanitary landfill. However, representative samples of excavated material would be collected and analyzed to designate and characterize the waste for disposal. Transportation would be overland by truck or rail. Transportation and disposal costs are estimated based on disposal at a local sanitary landfill.

Shoreline Stabilization

These actions would be implemented as described in Soil Alternative 2.

Inspection and Maintenance

Annual inspection and maintenance of the shoreline stabilization measures, soil cover, and associated features (such as paved pathways) would be required to ensure long-term effectiveness of this alternative. Activities that would disturb the cover would be restricted, and periodic visual inspections would be conducted and documented. Physical maintenance of the cover would be provided as needed. The effectiveness of the inspection and maintenance program would be reviewed and evaluated during the periodic reviews, discussed below.

Land Use Restrictions, Periodic Reviews

These components would be implemented as generally described in Soil Alternative 2. Under Soil Alternative 3, the land use restrictions would also require continued maintenance of the soil cover.

Estimated costs for Soil Alternative 3 are the following, assuming 5 years of operation and a 5 percent discount factor:

Capital cost:	$1,450,000
Total present value O&M costs:	$120,000
Total present worth:	$1,570,000

9.1.4 Soil Alternative 4—Removal and Disposal, Institutional Controls, Shoreline Stabilization

Soil Alternative 4 includes excavating and disposing of surface and subsurface soils that exceed remedial goals; and shoreline stabilization, land use restrictions, and periodic reviews as described in Soil Alternative 3. A description of the scope of these components follows.

Soil Excavation and Disposal

Surface soils in the areas designated in Figures 9-2, 9-3, and 9-4 would be removed to a minimum depth of 1 foot. Subsurface soils in the former ordnance burn area would be removed to a depth of approximately 10 feet. The total volume of excavated soils is estimated at approximately 19,000 cubic yards.

Sediment control measures, including sediment fencing or temporary cofferdams, would be employed near shoreline areas. The excavations would be backfilled and compacted with clean soil, and the site would be graded to original contours and revegetated.

Following excavation, confirmation sampling would be conducted to verify that all contaminated soils exceeding remedial goals are removed. Appropriate statistical methods would be used to determine the number of confirmation samples required. The actual number of samples would vary with field conditions.

The existing chemical information indicates that excavated soils would not be classified as dangerous wastes under Chapter 173-303 WAC and may be disposed of in a RCRA Subtitle D sanitary landfill. However, representative samples of excavated material would be collected and analyzed to designate and characterize the waste for disposal. Transportation would be overland by truck or rail. Transportation and disposal costs are estimated based on disposal at a local sanitary landfill.

Shoreline Stabilization, Land Use Restrictions, and Periodic Reviews

These would be implemented as described in Soil Alternative 2.

Estimated costs for Soil Alternative 4 are the following, assuming 5 years of operation and a 5 percent discount factor:

Capital cost:	$3,030,000
Total present value O&M costs:	$99,000
Total present worth:	$3,130,000

9.2 GROUNDWATER ALTERNATIVES

The RAOs for groundwater at OU 1 are based on protecting human health and the marine environment, by ensuring that water quality standards for marine waters are met at the point where groundwater discharges to surface water. The conditional point of compliance for attaining the groundwater remedial goals is in the intertidal zone, where groundwater discharges to marine water in a series of seeps and outfalls.

The results of the RI indicate that the inorganics arsenic, mercury, nickel, and silver each exceeded surface water cleanup levels at one or more locations. It is suspected that the arsenic concentrations are attributable to background. Mercury, nickel, and silver had very low frequencies of detection, and the detections were not reproducible. Mercury, nickel, and silver may also be attributable to background. To eliminate the uncertainty associated with groundwater background, the Navy is currently redetermining background concentrations by installing and sampling new background wells. The results of the new background data will be used to verify the conclusions drawn in the feasibility study and to ensure protectiveness of the final remedial action. These results will be available before the 5-year review. Based on the available information, actions under each of the groundwater alternatives to address the inorganics are limited to monitoring.

Four remedial alternatives have been considered for groundwater at OU 1.

9.2.1 Groundwater Alternative 1—No Action

The no-action alternative was included in the range of alternatives evaluated in the feasibility study, as required by the NCP. Groundwater 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.

Costs for Groundwater Alternative 1 are the following:

Capital cost:	$0
Total value O&M costs:	$4,300
Total present value:	$4,300

9.2.2 Groundwater Alternative 2—Institutional Controls and Monitoring

Groundwater Alternative 2 includes land use restrictions to prevent installation of drinking water wells; monitoring at seeps and outfalls; and periodic reviews. A description of the scope of these components follows.

Land Use Restrictions

Permanent land use restrictions would be placed on the property by the Navy. These restrictions would prevent the installation of drinking water wells at OU 1. Absent further cleanup, in the event of transfer of the property, it would be necessary to include deed or land use restrictions. Deed restrictions cannot be placed on the property until transfer of the property. Upon such transfer, notification of the history of the site would be attached to any property transfer and the property transfer would have to meet the requirements of CERCLA Section 120(h).

Seep/Outfall Monitoring and Groundwater Sampling

In the first year, up to 10 seep/outfall samples would be collected semiannually from seeps in the intertidal zone, at the point of discharge of groundwater to surface water. Samples would be analyzed for total and dissolved inorganics, benzene, 1,1-dichloroethene, trichloroethene, vinyl chloride, chlordane, and petroleum hydrocarbons to determine compliance with remedial goals. Upon review of the first year results, the number of samples could be adjusted in subsequent years. The monitoring program would also include collecting a total of 20 background groundwater samples for establishing groundwater background concentrations. The groundwater background concentrations would be statistically calculated prior to the first 5-year review. Additionally, two rounds of groundwater sampling would be conducted at the four existing monitoring wells at Site 110. The Site 110 groundwater samples would be analyzed for total and dissolved inorganics. If the results indicated that inorganics are present at concentrations below cleanup levels or background concentrations, then the scope of the land use restrictions would be modified to remove the restriction on installation of drinking water wells at Site 110. This determination would be made at the time of the 5-year review.

Periodic Reviews

Because this alternative would result in some exceedances of state cleanup levels for contaminants remaining in groundwater, a periodic review of the environmental data would be required no less frequently than every 5 years. The environmental data will be used by EPA, WDOE, and the Navy to ensure that the alternative remains protective of human health and the environment.

Estimated costs for Groundwater Alternative 2 are the following, assuming 5 years of operation and a 5 percent discount factor:

Capital cost:	$16,200
Total present value O&M costs:	$265,000
Total present worth:	$281,000

9.2.3 Groundwater Alternative 3—Source Removal, Institutional Controls, and Monitoring

Groundwater Alternative 3 includes exploration and physical removal/disposal of subsurface piping, tanks, or soils that may be acting as sources of chlorinated VOCs near the former ordnance burn area at Site 103; land use restrictions to prevent installation of drinking water wells; monitoring of seeps and outfalls; and periodic reviews. A description of the scope of these components follows.

Exploration and Removal of Sources

Three VOCs (1,1-dichloroethene, trichloroethene, and vinyl chloride) exceeded remedial goals in seeps and outfalls along the north shoreline of Site 103. The locations of the exceedances were SEEP-4, SP-704, OUT-15, and OUT-16 (Figure 9-6). No VOCs exceeded ARARs in inland monitoring wells, and therefore no source has been defined. OUT-15 is an outfall for an active stormwater drainage system. OUT-16 may represent a drain pipe from former facilities at Site 103.

Exploration could include one or more general approaches. Camera surveys of outfall pipes in the intertidal zone could be conducted to attempt to trace the pipes inland. This effort may be able to identify a feature (such as a tank) that may be acting as a source of contamination. The identified feature, along with associated contaminated soil, would then be excavated and disposed of. While this procedure would be relatively straightforward, a crushed pipe could prevent the probe from advancing. Further, the survey could identify a feature, such as a tank, that is not the true source of contamination. Geophysical investigation methods such as ground-penetrating radar (GPR) could be used to attempt to trace outfall pipes and identify subsurface features. Because fill material is in the area, it is likely that a very large number of anomalies would be identified and that the results of the GPR survey would be inconclusive. Finally, outfalls could be directly excavated starting in the intertidal zone where their location is known and proceeding inland. The actual exploration method(s) used under this alternative would be defined in the remedial design.

If the exploration reveals a source of VOC contamination, the source would be removed if practicable. However, it may not be possible to identify or remove sources that may exist beneath the helipad.

Transport and Disposal

Excavated material would be sampled for characterization. Excavated material that exceeded the remedial goals would be transported, and disposed of off site. The general procedures used for sampling, transport, and disposal would be as described in Soil Alternative 4.

Land Use Restrictions, Seep/Outfall Monitoring, Groundwater Sampling, and Periodic Reviews

These components would be implemented as described in Groundwater Alternative 2.

The effectiveness of the source removal is dependent on the successful identification and removal of sources of groundwater contamination. If no sources are found, this alternative would have no effect on groundwater or seep/outfall quality.

Costs for this alternative are highly uncertain, due to uncertainties in the types of exploration methods that would actually be used, as well as the quantities and types of material that would be excavated and disposed of. These costs should be considered an order of magnitude estimate and may lie outside the -30 percent to +50 percent margin of error typically used in feasibility study cost estimates.

Estimated costs for Groundwater Alternative 3 are the following, assuming 5 years of operation and a 5 percent discount factor:

Capital cost:	$178,000
Total value O&M costs:	$265,000
Total present worth:	$443,000

9.2.4 Groundwater Alternative 4—Physical Containment, Institutional Controls, and Monitoring

Groundwater Alternative 4 includes installing a groundwater barrier (slurry wall) encircling approximately 1.4 acres near the former ordnance burn area; installing a low-permeability cover to prevent infiltration of rainwater; land use restrictions to prevent installation of drinking water wells; monitoring seeps and outfalls; and periodic reviews. A description of the scope of these components follows.

Slurry Wall Construction

A slurry wall would be constructed encircling the approximate area shown in Figure 9-6. The purpose of the slurry wall is to prevent groundwater movement through the area suspected of containing the source of the VOCs found in seeps and outfalls at Site 103. The slurry wall would extend approximately 40 feet below ground surface and would be keyed into the till unit to prevent any flow of groundwater through the suspected source area. (Note that the depth to the aquitard is estimated, because no boreholes in the immediate vicinity of this area were completed to the depth of the till unit.) The approximate area encircled by the slurry wall is 200 feet by 600 feet. The slurry wall would be oriented around the helipad to avoid interfering with the helipad. Assuming a depth of 40 feet, this would require approximately 72,000 square feet of slurry wall. The stormwater drainage line that runs through the containment area would have to be rerouted or reconstructed to allow penetration of the slurry wall while maintaining the function of the containment area.

Two general types of slurry walls are commonly used: soil-bentonite and cement-bentonite. Soil-bentonite walls are the most applicable for hazardous waste site remediation because their cost and permeability are lower and high compressive strength is not required. A treatability test would be required to determine the proper composition for the soil-bentonite slurry mix and the suitability of using the native soils in the slurry mix.

Slurry wall construction would occur with readily available construction equipment. Typically, a backhoe is used for trench excavations up to 50 feet deep. Slurry preparation would require hydration ponds, screens or hydrocyclones, a batch mixer, and bulldozers and dump trucks to move materials. Sufficient space is available at Site 103 to accommodate this type of action, although use of the helipad and existing recreational facilities would be affected. Pumps and hoses would be used to place the prepared slurry in the trench. Any excavated trench spoils that are not incorporated into the soil-bentonite slurry mix would be either consolidated under the cap or characterized and properly disposed of off site. The cost estimate assumes that 1,000 tons of trench spoils would require off-site disposal. Transport and disposal of this excess material would be conducted as described under Soil Alternative 4.

Any live ordnance encountered during the remedial action would be handled and destroyed by Navy EOD. Any OEW encountered during the remedial action would be treated onsite in a thermal treatment unit to destroy any ordnance residue. The thermal treatment unit would be a propane-fueled, single burner ammunition and fireworks disposal unit. Treated OEW would be properly disposed of off site or recycled.

The excavation and construction activities under this action may affect the cultural resources of Native American tribes. The extent of cultural resources is unknown because an archaeological survey has not been conducted at this site. Archaeological finds may affect the final design or delay implementation of this alternative.

Cap Construction

An impermeable cover would be constructed over the suspected source area to prevent percolation of rainwater and prevent the water level from rising within the area enclosed by the slurry wall. Assuming dimensions of 200 by 600 feet, the cap would cover approximately 2.8 acres. To the extent practicable, the cap would be designed to conform to the minimum functional standards (MFS) requirements set forth in Chapter 173-304 WAC. An MFS cap is the standard cap required for the closure of solid waste landfills. The proposed design of the MFS cap would be as follows:

1. The surface would be regraded to facilitate drainage. An aggregate leveling base averaging 6 inches thick would be placed on top of the regraded surface.

2. A geosynthetic clay liner would be installed on the top surface of the aggregate leveling base.

3. An impermeable flexible membrane layer composed of a 60-mil, high-density polyethylene sheet would be installed on top of the geosynthetic clay liner.

4. A synthetic drainage layer (a net-like product of two overlapping polyethylene strands covered with a geotextile fabric on both sides) would be placed on top of the flexible membrane layer.

5. The top layer would consist of a 2-foot-thick soil layer conducive to sustaining vegetative growth. The top of the vegetative soil layer would be fertilized and seeded.

Due to the uncertainty in the location and extent of the suspected source area, the actual dimensions of the slurry wall and cap could vary considerably. Despite this uncertainty, it is reasonable to assume that the cap and slurry wall will interfere with existing facilities, most notably the helipad and running track (see Figure 9-6). Because the helipad is essential to the operation of the hospital, all construction would have to allow continuous use of the helipad. It is assumed that the cap would tie into the edge of the helipad. Thus, the helipad would function as a portion of the cap, and the cap would not fully conform to MFS design criteria. Additional costs are also assumed for reconstruction of the running track. It is also probable that the segment of slurry wall and cap adjacent to the shoreline would interfere with the vegetated shoreline stabilization measures considered under Soil Alternatives 2, 3, and 4. Therefore, if Soil Alternatives 2, 3, or 4 were implemented in conjunction with this groundwater alternative, shoreline protection along the slurry wall may necessarily be a riprap seawall, which may worsen erosion elsewhere along the shoreline.

Institutional Controls, Seep/Outfall Monitoring, Groundwater Sampling, and Periodic Reviews

These components would be implemented as described in Groundwater Alternative 3.

The effectiveness of this containment alternative is uncertain. If the actual source of the VOCs is not within the containment area, this alternative would be completely ineffective.

Given the uncertainty in the required dimensions of the slurry wall and cap, costs for this alternative should be considered an order of magnitude estimate and may lie outside the -30 to +50 percent margin of error typically used in feasibility study cost estimates. Estimated costs for Groundwater Alternative 4 are the following, assuming 5 years of operation and a 5 percent discount factor:

Capital cost:	$1,940,000
Total present value O&M costs:	$342,000
Total present worth:	$2,280,000

9.3 MARINE TISSUE ALTERNATIVES

The following subsections describe the marine tissue alternatives, which are designed to reduce human health risks associated with ingestion of marine tissue (clams and crabs). Marine sediments, and ecological risks associated with the sediments, will be addressed in the ROD for OU 2.

9.3.1 Alternative 1—No Action

The no-action alternative was included in the range of alternatives evaluated in the feasibility study, as required by the NCP. Marine Tissue 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 baseline from which to judge the performance and cost of other action-oriented alternatives.

Costs for Marine Tissue Alternative 1 are the following:

Capital cost:	$0
Total present value O&M costs:	$4,300
Total present worth:	$4,300

9.3.2 Marine Tissue Alternative 2—Institutional Controls and Monitoring

Marine Tissue Alternative 2 includes marine tissue monitoring; potential restrictions on shellfish harvesting; and periodic reviews. A description of the scope of these components follows.

Marine Tissue Monitoring

Up to 16 shellfish tissue samples would be collected biannually from Ostrich Bay and analyzed for antimony, arsenic, vanadium, 3,3-dichlorobenzidine, pentachlorophenol, and ordnance compounds. Additionally, background concentrations of antimony, arsenic, and vanadium in shellfish tissue would be established, through either sample collection at off-site locations or review of information from other sources. The results of the shellfish sampling would be used to determine when the shellfish are safe to eat. Two rounds of sampling would be conducted prior to the 5-year review. After the 5-year review, the specific numbers and types of samples, sampling frequency, and analytical methods could be adjusted in subsequent years.

Potential Restrictions on Shellfish Harvesting

The Navy, with concurrence from EPA, WDOE, and the Washington State Department of Health, and with input from the community, would decide when shellfish on JPHC/NHB beaches can be harvested and the purpose of those harvests, e.g., subsistence, recreational, commercial, or ceremonial gathering. Signs would be posted along the shoreline to notify Jackson Park Housing Complex residents of any of harvest restrictions.

Periodic Reviews

This alternative may result in potential human health risks associated with shellfish harvesting. Although these risks would be controlled, a periodic review of the environmental data would be required no less frequently than every 5 years.

Estimated costs for Marine Tissue Alternative 2 are the following, assuming 5 years of operation and a 5 percent discount factor:

Capital cost:	$18,600
Total present value O&M costs:	$356,000
Total present worth:	$375,000

9.3.3 Marine Tissue Alternative 3—Piling Removal, Institutional Controls, and Monitoring

Marine Tissue Alternative 3 includes removal of pilings in Ostrich Bay; marine tissue monitoring; potential restrictions on shellfish harvesting; and periodic reviews. A description of the scope of these components follows.

Removal of Pilings in Ostrich Bay

Approximately 450 wooden pilings from abandoned piers or other Navy structures are present in Ostrich Bay. It is suspected that wood preservatives on these pilings may be the source of the chemical detections of PCP in marine tissue. Under this alternative, all of the wooden pilings and the fishing pier at Site 103 would be removed and properly disposed of.

Several methods are available for piling removal, including vibratory extraction, hydraulic/pneumatic chainsaw cutting, and clamshell dredging. Vibratory extraction involves mechanically vibrating the piling to loosen the pressure of sediment, and then directly pulling the entire piling. Vibratory extraction minimizes disturbance of sediments, although some pilings may break at the mudline, leaving stubs in the sediment. Chainsaw cutting typically involves excavating around the piling to a depth of about 2 feet, and then completing the cut below the mudline. Chainsaw cutting involves greater risks to workers, causes greater sediment disturbance, and leaves piling stubs in place that can continue to act as sources of contamination. Clamshell dredging can be used to mechanically dig out piling stubs left by vibratory extraction or chain saw cutting. However, large amounts of potentially contaminated sediments can be resuspended when a clamshell is used (WDOE 1995b).

Vibratory extraction is considered the preferred method at JPHC/NHB, because it can remove the entire piling while minimizing disturbance of sediments. Because the entire piling would be removed, vibratory excavation would have greater disposal costs compared to cutting the piling at the mudline. Regulatory agencies have expressed a preference for removing pilings and stubs completely (WDOE 1995b).

It is estimated that a substantial percentage (estimated at 1 to 10 percent) of the pilings will break at the mudline using vibratory extraction. Clamshell dredging could be used to remove these remaining piling stubs; however, it is possible that the resulting resuspension of potentially contaminated subsurface sediments would cause more environmental harm than leaving the stubs in place. Also, it is anticipated that no future construction, such as navigational dredging, would occur to disturb remaining piling stubs. Therefore, it is assumed that any broken pilings would be cut off 6 to 12 inches above the mudline, and the stubs left in place. The presence of the remaining stubs would be recorded with the Office of the Commissioner of Public Lands.

Disposal of the extracted pilings would be conducted in accordance with Washington State dangerous waste regulations, which provide a specific exemption for treated wood waste (WAC 173-303-071[3][g]). The regulations state that the pilings may be disposed of as solid waste, provided that the wood does not fail toxicity characteristics leaching procedure testing. Following such testing, the wood pilings would be transported and disposed of in a nearby permitted sanitary landfill.

Implementation of the piling removal activities would require consultation with natural resource agencies to fulfill the requirements of the Endangered Species Act. Remedial design specifics may be modified as a result of this consultation.

The effectiveness of piling removal in reducing risks from shellfish consumption is uncertain. The organic COCs in shellfish tissue (PCP and 3,3′-dichlorobenzidine) were detected at a very low frequency, and thus there was a great deal of uncertainty associated with the risk estimates in the HHRA. The pilings are a suspected source of the PCP, although this has not been demonstrated. If this alternative is selected, marine tissue monitoring and potential shellfish harvest restrictions would still be necessary to ensure protection of human health.

Marine Tissue Monitoring, Potential Restrictions on Shellfish Harvesting, and Periodic Reviews

These components would be implemented as described in Marine Tissue Alternative 2.

Estimated costs for Marine Tissue Alternative 3 are the following, assuming 5 years of operation and a 5 percent discount factor:

Capital cost:	$259,000
Total present value O&M costs:	$356,000
Total present worth:	$615,000

9.4 BENZENE RELEASE AREA ALTERNATIVES

Five remedial alternatives have been considered for the benzene release area at OU 1.

9.4.1 Benzene Release Area Alternative 1—No Action

The no-action alternative was included in the range of alternatives as required by the NCP. Alternative 1 includes no specific response actions to reduce contaminant concentrations at the site, control their migration, or prevent exposures. The no-action alternative serves as a baseline from which to judge the performance and costs of other action-oriented alternatives.

Estimated costs for Benzene Release Area Alternative 1 are the following, assuming 5 years of operation and a 5 percent discount factor:

Capital cost:	$0
Total present value O&M costs:	$4,300
Total present worth:	$4,300

9.4.2 Benzene Release Area Alternative 2—Air Sparging With Soil Vapor Extraction

The objective of Benzene Release Area Alternative 2 is to treat petroleum-impacted groundwater in situ, before it discharges to the marine environment. Petroleum-impacted soil at the NEX gas station would not be actively treated. Benzene Release Area Alternative 2 includes groundwater treatment with air sparging and soil vapor extraction, natural attenuation of the source area, compliance monitoring, and periodic reviews. A description of the scope of these components follows.

In Situ Air Sparging with Soil Vapor Extraction

In situ air sparging (IAS) is designed to stimulate aerobic degradation of petroleum in groundwater, saturated soils, and vadose-zone soils. With this technology, air is injected below the groundwater surface at points within the groundwater contamination plume. The injected air flows upward through the saturated zone and into the vadose zone. Groundwater is treated in situ, without removing it from the subsurface. Contaminant removal is accomplished through two mechanisms: physical stripping of volatile contaminants from groundwater into the air stream, and oxygenation of the subsurface, which allows enhanced rates of aerobic degradation.

To prevent contaminant vapors from migrating through the subsurface, or accumulating in buildings or utility corridors, soil vapor extraction (SVE) would be used in conjunction with IAS. SVE enhances vapor movement in the subsurface towards extraction points, where the vapors are collected. The collected vapors may be discharged directly to the atmosphere, or offgas treatment may be required with such technologies as carbon adsorption, catalytic oxidation, or internal combustion engines.

IAS/SVE Configuration. IAS can be physically configured with multiple vertical wells, horizontal wells, constructed trenches, or funnel-and-gate arrangements. At the benzene release area, the site lithology, hydrology, and contaminant distribution constrain the potential configurations of this technology. Groundwater is present in saturated sands or fill that overlies till. The thickness of the saturated zone ranges from less than 1 foot to nearly 10 feet, and varies seasonally and with location. Standard (vertical well) IAS applications would have a small radius of influence given the thinness of the saturated zone. The depth of the source area soil contamination that is suspected to exist at the gas station is unknown, but the results from boring HC-4 indicate that the soil contamination may extend deep into the fairly impermeable till unit, where IAS and SVE are expected to be ineffective (U.S. EPA 1992c; Marley et al. 1996).

Given these constraints, the most promising configuration for IAS/SVE at the benzene release area is a treatment trench constructed downgradient of the gas station. The location of the trench would be determined in the remedial design; for cost estimating purposes it is assumed that a 150-foot-long trench would be constructed along the west shoulder of South Shore Road. The trench would be excavated to the required depth (approximately 18 feet), backfilled with permeable gravel, and capped with asphalt or clays to match the existing grade and provide a surface seal. Perforated PVC piping would be used for air injection and vapor extraction lines in the trench. The trench would be constructed perpendicular to groundwater flow to the extent possible, considering the locations of existing utilities.

Treatment System. Once the design air flow rates and contaminant concentrations in extracted vapors are established, the need for offgas treatment would be determined based on the requirements of WAC 173-460. Although it is possible that offgas treatment would not be required, this alternative assumes that the treatment plant would include carbon adsorption to remove petroleum constituents from the offgas. Once the system was operational, actual vapor concentrations of individual petroleum constituents would be measured, and the need for offgas treatment could be reevaluated.

The treatment plant would be located in a new prefabricated building installed adjacent to the sanitary sewer pump station. The treatment plant would include blowers for air injection and vapor extraction, a water knock-out drum, and a vapor-phase carbon adsorption unit to treat the offgas. An in-line electric heater would be used to lower the relative humidity of the air stream entering the adsorber units. To enhance mass transfer efficiencies, the system would operate in a pulsed mode, cycling on and off periodically. The vapor extraction blower would be sized to extract more air than is injected.

Natural Attenuation of Source Area

Under this alternative, additional risk reduction for petroleum constituents in the source area would occur through natural attenuation. For subsurface soils and groundwater, biodegradation, volatilization, adsorption, and dispersion are all expected to be significant natural attenuation mechanisms. Although natural attenuation mechanisms alone have not been sufficient to prevent petroleum constituents in the groundwater plume from discharging to marine water, they are expected to result in diminishing concentrations within the source area over time.

Compliance Monitoring

Compliance monitoring would be conducted to verify long-term protection of human health and to assess the natural attenuation of petroleum constituents in groundwater. The monitoring program would consist of groundwater sampling conducted in existing monitoring wells and seeps upgradient and downgradient of the treatment trench. It is assumed that an annual average of 20 samples would be collected. Because a petroleum source may remain in an upgradient area, the monitoring could be required for several decades under this alternative.

Periodic Reviews

Because this alternative would result in some exceedances of state cleanup levels for contaminants remaining in groundwater, a periodic review of the environmental data would be required no less frequently than every 5 years. The environmental data would be used by EPA, WDOE, and the Navy to ensure that the alternative remains protective of human health and the environment.

The institutional controls that are described in the soil and groundwater alternatives for OU 1 would effectively prevent human exposures to residual petroleum in soils and groundwater. These controls would be comprehensive for OU 1 and would address any residual contamination in the benzene release area. For this reason no additional institutional controls are included in this alternative.

Estimated costs for Benzene Release Area Alternative 2 are the following, assuming 30 years of operation and a 5 percent discount factor:

Capital cost:	$320,000
Total present value O&M costs:	$1,300,000
Total present worth:	$1,600,000

9.4.3 Benzene Release Area Alternative 3—Groundwater Collection and Treatment

The objective of Benzene Release Area Alternative 3 is to intercept, extract, and treat petroleum-impacted groundwater. Petroleum-impacted soil at the NEX gas station would not be actively treated. Benzene Release Area Alternative 3 includes groundwater extraction, treatment, and discharge; natural attenuation of the source area; compliance monitoring; and periodic reviews. A description of the scope of these components follows.

Groundwater Extraction, Treatment, and Discharge

The pump-and-treat approach is designed to eliminate contaminant migration; it can be thought of as a hydraulic containment action that needs to be operated over the long term. Extracted groundwater would be treated to acceptable levels prior to discharge; however, the actual mass of contaminant treated would be limited.

Extraction System. The groundwater extraction system would be designed to collect all petroleum-contaminated groundwater that is currently discharging to the marine environment. The rate of groundwater discharge is expected to vary seasonally. On average, an estimated 700 gallons per day of groundwater would be collected. Because the saturated zone above the till surface is thin (estimated to average 3 feet or less), conventional vertical extraction wells could experience complete drawdown and would be ineffective in containing the plume. Under this alternative, a 150-foot-long groundwater interception trench would be constructed along the west shoulder of South Shore Road. Trench depth would be approximately 18 feet. Two utility vaults would be installed in the trench to serve as sumps. Pumps installed in the vaults would extract the water and pump it through piping to the treatment plant. The piping would be installed below grade to avoid disruption of existing facilities and freezing. Groundwater modeling would be conducted in the remedial design to verify the extraction rates and trench placement required for plume capture.

Treatment System. Extracted groundwater would be treated by liquid-phase granular activated carbon (GAC), which can effectively remove hydrocarbons to nondetectable concentrations.

Based on the relatively low flow rates required and low concentrations of dissolved hydrocarbons (estimated average less than 2,000 μg/L), carbon usage is not anticipated to be high.

The treatment plant would be located in a new prefabricated building installed adjacent to the sanitary sewer pump station. The treatment plant would include an accumulation tank, a feed pump, bag filters to remove particulates, and carbon adsorption units.

Discharge system. Treated groundwater could feasibly be discharged directly to surface water, discharged to a storm sewer, reinjected into the aquifer, or sent to the sanitary sewer for additional treatment at a publicly-owned treatment works (POTW). This alternative assumes that treated water would be discharged to the sanitary sewer system. If this alternative were selected as the preferred alternative, discharge options would be reevaluated in the remedial design.

Natural Attenuation of Source Area, Compliance Monitoring, and Periodic Reviews

These actions would be implemented as described in Benzene Release Area Alternative 2. As with Benzene Release Area Alternative 2, the monitoring and reviews could be required for several decades.

The institutional controls that are described in the soil and groundwater alternatives for OU 1 would effectively prevent human exposure to residual petroleum in soils and groundwater. These controls would be comprehensive for OU 1 and would address any residual contamination in the benzene release area. For this reason no additional institutional controls are included in this alternative.

Estimated costs for Alternative 3 are the following, assuming 30 years of operation and a 5 percent discount factor:

Capital cost:	$300,000
Total present value O&M costs:	$1,300,000
Total present worth:	$1,600,000

9.4.4 Benzene Release Area Alternative 4—Enhanced Natural Attenuation with Oxygen-Releasing Chemicals

The objective of Benzene Release Area Alternative 4 is to provide in situ treatment of petroleum-impacted groundwater and source area soils in the NEX gas station. Benzene Release Area Alternative 4 includes soil and groundwater treatment with oxygen-releasing chemicals, compliance monitoring, and periodic reviews. A description of the scope of these components follows.

Soil and Groundwater Treatment

Under this alternative, nontoxic chemicals would be used to supply oxygen to the subsurface, to stimulate aerobic degradation of petroleum in groundwater, saturated soils, and capillary-zone soils. The oxygen-releasing chemicals used would be a formulation of magnesium peroxide (MgO_2). Magnesium peroxide releases molecular oxygen over a period of several months, as the peroxide reacts with water to form magnesium hydroxide and oxygen.

A proprietary formulation of magnesium peroxide, known as ORC, or an equivalent product, would be used. The effectiveness of ORC in treatment of petroleum in soil and groundwater was investigated and documented in peer-reviewed articles in the literature (e.g., MacKay 1994, Brown et al. 1996, Heitkamp 1997).

Several methods can be used to emplace the ORC. The product can be injected as a slurry using direct-push methods, conventional augered boreholes can be backfilled with the product, the product can be placed directly into an open excavation, or "socks" containing the product can be placed into monitoring wells. The strategy for applying the ORC depends on the project objectives. An "oxygen barrier" can be created to control the leading edge of a plume and attain remedial goals at a point of compliance; however, this approach alone would not address the ongoing source and would require long-term maintenance and monitoring. Emplacing a relatively large amount of ORC in the source area can effectively provide remediation for the source area, but would not immediately treat an existing downgradient plume.

For the benzene release area, it is assumed that the soil source area would be treated by injecting ORC slurry into several boreholes. The existing groundwater plume would be treated by creating an ORC oxygen barrier at the downgradient edge of the plume, with either slurry injection or the use of ORC socks in monitoring wells. Preliminary modeling using known and estimated site characteristics (plume dimensions and concentrations, hydraulic gradients, hydraulic conductivity, etc.) indicate that the quantity of ORC required would be on the order of 10,000 pounds.

ORC is best suited to treating groundwater and saturated (or seasonally saturated) soils. Limited excavation and disposal may be considered for petroleum-contaminated soils that exist beneath the fuel dispenser island and above the groundwater level. Thus, the final ORC design could include limited excavation and disposal, along with ORC treatment of remaining source area soils and the groundwater plume. The remedial design will evaluate whether any excavation and disposal is an appropriate component of this alternative.

Compliance Monitoring and Periodic Reviews

Compliance monitoring of groundwater would be conducted during the treatment timeframe of approximately 1 to 2 years, and for up to 1 year following completion of treatment. It is assumed that an annual average of 40 samples would be collected. It is anticipated that at the time of the first 5-year review for OU 1, the benzene release area would be declared remediated and would not require additional monitoring.

The institutional controls that are described in the soil and groundwater alternatives for OU 1 would effectively prevent human exposure to residual petroleum in soils and groundwater. These controls would be comprehensive for OU 1 and would address any residual contamination in the benzene release area. For this reason no additional institutional controls are included in this alternative.

Estimated costs for Benzene Release Area Alternative 4 are the following, assuming 5 years of operation and a 5 percent discount factor:

Capital cost:	$280,000
Total present value O&M costs:	$250,000
Total present worth:	$540,000

9.4.5 Benzene Release Area Alternative 5—Source Excavation

The objective of Benzene Release Area Alternative 5 is to remove and dispose of petroleum-impacted source-area soils at the NEX gas station. Benzene Release Area Alternative 5 includes soil excavation and disposal, compliance monitoring, and periodic reviews. A description of the scope of these components follows.

Soil Excavation and Disposal

This alternative involves the excavation and disposal of subsurface soils near the NEX gas station that contain petroleum at concentrations greater than MTCA Method B cleanup levels. The extent of the petroleum-contaminated subsurface soils has not yet been defined. For cost estimating purposes it is assumed that the contaminated area measures approximately 50 feet by

100 feet, resulting in approximately 2,000 in-place cubic yards of clean overburden and 2,000 in-place cubic yards of petroleum-contaminated soil requiring removal.

The contamination is anticipated to extend beneath the pump island. Leaving this contamination in place would likely result in groundwater that continues to exceed surface water criteria, and would defeat the purpose of this alternative. Therefore, it is assumed that the pump island would be demolished and reconstructed. A detailed engineering design and construction management plan would be required for the demolition and reconstruction of fuel lines, valve pits, water lines, gas lines, sewer lines, electrical lines, paved areas, and (potentially) roads. The gas station would have to be shut down for 1 to 3 months during construction. Three alternative gas stations are located within 5 miles of the NEX gas station.

Approximately 2,000 cubic yards of the petroleum-contaminated excavated soils would require off-site disposal at a nearby RCRA Subtitle D sanitary landfill or at an approved thermal treatment facility. This alternative assumes the soils would be treated at a thermal desorption facility. Transportation to the thermal treatment facility would be overland by truck.

Excavated soils that are clean overburden would be used for backfill. Clean soil (common fill) would be used to return the area to grade. Careful compaction and regrading of the disturbed areas would be required to ensure that settling does not damage reconstructed buildings, utilities, etc.

The general procedures for excavating, hauling, backfilling, and confirmation sampling would be as described for Soil Alternative 4.

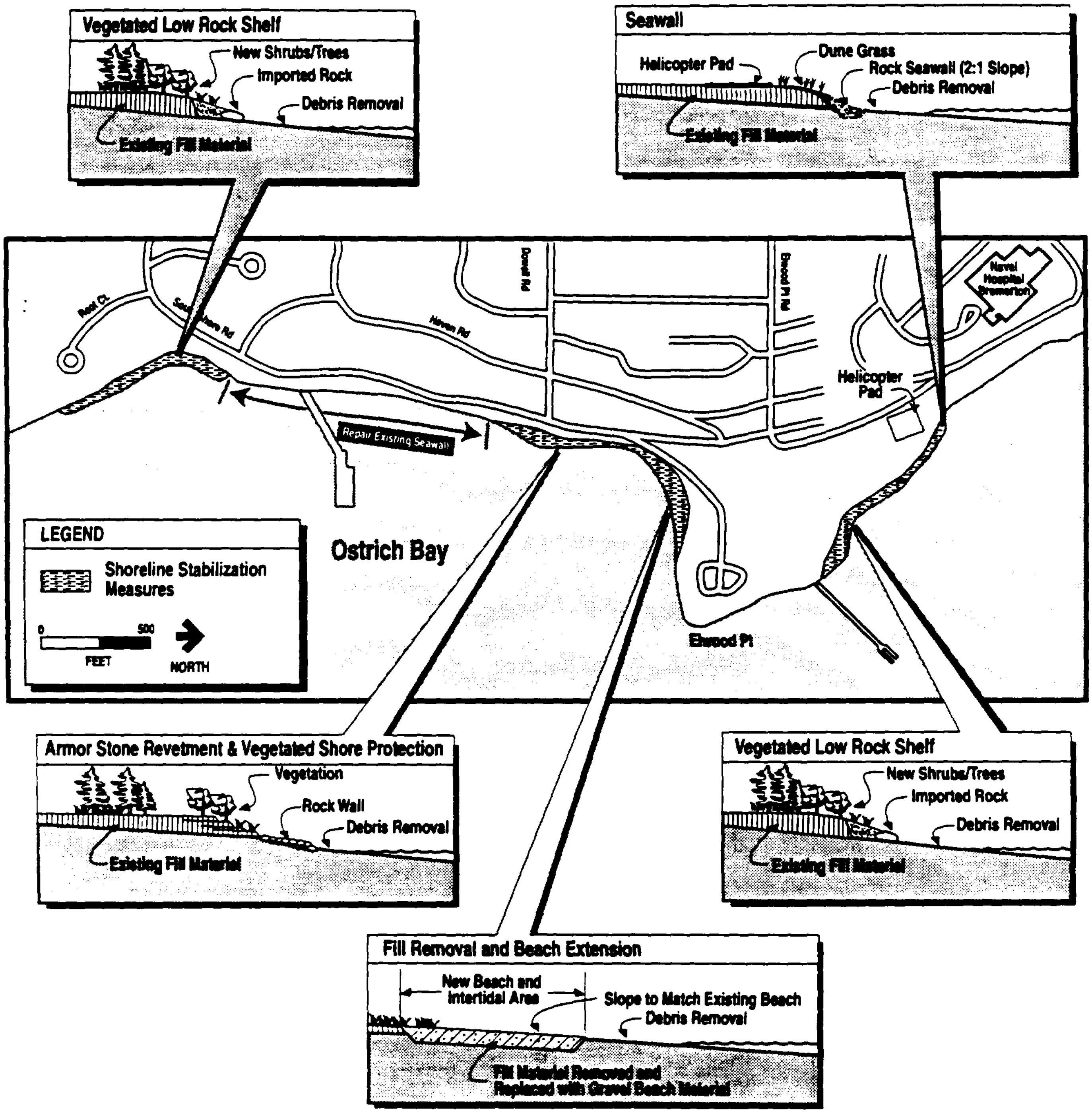
Compliance Monitoring and Periodic Reviews

Compliance monitoring of groundwater would be conducted for up to 2 years following completion of the soil removal. It is assumed that an annual average of 40 samples would be collected. If all source area soils were successfully removed, it is anticipated that at the time of the first 5-year review for OU 1, the benzene release area would be declared remediated and would not require additional monitoring.

The institutional controls that are described in the soil and groundwater alternatives for OU 1 would effectively prevent human exposures to residual petroleum in soils and groundwater. These controls would be comprehensive for OU 1 and would address any residual contamination in the benzene release area. For this reason no additional institutional controls are included in this alternative.

Estimated costs for Benzene Release Area Alternative 5 are the following, assuming 5 years of operation and a 5 percent discount factor:

Capital cost:	$760,000
Total present value O&M costs:	$170,000
Total present worth:	$930,000

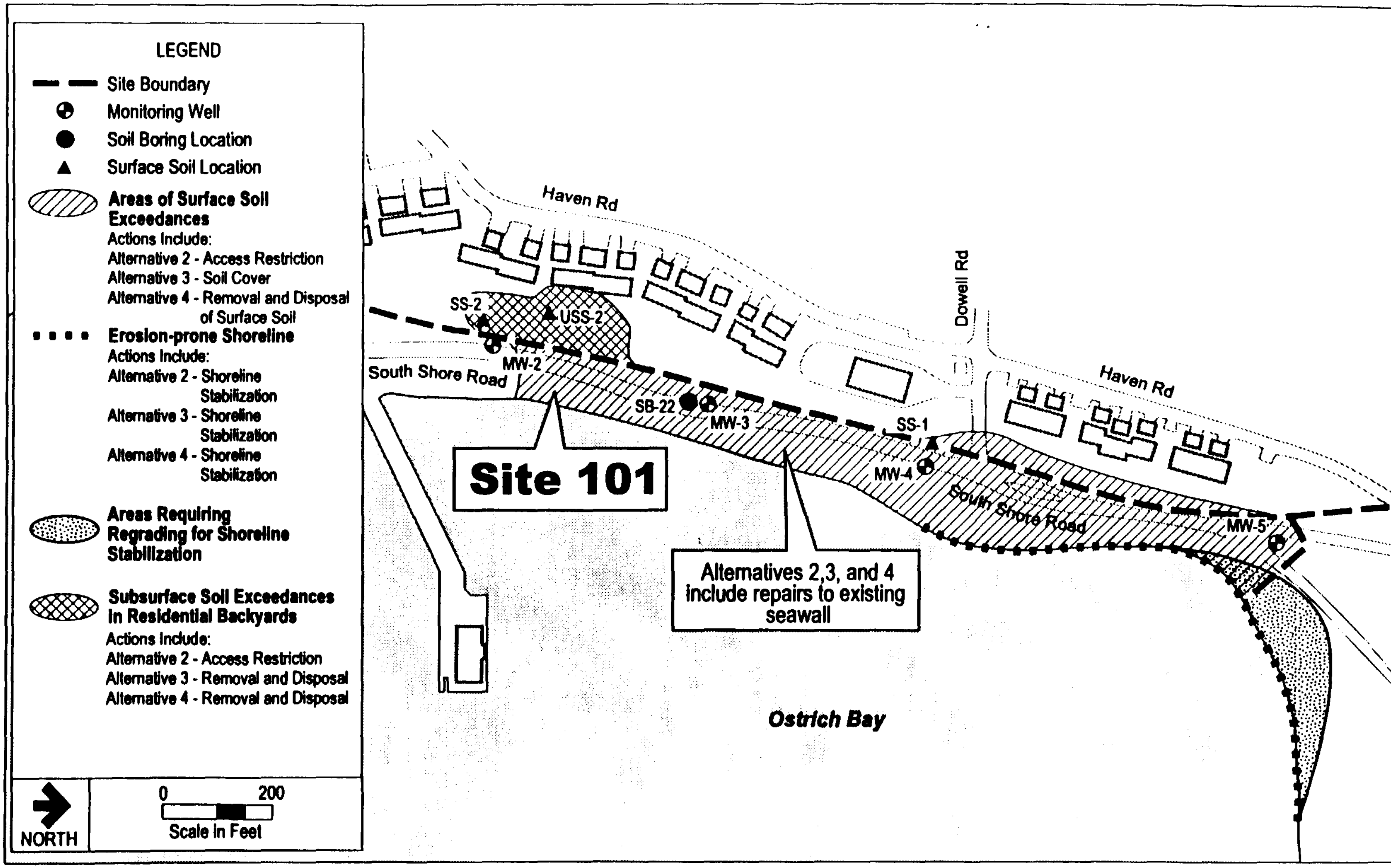


CLEAN
COMPREHENSIVE LONG-TERM ENVIRONMENTAL ACTION NAVY

Figure 9-1
Conceptual Approaches to Shoreline Stabilization

CTO 0031
JPHC/NHB
Bremerton, WA
OU 1 ROD

533031206-15-041200

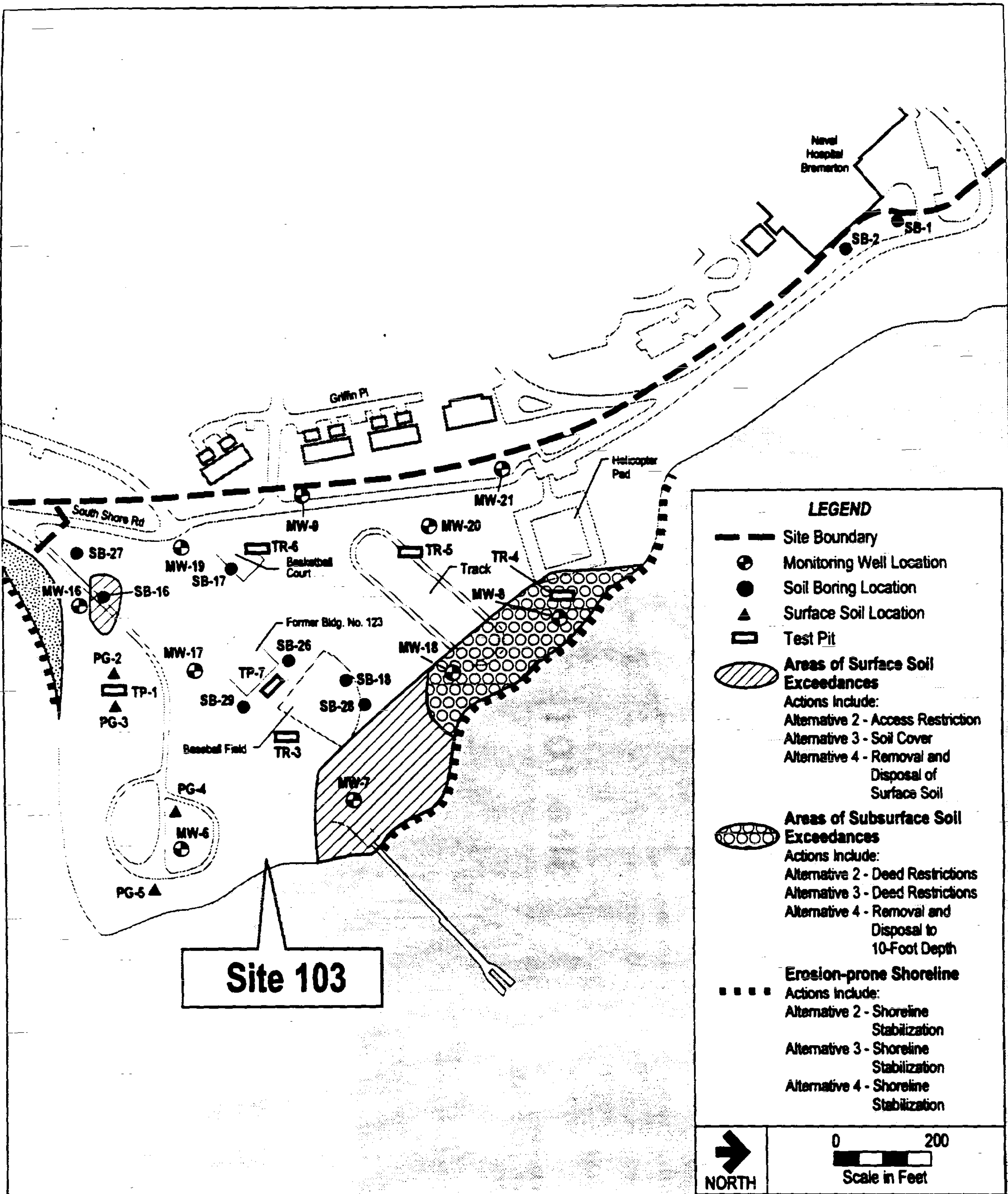


CLEAN
COMPREHENSIVE LONG-TERM ENVIRONMENTAL ACTION NAVY

Figure 9-2
Site 101 Soil Remedial Action Areas

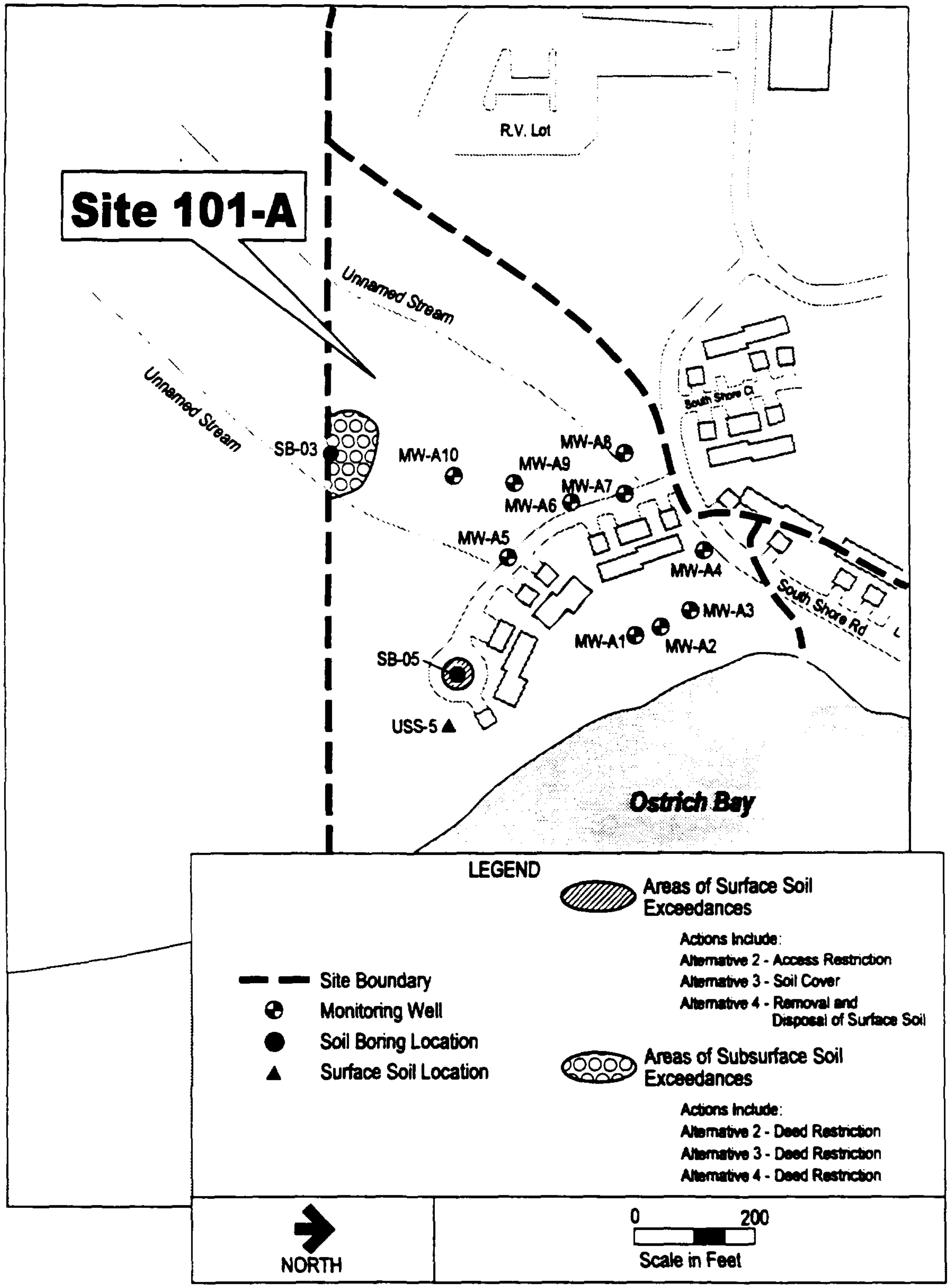
CTO 0031
JPHC/NHB
Bremerton, WA
OU 1 ROD

533031206-5c-120799



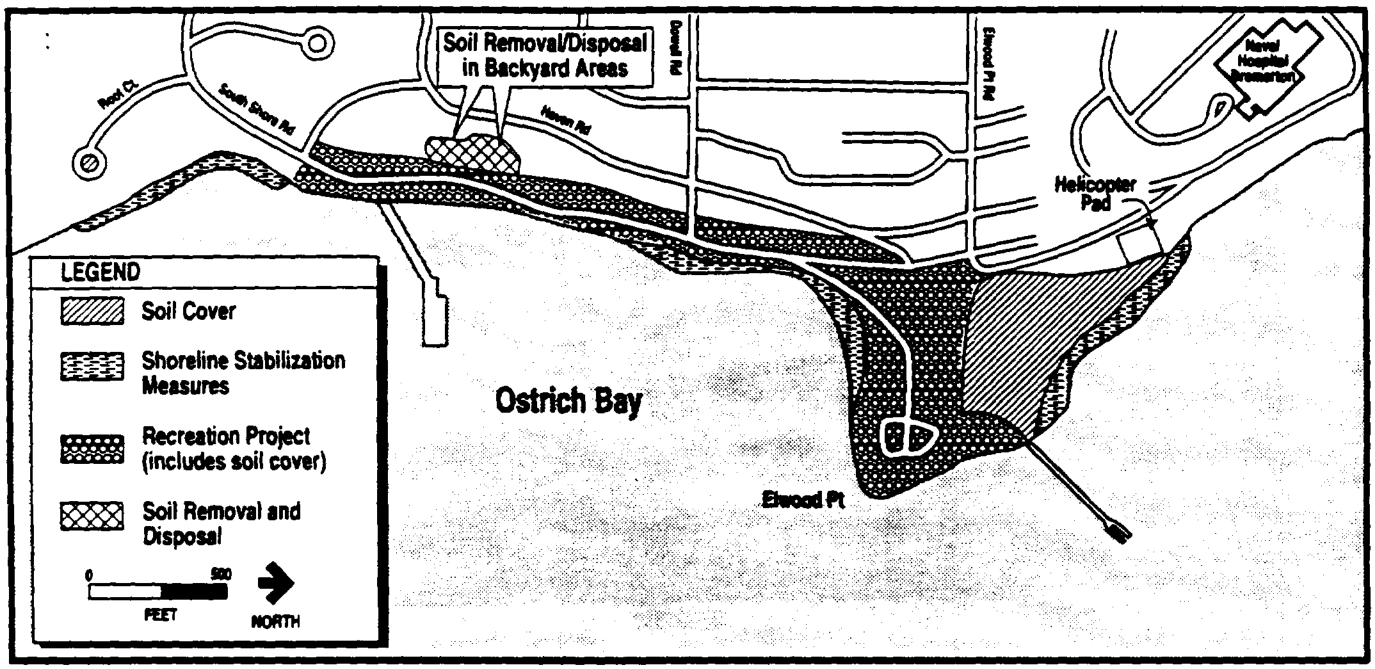
CLEAN COMPREHENSIVE LONG-TERM ENVIRONMENTAL ACTION NAVY	**Figure 9-3** **Site 103 Soil Remedial Action Areas**	CTO 0031 JPHC/NHB Bremerton, WA OU 1 ROD

533031206-32b-041200

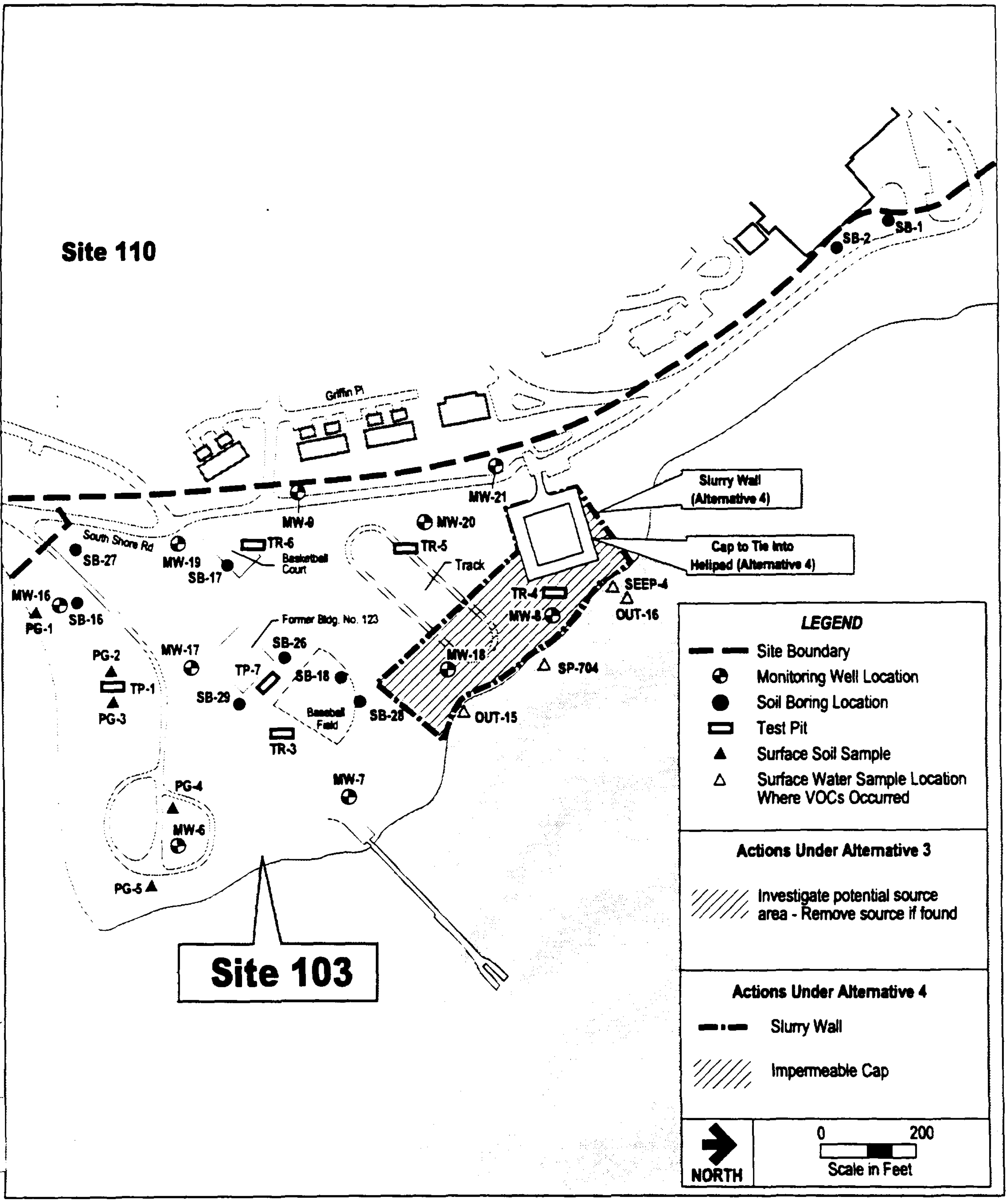


CLEAN COMPREHENSIVE LONG-TERM ENVIRONMENTAL ACTION NAVY	**Figure 9-4** **Site 101-A Soil Remedial Action Areas**	CTO 0031 JPHC/NHB Bremerton, WA OU 1 ROD

533031206-3d-041200



CLEAN COMPREHENSIVE LONG-TERM ENVIRONMENTAL ACTION NAVY	**Figure 9-5** **Soil Cover and Removal/Disposal Areas – Soil Alternative 3**	CTO 0031 JPHC/NHB Bremerton, WA OU 1 ROD



CLEAN
COMPREHENSIVE LONG-TERM ENVIRONMENTAL ACTION NAVY

Figure 9-6
Site 103 Groundwater Remedial Action Areas

CTO 0031
JPHC/NHB
Bremerton, WA
OU 1 ROD

333031206-32d-120799

10.0 COMPARATIVE ANALYSES OF ALTERNATIVES

The 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, or volume through treatment
- Short-term effectiveness
- Implementability
- Cost
- State acceptance
- Community acceptance

The following sections summarize the detailed evaluation of alternatives for soil, groundwater, and marine tissue in regard to the nine evaluation criteria.

10.1 SOIL

Each remedial alternative for soil is discussed in relation to EPA evaluation criteria in the following subsections.

10.1.1 Overall Protection of Human Health and the Environment

Under Soil Alternative 1, long-term protection of human health and the environment would not be ensured. COCs would remain in surface and subsurface soils at concentrations above state cleanup levels, and human health risks to current and potential future residents would exceed a carcinogenic risk level of 1.0E-05 and a noncarcinogenic hazard index of 1. Erosion of COCs in soil into the marine environment would be uncontrolled, and may result in environmental risks.

Soil Alternative 2 would provide overall protection of human health by limiting access to areas where COCs are present in surface soils, preventing future disturbance of subsurface soils that contain COCs, and ensuring that Site 103 is not used for residential purposes. However, the access restrictions under Soil Alternative 2 are likely to have limited effectiveness. Environmental protection would be provided by preventing erosion and potential contaminant transport along the shoreline. The erosion prevention measures would require ongoing maintenance to remain effective.

Soil Alternatives 3 and 4 would be most protective of human health by eliminating the potential for human contact with COCs in site soils. The soil cover under Soil Alternative 3 would eliminate human exposure to COCs in soils, but would require ongoing maintenance. The removal and disposal actions under Soil Alternative 4 would not require maintenance to ensure protectiveness. Both Soil Alternatives 3 and 4 would both protect the marine environment by preventing erosion and potential contaminant transport along the shoreline. The erosion prevention measures would require ongoing maintenance to remain effective.

10.1.2 Compliance With Applicable or Relevant and Appropriate Requirements

Soil Alternative 1 would not include cleanup actions or institutional controls to attain compliance with the requirements of MTCA. Because Soil Alternative 1 would not protect human health and the environment and would not comply with ARARs, it is not considered or discussed further under the remaining evaluation criteria.

Soil Alternatives 2, 3, and 4 would comply with state and federal ARARs. Compliance with state cleanup regulations would be achieved through the institutional controls and containment measures proposed in Soil Alternatives 2 and 3, respectively. Compliance with state cleanup regulations would be achieved through removal and disposal of the affected soils under Soil Alternative 4.

Shoreline stabilization measures under Soil Alternatives 2, 3, and 4 would be designed to fulfill the substantive requirements of all ARARs, including but not limited to key location-specific requirements such as the federal Coastal Zone Management Act (16 USC 1451), the Washington State Shoreline Management Act (Chapter 90.58 RCW), and the Washington State Hydraulic Project Approval (Chapter 75.20.100-160 RCW), and would protect any archaeological resources as required by the federal Archaeological Resources Protection Act (16 USC 470aa-11).

10.1.3 Long-Term Effectiveness and Permanence

The access restrictions under Soil Alternative 2 would require ongoing enforcement, may have limited effectiveness, and are not considered a permanent solution. The soil cover under Soil Alternative 3 would be highly effective over the long term, but would require long-term maintenance. The removal and disposal actions under Soil Alternative 4 would provide the highest degree of long-term effectiveness and permanence by eliminating potential future human exposure to COCs in soils.

For Soil Alternatives 2, 3, and 4, land use restrictions at Site 103 would effectively prevent residential development over the long term, and shoreline stabilization measures would effectively limit contaminant transport to the marine environment. Long-term maintenance of the shoreline stabilization measures would be required under Soil Alternatives 2, 3, and 4.

10.1.4 Reduction of Toxicity, Mobility, or Volume Through Treatment

Soil Alternatives 2, 3, and 4 do not include treatment as a principal component of the alternative. Treatment is not considered to be practicable for soil because of the heterogeneous nature of the fill material, the relatively low concentrations of COCs detected in soil, and the need for multiple treatment processes to address the chlorinated organic, non-chlorinated organic, and inorganic COCs.

10.1.5 Short-Term Effectiveness

Construction of the shoreline stabilization measures under Soil Alternative 2 would pose some short-term risks to construction workers and residents; these risks would be minimized by standard health and safety precautions. The potential for sediment transport to the marine environment during construction would be minimized by sediment control techniques. Some short-term disturbances to the ecology of intertidal areas would occur during construction of the shoreline stabilization measures. Construction of the shoreline stabilization measures could be completed within approximately 1 year. Protection of residents from exposure to COCs in soil would be achieved in a short timeframe via implementation of institutional controls and access restrictions.

Under Soil Alternative 3, short-term risks to construction workers and residents would be slightly greater than under Soil Alternative 2, due to the increased scope of construction activities near residential dwellings. These risks would be minimized by standard health and safety precautions. Under Soil Alternative 4, the massive excavation and transport of contaminated fill material would result in greater short-term risks to workers and residents, compared to Alternatives 2 and 3. Soil Alternatives 3 or 4 could be implemented within approximately 1 year, and would protect residents from exposure to COCs in soil once implemented.

10.1.6 Implementability

Soil Alternatives 2, 3, and 4 are readily implementable. There are no serious concerns about the technical feasibility or availability of resources to implement these alternatives. Coordination with other state and federal agencies will be required to fulfill substantive requirements related to shoreline stabilization. Obtaining the necessary agency approvals is not expected to delay implementation. For each of these alternatives, construction along the shoreline could affect the cultural resources of the Native American tribes. Archaeological finds may affect the implementability or delay implementation.

10.1.7 Cost

The estimated net present worth cost of Soil Alternative 2 is $1,130,000. The estimated net present worth cost of Soil Alternative 3 is $1,570,000, which is approximately 50 percent greater than Soil Alternative 2. The estimated net present worth cost of Soil Alternative 4 is $3,130,000, which is approximately twice the cost of Soil Alternative 3.

The cost estimates were prepared using costing techniques that typically achieve an accuracy of +50 percent to -30 percent, in accordance with EPA guidelines. Net present worth costs are based on 5 years of operation and an assumed annual discount rate of 5 percent.

10.1.8 State Acceptance

WDOE has been briefed on the remedial investigation, feasibility study, and the Proposed Plan. WDOE has expressed its support for Soil Alternative 3.

10.1.9 Community Acceptance

The Restoration Advisory Board has been involved in the review and comment process of all project documents leading to this ROD. On October 20, 1999, the Navy held an open house and public meeting to discuss the proposed plan for final action at OU 1. The public comment period extended from October 4, 1999 to November 4, 1999. Public comments received at the public meeting and during the public comment period are summarized and addressed in the Responsiveness Summary of this ROD. Comments received from the public indicated acceptance of Soil Alternative 3. Several comments related to design issues for the shoreline protection system. They will be addressed as part of the remedial design.

10.2 GROUNDWATER

Each remedial alternative for groundwater is discussed in relation to EPA evaluation criteria in the following subsections.

10.2.1 Overall Protection of Human Health and the Environment

Under Groundwater Alternative 1, long-term protection of human health and the environment would not be ensured. COCs would remain in groundwater at the point of discharge (at the seeps and outfalls) at concentrations above state and federal cleanup levels. Also, although it is considered unlikely that COCs found at the seeps and outfalls are affecting the marine environment, Groundwater Alternative 1 includes no further sampling or monitoring to verify this. Groundwater Alternative 1 includes no measures to prevent future construction of drinking water wells, which could result in unacceptable human health risks in the future.

Groundwater Alternative 2 would provide overall protection of human health by monitoring groundwater quality at the seeps and outfalls, and preventing future construction of drinking water wells within OU 1. The monitoring program would be used to evaluate long-term compliance with state and federal cleanup levels at the seeps and outfalls. The results of the monitoring would be used to verify whether COCs in seeps and outfalls are affecting the marine environment, and to determine the need for any further action in the future to protect the marine environment.

Groundwater Alternative 3 would include all components of Groundwater Alternative 2, but may provide a greater degree of protection of human health and the environment by removing sources of chlorinated VOCs in seeps and outfalls at Site 103. However, the effectiveness of attempting to remove the source of chlorinated VOCs at Site 103 is uncertain.

Groundwater Alternative 4 would provide a degree of protection similar to Groundwater Alternative 3. However, the effectiveness of attempting to contain the source of chlorinated VOCs at Site 103 is uncertain, and the containment would require long-term maintenance and monitoring.

10.2.2 Compliance With Applicable or Relevant and Appropriate Requirements

Groundwater Alternative 1 would not include cleanup actions or provide monitoring to determine long-term compliance with state and federal cleanup levels. Because Groundwater Alternative 1 would not protect human health and the environment and would not comply with ARARs, it is not considered or discussed further under the remaining evaluation criteria.

The monitoring and institutional controls proposed under Groundwater Alternative 2 would be used to determine long-term compliance with state and federal cleanup levels. The monitoring and background redetermination would be used to evaluate whether the inorganic COCs (arsenic, nickel, and silver) exceed background concentrations or cleanup levels. In the short term, concentrations of organic COCs in some seeps and outfalls may exceed state and federal cleanup levels.

Groundwater Alternatives 3 and 4 would include removal and containment actions (respectively) that would be designed to attempt to attain (to the extent practicable) state and federal cleanup levels for the organic COCs. Groundwater Alternatives 3 and 4 are more likely to attain state and federal cleanup levels than Groundwater Alternative 2.

10.2.3 Long-Term Effectiveness and Permanence

Under Groundwater Alternative 2, monitoring and restrictions on drinking water well construction would protect human health and the environment over the long term. Although Groundwater Alternative 2 does not include actions to treat, remove, or contain the organic COCs in seeps and outfalls, the concentrations of these COCs are expected to decrease over the long term as a result of natural attenuation mechanisms.

Groundwater Alternative 3 would provide the highest degree of permanence, by attempting to remove the source of chlorinated VOCs at Site 103. However, the source removal at Site 103 may have limited or no effectiveness.

Under Groundwater Alternative 4, the containment actions for the chlorinated VOCs at Site 103 may have limited or no effectiveness, would require ongoing monitoring and maintenance, and are not considered a permanent solution.

For Groundwater Alternatives 2, 3, and 4, restrictions to prevent drinking water well construction would effectively prevent human exposure to COCs in groundwater over the long term.

10.2.4 Reduction of Toxicity, Mobility, or Volume Through Treatment

Groundwater Alternative 2 does not include a treatment component.

Groundwater Alternative 3 potentially provides the greatest reduction in toxicity, mobility, and volume of contaminants. Any source material (e.g., contaminated soil or free-phase product) removed from Site 103 would be considered for off-site treatment to destroy the chlorinated organics.

Groundwater Alternative 4 relies on containment, not treatment, for the chlorinated organics at Site 103.

10.2.5 Short-Term Effectiveness

Groundwater Alternative 2 could be implemented immediately, and would pose no additional short-term risks to residents and workers. However, the concentrations of organic COCs in seeps and outfalls may not meet state and federal cleanup levels in the short term.

Groundwater Alternative 3 could be implemented within several months. Construction associated with the source removal at Site 103 would pose some short-term risks to construction workers and residents; these risks would be minimized by standard health and safety precautions. The potential for sediment transport to the marine environment during construction would be minimized by sediment control techniques. The source removal at Site 103 could be completed within several months, and if successful, cleanup levels would be achieved at Site 103 immediately following the source removal.

Under Groundwater Alternative 4, short-term risks to construction workers and residents would be slightly greater than Groundwater Alternative 3, due to the increased scope of construction activities at Site 103 and potential interferences with helipad operations. These risks would be minimized by standard health and safety precautions. Groundwater Alternative 4 could be implemented within approximately 1 year.

10.2.6 Implementability

Groundwater Alternative 2 is readily implementable.

Groundwater Alternative 3 is implementable; however, there are significant unknowns associated with the constructibility of the source removal action. The source area at Site 103 may not be found, or existing structures (such as the helipad) may prevent complete removal of the source. Construction along the shoreline could affect the cultural resources of the Suquamish Tribe. Archaeological finds may affect the implementability or delay implementation.

Groundwater Alternative 4 has significant implementability concerns. Further investigation would be needed to define the area requiring containment. The stormwater drainage line that runs through the containment area would have to be rerouted. The slurry wall may interfere with shoreline stabilization actions, and construction may affect operation of the helipad, which is critical to the mission of Naval Hospital Bremerton. Construction along the shoreline could affect the cultural resources of the Native American tribes. Archaeological finds may affect the implementability or delay implementation.

10.2.7 Cost

The estimated net present worth cost of Groundwater Alternative 2 is \$281,000. The estimated net present worth cost of Groundwater Alternative 3 is \$443,000. The estimated net present worth cost of Groundwater Alternative 4 is \$2,280,000.

The cost estimates were prepared using costing techniques that typically achieve an accuracy of +50 percent to -30 percent, in accordance with EPA guidelines. For Groundwater Alternatives 3 and 4, variations in quantities could result in actual costs outside this range of accuracy. Net present worth costs are based on 5 years of operation and an assumed annual discount rate of 5 percent.

10.2.8 State Acceptance

WDOE was briefed on the remedial investigation, feasibility study, and the Proposed Plan. WDOE has expressed its support for Groundwater Alternative 3.

10.2.9 Community Acceptance

The Restoration Advisory Board was involved in the review and comment process of all project documents leading to this ROD. On October 20, 1999, the Navy held an open house and public meeting to discuss the proposed plan for final action at OU 1. The public comment period extended from October 4, 1999 to November 4, 1999. Public comments received at the public meeting and during the public comment period are summarized and addressed in the Responsiveness Summary of this ROD. The public had no specific comments related to the various alternatives for groundwater.

10.3 MARINE TISSUE

Each remedial alternative for marine tissue is discussed in relation to EPA evaluation criteria in the following subsections.

10.3.1 Overall Protection of Human Health and the Environment

Under Marine Tissue Alternative 1, protection of human health would not be ensured. COCs would remain in clams and crabs at concentrations that may pose a carcinogenic human health risk greater than 1.0E-04 and a noncarcinogenic hazard index greater than 1. Marine Tissue Alternative 1 includes no measures to limit human consumption of marine tissue from Ostrich Bay. Also, Marine Tissue Alternative 1 includes no further sampling or monitoring to determine trends in concentrations of COCs in marine tissue.

Marine Tissue Alternative 2 would provide overall protection of human health by monitoring concentrations of COCs in marine tissue, and instituting shellfish harvest restrictions as required to protect human health. The monitoring program would also include determining background concentrations of antimony and vanadium in marine tissue from other locations in Puget Sound, to better define the incremental risks from these COCs. The results of the monitoring would be used to determine the need for ongoing shellfish harvest restrictions.

Marine Tissue Alternative 3 would include all components of Marine Tissue Alternative 2, and additionally would include removal of wooden pilings in Ostrich Bay that may be a source of PCP in shellfish. If the pilings are the source of PCP, then their removal may provide greater protection of human health in the long term. However, piling removal may pose short-term environmental risks in Ostrich Bay.

Risks to the environment associated with marine sediments will be addressed in the ROD for OU 2.

10.3.2 Compliance With Applicable or Relevant and Appropriate Requirements

Marine Tissue Alternative 1 would not include monitoring as required under MTCA. Because this alternative would not protect human health and would not comply with ARARs, it is not considered or discussed further under the remaining evaluation criteria.

The monitoring and potential restrictions on shellfish harvesting under Marine Tissue Alternative 2 would satisfy the requirements of MTCA.

Marine Tissue Alternative 3 would include monitoring and potential restrictions on shellfish harvesting that would satisfy the requirements of MTCA. Piling removal actions under Marine Tissue Alternative 3 would be conducted in accordance with all ARARs.

10.3.3 Long-Term Effectiveness and Permanence

Under Marine Tissue Alternative 2, monitoring and potential restrictions on shellfish consumption would protect human health over the long term. The effectiveness of this alternative is dependent on long-term implementation of these actions. Although Marine Tissue Alternative 2 does not include actions to treat, remove, or contain the COCs in marine tissue, the concentrations of these COCs may decrease over the long-term as a result of natural attenuation mechanisms.

Marine Tissue Alternative 3 would provide the highest degree of permanence, by removing a potential source of PCP from Ostrich Bay. However, the effectiveness of the piling removal in reducing PCP concentrations in tissue is unknown. Also, piling removal may not address the other COCs (antimony, vanadium, and 3,3′-dichlorobenzidine) in marine tissue.

10.3.4 Reduction of Toxicity, Mobility, or Volume Through Treatment

Marine Tissue Alternatives 2 and 3 do not include a treatment component.

10.3.5 Short-Term Effectiveness

Marine Tissue Alternative 2 could be implemented immediately, and would pose no additional short-term risks to residents and workers. However, concentrations of COCs in marine tissue would remain unchanged in the short term.

Marine Tissue Alternative 3 could be implemented within several months. Construction associated with the piling removal in Ostrich Bay would pose some short-term risks to construction workers and the environment; these risks would be minimized by standard health and safety precautions and techniques that minimize disturbance of sediments. The piling removal could be completed within several months. After the pilings are removed, concentrations of PCP in marine tissue may begin to decrease over a period of several months or years.

10.3.6 Implementability

Marine Tissue Alternatives 2 and 3 are readily implementable. There are no serious concerns over the technical feasibility or availability of resources to implement these alternatives. Coordination with other state and federal agencies will be required to fulfill substantive requirements related to piling removal. Obtaining the necessary agency approvals is not expected to delay implementation.

10.3.7 Cost

The estimated net present worth cost of Marine Tissue Alternative 2 is $375,000. The estimated net present worth cost of Marine Tissue Alternative 3 is $615,000.

The cost estimates were prepared using costing techniques that typically achieve an accuracy of +50 percent to -30 percent, in accordance with EPA guidelines. Net present worth costs are based on 5 years of operation and an assumed annual discount rate of 5 percent.

10.3.8 State Acceptance

WDOE has been briefed on the remedial investigation, feasibility study, and the Proposed Plan. WDOE has expressed its support for Marine Tissue Alternative 3.

10.3.9 Community Acceptance

The Restoration Advisory Board was involved in the review and comment process of all project documents leading to this ROD. On October 20, 1999, the Navy held an open house and public meeting to discuss the proposed plan for final action at OU 1. The public comment period extended from October 4, 1999 to November 4, 1999. Public comments received at the public meeting and during the public comment period are summarized and addressed in the Responsiveness Summary of this ROD. Comments received from the public indicated acceptance of the selected remedy for marine tissue. Several comments related to the nature of the bacterial contamination in Ostrich Bay (which is not caused by OU 1) and the specifics of the marine tissue monitoring. The monitoring specifics will be addressed as part of the remedial design.

10.4 BENZENE RELEASE AREA

Each remedial alternative for the benzene release area is discussed in relation to the EPA evaluation criteria in the following subsections.

10.4.1 Overall Protection of Human Health and the Environment

Under Benzene Release Area Alternative 1, long-term protection of human health and the environment would not be ensured. COCs would remain in groundwater at the point of discharge (at the seeps and outfalls) at concentrations above state and federal cleanup levels. Also, although it is considered unlikely that the benzene and petroleum found at the seeps and outfalls are affecting the marine environment, Benzene Release Area Alternative 1 includes no further sampling or monitoring to verify this.

Benzene Release Area Alternatives 2 and 3 would each provide overall protection of human health and the environment by treating groundwater before it is discharged to the marine environment. However, the source of contamination would remain untreated, and long-term institutional actions (provided under the soil and groundwater alternatives) would be needed to prevent human exposure.

Benzene Release Area Alternative 4 would provide overall protection of human health and the environment by treating groundwater and source area soils to permanently remove the source of contamination.

Benzene Release Area Alternative 5 would provide overall protection of human health and the environment by removing the contaminated source area soils and treating the soils at a thermal desorption facility. However, the feasibility of attempting to excavate all of the affected soils is uncertain.

10.4.2 Compliance With Applicable or Relevant and Appropriate Requirements

Benzene Release Area Alternative 1 would not include cleanup actions or provide monitoring to determine long-term compliance with state and federal cleanup levels. Because Benzene Release Area Alternative 1 would not protect human health and the environment and would not comply with ARARs, it is not considered or discussed further under the remaining evaluation criteria.

Benzene Release Area Alternatives 2 through 5 would include treatment or disposal actions to comply with state and federal cleanup levels for the COCs, and would be implemented in compliance with all ARARs.

10.4.3 Long-Term Effectiveness and Permanence

The treatment processes under Benzene Release Area Alternatives 2 and 3 would effectively prevent groundwater containing benzene and gasoline-range petroleum hydrocarbons from being discharged to surface water. However, these alternatives would require long-term operation, maintenance, and monitoring to remain effective. Concentrations of COCs in the source area are expected to decrease over the long term as a result of natural attenuation mechanisms. Treatment of the groundwater plume alone would remove a small mass of dissolved-phase COCs, and a remediation timeframe of several decades may be required.

Under Benzene Release Area Alternative 4, treatment of groundwater and source area soils using ORC is expected to provide permanent destruction of the COCs.

Under Benzene Release Area Alternative 5, removal and thermal treatment of source area soils is expected to provide permanent destruction of the COCs.

10.4.4 Reduction of Toxicity, Mobility, or Volume Through Treatment

Benzene Release Area Alternatives 2 and 3 include treatment of dissolved COCs to permanently eliminate their toxicity. However, by treating the groundwater plume only, a relatively small mass of contaminants would be destroyed every year, and ongoing treatment would be required.

Benzene Release Area Alternatives 4 and 5 provide the greatest reduction in toxicity, mobility, and volume of contaminants by treating the source area to permanently eliminate the toxicity of the COCs. Benzene Release Area Alternative 4 may provide slightly greater treatment than Benzene Release Area Alternative 5, because ORC would be used to treat both the source area and the existing groundwater plume.

10.4.5 Short-Term Effectiveness

Benzene Release Area Alternatives 2 and 3 could be implemented within several months. Construction of the trench and treatment plant would pose some short-term risks to construction workers and residents; these risks would be minimized by standard health and safety precautions. Cleanup levels at the seeps (the conditional point of compliance) would be achieved within about 1 to 3 months following startup. However, long-term operation would be required and these alternatives would have a remediation timeframe of up to several decades.

Benzene Release Area Alternative 4 involves the least construction and excavation, and thus presents the fewest short-term risks to workers and the community during remedial action. Under Benzene Release Area Alternative 4, cleanup objectives could be met at the point of groundwater discharge within about 1 to 3 months, and the site could be permanently cleaned up within 1 to 2 years.

Under Benzene Release Area Alternative 5, short-term risks to construction workers and residents would be somewhat greater than Benzene Release Area Alternatives 2, 3, or 4 due to the increased scope of construction activities. These risks would be minimized by standard health and safety precautions. The source removal could be completed within several months, and if successful, cleanup levels would be achieved at the point of groundwater discharge within another 6 to 12 months. Thus, under Benzene Release Area Alternative 5, the site could be permanently cleaned up within 1 to 2 years.

10.4.6 Implementability

Benzene Release Area Alternatives 2 and 3 are readily implementable. There are no serious concerns about the technical feasibility or availability of resources to implement these alternatives. The alignment of the trench may cause temporary disruption of storm sewers, sanitary sewers, and electricity and water lines, although careful construction could minimize disruptions. Under Benzene Release Area Alternative 3, administrative feasibility concerns may arise regarding the groundwater discharge option selected, particularly in obtaining approvals for discharge to surface water or a POTW.

Benzene Release Area Alternative 4 is readily implementable. There are no serious concerns over the technical feasibility or availability of resources to implement this alternative. Characterization of the source area (currently under way) is critical to successfully determining the quantities and locations for ORC injection. It is possible that existing structures (such as the pump island) could prevent direct injection of ORC in some contaminated areas. In these areas, upgradient injection should allow oxygenated groundwater to flow through the inaccessible areas to remediate the soils. If required, Benzene Release Area Alternative 4 could include limited excavation and off-site treatment of contaminated vadose zone soils. Careful review of drilling locations will minimize the potential for any disruption of storm sewers, sanitary sewers, and electric and water lines. Additional applications of ORC, if necessary, are readily implementable. No administrative feasibility concerns are anticipated.

Alternative 5 has significant implementablity concerns. Characterization of the source area (currently under way) is critical to successfully determining the quantities and locations for excavation. Excavation of all contaminated soil may require benching and overexcavation to provide access and ensure slope stability.

10.4.7 Cost

The estimated net present worth cost of Alternative 2 is $1,600,000. The estimated net present worth cost of Alternative 3 is $1,600,000. The estimated net present worth cost of Alternative 4 is $540,000. The estimated net present worth cost of Alternative 5 is $930,000.

The cost estimates were prepared using costing techniques that typically achieve an accuracy of +50 percent to −30 percent, in accordance with EPA guidelines. For Alternative 5, variations in quantities could result in actual costs outside this range of accuracy.

The expected remediation timeframes of the various remedial alternatives for the benzene release area affects the cost estimating assumptions. For Alternatives 2 and 3, net present worth costs are based on 30 years of operation and an assumed annual discount rate of 5 percent. For Alternatives 4 and 5, net present worth costs are based on 5 years of operation and an assumed annual discount rate of 5 percent.

10.4.8 State Acceptance

WDOE was briefed on the remedial investigation, feasibility study, and the proposed plan. WDOE has expressed its support for Benzene Release Area Alternative 4.

10.4.9 Community Acceptance

The Restoration Advisory Board was involved in the review and comment process of all project documents leading to this ROD. On October 20, 1999, the Navy held an open house and public meeting to discuss the proposed plan for final action at OU 1. The public comment period extended from October 4, 1999 to November 4, 1999. Public comments received at the public meeting and during the public comment period are summarized and addressed in the Responsiveness Summary of this ROD. Comments received from the public indicated no specific concerns or preferences associated with the various alternatives for the benzene release area.

11.0 THE SELECTED REMEDY

11.1 SOIL

11.1.1 Summary of the Rationale for the Selected Remedy

Soil Alternative 3 (soil cover, limited soil excavation, institutional controls, and shoreline stabilization) has been chosen as the selected remedy for soil at OU 1. Soil Alternative 3 is protective of human health and the environment and provides the best overall effectiveness proportional to its cost. Key factors that led to selecting Soil Alternative 3 include the following:

- Soil Alternative 3 has greater long-term effectiveness compared to Soil Alternative 2
- Soil Alternative 3 is equally effective, and has lower short-term risks associated with implementation, compared with Soil Alternative 4
- Soil Alternative 3 has a lower cost than Soil Alternative 4

Under Soil Alternative 3, the soil cover and removal will prevent human exposure to COCs in surface soil. Shoreline stabilization will prevent transport of COCs from soil to the marine environment. The institutional controls will prevent potential future human exposure to COCs in subsurface soil by allowing future excavation only under controlled conditions. The institutional controls will also limit human exposure to COCs in soil by preventing residential development at Site 103.

11.1.2 Description of the Selected Remedy

The selected remedy for soil includes the following components:

- A vegetated cover consisting of a minimum 1-foot thick soil cover plus sufficient topsoil to support vegetation will be installed over the identified areas where COCs in surface soils exceed the remedial goals (Figures 9-2, 9-3, and 9-4). The affected areas represent approximately 280,000 square feet at Sites 101, 101-A, and 103. To provide proper drainage and to match grades, the soil cover at Site 103 will extend inland to cover portions of Elwood Point where surface soils are not contaminated. Construction of the soil cover will be partially implemented by the grading activities already scoped as part of the Navy's shoreline recreation project. Figure 9-5 shows the extent of the soil covers to be provided by the shoreline recreation project and the remedial action. The costs for this alternative include the portions of the soil cover outside the areas covered by the shoreline recreation project. An estimated 10,000 cubic yards of fill and 5,000 cubic yards of topsoil will be required. Installation of the soil cover is expected to also involve construction of recreational facilities (e.g., a baseball field and running track).

- Surface soil containing arsenic and cPAHs above the cleanup levels in residential backyard areas on the east side of Haven Road will be excavated and properly disposed of. The affected backyard area(s) will be excavated to a maximum 2-foot depth to remove the contaminated surface soil, backfilled with clean fill, and revegetated. The volume of soil requiring excavation is estimated at 2,600 cubic yards. The remedial design will include a sampling program to characterize the exact extent of soils exceeding the cleanup levels.

- Shoreline stabilization measures will be installed along approximately 2,700 feet of shoreline at Sites 101, 101-A, and 103, to limit erosion of soils that may contain COCs. The conceptual approaches for shoreline stabilization measures are described in Section 9.1.2. Detailed design specifics will be determined in the remedial design. The intent of the remedial design will be to provide no net loss of productive fish and shellfish habitat. If placement of erosion protection causes intertidal encroachment in some locations, measures to offset such a loss will be incorporated into the project. Along the entire JPHC/NHB shoreline, anthropogenic debris that is present in shoreline and intertidal areas will be removed and properly reused, recycled, or disposed. Debris removal will be one measure to help offset any intertidal encroachment. The need for any additional offset measures will be determined after close consultation with interested parties and in accordance with the substantive requirements of the hydraulic code (Chapter 220-110 WAC), prior to the placement of erosion protection. As described in Section 12.0 of this ROD, implementation of the shoreline stabilization measures and other in-water or near-water components of the selected remedies for OU 1 will require consultation with natural resource agencies to fulfill the requirements of the Endangered Species Act. Remedial design specifics may be modified as a result of this consultation.

- All waste material requiring off-site disposal, including excavated soil, fill material, and debris that cannot be recycled, will be designated as nonhazardous solid waste, dangerous waste, or extremely hazardous waste using the criteria of the Washington State dangerous waste regulations (Chapter 173-303 WAC). Any live ordnance encountered during the remedial action will be handled and destroyed by Navy EOD. Any OEW encountered during the remedial action will be treated on site in a thermal treatment unit to destroy any ordnance residue, and then properly disposed of off site or recycled. All off-site treatment, storage, and disposal of CERCLA waste will occur at facilities that are acceptable under the Off-Site Disposal Rule (40 CFR 300.440).

- Regular inspection and maintenance of the shoreline stabilization measures and soil covers will be conducted and documented. The inspections will also occur after major storm events. Physical maintenance will be provided as needed.

- Permanent restrictions will be placed on the property by the Navy to limit or prevent activities that may disturb the former ordnance burn area at Site 103 or the construction debris landfill at Site 101-A. The restrictions will prevent residential development at Site 103, and require continued monitoring and maintenance of the shoreline stabilization measures and the soil cover. These institutional controls will be administered by the federal government while it owns the property. These institutional controls will include the following measures for Navy property in the areas identified in Figure 11-1:

  - **For the engineered soil covers at Sites 101, 101-A, and Site 103 (Areas A, B, C, and D in Figure 11-1):** Land use restrictions and requirements will address maintenance of the soil cover and procedures for controlling activities that involve digging or construction that could cause exposure to contaminants in soil. The Navy will be able to conduct digging and construction activities (e.g., building construction, utilities improvements, or maintenance) subject to restoring the integrity of the soil cover and taking necessary preventive measures to protect against short-term and long-term risks from contaminants.

  - **For the portions of Site 103 where residential soil cleanup levels were exceeded (Area E in Figure 11-1):** Land use restrictions to prevent use of the site for residential occupancy. If the Navy has a need to amend the land use or activity in the future, it may propose a change subject to concurrence by WDOE and EPA.

– **For the construction debris landfill at Site 101-A and remaining areas of petroleum-contaminated soil at Sites 101-A, 101, and 110 (Areas F, G, and H in Figure 11-1):** Land use restrictions and requirements will address procedures for controlling activities that involve digging or construction that could cause exposure to contaminants in soil. The Navy will be able to conduct digging and construction activities (e.g., building construction, utilities improvements, or maintenance) subject to taking necessary preventive measures to protect against short-term and long-term risks from contaminants.

– **For the designated intertidal areas and adjacent shoreline owned by the Navy (Area I in Figure 11-1):** Land use restrictions will address procedures for controlling construction and maintenance activities to prevent activities that may interfere with or compromise the function of the shoreline stabilization system. The restrictions will include requirements for ongoing monitoring and maintenance of the shoreline stabilization system.

– **For the upland bunkers at Site 110 (Areas J and K in Figure 11-1):** Soil containing arsenic and cPAHs above cleanup levels remains beneath paved areas in front of bunkers 100 and 101. Land use restrictions and requirements will address maintenance of the asphalt cover and procedures for controlling activities that involve digging or construction that could cause exposure to contaminants in soil. The Navy will be able to conduct digging and construction activities (e.g., building construction, utilities improvements, or maintenance) subject to restoring the asphalt cover (or equivalent protective barrier) and taking necessary preventive measures to protect against short-term and long-term risks from contaminants.

Absent further cleanup, in the event of transfer of the property, it will be necessary to include deed or land use restrictions to implement the institutional controls. Deed restrictions cannot be placed on the property until transfer of the property. Upon transfer of the property, notification of the history of the site will be attached to any property transfer, which would have to meet the requirements of CERCLA Section 120(h).

Specific procedures for implementing institutional controls (including deed restrictions) at JPHC/NHB are discussed separately in Section 11.5.

11.1.3 Summary of the Estimated Costs of the Selected Remedy

The anticipated costs associated with the selected remedy for soil are summarized in Table 11-1. The information in this cost estimate summary table is based on the best available information regarding the anticipated scope of the remedial alternative. Changes in the cost elements are likely to occur as a result of new information and data collected during the engineering and design of the remedial alternative. Major changes may be documented in the form of a memorandum in the administrative record file, an ESD, or a ROD amendment. This is an order-of-magnitude engineering cost estimate that is expected to be within +50 to –30 percent of the actual project cost.

11.2 GROUNDWATER

11.2.1 Summary of the Rationale for the Selected Remedy

Groundwater Alternative 3 (source removal, institutional controls, and monitoring) was chosen as the selected remedy for groundwater at OU 1. Groundwater Alternative 3 is protective of human health and the environment and provides the best overall effectiveness proportional to its cost. Key factors that led to selecting Groundwater Alternative 3 include the following:

- Groundwater Alternative 3 has potentially greater short- and long-term effectiveness compared to Groundwater Alternative 2

- Groundwater Alternative 3 is more readily implemented, and has lower short-term risks associated with implementation, compared with Groundwater Alternative 4

- Groundwater Alternative 3 has a lower cost than Groundwater Alternative 4

Under Groundwater Alternative 3, the identified area of groundwater contamination at Site 103 will be addressed by further investigating the area. Any sources that are found will be removed, if practical. The institutional controls will prevent potential future human exposure to COCs in groundwater by preventing construction of drinking water wells. The environmental monitoring program will be used to verify that COCs in inland groundwater and seeps are not posing a risk to the marine environment.

11.2.2 Description of the Selected Remedy

The selected remedy for groundwater includes the following components.

- An investigation will be conducted at Site 103 to attempt to identify the source of three VOCs (1,1-dichloroethene, trichloroethene, and vinyl chloride) that exceeded remedial goals in seeps and outfalls along the north shoreline of Elwood Point. The locations of the exceedances were SEEP-4, SP-704, OUT-15, and OUT-16 (shown in Figure 6-5). No VOCs exceeded ARARs in nearby inland monitoring wells, and therefore no source has yet been defined. The Navy will conduct an investigation to attempt to define a source of VOCs that may exist inland of the seeps and outfalls. Potential areas to be investigated may be defined by the physical location of pipes or other features. Geophysical investigation methods, camera surveys, or chemical sampling may also be used. Investigation specifics will be determined in the remedial design. Based on the investigation results, any source areas that are found will be removed. Whether a source of VOCs is identified or not, any excavation will be limited to ensure the physical stability of the helipad at Site 103.

- All waste material requiring off-site disposal, including excavated soil, fill material, and debris that cannot be recycled, will be sampled to characterize for disposal. The material will be designated as nonhazardous solid waste, dangerous waste, or extremely hazardous waste using the criteria of the Washington State dangerous waste regulations (Chapter 173-303 WAC). Any live ordnance encountered during the remedial action will be handled and destroyed by Navy EOD. Any OEW encountered during the remedial action will be treated on-site in a thermal treatment unit to destroy any ordnance residue, and then properly disposed of off site or recycled. All off-site treatment, storage, and disposal of CERCLA waste will occur at facilities that are acceptable under the Off-Site Disposal Rule (40 CFR 300.440).

- An environmental monitoring program will be conducted to include sampling of intertidal seeps and outfalls, sampling four existing Site 110 monitoring wells, and re-determining groundwater background concentrations. In the first year, up to 10 seep/outfall samples will be collected semiannually from seeps in the intertidal zone, at the point of discharge of groundwater to surface water. Samples will be analyzed for total and dissolved inorganics, benzene, 1,1-dichloroethene, trichloroethene, vinyl chloride, chlordane, and petroleum hydrocarbons to determine compliance with remedial goals. At Site 110, two rounds of sampling will be conducted at four existing monitoring wells (MW-11, MW-13, MW-14, and MW-15) to determine concentrations of total and dissolved inorganics. The results from the two groundwater sample rounds at Site 110 will be used to determine the need for restrictions on future groundwater use at Site 110, as discussed below. The monitoring program will also include collecting a total of 20 groundwater samples from off-site background wells to establish groundwater background concentrations. The groundwater background concentrations will be re-calculated prior to the first 5-year review. The specifics of the monitoring program (including sample numbers, sample locations, and chemicals analyzed) may be modified as requested by WDOE and/or the Navy and concurred with by WDOE and the Navy.

- Permanent restrictions will be placed on the property by the Navy to prevent construction of drinking water wells at Sites 101, 101-A, and 103. These restrictions will also be implemented at Site 110 unless the chemical data from the environmental monitoring program (discussed above) demonstrates that inorganics at Site 110 are not present above the cleanup levels presented in Section 8. These institutional controls will be administered by the federal government while it owns the property. These institutional controls will include the following measures for Navy property:

    - **For groundwater in the uppermost water-bearing unit in nearshore areas (Site 101, Site 101-A, Site 103, and lower portions of Site 110):** Land use restrictions will prevent construction of drinking water wells. These restrictions apply to groundwater that is present in limited quantities above the Vashon Till.

    - **For groundwater in the uppermost water-bearing unit in upland areas (upper portions of Site 110):** Land use restrictions will prevent construction of drinking water wells. These restrictions apply to groundwater that is present below the Vashon Till. These restrictions will be implemented initially, but may be removed at the time of the 5-year review. The decision to remove these restrictions will be made based on review of the chemical data from Site 110 monitoring wells. These data will be generated as part of the environmental monitoring program (discussed above). If the data indicate that inorganics are present in Site 110 groundwater at concentrations below cleanup levels or background concentrations, the restrictions will be removed. WDOE and EPA concurrence will be required before this restriction can be removed, as discussed in Section 11.5.

Absent further cleanup, in the event of transfer of the property, it will be necessary to include deed or land use restrictions to implement the institutional controls. Deed restrictions cannot be placed on the property until transfer of the property. Upon transfer of the property, notification of the history of the site will be attached to any property transfer and the property transfer would have to meet the requirements of CERCLA Section 120(h).

Specific procedures for implementing institutional controls (including deed restrictions) at JPHC/NHB are discussed separately in Section 11.5.

11.2.3 Summary of the Estimated Costs of the Selected Remedy

The anticipated costs associated with the selected remedy for groundwater are summarized in Table 11-2. The information in this cost estimate summary table is based on the best available information regarding the anticipated scope of the remedial alternative. Changes in the cost elements are likely to occur as a result of new information and data collected during the engineering and design of the remedial alternative. Major changes may be documented in the form of a memorandum in the administrative record file, an ESD, or a ROD amendment. This is an order-of-magnitude engineering cost estimate that is expected to be within +50 to –30 percent of the actual project cost.

11.3 MARINE TISSUE

11.3.1 Summary of the Rationale for the Selected Remedy

Marine Tissue Alternative 3 (piling removal, institutional controls, and monitoring) was chosen as the selected remedy for marine tissue at OU 1. Marine Tissue Alternative 3 is protective of human health and the environment and provides the best overall effectiveness proportional to its cost. Marine Tissue Alternative 3 was selected because by permanently removing a potential source of shellfish contamination from the marine environment, Marine Tissue Alternative 3 has potentially greater long-term effectiveness compared to Marine Tissue Alternative 2.

Under Marine Tissue Alternative 3, removal of pilings will eliminate a potential source of contaminants found in shellfish from Ostrich Bay. Institutional controls consisting of potential restrictions on shellfish harvesting will limit human exposure to COCs in shellfish. Shellfish sampling will be used to better define potential human health risks associated with COCs in shellfish, and determine the need for harvest restrictions.

Risks to the environment associated with marine sediments will be addressed in the ROD for OU 2.

11.3.2 Description of the Selected Remedy

The selected remedy for marine tissue includes the following components.

- Approximately 450 wooden pilings from abandoned Navy structures, including the fishing pier on Elwood Point and its associated wooden pilings, will be removed from Ostrich Bay and properly disposed of off site. Where possible, the pilings will be removed by vibratory extraction in an attempt to remove the entire piling from the sediment. If pilings are deteriorated and cannot be completely removed by vibratory extraction, then the pilings will be cut or snapped at the mudline and the stubs left in place. The presence of any remaining stubs will be recorded with the Office of the Commissioner of Public Lands.

- Disposal of the extracted pilings will be conducted in accordance with Washington State dangerous waste regulations, which provide a specific exemption for treated wood waste (WAC 173-303-071[3][g]). The regulations state that the pilings may be disposed of as solid waste, provided that the wood does not fail toxicity characteristics leaching procedure testing. Following such testing, the wood pilings will be transported and disposed of in a nearby permitted sanitary landfill. All off-site treatment, storage, and disposal of CERCLA waste will occur at facilities that are acceptable under the Off-Site Disposal Rule (40 CFR 300.440).

- A shellfish sampling program will be implemented. Up to 16 shellfish tissue samples will be collected biannually from Ostrich Bay and analyzed for antimony, arsenic, vanadium, 3,3-dichlorobenzidine, pentachlorophenol, and ordnance compounds. The first round of shellfish sampling will occur after the pilings are removed. Additionally, background concentrations of antimony, arsenic, and vanadium in shellfish tissue will be established, through either sample collection at off-site locations or review of information from other sources. Two rounds of sampling will be conducted prior to the 5-year review. After the 5-year review, the specific numbers and types of samples, sampling frequency, and analytical methods may be adjusted in subsequent years. The shellfish sampling will terminate when human health risks associated with antimony, arsenic, vanadium, 3,3′-dichlorobenzidine, pentachlorophenol, and ordnance compounds in shellfish reach 1E-05 excess cancer risk and Hazard Index of 1, or when these risks are reduced to a risk consistent with consumption of reference area shellfish. The specifics of the monitoring program (including sample numbers, sample locations, and chemicals analyzed) may be modified as requested by WDOE and/or the Navy and concurred with by WDOE and the Navy.

- The Navy, with concurrence from EPA, WDOE, and the Washington State Department of Health will decide when shellfish on JPHC/NHB beaches can be harvested and the purpose of those harvests, e.g., subsistence, recreational, commercial, or ceremonial gathering.

- Signs will be posted along the shoreline to notify the Jackson Park Housing Complex residents of any harvest restrictions.

11.3.3 Summary of the Estimated Costs of the Selected Remedy

The anticipated costs associated with the selected remedy for marine tissue are summarized in Table 11-3. The information in this cost estimate summary table is based on the best available information regarding the anticipated scope of the remedial alternative. Changes in the cost elements are likely to occur as a result of new information and data collected during the engineering and design of the remedial alternative. Major changes may be documented in the form of a memorandum in the administrative record file, an ESD, or a ROD amendment. This is an order-of-magnitude engineering cost estimate that is expected to be within +50 to –30 percent of the actual project cost.

11.4 BENZENE RELEASE AREA

11.4.1 Summary of the Rationale for the Selected Remedy

Benzene Release Area Alternative 4 (enhanced natural attenuation with oxygen-releasing chemicals) was chosen as the selected remedy for the benzene release area at OU 1. Benzene

Release Area Alternative 4 is protective of human health and the environment and provides the best overall effectiveness proportional to its cost. Key factors that led to selecting Benzene Release Area Alternative 4 include the following:

- Benzene Release Area Alternative 4 has potentially greater short- and long-term effectiveness compared to Benzene Release Area Alternatives 2 and 3

- Benzene Release Area Alternative 4 is more readily implemented, and has lower short-term risks associated with implementation, compared with Benzene Release Area Alternative 5

- Benzene Release Area Alternative 4 has a lower cost than Benzene Release Area Alternatives 2, 3, and 5

Under Benzene Release Area Alternative 4, the treatment actions will address the identified areas of groundwater and surface water contamination at the benzene release area. An environmental monitoring program will be used to verify the effectiveness of the cleanup actions.

11.4.2 Description of the Selected Remedy

The selected remedy for the benzene release area includes the following components.

- Oxygen-releasing chemicals will be placed in the subsurface using one or more of the following methods: injection of a slurry, backfilling of boreholes or open pits, or placement in monitoring wells. It is anticipated that on the order of 10,000 pounds of oxygen-releasing chemicals will be required. The specific quantities, locations, and application methods will be determined in the remedial design. The application will be designed to stimulate aerobic biodegradation of benzene and petroleum in soil and groundwater.

- Limited excavation and disposal of petroleum-contaminated soil may occur if significant petroleum contamination is found above the seasonal high-water table. The specific quantities and locations of any excavation will be determined in the remedial design. All waste material requiring off-site disposal, including excavated soil and debris that cannot be recycled, will be sampled to characterize for disposal. The material will be designated as nonhazardous solid waste, dangerous waste, or extremely hazardous waste using the criteria of the Washington State dangerous waste regulations (Chapter 173-303 WAC). All off-site treatment, storage, and disposal of CERCLA waste will occur at facilities that are acceptable under the Off-Site Disposal Rule (40 CFR 300.440).

- An environmental monitoring program will be conducted to verify effectiveness of the remedy. In the first 2 years, up to 10 groundwater and seep samples will be collected quarterly. Samples will be analyzed for petroleum hydrocarbons and benzene. Sampling requirements in following years will be based on the first 2 years' results. The specifics of the monitoring program (including sample numbers, sample locations, and chemicals analyzed) may be modified as requested by WDOE and/or the Navy and concurred with by WDOE and the Navy.

The selected remedy for the benzene release area does not include any institutional controls. The institutional controls that are included in the selected remedy for groundwater will prevent construction of drinking water wells within the benzene release area.

11.4.3 Summary of the Estimated Costs of the Selected Remedy

The anticipated costs associated with the selected remedy for the Benzene Release Area are summarized in Table 11-4. The information in this cost estimate summary table is based on the best available information regarding the anticipated scope of the remedial alternative. Changes in the cost elements are likely to occur as a result of new information and data collected during the engineering and design of the remedial alternative. Major changes may be documented in the form of a memorandum in the administrative record file, an ESD, or a ROD amendment. This is an order-of-magnitude engineering cost estimate that is expected to be within +50 to –30 percent of the actual project cost.

11.5 IMPLEMENTATION OF INSTITUTIONAL CONTROLS

To document and maintain institutional controls identified in this ROD, Naval Station Bremerton and Naval Hospital Bremerton will each prepare base instructions for their respective properties at OU 1. A schedule for the development of the base instructions will be submitted by the Navy to EPA and WDOE within 1 year of ROD signature. The base instructions will identify with geographic specificity all areas subject to the institutional controls selected in the ROD; identify the objectives of the institutional controls; identify what would be considered inconsistent with the institutional control objectives or protectiveness criteria, provide for the frequency and type (e.g., field inspection, process review, record review) of monitoring of the institutional controls; require an annual monitoring report; and identify current land users and uses. The monitoring report shall provide a description of how facility wide, and OU 1 requirements are met, including a check list identifying results of field inspections, and documentation of any failures. The monitoring report shall identify if institutional controls are being met, and shall describe any deficiencies which affect the protectiveness of the remedy and efforts taken, if any, to correct.

The base instructions will apply to all personnel at JPHC/NHB, including contractors and tenants, and all activities that will affect the institutional controls or the remedial actions selected for the site. The base instructions will include the following:

- The conditions and boundaries of sites subject to land use control, as well as the terms and conditions of the land use control, shall be recorded on appropriate installation master plans, and base instructions for maintaining institutional controls.

- A point of contact for implementing, maintaining, and monitoring institutional controls.

- If a change in land use subject to in-place land use control is being considered, the regulatory agency shall be notified as soon as possible, in order to allow sufficient time for regulatory review and modifications to remedy selection, design, or implementation decision documents. The notification will include:

    1) an evaluation of the risks to human health and the environment posed by the land use change and overall impact on remedy effectiveness;

    2) an evaluation of the need for any additional remedial action resulting from the anticipated land use changes; and,

    3) a proposal for any necessary changes in the selected remedial action

    The following are considered changes in land use affecting land use controls:

    1) A change in land use that is inconsistent with the exposure assumptions in the human health or ecological risk assessment that was the basis for the land use change (e.g., changes from industrial, commercial or recreational use to a more sensitive land use such as residential or day-care areas)

2) A change in land use that would allow activity that is prohibited under the existing ROD or would degrade the remedy

3) A change in land use that would require additional remediation before the new use could begin

- A requirement that the Navy notify EPA and WDOE as soon as possible but no later than 60 days prior to any transfer, sale, or lease of property subject to institutional controls. The notification process is intended so that the parties can ensure that appropriate provisions are included in conveyance documents to maintain institutional controls.

- A requirement that the Navy coordinate with EPA and WDOE any proposed deletion or termination of an institutional control. Any disagreement between the parties will be resolved in accordance with the Interagency Agreement.

- A requirement that the Navy promptly notify EPA and WDOE if it is discovered that an institutional control has failed in meeting the objectives described in Section 11.1.2 of this ROD, or caused a significant loss of protection of human health or the environment. The notification process is intended to allow the parties to identify any specific deficiencies in the institutional control process and for the Navy to implement corrections to prevent similar deficiencies in the future.

The base instructions do not create legal rights in any person or entity. However, this does not affect the enforceability of the institutional controls in this ROD.

Pursuant to Section 120(h)(1) of CERCLA and Part 373 of the NCP, should the United States enter into a contract for the sale or other transfer of JPHC/NHB property, the United States would give notice of hazardous substances that have been stored, disposed of, or released on the property. Pursuant to Section 120(h)(3) of CERCLA, the United States would include in each deed entered into for the transfer of the property a covenant stating that the remedial action(s) are completed and any additional remedial action found to be necessary after the transfer shall be conducted by the United States. In addition to the covenants required by Section 120(h) of CERCLA, the Navy is seeking General Services Administration (GSA) approval of restrictive covenants/deed restrictions that will be included in the conveyance document to effectuate the ROD in the event of transfer of the property to a non-federal entity. The conveyance document shall require the non-federal transferee to record the restrictive covenants/deed restrictions with the county auditor within 30 days of transfer. Such covenants/deed restrictions will address any limits to remain in effect after the time of transfer to restrict land use, restrict the use of groundwater, and manage excavation. The deed covenants will also include provisions addressing the continued operation, maintenance, and monitoring of the selected remedy. In the event that GSA does not approve the restrictive covenants/deed restrictions prior to the land transfer, EPA or the state may reopen this ROD.

11.6 EXPECTED OUTCOMES OF THE SELECTED REMEDIES

The selected remedy for soil will result in no changes to the current residential and recreational land use at OU 1. Sites 101, 101-A, and 110 will have no restrictions on future residential development. Absent further cleanup, land use restrictions will be required for portions of Site 103 to prevent any future residential development. Additional institutional controls will be required at OU 1 to maintain the long-term integrity of the soil remedy and prevent uncontrolled excavation into subsurface contamination.

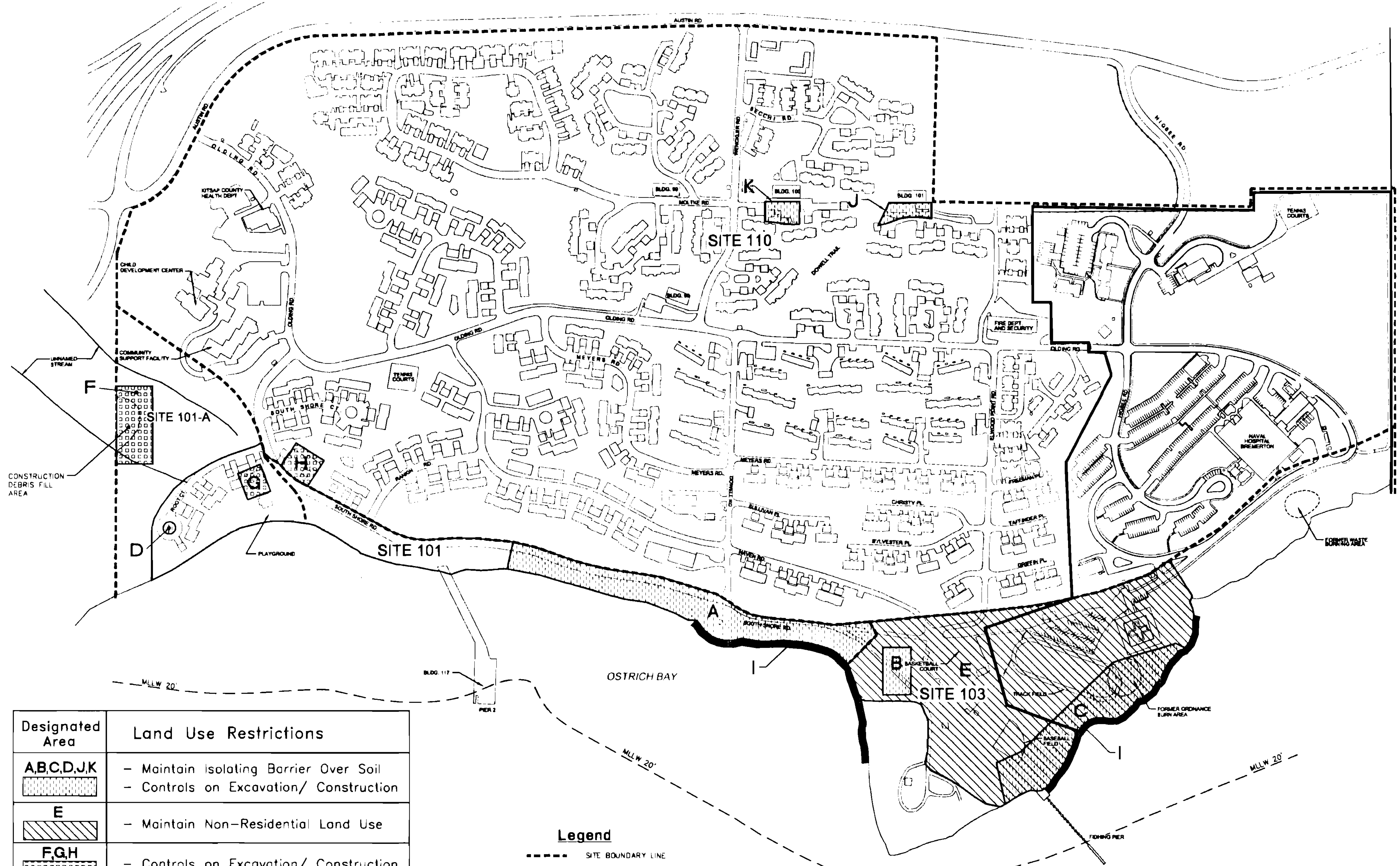
The available uses of groundwater at Sites 101, 101-A, and 103 will remain unchanged. Groundwater at these sites is not a potential source of drinking water, because it is present in limited quantities. Groundwater at these sites discharges to marine surface water. The selected remedies for groundwater and the Benzene Release Area may improve groundwater quality at Sites 101, 101-A, and 103, for the purpose of protecting the marine environment.

Groundwater that occurs beneath the Vashon Till at Site 110 could potentially be used as a source of drinking water in the future, although such use is considered unlikely. The use of groundwater at Site 110 as a future source of drinking water will be restricted at least until the time of the first five-year review. The decision to remove the restrictions on the use of Site 110 groundwater will be made at the time of the first five-year review. The decision will be based on the groundwater sampling that is part of the selected remedy for groundwater.

The final cleanup levels for soil and groundwater are set in Section 8.0 of this ROD. Implementing the selected remedies will result in human health risks below 10^{-5} lifetime excess cancer risk and Hazard Index of 1.

The selected remedy for soil is anticipated to provide ecological benefits to the marine environment by limiting the potential for erosion of potentially contaminated fill material, and by providing a net increase in productive fish and shellfish habitat. The selected remedies for groundwater and the Benzene Release Area may improve marine ecology by improving the quality of groundwater that flows to the marine environment.

The selected remedy for marine tissue includes permanently removing treated wood pilings from the marine environment, which are a potential source of shellfish contamination. Shellfish harvesting is currently prohibited in Ostrich Bay by the Washington State Department of Health because of contamination, including bacterial contamination. It is anticipated that the shellfish harvest prohibition will not be lifted until the bacterial contamination problem is solved by others.



Designated Area	Land Use Restrictions
A,B,C,D,J,K	- Maintain Isolating Barrier Over Soil - Controls on Excavation/ Construction
E	- Maintain Non-Residential Land Use
F,G,H	- Controls on Excavation/ Construction
I	- Maintain Shoreline Protection

Legend

- SITE BOUNDARY LINE
- NAVAL HOSPITAL PROPERTY LINE
- MLLW 20' — 20' MEAN LOW LOW WATER (MLLW) CONTOUR (APPROXIMATE)

CLEAN COMPREHENSIVE LONG-TERM ENVIRONMENTAL ACTION NAVY	CTO 0031 JPHC/NHB Bremerton, WA CU 1 ROD	N 0 100 200 400 SCALE IN FEET	**Figure 11-1** **Land Use Restrictions For Soil and Shoreline Areas**

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Table 11-1
Cost Estimate Summary for the Selected Remedy—Soil

Description	Quantity	Unit	Unit Cost ($)	Cost ($)
Direct Capital Costs				
Erosion Control:				
Seawall				
Equipment	1	LS	$10,000.00	10,000
Labor	750	HR	$130.00	97,500
Riprap	740	CY	$27.00	19,980
Fill/quarry spalls/grading	740	CY	$15.00	11,100
Geotextile	6,000	SF	$0.29	1,740
Hauling and disposal to Subtitle D landfill	2,100	Ton	$25.00	52,500
Softbank Protection				
Equipment	1	LS	$20,000.00	20,000
Labor	1,000	HR	$130.00	130,000
Hauling and disposal to Subtitle D landfill	6,240	Ton	$25.00	156,000
Backfill sand and stone material/grading	2,960	CY	$15.00	44,400
Debris removal—Subtitle D landfill	2,000	Ton	$25.00	50,000
Revegetation	1	LS	$20,000.00	20,000
EOD Crew Mobilization/Oversight	320	HR	$130.00	41,600
Waste Characterization Sampling				
Field work	44	HR	$75.00	3,300
Analytical	12	EA	$650.00	7,800
Data validation	12	EA	$65.00	780
Data management, reporting, QA	52	HR	$75.00	3,900
Soil Excavation and Disposal (Backyards)				
Soil Excavation	2,600	CY	$10.00	26,000
Hauling and Disposal to Subtitle D Landfill	3,600	Ton	$25.00	90,000
Site Restoration				
Haul, place, compact fill (18 in.)	2,000	CY	$5.00	10,000
Haul, place, compact topsoil (6 in.)	600	CY	$20.00	12,000
Fine grading, seed, fertilize	35,000	SF	$0.22	7,700
Confirmatory Soil Sampling				
Field work	60	HR	$75.00	4,500
Analytical	16	EA	$650.00	10,400
Data validation	16	EA	$65.00	1,040
Data management, reporting, QA	64	HR	$75.00	4,800
Soil Cover - Sites 101-A and 103				
Haul, place, compact fill (12 in.)	8,000	CY	$5.00	40,000
Haul, place, compact topsoil (6 in.)	3,700	CY	$20.00	74,000
Fine grading, seed, fertilize	200,000	SF	$0.22	44,000
TOTAL DIRECT CAPITAL COSTS (DCC)				995,040

Table 11-1 (Continued)
Cost Estimate Summary for the Selected Remedy—Soil

Description	Quantity	Unit	Unit Cost ($)	Cost ($)
INDIRECT CAPITAL COSTS				
Implementation of Deed Restrictions				15,000
Mob, bond, insurance (5% of DCC)				49,752
Engineering, construction management (15% of DCC)				149,256
Subtotal Indirect Costs				214,008
Capital/Indirect Contingency (20%)				241,810
TOTAL INDIRECT CAPITAL COSTS				455,818
TOTAL CAPITAL COSTS				**1,450,000**
ANNUAL O&M				
Shoreline Protection Maintenance	1	LS	$16,000.00	16,000
Soil Cover Maintenance	1	LS	$3,500.00	3,500
5-year Reviews (Annualized)	1	EA	$3,000.00	3,000
Subtotal				**22,500**
O&M Contingency (20%)				**4,500**
Total Annual O&M				**27,000**
PRESENT WORTH ANNUAL O&M (5 years, 5%)				**117,000**
TOTAL PRESENT WORTH COSTS				**1,570,000**

Notes:
Unit costs include contractor overhead and profit
DCC - direct capital costs
EOD - explosive ordnance disposal
O&M - operation and maintenance
QA - quality assurance

Table 11-2
Cost Estimate Summary for the Selected Remedy—Groundwater

Description	Quantity	Unit	Unit Costs ($)	Costs ($)
DIRECT CAPITAL COSTS				
Geophysical Exploration/Outfall Probe	1	LS	20,000	20,000
Soil Excavation	700	CY	10	7,000
Hauling and Disposal to Subtitle D Sanitary Landfill	490	Ton	25	12,250
Decontamination/Disposal of Tanks, Pipes, and Sumps	1	LS	20,000	20,000
Site Restoration				
Haul, place, compact fill	350	CY	10	3,500
Haul, place, compact topsoil (6 in.)	35	CY	20	700
Fine grading, seed, fertilize	1,800	SF	0.22	400
Confirmatory Soil Sampling				
Field work	40	HR	75	3,000
Analytical	10	EA	900	9,000
Data validation	10	EA	90	900
Data management, reporting, QA	60	HR	75	4,500
Total Direct Capital Costs				**81,250**
INDIRECT CAPITAL COSTS				
Implementation of Deed Restrictions	1	LS	5,000	5,000
Project Management	4	WK	3,500	14,000
Mobilization, Bond, Insurance	1	LS	4,060	4,060
Construction Management				
Field engineering	4	WK	3,000	12,000
Office engineering	4	WK	3,000	12,000
Design and Engineering				
Plans and specifications	1	EA	20,000	20,000
Subtotal Indirect Capital Costs				**67,100**
Contingency (20%)				29,670
Total Indirect Capital Costs				**96,770**
TOTAL CAPITAL COSTS				**178,000**

Table 11-2 (Continued)
Cost Estimate Summary for the Selected Remedy—Groundwater

O&M		
Groundwater Monitoring and Project Management (subtotal from Groundwater Alternative 2)		50,050
5-year review (annualized cost)		1,000
Subtotal		**51,050**
O&M Contingency (20%)		10,210
Total Annual O&M		**61,300**
PRESENT WORTH ANNUAL O&M (5 years, 5%)		**265,000**
TOTAL PRESENT WORTH COSTS		**$443,000**

Notes:
CY - cubic yard
EA - each
HR - hour
in. - inch
LS - lump sum
O&M - operation and maintenance
QA - quality assurance
WK - week

Table 11-3
Cost Estimate Summary for the Selected Remedy—Marine Tissue

Description	Quantity	Unit	Unit Costs ($)	Costs ($)
DIRECT CAPITAL COSTS				
Install signs	1	LS	2,000	2,000
Piling Removal	310	EA	381	118,110
Waste Characterization-TCLP	10	EA	2,000	20,000
Hauling and Disposal-Subtitle D	310	EA	40	12,400
Total Direct Capital Costs				**152,500**
INDIRECT CAPITAL COSTS				
Prepare Sampling Plans (tissue)	1	LS	10,000	10,000
Project Management	3	WK	10,500	10,500
Mobilization, Bond, Insurance	1	LS	7,600	7,600
Construction Management Field engineering Office engineering	 4 1	 WK WK	 3,000 3,000	 12,000 3,000
Design and Engineering Plans and specifications	 1	 EA	 20,000	 20,000
Subtotal Indirect Capital Costs				**63,100**
Contingency (20%)				43,100
Total Indirect Capital Costs				**106,200**
TOTAL CAPITAL COSTS				**259,000**
O&M				
Public Information Program	1	LS	10,000	10,000
Marine Tissue Monitoring (subtotal from Alternative 2)	1	LS	43,540	43,540
Project Management	4	WK	3,500	14,000
5-Year Review (annualized cost)				1,000
Subtotal				**68,540**
O&M Contingency (20%)				13,708
Total Annual O&M				**82,200**
PRESENT WORTH ANNUAL O&M (5 years, 5%)				**356,000**
TOTAL PRESENT WORTH COSTS				**615,000**

Notes:
EA - each
LS - lump sum
O&M - operation and maintenance
TCLP - toxicity characteristics leaching procedure
WK - week

Table 11-4
Cost Estimate Summary for the Selected Remedy—Benzene Release Area

Description	Quantity	Unit	Unit Cost ($)	Cost ($)
Direct Capital Costs				
ORC Treatment:				
Drilling Subcontractor	1	LS	37,846.00	37,846
ORC Product	12,000	LB	10.00	120,000
Field Crew	500	HR	80.00	40,000
TOTAL DIRECT CAPITAL COSTS (DCC)				197,846
INDIRECT CAPITAL COSTS				
Mob, bond, insurance (5% of DCC)				9,892
Engineering, construction management (15% of DCC)				29,677
Subtotal Indirect Costs				39,569
Capital/Indirect Contingency (20%)				47,483
TOTAL INDIRECT CAPITAL COSTS				87,052
TOTAL CAPITAL COSTS				**285,000**
ANNUAL O&M				
Compliance Monitoring				
Field Crew – Sampling	240	HR	60.00	14,400
Analytical	40	EA	250.00	10,000
Data Validation	40	EA	25.00	1,000
Data Management/Reporting/QA	280	HR	80.00	22,400
Project Management	8	WK	3,500.00	28,000
5-year Reviews (Annualized)	1	EA	2,000.00	2,000
Subtotal				**77,800**
O&M Contingency (20%)				**15,560**
Total Annual O&M				**93,360**
PRESENT WORTH ANNUAL O&M (3 years, 5%)				**254,000**
TOTAL PRESENT WORTH COSTS				**540,000**

Notes:
Unit costs include contractor overhead and profit
DCC - direct capital costs
EA - each
HR - hour
LB - pound
LS - lump sum
O&M - operation and maintenance
ORC - a proprietary formulation of magnesium oxide
QA - quality assurance
Wk - week

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 practicable. In addition, CERCLA includes a preference for remedies that use treatment that significantly reduces volume, toxicity, or mobility of hazardous substances, pollutants, or contaminants as their principal element. The selected remedies for OU 1 are discussed in terms of these statutory requirements in this section.

12.1 SOIL

12.1.1 Protection of Human Health and the Environment

The selected remedy for soil at OU 1 will protect human health by removing and disposing of contaminated surface soil in backyard areas, installing a soil cover to eliminate direct contact/ingestion of COCs in surface soil, and implementing institutional controls that will prevent future disturbance of subsurface soils and restrict land use at Site 103. The selected remedy will protect the environment by preventing erosion of fill material into Ostrich Bay.

12.1.2 Compliance With ARARs

The selected remedy for soil at OU 1 will comply with federal and state ARARs that have been identified. No waiver for any ARAR is being sought or invoked for any component of the selected remedy. The ARARs identified for this remedy are discussed in the following subsections.

Chemical-Specific ARARs

Washington State Model Toxics Control Act (Chapter 70.105D RCW; Chapter 173-340 WAC). This statute and implementing regulations are applicable to the soil remedy as follows: selection of cleanup actions (Ch. 173-340-360), institutional controls (-440), and cleanup standards for soil (-740).

Location-Specific ARARs

Federal Archaeological Resources Protection Act (16 USC 470aa-ll; 43 CFR Part 7). This statute and implementing regulations are applicable if any work along the shoreline (debris removal, excavation) should uncover evidence of archaeological resources (e.g., shell middens).

Federal Endangered Species Act (16 USC 1531 et seq.; 50 CFR Parts 17, 225, 402). This act protects fish, wildlife, and plants that are threatened or endangered (T/E) with extinction. T/E species that occur or may occur in the project area include Puget Sound Chinook salmon, bull trout, Steller sea lion, humpback whale, leatherback sea turtle, and bald eagle. The requirements of this act apply to cleanup actions that may affect a listed T/E species or designated critical habitat. The selected remedy will comply with the substantive requirements of these regulations as determined by consulting with the appropriate services (including U.S. Fish and Wildlife Service, the National Marine Fisheries Service, and the Washington State Department of Fish and Wildlife), to determine the need for avoidance or mitigation measures. As part of this consultation, and during the remedial design, the Navy will perform a biological assessment of the project. Once the biological assessment has been approved by the appropriate services, the Navy may initiate a formal or informal consultation with the appropriate services, which in turn may issue a biological opinion as to whether the species would be jeopardized by the proposed action. If a jeopardy opinion is reached, then the Navy must avoid the action or take appropriate mitigation measures so that the action does not affect the species or its critical habitat.

Federal Marine Mammal Protection Act (16 USC 1361-1389; 50 CFR Parts 13, 18, 216, and 229). This statute and implementing regulations are applicable should activities along the shoreline threaten to "take" (including harrass) marine mammals in Ostrich Bay. If this occurs, consultation with the National Marine Fisheries Service would be required to find ways to avoid the taking or to obtain special permission to do so (if administrative requirements applied, this permission would be in the form of a permit).

Federal Fish and Wildlife Coordination Act (16 USC 661 et seq.). The requirements of this statute are relevant and appropriate to any construction activities that modify the shoreline. Actions must prevent loss of and damage to wildlife resources.

Federal Coastal Zone Management Act (16 USC 1451). The requirements of this statute are applicable to any construction activities along the shoreline. Proposed actions must be consistent with state coastal zone management (as governed by the Washington State Shoreline Management Act).

Federal Clean Water Act Section 404(b)(1), Dredge and Fill (33 USC 1314; 33 CFR Parts 320, 323; 40 CFR Part 230) and Rivers and Harbors Act, Section 10 (33 USC 403; 33 CFR Parts 320, 322). These statutes and implementing regulations are applicable to dredging, filling, and other alteration of the bed of navigable waters in the United States. The primary mechanism for regulatory oversight is through permitting by the U.S. Army Corps of Engineers and permit review by EPA. On-site actions will comply with the substantive requirements for a Corps of Engineers' public-interest analysis of the proposed project. In addition, EPA review of the action under 40 CFR Part 230, Section 404(b)(1), Guidelines for Specification of Disposal Sites for Dredged or Fill Material, will apply. The selected remedy will comply with the substantive requirements of these regulations.

Washington State Shoreline Management Act (Chapter RCW 90.58; Chapters 173-, 173-16, 173-22, and 173-27 WAC). The substantive requirements of this statute and implementing regulations are applicable to construction activities along the shoreline (extending 200 feet landward). WAC 173-27-060(1) discusses the applicability of chapter 90.58 RCW to federal lands and agencies within the coastal counties, one of which is Kitsap County. Proposed actions must be consistent with the policies and goals of the approved Washington State coastal zone management program and with the policies and shorelands use designations of the local jurisdiction's shoreline master plan (Kitsap County shoreline designation maps, WAC 173-22-0636). Guidelines for local regulation of shoreline protection (WAC 173-16-060[17]) are relevant and appropriate for shoreline stabilization.

Washington State Hydraulic Projects Approval (Chapter 75.20.100-160 RCW; Chapter 220-110 WAC). This program is applicable to any work conducted along the OU 1 shoreline that changes the natural flow or bed of Ostrich Bay (and therefore has the potential to affect fish habitat). The requirements include bank protection (WAC 220-110-050), saltwater technical provisions (-230), and prohibited work times in saltwater areas, such as surf smelt spawning times (-271).

Native American Grave Protection and Repatriation Act (25 USC 3001-3013; 43 CFR Part 10). This statute requires that any federal agency discovering Native American cultural items (human remains and associated funerary objects) notify in writing the U.S. Department of the Interior and the appropriate Indian tribe. The federal agency must cease activity in the area of the discovery, make a reasonable effort to protect the items discovered before resuming such activity, and provide notice as described above. These requirements apply only if cultural items are discovered during implementation of the selected remedy.

Archaeological Resources Protection Act (16 USC 470aa et seq.; 43 CFR Part 7). This statute sets forth requirements that are triggered when archaeological resources are discovered on federal lands. It requires that excavation of these resources be conducted under a permit by professional archaeologists. These requirements apply only if archaeological items are discovered during implementation of the selected remedy.

Action-Specific ARARs

Federal Hazardous Materials Transportation Act (49 USC 5101-5127; 49 CFR Parts 171-173, 177). This program addresses the movement of hazardous materials on public highways. If waste generated during the selected remedy for soils is hazardous and must be transported to a treatment or disposal facility, the following regulations are applicable: 49 CFR Part 171, describing general requirements and hazardous waste shipments; Part 172, providing a table of hazardous materials and prescribing labeling and packaging; Part 173, providing general requirements for shipping and packaging by shippers; and Part 177, regulating hazardous material shipment by highways.

Federal Clean Air Act (42 USC 7401 et seq.; 40 CFR Part 50). This statute and regulations are applicable to any fugitive dust generated during soil remediation at OU 1. The ambient air quality standard for fine particulates (PM10) is relevant and appropriate to remedial activities for soil.

Federal Resource Conservation and Recovery Act—Subtitle C (42 USC 6921-6925; 40 CFR Parts 261-265 and 268). Hazardous waste identification, accumulation, manifesting, transport, treatment, storage, and disposal requirements are applicable if hazardous waste should be generated.

Federal Resource Conservation and Recovery Act—Subtitle D (42 USC 6941-6949; 40 CFR Parts 257, 258). Solid nonhazardous waste siting and disposal requirements are applicable to nonhazardous waste (including shoreline debris) generated.

Washington State Transportation of Hazardous Materials (Chapter 46.48 RCW; Chapter 446-50 WAC). The Washington State Patrol adopts by reference the federal Hazardous Materials Transportation Act regulations governing transportation of hazardous materials on public highways; these regulations are applicable to soil remediation.

Washington State Clean Air Act (Chapter 70.94 RCW; Chapters 173-400, 173-470 WAC). Ambient air quality standards for total suspended particulates and fine particulates (PM10) are relevant and appropriate to remedial activities for soil.

Puget Sound Air Pollution Control Agency (PSAPCA) Regulation I, Section 9.15, Fugitive Dust Control Measures. Precautions to minimize visible fugitive dust emissions are applicable to soil remediation and thermal treatment of ordnance-related waste.

Washington State Hazardous Waste Management Act (Chapter 70.105D RCW; Chapter 173-303 WAC). This statute and implementing regulations specify identification, accumulation, manifesting, transport, treatment, storage, and disposal requirements for dangerous waste (including state-only wastes). If the soil excavated during soil remediation exhibits characteristics or criteria of dangerous wastes, then the regulations would apply.

Washington State Solid Waste Management Act (Chapter 70.95 RCW; Chapter 173-351 WAC). Requirements for handling, siting, storage, and disposal of solid waste are applicable to excavated soil and shoreline debris generated during remediation that are disposed of as waste.

Other Criteria, Advisories, or Guidance To Be Considered (TBCs)

In implementing the Selected Remedy, the Navy, EPA, and WDOE have agreed to consider nonbinding criteria that are TBCs. The WDOE publication *Statistical Guidance for Site Managers* is considered a TBC for evaluating confirmational sampling and monitoring data.

12.1.3 Cost-Effectiveness

The selected remedy for soil at OU 1 is cost-effective and represents a reasonable value for the money that will be spent. In making this determination, the following definition was used: "A remedy shall be cost-effective if its costs are proportional to its overall effectiveness." (40 CFR 33.430(f)(1)(ii)(D). This was accomplished by evaluating the overall effectiveness of the alternatives that satisfied the threshold criteria (i.e., were both protective of human health and the environment and were ARAR-compliant). Overall effectiveness was evaluated by assessing three of the five balancing criteria in combination (long-term effectiveness and permanence; reduction in toxicity, mobility, or volume through treatment; and short-term effectiveness). Overall effectiveness was then compared to costs to determine cost-effectiveness.

The estimated present worth cost of the selected remedy is $1,570,000. The removal and disposal alternative considered for soil would cost approximately twice as much as the selected remedy and would not provide significantly greater protection. Therefore, the selected remedy represents a reasonable value for the money that will be spent.

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

The selected remedy for soil at OU 1 represents the maximum extent to which permanent solutions and treatment technologies can be used in a cost-effective manner for soil at OU 1. It is protective of human health and the environment, complies with ARARs, and provides the best balance of trade-offs 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 extent practicable. However, treatment was not found to be practicable for soil at OU 1 because of the heterogeneous nature of the fill material and the relatively low concentrations of chemicals. If any dangerous waste or extremely hazardous waste is found during the remediation, it will be treated as required for proper disposal.

12.1.5 Preference for Treatment as a Principal Element

The selected remedy for soil at OU 1 does not include treatment that reduces the toxicity, mobility, or volume of waste. As explained in the previous subsection, treatment was not found to be practicable for soil at OU 1.

The NCP establishes an expectation that EPA will use treatment to address the principle threats posed by a site wherever practicable (40 CFR 300.430(a)(1)(iii)(A)). EPA has also established an expectation for use of engineering controls, such as containment, for waste that poses a relatively low, long-term threat or where treatment is impracticable (40 CFR 300.430(a)(1)(iii)(B)). The "principle threat" concept is applied to the characterization of source materials at a Superfund site. A source material is a material that includes or contains hazardous substances, pollutants, or contaminants that act as a reservoir for migration of contamination to groundwater, surface water, or air, or acts as a source for direct exposure. Principle threat wastes are those source materials considered to be highly toxic or highly mobile that generally cannot be reliably contained, or would present a significant risk to human health or the environment should exposure occur.

The contaminated soils and fill material at OU 1 that are addressed by this ROD are not considered to be principle threat wastes. They are not highly toxic or highly mobile, and they can reliably be contained. Further, as explained in the previous subsection, treatment was not found to be practicable for the soil. Because no principle threat wastes are present in the soil, the selected remedy satisfies EPA's expectation that treatment should be used to address the principle threats posed by a site wherever practicable.

The selected remedy primarily involves on-site containment of contaminated soil and fill material, which is consistent with EPA's bias against off-site land disposal of untreated waste. A portion of the contaminated soil will, however, be disposed of off-site. Treatment will only be provided for this material if it is determined to be dangerous or extremely hazardous waste. The selected remedy is also consistent with EPA's expectation for use of engineering controls, such as containment, for waste that poses a relatively low, long-term threat or where treatment is impracticable.

12.1.6 Five-Year Review Requirements

Because this remedy will result in hazardous substances, pollutants, or contaminants remaining on site above levels that allow for unlimited use and unrestricted exposure, a statutory review will be conducted within five years after initiation of remedial action to ensure that the remedy is, or will be, protective of human health and the environment.

12.2 GROUNDWATER

12.2.1 Protection of Human Health and the Environment

The selected remedy for groundwater at OU 1 will protect human health and the environment by removing sources of chlorinated VOCs at Site 103 and preventing future construction of drinking water wells. Monitoring will ensure that COCs that may remain in groundwater are not adversely affecting the marine environment.

12.2.2 Compliance With ARARs

The selected remedy for groundwater at OU 1 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 groundwater at OU 1 are discussed in the following sections.

Chemical-Specific ARARs

Safe Drinking Water Act (42 USC 300f-300j-11; 40 CFR Part 141). Regulations provide maximum contaminant levels (MCLs) developed for public drinking water supply systems are relevant and appropriate to groundwater in upland portions of the site, which is a potential future drinking water source.

Clean Water Act (33 USC 1314; 40 CFR Part 131). The National Toxics Rule (40 CFR 131.36) has set forth surface water quality standards for the protection of human health (ingestion of water and aquatic life and ingestion of aquatic life only) for Washington State waters. The standards for ingestion of aquatic life are applicable to the seeps discharging to Ostrich Bay.

Washington State Water Pollution Control Act (Chapter 90.48 RCW; Chapter 173-201A WAC). Marine surface water quality standards for the protection of aquatic life are relevant and appropriate to the seeps discharging to Ostrich Bay.

Washington State Model Toxics Control Act (Chapter 70.105D RCW; Chapter 173-340 WAC). This statute and implementing regulations are applicable to the groundwater remedy at the site. The following sections of the regulation are applicable to upland groundwater, which is a potential source of drinking water: selection of cleanup actions (Chapter 173-340-360), institutional controls (-440), and cleanup standards for groundwater (-720). MTCA regulations applicable to groundwater that is not a potential source of drinking water are the same, except that they specifically follow WAC 173-340-720(3)(c).

Location-Specific ARARs

Federal Archaeological Resources Protection Act (16 USC 470aa-ll; 43 CFR Part 7). This statute and implementing regulations are applicable if any work along the shoreline (debris removal, excavation) should uncover evidence of archaeological resources (e.g., shell middens).

Federal Endangered Species Act (16 USC 1531 et seq.; 50 CFR Parts 17, 225, 402). This act protects fish, wildlife, and plants that are threatened or endangered (T/E) with extinction. T/E species that occur or may occur in the project area include Puget Sound Chinook salmon, bull trout, Steller sea lion, humpback whale, leatherback sea turtle, and bald eagle. The requirements of this act apply to cleanup actions that may affect a listed T/E species or designated critical habitat. The selected remedy will comply with the substantive requirements of these regulations as determined by consulting with the appropriate services (including U.S. Fish and Wildlife Service, the National Marine Fisheries Service, and the Washington State Department of Fish and

Wildlife), to determine the need for avoidance or mitigation measures. As part of this consultation, and during the remedial design, the Navy will perform a biological assessment of the project. Once the biological assessment has been approved by the appropriate services, the Navy may initiate a formal or informal consultation with the appropriate services, which in turn may issue a biological opinion as to whether the species would be jeopardized by the proposed action. If a jeopardy opinion is reached, then the Navy must avoid the action or take appropriate mitigation measures so that the action does not affect the species or its critical habitat.

Federal Marine Mammal Protection Act (16 USC 1361-1389; 50 CFR Parts 13, 18, 216, and 229). This statute and implementing regulations are applicable should activities along the shoreline threaten to "take" (including harrass) marine mammals in Ostrich Bay. If this occurs, consultation with the National Marine Fisheries Service would be required to occur to find ways to avoid the taking or to obtain special permission to do so (if administrative requirements applied, this permission would be in the form of a permit).

Federal Fish and Wildlife Coordination Act (16 USC 661 et seq.). The requirements of this statute are relevant and appropriate to any construction activities that modify the shoreline of OU 1. Actions must prevent loss of and damage to wildlife resources.

Federal Coastal Zone Management Act (16 USC 1451). The requirements of this statute apply to any construction activities along the shoreline. Proposed actions must be consistent with state coastal zone management (as governed by the Washington State Shoreline Management Act).

Washington State Shoreline Management Act (Chapter RCW 90.58; Chapters 173-, 173-16, 173-22, and 173-27 WAC). The substantive requirements of this statute and implementing regulations are applicable to construction activities along the shoreline (extending 200 feet landward). WAC 173-27-060(1) discusses the applicability of chapter 90.58 RCW to federal lands and agencies within the coastal counties, one of which is Kitsap County. Proposed actions must be consistent with the policies and goals of the approved Washington State coastal zone management program and with the policies and shorelands use designations of the local jurisdiction's shoreline master plan (Kitsap County shoreline designation maps, WAC 173-22-0636).

Washington State Hydraulic Projects Approval (Chapter 75.20.100-160 RCW; Chapter 220-110 WAC). This program is applicable to any work conducted along the OU 1 shoreline that changes the natural flow or bed of Ostrich Bay (and therefore has the potential to affect fish habitat). The requirements include bank protection (WAC 220-110-050), saltwater technical provisions (-230), and prohibited work times in saltwater areas, such as surf smelt spawning times (-271).

Action-Specific ARARs

Federal Hazardous Materials Transportation Act (49 USC 5101-5127; 49 CFR Parts 171-173, 177). This program addresses the movement of hazardous materials on public highways. If waste generated during the selected remedy for groundwater is hazardous and must be transported to a treatment or disposal facility, the following regulations are applicable: 49 CFR Part 171, describing general requirements and hazardous waste shipments; Part 172, providing a table of hazardous materials and prescribing labeling and packaging; Part 173, providing general requirements for shipping and packaging by shippers; and Part 177, regulating hazardous material shipment by highways.

Federal Clean Air Act (42 USC 7401 et seq.; 40 CFR Part 50). This statute and regulations are applicable to any fugitive dust generated during remediation at OU 1. The ambient air quality standard for fine particulates (PM10) is relevant and appropriate to remedial activities at OU 1.

Federal Resource Conservation and Recovery Act—Subtitle C (42 USC 6921-6925; 40 CFR Parts 261-265 and 268). Hazardous waste identification, accumulation, manifesting, transport, treatment, storage, and disposal requirements are applicable if hazardous waste should be generated during groundwater remediation.

Federal Resource Conservation and Recovery Act—Subtitle D (42 USC 6941-6949; 40 CFR Parts 257, 258). Solid nonhazardous waste siting and disposal requirements are applicable to nonhazardous waste generated during groundwater remediation.

Washington State Transportation of Hazardous Materials (Chapter 46.48 RCW; Chapter 446-50 WAC). The Washington State Patrol adopts by reference the federal Hazardous Materials Transportation Act regulations governing transportation of hazardous materials on public highways; these regulations are applicable to groundwater remediation.

Washington State Clean Air Act (Chapter 70.94 RCW; Chapters 173-400, 173-470 WAC). Ambient air quality standards for total suspended particulates and fine particulates (PM10) are relevant and appropriate to remedial activities for groundwater.

Puget Sound Air Pollution Control Agency (PSAPCA) Regulation I, Section 9.15, Fugitive Dust Control Measures. Precautions to minimize visible fugitive dust emissions are applicable to groundwater remediation at OU 1.

Washington State Hazardous Waste Management Act (Chapter 70.105D RCW; Chapter 173-303 WAC). This statute and implementing regulations specify identification, accumulation, manifesting, transport, treatment, storage, and disposal requirements for dangerous waste (including state-only wastes). If the soil excavated during groundwater remediation exhibit characteristics or criteria of dangerous wastes, then the regulations would apply.

Washington State Solid Waste Management Act (Chapter 70.95 RCW; Chapter 173-351 WAC). Requirements for handling, siting, storage, and disposal of solid waste are applicable to excavated soil and debris generated during remediation that are disposed of as waste.

Washington State Minimum Standards for the Construction and Maintenance of Wells (Chapter 18.104 RCW; Chapter 173-160 WAC). These standards are applicable to the construction, testing, and abandonment of resource protection wells such as monitoring wells.

Other Criteria, Advisories, or Guidance To Be Considered (TBCs)

In implementing the Selected Remedy, the Navy, EPA, and WDOE have agreed to consider nonbinding criteria that are TBCs. The WDOE publication *Statistical Guidance for Site Managers* is considered a TBC for evaluating confirmational sampling and monitoring data.

12.2.3 Cost-Effectiveness

The selected remedy for groundwater at OU 1 is cost-effective because it has been determined to provide overall effectiveness proportional to its cost, with an estimated present worth cost of $443,000. Groundwater Alternative 4 would cost approximately five times as much as the selected remedy, and would provide little or no added protection.

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

The selected remedy represents the maximum extent to which permanent solutions and treatment technologies can be used in a cost-effective manner for groundwater at OU 1. It is protective of human health and the environment, complies with ARARs, and provides the best balance of trade-offs in terms of long-term effectiveness, permanence, short-term effectiveness, implementability, cost, and reductions in toxicity, mobility, or volume achieved through treatment. Removing the source of chlorinated VOCs in groundwater at Site 103, if successful, will permanently reduce the toxicity, mobility, and volume of these contaminants. The selected remedy meets the statutory requirement to use permanent solutions to the maximum extent practical.

12.2.5 Preference for Treatment as a Principal Element

The selected remedy for groundwater at OU 1 satisfies the preference for treatment to address the principal threats posed by conditions at the site. No principal threat wastes have been identified that are associated with the chlorinated VOCs found in groundwater at Site 103. However, it is possible that if a source is found it may be considered a principal threat waste. Any recovered sources of chlorinated VOCs from Site 103 will be treated off site as required for proper disposal. These actions will permanently remove these contaminants from groundwater at OU 1. The contaminated groundwater itself is not considered a principal threat waste, and will not be treated.

12.2.6 Five-Year Review Requirements

Because this remedy will result in hazardous substances, pollutants, or contaminants remaining on site above levels that allow for unlimited use and unrestricted exposure, a statutory review will be conducted within five years after initiation of remedial action to ensure that the remedy is, or will be, protective of human health and the environment.

12.3 MARINE TISSUE

12.3.1 Protection of Human Health and the Environment

The selected remedy for marine tissue at OU 1 will protect human health and the environment by removing wooden pilings that are a potential source of pentachlorophenol found in marine tissue, and through potential restrictions on shellfish harvesting that will limit human exposures to COCs in shellfish. Monitoring of marine tissue will be used to determine the need for shellfish harvest restrictions.

12.3.2 Compliance With ARARs

The selected remedy for marine tissue at OU 1 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 remedy. The ARARs identified for marine tissue at OU 1 are discussed in the following sections.

Chemical-Specific ARARs

No chemical-specific ARARs have been identified for shellfish tissue.

Location-Specific ARARs

Federal Archaeological Resources Protection Act (16 USC 470aa-ll; 43 CFR Part 7). This statute and implementing regulations are applicable if any work along the shoreline (piling removal) should uncover evidence of archaeological resources (e.g., shell middens).

Federal Endangered Species Act (16 USC 1531 et seq.; 50 CFR Parts 17, 225, 402). This act protects fish, wildlife, and plants that are threatened or endangered (T/E) with extinction. T/E species that occur or may occur in the project area include Puget Sound Chinook salmon, bull trout, Steller sea lion, humpback whale, leatherback sea turtle, and bald eagle. The requirements of this act apply to cleanup actions that may affect a listed T/E species or designated critical habitat. The selected remedy will comply with the substantive requirements of these regulations as determined by consulting with the appropriate services (including U.S. Fish and Wildlife Service, the National Marine Fisheries Service, and the Washington State Department of Fish and Wildlife), to determine the need for avoidance or mitigation measures. As part of this consultation, and during the remedial design, the Navy will perform a biological assessment of the project. Once the biological assessment has been approved by the appropriate services, the Navy may initiate a formal or informal consultation with the appropriate services, which in turn may issue a biological opinion as to whether the species would be jeopardized by the proposed action. If a jeopardy opinion is reached, then the Navy must avoid the action or take appropriate mitigation measures so that the action does not affect the species or its critical habitat.

Federal Marine Mammal Protection Act (16 USC 1361-1389; 50 CFR Parts 13, 18, 216, and 229). This statute and implementing regulations are applicable should removal of pilings threaten to "take" (including harrass) marine mammals in Ostrich Bay. If this occurs, consultation with the National Marine Fisheries Service would be required to find ways to avoid the taking or to obtain special permission to do so (if administrative requirements applied, this permission would be in the form of a permit).

Federal Fish and Wildlife Coordination Act (16 USC 661 et seq.). The requirements of this statute are applicable to any construction activities that modify the shoreline. Actions must protect affected fish and wildlife resources.

Federal Coastal Zone Management Act (16 USC 1451). The requirements of this statute are applicable to pilings removal along the shoreline. Proposed actions must be consistent with state coastal zone management (as governed by the Washington State Shoreline Management Act).

Washington State Shoreline Management Act (Chapter RCW 90.58; Chapters 173-, 173-16, 173-22, and 173-27 WAC). The substantive requirements of this statute and implementing regulations are applicable to construction activities along the shoreline (extending 200 feet landward). WAC 173-27-060(1) discusses the applicability of chapter 90.58 RCW to federal lands and agencies within the coastal counties, one of which is Kitsap County. Proposed actions must be consistent with the policies and goals of the approved Washington state coastal zone management program and with the policies and shorelands use designations of the local jurisdiction's shoreline master plan (Kitsap County shoreline designation maps, WAC 173-22-0636). Guidelines for local regulation of shoreline protection [WAC 173-16-060(17)] are relevant and appropriate for piling removal.

Washington State Hydraulic Projects Approval (Chapter 75.20.100-160 RCW; Chapter 220-110 WAC). This program is applicable to any work conducted along the shoreline that changes the natural flow or bed of Ostrich Bay (and therefore has the potential to affect fish habitat). The requirements include saltwater technical provisions (WAC 220-110-230), and prohibited work times in saltwater areas, such as surf smelt spawning times (-271).

Action-Specific ARARs

Federal Hazardous Materials Transportation Act (49 USC 5101-5127; 49 CFR Parts 171-173, 177). This program addresses the movement of hazardous materials on public highways. If waste generated during the selected remedy for marine tissue is hazardous and must be transported to a treatment or disposal facility, the following regulations are applicable: 49 CFR Part 171, describing general requirements and hazardous waste shipments; Part 172, providing a table of hazardous materials and prescribing labeling and packarding; Part 173, providing general requirements for shipping and packaging by shippers; and Part 177, regulating hazardous material shipment by highways.

Federal Clean Air Act (42 USC 7401 et seq.; 40 CFR Part 50). This statute and regulations are applicable to any fugitive dust generated during piling removal. The ambient air quality standard for fine particulates (PM10) is relevant and appropriate to remedial activities at OU 1.

Federal Resource Conservation and Recovery Act—Subtitle C (42 USC 6921-6925; 40 CFR Parts 261-265 and 268). Hazardous waste identification, accumulation, manifesting, transport, treatment, storage, and disposal requirements are applicable if hazardous waste should be generated.

Federal Resource Conservation and Recovery Act—Subtitle D (42 USC 6941-6949; 40 CFR Parts 257, 258). Solid nonhazardous waste siting and disposal requirements are applicable to nonhazardous waste generated (which may include pilings).

Washington State Transportation of Hazardous Materials (Chapter 46.48 RCW; Chapter 446-50 WAC). The Washington State Patrol adopts by reference the federal Hazardous Materials Transportation Act regulations governing transportation of hazardous materials on public highways; these regulations are applicable to transportation of pilings.

Washington State Clean Air Act (Chapter 70.94 RCW; Chapters 173-400, 173-470 WAC). Ambient air quality standards for total suspended particulates and fine particulates (PM10) are relevant and appropriate to remedial activities.

Puget Sound Air Pollution Control Agency (PSAPCA) Regulation I, Section 9.15, Fugitive Dust Control Measures. Precautions to minimize visible fugitive dust emissions are applicable to piling removal.

Washington State Hazardous Waste Management Act (Chapter 70.105D RCW; Chapter 173-303 WAC). This statute and implementing regulations specify identification, accumulation, manifesting, transport, treatment, storage, and disposal requirements for dangerous waste (including state-only wastes). If the pilings that are removed exhibit characteristics or criteria of dangerous wastes, then the regulations would apply. WAC 173-303-071(3)(g) states that treated wood waste is excluded from dangerous waste regulations under certain conditions.

Washington State Solid Waste Management Act (Chapter 70.95 RCW; Chapter 173-351 WAC). Requirements for handling, siting, storage, and disposal of solid waste are applicable to pilings that are removed during remediation of OU 1 that are disposed of as waste.

Other Criteria, Advisories, or Guidance To Be Considered (TBCs)

In implementing the Selected Remedy, the Navy, EPA, and WDOE have agreed to consider nonbinding criteria that are TBCs. The WDOE publication *Statistical Guidance for Site Managers* is considered a TBC for evaluating confirmational sampling and monitoring data.

12.3.3 Cost-Effectiveness

The selected remedy for marine tissue is cost-effective because it has been determined to provide overall effectiveness proportional to its cost, with an estimated present worth cost of $615,000. Alternative 2 would also achieve the RAO for marine tissue, at a cost of $375,000. The selected remedy (Marine Tissue Alternative 3) provides for permanent removal of a potential long-term source of contamination, and may provide for greater beneficial use of shellfish resources in the future compared with Marine Tissue Alternative 2. Therefore, the selected remedy represents a reasonable value for the money that will be spent.

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

The selected remedy represents the maximum extent to which permanent solutions and treatment technologies can be used in a cost-effective manner for OU 1. It is protective of human health and the environment, complies with ARARs, and provides the best balance of trade-offs in terms of long-term effectiveness, permanence, short-term effectiveness, implementability, cost, and reductions in toxicity, mobility, or volume achieved through treatment. Removing the pilings will permanently eliminate a potential long-term source of contamination from the marine environment. The pilings will be treated only if required for proper disposal. Treatment was not found to be practicable for the other COCs found in marine tissue at OU 1 because no sources were identified. The selected remedy meets the statutory requirement to use permanent solutions and treatment technologies to the maximum extent practicable.

12.3.5 Preference for Treatment as a Principal Element

There are no principal threat wastes associated with the marine tissue contamination. Therefore, the selected remedy for marine tissue at OU 1 satisfies the preference for treatment to address the principal threat posed by conditions at the site. As explained above, the pilings will be treated only if required for proper disposal. Treatment was not found to be practicable for the other COCs found in marine tissue at OU 1 because no sources were identified.

12.3.6 Five-Year Review Requirements

Because this remedy will result in hazardous substances, pollutants, or contaminants remaining on site above levels that allow for unlimited use and unrestricted exposure, a statutory review will be conducted within five years after initiation of remedial action to ensure that the remedy is, or will be, protective of human health and the environment.

12.4 BENZENE RELEASE AREA

12.4.1 Protection of Human Health and the Environment

The selected remedy for the benzene release area at OU 1 will protect human health by treating groundwater and soil to permanently destroy the COCs.

12.4.2 Compliance With ARARs

The selected remedy for the benzene release area at OU 1 will comply with federal and state ARARs that have been identified. No waiver for any ARAR is being sought or invoked for any component of the selected remedy. The ARARs identified for this remedy are discussed in the following sections.

Chemical-Specific ARARs

Clean Water Act (33 USC 1314; 40 CFR Part 131). The National Toxics Rule (40 CFR 131.36) has set forth surface water quality standards for the protection of human health (ingestion of water and aquatic life and ingestion of aquatic life only) for Washington State waters. The standards for ingestion of aquatic life are applicable to the seeps discharging to Ostrich Bay.

Washington State Water Pollution Control Act (Chapter 90.48 RCW; Chapter 173-201A WAC). Marine surface water quality standards for the protection of aquatic life are relevant and appropriate to the seeps discharging to Ostrich Bay.

Washington State Model Toxics Control Act (Chapter 70.105D RCW; Chapter 173-340 WAC). This statute and implementing regulations are applicable to the benzene release area remedy. Specifically, the following sections of the regulation are applicable: selection of cleanup actions (Ch. 173-340-360), institutional controls (-440), cleanup standards for soil (-740), cleanup standards for surface water (-730), and cleanup standards for groundwater (-720).

Location-Specific ARARs

No location-specific ARARs have been identified for the benzene release area.

Action-Specific ARARs

Federal Hazardous Materials Transportation Act (49 USC 5101-5127; 49 CFR Parts 171-173, 177). This program addresses the movement of hazardous materials on public highways. If waste generated during the selected remedy for the benzene release area is hazardous and must be transported to a treatment or disposal facility, the following regulations are applicable: 49 CFR Part 171, describing general requirements and hazardous waste shipments; Part 172, providing a table of hazardous materials and prescribing labeling and packaging; Part 173, providing general requirements for shipping and packaging by shippers; and Part 177, regulating hazardous material shipment by highways.

Federal Clean Air Act (42 USC 7401 et seq.; 40 CFR Part 50). This statute and regulations are applicable to any fugitive dust generated during remediation at OU 1. The ambient air quality standard for fine particulates (PM10) is relevant and appropriate to remedial activities at OU 1.

Federal Resource Conservation and Recovery Act—Subtitle C (42 USC 6921-6925; 40 CFR Parts 261-265 and 268). Hazardous waste identification, accumulation, manifesting, transport, treatment, storage, and disposal requirements are applicable if hazardous waste should be generated during remediation at the benzene release area.

Federal Resource Conservation and Recovery Act—Subtitle D (42 USC 6941-6949; 40 CFR Parts 257, 258). Solid nonhazardous waste siting and disposal requirements are applicable to nonhazardous waste generated during remediation at the benzene release area.

Washington State Underground Injection Control Program Regulations (Chapter 173-218 WAC). These regulations set forth procedures and practices for injection of fluids into wells. They apply to the placement of treatment chemicals into wells or boreholes for the treatment of soil and/or groundwater.

Washington State Transportation of Hazardous Materials (Chapter 46.48 RCW; Chapter 446-50 WAC). The Washington State Patrol adopts by reference the federal Hazardous Materials Transportation Act regulations governing transportation of hazardous materials on public highways; these regulations are applicable to remediation in the same manner as the federal regulations.

Washington State Clean Air Act (Chapter 70.94 RCW; Chapters 173-400, 173-470 WAC). Ambient air quality standards for total suspended particulates and fine particulates (PM10) are relevant and appropriate to remedial activities at the benzene release area.

Puget Sound Air Pollution Control Agency (PSAPCA) Regulation I, Section 9.15, Fugitive Dust Control Measures. Precautions to minimize visible fugitive dust emissions are applicable to remediation at the benzene release area.

Washington State Hazardous Waste Management Act (Chapter 70.105D RCW; Chapter 173-303 WAC). This statute and implementing regulations specify identification, accumulation, manifesting, transport, treatment, storage, and disposal requirements for dangerous waste (including state-only wastes). If soil is excavated during remediation at the benzene release area and exhibits characteristics or criteria of dangerous wastes, then the regulations would apply.

Washington State Solid Waste Management Act (Chapter 70.95 RCW; Chapter 173-351 WAC). Requirements for handling, siting, storage, and disposal of solid waste are applicable to any excavated soil generated during remediation that is disposed of as waste.

Washington State Minimum Standards for the Construction and Maintenance of Wells (Chapter 18.104 RCW; Chapter 173-160 WAC). These standards are applicable to the construction, testing, and abandonment of resource protection wells such as monitoring wells.

Other Criteria, Advisories, or Guidance To Be Considered (TBCs)

In implementing the Selected Remedy, the Navy, EPA, and WDOE have agreed to consider nonbinding criteria that are TBCs. The WDOE publication *Statistical Guidance for Site Managers* is considered a TBC for evaluating confirmational sampling and monitoring data.

12.4.3 Cost-Effectiveness

The selected remedy for the benzene release area at OU 1 is cost effective because it has been determined to provide overall effectiveness proportional to its cost, with an estimated present worth cost of $540,000. The removal and disposal alternative considered for the benzene release area would cost approximately twice as much as the selected remedy and would not provide significantly greater protection. Benzene Release Area Alternatives 2 and 3, which involve long-term treatment of the groundwater plume but not the source area, would cost approximately three times as much as the selected remedy and would not provide greater protection. Therefore, the selected remedy represents a reasonable value for the money that will be spent.

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

The selected remedy represents the maximum extent to which permanent solutions and treatment technologies can be used in a cost-effective manner for the benzene release area at OU 1. It is protective of human health and the environment, complies with ARARs, and provides the best balance of trade-offs 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 extent practicable. The benzene and petroleum hydrocarbons in groundwater and soil will be treated using oxygen-releasing chemicals. The use of oxygen-releasing chemicals is an innovative treatment technology designed to stimulate in situ aerobic biodegradation of benzene and petroleum hydrocarbons.

12.4.5 Preference for Treatment as a Principal Element

Although there are no principal threat wastes associated with the benzene release area, treatment of contaminated soil and groundwater was found to be practicable and is part of the selected remedy. Therefore, the selected remedy for the benzene release area at OU 1 satisfies the preference for treatment to address the principal threats posed by the site. As explained above, the benzene and petroleum hydrocarbons in groundwater and soil will be treated using oxygen-releasing chemicals. The treatment will be designed to stimulate aerobic biodegradation of benzene and petroleum hydrocarbons.

12.4.6 Five-Year Review Requirements

Because this remedy will result in hazardous substances, pollutants, or contaminants remaining on site above levels that allow for unlimited use and unrestricted exposure, a statutory review will be conducted within five years after initiation of remedial action to ensure that the remedy is, or will be, protective of human health and the environment.

13.0 DOCUMENTATION OF SIGNIFICANT CHANGES

The Proposed Plan released for public comment in October 1999 discussed remedial action alternatives for OU 1 and identified the preferred alternatives. The selected remedy for OU 1 includes significant changes to the proposed remedy described in the Proposed Plan. These changes are as follows:

- The Proposed Plan indicated that a system of anchored logs would be used as a shoreline stabilization measure on the southern portion of the shoreline. The use of anchored logs is no longer considered appropriate at this location due to issues encountered with their use at another Navy site (FWENC 2000x). The shoreline stabilization measure described in the selected remedy for this area is a vegetated, low rock shelf. The vegetated low rock shelf consists of a row of approximately 2,000- to 3,000-pound stones placed in a single row at approximately mean higher high water level. Vegetation will be planted behind the stones, continuing into the upland area. The conceptual design for the low rock shelf is based on a successful section of shoreline on the southern boundary of Elwood Point. The Navy believes that this approach will provide more functional habitat and a more permanent solution, compared to anchored logs. The design specifics of the shoreline stabilization measures will be determined in the remedial design.

- The Proposed Plan did not include removal of the fishing pier on the North shore of Elwood Point. Removal of the pier and approximately 115 wooden pilings that support the pier has been added to the selected remedy. As a result, a greater amount of treated wooden pilings will be removed from Ostrich Bay.

14.0 RESPONSIVENESS SUMMARY

The public comment period extended from October 4 to November 4, 1999. Several verbal comments were made at the public meeting on October 20, 1999. Written comments were received from one community member, the Suquamish Tribe, and the Washington State Department of Fish and Wildlife. The comments and the Navy's responses are presented below:

14.1 VERBAL COMMENTS RECEIVED AT THE PUBLIC MEETING

Note: The comments below are summarized from verbal statements made at the public meeting. A verbatim transcription of the comments is available in the Administrative Record.

1. *What is the frequency of maintenance, and the cost of maintenance, expected for the riprap armor on the north shoreline of Elwood Point?*

Response: The Navy is committed to maintaining the shoreline protection system in perpetuity, or until future cleanup eliminates the need for the shoreline protection system. Land use restrictions that are part of the Selected Remedy will ensure that the integrity of the shoreline protection system is maintained. An Operations and Maintenance plan will be prepared that specifies regular inspections; the inspections will be used to identify the need for any maintenance. The remedial design will incorporate standard shoreline engineering and design practices to create a stable shoreline protection system and minimize the need for maintenance. For cost estimating purposes, the FS assumed an average annual maintenance cost of $16,000 for the entire OU 1 shoreline.

2. *Why was the site divided into two Operable Units?*

Response: The Navy chose to separate the site into two operable units to expedite the cleanup of the terrestrial portion of the site. OU 1 includes the four terrestrial sites. Human health risks, including ingestion of seafood, are also included in OU 1. By moving forward with cleanup at OU 1, the Navy can reduce human health risks faster, while the remaining ecological issues for OU 2 are resolved. A separate Proposed Plan and ROD will be issued for OU 2, which addresses sediments in Ostrich Bay and marine ecological risks.

Since the public meeting, the Navy has created a third operable unit for the site. OU 3 will address any unexploded ordnance (UXO) or ordnance explosive waste (OEW) that may be present on JPHC/NHB property or in Ostrich Bay. OU 3 was created because the approach for addressing UXO/OEW is still being developed, and the Navy did not want to delay the cleanup of OU 1. A separate Proposed Plan and ROD will be issued for OU 3.

3. *What is the source of the bacteria in the shellfish?*

Response: JPHC/NHB is not the source of the bacteria in shellfish. All sewage from JPHC and NHB is sent to the City of Bremerton for sewage treatment. The ban on shellfish harvesting is administered by the Washington State Department of Health. That agency has information on the potential sources of bacterial contamination in Ostrich Bay and other areas of Puget Sound.

4. *Are the cancer risks from eating clams and crabs cumulative?*

Response: Yes. The more clams and crabs a person eats in their lifetime, the greater their cancer risks. The human health risk assessment evaluated the risks for persons who eat clams only, crabs only, or both clams and crabs. Both recreational ingestion rates and subsistence ingestion rates were evaluated. The calculated Reasonable Maximum Exposure (RME) cancer risks under the future subsistence harvesting scenario assumed a person ate both clams and crabs over 24 years.

5. *Is the shellfish harvest closure in Ostrich Bay due to the JPHC/NHB Superfund Site, and chemical contamination in the shellfish, not just because of bacterial contamination?*

Response: The Navy met with the Washington State Department of Health, which indicated that two primary issues would have to be resolved before it would allow shellfish harvesting in the area.

First, questions regarding chemical contamination in shellfish would have to be resolved. The human health risk assessment calculated cancer risks greater than 1E-04 due to chemicals in the shellfish. However, as discussed in the risk assessment there is a great deal of uncertainty in the calculated risks. The uncertainty primarily is due to the low frequency of detections of chemicals of concern, and unknown background concentrations of antimony and vanadium. The marine tissue monitoring program that is part of the Selected Remedy will generate the data needed to address these uncertainties. Using this data, Washington State Department of Health can determine whether shellfish harvesting should be banned due to chemical contamination.

Second, fecal coliform levels in Ostrich Bay are unsafe. There is a concern that a City of Bremerton sewer outfall on the Port Washington Narrows is washing material into Ostrich Bay.

Privately owned septic systems in the area may also be contributing to fecal coliform levels in Ostrich Bay. Until the fecal coliform issues are resolved, the shellfish harvesting ban will remain in place.

6. *Why are ordnance compounds not listed as chemicals of concern in the Proposed Plan? Are there cleanup standards for these?*

Response: The RI included sampling for ordnance-related chemicals in soil, groundwater, surface water, sediments, and marine tissue (clams and crabs).

For soil, groundwater, and surface water, there are established state cleanup standards, based on toxicology, for most of the ordnance compounds—exceptions are picric and picramic acids. Although there were low-level detections of some ordnance compounds in these media, none of the detections exceeded state cleanup levels.

For marine tissue (clams and crabs), there are no established state cleanup standards. Although there were detections of some ordnance compounds in clams and crabs in the early 1990s, the detections were suspected to be artifacts of the analytical methods used at the time, and the data were rejected. The Human Health Risk Assessment used conservative partitioning calculations to predict ordnance concentrations in clam and crab tissues, based on measured sediment concentrations.

The Human Health Risk Assessment did not identify any significant risks related to ordnance compounds, based on measured concentrations in soil, groundwater, and surface water, and based on calculated concentrations in clams and crabs. Because no human health risks were identified and no cleanup levels were exceeded, ordnance compounds are not considered chemicals of concern for OU 1.

For marine sediments, no ecological-based cleanup levels have been established for the ordnance compounds. There were low-level detections of some ordnance compounds in Ostrich Bay marine sediments. The Navy is conducting studies to establish ecological-based cleanup levels for the ordnance compounds. Preliminary indications from these studies are that the concentrations of ordnance compounds found in Ostrich Bay sediments are below levels that cause adverse ecological responses. Any ecological risks that may be associated with ordnance compounds in marine sediments will be addressed as part of OU 2.

7. *What marine species would be monitored as part of the Preferred Alternative? A species that lives in the sediment, such as a worm, might be appropriate. Sea cucumber may also be an appropriate species.*

Response: The specifics of the monitoring program will be developed as part of the remedial design, in consultation with the Suquamish Tribe and the Washington State Department of Health. The marine tissue monitoring for OU 1 will be designed to (1) better define human health risk associated with ingestion of seafood from Ostrich Bay, and (2) provide the information needed so that the Washington State Department of Health can determine the need for shellfish harvest restrictions due to chemical contamination. As such, the monitoring program is expected to consist of sampling and analysis of one or more species of shellfish. Monitoring of a worm species would not be useful for determining human health risks, which are addressed in OU 1. It is possible that the Selected Remedy for OU 2 would include monitoring elements such as bioassays that assess ecological risk to species living in the sediment.

8. *How will magnesium peroxide be used to clean up the Benzene Seep area?*

Response: Magnesium peroxide is a powder designed to slowly release oxygen into groundwater. The oxygen allows naturally occurring microorganisms to degrade the petroleum. There are several methods that can be used to place the magnesium peroxide into the subsurface. These include pouring the powder into an open excavation or an open borehole, mixing the powder with water and injecting the slurry into the ground, and placing fabric bags filled with the powder into monitoring wells. The methods used for the Benzene Seep area are expected to include some combination of these placement techniques. The specifics will be determined in the remedial design.

9. *Are oysters in Chico Bay a potential health threat?*

Response: The oysters in Chico Bay were not evaluated as part of the Human Health Risk Assessment. They are not expected to be affected by any activity at JPHC/NHB. A sediment transport study (which was done as part of the OU 2 investigations) showed that sediments are not moving from Ostrich Bay north into Chico Bay. The Washington State Department of Health can provide more information on whether oysters are safe to eat from Chico Bay or other areas of Puget Sound.

14.2 WRITTEN COMMENTS

Suquamish Tribe Comments on Proposed Plan

1. *The Suquamish Tribe considers the modification of a natural, ecologically functioning beach to be inappropriate and unacceptable as mitigation for the helipad shoreline armoring. Mitigation should in some way enhance already degraded habitat. "Enhancing" natural beaches is not appropriate. We offer the following suggestions as mitigation for the helipad armoring in order of our preference:*

   1) *Remove the seawall at site 101. This seawall does not have a purpose since the road behind it is being removed. This area has already been swept for unexploded ordnance and if the erosion of contaminated soils is a concern a design similar to that described in comment 2 can be implemented.*

   2) *Move the pumphouse south of Elwood Point away from the shoreline.*

   3) *Remove the large, dilapidated pier south of Elwood Point.*

Response: Mitigation is not required because the modifications to the shoreline will not result in any net loss of habitat; in fact, calculations demonstrate that there will be a net gain in intertidal habitat as well as an improvement in intertidal substrate. As discussed in the Proposed Plan (Page 17), "The shoreline stabilization measures will be designed to promote a healthier marine and land ecology to the maximum extent practical." These measures include modification to the intertidal substrate to improve spawning areas for forage fish like surf smelt, reestablishment of riparian vegetation to provide shoreline shading and organic loading to the nearshore areas, and slope modifications to minimize beach scouring from reflected wave energy.

The Navy has assumed that the "natural beach" referenced in the comment is the beach located in Zones 5 and 6A1, or the Suquamish Tribe believed that the proposed pocket beach extended into the Zone 6B area where the beach is very healthy (this area was in fact the model used for two of the shoreline zones). The beach area in Zones 5 and 6A1 is actually in an area of known historical fill (circa 1940). The pocket beach proposed in this area involves removal of fill to re-create a shoreline that is more consistent with the pre-1940s shoreline. Fill in this area also contains ordnance and explosive wastes (OEW), as evidenced by the powder cans sticking out of the bank. Of the potential shoreline protection systems considered (hard armoring etc.), the Navy believes that a change to the beach depth (accomplished by removal of fill) will be the best solution to bank erosion in this area. Beach slope and depth changes were considered for other areas, however utilities in the backshore areas prevent modifications to the beach depth in those zones.

In response to the suggestions:

1. This option was considered during the design development, however, the seawall is needed for slope shoring in the area and cannot be removed without replacement by a similar structure. The volume behind the seawall is an area of known fill that may include contaminated soil and ordnance items. A geophysical investigation and excavation of test pits in this area indicates the potential for buried OEW in the fill. Patching the seawall to prevent the migration of fill material to the intertidal area represents the best option with the lowest short-term and long-term impacts.

2. This option was considered during the design development. The federal government does not own the pumphouse and associated sewage piping. Relocation of the pumphouse would necessitate relocation of the sanitary sewer pipes including a sewer force main (pressurized sewage pipe) that runs from the pumphouse south in the intertidal area to Bremerton. Input to the lift station is from a designed gravity feed system, which would probably not function if moved to higher elevation. All of these factors combined make this a very expensive and potentially nonviable option.

3. This option was considered. The pier may be in good condition and the building on the end of the pier is eligible for listing on the National Register of Historic Places, which affords it protection under the National Historic Preservation Act. For these reasons the pier will not be demolished. An analysis has been completed on the pier which verifies its structural integrity.

2. *According to the Proposed Plan the Navy plans to stabilize the shoreline between Elwood Point and the pumphouse with a rock wall. It is our understanding that the purpose of this armoring is to prevent the erosion of contaminated soil, fill debris, and unexploded ordnance into the marine environment. While this justifies some work along the shoreline, placing riprap in the intertidal zone is not consistent with improving the habitat and may be more detrimental to the shoreline ecology and the marine environment than the contamination problem.*

The Navy is also concerned about children coming in contact with eroded fill debris at this site. The Suquamish Tribe has similar concerns. However, riprap along the shoreline represents an equal risk to children who in their efforts to reach the beach may fall or otherwise injure themselves crawling over the riprap. More injuries may in fact result from this than from children handling debris potentially eroding from the shoreline. We would further argue that the recreational benefits of a more natural shoreline are far superior to the current plan of armoring with riprap. Given that this site is a recreational area, the benefits of a more natural shoreline should be more thoroughly evaluated.

We believe a solution that is compatible with each of these concerns can be designed. We suggest removing the existing riprap, excavating the top layer of beach material, and then backfilling the area with clean beach material (i.e., pea gravel) to create a more natural shoreline. This design removes any contaminated material from contact with the marine environment, improves recreational access to the beach, and provides a better habitat for fish and shellfish. Planting large trees along the shoreline would decrease erosion and also be consistent with the recreational and habitat goals. Given the relatively low wave energy of this environment, minimal maintenance of this beach would be required. This design would also minimize excavation of contaminated soils and associated disposal costs.

Response: The current design does not include placing exposed riprap in the intertidal area (defined in the Hydraulic Code Rules as the seaward beach below mean higher high water [+12 mean lower low water]). In some areas, the toe of the armoring (needed for scour protection) is in the intertidal area, however this area is covered with "fish mix" (pea gravel) in a manner consistent with what is described above. Although the wave energy is relatively low in this area, the wave energy is sufficient to erode the existing cut bank, and protection is needed. Failure to protect the slope as described in the comment would allow continued erosion of the cut bank. The material that would be eroding has the potential for the release of contamination into the environment. This is an area of known fill and is also an area where substantial OEW was encountered. There are limitations for changing the slope in this area as well. There are several utility lines located in the bank behind the slope. These include electrical power, potable water, sanitary sewer and storm sewer lines. The location of these utilities minimizes the ability to reduce the slope. The most effective and lowest impact solution is the solution described in the design documents, which includes the removal of debris on the beach, improving the armor protection, providing for toe scour, and covering the riprap toe with fish mix.

The concern for injury from walking on the riprap is addressed in the design by providing beach access via stairs. The addition of stairs has the added benefit of keeping foot traffic off of vegetation at the top of the slope, particularly during the vegetation establishment period.

The provision for improved forage fish habitat is addressed through the addition of fish rock. Additionally, riparian vegetation will be added in this area.

3. *The figure on page 16 of the Proposed Plan indicates the majority of the north shoreline of Elwood Point south of the helipad will be stabilized. We are concerned this area will be armored with riprap. As mentioned in comment 2, this is detrimental to the shoreline ecology and should be avoided. A solution which addresses the erosion of contaminated soils, and at the same time is beneficial to the physical habitat, should be attainable.*

Response: The armor protection in this area is of two types; riprap around the helipad area and a low rock shelf along the shoreline running to the east (to approximately the "fishing pier"). Many alternative designs were considered for this section of shoreline. The design being developed meets the needs of the Navy for protection of the helipad, reducing the erosion of contaminated soil, and having no net loss of habitat. The low stone shelf design is based on a very successful strategy currently in place in the southern shoreline of Elwood Point. This solution is proposed in this area because this is an established surf smelt area and the low rock shelf has little if any encroachment into the intertidal area. The rocks are placed above mean higher high water and provide a stable shelf for planting nearshore vegetation. In the absence of this protection, the bank would continue to erode (as it is currently doing), and vegetation would not be able to establish so close to the bank. Riprap is used around the helipad area due to the depth and slope of the bank. With the inability to encroach on the helicopter landing zone area, and the desire to not move the bank farther seaward, all options require that a relatively steep bank be maintained. Riprap is more desirable than concrete because of the reduction in wave energy due to friction on the irregular surface. Riprap was selected over concrete for this reason. A few small sections of the slope (above the toe and within the intertidal area) require armoring due to slope constraints. In these situations, the armor is covered with fish rock on a 1V:2H slope. Stakeholders have expressed concern as to whether this fish rock would (1) stay on this slope, and (2) if it would be beneficial to surf smelt spawning. Fish rock was placed on the slope as a temporary measure (in two separate locations) in 1999 and has survived the storm events to date. Stability of the rock over the long-term is unknown, however initial observations are not discouraging. Surf smelt eggs were also found on the fish rock slope during a field exercise in December 1999, although survivability of the eggs is not known.

Washington State Department of Fish and Wildlife Comments on Proposed Plan

1. *The Jackson Park shoreline stabilization project offers a tremendous opportunity to create a showpiece of beach habitat restoration and enhanced recreational opportunity on the shoreline, while completing the necessary remedial actions. Although the shoreline stabilization project is designed primarily to address cleanup objectives, beach restoration and the cleanup efforts are not mutually exclusive. We hope that the Navy will use this opportunity to reestablish healthy fish and wildlife habitat at Jackson Park.*

Response: The current design incorporates actions for the enhancement of the local ecology.

2. *Past bankline protection and intertidal fill projects have created poor upper and middle intertidal habitat conditions along most of the beach at Jackson Park. The nearshore area is important habitat for fish and shellfish resources, including juvenile salmonids during the spring outmigration for feeding and rearing habitat. Impacts from past bank protection projects and intertidal fill at Jackson Park are evident as direct loss of upper beach and conversion of sand/gravel beaches to coarse gravel/riprap beaches with mud. This change in beach characteristics results in reduced or altered prey resources available to salmonids and other fish resources. In addition, surf smelt, an important baitfish species, spawn in the upper intertidal habitat in the project vicinity. Direct loss of upper intertidal habitat can reduce available spawning area for baitfish species such as surf smelt and sandlance.*

Response: Historically, some intertidal areas at the site were filled in support of facility development and operations. In these areas, there has been a loss of upper intertidal habitat. Historical erosion control measures ranged from the engineered seawall at Site 101 to placement of concrete debris. Whether the existing, historically placed armoring (and the seawall) has resulted in larger cobble shingle on the beach is unknown. The Navy has no data available to document that the cobble has resulted from the historical armoring. There is an area, for example, on the eastern shoreline of Elwood Point that has not been armored and is covered with the same size cobble. This cobble may result from wave action and a net loss of finer material, whether there is armoring present or not.

The intent of the shoreline stabilization design for this remedial action is to prevent erosion of any contaminated fill material, while causing no net loss of intertidal habitat and promoting a healthier shoreline ecology to the maximum extent practical. The Navy is cognizant of the importance of baitfish spawning in the area and has incorporated protective actions in the design of the shoreline protection system. The design includes reclamation of upper intertidal habitat by removing fill and creating a "pocket beach" on the southern shoreline of Elwood Point (Zones 5 and 6A1). This action may restore the shoreline to approximate pre-1940s condition. In other areas, removal of historical intertidal fill is not practical and other protective measures are required. The design has placed virtually all of the hard armoring above mean higher high water. Fish rock has been added as substrate enhancement in several areas. Please also read Response 3 to the comments from the Suquamish Tribe.

3. *The project as proposed will degrade additional beach habitat at Jackson Park by adding a substantial amount of riprap to the intertidal area. The shoreline stabilization project should be designed to not only avoid new impacts to beach habitat but also to afford the opportunity to address past intertidal encroachments damaging beach habitat.*

Response: The current design does not include placing exposed riprap in the intertidal area. In some areas, the toe of the armoring (needed for scour protection) is in the intertidal area, however this area is covered with "fish mix" (pea gravel). For the project as a whole, calculations demonstrate that there will be both a net gain in intertidal habitat and an improvement in substrate. The design includes reclamation of upper intertidal habitat by removing fill and creating a "pocket beach" on the southern shoreline of Elwood Point (Zones 5 and 6A1). The responses to the Suquamish Tribe's comments 1, 2, and 3 describe some of the engineering limitations on addressing past intertidal encroachments on other portions of the shoreline.

4. *The proposed design for the "vegetated shore protection" includes a large amount of riprap at a relatively steep beach slope (3:1), with geogrids planted with vegetation at the highest elevations. The steep angle of the riprap cannot retain "fish rock" (pea gravel) placed as beach enhancement, such that the final product after storm events will be simply a bed of riprap extending approximately 20 feet into the intertidal in zones 3 and 4 (400 to 600 feet of shoreline). Although some vegetation is included in the design, use of the terms "vegetated shore protection" and "bioengineering" is misleading, as most of the project relies on riprap rather than native materials and plants for erosion control. This area is also very close to documented surf smelt spawning habitat at Elwood Point. This design needs modification, e.g., to be moved at least 20 feet landward, to avoid additional impacts to fish resources.*

Response: The design documents for the remedial action provide more specifics on the placement of the riprap. For most of the shoreline where riprap is the proposed solution to cut bank erosion, the riprap toe is the major portion of the riprap that is placed in the intertidal area.

The toe is typically on the same slope as the existing beach. The riprap toe is covered with fish rock. Because of this, the fish rock is anticipated to be quite stable. If the fish rock were to move due to storm events the exposed riprap would extend a maximum of 5 feet into the intertidal area versus the 20 feet suggested.

Where fish rock is placed on a steeper slope, such as 3H:1V (a few areas where the slope cannot be changed due to constructability issues), there may be issues with the longevity of the fish rock and with surf smelt egg survivability. Data are not currently available to definitively answer these two questions and this may merit further study.

The term "bioengineering" does not appear in the Proposed Plan, but was used in the design documents. The terms "bioengineering" and "vegetated shore protection" are not meant to be misleading. The bioengineering term for geogrids has been the topic of debate by others as well. One suggested replacement is biogeoengineering. Vegetated shore protection is appropriate because of the vegetation being added to the top of the bank to reduce stormwater flow velocity and subsequent erosion. Vegetation will ultimately be the primary inhibitor to shore slope erosion from stormwater runoff.

5. *An alternative design, which restores the natural beach profile and removes the existing riprap/concrete encroachments, is highly desirable to restore beach habitat conditions. Shoreline protection could be added landward of the extreme high tides (i.e., above the ordinary high water line) for erosion control, if needed. This may involve some excavation of contaminated material in the areas of intertidal encroachment and backfill with clean material. If this can be safely done, the habitat benefits of restoration of the beach profile would be very high. By recreating a natural profile, maintenance could potentially decrease over the artificial and intrusive rock riprap bank. In addition, recreational opportunity provided by a natural beach would be beneficial to Jackson Park residents.*

Response: Riprap shoreline protection has only been used in areas where constructability issues prevent excavation landward of the current backshore. For example, in Zones 3 and 4, buried utilities prevent excavation landward, and in Zone 7, the helipad prevents excavation landward. In other areas where rock is used (low rock shelf) the rock is placed above mean higher high water. In almost all areas where riprap is being used it is placed above mean higher high water except for portions of the toe. In Zones 5 and 6A2 the beach is being cut back (pocket beach), and the gentler slope is being used to dissipate wave energy. The cut back can be used in this area because there are no constructability issues.

6. *In the area of the helicopter pad, the seawall should be minimized in length and height to the greatest extent possible to reduce impacts to fish resources.*

Response: In the design, the riprap armor area of the helicopter pad was minimized in length to the extent possible.

7. *Mitigation for the proposed project impacts can only be fully evaluated after the project design is modified to result in the minimum impacts to natural resources necessary to achieve cleanup objectives. The current mitigation proposal suggests removal of wooden pilings from Ostrich Bay and development of one "pocket beach" on the south side of Elwood Point. The proposed plan did not indicate the number or location of pilings, but in past meetings, removal of approximately 300 old creosote piles was discussed to improve water quality. This type of mitigation is appropriate for water quality impacts and should be included as part of the mitigation package. However, piling removal does not address beach habitat direct and indirect losses due to shoreline stabilization efforts. The proposed "pocket beach" location already has relatively undisturbed habitat such that gains would be marginal. Surf smelt use of the "pocket beach" cannot be assumed, even if found in the vicinity, for reasons we do not fully understand at this time. Additional mitigation to address loss of beach habitat (assuming it has been minimized by design changes) should be added to the mitigation package. We recommend the following options:*

    1. *Restore beach habitat lost due to past bank protection/intertidal fill projects*
    2. *Replace the concrete wing walls from under the Elwood fishing dock to a location landward of the ordinary high water line to restore natural beach material movement*
    3. *Remove quarry spalls, riprap, and debris from the intertidal area*
    4. *Replant the riparian corridor along the shoreline*
    5. *Relocate the lift station and remove the intertidal fill*
    6. *Restore the small stream piped to the outfall to a functional stream with natural outlet to the beach*

Response: As discussed in Response 1 to the Comments from the Suquamish Tribe, mitigation is not needed because there is a net gain in intertidal habitat and an improvement in substrate. Calculations for habitat areas are included in the design documents. Addition of the pocket beach has not been added as a mitigative measure, but rather to reduce erosion from the cut bank by dissipating wave energy. A collateral effect is that upper intertidal habitat will be restored by removing the fill, and the beach may be similar to the pre-1940s condition (although this can not be directly verified). The removal of wooden pilings is not a mitigative measure. This removal is being conducted to reduce a potential source of pentachlorophenol in Ostrich Bay. Three hundred ten timber pilings are identified on page 11 of the Proposed Plan, under Marine Tissue Alternatives—Alternative 3. The Navy has also included the removal of the fishing pier on Elwood Point in the design; this is explained further in the Documentation of Significant Changes section of this ROD.

In response to the suggestions:

1. The design provides a net gain in intertidal habitat and an improvement in substrate. As explained in the response to Comments 1, 2, and 3 of the Suquamish Tribe and Comment 2 of the State of Washington Department of Fish and Wildlife, constructability issues preclude complete restoration of every area where fill or bank protection measures have historically been placed along the shoreline.

2. There is some indication (from review of aerial photographs) that the concrete abutment from the old railroad pier (currently the fishing pier) has modified the mass transport of beach substrate. Because this area (concrete abutment) is not an area of known contamination, removing the abutment would be out of scope of the remediation work.

3. The current plans call for the removal of debris, such as concrete, metal, and old storm water pipe tiles, from the intertidal area.

4. The design documents include extensive plantings to reestablish the riparian vegetation.

5. As explained in the Response to Comment 1 from the Suquamish Tribe, constructability issues preclude relocating the lift station.

6. This is not a viable option. This action would require the demolition of housing units, relocation of Navy personnel, removal and relocation of numerous utilities, and the excavation and removal of 50,000 to 100,000 tons of fill material, some of which has been in place since 1912.

Community Comments on Proposed Plan

Comment by: Theodore L. Bertsch

My comments are very simple. My congratulations on a job very well done (and in progress). I also commend Puget Sound Naval Shipyard and others involved for cleaning up many areas where federal guidelines require no action required. I, as a resident of Port Orchard, am very, very impressed by the dedication / action taken by all involved. Keep up the great job.

Response: The Navy appreciates public input and is committed to taking appropriate actions to protect human health and the environment at JPHC/NHB.

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