U.S. Environmental Protection Agency
Region 10
Seattle, Washington

West Harbor Operable Unit
Wyckoff/Eagle Harbor Superfund Site
RECORD OF DECISION

September 1992

EH 9.2.2-0001

CONTENTS

List of Figures

List of Tables

List of Acronyms

AET	Apparent Effects Threshold
AKARTs	All Known Available and Reasonable Methods of Treatment
ARAR	Applicable or Relevant and Appropriate Requirement
BMP	Best Management Practice
CERCLA	Comprehensive Environmental Response, Compensation, and Liability Act
COE	U.S. Army Corps of Engineers
Ecology	Washington Department of Ecology
EPA	U.S. Environmental Protection Agency
HPAH	High Molecular Weight Polynuclear Aromatic Hydrocarbons
LPAH	Low Molecular Weight Polynuclear Aromatic Hydrocarbons
MCUL	Minimum Cleanup Level
MFS	State of Washington Minimum Functional Standards
NCP	National Contingency Plan
NOAA	National Oceanic and Atmospheric Administration
NPDES	National Pollutant Discharge Elimination System
NPL	National Priorities List
PAH	Polynuclear Aromatic Hydrocarbon
PCB	Polychlorinated Biphenyl
PI	Preliminary Investigation
POTW	Publicly Owned Treatment Works
PRP	Potentially Responsible Party
PSAMP	Puget Sound Ambient Monitoring Program
PSDDA	Puget Sound Dredged Disposal Analysis
PSEP	Puget Sound Estuary Program
PSWQA	Puget Sound Water Quality Authority
RCRA	Resource Conservation and Recovery Act
Rfd	Reference Dose
RI/FS	Remedial Investigation/Feasibility Study
ROD	Record of Decision
RME	Reasonable Maximum Exposure
SF	Slope factor
SQS	Sediment Quality Standards
TBC	Other Factors To Be Considered
UST	Underground Storage Tank

DECLARATION
FOR THE
RECORD OF DECISION

SITE NAME AND LOCATION

Wyckoff/Eagle Harbor Superfund Site
West Harbor Operable Unit
Bainbridge Island, Washington

STATEMENT OF BASIS AND PURPOSE

This decision document presents the remedial action selected by the U.S. Environmental Protection Agency for the West Harbor operable unit (OU), one of three operable units at the Wyckoff/Eagle Harbor Superfund site, located at Bainbridge Island, Kitsap County, Washington.

The remedy was chosen in accordance with the Comprehensive Environmental Response, Compensation, and Liability Act of 1980 (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 this site.

The State of Washington concurs with the selected remedy (see Appendix B).

ASSESSMENT OF THE SITE

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

DESCRIPTION OF THE REMEDY

The remedy selected in this Record of Decision addresses contaminated sediments in the West Harbor operable unit, one of three operable units at the Wyckoff/Eagle Harbor site. This is the first Record of Decision to be completed for the site.

Mercury contaminated sediments containing 5 mg/kg or more of mercury are considered a "principal threat" at this operable unit. Concentrations of mercury exceed levels acutely toxic to marine life by factors of ten or more and are significantly higher than concentrations of mercury measured in other parts of the site. The selected remedy addresses this principal threat by requiring removal of these sediments from the marine environment.

The major components of the selected remedy for the West Harbor OU include:

- further evaluation and control of potential upland sources of contamination to West Harbor sediments;
- excavation, solidification/stabilization (if necessary), and upland disposal of sediments exceeding 5 mg/kg mercury (dry weight);
- placement of a cap of clean sediment over areas of high concern for adverse biological effects and potential contaminant resuspension and bioaccumulation;
- thin-layer placement of clean sediments to enhance sediment recovery in areas of moderate concern;
- natural recovery and monitoring in areas predicted to achieve the long-term sediment cleanup objective without sediment remedial action;
- continued institutional controls to protect human health from exposure to contaminated fish and shellfish; and
- long-term environmental monitoring to evaluate the effectiveness of the remedy.

EPA will be the lead agency for implementing sediment remediation in the West Harbor. Source control efforts will be coordinated with the Washington State Department of Ecology.

STATUTORY DETERMINATIONS

The selected remedy is protective of the marine environment and human health, complies with federal and state requirements that are applicable or relevant and appropriate for this remedial action, and is cost-effective.

The remedy uses permanent solutions and alternative treatment technologies to the maximum extent practicable for this site. Most sediments in the West Harbor OU are characterized by relatively low concentrations of contamination over large areas. For this reason, treatment was not judged practicable for most areas addressed by the selected remedy. For low levels of contamination, sediment containment is an appropriate remedy.

The principal threat at the West Harbor OU are sediments containing 5 mg/kg or more of mercury. These more contaminated sediments may require treatment by solidification if they exceed regulatory limits for the Toxicity Characteristic Leaching Procedure (TCLP). In this case, the remedy will satisfy the statutory preference for treatment of the principal threat as an element of the remedy. If, according to test results, sediments do not require treatment, the remedy will not satisfy this statutory preference.

This remedial action will result in hazardous substances above health-based and environmentally-based cleanup levels remaining at the West Harbor OU. Consequently, a review will be conducted within five years after commencement of remedial action, to ensure that the remedy continues to provide adequate protection of human health and the environment. Initiation of the 5-year review period will be scheduled by EPA.

9/29/92
Date

Dana A Rasmussen
Dana Rasmussen
Regional Administrator
U.S. Environmental Protection Agency
Region 10

1. OVERVIEW

The Decision Summary provides a description of the site-specific factors and analysis that led to selection of the remedy for the West Harbor operable unit of the Wyckoff/Eagle Harbor Superfund site. It includes information about the site background, the nature and extent of contamination, the assessment of human health and environmental risks, and identification and evaluation of remedial alternatives. Further information about these topics is provided in the Administrative Record for the site, specifically in the Remedial Investigation (RI) Report (November 1989), subsequent technical memoranda (See Table 1), the Revised Risk Assessment (May 1991), and the Feasibility Study (FS) (November 1991).

The Decision Summary also describes the involvement of the public throughout the process, along with the environmental programs and regulations that may relate to or affect the alternatives. The Decision Summary concludes with a description of the remedy selected in this Record of Decision (ROD) and a discussion of how the selected remedy meets the requirements of the Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA) and the National Contingency Plan (NCP).

The Decision Summary is presented in the following sections:

Section 2	Describes general characteristics of the site and individual operable units,
Section 3	Provides site history and previous investigations or enforcement activities,
Section 4	Presents highlights of community participation.
Section 5	Describes the scope of the response action in the context of the overall site strategy,
Section 6	Presents site characteristics,
Section 7	Provides a summary of site risks,
Section 8	Describes the cleanup alternatives evaluated,
Section 9	Compares the analyses in terms of the EPA evaluation criteria,
Section 10	Presents the selected remedy,
Section 11	Documents the conformance of the selected remedy with statutory requirements, and
Section 12	Describes significant changes between the preferred alternative presented in the proposed plan and the remedy selected in the ROD.

2. SITE LOCATION AND DESCRIPTION

2.1 Site Location

The Wyckoff/Eagle Harbor Superfund site is located on the east side of Bainbridge Island, in Central Puget Sound, Washington (Figure 1). The site includes an inactive 40-acre wood-treating facility, the adjacent Eagle Harbor, and other upland sources of contamination to the harbor, including a former shipyard (See Figure 2).

Groundwater and soils at the wood-treating facility (the Wyckoff Operable Unit) are contaminated with chemicals from the wood treatment process, primarily creosote-derived polynuclear aromatic hydrocarbons (PAHs) and pentachlorophenol. A groundwater and oil extraction system and treatment plant have been in operation at the facility since 1990 as part of an Expedited Response Action (ERA) aimed at controlling releases of contamination to the harbor. Additional source control efforts and a Remedial Investigation and Feasibility Study (RI/FS) are planned for the facility to address remaining contamination in soils and groundwater.

Sediments in areas of the Harbor are also contaminated with PAHs and other organic compounds, as well as metals, primarily mercury. The Environmental Protection Agency (EPA) Remedial Investigation (RI) (CH2M Hill, November 1989) of the sediment contamination in Eagle Harbor initially addressed the Harbor as a single unit; however, after completion of the Feasibility Study (FS) (CH2M Hill, November 1991), EPA proposed an administrative separation of the Harbor into two areas, or "operable units."

Although wood-treating operations have ceased, the East Harbor Operable Unit (East Harbor OU, or OU-1) is subject to continuing contamination from the Wyckoff facility through seeps. An interim ROD will be completed separately for the East Harbor OU to address severely contaminated sediments where ongoing seepage is not a significant source. A final ROD for the East Harbor is anticipated once significant sources to remaining East Harbor areas have been controlled.

This ROD specifically addresses sediments and sources of contamination in the West Harbor Operable Unit (West Harbor OU, or OU-3), where significant sources are believed to have been controlled or are readily controllable. Figure 3 shows the location of the West Harbor and East Harbor Ous, as well as the Wyckoff OU (OU-2).

2.2 Current Land Use

More than 15,000 people live on Bainbridge Island. Land use on Bainbridge Island, recently incorporated as a city, is principally residential, with some commercial and industrial use (Figure 4). The former City of Winslow (population 2,800) lies on the north side of the Harbor. Residences, commercial centers, a city park, several marinas, a yacht repair yard, a bulkhead enterprise, and a ferry terminal characterize the northern shoreline. The western and southern shores are primarily lined with residences, farms, marinas, and a boatyard. On the south shore at the harbor mouth, the former wood-treating facility extends into the harbor on fill.

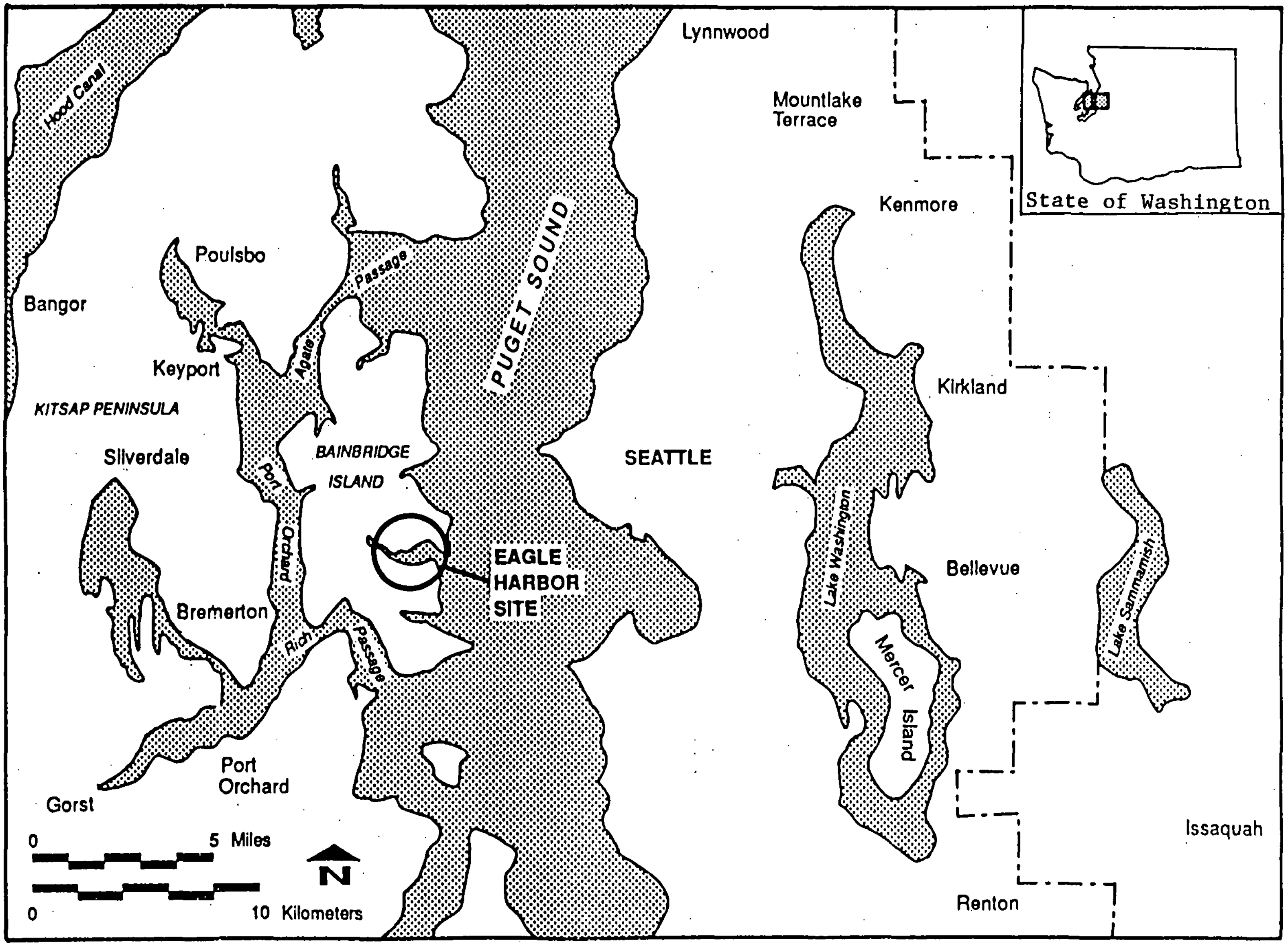

Figure 1.
Regional Setting

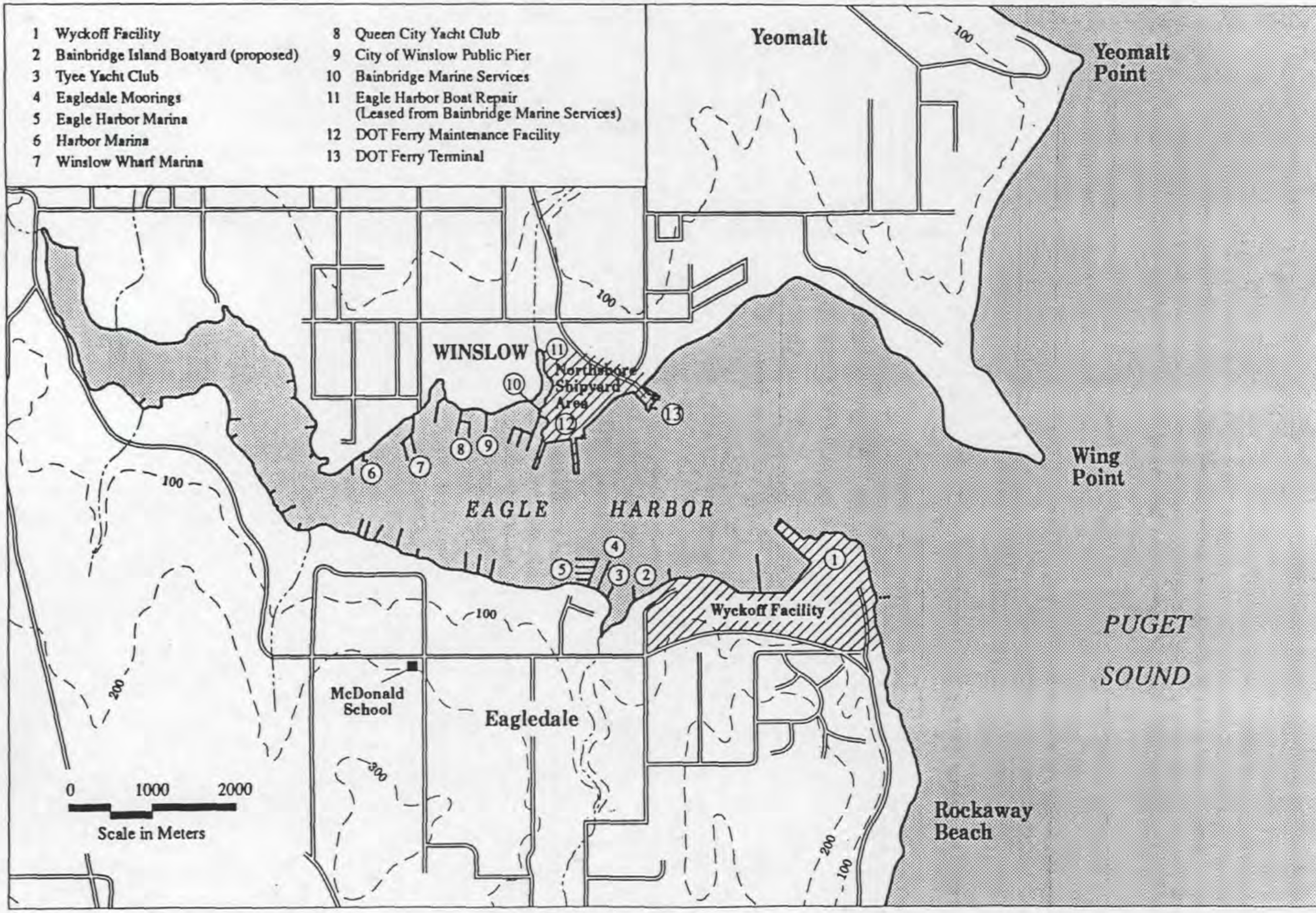

Figure 2.
Area Map

A significant use of the harbor is ferry transport of vehicles and passengers between the City of Bainbridge Island and Seattle. Currently, approximately twenty runs are made per day. The harbor is also used for moorage of pleasure boats, house boats, and working boats. Fishing, crabbing, and clam-digging were common recreational activities until 1985, when the Bremerton-Kitsap County Health District issued a health advisory to address bacterial and chemical contamination of seafood in Eagle Harbor. The advisory, recommending against the harvest and consumption of fish and shellfish, has significantly reduced recreational harvest of seafood from the harbor.

Eagle Harbor is within the usual and accustomed fishing area (U & A) of the Suquamish Tribe, whose reservation is located on the Kitsap Peninsula north of Bainbridge Island. The Suquamish Tribe retains the right to harvest fish and marine invertebrates and to have fishery resource habitat areas protected within the Suquamish Tribe's U & A.

2.3 Environmental Setting

Eagle Harbor is a Puget Sound embayment approximately 202 hectares (500 acres) in area, with a watershed (Figure 4) of approximately 1327 hectares (3,280 acres). The upper harbor is shallow, but the central channel is between 6 and 15 meters (20 to 50 feet) in depth. Several small creeks feed the harbor, and at the harbor mouth a long sandbar called Wing Point extends southward from the north shore.

The harbor supports several fish resources. Coho and chum salmon once used the creek on the north shore to spawn, and fingerlings are released there regularly. The creek at the head of the harbor is a salmon nursery, and chum may use the drainage on the south side as a spawning ground and nursery. Eagle Harbor may also be a spawning ground for surf smelt and Pacific sand lance (Washington Department of Fisheries, 1992). Other fish and invertebrates present in the harbor include several flatfish species, rockfish, pile perch, cod, lingcod, crabs, and shrimp. Several shellfish species are present in intertidal and subtidal areas.

Bainbridge Island supports a wide variety of resident and migratory birds and other wildlife. Major bird groups represented include waterfowl, shorebirds, gulls, songbirds, and raptors. Although residents report sightings of bald eagles, no critical habitats are formally designated near the site.

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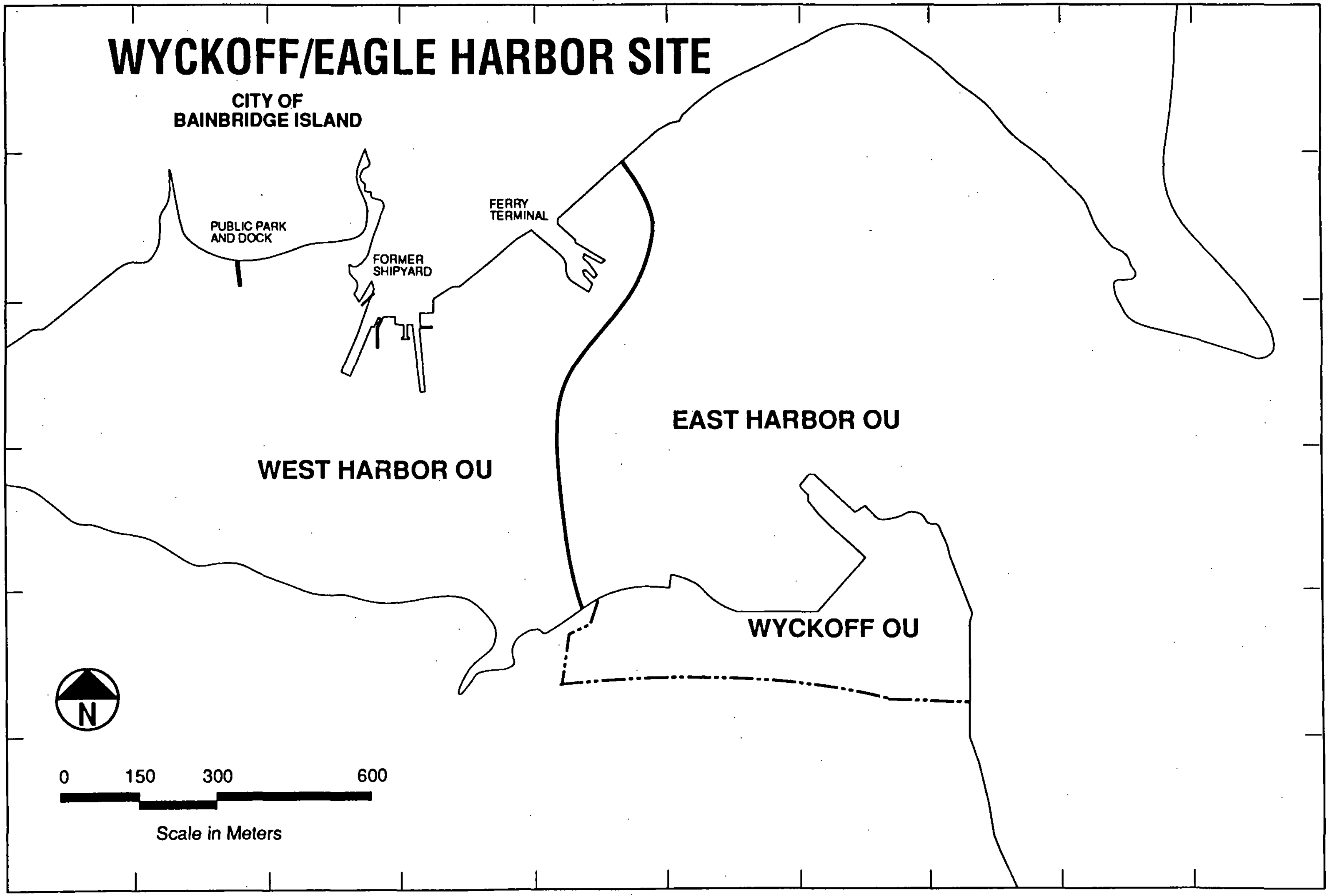


Figure 3
SITE OPERABLE UNITS

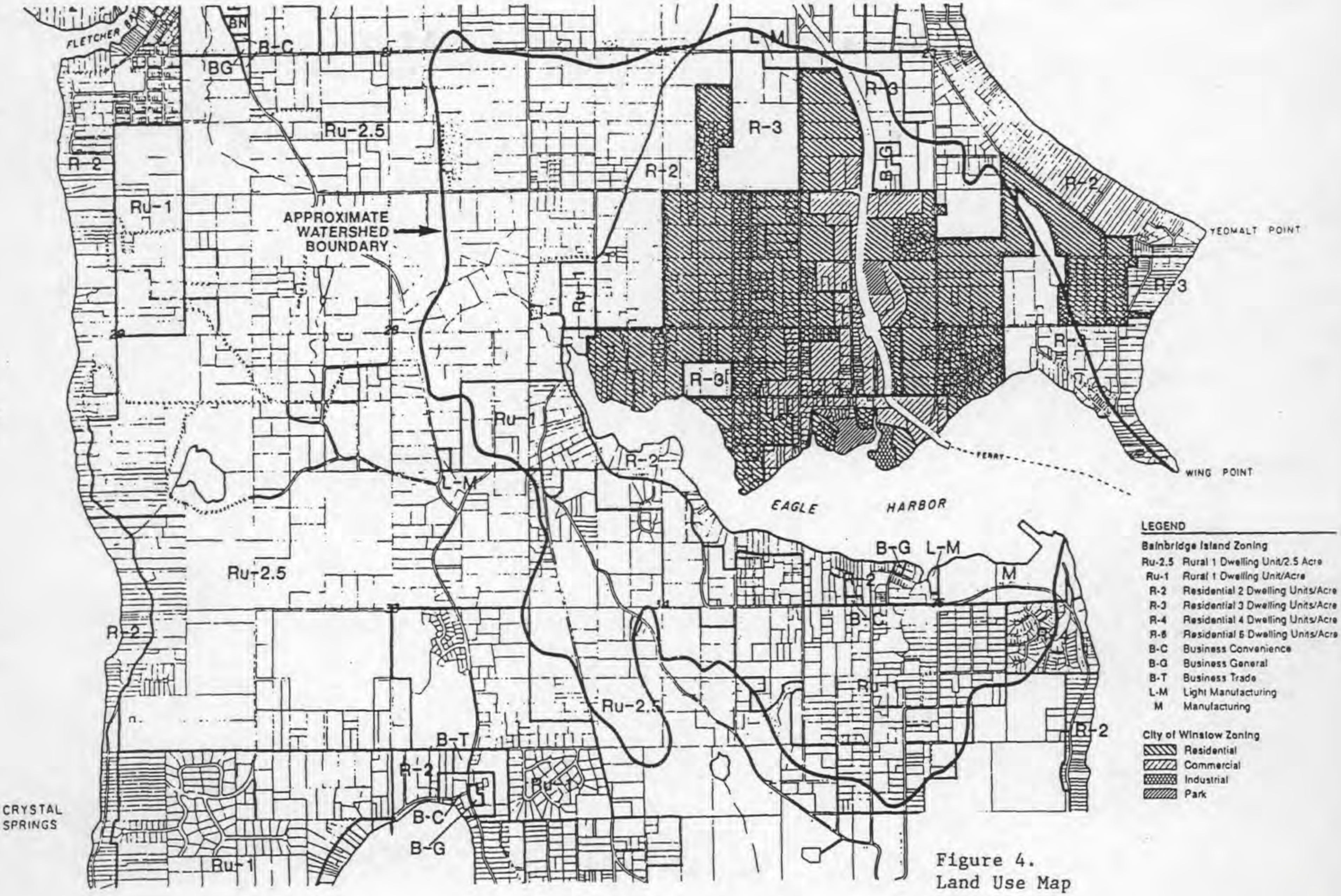


Figure 4.
Land Use Map

3. SITE HISTORY AND ENFORCEMENT ACTIVITIES

3.1 Site Background

Eagle Harbor was used as a Suquamish Indian village and burial site prior to non-Indian development in the mid-nineteenth century, and was an important shellfish harvest area for the Suquamish Tribe. Subsequent land use was residential, timber-related, or agricultural. Starting in 1903, a major shipyard was established on the north shore of Eagle Harbor, and wood-treating operations began on the south shore in 1905.

The early days of the shipyard emphasized wooden ship-building. After flourishing during World War I, the yard slumped during the 1930's. In the 1940's and 50's, the emphasis was on construction and repair of military ships, conversion of ships to wartime use, and postwar decommissioning under contracts with the Navy, Army, Coast Guard and other military entities. Repair contracts dwindled into the late 1950s, and in 1961 the property was sold and subsequently divided.

Wood treating operations at the Wyckoff OU began in 1905 and continued until 1988 through several changes of ownership. Pressure treatment with creosote was the primary method of wood preservation, although pentachlorophenol also came into use. Preservative chemicals were delivered to the facility by barge and ship and stored in tanks on the property. Spills, leaks, and drippage entered the ground directly or through unlined sumps. Wastewater was discharged into Eagle Harbor for many years, and the practice of storing treated pilings and timber in the water continued until the late 1940's.

During the 1970's, efforts were made to address oil seepage on beaches adjacent to the Wyckoff OU through inspections and recommendations. In March 1984, the National Oceanic and Atmospheric Administration (NOAA) advised EPA and the Washington Department of Ecology (Ecology) that samples of sediments, fish, and shellfish from Eagle Harbor contained elevated levels of PAHs in both sediments and biota (Malins, 1984a, 1984b).

In August of 1984, EPA issued a Unilateral Administrative Order (UAO) requiring the Wyckoff Company to conduct environmental investigation activities under the Resource Conservation and Recovery Act (RCRA) Section 3013 (42 U.S.C. § 6924), and Ecology issued an Order requiring immediate action to control stormwater runoff and seepage of contaminants. Data collected at the time revealed the presence of significant soil and groundwater contamination.

3.2 Site Listing

The Wyckoff/Eagle Harbor site was proposed to the National Priorities List (NPL) in September 1985. Under the Washington State Hazardous Waste Cleanup Program, Ecology completed a Preliminary Investigation of sediment contamination in Eagle Harbor (November 1986). In 1985, NOAA completed a study relating the presence of PAHs in sediment to the high rate of liver lesions in English Sole from Eagle Harbor (Malins, 1985). In March 1987, the Wyckoff Company entered into an Administrative Order on Consent (AOC) under CERCLA with EPA for further investigation of the facility.

The site, including Eagle Harbor, the wood-treating facility, and other sources of contamination to Eagle Harbor, was added to the NPL in July 1987, with EPA as lead agency. EPA separated the site into the Wyckoff OU and the Eagle Harbor OU, initiating the RI/FS for Eagle Harbor, and using enforcement authorities to address ongoing releases of contamination from the wood-treating facility.

3.3 CERCLA Enforcement Actions

EPA enforcement actions at the wood-treating facility after the site listing on the NPL include the following:

- A July 1988 AOC, under which the Wyckoff Company agreed to conduct an Expedited Response Action (ERA). The ERA, intended to minimize releases of oil and contaminated groundwater to the East Harbor, called for a groundwater extraction and treatment system and other source control measures.

- A June 1991 UAO requiring the Wyckoff Company (now Pacific Sound Resources) to continue the ERA with some enhancements. The UAO calls for increased groundwater extraction and treatment rates, improved system monitoring, and removal of sludge stored or buried at the Wyckoff OU.

A potentially responsible party (PRP) search was initiated in 1987 to identify parties potentially liable for response costs for Eagle Harbor, and ten parties were initially notified of potential liability in 1987 and early 1988. Continued PRP search efforts resulted in the notification of an additional party in January 1992. The liability of one of the ten parties was resolved in a bankruptcy settlement in 1991.

3.4 Eagle Harbor Remedial Investigation (RI) and Feasibility Study (FS)

CH2M Hill conducted the Eagle Harbor RI under EPA's REM IV contract. RI fieldwork began in early 1988, and the RI Report was issued November 1989. Subsequent field activities were conducted in 1989 and 1990 by CH2M Hill under the ARCS contract. These activities were described in technical memoranda and summarized in the FS, issued November 1991. Key technical memoranda are listed on Table 1.

Table 1. List of Technical Memoranda for Eagle Harbor

Memorandum Title	OU[a]	Date Finalized
Technical Memorandum on Baseline ARARs Analysis (#1)	EH/WH	September 1989
Technical Memorandum on Alternatives Identification and Screening (#2)	EH/WH	September 1989
Technical Memorandum on Development of Remedial Action Objectives (#3)	EH/WH	December 1989
Technical Memorandum on the Geophysical Survey (#6)	EH	December 1989
Technical Memorandum on the Sedimentation Rate Evaluation (#4)	EH/WH	December 1989
Technical Memorandum on Fish Tissue Sampling (#8)	EH/WH	March 1990
Technical Memorandum on the Need for Treatability Studies (#9)	EH/WH	May 1990
Technical Memorandum on the Subsurface Hydrology Study (#7)	EH	March 1990
Technical Memorandum on Source Identification (#5)	EH/WH	October 1990
Technical Memorandum on Northshore Sampling (#10)	WH	July 1990
Technical Memorandum on Deep Sediment Sampling (#11)	EH	July 1990
Technical Memorandum on Marine Biota Tissue Sampling and Analysis (#13)	EH/WH	April 1991

[a] The focus of each document is noted as EH (East Harbor OU) or WH (West Harbor OU)

4. COMMUNITY RELATIONS ACTIVITIES

Section 113(k)(2)(B) and Section 117 of CERCLA set forth the minimum requirements for public participation at sites listed on the NPL. The EPA has met these requirements and maintained an active community relations program at the site.

A community relations plan for the Wyckoff/Eagle Harbor site was prepared by Ecology in 1985 and adopted by EPA after the site was listed on the NPL in 1987. Notice of the listing of the site was published in the local paper, and a mailing list was compiled from a clip-out portion of the notice. Currently, the mailing list comprises over 650 addresses. Fact sheets have been mailed to interested citizens three or four times a year since the site listing.

The community has shown consistently high interest in the site. EPA and Ecology coordinated with the Eagle Harbor Task Force, which was active from 1985 to 1987. In 1988, public notice of the availability of funds for a technical assistance grant (TAG) was published, and the Association of Bainbridge Communities (ABC) applied for and received the grant. The group's volunteer technical advisory committee and a consultant hired with the grant monies have been active in EPA's Eagle Harbor Technical Discussion Group and regularly update the community in the ABC newsletter. The technical advisory committee and TAG consultants meet with EPA approximately bimonthly. The community relations plan was revised in late 1990 to reflect the existence of the TAG.

The Eagle Harbor RI Report was released to the public for review in November 1989. In December 1989, a public meeting was held to discuss the RI and to provide updated information on the Wyckoff facility ERA. Approximately thirty residents were present.

Throughout the RI/FS, key documents were kept at the Bainbridge Island branch of the Kitsap County Regional Library for public review. The Eagle Harbor administrative record was placed in the library in July 1991, and is updated regularly.

In December 1991, the draft final FS and Proposed Plan for Eagle Harbor were added to the information repository, and copies of the Proposed Plan were sent to citizens on the site mailing list. A sixty-day public comment period began on December 16, 1991. EPA held a public meeting on January 15, 1992 to provide information and answer community questions. An opportunity for formal public comment was provided at a second meeting on January 30, 1992. At the request of the public, the comment period was extended ten days to February 25, and comments from one party who received late notice of its potential liability were accepted until March 7.

Over 40 letters commenting on the proposed plan were submitted to EPA, and at least 70 citizens were in attendance at each of the January meetings. The Responsiveness Summary (Appendix C of this ROD) outlines and responds to the concerns voiced by the community in these forums.

The remedy selected in this ROD was selected in accordance with CERCLA, as amended, and with the NCP. The decision is based on information in the Administrative Record for the site.

5. SCOPE AND ROLE OF OPERABLE UNITS WITHIN THE SITE STRATEGY

Different environmental media, sources of contamination, public accessibility, enforcement strategies, and environmental risks in different areas of the Wyckoff/Eagle Harbor site led to the division of the Wyckoff/Eagle Harbor site into operable units. As stated in Section 2, the current division of the site is as follows:

- OU 1: East Harbor OU (subtidal sediments)

- OU 2: Wyckoff OU (soil, groundwater, East Harbor intertidal sediments)

- OU 3: West Harbor OU (subtidal/intertidal sediments, and upland sources)

Coordination between the operable units is an important element of the overall site cleanup. **This ROD presents the final selected remedy for cleanup of OU 3 (the West Harbor OU) only.**

This West Harbor OU ROD is intended to address chemical contamination of marine sediments, impacts to marine organisms, and related human exposure pathways. The focus of the actions described in Section 10 of this ROD is to control potential upland sources of contamination to the West Harbor, address highly contaminated sediments near the shipyard which may be acting as a source of contamination to other harbor areas, and reduce or eliminate environmental and human health risks associated with remaining contaminated sediments.

Other types of environmental or public health problems within the site boundaries are the responsibility of other federal, state, tribal, or local programs. Examples of problems beyond the scope of the Eagle Harbor project include problems related to bacterial contamination and impacts to marine organisms from physical disturbances such as propeller wash or shoreline uses. EPA coordinates with these other programs as appropriate.

6. SITE CHARACTERISTICS

This section summarizes information obtained during the RI/FS, including sources of contaminants, affected media, and the characteristics of the contamination.

6.1 Scope of Remedial Investigation/Feasibility Study

The RI/FS considered Eagle Harbor as a whole. The focus of the RI was to determine the nature and extent of contamination in the harbor, identify significant sources of contamination, and assess threats to human health and the environment due to chemical contamination.

Existing data which met EPA's quality assurance/quality control criteria were incorporated in the RI/FS, including data collected by Ecology in the 1986 Preliminary Investigation. As much as possible, RI/FS field sampling, laboratory analytical and biological testing methods, and processes for evaluating biological effects were consistent with methods and approaches developed for evaluating conditions in Puget Sound and later incorporated in the State of Washington Sediment Management Standards ("Sediment Standards"). The Sediment Standards are the primary Applicable or Relevant and Appropriate Requirement (ARAR) for the site.

6.2 Remedial Investigation Sampling

Initial RI field work was conducted in 1988 and included:

- intertidal and subtidal sediment sampling and chemical analysis to determine the nature and extent of contamination;
- shellfish tissue sampling and analysis to evaluate biological uptake and potential human health risks;
- laboratory bioassays to evaluate potential acute biological effects of the contamination on marine organisms;
- studies of the benthic (sediment-dwelling) community to evaluate potential chronic biological effects; and
- collection of oceanographic data for modeling contaminant fate and transport.

Ecology's 1986 Preliminary Investigation (PI) had identified a general problem area and problem chemicals, and had located a hotspot area of high PAH contamination. The problem areas and chemicals were determined based on exceedance of Puget Sound Apparent Effects Thresholds (AET), concentrations of contaminants which indicate possible biological effects.

Developed as part of the State of Washington's efforts to establish chemical standards for sediment quality, AETs were used in the RI/FS. For a given chemical, an AET is the chemical concentration in sediment above which specific biological effects have always been observed in Puget Sound studies. Chemical-specific AETs for Puget Sound have been developed for several different biological tests. Table 2 lists chemical-specific AETs (for four biological tests) available in 1988. Further discussion of AETs is provided in Section 7.

During the March 1988 field sampling for the RI, EPA collected subtidal sediment samples on an extensive grid and analyzed them for PAHs and metals to fill data gaps from Ecology's PI (Figure 5). These were compared to specific AETs in order to identify areas of potential biological effects. Areas where sediment concentrations of PAHs exceeded AETs for benthic effects (i.e., effects on the abundance of sediment-dwelling organisms) were sampled in June 1988 for an expanded list of contaminants, including PAHs, nine Nitrogen-Containing Aromatic Hydrocarbons (NCACs), four chlorophenols, other volatile and semivolatile compounds, and metals. The June sampling also included collection of sediment samples for laboratory bioassays (using amphipods and oyster larvae) and for evaluating the abundance and diversity of benthic organisms at the sample locations. The same sampling was conducted at ten sample locations in uncontaminated embayments near Eagle Harbor for comparison (Figure 6).

Intertidal sediment sampling was conducted in May and June, 1988, including a high, medium, and low tide sample from each of 16 beach transects. Samples were analyzed for the same chemicals as the June 1988 subtidal samples. At each transect, shellfish were collected and a composite sample of tissue from each transect was analyzed. Intertidal locations near and outside the harbor mouth were identified as background sampling transects (Figure 5, transects 1, 2, 3, 14, 15, and 16). Samples from the intertidal background locations contained PAHs at levels comparable to the subtidal background areas. Mercury was undetected at 0.1 mg/kg, comparable to subtidal background.

Subsequent field activities, conducted in 1989 and 1990, included sampling of beach sediments on the north shore of Eagle Harbor to further define an intertidal hotspot and to evaluate potential PAH contamination along the north shore of Eagle Harbor. Tissues of fish from Eagle Harbor and Port Madison (See Figure 6) were analyzed for metals. In the East Harbor, a diver survey, deep sediment coring, subsurface hydrology studies, and a geophysical investigation were conducted to determine the extent of a known subtidal sediment hotspot, investigate potential transport of contamination from the Wyckoff OU through the subsurface, and estimate the depth of contamination. Additional fish, shellfish, and sediment sampling was conducted in 1990 to provide more complete information about human health risks. The results of activities subsequent to the RI were presented in the technical memoranda listed in Table 1 and incorporated in the FS (November 1991).

6.3 Nature and Extent of Sediment Contamination

The nature and extent of contamination is discussed by contaminant type (organic and inorganic) and by location (intertidal or subtidal sediment).

Intertidal samples from Eagle Harbor were found to exceed the maximum concentrations measured at background locations for a number of metals (Figure 7). The greatest number of metals detected and the highest concentrations were detected near the former shipyard on the north shore. In subtidal samples, copper and lead exceeded background by two to four times in much of the harbor, and a few locations exceeded background values for zinc, cadmium, and arsenic. Subtidal mercury concentrations exceeded maximum background values by between two and twenty times throughout the harbor and were particularly high near the former shipyard (Figure 8).

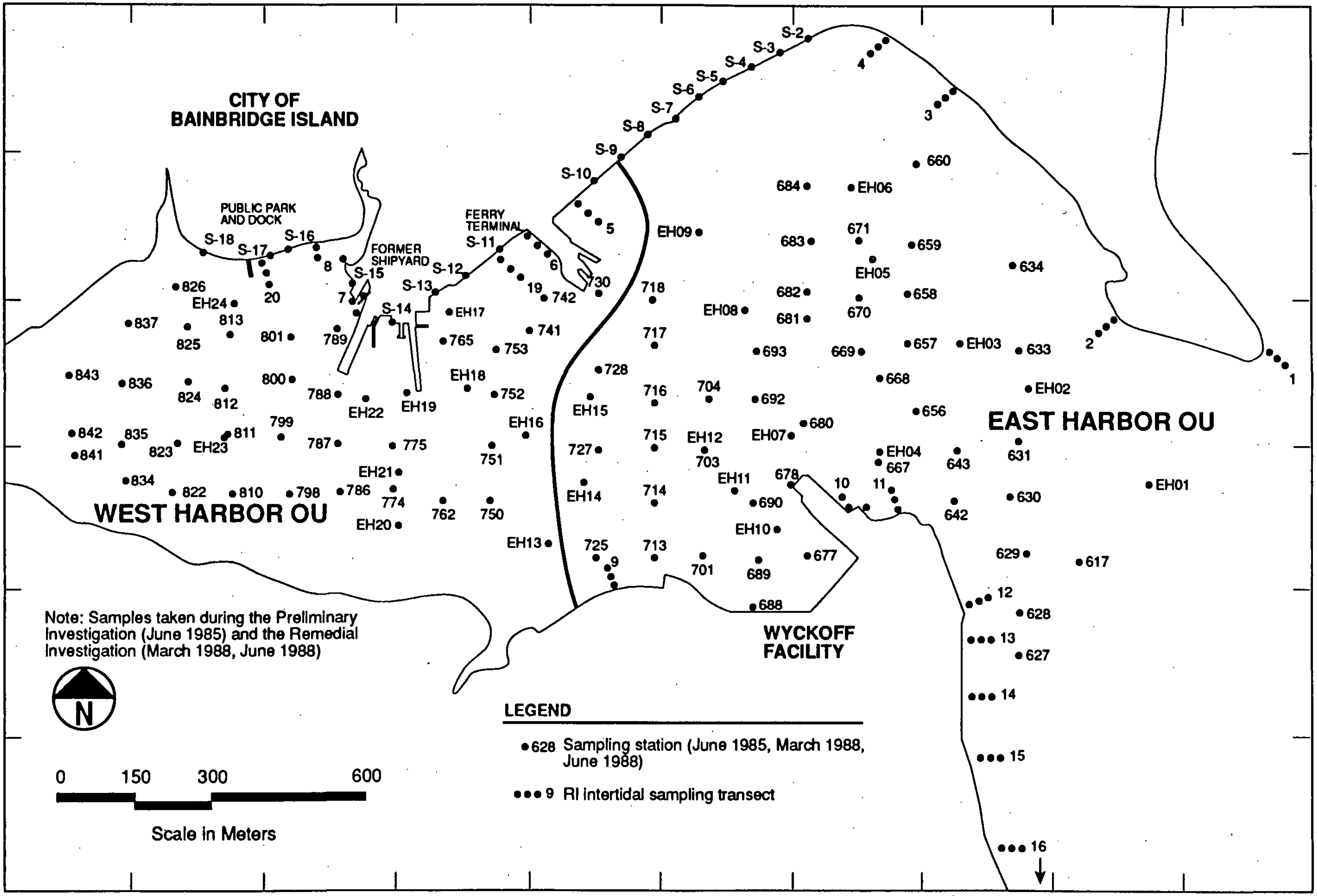


Figure 5
EAGLE HARBOR
SAMPLE LOCATIONS

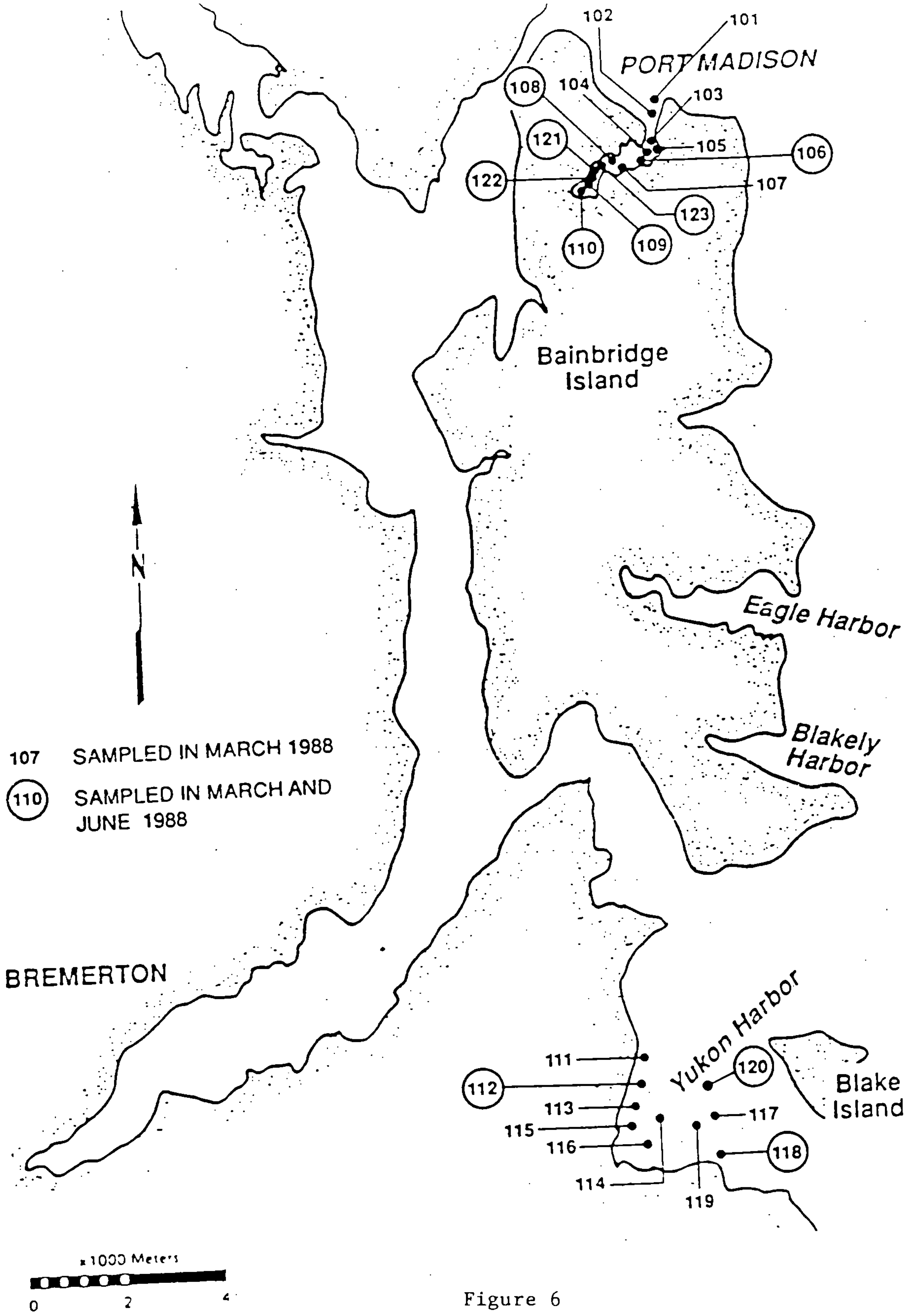


Figure 6
Subtidal Background Locations

Table 2
1988 Puget Sound AET for Selected Chemicals

Chemical	Apparent Effects Threshold (Normalized to Dry Weight)			
	Amphipod[a]	Oyster[b]	Benthic[c]	Microtox[d]
<u>Metals (mg/kg dry weight; ppm)</u>				
Antimony	200[e]	*	150[e]	*
Arsenic	93	700	57[f]	700
Cadmium	6.7	9.6	5.1[f]	9.6
Chromium	270	*	260[e]	*
Copper	1,300[g,e]	390	530[f]	390
Lead	660	660	450[e]	530
Mercury	2.1[g]	0.59	2.1[e]	0.41
Nickel	>140[h,g,e]	*	>140[h,e]	*
Silver	6.1[g,e]	>0.56[h]	>6.1[h,e]	>0.56[h]
Zinc	960[g,e]	1,600	410[e]	1,600
<u>Organic Compounds (μg/kg dry weight; ppb)</u>				
Low molecular weight PAH	24,000[e]	5,200	13,000[g,e]	5,200
Naphthalene	2,400[e]	2,100	2,700[e]	2,100
Acenaphthylene	1,300[f]	>560[h]	1,300[g,e]	>560[h]
Acenaphthene	2,000[g,e]	500	730[e]	500
Fluorene	3,600[e]	540	1,000[g,e]	540
Phenanthrene	6,900[g,e]	1,500	5,400[g,e]	1,500
Anthracene	13,000[g,e]	960	4,400[g,e]	960
2-Methylnaphthalene	1,900[f]	670	1,400[e]	670
High molecular weight PAH	69,000[g,e]	17,000	69,000[g,e]	12,000
Fluoranthene	30,000[g,e]	2,500	24,000[g,e]	1,700
Pyrene	16,000[g,e]	3,300	16,000[g,e]	2,600
Benz(a)anthracene	5,100[g,e]	1,600	5,100[g,e]	1,300
Chrysene	9,200[g,e]	2,800	9,200[g,e]	1,400
Benzofluoranthenes	7,800[f]	3,600	9,900[g,e]	3,200
Benzo(a)pyrene	3,000[e]	1,600	3,600[g,f]	1,600
Indeno(1,2,3-cd)pyrene	1,800[g,e]	690	2,600[g,f]	600
Dibenzo(a,h)anthracene	540[g,e]	230	970[g,f]	230
Benzo(g,h,i)perylene	1,400[g,e]	720	2,600[g,f]	670
Phenols				
Phenol	1,200[g,e]	420	1,200	1,200
2-Methylphenol	63	63	72[e]	>72[h]
4-Methylphenol	3,600[e]	670	1,800[f]	670
2,4-Dimethyl phenol	72[e]	29	210[e]	29
Pentachlorophenol	360[e]	>140[h]	690[e]	>140[h]

[a]Based on 287 stations (including recent surveys in Eagle Harbor, Elliott Bay, and Everett Harbor not included in the previous generation of 1986 AET).
[b]Based on 56 stations (all from Commencement Bay Remedial Investigation and Blair Waterway dredging study); unchanged since 1986.
[c]Based on 201 stations (updated from earlier AET by incorporation of recent surveys in Eagle Harbor, Elliott Bay, and Everett Harbor not included in the previous generation of 1986 AET).
[d]Based on 50 stations (all from Commencement Bay Remedial Investigation).
[e]The value shown exceeds AET presented in Beller et al. (1986) because of addition of Puget Sound data from the Eagle Harbor, Elliott Bay, or Everett Harbor surveys.
[f]The value shown is less than AET presented in Beller et al. (1986) because of the exclusion of chemically or biologically amomalous stations from the AET dataset.
[g]The value shown exceeds AET established from Commencement Bay Remedial Investigation data (Barrick et al., 1985) becouse of addition of Puget Sound data presented in Beller et al. (1986).
[h]Indicates that a defined AET could not be established because there were no "effects" stations with chemical concentrations above the highest concentration among "no effects" stations.

Note: Asterisk (*) indicates AET data not available.

Source: PTI, 1988c.

PAHs were extremely high in intertidal sediments adjacent to the Wyckoff facility (in the East Harbor OU) and, to a lesser extent, near the ferry terminal (West Harbor OU). Sediment PAH concentrations adjacent to the former shipyard in the West Harbor were lower, but were still higher than at intertidal background stations. Subtidal samples showed heavy PAH contamination in the East Harbor, with several high values near the former shipyards in the West Harbor. Estimated average concentrations of HPAH, the high molecular weight subgroup of PAH compounds, were highest north of the Wyckoff facility and in the central harbor, consistent with the initial PI problem areas, and were significantly higher than background values. Concentrations of total PAH (TPAH), low molecular weight PAH (LPAH), and NCACs followed the same general pattern. Although two of the four chlorophenols were detected, contamination by pentachlorophenol is not widespread. Figure 9 shows ranges of TPAH measured in subtidal sediments.

On the basis of their widespread prevalence above AETs, mercury and the sixteen PAH were selected as indicator contaminants to define areas for remediation. Areas of contamination by other organic compounds and metals are encompassed within areas defined by PAH and mercury.

The results of the bioassays and benthic evaluations are discussed under Section 7.2 (Ecological Assessment), while seafood contamination is discussed under Section 7.1 (Human Health Risk Assessment).

6.4 Sources of Contamination

A technical memorandum was developed (see Table 1) to identify sources of contamination to the harbor. Based on historical information and chemical data from RI/FS sampling, the memorandum listed probable major and minor sources of contamination to Eagle Harbor, including both historical and ongoing sources. The wood treating facility was identified as the major source of PAH, particularly in the East Harbor, through both past operating practices and ongoing contaminant transport through the subsurface.

In the West Harbor, PAH contamination in nearshore sediments appears to be from combustion products, minor spills, and pilings and piers, while subtidal PAH contamination in the West Harbor is believed to reflect a combination of these sources, disposal practices at the former shipyard, and releases from the Wyckoff OU. Elevated concentrations of metals, particularly near the former shipyard, are clearly associated with past shipyard operations, including the application, use, and removal (by sandblasting) of bottom paints and antifoulants.

Ongoing operations at the former shipyard include a bulkhead construction business, a yacht repair yard, and a ferry maintenance facility. These operations could be associated with continuing sources of contamination to the harbor. Other minor sources of contamination may include other boatyards and marinas, surface water and groundwater from contaminated areas of the shipyard, and storm drain releases from paved parking areas and streets.

6.5 Other Contaminated Media

The primary media of concern affected by contaminants in Eagle Harbor are intertidal and subtidal sediments, as described in previous sections. Other media considered were marine surface water, groundwater, and air.

Marine surface water and air were not identified as media of concern. Concentrations of contaminants in the air were considered negligible at the harbor, because the contaminants are primarily associated with sediments which remain under water all or much of the time. Contaminant concentrations in the marine surface water were expected to be highly dilute relative to sediment concentrations, and would pose negligible human health risk from direct contact relative to exposure to contaminated sediments. Ecology samples of surface water from ten Eagle Harbor locations (provided in the FS, Appendix B3) did not exceed water quality criteria.

EPA does not consider groundwater a medium of concern for the West Harbor OU. Groundwater is not significantly affected by the sediment contamination. Similarly, since the major source of contamination to the West Harbor OU was past direct discharges to the marine environment, the potential for groundwater transport of contamination to the sediments is low. Wyckoff facility groundwater, intertidal seeps, and soil contamination are not significant sources of contamination to the West Harbor OU. These sources, and their influence on the East Harbor OU, are being addressed as part of the ongoing studies at the Wyckoff facility and East Harbor OUs.

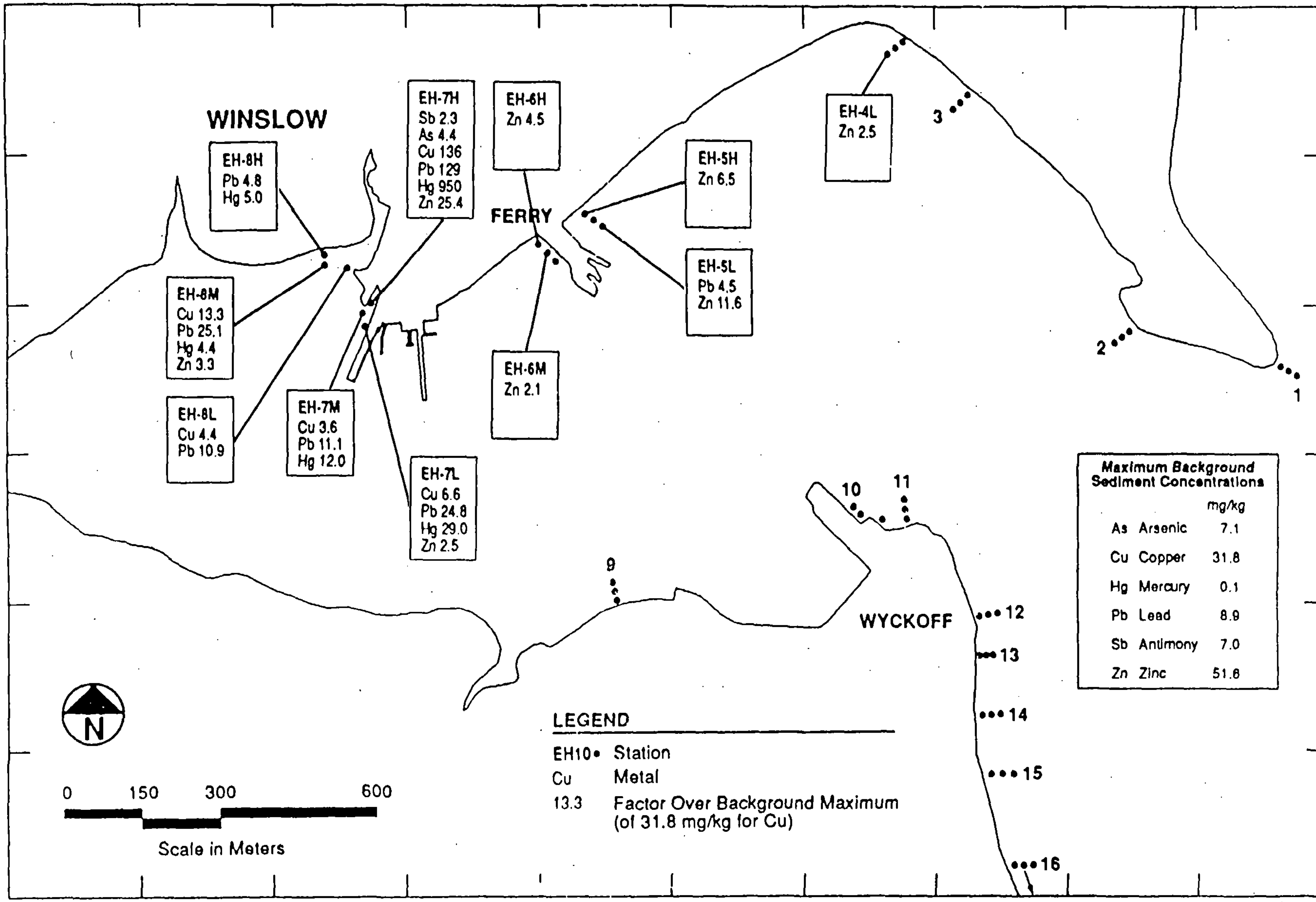
Although they are not considered environmental media, fish and shellfish tissues are of interest in Eagle Harbor as indicators of exposure of ecological receptors to contaminated sediments. Also, contaminated seafood may be consumed by the public. Mercury and PAH concentrations in fish and shellfish tissue from Eagle Harbor indicate elevated concentrations of the contaminants of concern relative to uncontaminated areas of Puget Sound.

6.6 Depth of Concern

Sampling to evaluate the depth of contaminated sediment in the West Harbor was limited. However, most contamination in this area appears to be in the upper half meter with the possible exception of areas adjacent to the former shipyard where sandblasting wastes were disposed of. RI sediment sampling focused primarily on contamination in the top ten centimeters of marine sediment, considered the most biologically active zone in Eagle Harbor sediments.

6.7 Routes of Migration

PAH and mercury in the environment tend to adsorb to soils or sediments, particularly marine sediments. Modeling of fate and transport of sediment-bound contaminants was conducted during the RI/FS. East Harbor subtidal areas were identified where propeller wash (generated primarily by ferries waiting at the terminal) creates high water velocities near the harbor bottom (Figure 10). In these areas, fine sediments and any attached contaminants could be remobilized. The fine particles and potentially some intermediate-sized particles may be carried up into the harbor or out of the harbor mouth, depending on the direction of tidal flow. Coarser-grained material stirred up by



NOTE: Background stations include transects 1, 2, 3, 14, 15 and 16.

Figure 7.
Intertidal Metals Relative to Background

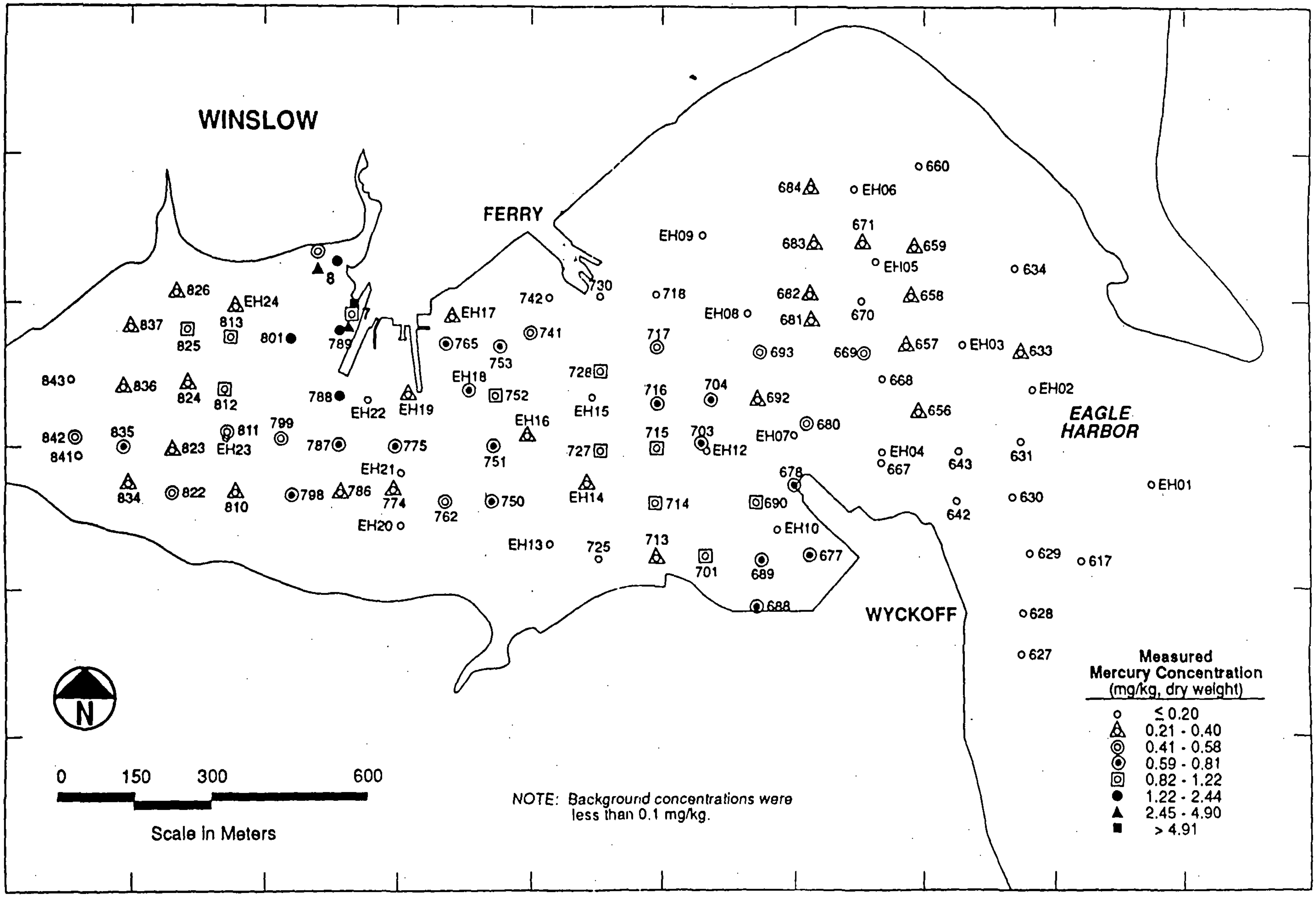
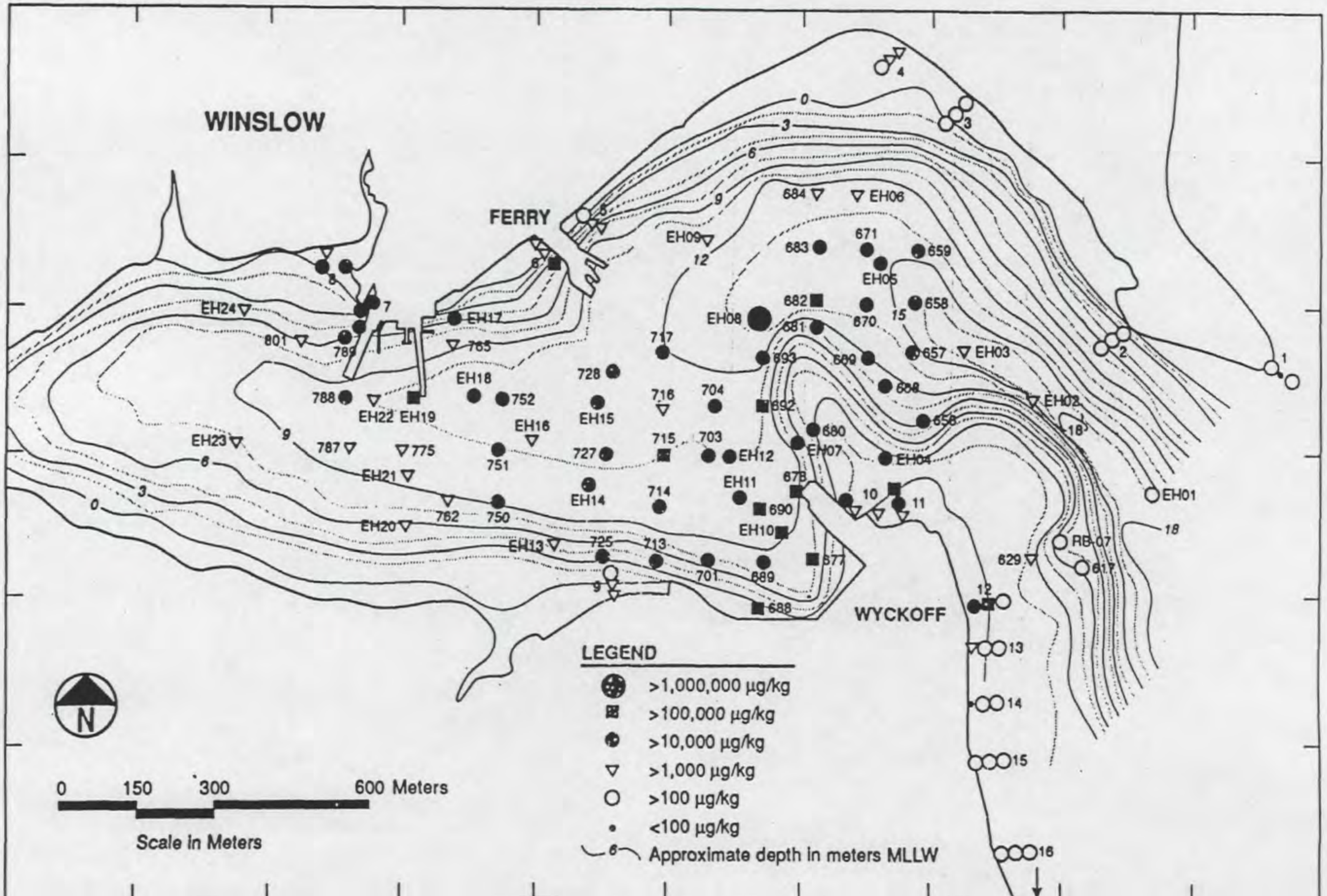


Figure 8
Subtidal Mercury Concentrations



NOTE: For clarity, subtidal station numbers have been shortened by eliminating the hyphen (e.g., EH08 rather than EH-08). The three-digit subtidal station numbers are shown without the EH- (e.g., 714 instead of EH-714). EH stations (e.g., EH-08) were sampled in the PI. Numerical stations (e.g., 714) were sampled in the RI.

SOURCE: EPA, November 1989.

Figure 9
Concentrations of TPAH at Stations Sampled During RI (1988) and PI (1986)

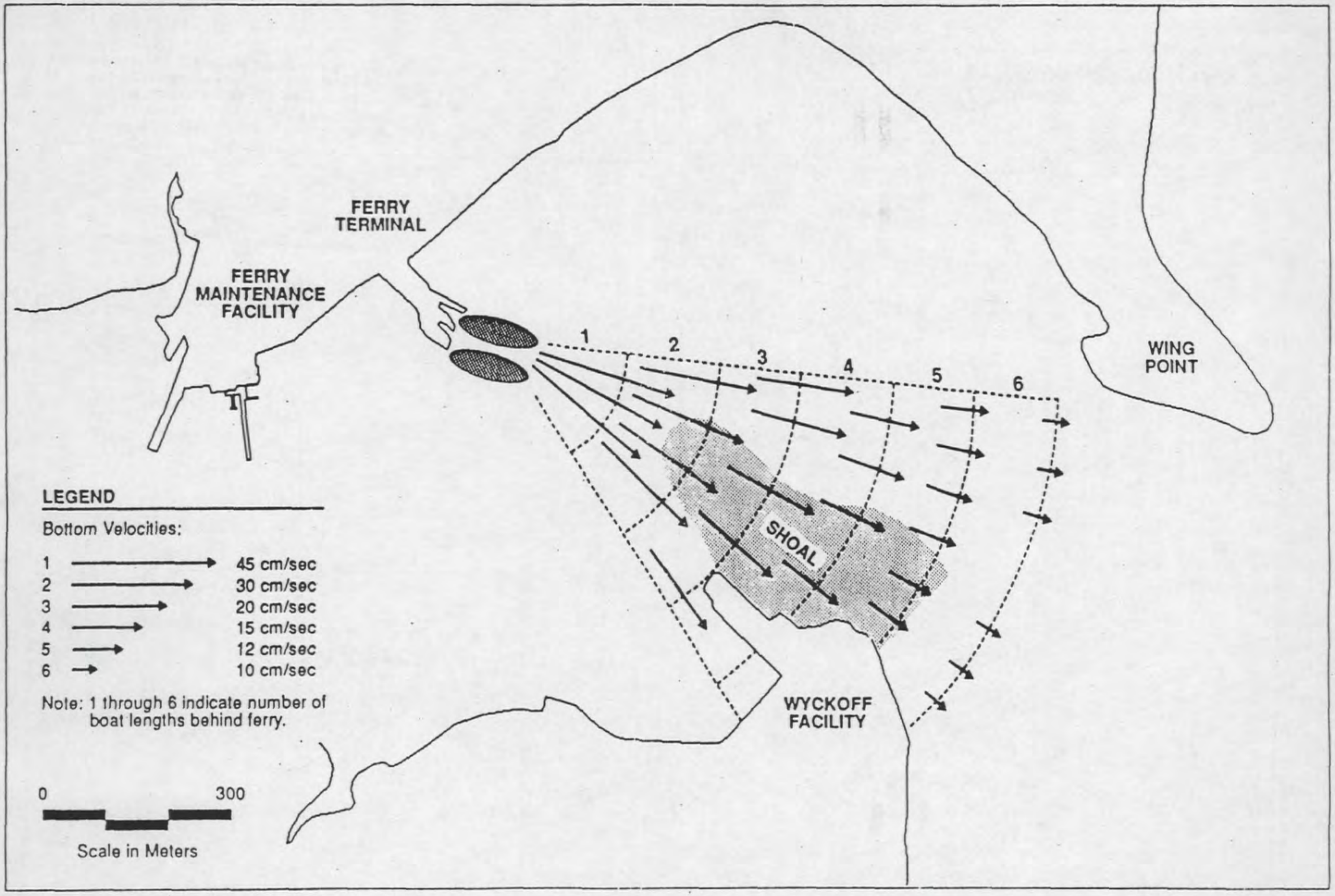


Figure 10
Areas of Ferry Propeller Influe

propeller-induced flows would not be transported a significant distance, but would resettle in the same general area.

On steep slopes or in shallow areas with active boat traffic, movement of contaminated particles may contribute to contaminant migration. In some intertidal areas, wave action can suspend fine sediments. Sheltered intertidal areas where fine particles have accumulated, such as near the mouth of the ravine near the former shipyard, are unlikely to experience significant resuspension of particles because wave and current action in such areas is limited.

Both mercury and PAHs can be redistributed in the environment through uptake by plant and animal species and accumulation in tissues; this requires the microbial transformation of inorganic mercury to bioavailable forms. Although generally metabolized by vertebrates, PAHs can accumulate in invertebrate tissues. Photodegradation, chemical decay, and microbial action degrade individual PAH compounds at different rates.

In summary, in the absence of sediment remediation, contaminant transport pathways are likely to continue to redistribute contamination in sediments and biota in and near the harbor.

6.8 Potentially Exposed Populations

Human populations potentially exposed to contamination include children and adults who consume contaminated fish and/or shellfish, and individuals, particularly children, who might be exposed to contaminated intertidal sediments through dermal exposure (skin contact) or incidental ingestion. Waterfront residences, a public park, and fishing piers provide access to potentially contaminated intertidal beaches and harvestable seafood.

Marine organisms potentially exposed to contaminated sediments include sediment-dwelling organisms in three major taxonomic groups: mollusca (e.g. clams), polychaeta (worms), and crustacea (e.g. amphipods). Marine animals such as bottom-feeding fish and crabs are exposed to both contaminated sediments and contaminated prey organisms. Animals higher in the food chain may in turn be exposed. Thus, although the biological tests may indicate impacts to specific sediment-dwelling organisms, these organisms are a building block of the marine ecosystem. Adverse effects at their level signal potential impacts on the overall health of the harbor.

6.9 Principal Threat

The NCP (Section 300.430(a)(1)) outlines expectations for Superfund actions to address "principal threats" through treatment. Principal threats include wastes with high concentrations of toxic compounds (e.g., several orders of magnitude above levels that allow for unrestricted use and unlimited exposure). RI sediment samples from locations adjacent to the former shipyard contained concentrations up to 95 mg/kg mercury, over 100 times higher than concentrations acutely toxic to oyster larvae. Other metals are also present, and acute bioassays indicate adverse biological effects in this area. EPA has defined sediments containing concentrations of 5 mg/kg or more mercury as the principal threat in the West Harbor. At this concentration, the oyster larvae measure is exceeded by less than 10. Most of the remaining sediments contain less than 1.0 mg/kg mercury and, while of concern, are not defined as principal threats.

7. SUMMARY OF SITE RISKS

CERCLA response actions at the West Harbor operable unit as described in this ROD are intended to protect the marine environment and human health from risks related to current and potential exposure to hazardous substances in the West Harbor.

To assess the risk posed by site contamination, human health and environmental risks assessments were completed as part of the Eagle Harbor RI. Additional information gained during the preparation of the FS was incorporated in a Revised Risk Assessment for human health. Although risks were assessed for the harbor as a whole, this section emphasizes results from the West Harbor OU.

7.1 Human Health Risk Assessment

Cancer and noncancer risks to human health were evaluated using chemical data from Eagle Harbor and background areas. Table 3 shows the potential exposure pathways evaluated. Other exposure pathways considered were eliminated because risks associated with these routes were not expected to add significantly to human health concerns related to the site.

Human exposure to contamination was considered of concern in intertidal areas, where dermal contact with and ingestion of contaminated sediments is possible. Harvest and consumption of contaminated fish and shellfish was also of concern. For this reason, risks from four exposure routes were calculated, including ingestion of contaminated clams and crabs, ingestion of contaminated fish, ingestion of contaminated intertidal sediments, and dermal contact with contaminated intertidal sediments.

7.1.1 Identification of Chemicals of Concern

Sixty-five chemicals were detected in intertidal sediments and/or fish and shellfish. The risk assessment identified 42 of these as chemicals of potential concern for human health, based on the frequency and magnitude of measurements in sediments and seafood from Eagle Harbor. Of these, 13 were eliminated because sufficient information was lacking to characterize the risk or because the concentrations observed did not add significantly to the total risk. The remaining 29 chemicals (Table 4) were carried forward for calculations of risk.

7.1.2 Toxicity Assessment

Toxicity information was provided in the risk assessment for the chemicals of concern. Generally, cancer risks are calculated using toxicity factors known as slope factors (Sfs), while noncancer risks rely on reference doses.

SFs have been developed by EPA's Carcinogenic Assessment Group for estimating excess lifetime cancer risks associated with exposure to potentially carcinogenic contaminants of concern. SFs are expressed in units of $(mg/kg\text{-}day)^{-1}$ and are multiplied by the estimated intake of a potential carcinogen, in mg/kg-day, to provide an upper-bound estimate of the excess lifetime cancer risk

Table 3
Potential Exposure Pathways Retained for Risk Assessment

Contaminated Media	Exposure Point	Exposure Route	Potential Receptors	Rationale
Intertidal sediments	Residential beaches	Ingestion Dermal absorption	Residents	Beaches readily accessible to residents and visitors.
Intertidal sediments	Industrial beaches	Ingestion Dermal absorption	Workers or visitors	Beaches readily accessible to workers and visitors.
Intertidal sediments	Public beaches	Ingestion Dermal absorption	General public	Beaches readily accessible to public.
Shellfish	Residential beaches	Ingestion	Residents	Beaches readily accessible to residents and visitors. Clams exist at beaches.
Shellfish	Industrial beaches	Ingestion	Workers or visitors	Beaches readily accessible to workers and visitors. Clams exist at beaches.
Shellfish	Public beaches	Ingestion	General public	Beaches readily accessible to public. Clams exist at beaches.
Pelagic or bottomfish	Deeper waters within Eagle Harbor	Ingestion	General public	Presence of fish and recreational fishermen.

Table 4
Chemicals of Potential Concern for Human Health

Chemicals Retained[a]	Chemicals Excluded
Semivolatile Compounds	
Bis(2-ethylhexyl)phthalate Dibenzofuran **Pentachlorophenol** **Phenol** 2,3,4,5-Tetrachlorophenol	Benzoic acid 2-Methylphenol 4-Methylphenol 2,4,5-Trichlorophenol
Polycyclic Aromatic Hydrocarbons (PAH)	
Acenaphthene Acenaphthylene **Anthracene** **Benzo[a]anthracene** **Benzo[a]pyrene** **Benzo[b]fluoranthrene** Benzo[g,h,i]perylene **Benzo[k]fluoranthene** **Chrysene** **Dibenzo[a,h]anthracene** **Fluoranthene** Fluorene **Indeno[1,2,3-cd]pyrene** 2-Methylnaphthalene **Naphthalene** Phenanthrene **Pyrene**	
Nitrogen-Containing Aromatic Compounds (NCACs)	
Acridine Benzoquinoline **Carbazole** Indole Isoquinoline Methylcarbazole **Quinoline**	
Volatile Organic Compounds (VOCs)	
Chloroform **Chloromethane**	Acetone 2-Butanone Carbon disulfide Ethylbenzene Methylene chloride Styrene Toluene Xylenes
Metals	
Antimony **Arsenic** **Beryllium** **Cadmium** **Chromium** Lead **Nickel** **Thallium** **Copper** **Zinc** **Mercury**	Aluminum Barium Calcium Cobalt Iron Magnesium Manganese Potassium Selenium Silver Sodium Vanadium

[a]Highlighted chemicals were evaluated quantitatively in the RA.

Note: In the intertidal sediment and shellfish samples that were analyzed from Eagle Harbor, 65 chemicals were detected at least once. The detected chemicals are presented in this table. Chemicals that were analyzed for but not detected are presented in the RI Data Report (EPA, March 1989).

associated with exposure at that intake level. The term "upper bound" reflects the conservative estimate of the risks calculated from the SF. Use of this approach makes underestimation of the actual cancer risk highly unlikely. SFs are derived from the results of human epidemiological studies or chronic animal bioassays to which animal-to-human extrapolation and uncertainty factors have been applied (e.g. to account for the use of animal data to predict effects on humans.)

Reference doses (RfDs) have been developed by EPA for indicating the potential for adverse health effects from exposure to contaminants of concern exhibiting noncarcinogenic effects. RfDs, which are expressed in units of mg/kg-day, are estimates of lifetime daily exposure levels for humans, including sensitive individuals. Estimated intakes of contaminants of concern from environmental media (e.g. the amount of a contaminant of concern ingested from contaminated drinking water) can be compared to the RfD. RfDs are derived from human epidemiological studies or animal studies to which uncertainty factors have been applied.

The risk assessment relied on oral SFs and RfDs. Because dermal toxicity factors have not been developed for the chemicals evaluated, oral toxicity factors were used in estimating noncancer risks from dermal exposure. The noncancer toxic endpoints (e.g. the affected organs) are similar for dermal and oral exposure. Cancer risks from dermal exposure could not be calculated. The toxicity factors, shown on Table 5, were drawn from the Integrated Risk Information System (IRIS) or, if no IRIS values were available, from the Health Effects Summary Tables (HEAST). The oral SF of benzo(a)pyrene was used for all seven carcinogenic PAHs in estimating cancer risks from ingestion pathways. This approach is intended to address uncertainties in the toxicity of the remaining 6 PAHs.

7.1.3 Exposure Assessment

The exposure assessment identified potential pathways for contaminants of concern to reach the exposed population. Exposure assumptions were based primarily on EPA regional and national guidance, except where tailored to specific site conditions (Table 6).

A 1988 Puget Sound Estuary Program (PSEP) study of seafood consumption in Puget Sound (Tetra Tech, 1988) provided a high (95th percentile) Puget Sound consumption rate of 95.1 grams per day of fish. This rate corresponds to 230 servings of 1/3-lb of fish over the course of a year. The high rate for shellfish consumption was estimated to be 21.5 g/day, equivalent to a 1/3-lb serving a week. (The study estimated that an average consumer eats at most 30 such servings of fish and 3 such servings of shellfish per year).

The high rates above were used for the reasonable maximum exposure (RME) assumption for adults. These assumptions were modified to develop ingestion rates for children, based on body weight ratios. Soil ingestion and site-specific dermal exposure assumptions were also developed.

For carcinogens, risks are estimated as the incremental probability of an individual developing cancer over a lifetime as a result of exposure to the carcinogen. Excess lifetime cancer risk is calculated by multiplying the SF (see toxicity assessment above) by the "chronic daily intake" developed using the exposure assumptions. These risk are probabilities generally expressed in scientific notation (e.g., 1×10^{-6}). An excess lifetime cancer of 1×10^{-6} indicates that an individual has a 1 in 1,000,000 chance of developing cancer as a result of site-related exposure to a carcinogen over a 70-year lifetime under the specific exposure conditions assumed.

The potential for noncarcinogenic effects is evaluated by comparing an exposure level over a specified time period (e.g. lifetime) with a reference dose (see toxicity assessment above) derived for a similar exposure period. The ratio of exposure to toxicity is called a hazard quotient. Hazard quotients are calculated by dividing the chronic daily intake by the specific Rfd. By adding the hazard quotients for all contaminants of concern that affect the same target organ (e.g., liver), the hazard index can be generated.

The RME provides a conservative but realistic exposure in considering remedial action at a Superfund site. Based on the RME, when the excess lifetime cancer risk estimates are below 1 X 10^{-6} or when the noncancer hazard index is less than 1, EPA generally considers the potential human health risks to be below levels of concern. Remedial action is generally warranted where excess cancer risks exceed 1 X 10^{-4} (one in ten thousand). Between 10^{-6} and 10^{-4}, cleanup may or may not be selected, depending on individual site conditions, including ecological concerns.

Both average and RME risks were estimated for each of the four exposure pathways to show a range of uncertainty. Because EPA policy dictates the use of the RME in evaluating human health risks, only RME results are discussed in the following sections.

7.1.4 Risk Characterization

The following discussion presents summarized non-cancer and cancer risk characterization results separately.

Non-cancer risks:

The lifetime and child noncancer hazard indices for ingestion of contaminated intertidal sediments were well below 1. Calculated noncancer risks from dermal contact with PAH-contaminated beach sediments (using oral exposure Rfds) were significantly below 1 for both lifetime and child exposures.

Clam tissue data from 1988 and 1990 were used to evaluate noncancer risks from consumption of clams. The 1988 data yielded lifetime hazard indices from 0.6 to 1 for most Eagle Harbor and background clam sampling locations (for child exposure assumptions, these hazard indices were between 1 and 2). Because of differences in the mercury results, the highest hazard index based on 1990 clam tissue data was 0.07, which was lower than 1988 results.

Noncancer risks were evaluated both for consumption of fish and consumption of shellfish. Data from 1989 and 1990 fish tissue sampling were used and, as with the clam data, the 1990 results were lower. Fish tissue data from the 1989 sampling resulted in lifetime hazard indices approaching or exceeding 1 (up to 2 for the child exposure), while data gathered in 1990 produced hazard indices considerably less than 1 (and less than 2 for children).

Cancer Risks:

Cancer risks from sediment ingestion were within or below EPA's acceptable risk range of 10^{-4} to 10^{-6}. As noted, slope factors were unavailable to calculate cancer risks from dermal exposure to carcinogenic PAHs in sediments.

Two data sets (1988 and 1990) were used in estimating the total excess lifetime cancer risks for consumption of clams and yielded comparable results. Clams collected in 1988 in the West Harbor (near the ferry terminal and the former shipyard) resulted in risk estimates from 4 x 10^{-4} to 9 x 10^{-4}, with 1990 results as high as to 1 x 10^{-3}. The highest risk of 3 x 10^{-3} was associated with clams adjacent to the Wyckoff facility. Background clam tissues collected near the mouth of Eagle Harbor produced risks from 1 x 10^{-4} to 5 x 10^{-4}.

Table 5 - Human Toxicity Factors of Chemicals Retained for Risk Quantification			
COMPOUND	Weight of Evidence	Oral Slope Factor $(mg/kg\text{-}day)^{-1}$	Oral Chronic RfD $(mg/kg\text{-}day)^{-1}$
Semivolatile Compounds			
Bis(2-ethylhexyl)phthalate	B2	0.014	0.02
Pentachlorophenol	B2	0.12	0.03
Phenol			0.6
Polynuclear Aromatic Hydrocarbons			
Acenaphthene			0.06
Anthracene			0.3
Benzo(a)anthracene	B2	11.5	
Benzo(a)pyrene	B2	11.5	
Benzo(b)fluoranthene	B2	11.5	
Benzo(k)fluoranthene	B2	11.5	
Chrysene	B2	11.5	
Dibenzo(a,h)anthracene	B2	11.5	
Fluoranthene			0.04
Indeno(1,2,3)pyrene	B2	11.5	
Naphthalene			0.004
Pyrene			0.03
Nitrogen-Containing Aromatic Compounds (NCACs)			
Carbazole	B2	0.02	
Quinoline	C	12	
Volatile Organic Compounds			
Chloroform	B2	0.0061	
Chloromethane	C	0.013	0.01
Metals			
Antimony	A	1.75	0.0004
Arsenic	B2	4.3	0.001
Beryllium			0.005
Cadmium			0.001
Chromium (VI)			0.005
Copper			0.037
Mercury			0.003
Nickel (in soluble salts)			0.02
Thallium (in soluble salts)			0.00007
Zinc			0.2

EPA Carcinogenic Classification: A = Human Carcinogen
B2 = Probable Human Carcinogen
C = Possible Human Carcinogen

Table 6 - Exposure Assumptions for Human Health Risk Assessment

Exposure Assumptions for Ingestion of Seafood

		Age: 2-3 yr	4-6 yr	7-9 yr	10-12 yr	13-15 yr	16-18 yr	19-75 yr
Reasonable Maximum Exposure (RME) for Clams and Crabs								
IR:	Ingestion rate (kg/meal)[a,b]	0.047[e]	0.059[e]	0.076[e]	0.097[e]	0.122[e]	0.138[e]	0.151[f]
FI:	Fraction ingested (unitless)[f]	1	1	1	1	1	1	1
EF:	Exposure frequency (meals/year)[a]	52	52	52	52	52	52	52
ED:	Exposure duration (years)[d]	2	3	3	3	3	3	57
BW:	Body weight (kg)[c]	12	17	25	36	51	671	70
ATn:	Averaging time for noncarcinogenic effects (days)[f]	730	1,095	1,095	1,095	1,095	1,095	20,805
ATc:	Averaging time for carcinogenic effects (days)[f]	27,375	27,375	27,375	27,375	27,375	27,375	27,375
Reasonable Maximum Exposure (RME) for Fish								
IR:	Ingestion rate (kg/meal)[a,b]	0.206[e]	0.260[e]	0.336[e]	0.428[e]	0.540[e]	0.609[e]	0.668[g]
FI:	Fraction ingested (unitless)[f]	1	1	1	1	1	1	1
EF:	Exposure frequency (meals/year)[a]	52	52	52	52	52	52	52
ED:	Exposure duration (years)[d]	2	3	3	3	3	3	57
BW:	Body weight (kg)[c]	12	17	25	36	51	61	70
ATn:	Averaging time for noncarcinogenic effects (days)[f]	730	1,095	1,095	1,095	1,095	1,095	20,805
ATc:	Averaging time for carcinogenic effects (days)[f]	27,375	27,375	27,375	27,375	27,375	27,375	27,375

Equation for ingestion of fish and shellfish (EPA, July 1989c):

$$\text{Intake (mg/kg-day)} = \frac{\text{concentration (mg/kg)} \times IR \times FI \times EF \times ED}{BW \times AT}$$

[a]Tetra Tech, 1988.
[b]P. Cirone, EPA Region 10, personal communication, 1991.
[c]EPA, July 1989c.
[d]EPA, January 1990.
[e]The amount ingested was scaled down to the 2/3 power of the ratio of child to adult body weight (P. Cirone, EPA Region 10, personal communication, 1991)
[f]0.151 kg shellfish/meal x 52 meals/year x 1 year/365 days x 1,000 g/kg = 21.5 g/day. This is the high ingestion rate computed from the Puget Sound study (Tetra Tech, 1988).
[g]0.668 kg fish/meal x 52 meals/year x 1 year/365 days x 1,000 g/kg = 95.1 g/day. This is the high ingestion rate computed from the Puget Sound study (Tetra Tech, 1988).

A single data set from 1990 was available to evaluate cancer risks from consumption of fish and crabs. Risk levels depended on the type of tissue (whole fish, fish muscle, crab muscle, hepatopancreas). The highest risk from this route was 1 x 10^{-3} for consumption of whole perch. For all other tissues, both Eagle Harbor and background samples produced results in the 10^{-4} range; however, the data for the PAH contributing most to the risk calculations for fish consumption were qualified as estimates in these samples.

Summary:

The risk assessment discussed uncertainties associated with the calculated risks. Among the uncertainties are the absence of complete toxicity information for all chemicals measured, uncertainties and variability in site data, the potential for other contaminants such as polychlorinated biphenyls (PCB) and dioxin in seafood, and uncertainties associated with exposure assumptions. The uncertainties can result either in underestimates or overestimates of the true health risks associated with the site.

In summary, chemical concentrations in Eagle Harbor sediments and seafood are elevated with respect to background locations, but the associated human health risk estimates are within or below EPA's range of acceptable risks for exposure to sediment contaminants through dermal contact and sediment ingestion. For seafood ingestion, calculated cancer risks are generally between 10^{-4} and 10^{-6} at both Eagle Harbor and background locations. Consumption of shellfish from specific areas (such as West Harbor areas near the former shipyard and the ferry terminal) result in risks above 10^{-4}. While similar results were obtained for certain tissues, such as whole perch, sole muscle, and crab hepatopancreas, uncertainties in the data should be considered. Similarly, while noncancer hazard indices for seafood consumption at both Eagle Harbor and background locations were as high as 1 in 1988, subsequent data resulted in significantly lower values.

Human health risks for Eagle Harbor are thus primarily associated with the consumption of contaminated shellfish. In the West Harbor, the cancer risks in the 10^{-3} range were associated with clam tissues from areas near the ferry terminal and the former shipyard.

7.2 Ecological Assessment

The Eagle Harbor ecological assessment focused on biological effects in subtidal areas. During the RI, sediment chemical and physical data were collected, laboratory bioassays were conducted on subtidal sediments, and evaluations of the existing benthic communities were completed. Available information from previous studies and research was incorporated as appropriate. Although clam tissue and sediment chemical data were developed for evaluating intertidal areas, the emphasis in intertidal areas was on evaluating potential human health risks.

The assessment of ecological risks relied on the "triad approach" which links contamination to specific adverse ecological effects using a preponderance of field and laboratory evidence. The three elements of sediment chemical analyses, laboratory toxicity tests (bioassays), and evaluation of the abundance of benthic organisms from specific locations are used in combination as the three elements of the triad approach. The approach was used to develop the Puget Sound AETs, and these chemical concentrations, in conjunction with site-specific biological data, formed the basis of the ecological assessment in Eagle Harbor.

As described in Section 6, an AET, or "Apparent Effects Threshold," is the concentration of a chemical in sediment above which a particular adverse biological response has always been observed. Generally, for any one chemical, different biological indicators are associated with different levels of chemical contamination, leading to a range of AETs (e.g., for benthic effects, amphipod toxicity, oyster larvae effects, and microtox responses) for each compound (See Table 2, Section 6).

7.2.1 Chemicals of Concern

RI sampling of Eagle Harbor sediments included a broad range of metals and organic compounds of potential concern for environmental risk. Contaminants of concern were identified for the ecological assessment based on information about their effects in the marine environment. For this reason, not all were the same as the contaminants of concern identified for human health.

Sediments in Eagle Harbor exceeded 2.1 mg/kg, the high AET (HAET) for mercury, at several stations sampled during the RI, and exceeded two AETs (for oyster larvae and microtox) in most remaining contaminated areas. Above the HAET, AETs for four biological measures are exceeded. Individual PAHs exceeded their respective benthic AETs in much of the harbor, and at several locations all sixteen PAH compounds exceeded their benthic AETs. Based on the comparison of the concentrations in Eagle Harbor samples with the 1988 benthic AETs for Puget Sound, EPA selected mercury and all sixteen PAHs as contaminants of concern. These contaminants are used as indicators of the extent of contamination. Toxicity information for PAH and mercury was summarized in the ecological risk assessment.

Contaminants that exceeded AETs at only one or two locations were not carried forward as contaminants of concern for the ecological risk assessment. These locations are included within areas of concern for mercury or PAHs, and cleanup for PAHs and mercury would also address these contaminants.

7.2.2 Biological Effects

Laboratory bioassay results from Eagle Harbor samples were grouped by sediment grain size and statistically compared with control samples and background samples. Bioassays for acute toxicity indicated that sediments from the majority of sampled locations in the East Harbor, and from several locations in the West Harbor, were toxic to amphipods, oyster larvae, or both. In general, the bioassay responses were most severe in areas of high PAH contamination.

The test species used in amphipod toxicity tests (*Rhepoxynius abronius*) resides in Puget Sound and is a member of a crustacean group that forms an important part of the diet of many estuarine fish. Amphipods are sensitive to many chemical contaminants, and species such as *R. abronius* have a high pollutant exposure potential because they burrow into the sediment and feed on sediment material. The oyster larvae used as a test species (*Crassostrea gigas*) resides in Puget Sound and supports commercial and recreational fisheries. The life stages tested (embryo and larva) are very sensitive stages of the organism's life cycle. The primary endpoint is a sublethal change in development that has a high potential for affecting larval recruitment.

Benthic infauna are valuable indicators because they live in direct contact with the sediments, they are relatively stationary, and they are important components of estuarine ecosystems. If sediment-associated impacts are not present in the infauna, then it is unlikely that such impacts are present in other biotic groups such as fish or plankton unless contaminants are bioaccumulating at levels significant for higher food-chain organisms.

During the RI, replicate benthic infauna measures were not conducted at each station in Eagle Harbor. Consequently, statistical comparisons of benthic abundance data between individual stations was not possible. Overall, there was a greater abundance of polychaetes in Eagle Harbor than in the background areas, which could indicate a predominance of pollution tolerant organisms. However, no statistically significant difference relative to background areas was observed for molluscs, amphipods, and other crustacea.

Other benthic studies of Eagle Harbor tend to support the indication in the RI that, while sediment contamination is present above the AETs, adverse effects on benthic communities may not be occurring at the level of major taxa (polychaeta, molluscs, amphipods, other crustacea) in most subtidal areas of the West Harbor.

Additional evidence of biological effects in Eagle Harbor includes the prevalence of liver lesions and tumors in English sole, as documented by NOAA (Malins, 1985). The high incidence of such effects in Eagle Harbor relative to other Puget Sound embayments was confirmed in the Puget Sound Ambient Monitoring Program 1991 sampling. This and laboratory research citing the effects of PAH and other sediment contaminants on marine organisms add to the preponderance of evidence already indicating potential damage to Eagle Harbor marine life. In addition, PAH and metals in the tissues of fish and shellfish indicate uptake of sediment contamination. Mercury tends to bioaccumulate in fish, while PAHs can bioaccumulate in some invertebrates.

Uncertainty in the ecological assessment is associated with data variability, spatial variability of contamination and benthic communities, potential biological effects of organic enrichment, grain size, and physical disturbance, and the availability of appropriate background locations for comparison.

In summary, biological risks due to contamination in the West Harbor are evidenced by documented acute toxicity of sediments near the former shipyard and at some locations in the central channel, by predicted adverse effects of other sediments above AETs, and by the widespread presence of mercury and PAHs, which can accumulate in the tissues of food chain organisms.

7.3 Summary of Risk Assessment

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

Based on the RI, the risk assessments, and available information, cleanup of the West Harbor OU is warranted. Consumption of shellfish from certain intertidal locations of the West Harbor pose a human health risk above the acceptable risk range. Sediment cleanup is expected to result in reductions of contaminant levels in fish and shellfish, and over the long term, sediment cleanup and natural recovery may eventually reduce risks to levels comparable to background. However, the correlation between fish or clam tissue contamination and sediment chemical concentrations is not sufficient to develop sediment cleanup levels corresponding to specific reductions in human health risks.

Adverse biological effects have been documented in portions of the West Harbor and are predicted by the contaminant concentrations present. Most of the biological effects observed are associated with areas of heavy sediment contamination. Potential redistribution of contaminants through sediment redistribution from heavily contaminated areas is also of concern, as is the potential for uptake by marine organisms. Where chemical information predicts significant adverse effects on benthic organisms but redistribution and biological uptake are not of concern, cleanup is warranted unless the absence of adverse biological effects at levels of concern is documented.

7.4 Special Site Characteristics

Investigation and remediation of sediment contamination pose inherent challenges, as briefly indicated below:

> 1) the accumulation of contaminants at the sediment-water interface, a significant zone for habitat and food sources, creates complex and sensitive ecological conditions and can lead to contaminant transfers through the food chain;

2) contaminants that accumulate in sediments are generally dispersed from their sources, resulting in relatively large areas of low level contamination;

3) surface sediment contamination reflects both historical and on-going contamination, because marine biological activity in the biologically active top layer mixes recently deposited sediments with existing sediments and because physical disturbances such as currents or propeller wash can redistribute surface contamination;

4) the relatively large volumes of sediments requiring remediation can present problems regarding disposal site availability and capacity; and

5) underwater conditions compound the technical challenges associated with assessing, controlling, and remediating contamination of environmental media.

Remediation of Eagle Harbor sediments is further complicated by the active use of the harbor. Cleanup activities will require coordination and planning in nearshore areas, subtidal leased lands, residential moorage locations, and the navigational pathways used by the Washington State Ferries. These and other special features of a marine sediment site have been considered in the RI/FS and this ROD.

8. DESCRIPTION OF ALTERNATIVES

This section briefly summarizes the identification of cleanup areas in the West Harbor, discusses common elements of the cleanup alternatives developed in the November 1991 FS, and provides information about alternatives, including estimated costs and volumes.

The FS identified a number of sediment cleanup technologies, of which nine were developed into detailed alternatives and further evaluated. The active remedial alternatives included in-place alternatives involving treatment or containment options and removal alternatives requiring excavation or dredging of sediments with subsequent treatment and/or containment of the sediments. No Action, or allowing the site to recover naturally, was also evaluated.

In addition to the nine FS alternatives above, the Proposed Plan, issued December, 1991, introduced Supplemental Alternative N (Low-Impact Capping/Thin Layer Placement). This alternative was developed as a means of accelerating the harbor recovery rate by providing a source of clean sediment for distribution in areas with marginal exceedance of the Sediment Standards chemical cleanup levels.

Three other alternatives, Alternative F: Removal, Consolidation, and Upland Disposal, Alternative J: Removal, Treatment by Soil Washing, and Disposal, and Alternative K: Removal, Treatment by Solvent Extraction, and Disposal, were eliminated from detailed evaluation for a variety of reasons including uncertainty about waste characteristics, process complexity, treatability, and the availability of more suitable options.

Table 7 lists the alternatives evaluated and indicates the areas for which they were evaluated. Descriptions of the alternatives retained are provided in Section 8.3.

8.1 Estimated Cleanup Areas

As noted in Section 6, the State of Washington Sediment Management Standards (Sediment Standards) are a primary ARAR for this site. Promulgated on April 27, 1991, the Sediment Standards provide a process for defining sediment cleanup sites by comparing site chemical data to chemical criteria. Collection of biological data is optional, but if specific biological information meets the biological criteria of the Sediment Standards, these results determine whether or not sediments meet the Sediment Standards. The Sediment Standards provide biological and chemical criteria for both a minimum cleanup level (MCUL) and the more stringent sediment quality standards (SQS), as shown in Tables 8 and 9.

Figure 11 shows where sediments exceed these chemical criteria, indicating a minimum and maximum cleanup area on the basis of MCUL and SQS chemical criteria alone. In the West Harbor OU, this results in potential cleanup areas ranging from approximately 220,000 m^2 (based on the MCUL chemical criteria) to 330,000 m^2 (based on the SQS chemical criteria), or from 55 to 82 acres. Present biological data for the harbor do not completely satisfy the biological requirements of the Sediment Standards. However, they do suggest that many portions of the Harbor are less toxic than the chemistry would indicate.

For this reason, reduced areas of probable biological effects were estimated in the FS using available acute toxicity data, assumptions about potential chronic biological effects, and best professional judgment. The purpose of estimating these preliminary areas was to estimate costs and compare cleanup alternatives. (Areas and costs are further refined in Section 10. Additional refinement will be necessary during the remedial design phase.)

Table 7 - Screening of Alternatives				
		Problem Area		
		Intertidal Sediments		Subtidal Sediments
Alternative		Mercury	PAH	Mercury
A.	No Action	●	●	●
B.	Institutional Controls	●	●	●
C.	Capping	●	●	●
D.	Removal, Consolidation, and Confined Aquatic Disposal	●	●	●
E.	Removal, Consolidation, and Nearshore Disposal	●	●	●
F.	Removal, Consolidation, and Upland Disposal at Wyckoff			
G.	Removal, Consolidation, and Upland Disposal at a Commercial RCRA Landfill	●		●
H.	Removal, Treatment by Incineration, and Disposal		●	
I.	Removal, Treatment by Solidification/ Stabilization, and Disposal	●		●
J.	Removal, Treatment by Soil Washing, and Disposal			
K.	Removal, Treatment by Solvent Extraction, and Disposal			
L.	Removal, Treatment by Biological Slurry, and Disposal		●	
M.	In Situ Solidification/Stabilization	●		
N.	Low-Impact Capping/Thin Layer Placement	●		●

● Alternative carried forward for area and contaminant indicated.

(shaded) Not carried forward.

Table 8
Sediment Standards Chemical Criteria for Mercury and PAH[1]

Contaminant	SQS[2]	MCUL[3]
Mercury	0.41 mg/kg (dry weight)	0.59 mg/kg (dry weight)
Individual PAHs and PAH groups	units of mg/kg organic carbon[4]	units of mg/kg organic carbon[4]
LPAH[5]	370	780
Naphthalene	99	170
Acenaphthylene	66	66
Acenaphthene	16	57
Fluorene	23	79
Phenanthrene	100	480
Anthracene	220	1,200
2-Methylnaphthalene	38	64
HPAH[6]	960	5,300
Fluoranthene	160	1,200
Pyrene	1,000	1,400
Benz(a)anthracene	110	270
Chrysene	110	460
Total benzofluoranthenes[7]	230	450
Benzo(a)pyrene	99	210
Indeno(1,2,3-c,d)pyrene	34	88
Dibenzo(a,h)anthracene	12	33
Benzo(g,h,i)perylene	31	78

[1] Where laboratory analysis indicates a chemical is not detected in a sediment sample, the detection limit shall be reported and shall be at or below the criteria value shown in this table. Where chemical criteria in this table represent the sum of individual compounds or isomers, and a chemical analysis identifies an undetected value for one or more individual compounds or isomers, the detection limit shall be used for calculating the sum of the respective compounds or isomers.

[2] Sediment Quality Standards

[3] Minimum Cleanup Level

[4] The listed chemical parameter criteria represent concentrations in parts per million, "normalized," or expressed, on a total organic carbon basis. To normalize to total organic carbon, the dry weight concentration for each parameter is divided by the decimal fraction representing the percent total organic carbon content of the sediment.

[5] The LPAH criterion represents the sum of the following "low molecular weight polynuclear aromatic hydrocarbon" compounds: Napthalene, Acenaphthylene, Acenaphthene, Fluorene, Phenanthrene, and Anthracene. The LPAH criterion is not the sum of the criteria values for the individual LPAH compounds as listed.

[6] The HPAH criterion represents the sum of the following "high molecular weight polynuclear aromatic hydrocarbon" compounds: Fluoranthene, Pyrene, Benz(a)anthracene, Chrysene, Total Benzofluoranthenes, Benzo(a)pyrene, Indeno(1,2,3,-c,d)pyrene, Dibenzo(a,h)anthracene, and Benzo(g,h,i)perylene. The HPAH criterion is not the sum of the criteria values for the indivisual HPAH compounds as listed.

[7] The TOTAL BENZOFLUORANTHENES criterion represents the sum of the concentrations of the "B," "J," and "K" isomers.

Table 9- Sediment Standards Biological Criteria	
SQS[a] Biological Criteria	MCUL[b] Biological Criteria
Sediments are determined to have adverse effects on biological resources when any one of the confirmatory marine sediment biological tests of WAC 173-204-315(1) demonstrate the following results: (a) Amphipod: The test sediment has a higher[c] mean mortality than the reference sediment and the test sediment mean mortality exceeds 25%, on an absolute basis. (b) Larval: The test sediment has a mean survivorship of normal larvae that is less[c] than the mean normal survivorship in the reference sediment and the test sediment mean normal survivorship is less than 85% of the mean normal survivorship in the reference sediment (i.e., the test sediment has a mean combined abnormality and mortality that is greater than 15% relative to time-final in the reference sediment). (c) Benthic abundance: The test sediment has less than 50% of the reference sediment mean abundance of any one of the following major taxa: Crustacea, Mollusca, or Polychaeta, and the test sediment abundance is statistically different[c] from the reference sediment abundance. (d) Juvenile polychaete: The test sediment has a mean biomass of less than 70% of the reference sediment mean biomass and the test sediment biomass is statistically different[c] from the reference sediment biomass. (e) Microtox: The mean light output of the highest concentration of the test sediment is less than 80% of the reference sediment, and the two means are statistically different.	The MCUL is exceeded when any two of the biological tests exceed the SQS biological criteria; or one of the following test determinations is made: (i) Amphipod: The test sediment has a higher[c] mean mortality than the reference sediment and the test sediment mean mortality is more than 30% higher than the reference sediment mean mortality, on an absolute basis. (ii) Larval: The test sediment has a mean survivorship of normal larvae that is less[c] than the mean normal survivorship in the reference sediment and the test sediment mean normal survivorship is less than 70% of the mean normal survivorship in the reference sediment (i.e., the test sediment has a mean combined abnormality and mortality that is greater[c] than 30% relative to time-final in the reference sediment). (iii) Benthic abundance: The test sediment has less than 50% of the reference sediment mean abundance of any two of the following major taxa: Crustacea, Mollusca, or Polychaeta and the test sample abundances are different[c] from the reference abundances. (iv) Juvenile polychaete: The test sediment has a mean biomass of less than 50% of the reference sediment mean biomass and the test sediment biomass is statistically different[c] from the reference sediment biomass.

[a] Sediment Quality Standards
[b] Minimum Cleanup Level
[c] Statistical Significance is defined with a test, p less than or equal to 0.05.

Test results from at least two acute effects tests and one chronic effects test shall be evaluated. The biological tests shall not be considered valid unless test results for the appropriate control and reference sediment samples meet the performance standards described in WAC 173-204-315(2).

The preliminary cleanup areas from the FS (listed in Table 10) are used in the following discussion and are identified by predominant contaminant (i.e., mercury or PAH) and physical location (i.e., intertidal or subtidal). For subtidal sediments, areas and cost estimates include a lower and a higher estimate.

Cleanup areas in the West Harbor include the subtidal mercury area (low and high estimates), intertidal mercury area, and the intertidal PAH area. Costs for cleanup of the West Harbor intertidal PAH area (adjacent to the ferry terminal) were calculated as one third of the FS cost estimates for the intertidal PAH areas in the harbor as a whole. The area estimates in Table 10 formed the basis for the costs summarized on Tables 12a, 12b, 12c, and 12d.

Table 10
FS Preliminary Areas/Volumes for the West Harbor[a]

Problem Area	Area (sq m)	Volume (cu m)
Intertidal Mercury	14,000	7,000
Intertidal PAH	20,000	10,000
Subtidal Mercury		
Lower-bound area	50,000	25,000
Upper-end area	125,000	63,000

[a] Volume estimates assume a depth of 0.5 meters. Most contamination in the west harbor is not expected to exceed this depth.

The dark shading of Figure 12 indicates where the Eagle Harbor bioassays failed one or more of the MCUL biological effects criteria. In remaining areas above the chemical criteria (Figure 11), uncertainty exists about potential adverse biological effects. In order to meet the Sediment Standards biological criteria, at least three different biological measures--two acute and one chronic--must meet the criteria.

A number of locations in the West Harbor met criteria for two acute tests or for a chronic and an acute test. No location has complete information for comparison to the biological criteria, however. Areas of the West Harbor may meet the biological criteria if tested. Without further testing, however, actual cleanup areas must be based on chemical data only.

8.2 Common Components of Alternatives

A number of remedial alternatives evaluated in the FS share certain components. For alternatives involving dredging or capping, common elements include methods of sediment removal and placement, field analytical methods, and the need for turbidity control. For alternatives which include treatment, common elements include the need for sediment storage areas, pretreatment processing, treatment sites, treatability studies, wastewater and stormwater storage and treatment, and fugitive air emission controls. Table 11 shows which elements are associated with the alternatives considered. Further detail is provided in the FS. Potential navigational constraints were considered for all of the active remedial alternatives.

Table 11
Summary of Common Components for Remedial Alternatives

Alternative	Type of Dredging, Excavation, or Mixing		Turbidity Control	Temporary Nearshore Sediment Storage[e]	Treatment at Wyckoff Property	Pretreatment			Storage and Treatment of Wastewater	5-year review Mandated by CERCLA[g]
	Mechanical	Hydraulic				Debris Removal	Sediment Resizing	Dewatering		
A. No Action										●
B. Institutional Controls										●
C. Capping	●[a]	●[b]	●			●				●
D. Removal, Consolidation, and Confined Aquatic Disposal	●	●[c]	●			●				●
E. Removal, Consolidation, and Nearshore Disposal	●	●[d]	●			●				●
G. Removal, Consolidation, and Upland Disposal at a Commercial RCRA Landfill	●		●	●		●		●	●	●
H. Removal, Treatment by Incineration, and Disposal	●		●	●	●	●	●	●	●	●
I. Removal, Treatment by Solidification/ Stabilization, and Disposal	●		●	●	●[f]	●			●	●
L. Removal, Treatment by Biological Slurry, and Disposal	●		●	●	●	●	●	●	●	●
M. In Situ Solidification/ Stabilization	●		●			●			●	●
N. Low-Impact Capping/Thin Layer Placement	●	●	●			●				●

[a]It has been assumed that imported fill for the intertidal cap would be mechanically placed.
[b]It has been assumed that clean sediment for the subtidal cap would be hydraulically dredged.
[c]It has been assumed that the CAD pit would be hydraulically dredged.
[d]It has been assumed that the cap would be hydraulically dredged (excluding the surface layer that would be imported fill).
[e]If only a small volume of sediment is treated (e.g. intertidal mercury) then temporary nearshore sediment storage would not be needed.
[f]If only the mercury area is treated, the treatment location has been assumed to be the shore.
[g]The 5-year review would be conducted with all alternatives.
● = Component is included in alternative.

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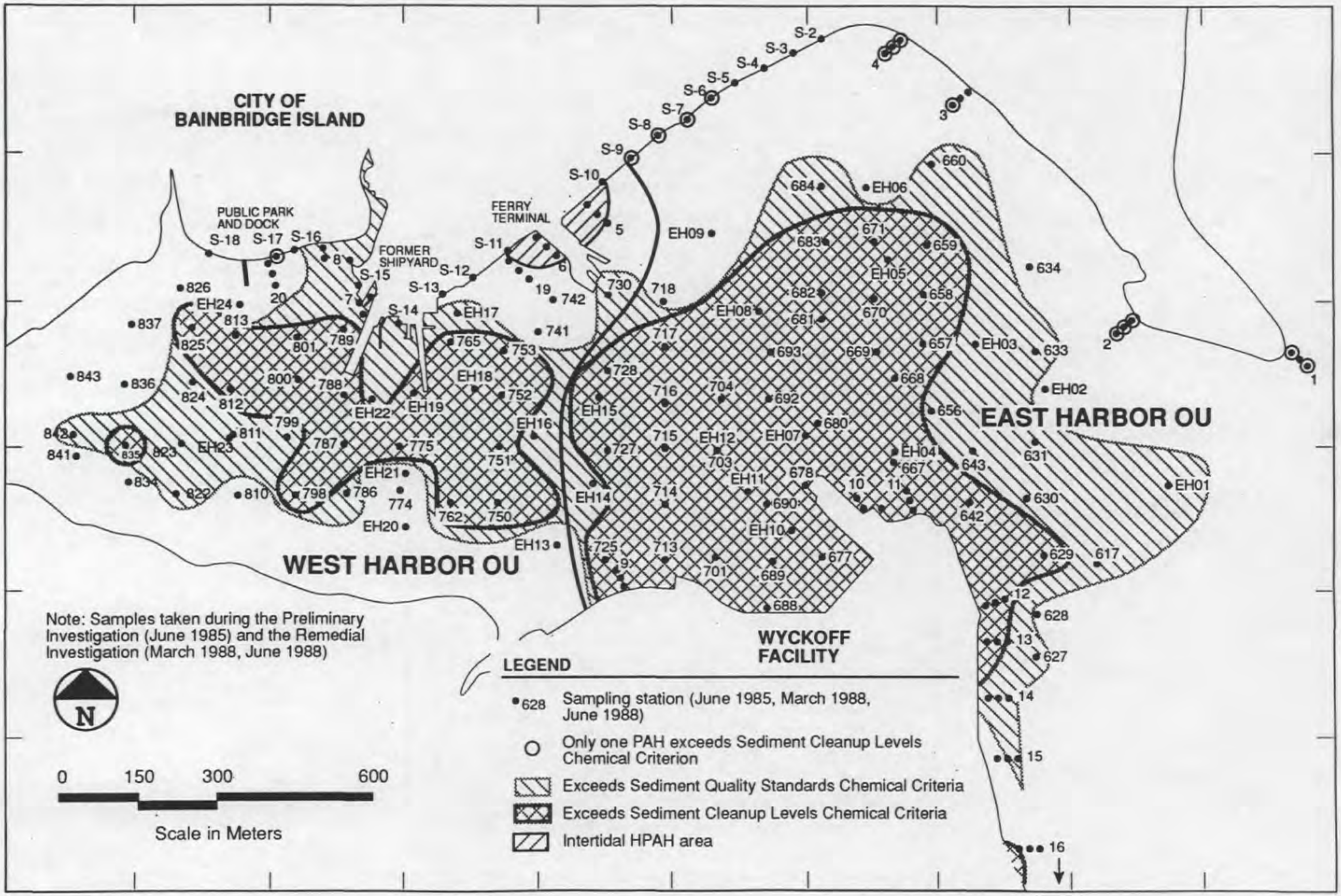

Figure 11
AREAS EXCEEDING SEDIMENT STANDARDS CHEMICAL CRITERIA

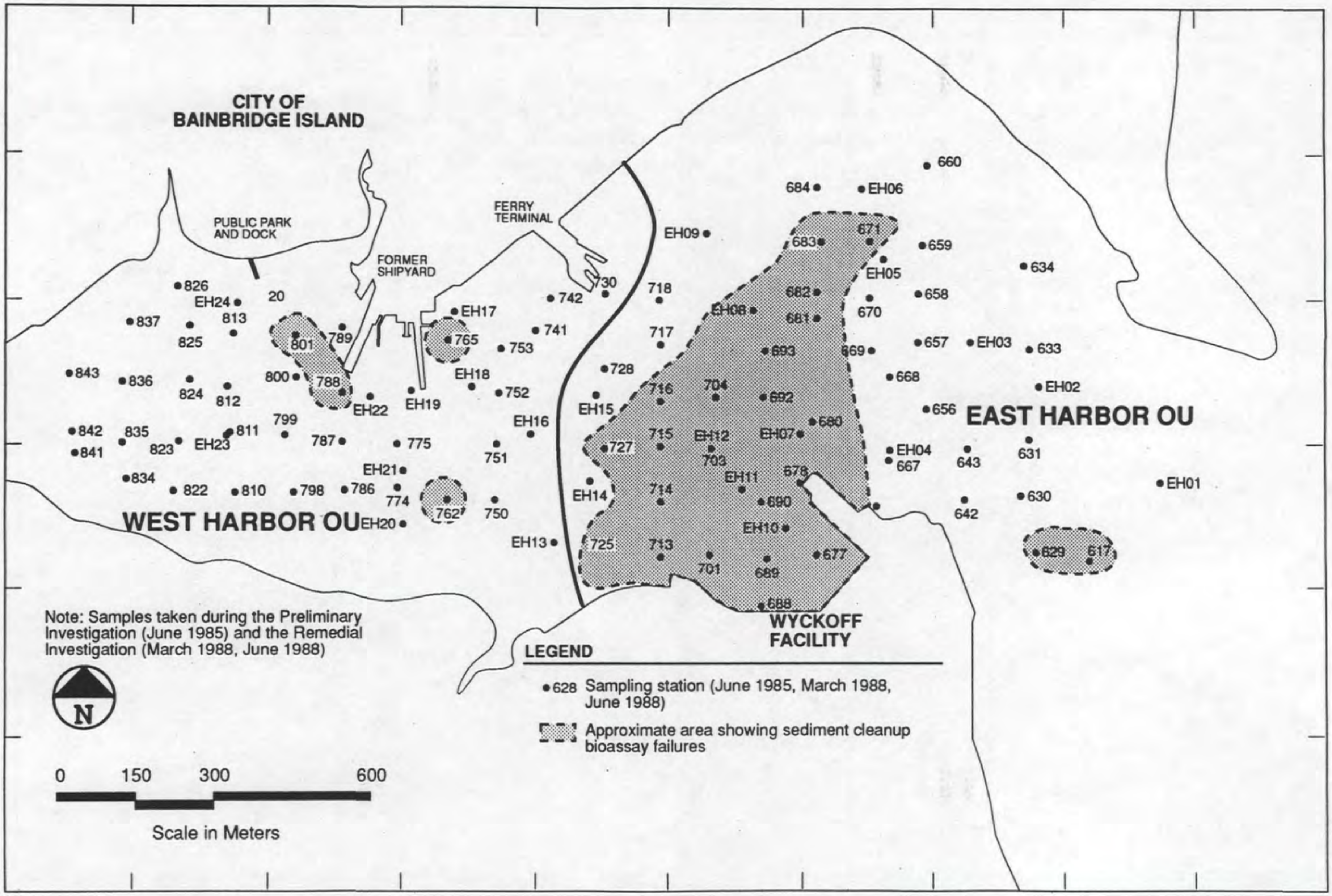

Figure 12
AREAS EXCEEDING SEDIMENT STANDARDS MCUL BIOLOGICAL CRITERIA

In addition, all the alternatives include one or more of the following elements:

-institutional controls
-source control
-natural recovery
-sampling during remedial design
-monitoring during and after cleanup

A brief discussion of each is provided below.

8.2.1 Institutional Controls

Institutional controls for Eagle Harbor consist mainly of public warnings to reduce potential exposure to site contamination, particularly ingestion of contaminated seafood. Provided the controls protect public health and the environment and meet existing state and federal environmental requirements, institutional controls alone can be considered a remedial alternative.

At Eagle Harbor, continuation of the existing health advisory was considered as an individual alternative (Alternative B). It was also considered in conjunction with all of the active remedial alternatives because implementation of remedial action may take several years and may not reduce contaminant concentrations in seafood to acceptable levels for some time. In any event, the Kitsap County Health District is likely to continue its health advisory due to bacterial contamination of Eagle Harbor shellfish.

8.2.2 Source Control

Source control in a dynamic environment such as a harbor can be difficult to achieve. Sources may include discharges, runoff, or spills directly to the beaches or the water, as well as releases through more indirect pathways such as groundwater transport, seepage, or air deposition. In addition, more heavily contaminated sediments in one area of a harbor may be dispersed to other less contaminated areas.

During the RI/FS, EPA evaluated sources of contamination to Eagle Harbor. Based on this evaluation, past practices contributed to initial contamination, and environmental processes continue to transport contaminants to other areas. EPA expects that potential ongoing releases from West Harbor upland areas are minor and can be readily controlled. Cleanup actions at the Wyckoff OU are anticipated to control significant contaminant sources to East Harbor sediments, and it is anticipated that potential transport of contaminated sediments from the East Harbor will be minimized by coordinated sediment remediation in heavily contaminated areas of the East Harbor OU.

Source control as an element of remedial action would be required for all of the active remedial alternatives. For No Action and Institutional Controls, cleanup of other operable units would be the only contribution to source control conducted under Superfund authorities. Details and costs of source control efforts are not included in the individual FS alternatives. They will be refined during remedial design.

8.2.3 Natural Recovery

Mathematical modeling was conducted during the RI/FS to evaluate the potential for natural recovery of contaminated Eagle Harbor sediments. A watershed model was used to estimate sedimentation rates (See Table 1, Technical Memorandum #4, 1989). Since Eagle Harbor is not fed by a river or other major upland sources of sediment, estimated sedimentation rates in Eagle Harbor were relatively low. Contaminant sources were assumed to be controlled, and existing information was used to develop estimates for HPAH degradation rates, loss by advection (sediment movement), and other natural processes (Feasibility Study, Appendix D1).

For the West Harbor, natural recovery was predicted to be most effective in intertidal areas containing PAHs but without metals contamination. Intertidal areas have an active water regime and are exposed to light and air, which encourages microbial and chemical degradation of PAH.

All of the subtidal sample locations in the West Harbor, except one near the former shipyard, were predicted to achieve the sediment cleanup objective (MCUL) for PAHs within ten years. Mercury does not degrade, however, and site-specific information about rates of mercury methylation, biological uptake and dispersion through the food chain is limited. Sedimentation is anticipated to be the primary means of natural recovery. Due to the low sedimentation rates estimated, only minor reductions in subtidal metals concentrations are predicted over the ten year period. In the more heavily contaminated areas near the former shipyard, natural recovery is very unlikely.

The Sediment Standards allow mathematical modeling as a means to identify areas where natural recovery could occur in ten years without active remediation. Because the natural recovery evaluation in the FS did not predict natural recovery for most areas of Eagle Harbor, the cleanup areas discussed are based on current conditions. However, additional mathematical modeling approved by EPA could be conducted where contamination is near the cleanup level to better define areas expected to recover in ten years. If so, key assumptions and their significance should be evaluated, additional site data obtained, and modeling methods agreed on.

8.2.4 Sampling During Remedial Design

Although extensive source, chemical, and biological information has been collected during the RI/FS and previous studies of Eagle Harbor, some sampling may be necessary during remedial design to refine estimated cleanup areas or volumes, and to determine waste characteristics.

The Sediment Standards define two sets of biological criteria which correspond to the minimum cleanup level (MCUL) and sediment quality standards (SQS) chemical criteria. The results of optional biological tests conducted according to the Sediment Standards override the chemical information for a given location. Although biological testing has been conducted in Eagle Harbor, the level of benthic information required to override the chemical data was not obtained. Sampling and testing to obtain complete biological information are considered an option for remedial design, and could affect the size of the cleanup areas. Additional sampling during remedial design could include chemical sampling to refine areas of sediment requiring cleanup. Such sampling is assumed for all alternatives other than No Action and Institutional Controls.

For removal alternatives, waste volumes and characteristics would be necessary, and for some treatment alternatives, treatability tests may be required during remedial design.

8.2.5 Monitoring

Physical, chemical and biological monitoring after cleanup will continue as long as necessary. Monitoring during implementation of remedial actions is important to assess short term environmental and human health effects and to confirm compliance with the selected remedial design.

Monitoring after remediation is also critical, for several reasons:

- to evaluate potential sources and the effectiveness of source control efforts.
- to confirm the success of the remedy and attainment of the cleanup objectives.
- to confirm predicted natural recovery.
- to determine the need for continued institutional controls,
- *to evaluate improvements in the overall health of the harbor.*

For FS cost estimates, monitoring was assumed to continue for thirty years and generally included chemical and biological monitoring, tissue sampling, and monitoring of treatment areas as appropriate. Monitoring costs are included under operation and maintenance (O & M), and vary according to the different alternatives and cleanup areas.

8.3 Description of the Alternatives

The following description of the Eagle Harbor cleanup alternatives considered is an abbreviated version of the detailed description of alternatives developed in the Eagle Harbor FS, supplemented by a description of Alternative N.

Cost estimates for each of the West Harbor areas are summarized on Tables 12a, b, c, d, based on areas listed in Table 10. Table 13 provides a summary of the time estimated to implement each alternative, assuming each alternative is applied in all areas for which the alternative was carried forward for detailed evaluation. Remedial action areas, costs and timeframes for the West Harbor will be refined during remedial design.

ALTERNATIVE A. NO ACTION/NATURAL RECOVERY

The No Action Alternative must be evaluated to provide a baseline to which other alternatives can be compared. No active remediation of sediment contamination would take place, although source control activities at the Wyckoff OU would continue. Humans and aquatic organisms using contaminated areas of Eagle Harbor would continue to be exposed to elevated levels of contaminants until natural recovery was achieved.

Natural recovery could occur gradually, in some areas over a period of fifty years or more, through deposition of new sediments, degradation of PAH by physical, chemical, and biological processes, and movement of contaminated fine sediments with tidal and other currents.

No initial costs are included, and the cost of monitoring of seafood to evaluate reductions in contaminant concentrations over time is included as O&M.

ALTERNATIVE B. INSTITUTIONAL CONTROLS/NATURAL RECOVERY

This alternative was evaluated for all areas of the West Harbor.

As with the No Action alternative, the Institutional Controls alternative does not involve active remediation of contaminated sediments. Natural recovery of contaminated sediments would occur gradually in some areas, and

Table 12a - Cost Estimates for Preliminary Intertidal Mercury Area			
Alternative	Initial Cost	O & M Cost	Total Cost
A. No Action	$ 0	$ 200,000	$ 200,000
B. Institutional Controls	$ 0	$ 300,000	$ 300,000
C. Capping	$ 1,800,000	$ 2,100,000	$ 3,900,000
D. Confined Aquatic Disposal	$ 2,400,000	$ 2,800,000	$ 5,200,000
E. Nearshore Disposal	$ 10,800,000	$ 11,700,000	$ 22,500,000
G. Upland Disposal (RCRA)	$ 11,700,000	$ 12,100,000	$ 23,800,000
I. Solidification/Stabilization	$ 4,400,000	$ 4,700,000	$ 9,100,000
M. Insitu Solidification/Stabilization	$ 3,200,000	$ 3,500,000	$ 6,700,000
N. Low-Impact Capping/Thin Layer Placement	*	*	*
* Cost estimate included with the Upper and Lower-bound areas			

Table 12b - Cost Estimates for Preliminary Intertidal PAH Area			
Alternative	Initial Cost	O & M Cost	Total Cost
A. No Action	$ 0	$ 300,000	$ 300,000
B. Institutional Controls	$ 24,000	$ 400,000	$ 424,000
C. Capping	$ 5,900,000	$ 6,500,000	$ 12,400,000
D. Confined Aquatic Disposal	$ 9,800,000	$ 10,600,000	$ 20,400,000
E. Nearshore Disposal	$ 29,500,000	$ 31,000,000	$ 60,500,000
H. Incineration	$ 99,200,000	$ 102,000,000	$ 201,200,000
L. Biological Slurry	$ 71,500,000	$ 73,400,000	$ 144,900,000

Table 12c - Cost Estimates for Lower-End Subtidal Mercury Area			
Alternative	Initial Cost	O & M Cost	Total Cost
A. No Action	$ 0	$ 200,000	$ 200,000
B. Institutional Controls	$ 0	$ 300,000	$ 300,000
C. Capping	$ 2,700,000	$ 3,000,000	$ 5,700,000
D. Confined Aquatic Disposal	$ 6,000,000	$ 6,400,000	$ 12,400,000
E. Nearshore Disposal	$ 23,200,000	$ 24,400,000	$ 47,600,000
G. Upland Disposal (RCRA)	$ 35,900,000	$ 36,800,000	$72,700,000
I. Solidification/Stabilization	$ 11,700,000	$ 12,100,000	$ 23,800,000
N. Low-Impact Capping/Thin Layer Placement	$ 1,400,000	$ 300,000	$ 1,700,000

Table 12d - Cost Estimates for Higher-End Subtidal Mercury Area			
Alternative	Initial Cost	O & M Cost	Total Cost
A. No Action	$ 0	$ 300,000	$ 300,000
B. Institutional Controls	$ 0	$ 400,000	$ 400,000
C. Capping	$ 4,900,000	$ 5,300,000	$ 10,200,000
D. Contained Aquatic Disposal	$ 12,300,000	$ 13,000,000	$ 25,300,000
E. Nearshore Disposal	$ 37,400,000	$ 39,000,000	$ 76,400,000
G. Upland Disposal (RCRA)	$ 88,700,000	$ 90,800,000	$ 179,500,000
I. Solidification/Stabilization	$ 28,300,000	$ 29,200,000	$ 57,500,000
N. Low-Impact Capping/Thin Layer Placement	$ 2,000,000	$ 300,000	$ 2,300,000

institutional controls such as access and use restrictions, health advisories, and hazard education programs for the public would be used to limit potential human exposure to contaminants. These measures would be continued as needed until concentrations of mercury and PAH were below levels of concern for human health.

Use restrictions would include increased posting of the existing health advisories against fish and shellfish consumption in intertidal and subtidal areas to reduce the potential for human exposure to unacceptable levels of contaminants in seafood. Restrictions on commercial harvesting of fish and shellfish could also be implemented. Dredging in problem areas would be restricted and best management practices (BMPs) for maintenance of creosoted pilings and other shoreline operations would be required. Costs are considered under O&M.

ALTERNATIVE C. CAPPING

This alternative was evaluated for all areas of the West Harbor.

Capping consists of leaving the contaminated subtidal and intertidal sediments in place and covering them with clean material to isolate the contamination. The physical conditions that the cap would be exposed to would vary depending on its location and would determine the detailed design requirements.

Subtidal capping would involve placement of a 1-meter (3-foot) thick layer of clean medium- to coarse-grained sand to isolate contaminants and limit their vertical migration and release into the water column. This cap thickness would also limit the potential for marine organisms to reach the contaminated sediment. For purposes of estimating costs it was assumed that suitable sandy material could be obtained by dredging within a 3-kilometer (1.9 mile) radius of Eagle Harbor. Identification of an actual source would be conducted during remedial design and would affect cost.

To have better perimeter area coverage, the cap would overlap somewhat onto adjacent areas. For purposes of estimating quantities in the FS, approximately 3 meters (10 feet) of overlap was assumed.

Physical conditions such as the slope and wave environment as well as biological and habitat issues would be considered in the selection of material characteristics. Areas affected by currents induced by ferry propellers would require a coarser grained material as "armoring" to hold the cap in place.

If necessary, the stream near the mercury intertidal area would be temporarily rerouted during cap placement, and the cap would be designed to accommodate the stream.

Cap performance requirements and limitations on permeability (e.g., construction materials, cap maintenance requirements, and testing of contained materials) would be further analyzed during remedial design.

It is estimated that design, procurement, and construction of the cap (for both subtidal and intertidal areas) would take 3 to 4 years. This assumes 6 months for final design, 1 year for pilot testing of the cap, 3 months for design refinement, 6 months for mobilization/demobilization, and 6 months for placement of capping materials.

ALTERNATIVE D. REMOVAL, CONSOLIDATION, AND CONFINED AQUATIC DISPOSAL

This alternative was evaluated for all areas of the West Harbor.

Confined aquatic disposal (CAD) consists of dredging or excavating contaminated sediments from the subtidal and intertidal zones, placing them in an excavated subtidal pit in Eagle Harbor, capping the relocated sediments with a meter (3 feet) of clean sediment from the pit, and disposing of any excess clean sediment at a Puget Sound Dredge Disposal Analysis (PSDDA) open-water disposal site (or applying them to beneficial uses elsewhere). Important considerations in the design of this alternative include:

The CAD site would be in a subtidal area below -7.5 meters (25 feet) mean lower low water (MLLW), with low current velocities. The upper surface of the CAD cap would be consistent with the original harbor bottom contours in order to minimize cap erosion, disruption of navigation, and impacts on harbor circulation. The west-central portion of the harbor could meet these conditions and has sufficient area to accommodate the contaminated sediment.

Contaminated sediment removed from intertidal areas would be replaced with uncontaminated material of a similar type to mitigate the loss of intertidal substrate. If necessary, some of the contaminated sediment removed from the subtidal area would be replaced with similar uncontaminated material to assist in the restoration of eelgrass.

It is estimated that design, procurement, and construction of the CAD for the total volume of contaminated sediment would take 4 to 6 years. This estimate assumes a minimum of 1 year for design, 6 months to excavate the CAD basin, 2 years to dredge and place the contaminated sediment, 6 months to cover, and 1 year to mobilize and demobilize the operation.

ALTERNATIVE E. REMOVAL, CONSOLIDATION, AND NEARSHORE DISPOSAL

This alternative was evaluated for all areas of the West Harbor.

The alternative consists of constructing a containment area adjacent to the shore in Eagle Harbor, removing contaminated sediments from subtidal and intertidal problem areas, placing the contaminated sediments in the containment area in the harbor, and capping the sediments in the containment area with imported clean sand. The final elevation of the upper surface of the containment area would match the existing upland surface.

This nearshore fill site would be located in an area that would minimize disruption of navigation and operations on contiguous upland areas. The size of the disposal site would depend on the ultimate volume of sediment removed.

Contaminated sediment in the disposal site would be kept saturated in order to limit contaminant release. The surface of the clean sediment cap would be paved and a stormwater collection system would be installed.

It is estimated that design, procurement, and construction of the nearshore disposal facility for the total volume of sediment would take 4 to 5 years.

ALTERNATIVE G. REMOVAL, CONSOLIDATION, AND UPLAND DISPOSAL AT AN OFF-SITE COMMERCIAL RCRA LANDFILL

This alternative was evaluated for all areas of the West Harbor except the intertidal HPAH area.

The alternative consists of dredging the contaminated sediments, dewatering them, and transporting them to an off-site RCRA-permitted hazardous waste landfill. Mechanical equipment would be used for dredging, and trucks would be used for transport.

Table 13 Estimated time to complete Remediation			
	Alternative	Estimated Time for Design, Procurement, and Remediation[a] (years)	Estimated Cost
A.	No Action	NA	NA
B.	Institutional Controls	1 to 10	Very low
C.	Capping	3 to 4	Low
D.	Removal, Consolidation, and Confined Aquatic Disposal	4 to 6	Low
E.	Removal, Consolidation, and Nearshore Disposal	4 to 5	Low
G.	Removal, Consolidation, and Upland Disposal at Commercial RCRA Landfill	1 to 2	High
H.	Removal, Treatment by Incineration, and Disposal	8 to 11	High
I.	Removal, Treatment by Solidification/ Stabilization, and Disposal	3 to 6	Moderate
L.	Removal, Treatment by Biological Slurry, and Disposal	9 to 11	Moderate
M.	In Situ Solidification/Stabilization	3 to 6	Moderate
N.	Low-Impact Capping/Thin Layer Placement	3 to 4	Low

[a]Based on modification of FS table 5-1, which was based on remediation of the total of sediment problem areas in Eagle Harbor (430,000 M^3). Time frames reflect volumes in problem areas for which alternative was developed for detailed evaluation.
NA = Not Applicable.

Although sediments in the West Harbor are not listed dangerous or hazardous wastes (listed DW/HW) according to RCRA or the State Dangerous Waste Regulations, they may be characteristic wastes (DW/HW) on the basis of the Toxicity Characteristic Leaching Procedure (TCLP) or may be "Washington-State-only dangerous waste" (state-only DW) on the basis of state criteria for toxicity, persistence, or carcinogenicity.

If the excavated sediments are determined to be DW/HW, they will require treatment to achieve compliance with RCRA land disposal restrictions. Bench scale studies may be necessary to establish that the appropriate treatment standards are achievable through stabilization/solidification. If not, a treatability variance would be necessary.

During dredging and transport, some sediment could be stored in barges to allow for the sediment to be transported off site at a slower rate than it is dredged. The sediment would be dewatered on site prior to shipment. The dewatering process may be enhanced by placing vibrators in the dewatering basins. Waste water would be collected and treated by carbon filtration prior to discharge to the harbor. The sediment would be placed in lined roll-off boxes for transport by trucks to the selected hazardous waste landfill and, if necessary, would be treated by solidification/stabilization at the landfill prior to disposal.

It is estimated that design, procurement, and remediation would take 1 to 2 years, with actual on-site activities requiring approximately 6 months.

ALTERNATIVE H. REMOVAL, TREATMENT BY INCINERATION, AND DISPOSAL

This alternative was evaluated for areas without mercury contamination. In the West Harbor, use of this alternative would be limited to intertidal PAH areas below the MCUL for mercury.

In this alternative, the excavated sediment would be incinerated on site after dewatering and milling to reduce the size of large sediment particles. It has been assumed that the solids content of the sediment after dewatering would be approximately 50 percent because of the sandy nature of the sediments.

The FS assumed that the incineration would be done in a rotary kiln, using natural gas or oil as supplemental fuel. The incineration rate would be 275 m^3 of sediment per day. The utilization factor for the incinerator was assumed to be 80 percent and the treatment efficiency 99.99 percent. The area needed for the incinerator would be about 16,000 m^2. The incinerator would be equipped as necessary to control the release of particulate and gaseous emissions.

It is estimated that design, procurement, and incineration of the total volume of PAH contaminated sediment in Eagle Harbor would take 8 to 11 years. The volume of West Harbor intertidal sediments contaminated only with PAH is significantly smaller, and would take less time to incinerate. Incinerated sediment from the West Harbor would not be considered RCRA listed waste.

If tests of the treated sediment demonstrated compliance with performance standards and PSDDA criteria, the treated sediment could be disposed of at an open-water disposal site.

ALTERNATIVE I. REMOVAL, TREATMENT BY SOLIDIFICATION/STABILIZATION, AND DISPOSAL

This alternative was evaluated for sediments with mercury contamination and moderate to low PAH concentrations. Other treatment alternatives for mercury contaminated sediments were limited. In the West Harbor, such sediments include intertidal and subtidal mercury areas. High concentrations of organic compounds such as PAHs can interfere with the solidification/stabilization process, and the alternative was not evaluated for the West Harbor intertidal PAH area.

In this alternative, the dredged or excavated sediment would be mixed with solidifying and stabilizing agents in equipment similar to that used for mixing concrete. If sediments are neither state-only DW or characteristic DW/HW after solidification/stabilization, they may be disposed of at a municipal landfill.

Solidification combined with stabilization treatment does not destroy or remove the contaminants from the sediment but chemically binds the contaminated sediments into a structurally fixed matrix. In this way the leachability, and thus the mobility, of the contaminants is reduced.

The volume of the sediment is assumed to increase by about 20 percent with the addition of the stabilizing agent. Treatment rates and the percentage increase in volume would depend upon the types and quantities of reagents used. The treated sediments would be tested to demonstrate compliance with performance criteria specified during remedial design, and the solidified mass would be disposed of on site, transported to a local municipal landfill, or used for productive purposes. It is estimated that design, procurement, and remediation would take 3 to 6 years.

ALTERNATIVE L. REMOVAL, TREATMENT BY BIOLOGICAL SLURRY, AND DISPOSAL

This alternative was evaluated for sediments with lower mercury concentrations. As with any biological treatment technology, the biological slurry treatment would not be effective for metals such as the mercury found in some of the West Harbor sediments.

In this alternative excavated sediments would be mixed and aerated as a slurry to enhance the biological degradation of PAH and other organic contaminants. Control over treatment conditions would help maintain treatment effectiveness with the relatively low organic content of the sediments at Eagle Harbor.

The sediment would be treated in mobile treatment reactors brought on site. The treatment tanks would be covered, and the off-gas would be treated as appropriate. The area needed for the treatment tanks and equipment would be about 30,000 m^2. A portion of the Wyckoff facility could be used for the treatment operations if they were coordinated with ongoing and future cleanup activities there.

The treated sediments would be tested to demonstrate compliance with performance criteria and disposed of at a PSDDA open-water disposal site. Excess wastewater from the sediment treatment would be treated on site prior to discharge to the harbor.

It is estimated that design, procurement, and remediation would take 9 to 11 years for PAH-contaminated sediments throughout Eagle Harbor. For the West Harbor, less time would be necessary.

ALTERNATIVE M. IN SITU TREATMENT BY SOLIDIFICATION/STABILIZATION

This alternative was evaluated only for mercury-contaminated intertidal sediments with lower PAH concentrations, e.g., the mercury intertidal area. This technology has not been proven for contaminated sediments in marine waters in the United States, and the stabilizing agent might be susceptible to erosion in subtidal areas or areas with strong currents.

In this in-place alternative, sheet pile or a berm would first be placed around the area to be treated. The sediment would then be mixed with solidification agents by using either an auger-type mixing rig or equipment such as a backhoe or a plow.

The volume of the sediment is assumed to increase by about 20 percent with addition of the stabilizing agent. Treatment rates and the percentage increase in volume would depend upon the types and quantities of reagents used. The treated sediments would be tested during remedial design to demonstrate compliance with specified performance criteria. The solidified sediments would be left in place and would be capped with clean sediments.

It is estimated that design, procurement, and remediation would take 3 to 6 years for intertidal mercury, of which approximately 1 year is required for the actual remediation step.

ALTERNATIVE N. LOW-IMPACT CAPPING/THIN LAYER PLACEMENT

This alternative is considered only for subtidal areas of the West Harbor, where currents are moderate to slow and contamination is marginal. Initially identified as low-impact capping, this alternative is more accurately termed thin-layer placement, because it does not isolate contaminated sediments throughout a problem area. Rather, clean sediments are added to the environment to allow enhancement of natural sedimentation without a widespread or major impact on existing biological communities.

Where applied, uniform coverage would not be expected, and some areas could receive little or no clean material in order to leave areas where existing biota would be minimally affected. Over time, vertical mixing through biological activity and lateral redistribution of the clean sediment would promote attainment of the sediment cleanup chemical criteria.

As described in a separate feasibility evaluation completed by the U.S. Army Corps of Engineers (COE, 1992), the clean material is assumed to be placed in longitudinal hills (windrows) parallel to the shoreline approximately 60 meters (200 feet) apart. Along the windrow centerline, the target thickness of the clean sediment would probably not exceed 30 cm (1 foot), and the clean sediment thickness would taper between rows to less than 3 centimeters (1 inch).

The time to remediate is estimated to be 3 - 4 years, the same as for Alternative C.

8.4 Applicable or Relevant and Appropriate Requirements

Remedial actions implemented under CERCLA must meet legally applicable, or relevant and appropriate requirements (ARARs). ARARs include promulgated environmental requirements, criteria, standards, and other limitations. Other factors to be considered (TBCs) in remedy selection and implementation may include nonpromulgated standards, criteria, advisories, and guidance, but are not evaluated pursuant to the formal process required for ARARs.

ARARs of federal, state, and tribal governments must be complied with during CERCLA response actions. Local ordinances with promulgated criteria or standards are not considered ARARs, but may be important TBCs. Major ARARs and TBCs associated with the different alternatives are presented in Table 14.

Table 14
Potential Action Specific ARARs[a]

General Response Action Technology/Process Option	Citation	Requirements	Prerequisite	Potential ARAR/TBC Determination[b]	Comments
In Situ Capping\Containment, Thin Layer Placement	33 USC 403 33 CFR 320-330 40 CFR 230	Dredge and Fill activities must comply with Section 10 of Rivers and Harbors Act, Section 404 of Clean Water Act, and U.S. Army Corps of Engineers regulations.	Dredge and fill in navigable waters of the United States.	Applicable	Inplace capping of sediments constitutes filling.
	WAC 173-201 RCW 90.48	Dredge and Fill activities must comply with water quality standards for Class A marine waters.	Action takes place in surface waters of Washington state.	Applicable	
	WAC 220-110 RCW 75.20	Dredge and Fill activities must meet substantive requirements of hydraulics project approval process.	Action may interfere with natural water flow of Washington state waters.	Applicable	
	WAC 173-19-2604	Protect public interest associated with shorelines.	Action occurs within 200 feet of shorelines of statewide significance.	Applicable or relevant and appropriate	If action occurs within 200 feet of shorelines, this requirement may be applicable. If action does not take place on shorelines, then requirement is not applicable, but could be relevant and appropriate.
Excavation/Dredging of Contaminated Sediments	33 USC 403 33 CFR 320-330 40 CFR 230	Dredge and Fill activities must comply with Section 10 of Rivers and Harbors Act, Section 404 of Clean Water Act, and U.S. Army Corps of Engineers regulations.	Dredge and fill in navigable waters of the United States.	Applicable	
	WAC 220-110 RCW 75.2	Operations must comply with hydraulic project approval.	Action may interfere with natural water flow of Washington state waters.	Applicable	
	WAC 173-19-2604	Protect public interest associated with shorelines.	Action occurs within 200 feet of shorelines of statewide significance.	Applicable	
	RCW 90.48 WAC 173-201 RCW 90.54	Water quality antidegradation policy of the State of Washington.	Beneficial uses shall be maintained and protected, and no further degradation of water quality that would interfere with or become injurious to existing beneficial uses.	Applicable	

Table 14
Potential Action Specific ARARs[a]

General Response Action Technology/Process Option	Citation	Requirements	Prerequisite	Potential ARAR/TBC Determination[b]	Comments
Sediment Treatment ● General Requirements	WAC 173-220 WAC 173-216	Onsite Treatment Facilities. No pollutants shall be discharged to any surface water of the State of Washington from a point source, except in compliance with substantive treatment and disposal requirements.	Surface discharge of treated effluent to Puget Sound.	Applicable	These requirements would be applicable if sediments are treated onsite and effluent is discharged to Eagle Harbor.
	WAC 173-220-210	Discharge must be monitored to assure compliance. Monitoring includes measurement of flow and mass of each pollutant.		Applicable	
	WAC 173-216-060	Discharge to POTW. Pollutants that pass through a POTW without treatment, interfere with POTW operation, or contaminate POTW sludge are prohibited. Specific prohibitions preclude the discharge to POTWs of pollutants that: • Create a fire or explosion hazard in the POTW. • Are corrosive (pH <5.0 or >11.0). • Obstruct flow resulting in interference. • Are discharged at a flow rate and/or concentration that will result in interference. • Increase the temperature of wastewater entering the treatment plant resulting in interference. Discharge must comply with local POTW pretreatment program including POTW-specific pollutants, spill prevention program requirements, and reporting and monitoring requirements.	Liquid waste discharge to sewage system.	Applicable	Categorical standards have not been promulgated for CERCLA sites. Discharge standards must be determined on a case-by-case basis and are dependent on the characteristics of the waste stream and the receiving POTW. These regulations would be applicable if treated effluent is discharged to POTW.

Table 14
Potential Action Specific ARARs[a]

General Response Action Technology/Process Option	Citation	Requirements	Prerequisite	Potential ARAR/TBC Determination[b]	Comments
Sediment Treatment ● General Requirements	40 CFR 261.3 40 CFR 260	Solid waste derived from treatment, storage, or disposal of a listed RCRA hazardous waste or a listed state dangerous waste is itself a listed waste regardless of concentration of HW constituents. To be exempt, the "derived-from" HW must be delisted.	RCRA or state listed waste(KOO1, FO34, UO51, and/or FO27).	Applicable	
	WAC 173-201 RCW 90.48 RCW 90.54	Water quality antidegradation policy of the State of Washington.	Beneficial uses shall be maintained and protected, and no further degradation of water quality that would interfere with or become injurious to existing beneficial uses.	Applicable	

Table 14
Potential Action Specific ARARs[a]

General Response Action Technology/Process Option	Citation	Requirements	Prerequisite	Potential ARAR/TBC Determination[b]	Comments
Sediment Treatment • Dewatering	40 CFR 264.600 40 CFR 262 WAC 173-303	Management of HW or DW must be done in a manner that protects human health and the environment. Prevention of releases that may have adverse effects on human health or the environment because of migration of waste constituents in groundwater, subsurface environment, surface water, wetlands, soils, or air.	Sediments must be classified as HW, DW, or EHW, and treatment may take place inside or outside of Eagle Harbor.	Applicable or relevant and appropriate depending on classification of wastes.	EHW shall not be land disposed in Washington. Sediments would have to be shown to be HW, DW, or EHW before requirements would be applicable or relevant and appropriate.
	WAC 173-201	Effluent must meet the surface water quality criteria in the established mixing zone.	Surface discharge of effluent to Puget Sound.	Applicable or relevant and appropriate.	If discharge is offsite to Puget Sound, both administrative and procedural requirements would apply.
	WAC 173-201-035	Effluent must meet the surface water quality criteria after application of AKART.	Surface discharge of effluent to Puget Sound.	TBC	If proposed regulation is promulgated, then substantive portion of requirements would be applicable.
	RCW 90.48 RCW 90.54	Water quality antidegradation policy of the State of Washington.	Beneficial uses shall be maintained and protected, and no further degradation of water quality that would interfere with or become injurious to existing beneficial uses.	Applicable	

Table 14
Potential Action Specific ARARs[a]

General Response Action Technology/Process Option	Citation	Requirements	Prerequisite	Potential ARAR/TBC Determination[b]	Comments
Sediment Treatment • Dewatering	WAC 173-216	Onsite Treatment Facilities. No pollutants shall be discharged to any surface water of the State of Washington from a point source, except in compliance with substantive requirements.	Surface discharged of treated effluent to Puget Sound.	Applicable	
	WAC 173-220-210	Discharge must be monitored to assure compliance. Monitoring includes measurement of flow and mass of each pollutant.		Applicable	
	WAC 173-216-060	Discharge to POTW. Pollutants that pass through a POTW without treatment, interfere with POTW operation, or contaminate POTW sludge are prohibited. Specific prohibitions preclude the discharge to POTWs of pollutants that: • Create a fire or explosion hazard in the POTW. • Are corrosive (pH <5.0 or >11.0). • Obstruct flow resulting in interference • Are discharged at a flow rate and/or concentration that will result in interference. • Increase the temperature of wastewater entering the treatment plant resulting in interference. Liquid waste discharged to sewage system. Discharge must comply with local POTW pretreatment program, including POTW-specific pollutants, spill prevention program requirements, and reporting and monitoring requirements.	Liquid waste discharged to sewage system.	Applicable	Categorical standards have not been promulgated for CERCLA sites. Discharge standards must be determined on a case-by-case basis and are dependent on the characteristics of the waste stream and the receiving POTW.

Table 14
Potential Action Specific ARARs[a]

General Response Action Technology/Process Option	Citation	Requirements	Prerequisite	Potential ARAR/TBC Determination[b]	Comments
Sediment Treatment • Incineration	WAC 173-303-670 40 CFR 264.341 40 CFR 264.351 40 CFR 264.343 40 CFR 264.342 40 CFR 261.31	Analyze the waste feed. Dispose of all HW, DW, or EHW waste and residues, including ash, scrubber water, and scrubber sludge. Performance standard for incinerators includes a reduction of hydrogen chloride emissions to 1.8 kg/hr or 1 percent of the HC1 in the stack gases before entering any pollution control devices. Monitoring of various parameters during operation of the incinerator is required. These parameters include: • Combustion temperature • Waste feed rate • An indicator of combustion gas velocity • Carbon monoxide	Sediments must be classified as DW or EHW.	Applicable	If wastes to be incinerated are classified as DW or EHW, the requirements would be applicable. If F027 wastes are incinerated, F028 wastes are generated.
	WAC 173-400 40 CFR 52	Sources of fugitive dust must be controlled to avoid nuisance conditions.	All air pollution sources.	Applicable	
	40 CFR 52	Estimation of emission rates for each pollutant expected, including: • Modeled impact analysis of source emissions • Best available control technology (BACT) reviews for source operation	Source meeting the "major" criteria and/or sources proposed for nonattainment areas.	Relevant and appropriate	
	WAC 173-490 40 CFR 52	Predict total emissions of volatile organic compounds (VOC) to demonstrate emissions do not exceed 450 lb/hr, 3,000 lb/day, or 10 gal/day or allowable emissions from similar sources BACT.	Source must be in an ozone nonattainment area.	Applicable	

Table 14
Potential Action Specific ARARs[a]

General Response Action Technology/Process Option	Citation	Requirements	Prerequisite	Potential ARAR/TBC Determination[b]	Comments
Sediment Treatment • Incineration (cont.)	WAC 173-460	Controls for new sources of air toxics	New air emission source.	Applicable	
	Regulation III, Puget Sound Air Pollution Control Agency	Regulates air emissions	Air emissions source.	Applicable	
Sediment Treatment • Solidification/Stabilization	40 CFR 264.601 40 CFR 262 WAC 173-303	Management of HW or DW must be done in a manner that protects human health and the environment. Prevention of releases that may have adverse effects on human health or the environment because of migration of waste constituents in groundwater, subsurface environment, surface water, wetlands, soils, or air.	Sediments must be classified as HW, DW, or EHW, and treatment may take place inside or outside of Eagle Harbor OU.	Applicable or relevant and appropriate	EHW shall not be land disposed of in Washington. "Placement" of wastes occurs when restricted wastes are placed in RCRA land-based units. Placement does not occur when wastes are moved within an existing unit.
	WAC 173-303-809	Substantive requirements for research, development, and demonstration of an innovative and experimental DW waste treatment technology at a DW facility.	Treatment facility not permitted in WAC 173-303-500 through WAC 173-303-670.	Applicable	

Table 14
Potential Action Specific ARARs[a]

General Response Action Technology/Process Option	Citation	Requirements	Prerequisite	Potential ARAR/TBC Determination[b]	Comments
Disposal of Sediments • Confined aquatic disposal (includes nearshore area within Eagle Harbor OU)	PSDDA Management Plan for Unconfined Open-Water Disposal of Dredged Material, Phase I (June 1988), Dredged Material Evaluation Application Report (January 1991)	Guidelines for dredged sediments disposed of at approved unconfined open water sites.	Sediments meet chemical and biological criteria specified in document.	TBC	Guidelines may be TBC for actions that involve unconfined disposal of sediments.
	1989 Puget Sound Water Quality Management Plan	Element S-4 of Puget Sound Management Plan.	Requires Ecology to develop standards for confined disposal of sediments that exceed P-2 criteria but are not designated as DW.	TBC	
	EPA Wetlands Action Plan, EPA Office of Water and Wetland Protection (1/89)	No net loss of remaining wetlands.	Disposal of material nearshore.	TBC	
	WAC 173-201 RCW 90.48 RCW 90.54	Water quality antidegradation policy of the State of Washington.	Beneficial uses shall be maintained and protected, and no further degradation of water quality that would interfere with or become injurious to existing beneficial uses.	Applicable	
	WAC 220-110	Disposal activities must meet substantial requirements of hydraulics project approval process.	Action may interfere with natural flow of Washington state waters.	Applicable	
	33 USC 403 33 CFR 320-330 40 CFR 230	Fill (disposal) activities must comply with Section 10 of Rivers and Harbors Act, Sections 301 and 404 of Clean Water Act, and U.S. Army Corps of Engineers regulations.	Dredge and till activities in navigable waters of the United States.	Applicable	

Table 14
Potential Action Specific ARARs[a]

General Response Action Technology/Process Option	Citation	Requirements	Prerequisite	Potential ARAR/TBC Determination[b]	Comments
Disposal of Sediments • Confined Aquatic Disposal (cont.)	WAC 173-19-2604 RCW 90.58	Protect public interest associated with shorelines.	Action occurs within 200 feet of shoreline of statewide significance.	Applicable	
	40 CFR 268 Subparts A, B, D	Restrictions for land disposal of hazardous waste.	Prior to land disposal hazardous wastes must be treated to specified levels.	Applicable	If treatment standards cannot be met, then a waiver must be obtained.
Upland Disposal of Sediments (onsite and/or offsite)	40 CFR 264.314 WAC 173-303-140	Disposal of DW or EHW at permitted hazardous waste facility.	Elimination of free liquids if dredged material is designated as DW or EHW and disposed of at hazardous waste facility.	Applicable	EHW shall not be land disposed in Washington.
	WAC 173-304-460	Onsite landfill operation shall conform to relevant and appropriate standards and location requirements for landfills.	Sediments are not classified or designated as HW, DW, or EHW. Free liquids have been eliminated from dredge sediments.	Relevant and Appropriate	
	1989 Puget Sound Water Quality Management Plan	Element S-4 of Puget Sound Management Plan.	Requires Ecology to develop standards for contained disposal of sediments that exceed P-4 criteria and are not suitable for PSDDA open-water disposal but are not designated as DW.	TBC	If S-4 guidelines are developed by Ecology for confined upland disposal, then they may become TBCs for disposal of sediments at upland area of site.

Table 14
Potential Action Specific ARARs[a]

General Response Action Technology/Process Option	Citation	Requirements	Prerequisite	Potential ARAR/TBC Determination[b]	Comments
Dredge Water Treatment	40 CFR 261.3 40 CFR 260	Solid waste derived from treatment, storage, or disposal of a listed RCRA hazardous waste is itself a listed waste regardless of concentration of HW constituents. To be exempt, the derived from HW must be delisted.	RCRA listed HW waste.	Applicable	Sediments have not been shown to be listed hazardous waste. Such finding would be necessary for requirement to be applicable.
	WAC 173-216-060	Discharge to POTW. Pollutants that pass through a POTW without treatment, interfere with POTW operation, or contaminate POTW sludge are prohibited. Specific prohibitions preclude the discharge to POTWs of pollutants that: • Create a fire or explosion hazard in the POTW. • Are corrosive (pH <5.0 or >11.0). • Obstruct flow resulting in interference. • Are discharged at a flow rate and/or concentration that will result in interference. • Increase the temperature of wastewater entering the treatment plant resulting in interference. Discharge must comply with local POTW pretreatment program including POTW-specific pollutants, spill prevention program requirements, and reporting and monitoring requirements. Liquid waste discharged to sewage system.	Liquid waste discharged to sewage system.	Applicable	Categorical standards have not been promulgated for CERCLA sites. Discharge standards must be determined on a case-by-case basis, and are dependent on the characteristics of the waste stream and the receiving POTW.

Table 14
Potential Action Specific ARARs[a]

General Response Action Technology/Process Option	Citation	Requirements	Prerequisite	Potential ARAR/TBC Determination[b]	Comments
Dredge Water Treatment (filtration)	WAC 173-220 WAC 173-216	No pollutants shall be discharged to any surface water of the State of Washington from a point source, except in compliance with substantive treatment and disposal requirements. Discharge must be monitored to ensure compliance. Monitoring includes measurement of flow and mass of each pollutant.	Surface discharge of treated effluent. Discharge may not be designated as HW, DW, or EHW.	Applicable	Effluent must be tested to determine if it designates as a DW or EHW.
	WAC 173-201-047 WAC 173-201-045	State water quality criteria for the protection of aquatic life.		Relevant and appropriate	
	40 CFR 125.122-124	Requirements and criteria including compliance with federal water quality criteria and Best Available Technology (BAT).	Direct discharge to waters of the United States; applies to sources only.	Applicable	
	WAC 173-201-035(3)	Effluent must meet the surface water quality criteria after application of AKART.	Surface discharge of effluents to Puget Sound.	TBC	If proposed regulationis promulgated, substantive portion of requirements would be applicable.
	WAC 173-220-210	Discharge must be monitored to assure compliance. Monitoring includes measurement of flow and mass of each pollutant.		Applicable	

[a] The primary ARAR of the State of Washington Sediment Management Standards (WAC 173-204) will be used to define site-specific cleanup areas and objectives.
[b] Final ARAR determination is provided in Section 10 of this ROD.

9. SUMMARY OF COMPARATIVE ANALYSIS OF ALTERNATIVES

The NCP requires that each remedial alternative be evaluated according to specific criteria. The purpose of the evaluation is to identify the advantages and disadvantages of each alternative and thereby guide selection of the remedy offering the most appropriate means of achieving the stated cleanup objectives. While all of the nine criteria are important, they are weighted differently in the decision-making process. The alternatives described in Section 8 were evaluated under CERCLA according to the following criteria:

Threshold Criteria
- Overall protection of human health and the environment
- Compliance with ARARs

Primary Balancing Criteria
- Long-term effectiveness and permanence
- Reduction of toxicity, mobility, or volume through treatment
- Short-term effectiveness
- Implementability
- Cost-effectiveness

Modifying Criteria
- State and tribal acceptance
- Community acceptance

Following is a description of the evaluation criteria and the comparative evaluation of each candidate remedial alternative.

9.1 Threshold Criteria

The remedial alternatives were first evaluated in relation to the threshold criteria of overall protection of human health and the environment and compliance with ARARs. The threshold criteria must be met by the candidate alternatives for further consideration as remedies for the ROD.

9.1.1 Overall Protection of Human Health and the Environment

This criterion considers whether, as a whole, each alternative would achieve and maintain protection of human health and the environment.

All cleanup alternatives except No Action and Institutional Controls protect both human health and the environment. These alternatives are considered protective of the environment only in areas where natural recovery can reduce contaminant levels to the cleanup objective within ten years. Institutional Controls can be used to provide protection of human health but do not protect the environment in areas where natural recovery is not predicted.
Alternatives involving on-site containment of contaminated sediments require long-term monitoring and maintenance in order to assure continued protection.

9.1.2 Compliance with Applicable or Relevant and Appropriate Requirements

The evaluation against this criterion considers whether each alternative would comply with ARARs, or whether a waiver of any ARAR might be necessary and justified, and whether there is any other information or guidance "to be considered."

All alternatives except No Action and Institutional Controls comply with the primary ARAR (the Sediment Standards) for the West Harbor OU.

RCRA and the State of Washington Dangerous Waste Regulations would not be applicable but could be relevant and appropriate for on-site alternatives involving consolidation and containment without treatment within an area of contamination (AOC). This includes confined aquatic disposal, nearshore disposal, or on-site upland disposal. For alternatives involving removal and treatment of West Harbor sediments, these laws would be applicable for sediments determined to be characteristic DW/HW or State-only DW.

For off-site actions, such as disposal at a RCRA landfill or a municipal landfill, all regulatory requirements, including administrative requirements, would apply. Depending on the characteristics of the excavated sediments, state solid waste regulations could apply to off-site disposal options, and state and federal dangerous/hazardous waste regulations could apply for off-site transport and disposal. Characteristic DW/HW sediments would have to be treated to achieve treatment standards under the RCRA Land Disposal Restrictions (LDR) prior to land disposal. If the sediments were State-only DW, the federal LDR would not apply, but Dangerous Waste Regulations would.

No Action and Institutional Controls would meet the Sediment Standards only in areas where natural recovery could occur in ten years. Based on the natural recovery evaluation in the FS, EPA and Ecology believe that, provided sources are controlled, intertidal sediments on the north shore exceeding the Sediment Standards MCUL chemical criteria for PAHs (but not for metals) can achieve the MCUL within ten years through natural recovery.

9.2 Primary Balancing Criteria

Once an alternative satisfies the threshold criteria, five primary balancing criteria are used to evaluate other aspects of the potential remedies. Each alternative is evaluated by each of the balancing criteria. One alternative will not necessarily receive the highest evaluation for every balancing criterion. The balancing criteria evaluation is used to refine the selection of candidate alternatives for a site. The five primary balancing criteria are: long-term effectiveness and permanence; reduction of toxicity, mobility or volume through treatment; short-term effectiveness; implementability; and cost-effectiveness. Each criterion is further explained in the following sections.

9.2.1 Long-Term Effectiveness and Permanence

The evaluation against this criterion assesses the long-term effectiveness of each alternative in maintaining protection of human health and the environment after the cleanup objectives have been met, with a focus on the magnitude of risk posed by treatment residuals or untreated contaminated sediments remaining at a site after the remedial actions have been completed.

CERCLA requires that EPA favor treatment options over institutional controls or off-site disposal of untreated waste. Biological Treatment and Incineration permanently destroy PAH and other organic compounds, but cannot destroy mercury or other metals. Solidification can immobilize metals, but is not as effective for organic compounds such as PAH. In general, treatment is practical and preferable for small volumes of highly contaminated material.

Options involving containment can be effective in the long term, but do not permanently remove or destroy the contaminants. Containment alternatives are more appropriate when large volumes of relatively low-concentration materials or waste are involved, as with many contaminated sediment sites. Containment requires monitoring and maintenance to ensure long-term effectiveness.

Off-site containment at an approved hazardous waste landfill, municipal landfill or other upland disposal site can provide effective long term control, provided any necessary treatment is completed and permits or other institutional controls are in place to ensure appropriate design, construction, maintenance and monitoring of the disposal site.

9.2.2 Reduction of Toxicity, Mobility, or Volume through Treatment

The evaluation against this criterion assesses the anticipated performance of the treatment technologies in each of the alternatives.

Biological treatment and incineration would reduce the toxicity and mobility of PAH contamination, but would not address metals. Solidification (Alternatives I, M, and potentially other options involving land disposal) would decrease the mobility of the metal contaminants, but would increase the volume.

Capping, confined aquatic or nearshore disposal, and upland disposal of untreated sediments are alternatives which restrict the movement of contaminants by containing the sediments to which they are bound and which limit the availability of the contaminant to marine organisms. However, these alternatives do not alter the toxicity, mobility, or volume of the chemical contaminants themselves through treatment.

9.2.3 Short-Term Effectiveness

The evaluation against this criterion assesses the effectiveness of each alternative in protecting human health and the environment from construction and implementation of a remedy until achievement of the cleanup objectives. It focuses on protection of the environment, the community, and workers during implementation of the remedial action.

Capping with clean sediment provides the greatest short-term effectiveness. It can be completed most quickly and has fewer short-term impacts on human health and the environment than other active remedial alternatives.

Any alternatives involving the dredging of subtidal contaminated sediments could have negative short-term impacts on the environment, particularly in areas with heavy contamination. Dredging could remobilize contamination into the water, potentially spreading contamination to nearby areas. Intertidal areas can be excavated at low tide to minimize remobilization of contaminants.

Studies show that marine organisms soon recolonize clean sediment. This process can begin immediately after capping or removal of contaminated sediments, but development of a mature community of sediment-dwellers can take several years. Recolonization of larger areas may be slower.

Alternatives which involve extensive handling of contaminated sediments, such as treatment alternatives, pose somewhat greater risks to workers and the community during implementation. The No Action and Institutional Controls alternatives have no short term impacts, but do not protect the environment.

Among the active remedial alternatives, capping takes the least time to implement, while treatment alternatives generally take longer (Table 13).

9.2.4 Implementability

Three factors were evaluated to assess the implementability of the remedial alternatives: technical feasibility, administrative feasibility, and the availability of disposal sites, services, and materials. Technical feasibility requires an evaluation of the ability to construct and operate the technology, the reliability of the technology, the ease of undertaking additional remedial action (if necessary) and monitoring considerations. The ability to coordinate actions with other agencies is the only factor in evaluating administrative feasibility. The availability of disposal sites, services and materials requires evaluation of the following factors: availability of treatment, storage capacity, and disposal services; availability of necessary equipment and specialists; and availability of prospective technologies.

All of the alternatives were considered technically feasible for the areas considered, although some treatability testing would be necessary to assure the achievement of performance standards of treatment alternatives.

Although all of the alternatives are administratively feasible, some pose greater administrative challenges. Institutional controls require coordinated action with state and local entities. Alternatives such as capping, which involve clean sediment placement, require coordination with PSDDA agencies to obtain clean sediments. Coordinating ferry and tidal schedules pose additional challenges for options involving dredging and, to a lesser extent, capping. Treatment options generally take longer and involve extensive or complex administrative requirements. Incineration is the least administratively feasible because of the difficulties in locating an incinerator on site in a residential community.

Alternatives involving removal and dewatering of sediment prior to treatment, containment, or disposal require the management of sediment and drained water. Treatment options would necessitate storage or sequential dredging to accommodate the materials to be treated and management of treatment residuals. On-site storage and treatment areas are limited.

Removal of intertidal sediments can be done from land at extreme low tide, while capping in intertidal areas may require special equipment. Standard equipment for capping or dredging in subtidal areas is readily available, but could require air monitoring and controls, and engineering controls to limit water column releases.

9.2.5 Cost-Effectiveness

In evaluating project cost-effectiveness, present-worth estimates of capital costs and operation and maintenance costs, are provided for each alternative and compared. Estimates are aimed at providing an accuracy of +50 to -30 percent within the defined scope.

In general, initial costs for treatment options, such as incineration or bioremediation, and for hazardous waste disposal options are high. On-site containment costs tend to be lower initially, but have higher monitoring and/or maintenance costs over the long term. Institutional controls are usually low cost, and No Action is the least costly, but these alternatives may not achieve the cleanup objectives or meet threshold evaluation criteria.

9.3 Modifying Criteria

The final two criteria reflect the apparent preferences among, or concerns about, the alternatives, as expressed by the State, the Suquamish Tribe, and the Community.

9.3.1 State and Tribal Acceptance

The State Department of Ecology had early involvement in the Wyckoff/Eagle Harbor Superfund site, in proposing the site for the National Priorities List, and conducting the Preliminary Investigation. After final listing of the site on the NPL, Ecology reviewed RI planning documents, coordinated with EPA on the developing sediment management standards, and identified state ARARs.

The State supported the preferred alternative in the proposed plan (Appendix A) and concurs with the selected remedy, based on the consistency of the remedy with the recently promulgated Sediment Management Standards. A letter documenting the State's concurrence is included as Appendix B.

The Suquamish Tribe was invited to participate in aspects of the RI through the Technical Discussion Group. The Tribe reviewed key documents such as the RI and FS, received technical memoranda issued by EPA, and provided comments on the proposed plan. Contamination of fish and shellfish resources in Eagle Harbor is of concern to the Tribe and may be addressed by cleanup actions described in the selected remedy.

9.3.2 Community Acceptance

EPA has carefully considered all comments submitted during the public comment period and has taken them into account during the selection of the remedy for the West Harbor and East Harbor operable units.

Based on the comments received during the public comment period, members of the community are divided between support for EPA's preferred alternative and a preference for lower cost alternatives such as the No Action alternative (natural recovery over an indefinite time period of 10 to over 50 years) or some combination of institutional controls, sediment source removal, and natural recovery.

EPA responses to comments received during the public comment period are included in Appendix C.

9.4 Summary

Although the individual alternatives were evaluated for each area described in Section 8, EPA anticipated the need for combining alternatives to arrive at an overall cleanup approach suited to the West Harbor OU conditions and presented such an approach as the preferred alternative in the proposed plan (included as Appendix A).

The selected remedy, described in the following section (Section 10), follows the same approach. It is intended to provide continued protection of human health from risks associated with the West Harbor OU, to address possible changes in the definition of areas failing the Sediment Standards, and to assure and document the attainment and continued compliance with the Sediment Standards and other environmental standards. In addition, it considers the suitability of higher-cost disposal or treatment alternatives for small areas of high contamination; lower-cost containment alternatives suitable for large areas of relatively low contamination; and natural recovery for marginally contaminated areas likely to achieve cleanup objectives without active remediation.

Section 11 documents how the selected remedy meets statutory requirements and provides the most appropriate balance of elements. Section 12 describes significant changes from the proposed plan reflected in the ROD.

10. SELECTED REMEDY

Based on CERCLA, the NCP, the administrative record, and the comparative analysis of alternatives, EPA has selected a remedy which combines the following remedial alternatives described in the proposed plan:

Alternative B (Institutional Controls/Natural Recovery),

Alternative C (Capping),

Alternative G or I (Removal and Appropriate Disposal), and

Alternative N (Low-Impact Capping/Thin Layer Placement)

Specific sediment cleanup areas and the remedial actions selected for each are shown in Table 15 and Figure 13. EPA has determined that this combination is the most appropriate means of achieving the project objectives described in Section 10.1, below. The State of Washington concurs with the selected remedy.

To further ensure that project objectives will be achieved, source evaluation and control of significant sources are also included in this ROD. Monitoring will be conducted before, during, and after remediation to evaluate changes in environmental conditions over time. Site-wide institutional controls will be implemented to limit human exposure to chemical contaminants in seafood from Eagle Harbor.

10.1 Cleanup Objectives

The sediment cleanup objective for the West Harbor OU combines an overall site-specific cleanup objective developed according to the State of Washington Sediment Management Standards (Sediment Standards) with supplemental objectives developed by EPA to address specific concerns and identify areas for actions required at the site, as described in the following sections. The combined sediment cleanup objectives were developed to ensure protection of public health and the environment.

10.1.1 State Sediment Management Standards

The Sediment Standards, the primary ARAR for the West Harbor, were promulgated in April 1991 and provide a framework for developing site-specific sediment cleanup objectives at Eagle Harbor. The long-term goal of the Sediment Standards is "to reduce and ultimately eliminate adverse effects on biological resources and significant health threats to humans from surface sediment contamination." The process for defining sediment cleanup sites and establishing site-specific objectives is summarized in the following paragraphs.

The Sediment Standards define two levels of chemical and biological criteria which correspond to the long-term goal for sediment quality of "no adverse effects" on sediment biological resources, and to a "minor adverse effects" level, exceedance of which triggers consideration of sediment cleanup. The chemical criteria are based on Puget Sound data which indicate sediment chemical concentrations above which specific biological effects have always been observed in test sediments (see Section 6 for description of AETs). The biological criteria have been developed for several types of biological tests. If the chemical criteria indicate the potential for adverse biological effects, compliance with the Sediment Standards must be demonstrated using at least three tests, including two for acute toxicity to marine organisms and one for chronic biological effects.

The absence of adverse effects is predicted by attainment of the "marine sediment quality standards chemical criteria" (SQS chemical criteria), while minor adverse effects are predicted at chemical concentrations above the SQS but below the "minimum cleanup level chemical criteria" (MCUL chemical criteria).

Exceedance of the MCUL chemical criteria alone can be used to define cleanup areas, or "sites"; however, the Sediment Standards recognize that the chemical data may not accurately predict biological effects for all sediment locations. Biological testing, allowed under the Sediment Standards, can be conducted to determine whether biological effects predicted by the chemical concentrations are actually occurring. If the biological criteria are met for a given area, this area is not defined as part of the cleanup site.

The intent of the Sediment Standards is for sediments within a cleanup site to ultimately meet the sediment quality standards (SQS), the level of no adverse effects. Once a cleanup site has been defined as described above, a site-specific cleanup objective is developed based on an evaluation of the net environmental benefit, cost, and implementability of remedial action. The site-specific objective must be between the no adverse effects level (SQS) and the minor adverse effects level (MCUL). In all cases, if both biological and chemical data are obtained, the biological information determines compliance with the site-specific cleanup objective developed under the Sediment Standards. At a minimum, sediments must meet the MCUL within ten years after active remediation is completed, unless an extension is approved.

The Sediment Standards allow a period of ten years from completion of remedial action for cleanup sites to meet the MCUL in recognition that, in certain cases, natural processes such as chemical breakdown, dispersion, or sedimentation may reduce levels of sediment contamination over time. If mathematical modeling predicts that certain areas of contaminated sediment will meet the site-specific objectives within ten years without resort to active remediation, these may be defined as "natural recovery" areas. In such areas, instead of active remediation, monitoring and compliance testing may be used to confirm the predicted recovery.

10.1.2 Site-Specific Goals and Objectives

Within the framework described above, site-specific cleanup goals and objectives were developed for the West Harbor OU. Consistent with the intent of the State Standards, achievement of the SQS and reduction of contaminants in fish and shellfish to levels protective of human health and the environment are long-term goals of sediment remedial action in the West Harbor OU. While these goals represent a conceptual target condition, the measurable site-specific objective is the MCUL, and achievement of the MCUL is the primary focus of remedial action in this OU. The MCUL must be achieved in the top ten centimeters of sediment throughout the West Harbor within ten years after the completion of active sediment remediation or, in areas where natural recovery is predicted based on accepted mathematical modeling, within ten years from control of significant sources to such areas. Compliance with the MCUL is documented by compliance with the MCUL biological criteria or, in the absence of biological data, with the MCUL chemical criteria.

Existing data indicate that adverse biological effects in the West Harbor are associated with heavily contaminated areas near the former shipyard. These data also suggest that adverse biological effects predicted in areas marginally above the MCUL chemical criteria may not be occurring. For this reason, in West Harbor areas below the MCUL chemical criteria, adverse biological effects are not expected. In addition, because there are no rivers or other major sources of clean sediment to Eagle Harbor, achieving the SQS would require active cleanup in areas below the MCUL chemical criteria. The potential benefits of cleanup are not believed to outweigh the costs and potential environmental impacts of remediation in such areas.

The MCUL represents an appropriate and achievable objective for the West Harbor OU. Achievement of the MCUL will be an important step toward the SQS and considers the factors of net environmental benefit, cost, and engineering feasibility as contemplated by the Sediment Standards.

In order to define areas requiring specific types of remedial action, the above site-specific objective developed according to the Sediment Standards is supplemented by three EPA objectives:

1) to address sediments containing 5 mg/kg (dry weight) or more of mercury ("Mercury Hotspot"), as a means of source control;

2) to address intertidal sediments containing 1,200 µg/kg (dry weight) or more of HPAH ("Intertidal HPAH Areas"). Shellfish in such areas contained carcinogenic HPAH above EPA acceptable levels for protection of human health (See Sections 6 and 7);

3) to address predicted biological impacts, minimize potential sediment resuspension, and limit biological uptake in areas where sediment concentrations of mercury exceed 2.1 mg/kg mercury dry weight ("Mercury HAET Areas"). The sediment concentration of 2.1 mg/kg (dry weight) is more than three times the MCUL and is the High Apparent Effects Threshold (HAET) for mercury. (This is the sediment concentration of mercury above which Puget Sound test sediments have always failed acute toxicity tests for both amphipods and oyster larvae and have demonstrated chronic benthic effects).

Although these additional objectives do not alter the requirement of achieving the MCUL throughout the West Harbor, areas defined by the three chemical objectives must be addressed. As described in the following sections, regardless of biological testing options considered under the Sediment Standards, certain minimum actions are required in these areas to address human health and environmental concerns related to potential contaminant resuspension and biological uptake. Also, on the basis of RI/FS information and natural recovery modeling to date, EPA and Ecology believe that natural recovery will occur in intertidal areas described under the second EPA objective, but is unlikely in the Mercury Hotspot and Mercury HAET areas. For this reason, no further modeling is considered in areas defined by objectives 1 and 3, above.

10.2 Problem Areas and Actions

The following problem areas are defined by exceedance (based on RI/FS and PI data) of the goal of the Sediment Standards SQS, the objective of the Sediment Standards MCUL chemical criteria, and the three EPA supplemental objectives. The areas listed below are shown on Figure 13:

- Mercury Hotspot
- Mercury HAET Areas
- Intertidal HPAH Areas
- MCUL Areas
- SQS Areas

The following sections describe the selected remedial action for areas which fail the sediment objectives. Information is provided about how future biological testing or natural recovery modeling, when considered, may result in modifications according to the selected remedy. Actions not linked to individual sediment cleanup areas, such as institutional controls and source control are discussed in Section 10.3 and 10.4. Monitoring objectives are discussed in Section 10.5, and implementation of the remedy is discussed in Section 10.6.

10.2.1 Mercury Hotspot

For sediments with mercury contamination greater than or equal to the 5 mg/kg criterion, the selected remedy is excavation and appropriate upland disposal (as described in Alternative G, or I, or upland on site). The volume of sediments exceeding this criterion is estimated to range from 1,000 to 7,000 cubic meters (1300 to 9200 cubic yards). Further sampling of intertidal and nearshore subtidal sediments will be necessary during remedial design or early stages of remedial action to refine volume estimates prior to final remedial action.

The mercury hotspot is defined by sediment mercury concentrations greater than or equal to 5 mg/kg dry weight. This value is a site-specific criterion developed by EPA to reduce potential resuspension of mercury and other metals in this area, and their redistribution to other parts of the harbor (Fuentes, 1991). The highest mercury concentration observed in the harbor (95 mg/kg) was within this sediment hotspot located adjacent to the former shipyards.

Optional biological testing and natural recovery modeling considered by the Sediment Standards will not be applicablefor modification of actions required in this area. Adverse biological effects have been documented, and mercury concentrations have been measured at close to 10 to over 150 times greater than the MCUL chemical criterion of 0.59 mg/kg.

Disposal methods will comply with ARARs and will be protective of human health and the environment. To determine the appropriate disposal option, sampling during remedial design will include waste characterization of the hotspot sediments. Options for disposal of the excavated material include disposal at an approved commercial hazardous waste landfill, a municipal landfill, or an upland on-site disposal area, depending on the waste designation of the excavated sediments and the availability of an appropriate disposal site.

If the sediments fail the criteria for the toxicity characteristic, they will be designated "characteristic" dangerous waste (DW/HW) or Extremely Hazardous Waste (EHW). Solidification/stabilization of such sediments will be required for disposal off site, and if the sediments, when solidified, cannot meet applicable treatment standards (as specified in 40 C.F.R. § 268), off-site disposal at a commercial hazardous waste landfill is appropriate. In this case, to comply with federal land disposal restrictions, a treatability variance as specified by Superfund guidance (OSWER #9347.3-06FS) would be necessary prior to land disposal. For sediments determined to be "Washington State-only DW" according to dangerous waste criteria other than TCLP testing, off-site disposal must be at a commercial hazardous/dangerous waste landfill unless the sediments can be treated so they no longer fail the criteria.

Excavated sediments which are neither DW/HW nor DW, or which can be treated to no longer be DW/HW or DW, will be considered "problem waste" as defined by the State of Washington Minimum Functional Standards (MFS). In keeping with EPA's off-site disposal policy, off-site disposal of problem wastes at a municipal landfill (provided a landfill will accept the waste) must comply with the MFS.

On-site disposal of problem waste may is also acceptable, provided an on-site disposal area becomes available during remedial design. The relevant and appropriate requirements of the MFS will be determined, and the developing standards for confined disposal of contaminated sediments (under Element S-4 of the Puget Sound Water Quality Management Plan) will be considered in evaluating disposal options. Any necessary treatment and landfill design requirements will be determined based on protection of the environment and human health.

Selection of methods for sediment excavation or dredging will consider the need to minimize remobilization of mercury or other contaminants to the water column. Excavated areas will be backfilled to replicate existing topography as closely as possible, or will meet design specifications intended to create favorable aquatic or intertidal benthic habitat. Backfill materials will be selected which have chemical concentrations below the SQS chemical criteria, and which provide for structural stability and suitable intertidal or subtidal habitat.

If feasible, any pit left after excavation of mercury hotspot sediments may be partially backfilled with less contaminated sediments from surrounding areas (for which capping is identified as the selected remedy, see Section 10.2.2 below). The top 3-foot layer of sediments applied to restore original topography or create favorable habitat after excavation would have to meet the SQS. The purpose of this approach is to minimize

Table 15
Chemical Levels, Selected Remedies, and Potential Modifications

Sediment Chemistry	If no biological testing conducted	Passes all 3 tests[1]	Fails 1 of 3 tests	Fails 2 or more tests
Greater than or equal to 5 mg/kg mercury	Removal and Appropriate Disposal	no change	no change	no change
Less than 5 but greater than 2.1 mg/kg mercury	1-meter thick cap	15-cm sediment cap	Evaluate need for 1-meter cap	1-meter cap
Less than or equal to 2.1 mg/kg mercury but above MCUL[2]	Thin Layer Placement (TLP)	No Action	Thin Layer Placement	Evaluate need for 1-meter cap

[1] Tests must be conducted in accordance with the State of Washington Sediment Management Standards and must meet the MCUL biological criteria.

[2] Areas in this category which are predicted to recover to the MCUL or below in ten years (using approved modeling) do not require remedial action. Current EPA modeling indicates that intertidal areas above MCUL for PAHs but not mercury are predicted to recover naturally due to exposure to air and light. All natural recovery areas will be monitored to evaluate progress toward achieving MCUL.

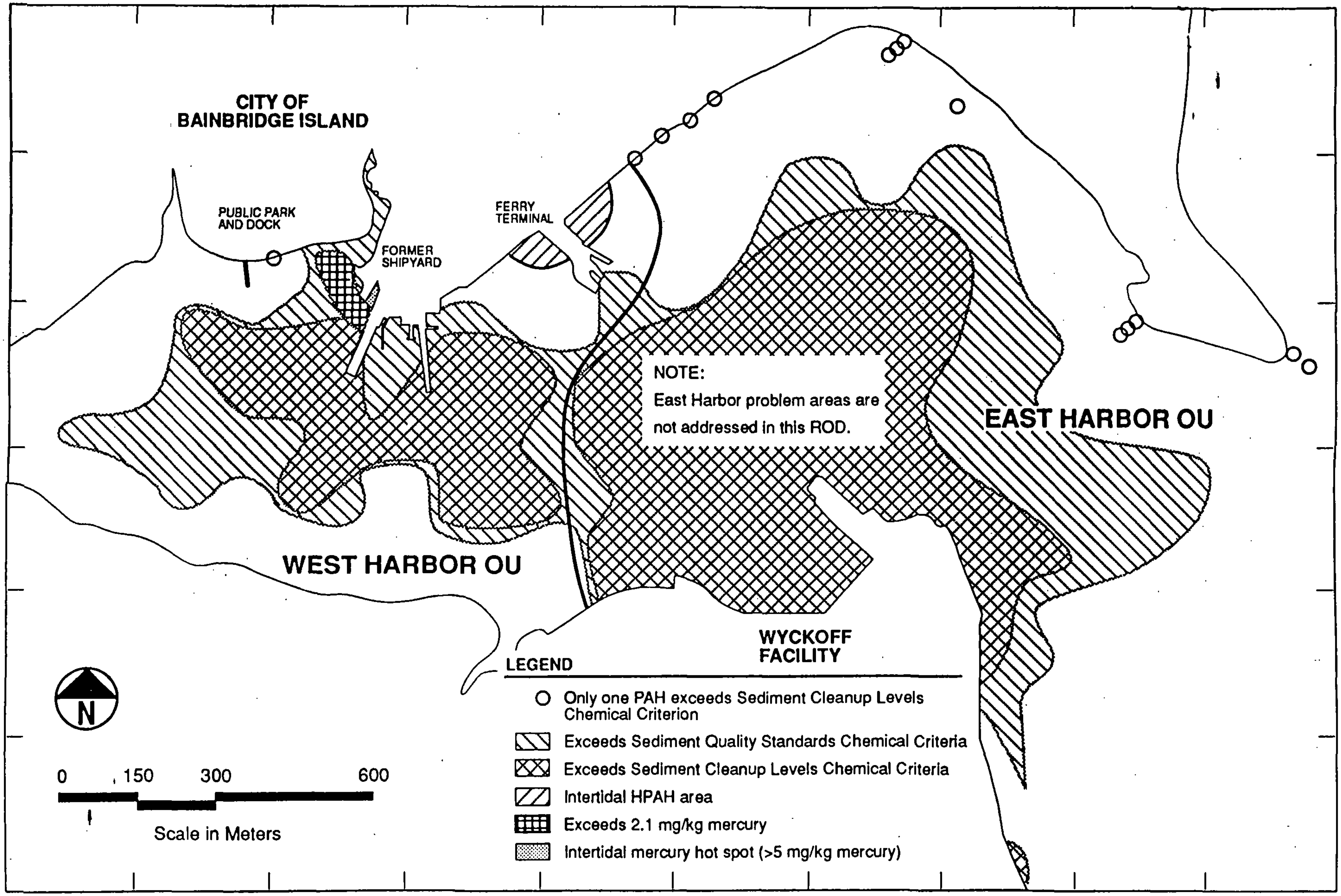

Figure 13
CLEANUP AREAS IDENTIFIED IN WEST HARBOR SELECTED REMEDY

potential habitat loss due to elevation changes from intertidal capping near the hotspot excavation. Restoration of habitat would consider the PSEP Habitat Assessment Protocols (EPA, September 1991), and any necessary mitigation of lost habitat will be required.

Sampling will be necessary to confirm the removal of sediments to the 5 mg/kg mercury cleanup objective. If solidification is required, treatability tests will be conducted during the remedial design phase. If on-site containment is determined to be appropriate, requirements for locating, constructing, and monitoring disposal areas will be identified during remedial design.

10.2.2 Mercury HAET Areas

Near the mercury hotspot are areas of the harbor where sediment concentrations are greater than 2.1 mg/kg mercury (shown on Figure 13). The value of 2.1 mg/kg, the High Apparent Effects Threshold (HAET) for mercury, is the concentration of mercury in sediments above which amphipod and oyster larvae acute toxicity and benthic effects have always been observed in Puget Sound studies. The selected remedy for addressing predicted or documented adverse impacts to aquatic life in such areas is an *in situ* sediment cap no less than 1 meter thick (Alternative C).

Further mathematical modeling of the potential for natural recovery, in accordance with the Sediment Standards, will not be considered for this area, because concentrations of mercury are not expected to decline sufficiently over ten years to meet the MCUL. However, biological testing may be conducted in accordance with the Sediment Standards. If these tests show that the sediments meet the MCUL biological criteria, the contingent remedy will be precision placement of 15 to 30 centimeters of clean sediment (to provide coverage of at least 15 cm) to minimize any remobilization and/or bioaccumulation.

In biologically affected sediments under structures such as piers, or in shallow areas 3 meters or less below mean lower-low water (MLLW), the selection of a 1-meter thick cap or a 15 - 30 cm cap will be initially made as described above. However, cap thickness, placement methods, and the potential need for excavation and disposal of contaminated sediment prior to placement will be evaluated to allow consideration of engineering feasibility, impacts on habitat or fisheries resources, stream flow from the adjacent ravine, and habitat mitigation.

During remedial design, baseline sampling will be necessary to further define the areas requiring the 1-meter thick cap, and optional biological testing may be conducted at this time.

Both the 1-meter and minimum 15-cm caps must achieve the MCUL within ten years from completion of remedial action. Performance standards for the selected (and/or contingent) remedy will be refined during remedial design. They will include the following: clean sediment used for capping shall, at a minimum, meet the SQS chemical criteria, effectively isolate contaminated sediments from the marine environment, and provide suitable habitat for recolonization by benthic organisms.

10.2.3 Intertidal HPAH

The selected remedy for intertidal sediments with HPAH concentrations of 1,200 μg/kg or more (dry weight) is natural recovery combined with institutional controls (Alternative B). In areas such as the former shipyard, where contaminant concentrations exceed both this HPAH criterion and one or more of the chemical objectives for mercury, sediments will be addressed by remedial actions described for the appropriate mercury criterion (as described in Sections 10.2.1, 10.2.2, and 10.2.4).

The FS recommended 1,200 μg/kg HPAH in sediments (corresponding to the 90th percentile of Puget Sound subtidal background concentrations for HPAH (PTI, 1989)) as an objective for protection of human health. HPAH most closely approximates the carcinogenic PAHs evaluated in the risk assessment, and clam tissue concentrations from the RI showed a moderate correlation with intertidal sediment concentrations. Carcinogenic PAH concentrations in clams from intertidal sediments containing HPAH above this criterion (See Figure 13) resulted in cancer risk estimates above EPA levels of concern. In the West Harbor, intertidal sediments in publicly accessible areas near the ferry terminal and the former shipyard exceed this criterion.

In beach sediments adjacent to the ferry terminal, this HPAH criterion is exceeded, but metals are below the MCUL chemical criteria. Because HPAH are rapidly degraded by exposure to ultraviolet or visible light (Payne and Phillips, 1985), natural recovery is considered appropriate in these intertidal areas. Once significant source control is achieved, PAH concentrations are expected to decrease to the MCUL within ten years.

Intertidal areas of Eagle Harbor exceeding the HPAH criterion correspond closely with areas where intertidal sediments exceed two or more MCUL chemical criteria for PAHs. Some West Harbor locations along the north shore are below the MCUL for metals and the HPAH criterion but may marginally exceed the MCUL chemical criteria for PAHs. These areas will be monitored to ensure that natural recovery will achieve the MCUL chemical criteria in these locations also.

The 1,200 μg/kg (dry weight) criterion is intended to protect human health. For this reason, biological testing according to the Sediment Standards cannot be used to eliminate or reduce cleanup requirements contaminated above this level. Optional biological testing is acceptable in intertidal areas which exceed the MCUL for PAH but are less than or equal to 1,200 μg/kg HPAH (see Section 10.2.4 below). If the MCUL biological criteria are met, these areas are eliminated from further consideration.

Sampling will be necessary to refine the problem areas and establish baseline information for monitoring natural recovery. Contaminant concentrations in the above areas must meet the MCUL within ten years from control of significant sources of contamination to these areas. A contingency plan for enhancement of natural recovery, for example by nutrient enhancement or tilling of the sediments, will be developed during remedial design. It may be implemented within the ten year period if sediment monitoring does not indicate sufficient progress towards the MCUL.

10.2.4 MCUL Areas

Areas of intertidal and subtidal sediment in the West Harbor not included under the foregoing sections exceed the MCUL chemical criteria for mercury or PAH, based on existing data. These areas are shown in Figure 13. Mercury concentrations are below 2.1 mg/kg, thus less than 3.5 times the MCUL chemical criterion for mercury (0.59 mg/kg dry weight), and in many locations are less than twice the MCUL chemical criterion for mercury. Intertidal and certain subtidal sediments in the West Harbor are predicted to meet the MCUL chemical criteria for PAH within ten years through natural processes (FS Appendix D1). However, significant decreases in mercury concentrations are not expected in ten years due to the low sedimentation rate and the fact that mercury does not break down. Existing biological information suggests that the impacts of the contamination in areas marginally above the MCUL chemical criteria are not severe and may not warrant a meter-thick cap. Thus, the selected remedy for areas above the MCUL chemical criteria but meeting all other site objectives is enhancement of natural recovery by means of low-impact capping\thin layer placement (Alternative N).

Low-impact capping/thin layer placement is defined as placement of shallow layers, mounds, or "windrows" (longitudinal hills) of clean sediment intended to reduce concentrations in the biologically active zone without causing widespread physical impacts on existing sediment biological communities. Low-impact capping/thin layer placement is technically feasible and is expected to enhance the low sedimentation rate in Eagle Harbor sufficiently to achieve the MCUL objectives for PAH and mercury in areas addressed in this section within ten years of completion of remedial action (COE, March 1992).

Natural recovery is a contingent remedy for this area or for portions of this area. Mathematical modeling during remedial design to evaluate the potential for natural recovery is optional and must meet EPA requirements. If such modeling predicts that certain areas will achieve the project objectives within ten years of active remediation in the harbor through natural processes, the contingent remedy in these areas will be monitoring and natural recovery without enhancement. However, if monitoring during the ten year period does not confirm predicted progress toward the MCUL through natural recovery, low-impact capping/thin layer placement may be required at a later date to ensure achievement of these objectives.

Optional biological testing in accordance with the Sediment Standards may also be conducted to define areas of adverse biological effects. Areas which meet the MCUL biological criteria do not require cleanup. Thin-layer placement is required in areas failing only one of the MCUL biological criteria, and a sediment cap may be required in areas failing MCUL criteria for two or more biological criteria. Such failure indicates more adverse biological effects than anticipated based on available data.

Performance standards will be further defined during remedial design. At a minimum, material used for thin-layer placement and sediment caps will meet the SQS chemical criteria and will provide suitable habitat for recolonization by benthic organisms. Methods and costs for thin-layer placement have been evaluated by EPA (COE, May 1992). A specific placement method will be selected during remedial design. It will provide for the minimization of impacts on existing biota and habitat while providing sufficient clean sediment to achieve the MCUL in the top ten centimeters of sediment within ten years of placement.

Modeling may be required to develop design criteria which will ensure that areas of thin layer placement will achieve the MCUL. If other contaminants exceeding the MCUL chemical criteria are identified during remedial design, the selected remedy will apply as for PAHs and mercury (provided approved modeling predicts that the actions will achieve the MCULs for these contaminants within ten years). If modeling does not predicet this result, a thicker or more uniform cap will be required.

In the event that significant improvements in sediment quality are not indicated for PAH, mercury, or any other contaminants exceeding the MCUL chemical criteria, EPA may require that additional clean sediment be applied during the ten year period to achieve the MCUL.

10.2.5 SQS Areas

Although the site-specific objective is achievement of the MCUL, contiguous areas may exceed the long-term goal of the Sediment Standards SQS chemical criteria. Limited monitoring will be required in these areas to evaluate the effectiveness of source control and the effect of remedial actions in other areas. In addition, engineering feasibility in implementing the capping alternatives may dictate placement of clean sediment in these areas (Figure 13).

For example, to allow full coverage of areas currently above the MCUL chemical criteria, the trailing edges of a cap or thin-layer placement may extend into the SQS area. Extending remediation into the SQS areas in this manner is consistent with the intent of the Sediment Standards and could hasten the achievement of the SQS throughout the West Harbor.

10.3 Source Control

Source control actions described below as part of the West Harbor selected remedy include only actions to be taken to identify and control significant upland sources of contamination to the West Harbor.

The following sources will be evaluated and controlled to the extent that sediment cleanup objectives defined in Section 10 can be achieved and maintained, and that discharges will not cause violations of water quality standards, the State Sediment Management Standards, or any other appropriate environmental standards:

- Stormwater discharges from urban runoff (e.g., storm drains)
- Marine operations (boatyards, marinas)
- Releases from contaminated uplands (e.g., shipyard area)

Contaminant releases from the former shipyard facility and from other upland sources, including stormwater discharges and marine operations, are to be evaluated during remedial design. Remedial design and remedial action will be coordinated with efforts to control significant sources of contamination. Cleanup of a given area will occur after controls have been implemented for significant sources to the this area, to minimize potential recontamination of harbor sediments. Since the mercury hotspot itself is believed to be a source of contamination, excavation of hotspot sediments may precede control of sources to other areas of the harbor. Control of significant contaminant sources to sediment areas which are predicted to recover naturally, such as near the ferry terminal, will signal the beginning of the ten year period of natural recovery in these areas.

10.3.1 Stormwater

The following will be evaluated for potential stormwater discharge of chemical contaminants to the West Harbor, and controls will be implemented as necessary:

- urban runoff
- runoff from parking and ferry maintenance areas

Source control efforts will be designed to minimize or eliminate discharge to the harbor of urban runoff in exceedances of water quality standards, or at levels which may cause exceedance of the Sediment Standards. Controls will consider recommendations in the Department of Ecology Stormwater Program manual. Inspections of facilities and monitoring of sources and sediments will be conducted as necessary to document control of sources.

10.3.2 Marine Operations

At Eagle Harbor, marine operations currently active include the Washington State Ferries maintenance yard, several smaller boatyards, and a number of marinas and yacht clubs. At these facilities, inspection and evaluation of potential sources and implementation of specific best management practices (BMPs) necessary to assure source control will be conducted. These BMPs will be made enforceable through the issuance of orders, or as requirements of National Pollution Discharge Elimination System (NPDES) permits.

The BMPs generally include a requirement that underground storage tanks (USTs) comply with federal and state requirements. Several USTs are located on land adjacent to Eagle Harbor. An inventory of such tanks, an evaluation of their significance to harbor sediments, and their status of their compliance, will be completed as part of the source control efforts in Eagle Harbor. A schedule for addressing noncompliant USTs will be developed as appropriate.

10.3.3 Contaminated Upland Areas

Although the shipyard practices that initially introduced significant amounts of contamination to the harbor have ceased, contamination of upland surface soils at the former shipyard may be sufficient to cause further releases of contaminants to the harbor.

Evaluation of the shipyard area as a continuing source of contamination to the harbor through surface water runoff, point source discharges, or leaching and infiltration will be conducted. Washington State Department of Transportation (WSDOT) samples of the former shipyard area indicate that, in some areas, PAHs and metals exceed the state Model Toxics Control Act (MTCA) cleanup levels. Implementation of any necessary actions (e.g., providing run-on/run-off control) to prevent contamination from upland areas of the former shipyard from causing exceedances of water quality and sediment cleanup objectives will be required prior to sediment remediation.

10.4 Institutional Controls

Consumption of clams, crabs, fish and other marine organisms from Eagle Harbor is considered a pathway of potentially significant health concern.

Since 1985, the Bremerton-Kitsap County Health District has alerted citizens to chemical and bacterial concerns, advising against the harvest of fish or shellfish from the harbor, through signs posted in publicly accessible areas, a hotline, and correspondence to potentially affected residents. EPA supports the continuation of this advisory until chemical contaminants in seafood are below EPA levels of concern identified below. Although not part of this ROD, it is expected that advisories for other reasons, such as bacterial contamination, will also continue as necessary.

Using the reasonable maximum exposure assumptions of the risk assessment (see Section 7), EPA has identified concentrations of methyl-mercury in fish and shellfish tissue which would produce a hazard index of 1. Similar values were calculated for carcinogenic PAHs which would produce a lifetime excess cancer risk of 10^{-4}. These indicator concentrations will be used during long-term monitoring to evaluate potential continuing human health risks, and to generally assess the success of remedial action.

Concentrations of methyl-mercury corresponding to a hazard index of 1 are 0.22 mg/kg and 0.98 mg/kg (wet weight) in fish and shellfish tissue, respectively. Since the benzo(a)pyrene slope factor is assumed to be the same for all other carcinogenic PAHs, 15 μg/kg and 60 μg/kg total carcinogenic PAH concentrations in fish and shellfish, respectively, correspond to an estimated excess lifetime cancer risk of 10^{-4}, using current PAH toxicity information (CH2M Hill, 1992). While these are the primary considerations for continuance of the health advisory for chemical contamination, EPA and the health agencies may establish additional thresholds for other contaminants to protect human health.

To supplement the Health District's efforts, additional warning signs (using the same visual symbols and the warning in multiple languages) will be posted on publicly accessible beach areas and piers to make the warning visible to recreational boaters and to people on the affected beaches. An informational display will be placed in a high traffic area, such as the ferry terminal building. Periodic inspections and necessary maintenance of the signs and the display will be conducted for the duration of the advisory.

10.5 Monitoring

Monitoring is necessary to document progress toward and attainment of the cleanup goals and objectives described in Section 10.1. Detailed plans for monitoring of chemical, physical, and biological conditions before, during, and after remediation will be developed during remedial design. EPA will review and approve the plans in consultation with Ecology, the Suquamish Tribe, and the appropriate public health and natural resource agencies (Natural resource agencies include natural resource trustees, whose role in the Superfund process is briefly described in the Responsiveness Summary, attached as Appendix C).

In addition to sediment chemistry and biological tests to document attainment of the cleanup objectives, the plans may include sampling for other environmental conditions, such as physical conditions, concentrations of contaminants in marine organisms of importance to human health or the environment, evaluations of the diversity and abundance of marine organisms, and integrative measures of exposure to, or effects from, sediment contamination, as discussed below.

Where possible, sampling and other activities will be conducted according to existing protocols (e.g., PSEP); will complement other Puget Sound monitoring efforts (such as the Puget Sound Ambient Monitoring Program, PSAMP); and will provide information for evaluating as many objectives as possible. If additional information arises regarding sources, contaminants, or biological effects, sampling requirements may be modified by EPA.

Under federal requirements, monitoring may continue for as long as thirty years. New or modified monitoring methods may be developed over this period. EPA will continue to evaluate these developments and, in consultation with Ecology, the Suquamish Tribe, natural resource agencies, and other technical resources, will adopt them as appropriate.

10.5.1 Monitoring for Environmental Conditions

The objectives of monitoring the harbor physical, chemical, and biological conditions in the West Harbor OU are briefly listed below:

- to evaluate sources of contaminants and the need for source controls;
- to determine areas, volumes, and other characteristics necessary for designing specific remedial actions;
- to establish baseline conditions necessary for assessing the success of the remedial actions;
- to evaluate short term environmental effects during implementation of the remedial actions;
- to confirm predicted natural recovery of sediments within ten years from completion of West Harbor remedial actions;
- to evaluate the success of source control, natural recovery, sediment removal, capping, and thin-layer placement in meeting and maintaining the cleanup objectives; and
- to evaluate changes in the marine environment through measures which integrate overall conditions.

Monitoring plans to address these objectives will be developed during remedial design. Monitoring efforts will be focused primarily on the first ten years after completion of remedial action. Final cleanup areas must be determined, and baseline conditions must be established prior to remedial action. Any sampling necessary to further characterize source control needs will also be conducted during remedial design.

During excavation, dredging, or placement of clean materials, monitoring will be conducted to evaluate short-term effects on the environment and to assure accurate and adequate materials placement.

If monitoring after remedial action documents compliance with the MCUL by or before the tenth year, the type and frequency of monitoring may be adjusted, or monitoring may be phased out, provided continued compliance with the objectives is assured. If monitoring indicates that the MCUL may not be attained within ten years, EPA will evaluate the need for additional remedial action during the CERCLA five-year review (Section 10.7, below) or as appropriate.

10.5.2 Monitoring Human Health Risks

Periodic monitoring for chemical contaminants in fish, crabs, and clams from Eagle Harbor will be used to assess public health risks and evaluate the success of remediation in reducing contaminant concentrations in edible seafood. A detailed monitoring plan will be completed during remedial design.

During remedial design, additional contaminants of potential concern, including PCBs, dioxins and furans, will be monitored in seafood at least once to determine if further monitoring for these contaminants is needed.

At the CERCLA five-year review and ten years after completion of remedial action in the West Harbor, EPA will evaluate the need for continued monitoring of fish and shellfish tissues. If tissue monitoring does not indicate a trend toward decreasing concentrations of site contaminants ten years after completion of all final remedial actions in Eagle Harbor, EPA will evaluate the need for additional action.

10.6 Implementation

Implementation of the selected remedy requires coordination among EPA, Ecology, and other involved agencies, including the Washington State Ferries, the City of Bainbridge Island, the COE, natural resource agencies, the Suquamish Tribe, and state and local health agencies. Coordination with the affected community and potentially responsible parties will also be important during remedial design and remedial action. Individual actions within the West Harbor OU will be coordinated, and West Harbor cleanup activities will be coordinated with actions in the East Harbor OU and Wyckoff OUs as appropriate. Although no critical habitats have been identified in the West Harbor, EPA will continue to coordinate with the U.S. Fish and Wildlife Service to assure that remedial activities do not adversely affect endangered species.

In order to expedite achievement of the cleanup objectives, mathematical modeling to evaluate natural recovery, where considered by the selected remedy, should be completed as soon as possible. Biological testing to modify cleanup areas or requirements may be conducted concurrently with baseline sampling. New information on previously unidentified contaminants will also be evaluated during the remedial design phase and integrated into the remedial design sampling and analysis strategy. For example, the presence of dioxin and PCBs in some seafood warrants further development of sediment data and source information.

Figure 14 provides a general framework for the timing of remedial activities. EPA anticipates that negotiations with potentially responsible parties, remedial design (including sampling to refine problem areas and options), and implementation may take two to three years to complete. A detailed schedule for activities such as source evaluation and control, key aspects of the remedial design and remedial action phases, and development of monitoring plans will be prepared as an initial step in implementation of the ROD.

10.7 CERCLA Five Year Review

The FS discussed the 5-Year Review mandated by CERCLA for remedial actions that leave contaminants at the site. The review is required at least once every five years to ensure that human health and the environment are being protected. The five-year review was considered necessary for all of the individual alternatives. The review is required for the selected remedy, a combination of several alternatives.

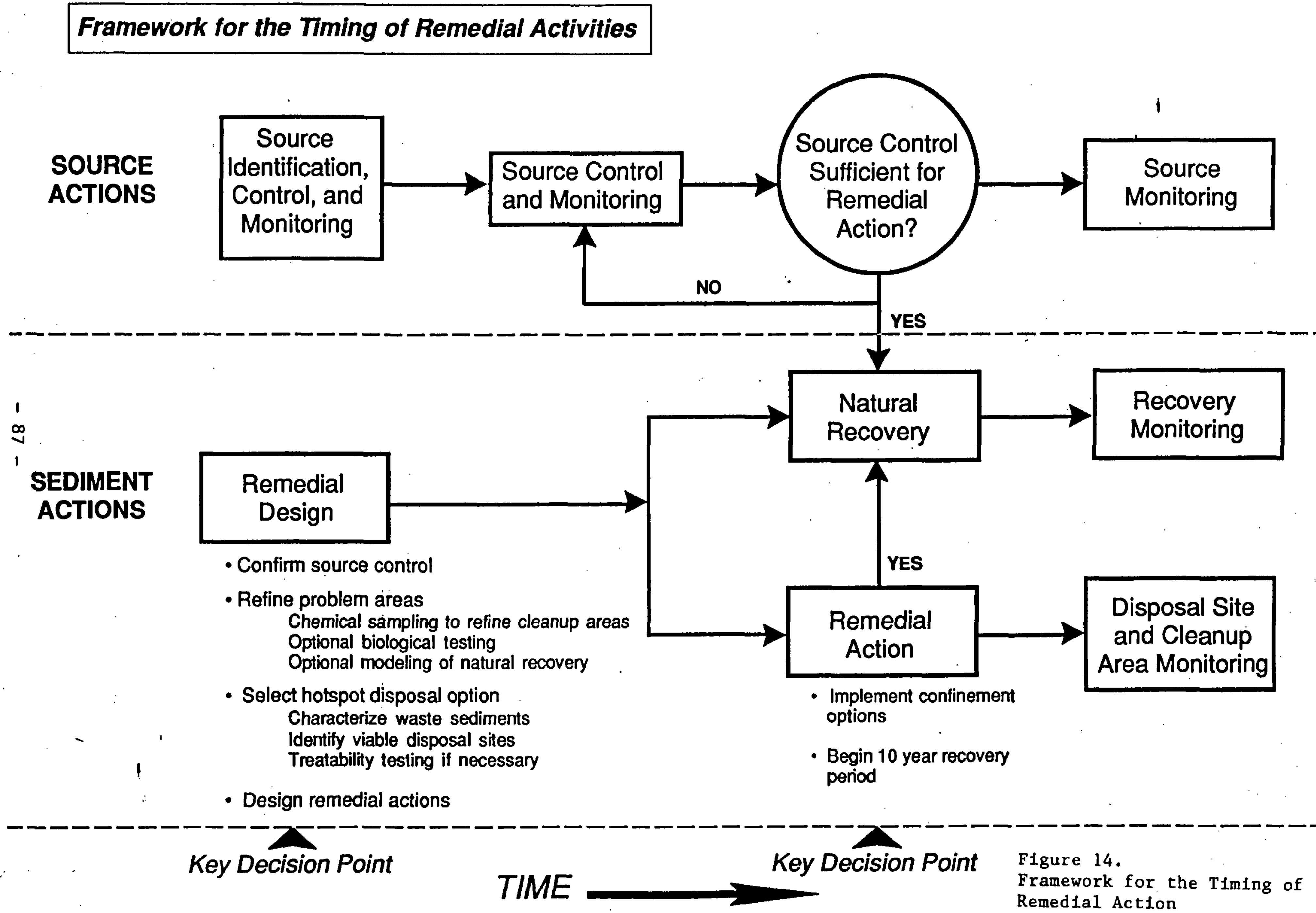

Figure 14. Framework for the Timing of Remedial Action

10.8 Costs

Estimated costs associated with the selected remedy are summarized in Table 16. Sediment cleanup volume estimates will be refined during the remedial design phase, and costs are anticipated to change accordingly. Costs may also be affected if optional biological testing and natural recovery evaluations result in modifications according to the selected remedy.

The present worth cost estimates provided are intended to be within +50% and -30% of the actual costs of remediation, and are based on volume estimates established during the FS using the following key assumptions:

- Adverse biological effects will not occur in areas which meet the three EPA objectives and which passed MCUL criteria for two acute toxicity tests during the RI. (Costs may increase if areas defined by the MCUL chemical criteria are remediated without the use of biological testing options.)
- Natural recovery will not be predicted to occur in areas currently exceeding the MCUL for mercury. (Costs may decrease if optional modeling of natural recovery identifies natural recovery areas).
- Mercury hotspot sediments will not exceed 7,000 cubic meters and will be disposed of at a hazardous waste landfill. (Disposal at a municipal landfill or on site could decrease costs, but costs could increase if volumes to be disposed of increase.)
- Clean sediment for capping will be available at costs outlined in the FS. (These costs may be lower if sediments scheduled for routine dredging by the U.S. Army Corps of Engineers are available.)
- Costs for West Harbor intertidal areas with 1,200 μg/kg or more HPAH will be one third of costs estimated in the FS for such areas in the combined East Harbor and West Harbor OUs.

Based on these assumptions, total costs for the selected remedy are expected to range from $6.2 to 16 million.

Costs associated with source control activities are not included in this ROD, because source controls are expected to be implemented largely according to non-CERCLA environmental authorities and programs.

Table 16 - Estimated Costs for West Harbor Selected Remedy				
CLEANUP AREA	VOLUME/AREA ESTIMATE	INITIAL COSTS[a]	PRESENT WORTH OF O&M[a]	TOTAL COSTS PRESENT WORTH[a]
Mercury Hotspot	1,000 - 7,000 m^3	2.5 - 11.7	0.3	2.8 - 12[b]
Mercury HAET Areas	4,600 m^2	1.2	.3	1.5
MCUL Areas	283,300 m^2	1.4 - 2.0	0.3	1.7 - 2.3
Intertidal HPAH	20,000 m^2	0	0.2	0.2
TOTALS:	314,900 m^2	5.1 - 14.9	1.1	6.2 - 16

[a] Cost estimates are in millions of dollars.

[b] Assuming disposal in a RCRA permitted hazardous waste landfill. For disposal in a municipal landfill, initial costs are expected to be no more than $ 4.4 million, for a total costs of approximately $ 4.7 million.

11. STATUTORY DETERMINATIONS

Under CERCLA, EPA's primary responsibility is to undertake remedial actions that assure adequate protection of human health, welfare, and the environment. In addition, Section 121 of CERCLA establishes cleanup standards which require that the selected remedial action comply with all applicable or relevant and appropriate requirements (ARARs) established under federal and state environmental law, unless any such requirements are waived by EPA in accordance with established criteria. The selected remedy must also be cost-effective and must utilize permanent solutions, alternative treatment technologies, or resource recovery technologies to the maximum extent practicable. Finally, CERCLA regulations include a preference for remedies that employ treatment that permanently and significantly reduces the volume, toxicity, or mobility of hazardous waste as a principal element. The following sections discuss how the selected remedy meets these CERCLA requirements.

11.1 Protection of Human Health and the Environment

The selected remedy combines alternatives which were evaluated separately in the FS. It combines upland source control, removal of hotspot sediments, capping of moderately contaminated sediments, low-impact capping/thin layer placement of marginally contaminated sediments, and institutional controls.

Upland source control is intended to reduce or eliminate future contaminant discharges which could recontaminate sediments. Removal of hotspot sediments, i.e., those with the highest mercury concentrations, will eliminate a significant source of mercury contamination to the marine environment. Capping large areas of subtidal sediments with clean materials is an effective means of quickly protecting the environment with minimal short-term effects. Within areas to be capped, use of a meter thick cap will limit potential redistribution of mercury and address more significant environmental risks. Low-impact capping/thin layer placement in marginally contaminated areas will reduce surface sediment chemical concentrations to levels protective of human health and the environment without unnecessary cost.

Restrictions on the harvest and consumption of contaminated seafood will further ensure protection of public health.

11.2 Compliance with Applicable or Relevant and Appropriate Requirements

The selected remedy will be designed and implemented to attain all ARARs identified in this section.

Applicable requirements are those clean-up standards and other substantive environmental requirements, criteria, or limitations promulgated under federal or state law which specifically address a hazardous substance, pollutant, or contaminant, remedial action, location, or other circumstance at a CERCLA site. Relevant and Appropriate requirements are those cleanup standards and other substantive environmental requirements, criteria, or limitations promulgated under federal or state law which are not applicable, but nevertheless address matters sufficiently similar to those encountered at a CERCLA site (relevant), and their use is well suited to a particular site (appropriate).

ARAR compliance for on-site remedial action is strictly limited to the substantive portions of ARARs. Administrative or procedural requirements in ARARs, such as approval or consultation with administrative bodies, permitting requirements, reporting, record keeping, and enforcement provisions need not be met. Off-site actions, however, comply with both administrative and substantive aspects of federal and state law.

No waiver of any ARAR is sought or invoked in this ROD. The ARARs for the site are as follows:

By taking remedial action for sediments which do not meet the minimum cleanup level (MCUL), EPA will comply with the substantive requirements of the primary ARAR, the State of Washington Sediment Management Standards (Washington Administrative Code [WAC] Chapter 173-204). Sediments are required to meet the MCUL ten years after the completion of remedial action, unless otherwise indicated in the selected remedy.

Fill activities (e.g., capping in subtidal or intertidal areas) and dredging or excavation of contaminated sediments (e.g., the mercury hotspot) will comply with the substantive requirements of federal regulations promulgated pursuant to Section 404(b)(1) of the Clean Water Act (40 C.F.R. § 230) and Section 10 of the Rivers and Harbors Act (33 C.F.R. § 320-330). These regulations are intended to protect marine environments, and to prevent unacceptable adverse effects on municipal water supplies, shellfish beds, fisheries (including spawning and breeding areas), wildlife, and recreational areas during dredging activities.

Fill, dredging, and other remedial activities conducted within 200 feet of the shoreline (e.g., at the mercury hotspot) will also comply with the substantive requirements of the Kitsap County Shoreline Master Plan (WAC 173-19-2604), as developed pursuant to the State Shoreline Management Act (RCW 90.58), and adopted by the former City of Winslow.

If fill or dredging activities will change the natural flow or bed of state waters, EPA will meet the substantive requirements of the Washington State Hydraulic Code Rules (WAC 220-110). These substantive requirements are intended to protect fish by, e.g., placing limitations on the timing and duration of dredge/fill activities. If it becomes necessary to re-route the stream entering Eagle Harbor near Waterfront Park, relevant and appropriate requirements of these regulations pertaining to channel changes will be met.

Liquids and other wastewaters from sediment dewatering or solidification/stabilization processes will be managed (treated and discharged) in compliance with substantive requirements of the following:

- State of Washington Water Pollution Control Act (RCW 90.48) and Water Quality Standards (WAC 173-201);
- NPDES Permit Program (WAC 173-220) for effluent limitations, water quality standards, and other substantive requirements; and
- State Waste Discharge Permit Program (WAC 173-216) restrictions on certain discharges to POTWs (if wastewater is discharged to a POTW).

Most RCRA hazardous waste is regulated under a program delegated to the Washington Department of Ecology. State Dangerous Waste Regulations (WAC 173-303) promulgated pursuant to this authority will be met. These regulations control most RCRA listed hazardous/dangerous waste (listed DW/HW) and TCLP characteristic waste (characteristic DW/HW), and include criteria for "Washington-State-only" dangerous waste (DW) and "extremely hazardous waste" (EHW).

Excavated sediments will be characterized pursuant to the Toxicity Characteristic Leaching Procedure (TCLP) found in Appendix II of 40 C.F.R § 261. Failure of TCLP criteria generally causes waste materials to be designated as characteristic DW/HW. Determinations of whether the waste is DW according to other state criteria will also be necessary.

If the wastes are DW or DW/HW, the handling, storage, and disposal requirements of RCRA and/or the State Dangerous Waste Regulations will be triggered for off-site actions. Prior to land disposal, DW/HW must be treated to meet the RCRA treatment standards for land disposal as set forth in 40 C.F.R. § 268. If waste cannot be treated to meet the RCRA treatment standards, a treatability variance will be necessary prior to treatment and disposal at a landfill in compliance with federal and state requirements (40 C.F.R. §§ 262, 268, and WAC 173-303-200 and 173-265-141).

For sediments which are state-only DW, off-site disposal must be at an approved hazardous waste landfill. For sediments which are neither DW/HW nor state-only DW, disposal at an off-site municipal landfill must comply with Washington State Minimum Functional Standards (WAC 173-304). If a suitable on-site disposal area is available, the relevant and appropriate requirements of the Minimum Functional Standards will be met for disposal of "problem waste". Any on-site disposal will be protective of groundwater and human health.

Source Control Actions, including activities to control stormwater, marine operations, and contaminated upland areas, will meet the substantive requirements of the following:

- Washington Water Pollution Control Act (RCW 90.48) and Water Quality Standards (WAC 173-201);
- State Waste Discharge Permit Program (WAC 173-216-060) restrictions on certain discharges to POTWs;
- Effluent limitations, water quality standards, and other substantive requirements for treatment and discharge restrictions under the NPDES Program (WAC 173-220-120, 130);
- Kitsap County Shoreline Master Plan (WAC 173-19-260).

Additional policies, guidance, and other laws and regulations to be considered for source control and remedial actions include:

- Executive Orders 11990 and 11988 (40 C.F.R. 6, Appendix A) which are intended to avoid adverse effects, minimize potential harm, and restore and preserve natural and beneficial uses of wetlands and floodplains;
- Requirements and guidelines for evaluating dredged material, disposal site management, disposal site monitoring, and data management established by Puget Sound Dredge Disposal Analysis (PSDDA) (1988, 1989);
- Critical toxicity values (acceptable daily intake levels, carcinogenic potency factor) and U.S. Food and Drug Administration action levels for concentrations of mercury and PCBs in edible seafood tissue;
- EPA Wetlands Action Plan (U.S. EPA 1989) describing the National Wetland Policy and primary goal of "no net loss";
- Element S-4 of Puget Sound Water Quality Management Plan (relating to confined disposal of contaminated sediments) ((1988, 1989, 1991));
- Puget Sound Stormwater Management Program (pursuant to 40 C.F.R. Parts 122-24, and RCW 90.48);
- AKART (All Known, Available, and Reasonable Technologies) guidelines and 1989 PSWQA plan. Elements P-6 and P-7 for the development of AKART guidelines and effluent limits for toxicants and particulates.
- Federal Ambient Water Quality Criteria (40 C.F.R. 131)
- Puget Sound Estuary Program Protocols, (1987) as amended, for sample collection, laboratory analysis, and QA/QC procedures.

11.3 Cost Effectiveness

EPA believes that the combination of remedial actions identified as the selected remedy for the West Harbor OU will reduce or eliminate the risks to human health and the environment at an expected cost between 6.2 and 16 million dollars. The remedy is cost-effective. It provides an overall protectiveness proportional to its costs.

By tailoring the remedy so that removal and any necessary treatment are applied to small-volume, high-concentration sediments, and using lower-cost containment alternatives for the large areas of moderate to marginal contamination, the selected remedy cost-effectively provides an appropriate level of protection for each area. Allowing natural recovery in areas where cleanup objectives will be achieved in ten years, and allowing biological testing to modify the selected remedy and perhaps eliminate cleanup areas, avoids costly and unnecessary remedial actions.

11.4 Utilization of Permanent Solutions and Alternative Treatment Technologies

The selected remedy utilizes permanent solutions and alternative treatment technologies to the maximum extent practicable. Among the alternatives which are protective of human health and comply with ARARs, the selected remedy provides the best balance of long-term effectiveness and permanence; reduction of toxicity, mobility, volume, and persistence; short-term effectiveness; implementability; and cost. The selected remedy considers the statutory preference for treatment as a principal element and considers state and community acceptance.

A number of alternative technologies were explored in the FS, particularly for PAH-contaminated sediments. However, alternative technologies for treatment of mercury-contaminated sediments are limited. Only one treatment alternative, stabilization/solidification, was carried forward for detailed evaluation for mercury-contaminated sediments, because of technical uncertainties associated with other treatment alternatives.

Excavation and solidification/stabilization was evaluated for mercury-contaminated sediments. Solidification/stabilization in place was also considered, but only for intertidal sediments. Although it was advantageous in some respects, including cost, implementability, reduction of contaminant mobility, and short-term effectiveness, *in situ* solidification has not been tested extensively in a marine environment. This uncertainty led to a lower rating for long-term effectiveness and permanence.

While it was considered for all mercury contaminated sediments, treatment was found not practicable for large volumes of sediments containing low contaminant concentrations. The mercury hotspot is a low-volume, high concentration area, however, and if treatment is necessary to control leaching, it will be practicable and appropriate.

Upland disposal of the mercury hotspot sediments is appropriate for reasons of long-term effectiveness and permanence, because it permanently removes the most concentrated mercury contamination from the marine environment. This important criterion outweighed the advantages of *in situ* solidification/stabilization and other alternatives.

Treatment by solidification/stabilization may be required prior to land disposal of excavated mercury hotspot sediments. These sediments may be hazardous or dangerous waste or may pose a threat to groundwater through leaching. Solidification/stabilization will not be required if the excavated sediments do not pose a risk of leaching.

11.5 Preference for Treatment as a Principal Element

If solidification/stabilization is necessary prior to land disposal of excavated mercury hotspot sediments, the selected remedy will satisfy the CERCLA preference for treatment of principal threats. If treatment is not necessary for these sediments, disposal actions will be conducted in accordance with ARARs, but the preference for treatment will not be satisfied. Remaining West Harbor sediments have lower concentrations of contaminants and are not a principle threat. For these sediments, the selected remedy calls for engineering controls such as capping and thin-layer placement.

12. DOCUMENTATION OF SIGNIFICANT CHANGES

Subsequent to issuing the Proposed Plan, EPA reviewed public comments. In response, EPA clarified the cleanup objectives and areas with respect to the Sediment Standards, provided more detail for source control and remedial actions for the West Harbor OU, and re-evaluated more cost-effective approaches to achieving the cleanup objectives.

Based on these considerations, the following changes were made to the Proposed Plan and have been incorporated into the selected remedy:

1. Clarification of Low-Impact Capping/Thin Layer Placement methods and costs,
2. Clarification of the basis for defining capping subareas,
3. Further definition of future source control efforts,
4. Clarification of appropriate disposal for excavated sediments,
5. Elimination of the requirement for additional biological testing to determine cleanup areas,
6. Further consideration of Natural Recovery, and
7. Reevaluation of areas exceeding the Sediment Standards.

These changes are discussed below:

12.1. Low-Impact Capping/Thin Layer Placement Methods and Costs

The Proposed Plan described Low-Impact Capping (Supplemental Alternative N) broadly as a means to minimize the impact of a thick cap in areas where contamination and biological effects were not severe. The method would involve placement of clean sediment for dispersal, either by mechanical placement or natural processes. Preliminary costs provided in the description of alternatives and in the Preferred Alternative summary were based on placement of mounds of clean sediment on a grid pattern.

Under a cooperative agreement with EPA, the COE identified several feasible Low-Impact Capping methods. Using computer modeling, existing information on harbor currents and biological data, current knowledge of methods of sediment application, and information on sources of clean dredged material, the COE developed a type of low-impact capping defined as Thin Layer Placement in a report issued in March 1992 (COE, 1992). Thin-Layer Placement is the basis for the cost estimates provided for the Low-Impact Capping alternative in Section 8 of this ROD.

In their 1992 report, the COE provided an initial cost estimate based on obtaining capping materials at low cost from river dredging projects (excluding design, construction development, mitigation costs, eelgrass surveys, operations and maintenance, and other items). These cost estimates were revised to be consistent with the costing assumptions and methods used in the FS. The final cost estimate was comparable to the Proposed Plan cost estimate for Low-Impact Capping, although actual costs may be reduced if lower cost dredging materials can be used (Table 17).

Table 17 - Comparison of Cost Estimates For Low-Impact Capping/Thin Layer Placement			
	Proposed Plan	COE Report	Revised Cost
Initial Costs[a]	1.8 - 3.3	0.28	1.9
Present Worth of O&M	0.3	none	0.3
Total Present Worth	2.1 - 3.6	0.28	2.2
[a] Cost Estimates are in Millions of Dollars			

12.2. Basis for Defining Capping Subareas

The Proposed Plan included Low-Impact Capping/Thin Layer Placement as a component of the preferred alternative, in combination with the removal of the mercury hotspot, natural recovery of the HPAH area, and capping. Locations appropriate for Low-Impact Capping/Thin Layer Placement should be determined based on harbor currents, existing chemical data, and the biological data gathered to delineate cleanup areas. The basis for defining subareas for Low-Impact Capping/Thin Layer Placement, or for a meter thick cap (or 15 -30 cm thick cap if sediments meet Sediment Standards biological criteria) has been further defined in this ROD (See Section 10, selected remedy).

West Harbor areas with concentrations of mercury below the HAET are considered appropriate for use of Low-Impact Capping/Thin Layer Placement. Harbor currents are sufficiently slow in the West Harbor that placed materials would not be expected to erode. In West Harbor areas below the HAET for mercury, PAH concentrations are also generally lower, and could be expected to recover naturally in ten years. Existing biological data indicate that acute biological effects are generally not occurring in the West Harbor except where PAHs exceed MCUL chemical criteria. Mercury concentrations below the HAET exceed the MCUL by a factor of less than four, and enhancement of natural sedimentation may be sufficient to achieve the mercury MCUL in ten years.

At concentrations four times the MCUL or more, mixing of surface sediments above the HAET is unlikely to reduce contaminant levels sufficiently to achieve the MCUL chemical criteria within ten years. Such sediments pose potential redistribution and biological uptake concerns and are predicted to have biological impacts greater than those associated with the MCUL. As described in Section 10, areas above the mercury HAET merit a sediment cap of one meter thickness to address predicted biological effects. However, if an absence of biological effects can be demonstrated, a cap of 15 - 30 centimeters thickness is warranted and should be sufficient to minimize redistribution and biological uptake.

12.3. Further Definition of Future Source Control Efforts

The Proposed Plan for the West Harbor stated that "as a safeguard, the most actively used part of the old shipyard would be tested before cleanup to ensure that rainwater runoff does not recontaminate the sediment. Operations involving hazardous materials, such as boatyard work and ferry maintenance, would be monitored."

In the selected remedy, EPA has further defined the source control requirements for the West Harbor, and the means of achieving source control. Because the harbor may be affected by a number of minor sources, EPA intends to address them by two means. Where probable upland sources are related to potentially responsible parties for the Harbor OU, EPA will require an evaluation of these sources and implementation of any necessary source control for the West Harbor. For potential sources unrelated to potentially responsible parties, separate arrangements will be made for the evaluation of these sources and implementation of necessary source controls.

Costs for source control are not included in this ROD (See Section 10.8).

12.4. Clarification of Appropriate Disposal for Excavated Sediments

Appropriate Disposal, as described in the Proposed Plan, included only two disposal options for excavated mercury hotspot sediments: disposal at a municipal landfill or at an approved hazardous waste landfill. The ROD broadens the definition of appropriate disposal to include disposal at an upland location within the site. As detailed in Section 10, on-site upland disposal may be appropriate for sediments which are not hazardous or dangerous waste. The disposal area must be protective of human health and groundwater, and must not cause recontamination of the sediments after remediation.

12.5. Elimination of Requirement for Additional Biological Testing

The Proposed Plan stated that biological testing in areas exceeding the MCUL would be required in order to define areas for cleanup. In order to be consistent with the Sediment Standards, however, this ROD incorporates biological testing as an option, rather than a requirement. The Sediment Standards allow cleanup areas to be defined solely on the basis of chemical data, but biological information, if obtained, outweighs chemical information in determining these areas. The selected remedy also allows optional biological testing in certain West Harbor areas to refine cleanup areas or modify the remedial action to be implemented for these areas.

12.6. Consideration of Natural Recovery

The Sediment Standards allow natural recovery as an alternative to active remediation in areas where the cleanup objectives will be met within 10 years. The Proposed Plan indicated that natural recovery was unlikely in most areas of Eagle Harbor based on FS evaluations. Public comment indicated a preference for greater consideration of natural recovery. In the selected remedy, Low-Impact Capping/Thin Layer Placement is required for subtidal areas of the West Harbor exceeding the MCUL by a small margin. However, the remedy allows for additional, more detailed evaluation of natural recovery rates as an option to further reduce areas requiring active remediation. The evaluation must be approved by EPA and can be used to define areas for natural recovery. Monitoring in these areas will be necessary to determine whether the predicted recovery is occurring.

12.7. Reevaluation of Areas Exceeding the MCUL Biological Criteria

Comments received during the public comment period prompted a reevaluation of the basis for defining areas failing the criteria of the Sediment Standards. The FS had identified areas which failed one or more of the acute bioassays conducted during the RI and areas where one acute bioassay passed and the other acute bioassay was either unknown or incomplete. The reevaluation of biological data revealed that the statistical interpretation of oyster larvae bioassays completed during the RI was not correct. Figure 15 indicates changes as a result of the recalculation. An increased number of stations fail acute biological tests in the East and West Harbor OUs, including several stations adjacent to the former shipyard. Some locations with incomplete results for a second acute bioassay are now shown to pass two acute toxicity tests, offsetting the additional failures in the West Harbor. Overall, the changes support the link between areas with high contamination and acute biological effects. However, they do not indicate areas meeting the Sediment Standards biological criteria, since attainment of the chronic biological criterion cannot be demonstrated. Nevertheless, since cleanup areas will be defined on the basis of chemical data (unless additional biological testing or natural recovery modeling is conducted) the revised results do not affect the selection of the remedy.

12.8 Summary

The above changes are logical outgrowths from information in the Proposed Plan and RI/FS. The selected remedy, which incorporates these changes, provides a framework for major West Harbor OU decisions. Additional refinement of the selected remedy is anticipated during remedial design, based on biological and chemical data, natural recovery modeling, waste characterization, treatability testing, and other potentially new information. Minor, significant, and fundamental changes to the remedy after issuance of the ROD will be evaluated and made in accordance with the NCP.

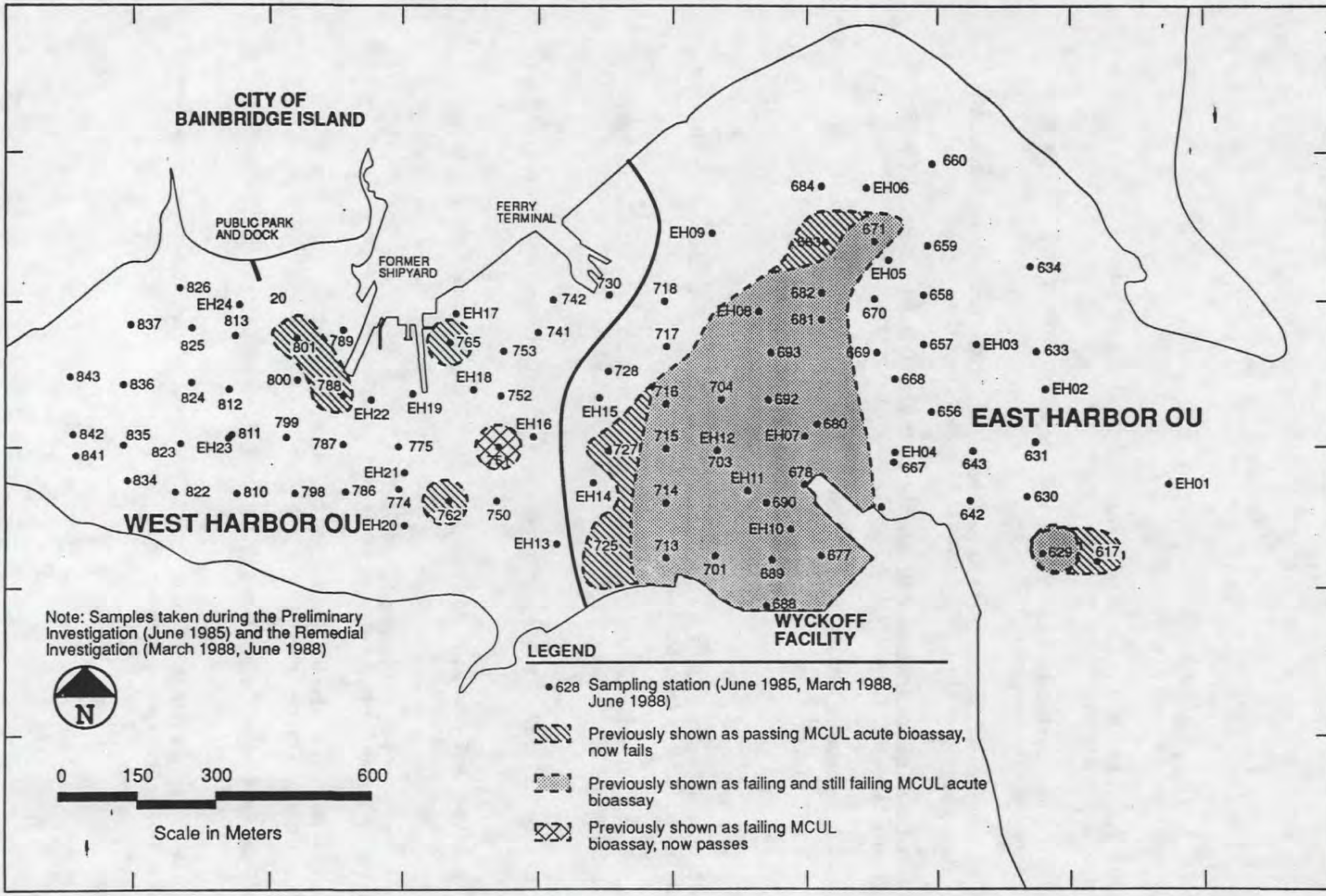

Figure 15.
CHANGES IN AREAS ABOVE MCUL BIOLOGICAL CRITERIA AFTER RECALCULATION

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U.S. Environmental Protection Agency. Obtaining a Soil and Debris Treatability Variance for Remedial Actions (OSWER Directive # 9347.3-06FS). Office of Emergency and Remedial Response. September 1990.

[a] This is a partial list of documents used in preparing the Record of Decision. The decision is based on the administrative record for the site.
[b] References from RI/FS documents retain the suffix letter used in the original citation for consistency.

APPENDIX A

Proposed Plan

EPA

Region 10
1200 Sixth Avenue
Seattle WA 98101

Alaska
Idaho
Oregon
Washington

Superfund Fact Sheet

December 16, 1991

The Proposed Plan for Cleanup of Eagle Harbor

Wyckoff/Eagle Harbor Superfund Site
Bainbridge Island, Washington

Public Comment Period:
December 18, 1991 - February 15, 1992

Public Meeting Schedule:

Informational Meeting to Discuss Cleanup Alternatives
January 15, 1992, 7:00 PM

Meeting for Public Comment
January 30, 1992, 7:00 PM

at
Commodore Middle School
9530 NE High School Road
Winslow, WA

Introduction

This proposed plan describes the U.S. Environmental Protection Agency's (EPA's) preferred cleanup plan for the Eagle Harbor portion of the Wyckoff/Eagle Harbor Superfund Site on Bainbridge Island, Washington (Figure 1). EPA is the lead agency for the site and works closely with the Washington Department of Ecology (Ecology). This document summarizes the cleanup alternatives considered by EPA and presents EPA's recommended approach for phased cleanup of contaminated sediments in the Eagle Harbor portion of the site. Ecology supports this approach.

This proposed plan describes cleanup alternatives for Eagle Harbor only. The Wyckoff/Eagle Harbor site is currently divided into two units, the harbor and the Wyckoff facility. Interim cleanup measures are underway at the Wyckoff facility; final cleanup of the facility will be addressed in a future proposal. Contaminated beaches adjacent to Wyckoff will be addressed in the future proposal for cleanup of the facility.

We invite you to comment on EPA's preferred plan and on individual cleanup alternatives. **Your comments will help EPA make a decision on the cleanup approach for Eagle Harbor that is technically sound and addresses the concerns of the community.**

An opportunity for questions and verbal comment will be provided at two public meetings. **Written comments on the Proposed Plan and other alternatives should be postmarked by February 15 and addressed to:**

Ellen Hale
EPA Site Manager, Eagle Harbor
1200 6th Avenue, HW-113
Seattle, WA 98101

This proposed plan summarizes information explained in greater detail in the Eagle Harbor Remedial Investigation and Feasibility Study, as well as in several Technical Memoranda. These documents are available for public review as part of the administrative record for the site at:

Region 10 EPA
1200 Sixth Avenue
Seattle, Washington
Tel: 553-1215

or

Bainbridge Public Library
1270 Madison Avenue North
Winslow, WA
Tel: 842-4126

Background

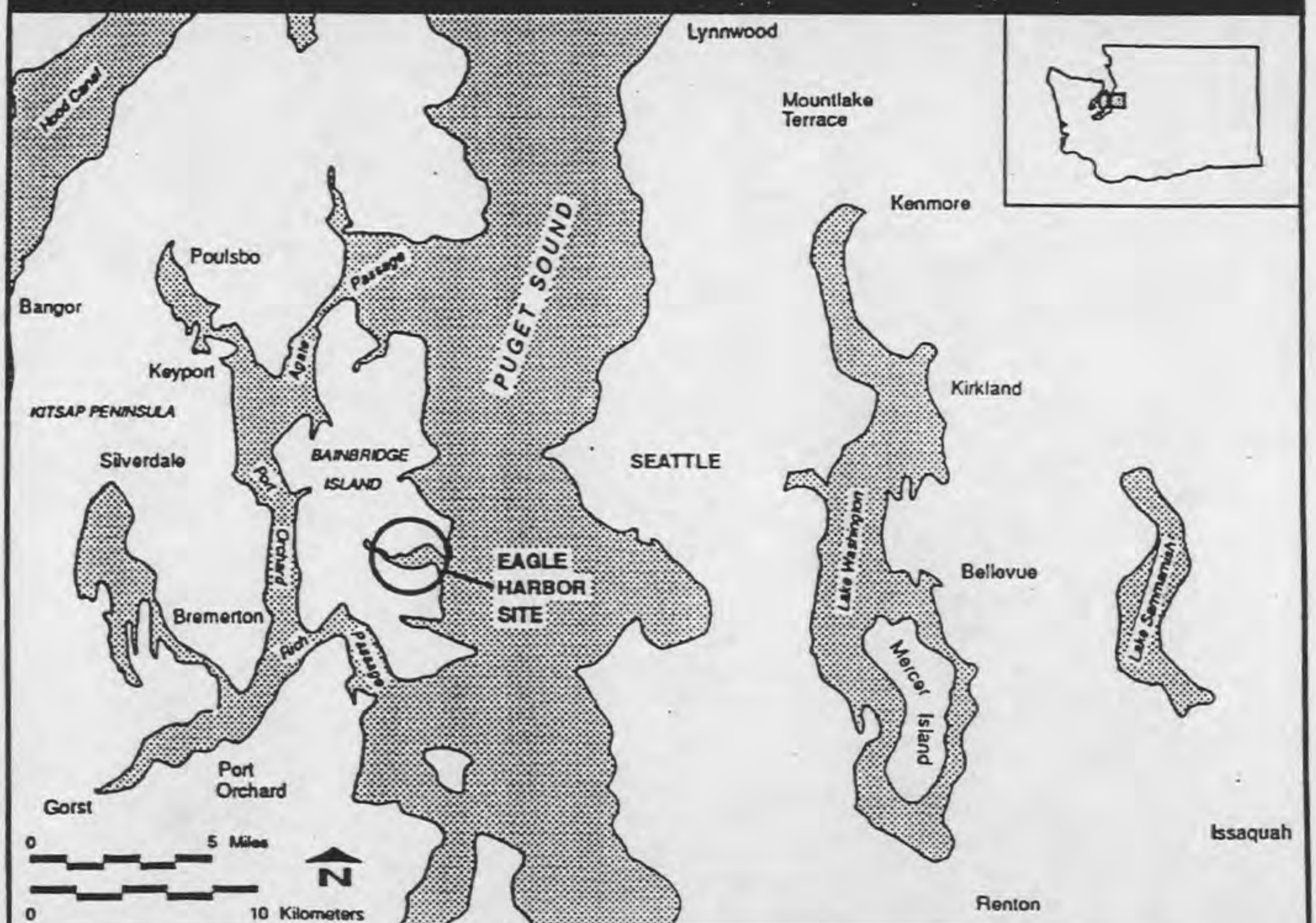
The Wyckoff/Eagle Harbor site was listed as a Superfund site for investigation and cleanup of uncontrolled hazardous substances in 1987. The site includes Eagle Harbor and the former Wyckoff wood treating facility. Sediments in much of Eagle Harbor contain hazardous substances such as mercury and polynuclear aromatic hydrocarbons (PAH). (Figures 2 and 3 indicate their distribution in the harbor.) PAH represents a group of chemical compounds found in creosote, used oil, and other sources. Mercury and other metals in sediment are often associated with practices such as sandblasting and refurbishing boat bottoms. While other substances have been detected, PAH and mercury are the primary contaminants of concern.

On the north shore of the harbor, ship building, maintenance, and repair activities have been conducted since the turn of the century. Past activities have been identified as the primary source of the mercury and other metals found in the harbor. PAH is also found near the shipyard and ferry terminal.

On the south shore, a succession of owners operated a wood-treating facility from 1905 to 1988. Soils, beach sediments, and ground water in this area contain compounds associated with wood treating, particularly PAH. The wood treating facility has been identified as the primary source of PAH contamination in the harbor.

In 1987, EPA separated the Wyckoff/Eagle Harbor site into two units. This allowed EPA to move forward with the investigation of the harbor while taking enforcement action to reduce PAH contamination at the wood-treating facility. Pacific Sound Resources, formerly Wyckoff Company, began source control work under a 1988 administrative

Figure 1:
Site Location



order, which has since been revised in a 1991 order. Specifically, the company is pumping and treating PAH-contaminated ground water and subsurface oil at the facility, under EPA oversight.

EPA plans a detailed study of soil and groundwater contamination at the Wyckoff facility and adjacent beaches in order to develop a comprehensive cleanup plan for this area. This is a necessary step in the final cleanup of Eagle Harbor. When proposed, the Wyckoff facility cleanup plan will be subject to public comment.

Site Risk Assessment

EPA believes that existing human health and environmental risks warrant cleanup of the site. EPA evaluated potential human cancer and non-cancer health risks from eating fish and shellfish and from skin contact and ingestion of contaminated sediments.

The primary pathway for human health risk at Eagle Harbor is long term, frequent consumption of PAH-contaminated shellfish, such as crabs and clams. Data on fish contaminants suggest that a steady diet of Eagle Harbor fish should also be avoided until more is known.

In 1985, the Bremerton-Kitsap County Health District issued a public health advisory cautioning against consumption of fish and shellfish from Eagle Harbor. Warning signs are posted around the harbor and a hotline recording confirms the advisory. EPA supports the health advisory and will require continued monitoring of contaminants in Eagle Harbor fish and shellfish until the concentrations are below EPA levels of concern. Monitoring of environmental effects will also continue after cleanup.

Environmental damage is indicated by liver tumors in English sole and toxic effects on some sediment-dwelling organisms. Over the last several years, EPA and Ecology have collected and analyzed sediment samples, shellfish and fish tissues, and marine organisms in Eagle Harbor. In addition to showing mercury, PAH, and other contaminants in seafood, the studies indicate that contaminated sediments in parts of the harbor are damaging to marine animals that live in or on sediment, such as bottom fish and organisms such as burrowing worms and small crustaceans. These organisms serve an important function in the ecosystem of the harbor. EPA's Remedial Investigation (11/89) and several supplemental reports describe the results of EPA's work.

General Cleanup Goals

EPA's goal is to protect human health and the environment. EPA believes that existing human health and environmental risks will be reduced by controlling sources of contaminants to the harbor and by addressing contaminated harbor sediments. Clean sediment provides a better habitat for marine organisms and reduces contaminants in the food chain.

The proposed plan describes cleanup alternatives for two general categories of sediment:

- **Intertidal:** beach sediments exposed at low tide, and;
- **Subtidal:** bottom sediments below the low tide line.

The objective of the plan is to address contaminated sediments and to ensure that they meet state and federal criteria for the protection of human health and the environment.

Cleanup Objectives - Washington's Sediment Management Standards

In conducting Superfund cleanups, EPA is required to meet or waive certain state and federal regulations. These are referred to as "applicable or relevant and appropriate requirements" (ARARs). For Eagle Harbor, the 1991 Sediment Management Standards developed by the Washington Department of Ecology are a significant ARAR. **EPA will be using the state sediment standards as the primary cleanup objective for Eagle Harbor.** The goal of the standards is to "reduce and ultimately eliminate adverse effects on biological resources and significant health threats to humans from surface sediment contamination".

The standards include a Puget Sound-wide approach for defining problem sediments for cleanup. If sediment can be cleaned up by natural processes in ten years, active cleanup is not required. A combination of chemical and biological tests is used to define areas which may need cleanup. Chemical tests measure concentrations of contaminants in the sediment; biological tests assure that the combined effects of any contaminants present are considered in determining cleanup areas.

Adverse biological effects do not appear to be occurring in all areas of Eagle Harbor. Tests showed definite biological effects in the darkly shaded areas of Figure 4. In the lightly shaded areas, where concentrations of mercury and/or PAH indicate the potential for a biological impact, limited testing showed no clear adverse biological effects. Further biological testing in accordance with the state standards is necessary in these lightly shaded areas to fully evaluate potential biological effects from the chemicals found in the sediment and to define cleanup needs.

EPA has identified two cleanup objectives in addition to meeting the state sediment management standards--specifically,

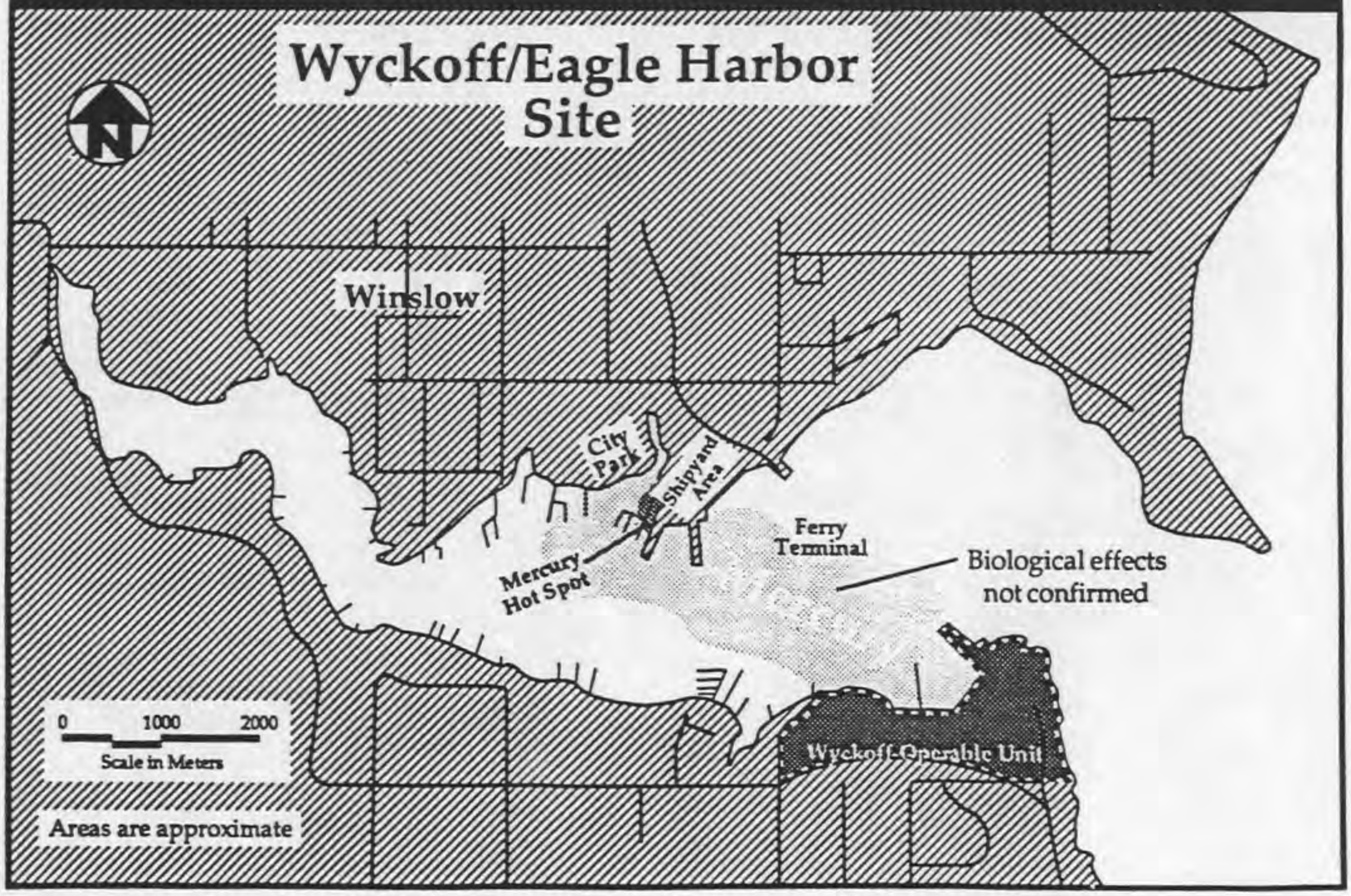
(1) to remove and dispose of sediment containing high levels of mercury (more than 5 parts per million mercury) because it may act as a source of contamination to other areas of the harbor, and
(2) to address intertidal sediments with high-molecular-weight PAH (HPAH) above 1200 parts per billion. Tissues of clams taken from some PAH-contaminated beaches contained HPAH at levels of concern for public health.

Source Control

A major factor in any cleanup decision is whether sources of contamination have been controlled enough to avoid future contamination of cleaned-up areas. At Eagle Harbor, contamination from the shipyard activities on the northwest shore appear to be controlled. EPA will confirm source control in this area prior to cleanup.

Ground water contamination at the Wyckoff wood treating facility is a source of continuing PAH contamination to parts of eastern Eagle Harbor. Wood-treating operations were conducted at the facility for over eighty years under various owners. Over the years, leaks, drippage, and spills of creosote and other wood preservatives resulted in severe contamination of soil and ground water at the facility, seepage of contaminants onto adjacent beach-

Figure 2:
Mercury Contamination



es, and apparent movement of PAH into sediments some distance from shore. To supplement ongoing oil and ground water extraction and treatment, EPA issued Wyckoff an order for additional source control work at the site in June 1991.

The potential for recontamination of the harbor requires further evaluation. EPA does not expect to propose a final cleanup plan for the eastern portion of Eagle Harbor until sufficient information about the volume and movement of contaminants from the Wyckoff facility and the need for controlling this source is obtained. In contrast, shipyard sources in the western part of the harbor are more easily controlled. Therefore, EPA is proposing a final cleanup in this area.

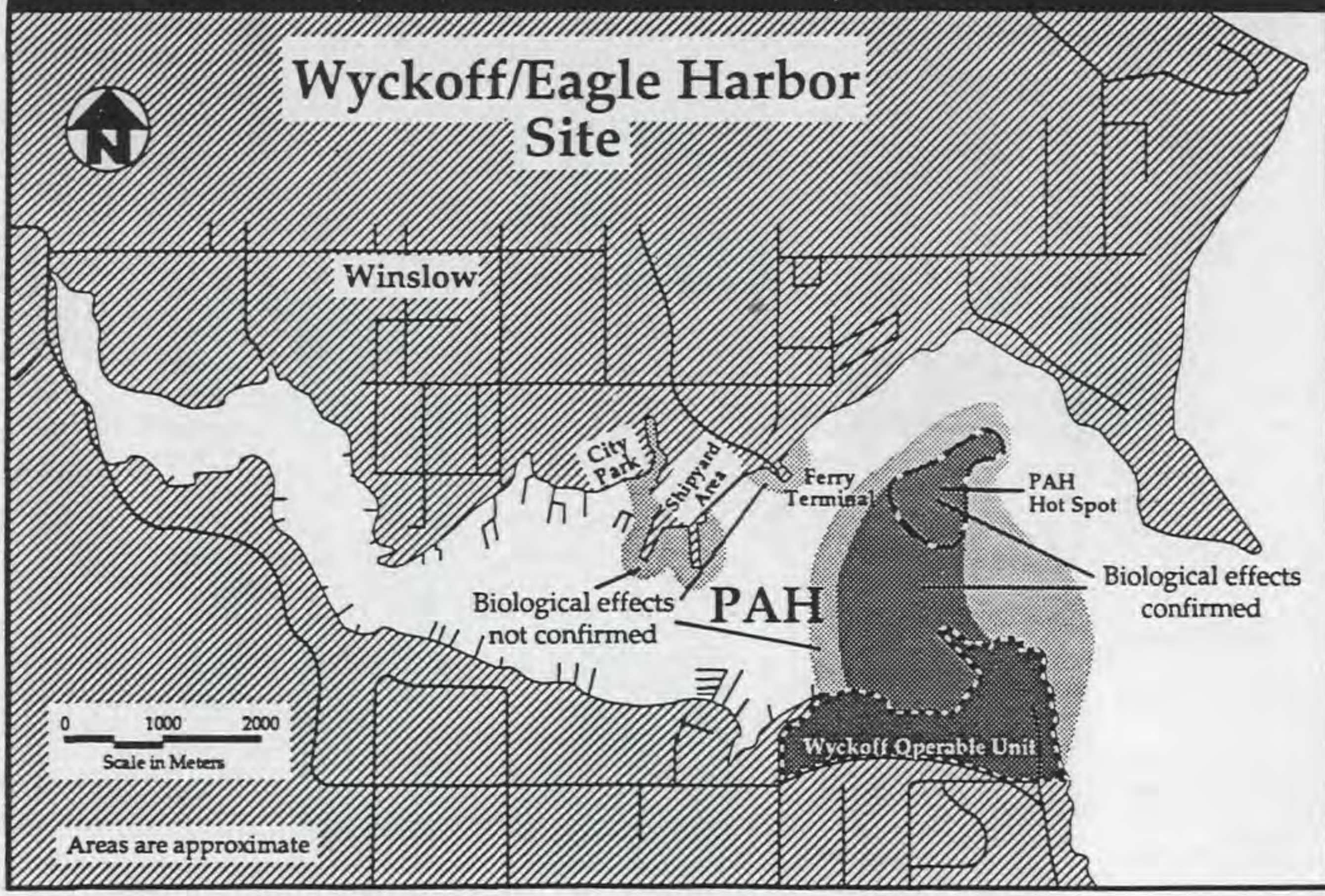
Sediment Cleanup Alternatives

In the November 1991 Eagle Harbor Feasibility Study (FS), EPA evaluated several technologies for cleaning up the harbor. The study defines preliminary cleanup areas and describes a range of technologies for cleanup in these different areas, comparing effectiveness, cost, feasibility, and other factors. Overall, the cleanup alternatives fall into three categories:

- no action,
- institutional controls, and
- active cleanup.

EPA always considers "no action" to compare risks and benefits of other cleanup approaches. Institutional controls reduce exposure to contaminants, but don't clean up the contamination. Active cleanup options range from covering

Figure 3:
PAH Contamination



contaminated areas with clean sediment ("capping") to treating or disposing of contaminated sediment. Because some cleanup alternatives do not apply to all contaminant types or physical settings, EPA anticipated combining alternatives in a site-wide plan. The FS provided examples of several combinations and is available for public review at EPA in Seattle and at the Bainbridge Public Library.

Common Elements of the Cleanup Alternatives

EPA has developed an integrated plan to address the different sources, contaminants, and cleanup areas of the harbor. The individual cleanup alternatives and EPA's proposed plan are presented below. EPA encourages comment on each alternative and on the integrated plan, EPA's "preferred alternative".

Some elements are common to more than one alternative. For example, EPA requires periodic monitoring for all alternatives, including "no action," to evaluate changes in environmental conditions with active cleanup or natural processes. In all cases, EPA supports continuation of the current health advisory as long as necessary. Many of the alternatives rely on some form of sediment containment--either in place, or in containment areas under water, near the shore, on adjacent uplands, or off site. Alternatives D through J require dredging of contaminated sediment, and Alternatives H and L employ treatment to destroy organic contaminants.

All alternatives other than No Action and Institutional Controls include two additional steps before active cleanup can occur:

(1) additional chemical and biological testing according to the state sediment standards to further delineate cleanup areas in the western part of the harbor, and

(2) an investigation of potential PAH movement from the Wyckoff facility into the eastern portion of the harbor through deep soils and sediment.

Plans for these two activities are summarized in supplements to the FS and would be implemented before cleanup in each respective portion of the site.

EPA used available chemical and biological data to estimate approximate cleanup areas and costs in the FS. The FS grouped areas by major contaminant (i.e. mercury or PAH) and physical type (i.e., intertidal or subtidal) and provided low-end and high-end area estimates. These areas, shown below, formed the basis for the costs provided with each alternative.

Intertidal
Mercury (near city park) .... 14,000 m^2 (3.5 acres)
Intertidal
PAH (at ferry terminal) .... 20,000 m^2 (5 acres)
Subtidal
Mercury .... 50,000-125,000 m^2 (12.5-31 acres)
Subtidal
PAH .... 60,000 - 235,000 m^2 (15 - 59 acres)
Estimated
Sum of Areas: 144,000 - 394,000 m^2 (36 - 98.5 acres)

Areas, and therefore costs, may increase or decrease significantly, depending on the results of the additional biological testing and the PAH investigation. The actual cleanup area could decrease to 62,000 m^2 (15.5 acres) or increase to as much as 650,000 m^2 (160 acres). (The combined shaded areas shown in Figure 4 indicate this upper bound area.)

Costs for the biological testing in the western portion and the PAH investigation in the eastern portion are included in the costs shown with each alternative, except for No Action and Institutional Controls. Timeframes provided are for completion of the cleanup action in the areas considered. Chemical and biological monitoring after cleanup will continue as long as necessary. For costing purposes, monitoring is assumed to continue for thirty years. These costs are included under operations and maintenance (O & M).

Discussion of the Cleanup Alternatives

Alternative A: *No Action*

Under "no action," the harbor would be left in its present condition to recover over time through natural processes such as sedimentation (i.e. gradual burial of contaminated sediments), chemical and biological breakdown of PAH, and dispersal/dilution of contaminated sediments.

Eagle Harbor has little new sedimentation, and mercury does not break down over time. Burial, dispersal, or dilution of mercury could take a very long time. EPA estimates that even with complete source control, PAH could take from 30 to 180 years to decrease to the state's sediment chemical standards in heavily contaminated areas. PAH exposed to light and air break down faster, and some beach areas are expected to meet the state standards in ten years without active cleanup.

Costs for thirty years of monitoring fish and shellfish tissue, sediment chemistry, and biological effects for ALL estimated areas are shown below. The Wyckoff facility cleanup would continue, but no additional source investigation or control work is included for the harbor.

Viable for: Mercury, PAH
Primary Area: Harbor-wide
Estimated Area: 144,000 - 394,000 m^2 (31.5 - 98.5 acres)
O & M: 0.8 - 1.2 million dollars
Total Estimate: 0.8 - 1.2 million dollars
Timeframe: not applicable

Alternative B: *Institutional Controls/Natural Recovery*

Institutional controls could include fencing of contaminated beach areas, restricting commercial fish and/or shellfish harvests, and posting advisory signs in order to limit exposure of humans to contaminated seafood and sediments. Marine organisms would continue to be exposed to contamination until the sediments recovered naturally as described in Alternative A. For the purpose of estimating costs, periodic monitoring of fish and shellfish tissue, sediment chemistry, and biological effects were assumed to continue for thirty years.

Viable for: Mercury, PAH
Primary Area: Harbor-wide
Area Estimate: 144,000 - 394,000 m^2 (31.5 - 98.5 acres)
Initial Costs: 24,000 dollars for fence
O & M: 1 - 1.2 million dollars
Total Estimate: 1 - 1.2 million dollars
Timeframe: Less than a year.

Alternative C: *Capping*

Capping with clean sediment limits movement of contaminated sediment, isolates contaminants from the marine environment, and provides clean habitat for sediment-dwelling organisms. In heavily contaminated subtidal areas of Eagle Harbor, a three-foot thick sand cap would be effective. Where the current is strong, for example from ferry propeller wash, coarser materials would be placed on top of the sand to keep it in place. Sediments saturated with oily contamination would probably require a base layer containing finer, clay-like materials to block contaminant movement up through the cap. The need for additional engineering controls would be evaluated during the detailed cap design.

Viable for: Mercury, PAH
Primary Area: Harbor-wide
Area Estimate: 144,000 - 394,000 m^2 (31.5 - 98.5 acres)
Initial Costs: 14.1 - 23.8 million dollars
O & M: 1.1 - 1.3 million dollars
Total Estimate: 15.2 - 25.1 million dollars
Timeframe: 2 - 4 years

Alternative D: *Removal, Consolidation, Confined Aquatic Disposal*

Confined aquatic disposal (CAD) would involve dredging contaminated sediments from the subtidal and intertidal zones, placing it in a pit dredged at the bottom of Eagle Harbor, and covering the relocated sediments with clean sediment originally dredged from the pit. The FS considered an area in the central channel of the east harbor for a CAD location. Contaminated sediments removed from intertidal areas would be replaced with clean material to replace disturbed intertidal habitat. The top of the CAD area would be level with the harbor bottom, and excess clean sediment would be disposed of at an approved open water site.

Viable for: Mercury, PAH
Primary Area: Harbor-wide
Area Estimates: 144,000 - 394,000 m^2 (31.5 - 98.5 acres)
Initial Costs: 21.3 - 46.9 million dollars
O & M: 1.4 - 1.7 million dollars
Total Estimate: 22.7 - 48.6 million dollars
Timeframe: 4 - 6 years

Alternative E: *Removal, Consolidation, and Nearshore Disposal*

This alternative calls for constructing a sediment containment area in the harbor adjacent to the shore. Contaminated sediments would be dredged from subtidal and intertidal areas, placed in the containment area, and capped with clean sand. The containment area surface would be an extension of the existing land surface. Areas considered for such containment include the log-rafting area near Wyckoff and a smaller area east of the Winslow waterfront park. Leaching controls and monitoring would be necessary.

Viable for: Mercury, PAH
Primary Area: Harbor-wide
Area Estimate: 144,000 - 394,000 m^2 (31.5 - 98.5 acres)
Initial Costs: 71 - 108 million dollars
O & M: 2.6 - 2.7 million dollars
Total Estimate: 73.6 - 110.7 million dollars
Timeframe: 4 - 5 years

Alternative G: *Removal, Consolidation, and Upland Disposal at a Commercial Hazardous Waste Landfill*

This alternative would involve dredging the contaminated sediment, dewatering it, and transporting it to a permitted off-site hazardous waste landfill. Barges and trucks would be used for transport of the dredged sediment. Waste water would be treated on site. Mercury-containing sediments would have to be treated (i.e. solidified) to meet standards for land disposal. Sediments with PAH contamination are not considered for this alternative as most cannot be land disposed without excessively costly treatment.

Viable for: Mercury
Primary Area: West Harbor subtidal and intertidal
Area Estimate: 64,000 - 139,000 m^2 (16 - 34.5 acres)
Initial Costs: 49.5 - 103.5 million dollars
O & M: 0.4 - 0.5 million dollars
Total Estimate: 50 - 104 million dollars
Timeframe: 1 - 2 years

Alternative H: *Removal, Treatment by Incineration, and Disposal*

For this alternative, contaminated sediments would be dredged, dewatered, ground to break up larger particles, and incinerated. The incinerator would be a mobile rotary kiln equipped with air pollution control equipment. The incinerator could be located at Wyckoff facility or elsewhere within the site boundaries. Incinerator residue would be disposed of in accordance with state and federal regulations. After burning, the sediment would be disposed of either in an open water disposal site or at an approved landfill, depending on the nature of remaining materials. Disposal restrictions on incinerated sediments containing wood-treating waste may make this alternative difficult to implement.

Viable for: PAH
Primary Area: East Harbor subtidal, West Harbor intertidal
Area Estimate: 80,000 - 255,000 m^2 (20 - 64 acres)
Initial Costs: 173.9 - 273.6 million dollars
O & M: 0.5 million dollars
Total Estimate: 174.5 - 274.1 million dollars
Timeframe: 8 - 11 years

Alternative I: *Removal, Treatment by Solidification-Stabilization, and Disposal*

Contaminated sediments would be dredged and mixed with solidifying and stabilizing agents in equipment similar to that used for mixing concrete. The solidified sediment would increase in volume and would be disposed of at a municipal landfill. Sediments with high concentrations of PAH or other organics are not readily solidified. Only areas with mercury contamination are included in the costs below.

Viable for: Mercury
Primary Area: West Harbor subtidal and intertidal
Area Estimate: 64,000 - 139,000 m^2 (16 - 34.5 acres)
Initial Costs: 17 - 34 million dollars
O & M: 0.37 - 0.5 million dollars
Total Estimate: 17.4 - 34.5 million dollars
Timeframe: 3 - 6 years

Alternative L: *Removal, Treatment by Biological Slurry, and Disposal*

After dredging and dewatering, contaminated sediments would be mixed in a slurry, aerated, and gradually run through a biological treatment system to break down PAH and other organic contaminants. Biological treatment tanks, which could be located on the Wyckoff property, would be equipped with pollution controls. The treated sediment would have to demonstrate compliance with standards for open-water disposal, and waste water from the process would be biologically treated on site. As with other biological treatment technologies, this alternative would not be effective for sediments with high mercury or other metals contamination. Costs are only for PAH-contaminated areas.

Viable for: PAH
Primary Area: East Harbor subtidal
Area Estimate: 80,000 - 255,000 m^2 (20 - 64 acres)
Initial Costs: 100.3 - 204.9 million dollars
O & M: 0.5 - 0.7 million dollars
Total Estimate: 100.8 - 205.6 million dollars
Timeframe: 9 - 11 years

Alternative M: *In Situ Treatment by Solidification*

This alternative is considered only for the intertidal mercury area. Like Alternative I it involves solidification of sediment, but no dredging would be needed. The sediment would be solidified in place. Solidifying agents would be mixed into the sediment by an auger-type mixer, backhoe, or plow. A layer of clean sediment would be added after solidification to provide habitat for marine organisms.

Viable for: Intertidal areas with mercury
Primary Area: West Harbor intertidal
Area Estimate: 14,000 m^2 (3.5 acres)
Initial Costs: 4.3 million dollars
O & M: 0.2 million dollars
Total Estimate: 4.5 million dollars
Timeframe: 1 year

Supplemental Alternative N: *Low-Impact Capping*

This alternative is presented in a supplement to the Feasibility Study. It provides a means to minimize the impact of a thick cap where contamination and biological effects are not severe. Clean sediment brought to the harbor would be dispersed in a thin layer, either with natural processes over a period of years or with mechanical placement. This approach would not apply in high-current areas or heavily contaminated areas. Locations appropriate for use of the low-impact cap would be determined based on harbor currents, existing chemical data, and the biological data gathered to delineate cleanup areas in the western areas. Preliminary costs and a comparison of this approach to other alternatives will be provided in a supplement to the Feasibility Study.

Viable for: Mercury, PAH
Primary Area: West Harbor subtidal
Area Estimate: 125,000 m^2 (31 acres)
Initial Costs: 1.8 - 3.3 million dollars
O & M: 0.3 million dollars
Total Estimate: 2.1 - 3.6 million dollars
Timeframe: 2 - 10 years

Table 1:
Evaluation Criteria

EPA uses nine criteria to identify its preferred alternative for a given site or contaminant. With the exception of the no action alternative, all alternatives must meet the first two "threshold" criteria. EPA uses the next five criteria as "balancing" criteria for comparing alternatives and selecting a preferred alternative. After public comment, EPA may alter its preference on the basis of the last two "modifying" criteria.

Threshold Criteria:

1. **Overall protection of human health and the environment** - How well does the alternative protect human health and the environment, both during and after construction?

2. **Compliance with federal and state environmental standards** - Does the alternative meet all applicable or relevant and appropriate state and federal laws?

Balancing Criteria:

3. **Long-term effectiveness and permanence** - How well does the alternative protect human health and the environment after completion of cleanup? What, if any, risks will remain at the site?

4. **Reduction of toxicity, mobility, or volume** - Does the alternative effectively treat the contamination to significantly reduce the toxicity, mobility, and volume of the hazardous substance?

5. **Short-term effectiveness** - Are there potential adverse effects to either human health or the environment during construction or implementation of the alternative? How fast does the alternative reach the cleanup goals?

6. **Implementability** - Is the alternative both technically and administratively feasible? Has the technology been used successfully on other similar sites?

7. **Cost** - What are the estimated costs of the alternative?

Modifying Criteria:

8. **State acceptance** - What are the state's comments or concerns about the alternatives considered and about EPA's preferred alternative? Does the state support or oppose the preferred alternative?

9. **Community acceptance** - What are the community's comments or concerns about the preferred alternative? Does the community generally support or oppose the preferred alternative?

EPA's Preferred Alternative

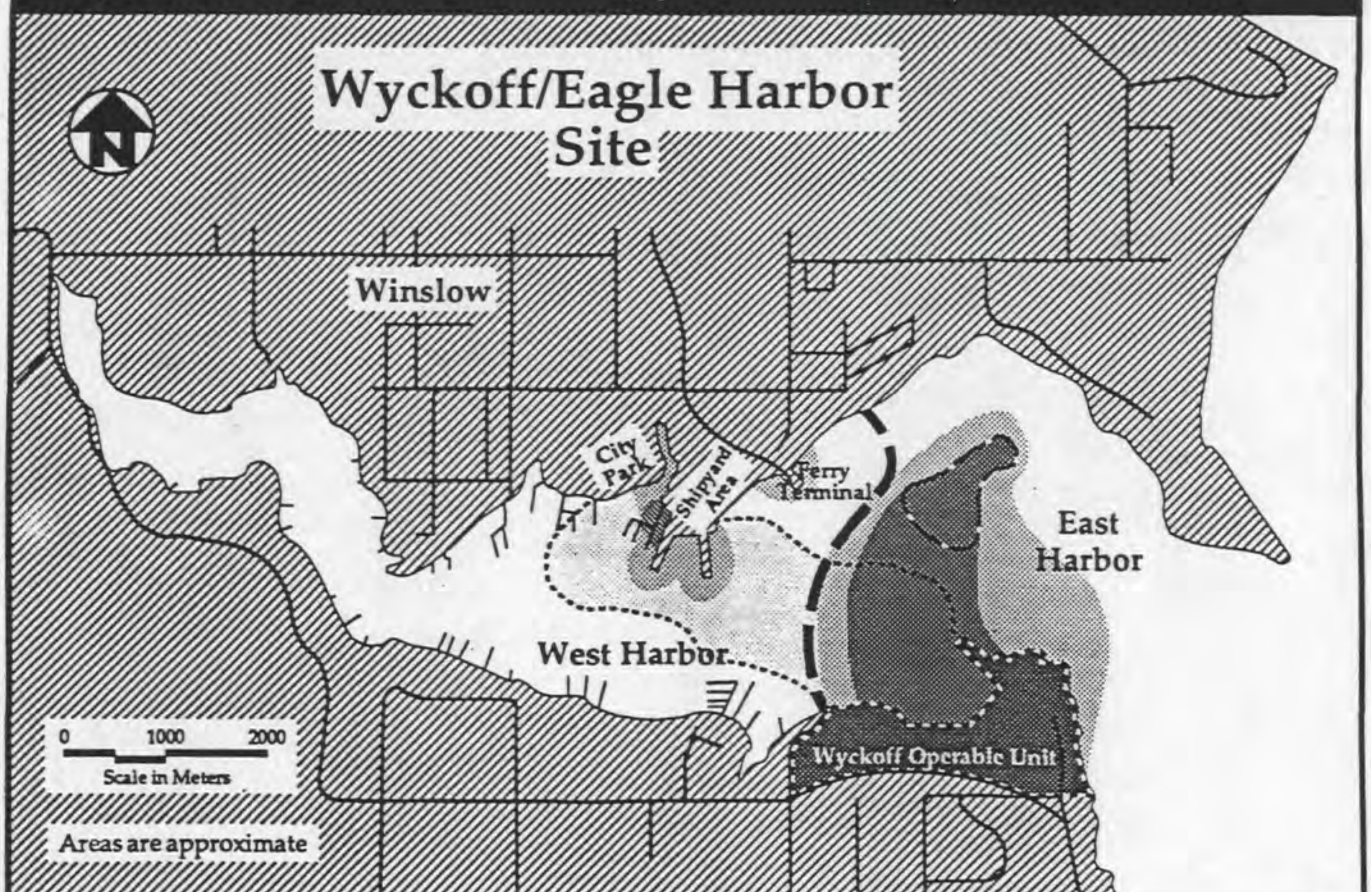
Portions of the harbor can and should be cleaned up now. EPA is proposing to divide Eagle Harbor into two additional "operable units" with a separate cleanup plan for each. The division (Figure 4) is based on the types of contamination present and the potential for recontamination. The Preferred Alternative would divide the harbor as follows:

1)The West Harbor Operable Unit would have a final cleanup plan to remove the mercury hotspot and address remaining contaminated sediments through in-place capping and institutional controls. Sampling before cleanup would define biologically affected areas and the boundaries of the hotspot.

2)The East Harbor Operable Unit would have an interim cleanup plan, providing a permanent in-place cap for the severe PAH contamination in the central harbor channel. Before placement of the cap, testing would be conducted to evaluate the potential for recontamination by PAH moving from Wyckoff. Remaining contaminated areas in the East Harbor would be addressed in a future cleanup plan, after a comprehensive study of the Wyckoff facility provides a better understanding of recontamination potential for sediment closer to the facility.

As components of a dynamic natural system, all areas of the site--East and West Harbor areas and the Wyckoff Facility itself--are interrelated. Prompt action is justified in areas where recontamination is unlikely (i.e. the West Harbor) and where the impacts of contamination are particularly severe (i.e. the PAH hotspot in the East Harbor). EPA believes that dividing the harbor and proceeding with cleanup will accelerate the recovery of the Eagle Harbor ecosystem and protection of human health.

Figure 4:
Proposed Harbor Division



For most areas of Eagle Harbor, EPA prefers capping in place to other alternatives developed. Treatment of large volumes of waste containing relatively low levels of contamination is expensive and slow. Capping is a cost-effective remedy which can isolate any contaminants present, both organic and inorganic. Capping is less likely than dredging to disturb contaminants and release them to the water and air. Capping can also be implemented fairly readily, allowing the harbor to start recovering sooner.

West Harbor
Proposed Final Remedy

Mercury Hotspot:

The principal contaminant in the West Harbor is mercury. The highest mercury concentrations are in the intertidal area west of the ferry maintenance facility, where ships were built and repaired from the turn of the century to the late fifties. Other metals are also found here, as well as PAH.

The "mercury hotspot" (Figure 2) merits cleanup as soon as possible. Biological effects on marine life have been observed, and the contaminated area is accessible to the public. Mercury concentrations generally decrease with distance from this area, indicating that it is a potential source of mercury to the rest of the harbor. Removal and proper disposal of the most contaminated sediments should prevent further spreading of mercury into the harbor.

EPA believes the risk of recontamination after cleanup of the West Harbor is low. As a safeguard, however, the most actively used part of the old shipyard would be tested before cleanup to ensure that rainwater runoff does not recontaminate the sediment. Operations involving hazardous materials, such as boatyard work and ferry maintenance, would be monitored.

Intertidal PAH:

Unlike mercury, PAH can break down naturally over time under certain conditions, particularly when exposed to air and light. Beach areas near the ferry landing contain PAH above the state sediment standards and EPA's HPAH cleanup objective. Elevated mercury concentrations were not detected. In this area, EPA expects that sediments will meet the standards within the accepted ten year period for "natural recovery". Monitoring of sediments and shellfish would be conducted to ensure that PAH concentrations were decreasing. The advisory against consumption of seafood would be maintained.

Other Areas:

Other subtidal and intertidal areas in the West Harbor contain PAH and mercury at lower levels (Figure 4). Biological testing in these areas would determine whether additional cleanup is required to meet the state sediment criteria. If so, a layer of clean sediment would be used to isolate the contaminated sediments and provide new habitat. Periodic monitoring and the advisory against consumption of fish and shellfish would continue until concentrations fell below levels of concern.

Existing biological data have not indicated adverse biological effects in these areas. If more complete biological testing shows limited adverse effects--for example, failure of biological tests by a narrow margin, failure of only one of the three test types, or scattered failures--a thick cap may be inappropriate. EPA has evaluated the lower-impact Alternative N for feasibility in the West Harbor. This method could bring sediment concentrations below levels of concern within a ten year period and may be preferable to the thicker cap in less contaminated areas. Further evaluation of the low-impact cap, either alone or in combination with the thick cap, may be appropriate during detailed design of the West Harbor cleanup.

East Harbor
Proposed Interim Remedy

East Harbor Hotspot:

The principal contaminant of concern in the East Harbor is PAH. Adverse biological effects have been demonstrated in the most heavily PAH-contaminated areas. Because PAH continues to enter the harbor near Wyckoff, EPA is proposing initial cleanup of only part of the East Harbor, with final cleanup to be proposed in the future.

The interim proposal focuses on the most severely PAH-contaminated area, known as the "central harbor hotspot" (Figure 3). Tidal currents and propeller turbulence during low tides keeps the PAH contamination in this area exposed and may spread contaminants to adjacent areas. A cap of clean sediment would be placed over the hotspot to provide a better habitat for marine organisms. Special capping techniques would be needed to keep the clean material in place and to successfully contain the PAH.

EPA data suggest that this area is far enough from Wyckoff to no longer be significantly affected by PAH seepage from the facility. As part of the plan, the additional investigation of PAH transport from Wyckoff would be conducted prior to cleanup to confirm this hypothesis. This investigation would include deep wells on the Wyckoff facility and deep borings between the facility and the hotspot. If the tests indicate that the risk of recontamination is high, additional work to control the sources would be required before cleanup.

The investigation may show that the risk of recontamination is low enough to warrant prompt cleanup of additional areas between the hotspot and Wyckoff where acute biological effects were shown (the darker shaded area of the East Harbor). EPA is considering the central area "hotspot" as a minimum area for this partial East Harbor cleanup, and the total area of known biological effects as a maximum.

Other East Harbor Areas:

Although the East Harbor contamination (Figure 4) consists mostly of PAH, some mercury contamination is also present near the Wyckoff facility. Removal of the mercury hotspot in the West Harbor should limit increases in mercury contamination in the East Harbor.

A final proposed plan for cleanup of contaminated areas not addressed in the East Harbor interim cleanup will be presented for public comment after confirmation of sufficient source control. The plan will be developed after a comprehensive study of the Wyckoff facility and, if necessary, after cleanup of soil and ground water at Wyckoff. At that time, likely to be several years from now, sediment cleanup alternatives will be further evaluated. Public comment on the cleanup proposal for these areas will be solicited before a final decision is made.

Preferred Alternative Summary

WEST HARBOR

Mercury Hotspot--*Removal and Disposal of Sediments*
Sediments containing mercury concentrations greater than 5 parts per million (ppm) would be removed and disposed of at a landfill--either a hazardous waste or municipal landfill, depending on the leaching characteristics of the waste. Clean fill material would be used to restore the original bottom contours where necessary.

Volume Range: 1000 - 7000 m^3 (m^3 is cubic meters)
Cost Range: $ 3.1 - 12.4 million (hazardous waste landfill)
(municipal landfill costs are about 50% lower)
Timeframe: 2 - 3 years

PAH Intertidal (ferry terminal)--*Institutional Controls/ Natural Recovery*
The area would be monitored and allowed to recover naturally in ten years. The existing advisory and additional signs would be used to alert the public to risks from consuming contaminated shellfish. Costs assume monitoring for thirty years.

Area Estimate: 20,000 m^2
Cost Estimate: $ 137,000
Timeframe: not applicable

West Harbor Intertidal/Subtidal--*Thick Cap and/or Low-Impact Cap*
After cleanup areas are further defined by biological tests, contaminated intertidal and subtidal sediments on the West Harbor will be addressed by a clean sediment cap (either the thick cap described in Alternative C, a low-impact cap such as described in Supplemental Alternative N, or a combination).

Area Estimate: 50,000 - 125,000 m^2 (12.5 - 31 acres)
Cost Range: $ 5.5 - 7.9 million (thick cap)
$ 2.1 - 3.6 million (thin cap)
Timeframe: 2 - 4 years

EAST HARBOR

East Harbor Subtidal Hotspot--*Thick Cap*
This area, under 35 to 50 feet of water in the central channel, would be covered with a thick cap and armored to prevent loss of capping material. The capped area could be increased to include other biologically affected areas if the PAH investigation indicates that recontamination is unlikely.

Area Estimate: 60,000 - 235,000 m^2 (15 - 59 acres)
Cost Range: $ 7.5 - 15.1 million
Timeframe: 3 - 4 years

Preferred Alternative Summary
Total Area: 144,000 - 394,000 m^2 (31.5 - 98.5 acres)
Total Costs: Approximately 11.2 - 32.8 million dollars
Total Timeframe: up to 4 years

Analysis of Alternatives:

The alternatives in the FS were evaluated based on the nine evaluation criteria described in Table 1. The following is a discussion of that evaluation.

Protectiveness of Human Health and the Environment:

All cleanup alternatives except No Action and Institutional Controls protect human health and the environment. No Action can be protective of the environment in areas where natural recovery can occur in ten years. In these and other areas, Institutional Controls can be used to provide protection of human health. Alternatives involving on-site containment of contaminated sediments require long-term monitoring and maintenance in order to assure continued protection.

EPA's preferred alternative is protective of both public health and the environment. It removes source metals, addresses human health risks from consumption of contaminated seafood by continuing the existing advisory until contaminants are below levels of concern, and isolates sediment from adversely affected marine organisms.

Compliance with ARARs:

All alternatives except No Action and Institutional Controls comply with the state sediment standards throughout the harbor. Alternative F, involving an onsite landfill at Wyckoff, may not meet state criteria for the disposal of hazardous waste. Alternative G, involving transport of the contaminated sediment to an offsite landfill, would be subject to state and federal dangerous and hazardous waste regulations, as well as treatment standards for Land Disposal Restrictions.

No Action and Institutional Controls would meet the state sediment management standards ONLY in areas where natural recovery could occur in ten years. EPA and Ecology believe that intertidal sediments on the north shore exceeding the state standards for PAH but not for metals may meet the ten-year requirement with natural recovery.

EPA's preferred alternative can meet all ARARs.

Long-Term Effectiveness and Permanence:

Biological Treatment and Incineration permanently destroy PAH and other organic compounds. Mercury, an element, cannot be destroyed. Solidification can keep metals from moving, but is not as effective for organic compounds such as PAH. Options involving containment do not permanently remove or destroy the contaminants. Superfund policy generally favors on-site treatment options over institutional controls or off-site disposal of untreated waste.

Containment is most appropriate for areas with mixed organic and metal contamination, especially when very large volumes of relatively low-concentration waste are involved, as with many contaminated sediment sites. Containment requires maintenance to be effective long term. Offsite containment at an approved hazardous waste landfill can also provide effective long term control.

The preferred alternative combines removal of the mercury source sediments with capping where biological effects are shown. Solidification and appropriate landfill selection will be relatively permanent. Longterm monitoring and/or maintenance will be needed in the capped areas.

Reduction of Toxicity, Mobility, and Volume:

Biological treatment and incineration would reduce the toxicity and mobility of PAH contamination, but would not eliminate metals. Solidification (Alternatives I, M, and potentially other options involving land disposal) would decrease the mobility of the metal contaminants, but would increase the volume.

Under the preferred alternative, mercury source sediments would be solidified before landfill disposal. Capping, a major component of the preferred alternative, does not alter the chemical nature of the contamination, but restricts the movement of sediment particles to which organic contaminants are bound.

Short-Term Effectiveness:

Capping with clean sediment provides the greatest short-term effectiveness because it can be implemented most quickly. Any alternative involving the dredging of subtidal contaminated sediments could have negative short-term impacts on the environment, particularly in areas with heavy PAH contamination. Dredging could remobilize contamination into the water, particularly for oily, PAH-contaminated sediments, causing contamination to spread to nearby areas. Intertidal areas can be excavated at low tide to minimize remobilization of contaminants.

Studies show that marine organisms soon repopulate clean sediment. This process can begin immediately after capping or removal of contaminated sediments, but development of a mature community of sediment-dwellers can take several years. Recolonization of larger areas may be slower.

Implementability:

All of the alternatives can be implemented, although with varying degrees of difficulty. Options involving removal and dewatering of sediment prior to treatment, containment, or disposal require the management of sediment and drained water. Treatment options would necessitate storage or sequential dredging to accommodate the materials to be treated.

Air monitoring and controls, engineering controls to limit water column releases, and coordinating ferry and tidal schedules pose additional challenges for options involving dredging and, to a lesser extent, capping. Institutional controls would require coordinated action with state and local entities.

The capping component of the preferred alternative involves no dredging, storage, dewatering, or processing of contaminated sediment. Careful design, scheduling, and environmental monitoring are essential. Removal of the mercury source sediments can be done from land at extreme low tide. These options are more readily implemented than most of the other active cleanup alternatives.

Cost:

The estimated cost range provided with each alternative assumes the alternative is applied wherever feasible and appropriate, given the contaminants and physical location. In general, initial costs for treatment options and disposal options are high. Containment costs tend to be lower initially, with higher monitoring and/or maintenance costs. Institutional controls are usually the least costly. The preferred alternative combines offsite disposal, containment in place, and institutional controls.

What Next?

Two public meetings about this plan will be held in Winslow in January. The first, on January 15, is an opportunity to discuss the proposed plan and to ask questions. The second, on January 30, is for additional questions and formal public comment.

EPA will respond to written and verbal comment on the proposed plan in a document called a "responsiveness summary." After considering all public comments, EPA will make its cleanup decisions for the East Harbor and the West Harbor operable units. The decisions will be documented in two "Records of Decision" (RODs), with the responsiveness summary attached. Both RODs will be available for review at EPA and the public library in Winslow.

Once the ROD is signed, EPA will enter into negotiations with the potentially responsible parties to implement the cleanup outlined in the RODs. Implementation includes necessary testing and detailed engineering design before actual cleanup action begins. To ensure the continued protectiveness of Superfund cleanups where contaminants remain on site, EPA requires a review every five years after cleanup activities begin.

For Furthur Information

Contact:

Ellen Hale
EPA Project Manager
(206) 553-1215

or

Dan Phalen
EPA Community Relations Coordinator
(206) 553-6709

Call EPA toll-free at 1-800 424-4EPA.

APPENDIX B

Letter of Concurrence

STATE OF WASHINGTON

DEPARTMENT OF ECOLOGY

Mail Stop PV-11 • Olympia, Washington 98504-8711 • (206) 459-6000

September 25, 1992

Ms. Dana Rasmussen
Regional Administrator
U.S. EPA, Region X
1200 Sixth Avenue
Seattle, WA 98101

Dear Ms. Rasmussen:

The Washington State Department of Ecology has reviewed the Record of Decision for the West Harbor Operable Unit of the Wyckoff/Eagle Harbor Superfund Site. We concur with the selected remedies described in Chapter 10 of the Record of Decision. These remedies are consistent with the Sediment Management Standards [WAC 173-204-520(3)]. We also concur with measures to obtain control of significant sources of contamination to the West Harbor Operable Unit.

We look forward to assisting the EPA in the completion of remedial activities for this and the other operable units of the Wyckoff/Eagle Harbor Superfund Site.

Sincerely,

Carol L. Fleskes

Carol L. Fleskes
Program Manager
Toxics Cleanup Program

CLF:PCB:gj

cc: Timothy L. Nord, Dept. of Ecology
Carol Kraege, Dept. of Ecology
Brett Betts, Dept. of Ecology

APPENDIX C

Responsiveness Summary

WEST HARBOR ROD

RESPONSIVENESS SUMMARY
TO
PUBLIC COMMENTS
ON THE FEASIBILITY STUDY AND PROPOSED PLAN
FOR
EAGLE HARBOR

RESPONSIVENESS SUMMARY
WEST HARBOR ROD

RESPONSIVENESS SUMMARY TO PUBLIC COMMENTS ON THE FEASIBILITY STUDY AND PROPOSED PLAN FOR EAGLE HARBOR

Contents

Section 1

Introduction

1.1 Overview:

The purpose of this responsiveness summary is to summarize and respond to public comments submitted in regard to the Proposed Plan for cleanup of the West Harbor and East Harbor operable units (OUs) of the Wyckoff/Eagle Harbor Superfund site. While it addresses public comments related to both OUs, it is specifically tailored to be an attachment to the West Harbor OU Record of Decision. This responsiveness summary meets the requirements of Section 117 of the Comprehensive Environmental Response, Compensation, and Liability Act of 1980 (CERCLA) as amended by the Superfund Amendments and Reauthorization Act of 1986 (SARA).

In the Proposed Plan, issued December 16, 1991, the U.S. Environmental Protection Agency (EPA) and the Washington Department of Ecology (Ecology) described alternatives considered in the Feasibility Study (1992) for cleanup of Eagle Harbor sediments and identified the preferred alternative. Public comment on the proposed plan was solicited, and a comment period of over sixty days was provided. Both agencies have carefully considered all comments submitted during the public comment period. EPA prepared this responsiveness summary.

Based on comments received during the comment period, it appeared that the Bainbridge community was somewhat divided on the need for active cleanup of the harbor sediments. Those not supporting the Proposed Plan were generally of the opinion that the human health and ecological risks did not warrant the cost of active cleanup. These commenters generally preferred institutional controls in combination with either limited action in hotspot areas only or no remediation action (i.e., natural recovery over an indefinite time period). The remaining commenters generally supported the Proposed Plan as written. A number of commenters also emphasized the need for a more aggressive cleanup effort at the wood-treating facility operable unit.

Comments from state and federal agencies supported the approach of removing mercury source sediments in the West Harbor, capping the PAH hotspot in the East Harbor, and providing continued institutional controls. In addition, the capping of remaining contaminated sediments was supported by most, though not all, of these commenters.

Potentially Responsible Parties (PRPs) also expressed opinions on aspects of the Proposed Plan and on the Remedial Investigation and Feasibility Study (RI/FS) which form the primary basis for the plan. Some PRPs proposed alternative means of disposing of the mercury-contaminated sediments after removal, and proposed a cleanup approach focusing on hotspot remediation only, relying on natural recovery in the remaining areas. A number of PRPs asserted that EPA underestimated the potential for natural recovery in Eagle Harbor and as a result overestimated areas needing cleanup. Several commenters expressed dissatisfaction with the quality of data obtained during the RI/FS.

Comments received from the entire affected community have been considered in the selection of remedy and responded to in this Responsiveness Summary.

The cleanup alternatives described in the Proposed Plan addressed contamination of the harbor sediments by mercury, polynuclear aromatic hydrocarbons (PAHs), and other chemical contaminants. The alternatives ranged from no action or institutional controls to active remedial alternatives requiring containment or treatment of sediments, either after dredging or *"in situ"* (in place).

The preferred alternative identified in the Proposed Plan called for: an overall strategy of dividing the harbor into West and East Harbor operable units; final cleanup in the West Harbor; and an interim cleanup decision to control the "hotspot" in the East Harbor, with remaining contaminated sediments to be addressed after significant sources of contamination to these sediments are more fully controlled. Remedial design work proposed would include testing in the West Harbor to further define areas failing the State of Washington Sediment Management Standards (Sediment Standards) and, in the East Harbor, field work to determine the magnitude of potential subsurface sources of PAH contamination.

Remedial actions proposed for the West Harbor included removal of sediments containing 5 or more parts per million (ppm) mercury, in-situ capping of other sediments that fail the Standards in the West Harbor, natural recovery of PAH-contaminated intertidal sediments near the ferry landing, and continuation of the seafood health advisory currently in place.

The remedy proposed for the East Harbor was *in situ* capping of the hotspot of PAH-contaminated sediments most distant from the wood treating facility source. Further action in the West Harbor was to be dependent on confirmation of the control of sources of contamination to the West Harbor from the former wood treating facility.

The selected remedies, to be described in the two Eagle Harbor Records of Decision, have been modified from the Proposed Plan in response to comments. Based on public comment, the final plan for the West Harbor OU described in this ROD has been modified in several areas, including:

- considering a wider range of disposal options for mercury-contaminated sediments;
- including additional detail on the low-impact capping/thin layer placement alternative and the basis for its selection and application;
- clarifying the nature of the institutional controls and clarifying source evaluation efforts proposed;
- providing for additional consideration of natural recovery;
- incorporating monitoring goals and objectives;
- clarifying the basis for applying capping and other containment alternatives in the mercury-contaminated areas; and
- including additional information about remedial design sampling requirements.

Modifications to the proposed plan are also discussed in Section 12 of the Record of Decision.

1.2 Structure

This document is divided into Sections 1 - 5, as follows.

Section 1 provides an introduction and overview of the document.

Section 2 focuses on community involvement. It briefly summarizes the history of public involvement before and during EPA's study phase, which began when the site was added to the National Priorities List in July 1987. Included is a brief summary of issues raised by the community and by the technical discussion group (TDG)--a group composed of members of the community, other state and federal agencies, and potentially responsible parties--during the RI/FS.

Section 3 summarizes comments on specific aspects of the Proposed Plan and provides EPA's responses. Individual comments were paraphrased and grouped under general topic headings to allow a unified EPA response. Section 3 comprises the largest part of this responsiveness summary.

Section 4 provides a brief summary of remaining issues and concerns which fall outside the scope of remedy selection.

Section 5 is an appendix which includes a bibliography of source materials and a list of commenters.

1.3 Scope of Response to Comments.

The primary aim of this Responsiveness Summary is to address specific comments. General statements of support or opposition to the preferred alternative, although considered, are not specifically responded to.

Section 2

Community Involvement

2.1 Background

The Bainbridge Island community was involved in pollution issues related to Eagle Harbor for several years prior to the proposal of the Wyckoff/Eagle Harbor site to the National Priorities List in September 1985. Until 1984, most of the community concerns focused on contamination at and leaving the 11Wyckoff facility and on bacterial pollution in the harbor waters and seafood.

In 1984, studies of chemical contamination in Eagle Harbor shellfish prompted the Bremerton-Kitsap County Health Department to issue a health advisory. The Mayor of the City of Winslow (now part of the incorporated City of Bainbridge Island) and the Kitsap County Commissioner formed the Eagle Harbor Task Force, a ten-member citizens' committee to assemble information and press for action on Eagle Harbor's pollution problems. This group followed the preliminary investigation (PI) conducted by the Washington Department of Ecology (Ecology) and was involved with subsequent efforts by EPA and Ecology to address contamination in the harbor and at the Wyckoff Facility under Superfund authorities. After the site was listed on the NPL in July 1987, the Task Force continued to press for control of pollution sources at the Wyckoff facility.

In March 1988, EPA issued a fact sheet and brought the community together to discuss an Expedited Response Action (ERA) planned at the Wyckoff facility to control sources of contamination to the harbor. Verbal comments from this meeting and subsequent written comment assisted EPA in deciding on actions at the facility. In July 1988, EPA and the Wyckoff Company signed an Order on Consent for source control activities, including a ground water and oil extraction and treatment system.

Field work for the Remedial Investigation and Feasibility Study (RI/FS) of Eagle Harbor began in early 1988. At this time, EPA established a forum for exchanging technical information during the RI/FS. This Technical Discussion Group (TDG) was composed of interested health and environmental agencies, technical representatives of potentially responsible parties, and members of community and/or environmental groups. The TDG commented on planning documents and draft reports and discussed technical issues at key points in the RI/FS.

In 1988, the Association of Bainbridge Communities (ABC) applied for and was granted a Technical Assistance Grant (TAG) for $50,000 from EPA. Using grant monies and matching funds, ABC hired an environmental consultant to participate in the TDG and help interpret technical issues for the community during the Eagle Harbor RI/FS.

When the RI report was issued in November 1989, EPA held a public meeting in Winslow to present the results and to answer questions from the community. EPA summarized the extensive chemical and biological information obtained during the RI, presented the results of the risk assessment, and described additional field work to be conducted during the Feasibility Study.

Throughout the RI/FS, EPA periodically updated the community and other interested parties. The EPA site managers met with, corresponded with, or otherwise contacted ABC almost quarterly. EPA also issued updates on the Wyckoff facility cleanup and Eagle Harbor RI/FS. From September 1987 to December 1991, 18 updates were sent out. The mailing list currently includes over 600 addresses. Updates and key project documents are kept on file for public review at the Kitsap Regional Library, Bainbridge Island Branch.

2.2 Concerns Expressed During the Investigation Phase

During the course of the RI/FS, a number of concerns were raised by the community and by the TDG. While comments raised during the comment period are addressed in Section 3, the following section provides a brief discussion of some general community concerns, including:

- the need to address sources of contamination at the Wyckoff OU;
- technical issues related to the RI/FS;
- potential health risks from exposure to harbor waters, sediments and seafood; and
- the impacts of Superfund activities on shoreline development.

2.2.1 Source Control at the Wyckoff Facility

While both are part of the same Superfund site, Eagle Harbor and the Wyckoff Facility have been addressed separately. Efforts at the Wyckoff Facility have been focused on controlling surface runoff, seeps, and contaminated groundwater entering the harbor from the facility. Using Superfund authorities, EPA required the Wyckoff Company to conduct sampling and to implement specific source control activities. While much has been done to understand and reduce contaminant sources, sediments near the facility may still be affected by ongoing seepage. Rather than delay sediment cleanup until the facility has been cleaned up, EPA chose to complete cleanup in sediment areas unaffected by ongoing releases of contamination from the facility. Increased source control efforts are underway and an RI/FS has been initiated at the facility. Final sediment cleanup in areas currently affected by ongoing releases of contamination to the harbor will be delayed.

2.2.2 Potential Human Health Risks

Although the Bremerton-Kitsap County Health District advisory has been in place since 1984, members of the community have been concerned about exposure to Eagle Harbor beach sediments and potential risks to subsistence fishing populations and consumers of sea lettuce, sea cucumbers, and other seafood not evaluated in the risk assessment.

EPA's 1989 human health risk assessment was revised in 1991 to include updated toxicity information and additional fish and shellfish data. Risk assessments are limited by uncertainties in toxicity information, exposure assumptions, and environmental data. Although risk assessments usually cannot quantify all potential risks, they address uncertainty by focusing on the significant pathways and using reasonable maximum exposure assumptions.

As noted in the Eagle Harbor risk assessments, consumption of contaminated fish and shellfish is believed to be the primary source of potential human health risk. Consumption rates above those assumed may add slightly to the total human health risk. Based on available toxicity data, dermal exposure to sediments does not appear to contribute significantly to overall site risks. EPA recommends continuation of the health advisory, increased public information, and informed personal decision-making.

2.2.3 Technical Concerns during the RI/FS

The technical basis for remedial decisions has been a topic of general concern to ABC, PRPs, and other affected parties at stages throughout the RI/FS. Concerns ranged from overall study approach to specific matters such as analytical data quality, numbers and types of samples, and biological testing or evaluations. The TDG was formed in 1988 to allow public participation in technical aspects of the RI/FS. The group met frequently during the study phase to discuss technical aspects of the RI/FS. EPA found the TDG valuable and has made technical decisions that considered the group's input.

Responses to TDG concerns raised during the RI/FS can be reviewed in the Administrative Record at the Winslow Public Library, which includes a preliminary responsiveness summary to TDG comments on the draft FS. Comments on the RI/FS submitted during the public comment period are addressed in Section 3 of this document. EPA is satisfied that the RI/FS obtained the information necessary to evaluate human health and ecological risks, determine the nature and extent of contamination, and select a remedy for Eagle Harbor sediments.

2.2.4 Impacts on Shoreline Development

During the RI/FS, members of the community applying for permits for dredging, pier or bulkhead construction, and other shoreline projects have had to address concerns about the potential environmental impact of such actions in a contaminated area. In some cases, EPA, the U.S. Army Corps of Engineers (COE) and natural resource agencies have recommended or required sediment sampling or have imposed limitations on activities which could resuspend potentially contaminated sediments.

Applicants may have found the added restrictions onerous; however, development in or near a Superfund site requires special scrutiny, because of the potential for risks to human health and the environment due to site contamination. While the RI has identified specific areas for sediment cleanup, overall harbor conditions are expected to require continued careful review of permits for shoreline activities.

2.3 The Public Comment Period

Considerable efforts were made to involve the community in the harbor cleanup decision. EPA issued the Proposed Plan on December 16, 1991 and provided a comment period of sixty days. Two public meetings were held at Commodore Middle School during this period. At the first meeting, held on January 15, 1992, EPA presented outlines of the RI/FS and Proposed Plan and provided time for an extensive question and answer session. The second, held fifteen days later, provided the community with a formal opportunity for spoken comments. Transcripts are available for both public meetings. Throughout the public comment EPA also solicited written comments from interested parties.

Near the end of the sixty day period, several requests for additional time prompted EPA to extend the comment period for ten days. In addition, a party notified of potential liability in late January was given until March 7 to submit comments to EPA.

2.4 Future Public Involvement

TDG suggestions were often very helpful to EPA. EPA intends to continue using the Technical Discussion Group (TDG) as a forum for exchanging technical information and expertise during the cleanup design and implementation phase.

The Association of Bainbridge Communities (ABC) may apply for additional grant monies and will likely serve as a primary contact group for Bainbridge Island community concerns.

The City of Bainbridge is expected to increase its involvement, as some remedial action may take place on or require access to City-owned property adjacent to the Waterfront Park.

Section 3

Response to Comments Received During the Public Comment Period

Section 3 summarizes and responds to substantive comments submitted during the public comment period following issuance of the Proposed Plan. Comments and responses in Section 3 are arranged by topic. Those which applied to more than one topic were responded to under the heading considered the most appropriate. Paraphrasing was used to incorporate related concerns expressed in more than one comment. Every attempt has been made to respond to concerns raised during the comment period.

3.1.1. Superfund Process

3.1.1.1
Comment: What is Superfund? Who will pay for the cleanup of Eagle Harbor?

Response: Superfund (formally known as the Comprehensive Environmental Response, Compensation, and Liability Act, or CERCLA) is a law created by Congress in 1980 to clean up hazardous waste sites.

The Superfund process for sites on the National Priorities List (NPL) includes a Remedial Investigation (RI) to determine the nature and extent of contamination and assess human health and environmental risks, a Feasibility Study (FS) to evaluate cleanup alternatives, and a Record of Decision documenting EPA's cleanup decision. The selected remedy is then implemented during the Remedial Design and Remedial Action (RD/RA) phase. A more detailed discussion of the Superfund process is available from EPA.

Although a fund (i.e., "Superfund") was established to allow EPA to proceed with site cleanups, Congress intended for EPA to use the law to require "responsible parties" to conduct the cleanup or to pay costs incurred by EPA in responding to the sites. Potentially Responsible Parties (PRPs) may include current and former land owners, facility operators, and generators and transporters of hazardous substances.

EPA may therefore use a combination of options to implement response activities at Superfund sites: 1) use Superfund monies and attempt to recover costs from responsible parties, 2) negotiate consent agreements with responsible parties to perform cleanups and reimburse EPA for costs incurred, and 3) order responsible parties to conduct the cleanup.

At Eagle Harbor, EPA performed the RI/FS using Superfund monies. However, following the ROD, EPA intends to require responsible parties to implement the selected remedy and to pay EPA for past and future response costs.

3.1.1.2
Comment: The RI/FS does not comply with state and federal authorities.

Response: The RI/FS and ROD for Eagle Harbor are not inconsistent with CERCLA and the National Contingency Plan (NCP). The State of Washington reviewed the Record of Decision and concurs with the selected remedy. No inconsistency with state laws or regulations has been noted.

3.1.1.3
Comment: Will local businesses be affected by the cleanup? In particular, the community is concerned about the bulkhead construction business and yacht repair yard located on the former shipyard property.

Response: At a minimum, operations which may be acting as sources of contamination to the harbor will be required to comply with existing environmental regulations related to protection of the harbor environment. Under the Superfund liability provisions, the bulkhead construction business may be liable for cleanup costs at the site. EPA has broad discretion in applying these provisions, however, and will evaluate how PRPs should be involved in the cleanup.

3.1.1.4
Comment: *Potential liability of some of the smaller PRPs is a concern. For this reason, EPA should select among the lowest cost alternatives, such as No Action and/or Institutional Controls.*

Response: EPA considers the No Action alternative as a basis for comparison to other alternatives. However, No Action does not meet the threshold criteria of protection of public health and the environment, nor does it meet the threshold of compliance with ARARs. In selecting the remedy, however, EPA must consider cost-effectiveness. The Proposed Plan reflected this consideration by recommending a cleanup strategy that would vary the remedy according to the level of impact. It also recommended containment options, where appropriate, as the most cost-effective means of addressing the high volume/low concentration characteristics of contaminated marine sediments. The selected remedy gives further consideration to cost by allowing consideration of natural recovery in marginally contaminated areas.

3.1.2. Cost and/or Quality of Studies

3.1.2.1
Comment: *The costs of the RI/FS and of some of the alternatives seem excessive in comparison to the benefits.*

Response: The figure of six million dollars cited in the local press for the RI/FS represents EPA response costs from 1987 to the present and includes both the harbor investigation and enforcement and oversight of Wyckoff facility cleanup actions. The actual costs (*approximately four million dollars) for the RI/FS in Eagle Harbor are not surprising for a four-year study at a large site with challenging field requirements, a range of chemical analyses, extensive coordination and public involvement, and complex human health and ecological issues. Data requirements for determining compliance with the Sediment Standards made the results of the investigation seem less definitive, but EPA believes that the RI/FS provided the necessary information for evaluating risks posed by the site and for making the site cleanup decision.

3.1.3. Coordination with other Agencies/Programs

3.1.3.1
Comment: The cleanup effort should be coordinated with various federal, state and local agencies.

Response: EPA is committed both in principle and by statute to coordination with other agencies on the cleanup of Eagle Harbor. In addition to Ecology and the COE, EPA will coordinate with federal and state natural resource agencies, state and local health agencies, the Suquamish Tribe, and the City of Bainbridge Island. Implementation of the remedy will also require coordination with the Washington State Ferries.

The need for coordination was underscored by the Bremerton-Kitsap County Health District with regard to community education and health advisories. When possible, EPA will work with the Health District to help disseminate information about bacterial and chemical contamination in harbor shellfish. The selected remedy provides for additional public education about pollution problems in the harbor.

3.1.3.2
Comment: EPA should discuss the role of the Natural Resource Trustees in the Superfund Process.

Response: Natural Resource Trustees are federal, state, and tribal entitities identified pursuant to CERCLA. They are authorized to assess damages at Superfund sites to the natural resources (e.g., fish, wildlife, habitats, groundwater) for which each is a trustee. Trustees may pursue cost recovery from responsible parties (RPs) for funding to address damages to the resources or may enter into agreements with RPs to undertake actions to protect and restore the resources beyond the Superfund Actions in the ROD. EPA is directed by CERCLA and the NCP to coordinate with the Natural Resource Trustees.

Trustees with whom EPA has coordinated at this site include the Washington State Department of Ecology (Ecology), the U.S. Department of Interior (including the U.S. Department of Fish and Wildlife, the U.S. Geological Survey, the Bureau of Indian Affairs, and other bureaus), the U.S. Department of Commerce (including the National Oceanic and Atmospheric Administration (NOAA), and the Suquamish Tribe. EPA has also coordinated with state resource agencies, including the Washington Department of Natural Resources and the Washington Department of Fisheries.

3.1.3.3
Comment: The Washington State Department of Natural Resources (DNR) manages state-owned aquatic lands at the site. DNR believes that the remedial actions should be designed and implemented in a manner to minimize impacts to parties leasing state-owned aquatic lands and to allow these lands to continue functioning in the interest of the public trust.

Response: In selecting a remedy, EPA evaluates cleanup alternatives using the nine criteria described in the Record of Decision (See Section 9). These criteria adequately consider the impact of remedial action on public and private lands. In designing and implementing the remedy, EPA will follow applicable or relevant and appropriate requirements and will coordinate with agencies and property owners as appropriate.

3.1.3.4

Comment: DNR also commented that the state should receive recognition for the value of submerged land or capping material from state lands used in the cleanup and restoration of Eagle Harbor. This practice is followed at another Superfund site, where aquatic land is valued at fifty percent of upland value. Clean capping material from state-owned aquatic lands ranges from $0.25 to $0.50 per cubic yard, depending on the source.

Response: FS cost estimates included assumed costs for obtaining clean sediments for capping operations, but the source of capping material has not been finally determined. The value of capping materials and of land used for disposal may be a matter that DNR will wish to address in discussions with the party or parties implementing the ROD.

3.1.3.5

Comment: The liability associated with leaving contaminants on state-owned aquatic lands should be addressed.

Response: DNR manages the subtidal lands in Eagle Harbor and evaluated the alternatives in light of liability and other concerns related to DNR's public trust responsibilities. The DNR evaluation was submitted to EPA during the public comment period. EPA considers such concerns under the modifying criteria of state and community acceptance.

Alternatives such as in-situ capping or confined aquatic disposal (which leave contaminants on site) tend to rank favorably under the balancing criteria of cost, implementability, and short-term effects. As indicated in the NCP (40 C.F.R. §430(a)(1)(iii)(B)), engineering controls/containment options are consistent with EPA expectations for addressing large volumes of low-level contamination.

3.1.4. Applicable or Relevant and Appropriate Requirements (ARARs)

3.1.4.1

Comment: What standards will the agency use to evaluate the progress and success of the cleanup?

Response: The remedy will be required to achieve ARARs and the performance standards described in Section 10 of the ROD. The primary ARAR for the selected remedy is the Washington Sediment Management Standards. In addition, the remedy will be designed to meet the objectives and requirements outlined in the selected remedy. More specific performance standards and detailed monitoring plans will be developed during remedial design to measure the progress of cleanup in meeting ARARs and other requirements of the selected remedy.

3.2. Human Health Risks

3.2.1
***Comment:** The lifetime exposure scenarios used by the agency were unrealistic, and human health risks associated with contamination in Eagle Harbor are overestimated.*

Response: EPA followed national guidance for most aspects of the exposure scenarios used in assessing human health risks at Eagle Harbor. Assumptions were modified where regional data were available or where a reasonable basis existed for making more appropriate assumptions. The risk estimates evaluate risks for a reasonable maximum exposure and are intended to allow EPA to make decisions protective of the overall population considered. Individual exposures may vary significantly. Uncertainties due to exposure assumptions and other aspects of the risk assessment are discussed in the 1989 and 1991 documents.

3.2.2
***Comment:** Data quality and other uncertainties in the risk assessment may underestimate human health risks. Concerns about public exposure to contaminated beaches and seafood should be addressed by additional posting of the fish and shellfish advisory at publicly accessible beaches, posting of warnings about risks from dermal exposure, and restricting commercial harvests of perch and sea cucumber.*

Response: All risk assessments involve considerable uncertainty. However, the uncertainties described for the Eagle Harbor risk assessment may call for some additional actions. As described in the selected remedy, EPA intends to increase public awareness of the shellfish advisory and to require chemical monitoring of seafood. Limitations on the commercial harvest of sea cucumber from Eagle Harbor may also be imposed by the appropriate agencies. Risks associated with dermal exposure to carcinogenic PAHs cannot be reliably estimated.

3.2.3
***Comment:** Please explain why some but not all of the PAH compounds were used in the revised risk assessment and why only the noncancer risks associated with dermal (skin) contact with PAH contaminated sediments were evaluated.*

Response: Toxicity information on PAHs is still developing. In general, EPA prefers to use only peer-reviewed, nationally accepted toxicity data to evaluate risks to human health. Some PAHs have no established toxicity factors, while others have toxicity factors for only certain exposure routes.

Toxicity factors for dermal exposure to both carcinogenic and non-carcinogenic PAHs have not been established. For non-carcinogenic PAHs, however, the same organs are affected by dermal as by oral routes. Thus, it was appropriate to use the oral toxicity factors available in this case. Since the target organs are different for oral and dermal exposure to carcinogenic PAHs, it was not appropriate to apply oral toxicity values for the dermal route.

3.2.4

***Comment:** The FS states that the "...revised risk assessment did not identify a significant human health risk related to direct ingestion of or contact with PAH-contaminated sediment..." However, Figure S-5 from the revised risk assessment shows that the excess cancer risk from ingesting intertidal sediment along the Wyckoff property and along the north shore exceeds 10^{-6} for both average and reasonable maximum exposure assumptions.*

> **Response:** Excess lifetime cancer risks from consumption of intertidal sediments reach 2 X 10^{-5} for certain locations. In accordance with the National Contingency Plan (40 CFR 300), exposure levels may be considered acceptable if they represent an excess upper-bound lifetime cancer risk to an individual of between 1 X 10^{-4} and 1 X 10^{-6}, as noted on the figure referenced above. Recent Superfund guidance for the use of risk assessment in remedy selection states that where cumulative carcinogenic site risk to an individual (based on reasonable maximum exposure) is less than 10^{-4}, action is generally not warranted unless there are adverse environmental impacts (OSWER Directive 9355.0-30, April 22, 1991).

3.2.5

***Comment:** The revised risk assessment uses a lower fish consumption rate (i.e., 4.9 g/day) to define average exposure conditions than was recommended in the Puget Sound seafood health risk assessment (Tetra Tech, 1988) (i.e., 12.3 g/day). As a result, the indicator concentrations for contaminants in fish as calculated in the FS are 2.5 times greater than they would be if the higher consumption rate had been used. This apparent discrepancy must be resolved because these values will be used to evaluate the effectiveness of sediment remediation.*

> **Response:** EPA agrees that the average fish consumption rate used in the revised risk assessment was not the same as the average ingestion rates from the *Health Risk Assessment of Chemical Contamination in Puget Sound Seafood* (Tetra Tech, 1988). Average risks reported in the revised risks assessment associated with fish consumption should be increased by a factor of 2.5 to be consistent with the Puget Sound study.
>
> The indicator concentrations corresponding to unacceptable risks for seafood ingestion (Section 2 of the FS) were developed using the reasonable maximum exposure (RME) assumptions. The consumption rates assumed for the RME are consistent with the Puget Sound study. Please note, however, that new information regarding PAH toxicity has changed the concentrations corresponding to unacceptable risks. The adjusted concentrations are somewhat higher and are provided in the ROD.

3.2.6

***Comment:** Explain why the study did not observe a correlation between elevated mercury levels in sediments and shellfish.*

> **Response:** EPA believes that the lack of correlation was due to the variable bioavailability of mercury. EPA measured the total concentrations of mercury in sediment samples. Total mercury includes both inorganic forms of mercury and organic compounds such as methylmercury. For mercury to be stored in clam and other tissues, the inorganic form must be converted into organic forms, usually by microbial action. Methylmercury in tissues contributed most to the noncancer risks from clam consumption.

The concentrations of methylmercury as a fraction of the total mercury was not determined for the sediment samples. The fraction will vary at different locations depending on the balance between microbial methylation rates and the rate methylmercury is evaporated or taken into the food chain. At a given location, the types and numbers of microbes, the supply of usable organic carbon, and other factors affect methylation rates.

Tissue data indicates that methylmercury is being taken into tissues of clams and fish. Although we do not see a correlation between concentrations in sediment and clam tissue, EPA believes that the total mercury in the harbor poses a potential risk of continued methylation and biological uptake.

3.3. Environmental Risks

3.3.1

Comment: *The biological testing conducted as part of the RI and preliminary investigation was inadequate to evaluate possible benthic effects. The need for additional biological sampling in Eagle Harbor is supported by the Sediment Standards. Additional testing should be conducted during the remedial design phase to better characterize the benthic community in the harbor. These baseline conditions must be defined to evaluate the effectiveness of sediment remediation.*

> **Response:** According to the Sediment Standards, cleanup areas can be defined using chemical data as an indicator of probable adverse effects, and biological information can be obtained to verify or refute predicted effects. The biological measures may include benthic analyses, but allow the use of other chronic measures instead. The collection of biological information to refine cleanup areas is optional, however, and for Eagle Harbor applies only in certain areas (ROD, Section 10). The extent of benthic and other biological information necessary to establish a baseline for long-term monitoring will be determined during remedial design.

3.3.2

Comment: *How can EPA assume that major benthic effects are not present in most areas of the harbor when concentrations of PAH and mercury exceed the Sediment Standards chemical criteria in most of the harbor and exceed these standards by as much as 10 times at numerous stations? In addition, bioassays may not be sensitive enough to detect subchronic and all acute effects of mercury.*

> **Response:** EPA believes this FS concern is addressed by the Record of Decision. During preparation of the FS, comparisons of RI/FS data to the Sediment Standards clearly indicated locations which failed the Sediment Standards (including most areas significantly above the chemical standards), but three biological test results were necessary to document that samples met the Sediment Standards. Since RI/FS data lacked this level of completeness, EPA elected to interpret the RI data and other studies to estimate preliminary areas likely to meet the Sediment Standards as a basis for cost estimates. The selected remedy calls for additional biological testing in areas where complete data is unavailable or cleanup of areas of the harbor based on chemical data only.
>
> EPA considers the Sediment Standards to be protective of the environment. The Standards are based on extensive data from Puget Sound. If future studies of Puget Sound indicate evidence of significant subchronic effects from levels of contamination below the Sediment Standards, the Standards could be adjusted. The CERCLA five-year review will provide an opportunity to evaluate whether the ROD is protective of human health and the environment.

3.3.3

Comment: *Contaminant concentrations in fish do not correlate with sediment concentrations. How are they be expected to respond to sediment remediation, and what will happen if no improvements are observed?*

Response: Although it is difficult to develop sediment cleanup objectives to achieve specific reductions in fish and shellfish tissue contamination, overall reductions of contamination in the environment is likely to have a positive effect on seafood contamination. The selected remedy requires monitoring of seafood contamination for comparison of measured concentrations with "indicator concentrations" associated with EPA levels of concern for human health risk. The monitoring will be used in decisions regarding the existing shellfish advisory, which addresses both chemical and bacterial contamination. The results will also be considered during the CERCLA 5-year review required at the site.

3.3.4
***Comment:** Mercury in Eagle Harbor may be adversely impacting Department of the Interior trust resources, such as waterfowl, shorebirds, and salmon.*

Response: At this time, EPA is unaware of direct evidence indicating impacts on these species. Because these animals are higher on the food chain, it is expected that if adverse effects are occurring, these effects will diminish as their food sources become less contaminated following sediment cleanup.

3.4. Source Control

3.4.1. Source Identification

3.4.1.1
Comment: The source of PAH in the northshore area seems to be rather vague. As stated on p. ES-25, the source appears to be released from the application of creosote by the Department of Transportation at the ferry terminal. However, in the FS Appendix (p. B5-12, 13), it is speculated that the former northshore shipyard could have been a significant contributor to the PAH contribution. Elsewhere (p.2-16) the former shipyard is presented as a known creosote source. Previous comments on the Draft FS requested that EPA provide specific historical documentation or other evidence of actual PAH releases to support this contention. Please specify what information EPA is relying upon for these conclusions.

> **Response:** Information on the historical sources of PAH to the harbor was supplied in the RI (see citations for Table 1-3, page 1-32) and in the *Technical Memorandum 5, Task 2, Source Identification*, CH2M HILL, July 5, 1990. Appendix B5 of the FS summarizes this document. Additional information on the PAH sources for the northshore area comes from activities reported to have taken place at the former shipyard (*Historical Assessment of Commercial and Industrial Activity, Eagle Harbor, Bainbridge Island, Washington*, Ecology and Environment, 1984; *Preliminary Investigation, Eagle Harbor, Washington*, Tetra Tech, 1986).

3.4.1.2
Comment: EPA has expressed contradictory opinions on the possibility of continuing migration of mercury from an adjacent upland area into the intertidal mercury hot spot and has suggested additional investigation of this possible source of contamination during remedial design. If EPA has specific information indicating this or other current upland sources, it should so state.

> **Response:** The upland area may be a secondary source of pollution, primarily due to residual contamination related to discontinued shipyard practices. Before proceeding with remediation, EPA needs to confirm that surface water runoff and other pathways for release from this area do not pose a threat of sediment recontamination.

3.4.2. Status of Wyckoff Facility

3.4.2.1
Comment: Commenters have expressed concern that efforts to achieve source control at the former wood treating facility have not been fully successful and that separation of the harbor and facility into operable units has created an artificial distinction. Cleanup of the harbor may be premature, because a full understanding of the extent of on-going contamination from the facility to the harbor is not known. Ecology has indicated that a 50% chance of recontamination would be unacceptable.

Response: EPA recognizes that efforts to control the source of PAH contamination from the Wyckoff facility have not been fully successful. However, concerns about the potential for deep transport of PAH were largely allayed by deep coring, geophysical testing, and sampling in the hotspot area in 1989. EPA issued a unilateral order in June 1991 to accelerate source control efforts at the facility, and believes that removal of buried sludges and continuation of groundwater and oil extraction at higher rates will effect control of the dissolved and floating contamination in time. EPA is currently excavating large quantities of contaminated sludge from the facility. EPA is also planning an RI/FS for the facility to address remaining soil and groundwater contamination.

EPA concurs that a thorough evaluation of the potential for recontamination of the PAH hotspot in the East Harbor OU will be important before cleanup plans are implemented. By conducting an investigation of potential deep sources of PAH to the East Harbor during Remedial Design, EPA expects to resolve the remaining uncertainties and remediate areas where continuing sources will not recontaminate.

3.4.3. Potential Recontamination

3.4.3.1
Comment: The potential for recontamination to occur from secondary sources that may not be adequately controlled should be evaluated before proceeding with the cleanup plan. Is there any way that activity at the Wyckoff site can be accelerated to permit a coordinated cleanup effort for the entire site?

Response: The subsurface contamination in the Wyckoff Operable Unit is being addressed separately. Evaluation of possible contaminant transport from Wyckoff to Eagle Harbor has been planned. Additional sampling of sediments north of Wyckoff will be conducted during the Remedial Design Phase for the East Harbor OU. Remedial efforts at the different OUs will be coordinated.

3.4.3.2
Comment: There appears to be an error on page B-15 of the FS. which reads: "...it appears that the wood-treating facility and northshore shipyard could be significant sources of the PAH contamination in the harbor. ...it appears that the latter facility represents the major source of the PAH contamination"

Response: Correction noted. The reference to the "latter facility" is an editorial error. The second sentence should read: "...it appears that the former wood treating facility represents the major source of PAH contamination."

3.4.3.3
Comment: PAH-contaminated seeps are visible in intertidal areas near Wyckoff and subsurface migration of Dense Non-Aqueous Phase Liquids (DNAPL) has not yet been ruled out as a potential source of contaminants to the central harbor. Why isn't groundwater considered a media of concern?

Response: Groundwater is a medium of concern at the Wyckoff Operable Unit. Transport of groundwater into the harbor was considered in the RI/FS for Eagle Harbor, and a subsurface hydrology study was performed to address this issue (*Technical Memorandum 7, March 7, 1990*). Although groundwater enters the harbor, dissolved contamination does not appear to be a major source for sediment contamination. Transport of DNAPL to the PAH hotspot north of the Wyckoff facility is not likely; however, EPA expects to investigate the potential for sediment recontamination from subsurface transport as part of the selected remedy for the East Harbor. Groundwater contamination and migration will be fully evaluated during the Wyckoff RI/FS.

3.4.3.4

***Comment** The mercury hotspot should not be excavated. Removal of the mercury hotspot, particularly in areas below the high water line, could disturb the sediment and risk contaminating surrounding areas.*

Response: Releases of mercury may occur during dredging or excavation of the hotspot. However, during remedial design, methods for minimizing such releases will be evaluated and employed during remedial action. Removal of this concentrated area of mercury contamination is expected to provide significant long-term benefits relative to in-place confinement or treatment alternatives.

3.4.3.5

***Comment:** The Record of Decision should specify actions to be taken by EPA and Ecology to control sources of contamination. The FS mentions that recontamination may occur, but does not discuss costs.*

Response: Discussions in the FS about potential recontamination primarily emphasized East Harbor areas, which may be affected by continuing contaminant sources at the Wyckoff OU. Costs of "re-remediation" were not specified because it is EPA's intention to avoid recontamination. The uncertainty in estimating areas which might be recontaminated after cleanup also prevents accurate estimates of the potential cost of remedy failure.

EPA intends to address concerns about potential recontamination in the East Harbor by addressing the heavily contaminated sediments in the central harbor with an interim cleanup decision. Additional source investigation will be completed to confirm that significant sources to these sediments are adequately controlled. A decision for remaining areas of the East Harbor will be addressed when the Wyckoff OU RI/FS or other environmental work have provided the appropriate source information.

For the West Harbor, this question is addressed in Section 10.3 of the Record of Decision. Although EPA has completed an initial evaluation of potential sources in the West Harbor, further evaluation and control of any significant sources will occur during the remedial design phase. Recontamination is not anticipated in the West Harbor.

3.4.3.6

Comment: *The Washington State Department of Transportation has stored treated wood in areas of the former shipyard. The FS does not describe how these recent or current sources in the north shore area will be evaluated and controlled before sediment remediation.*

Response: The West Harbor selected remedy indicates that additional source evaluation will be conducted during remedial design to determine efforts needed to control any significant sources. The source evaluation will address concerns about runoff from contaminated upland areas, including the former shipyard area.

3.5. Natural Recovery: Modeling and Estimates

3.5.1

[NOTE: Comments on EPA's evaluation of natural recovery were submitted by numerous commenters. EPA has chosen to respond at length to the detailed comments provided by the Washington State Department of Transportation (WSDOT), as other comments tended to be more general. Included with the letter of comment were the results of WSDOT's evaluation of natural recovery. The results suggested that natural recovery would occur in most subtidal areas of the West Harbor.]

Comment: EPA's assessment of natural recovery in the RI/FS should not be relied on for the following reasons:

1. *It did not consider direct measurements of sedimentation (e.g., sediment trap data collected by WSDOT).*
2. *It relied on a watershed runoff model.*
3. *It neglected the importance of mixing and diffusion.*
4. *The procedures used were not consistent with procedures recommended in the Sediment Standards.*
5. *It did not consider resuspension.*

The results of the model used by WSDOT to predict natural recovery in Eagle Harbor (Officer and Lynch, 1989) were provided in a comment letter and attachments.

Response: EPA's response addresses the numbered items, then provides comparisons between EPA's and WSDOT's natural recovery analyses.

1. As **direct measures of sedimentation,** the sediment trap data collected by WSDOT could indicate a gross sedimentation rate for Eagle Harbor. However, results from three traps in this shallow embayment with known localized sources of artificially-induced resuspension (e.g., ferry prop wash) are not considered accurate enough to predict average or local sedimentation rates under the conditions that prevail in Eagle Harbor. The WSDOT data are questionable for the following reasons:

    a. The gross sedimentation rates proposed are higher than rates observed in both Elliott Bay and Commencement Bay (Patmont and Crecelius, 1991), both embayments with substantially higher inputs of sediment from large river systems than occurs in Eagle Harbor.

    b. Local variations in the effect of ferry prop wash on rates of resuspension are likely to be extreme.

    c. The sediment traps sample a group of particulates that is not very representative of the bulk of the suspended particulates in terms of physical properties, because they consist primarily of biologically aggregated particulates rather than finely divided inorganic and organic particles.

2. EPA used the **watershed runoff evaluation** along with estimates of shoreline erosion to estimate the magnitude of new sediment sources to Eagle Harbor. The estimates of sedimentation rates were based on an evaluation of the potential sources in comparison with measured current speeds to determine what size and amount of sediment might be accumulating in Eagle Harbor (RI, Appendix B). The estimates of net sedimentation rates and depth of mixed sediment in Eagle Harbor proposed by Hart Crowser for WSDOT (March 15, 1989) were evaluated in technical memorandum 4 (EPA, December 5, 1989). It was concluded that the lead-210 data could be used to assess historical sedimentation rates, but did not adequately measure mixing depth or present sedimentation rates.

3. **Mixing and diffusion** were considered in EPA's assessment of natural recovery. In all of the models suggested by WSDOT, mixing is represented as a diffusion rate expressed throughout a sediment layer. In EPA's evaluation, a simplifying assumption was made that mixing with the biologically active zone was complete in less than 1 year. The term diffusion has also been applied to the process of advection of sediment to the water column, and subsequent movement out of Eagle Harbor. That process too was assessed, based on rates discussed and accepted by the Technical Discussion Group Natural Recovery Subgroup. WSDOT now proposes a much larger advection term (about 25 times larger). A more detailed evaluation of the specific assumptions of the WSDOT model are discussed below in response to Item 5, above.

4. The **procedures for evaluating natural recovery** used by EPA were simpler approximations of the procedures used in three models used previously in Puget Sound: SEDCAM, Core Mix, and WASP 4. They provided a relatively inexpensive way to evaluate natural recovery and were consistent in complexity with the input data that were and are available. The results were reviewed and accepted by the State Department of Ecology.

   A significant risk of relying on any of the models proposed (and used) by WSDOT is the underlying assumption that exchange between the surface mixed layer and the (often) more contaminated deep (i.e. below 10 cm.) layers is zero. Some exchange between the deeper sediment and the surface mixed layer is likely, but cannot be quantified. Two mechanisms of exchange, diffusion and upward flow of liquid contaminants, are discussed in Appendix D-3 of the FS with regard to PAH. Mercury does not occur as free liquid, but organic mercury is very likely to be associated with materials that are more diffusive than the organic compounds discussed in the FS.

   An alternative hypothesis to the model proposed by WSDOT is that the concentrations in the mixed layer represent a (short-term) equilibrium between upward diffusion and mixing from the deep sediments and balancing advection out of Eagle Harbor.

5. **Resuspension** was included in EPA's analysis of natural recovery (presented in Appendix D-1 of the FS). The rates of resuspension and advection out of Eagle Harbor were lower than those proposed by WSDOT in their comments and in Attachment A to their comments of February 25, 1992.

There are some inconsistencies between the assumed conditions in the WSDOT analysis and available evidence from Eagle Harbor. The WSDOT conditions (input variables) are compared with EPA conditions below.

Net sediment accumulation (v):

> 0.001 gm/cm^2-yr assumed by WSDOT. The EPA analysis considered a range of 0.0027 to 0.018 gm/cm^2-yr.

Advective exchange (V):

> 0.7 gm/cm^2-yr used by WSDOT. The EPA analysis used an equivalent, but much smaller, term of 0.021 mg/cm^2-yr. WSDOT's value was based on the sediment trap data discussed above, and a presumed (and reasonable) fraction of resuspended sediment that might be washed out of Eagle Harbor. The value of V assumed by WSDOT appears to exceed the supply of suspended sediment passing through Eagle Harbor (FS, Appendix D-1). Note that if the concentration of suspended solids in Eagle Harbor is about 3 mg/l (rather than the 1 mg/l assumed by EPA) and if all the particulates were advected out of Eagle Harbor, a value of $V=0.7$ gm/cm^2-yr would be possible. With a 50 percent advection as assumed by WSDOT, the particulate concentration in Eagle Harbor would have to be about 6 mg/l, about twice the highest value reported by Baker (1984) for central Puget Sound.

Diffusion or mixing coefficient (D):

> 0.7 gm^2/cm^4-yr used by WSDOT. The EPA analysis assumed a higher D, in excess of 1, so that mixing in the upper 10 cm of sediment would be complete in 1 year. D-0.7 gm/cm^4-yr is reasonable and supported by the literature. However, small changes in this constant do not significantly affect calculated concentrations after 10 years of mixing.

Mass of sediment accumulated in the mixed depth (d):

> 2.0 gm/cm^2 used by WSDOT. The EPA analysis used values of 5.4 to 7.4 gm/cm^2 for this term, values characteristic of the upper 2 to 10 cm of sediment in Eagle Harbor. The value used by WSDOT appears to be based on a shallower assumed mixing depth (4 cm) (Patmont and Crecelius, 1991) and a very low porosity. This value is inconsistent with values for other parts of Puget Sound (Romberg, et al., 1984) and observed in Eagle Harbor (Hart-Crowser, March 1989).
>
> Changes in estimated half-lives of contaminants in Eagle Harbor are roughly proportional to changes in the value of d if all other model inputs remain constant. Therefore, increasing d five-fold would increase half lives approximately five-fold. With an even deeper mixing zone of 15 to 20 cm, which occurs in parts of western Eagle Harbor (Weston, 1990), values of d could approach or exceed 15 gm/cm^2, and contaminant half-lives would be even longer.

3.5.2

Comment: Provide references for studies showing rapid natural degradation of PAH.

Response: The following review article provides an entry to the relevant studies of this issue: Payne, J.R., and C.R. Phillips. Photochemistry of petroleum in water. *Environmental Science and Technology*, 19:569-579. 1985. This article provides a number of other references.

3.5.3

Comment: EPA should be open to the further assessment of natural recovery at the Eagle Harbor site during the remedial design phase.

Response: The selected remedy for the certain areas of the West Harbor identifies natural recovery as the selected remedy if additional mathematical modeling indicates that the Sediment Standards MCUL can be achieved within 10 years. It must be emphasized, however, that modeling relies on assumptions about environmental characteristics when site-specific data are unavailable. EPA will evaluate the assumptions and modeling methods used before approving natural recovery as a means of achieving the site cleanup objectives in these areas.

3.6. Cleanup Alternatives and Areas

NOTE: Although this responsiveness summary is an attachment to the West Harbor OU ROD, it is structured to address comments on all actions described in the proposed plan.

This section is divided into five sub-sections corresponding to the specific areas of the harbor referred to by commenters;

General and/or Harbor-wide Comments
West Harbor Mercury Hot Spot,
West Harbor Intertidal HPAH Area,
West Harbor MCUL Areas and,
East Harbor Subtidal PAH Areas
(including the PAH Hot Spot).

This structure is intended to allow people with concerns about specific areas to locate the paraphrased comments and EPA responses.

*In some cases, comments applied to more than one area. Most such comments are addressed under the section **General and/or Harbor-wide Comments**. The last section, which pertains specifically to the East Harbor OU, is reserved. Comments on the East Harbor Subtidal Areas will be addressed in this section as an attachment to the East Harbor Record of Decision.*

3.6.1. General and/or Harbor-wide Comments

3.6.1.1
Comment: *The RI/FS did not provide enough information to select a preferred alternative.*

> **Response:** EPA believes that the RI, supplemental RI documents, the FS and other documents in the Administrative Record present enough information to justify action, to select a remedy, and to define cleanup areas according to the Sediment Standards. In following the Sediment Standards, however, the selected remedy relied on chemical information, while the FS used biological information from the RI/FS to estimate approximate areas failing the Sediment Standards biological criteria. Further biological testing to refine areas failing the biological criteria is an optional step in the remedial design phase.

3.6.1.2
Comment: *EPA should consider using alternatives that do not interfere with human activities in the West Harbor and that pose little or no threat to the intertidal and subtidal environments. The use of a combination of Alternative A (No Action), Alternative M (In Situ Treatment by Solidification), and Alternative N (Low Impact Capping) is recommended.*

> **Response:** No action is always considered as a basis for comparison, but is not a viable option throughout Eagle Harbor because of it does not protect human health or the environment. In areas which are predicted to achieve the Sediment Standards MCUL in 10 years, no action may be used if supplemented by institutional controls (Alternative B) for protection of human health. Alternative B and Alternative N (Low-Impact Capping/Thin Layer Placement) are components of the selected remedy.
>
> Alternative M (*In Situ* Treatment by Solidification) was considered for the mercury hotspot, but because this method has not been tested in an intertidal environment, and treatment would leave a large, solidified mass in the intertidal area, it was not identified as a component of the selected remedy.

3.6.1.3
Comment: *EPA should consider the use of Low-Impact Capping (Alternative B) throughout the harbor.*

> **Response:** EPA has considered using this alternative throughout the harbor, but believes it is most appropriate in areas of marginal contamination, moderate to low currents, and biological effects which are not severe.

3.6.1.4

***Comment:** In evaluating capping materials, the ability to support benthic organisms should be considered. The use of one size of substrate throughout the harbor could result in a "monoculture" and limit ecological diversity in restored habitats.*

Response: The selection of materials during remedial design will consider the need for graded materials. Use of poorly graded material throughout Eagle Harbor is not technically appropriate: Capping materials in areas of high currents or ferry propeller influence would need to be larger, while capping in the vicinity of the ship yard may be sand sized. Cap design will consider the need to establish appropriate habitats.

3.6.1.5

***Comment:** Figure 3-2a in the FS shows the unconfined disposal options as not being carried forward for alternatives development. This does not agree with the right-hand column in Table 3-1a of the FS.*

Response: Table 3-1a incorrectly indicates that unconfined disposal for intertidal sediments (mercury) was carried forward. This process option was in fact eliminated from further consideration. Figure 3-2a is correct.

3.6.1.6

***Comment:** Consideration of remedial alternatives in the FS must take into account anticipated waste volumes.*

Response: Volume estimates were used in the FS to develop cost estimates and to evaluate alternatives. Differences in sediment volume can affect unit costs, particularly when volumes are small. However, the difference between the approximate cleanup areas estimated in the FS and areas failing the MCUL chemical criterion does not significantly alter the comparison among alternatives, because both volumes are quite large.

In the preferred alternative for the West Harbor, removal of sediments was proposed for the mercury hotspot, and a range of anticipated volumes was provided based on available data. In the selected remedy, the need for waste characterization and determination of actual volumes to be excavated is identified.

3.6.1.7

***Comment:** Were costs to pre-densify sediments to prevent the cap from subsiding into the underlying sediments included in the cost estimates?*

Response: No. This concern is most relevant to the East Harbor OU PAH hotspot. Pre-densification may be further evaluated in remedial design, but the FS assumed that sediments will not be pre-densified. In the PAH hotspot area, predensification could potentially release free creosote product into the water column. Most subtidal sediments in the West Harbor are not expected to need pre-densification, particularly areas of thin-layer sediment placement.

3.6.1.8

Comment: When does EPA plan to address the following concerns?

- *How will cap be designed to withstand erosive forces generated by ferry propeller wash?*
- *Will compression due to weight of overlying cap material force PAH out along the edge of the cap?*
- *Will pilot tests be used to evaluate potential design options?*
- *Will geotextile material be used to prevent the cap from subsiding into the underlying contaminated sediments?*
- *Where will the cap material come from and what criteria will be used to determine that the cap material is clean?*
- *How will EPA evaluate dredge placement procedures?*

Response: These concerns will largely be addressed during the remedial design phase, which follows issuance of the Record of Decision. Based on the RI/FS, EPA anticipates the following: Large-grained materials will probably be used to prevent erosion of the cap due to ferry wash or currents; placement of materials will be designed to minimize the release of PAH due to compression; EPA does not expect that geotextile materials will be used under the cap. Sediment sources from existing dredge projects are likely to be used, and materials will be analysed to ensure that, at a minimum, they meet the SQS chemical criteria and PSDDA requirements. Currently available methods will be used to evaluate placement.

EPA will require that the remedy be designed to minimize short-term effects and to provide an effective cap for the contaminated sediments. Decisions on many of the issues raised will await the Remedial Design.

3.6.1.9

Comment: EPA should consider mitigation for potential adverse impacts to habitats as result of sediment remedial activity.

Response: Although short-term impacts to habitats may result from sediment remediation, the cleanup will be occurring in areas already adversely affected by contamination. The harbor environment will be significantly enhanced over the long term. Mitigation of eel-grass was included in the FS cost estimates where appropriate and will be required if eel-grass beds are damaged as a result of remediation. Remedial design will include determination of the need for this and any other mitigation.

3.6.1.10
Comment: EPA did not carry forward soil washing for certain wastes. What is the basis for eliminating soil washing?

Response: Some comments on the draft FS favored detailed evaluation of soil washing. The FS indicated that this alternative would not be effective for sediments containing paint chips, such as sediments near the former shipyard. Although potentially feasible for PAH-contaminated sediments, variations in sediment grain size and clay content in areas of the harbor would make consistent performance unlikely. This method has not been tested on marine sediments, and since other reliable treatment options for PAH-contaminated sediments were being evaluated soil-washing was not carried forward.

3.6.1.11
Comment: Alternatives that leave contaminants on state-owned aquatic lands could raise issues of future liability.

Response: (Refer to Response under 3.1.3.5.)

3.6.2 West Harbor Mercury Hot Spot

3.6.2.1. General Comments

3.6.2.1.1
Comment: Removing the contaminated intertidal mercury sediments could resuspend contaminated sediments and increase areas failing the Sediment Standards.

> **Response:** Contaminant resuspension is a concern for sediment removal, as well as for capping, in any of the cleanup areas. However, EPA believes that removal of the mercury hotspot is the most appropriate way to address this potential long-term source of mercury. Available methods of controlling or minimizing resuspension will be considered during the remedial design phase. Approaches include timing the removal to coincide with low tides, erecting silt curtains or other temporary barriers, and using removal methods that minimize disturbance.

3.6.2.1.2
Comment: We are disturbed by the following statement in the executive summary of the FS: "in general, the ranking of the alternatives was not changed by the size of the areas or the quantity of sediment involved." EPA should explain this statement.

> **Response:** The comment concerns an observation in the executive summary of the FS. Although alternatives were compared for each FS problem area (e.g. intertidal mercury, subtidal PAH) using the two threshold and five balancing criteria, between different areas the same relative ranking generally applied. For example, a given alternative was generally more cost-effective than another, or was no less implementable than another, regardless of the size of the problem area considered.

3.6.2.1.3
Comment: In the FS, EPA recommended that bioassays be conducted in areas of mercury-contamination to determine whether, in fact, remedial action is necessary. Limited testing will support a substantial reduction of the level of remedial action for mercury contaminated sediments.

> **Comment:** According to the Sediment Standards, if an absence of adverse biological effects can be documented, sediment cleanup is not required. However, as indicated in the proposed plan and selected remedy, certain areas which do not meet EPA's supplemental objectives must be addressed regardless of the outcome of biological testing. The remaining cleanup areas above the MCUL chemical criteria may be reduced if biological data in accordance with the Sediment Standards show that the sediments meet the MCUL biological criteria.

3.6.2.2. Protection of Public Health and the Environment

3.6.2.2.1
Comments: In this area, habitat restoration concerns should be addressed in the selection of capping materials. For example, reestablishment of aquatic vegetation such as eel grass should be considered as part of a cleanup remedy.

> **Response:** EPA recognizes the significance of intertidal habitat and intends to coordinate with the resource agencies and the Suquamish Tribe to address concerns about impacts of remediation and any necessary mitigation (See response 6.9.1.9).

3.6.2.2.2
Comment: We would not recommend implementation of remedial action in any intertidal areas until adverse biological effects are documented and the benefits of the remedy can be shown to outweigh the impacts of remedial action. This area is a good candidate for the Natural Recovery alternative.

> **Comment:** Mercury, the major contaminant of concern in this area, does not degrade, and EPA has not seen evidence to suggest that natural sedimentation would result in recovery to the MCUL within ten years. At comparable levels of contamination, adverse biological effects have always been observed in Puget Sound studies, and may be inferred here. In addition, concerns such as potential biological uptake and redistribution of contaminants from the most highly contaminated areas to other areas should be addressed. Thus, where mercury concentrations exceed the EPA supplemental objectives related to predicted biological effects, resuspension, and biological uptake (See ROD, Section 10), EPA believes that active remediation is necessary.

3.6.2.3. Feasibility & Permanence of Options

3.6.2.3.2
Comment: Can an intertidal cap provide long term protection when exposed to possible degradation from wind and wave action?

> **Response:** Concern over this issue supports EPA's selection of removal for the most highly mercury-contaminated sediments. EPA believes capping less contaminated intertidal sediments in the West Harbor can provide long-term protection, because slopes and currents are moderate. Careful design, selection of the appropriate sediment size for capping materials, and periodic monitoring of the cap thickness to determine maintenance needs is important to ensure long-term protection.

3.6.2.4. Removal and Disposal

3.6.2.4.1
Comment: Given the availability of treatment options and the CERCLA preference for on-site remedies over transport and disposal without treatment, it is unclear why removal and upland disposal is the preferred alternative for the mercury hotspot.

Response: The treatment options evaluated were limited to solidification/stabilization technologies. While such treatment may be necessary for hotspot sediments after excavation, solidification/stabilization in the marine environment has not been tested on contaminated intertidal sediments, would leave contaminants in the marine environment, and would create a solidified mass requiring habitat mitigation with a sediment cover. Removal of the mercury hotspot will eliminate a potential continuing source of mercury to the marine environment.

Many commenters clearly supported excavation of the hotspot sediments, particularly if a disposal site could be arranged on the former shipyard property. The selected remedy allows consideration of on-site and off-site locations, depending on the characteristics of the excavated materials. These characteristics will be evaluated during the remedial design phase.

3.6.2.4.2

Comment: EPA should consider refining the removal and upland disposal alternative to allow for the option of solidifying sediments (if necessary to control leaching) and nearby upland disposal. Soils removed to create a disposal site could be used for the cap, if they are clean.

Response: Removal, solidification if necessary, and on-site upland disposal is the selected remedy for mercury hotspot sediments under certain circumstances described in the West Harbor ROD. If soils excavated to create an upland disposal area are clean, they may be appropriate for use in capping the disposal site.

3.6.2.4.3

Comment: The FS states: "For purposes of the FS, it is assumed that the intertidal mercury sediments pass the TCLP and are a state-only dangerous waste." If the TCLP limit is not exceeded (0.2 mg/L mercury in extract), why would sediments still be a DW?

Response: Failure of the TCLP makes the waste both a RCRA hazardous waste and a state dangerous waste (DW/HW). Failure of any of the other dangerous waste criteria identified in the State of Washington Dangerous Waste Regulations (WAC 173-303), such as the toxicity criteria, could cause the waste to be designated a Washington State dangerous waste (state-only DW).

3.6.2.4.4

Comment: The FS states : "From the detailed evaluation, it appears that any of the active remedial alternatives identified for mercury-contaminated intertidal sediments could be used to achieve the RAOs." If this is true, then isn't it logical to select the least-cost rather than the highest-cost alternative of removal and upland disposal at an off-site hazardous waste landfill?

Response: Cost is one of five balancing criteria used to compare alternatives which meet the two threshold criteria (Section 9, West Harbor ROD). The preferred alternative proposed the removal and appropriate disposal of sediments from the mercury hot spot. This approach was intended to eliminate a continuing source of mercury to the harbor and, as such, a potential threat to human health and the marine environment. It was favored over remedial alternatives which would leave the highly contaminated mercury hotspot in the marine environment. The West Harbor selected remedy clarifies what disposal methods (upland on-site, off-site, or at a hazardous waste landfill) are appropriate given the characteristics of the excavated sediments.

3.6.2.4.5
Comment: *Solidification and stabilization performed on-site would most likely be more effective than the "fixation" processes used by off-site landfills. Common landfill practices include application of kiln dusts. Fixation technologies used on site would most likely be more rigorous and controlled.*

Response: As specified in the ROD, any necessary solidification/stabilization of excavated mercury hotspot sediments could be done on site or at a landfill. In either case, stringent performance criteria would be specified.

3.6.2.5. Cost & Volume/Area Estimates

3.6.2.5.1
Comment: *It may be possible to dramatically reduce the volume of mercury hot spot sediments to be removed. Combining a removal of 11 cm of contaminated sediment over the hot spot area with deposition of an equal amount of fill to restore contours would eliminate the pathway of concern. This would also limit the damage to the harbor as a whole.*

Comment: As a practical matter, removal of 11 cm (about 4.5 inches) of sediment may be technically difficult using heavy machinery. In addition, EPA considers the removal of 11 cm of the hotspot to be inadequate to ensure source control. Restoration of existing contours is an important consideration which will be addressed after removal of sediments above EPA's criterion of 5 mg/kg dry weight.

3.6.2.5.2
Comment: *EPA's estimate of the volume of sediments exceeding 5 mg/kg mercury (1,000 to 7,000 cubic meters (m^3) is high. Sediment sample collection and analysis performed by WSDOT in this area indicate a hot-spot volume range of approximately 500 to 2,000 m^3.*

Response: EPA reviewed chemical data obtained by WSDOT in soils and sediments at the former shipyard but relied primarily on quality-assured RI/FS data to defining the hot spot. The EPA estimates of 1,000 to 7,000 m^3 provide a conservative range of costs for removal. Sampling during remedial design may reveal smaller volumes than estimated by EPA.

3.6.2.6. Cost Effectiveness

3.6.2.6.1
Comment: *The FS general cost ratings (relatively low, moderate, and relatively high, shown in Table 3-1a) for process options in the intertidal mercury area are questionable for confined and unconfined disposal. Even if unconfined disposal requires sediment treatment, treatment costs should not be*

included in the overall cost rating. Relative to unconfined disposal, confined disposal typically has higher design and implementation costs.

Response: The comment is reasonable. However, the table cited above was used for screening process options prior to developing alternatives. Both confined and unconfined disposal were carried forward as alternatives or as components of alternatives. The relative costs shown in the table did not influence the screening of alternatives or the comparative evaluation of remedial alternatives which follow.

3.6.2.6.2

Comment: *Table 5-1 of the FS lists the respective costs for Nearshore Confined Disposal (Alternative E), Upland RCRA Disposal (Alternative G), and Solidification/Stabilization and Disposal (Alternative I) as "low", "high", and "moderate". However, the FS figure which summarizes the comparative evaluation (ES-7) indicates that the costs for these three alternatives compare unfavorably with most other alternatives. Based on Figure ES-7, Alternative M (In Situ Solidification/Stabilization) should be equally or more favorably ranked overall relative to Alternatives E, G, and I.*

Response: The +, -, and o symbols in the summary table in the FS (ES-7) were not the exclusive basis for developing the preferred alternative. The basis for selecting removal and appropriate disposal for the mercury hot spot sediments is described in the West Harbor ROD and in the response to comment 3.6.2.4.4. It is noted that Table 5-1 should indicate a cost rating of "high" for Alternative E.

3.6.3. West Harbor Intertidal Areas

3.6.3.1. General Comments

3.6.3.1.1
Comment: The US Fish and Wildlife Service (USFWS) recommends removal of intertidal sediments containing greater than the mercury MCUL (0.59 mg/kg dry weight) and replacement with clean substrate of similar composition.

> **Response:** The selected remedy includes removal of sediments containing 5 mg/kg (dry weight) mercury or above and replacement with clean substrate. However, other intertidal sediments above the MCUL are to be capped. Any mitigation necessary to address loss of intertidal habitat will be planned during the remedial design phase.

3.6.3.2. Protection of Public Health and the Environment

3.6.3.2.1
Comment: Capping may alter the habitat type and value of the intertidal zone by changing the substrate elevation, especially if a 3-foot cap is used. Because of this, the removal and disposal option is preferred.

> **Response:** A 3-foot thick cap in the intertidal area would elevate the contours of the intertidal substrate, shifting the intertidal zone somewhat waterward from its current location, and some loss of subtidal/intertidal transition zone habitat may result. This may be less of a concern for a thinner cap. The selected remedy is intended to be flexible, providing responses appropriate for levels of contamination and biological impact. As stated above, any mitigation requirements will be incorporated during the remedial design phase.

3.6.3.3. Feasibility & Permanence of Options

3.6.3.3.1
Comment: The long-term effectiveness of capping the remaining intertidal sediments that exceed the sediment management standard for mercury is questioned. An erosion and sediment transport analysis of the intertidal zone should be conducted to develop design criteria for cap construction. Leachability of confined materials should also be considered. Can a low-impact cap be constructed in an intertidal zone where it would be subject to degradation by wind and wave action?

> **Comment:** These issues were considered during the evaluation of sediment capping technologies. Based on the RI/FS and the 1992 COE evaluation, EPA believes that capping or thin-layer placement (previously called low-impact capping) is feasible in certain subtidal and intertidal areas and can be effective long term. Design criteria and a monitoring plan will be developed in the remedial design phase.

3.6.3.4. Cost & Volume/Area Estimates

3.6.3.4.1

Comment: *It is still not clear how the 90th percentile value from reference area data (1,200 ug/kg dry weight) was selected as the objective for PAH-contaminated intertidal sediments. Why was the 90th percentile selected instead of an 80th or 95th percentile? How does the 90th percentile reference area concentration for mercury compare to the SQS (0.41 mg/kg dry weight) and the MCUL (0.59 mg/kg dry weight).*

Response: It should be noted that, although EPA is using the 90th percentile HPAH value as a means of defining a problem area, the sediment cleanup objective which must be met within ten years of source control in this area is the MCUL chemical criteria for any PAH.

The selection of the 90th percentile of the reference area data for HPAH as the means of defining the extent of the problem area for remediation of intertidal sediments was based on performance standards being developed at the time (*Interim Performance Standards for Puget Sound Reference Areas*, PTI, 1989). The Washington State Department of Ecology recommended the use of this value at the time the decision was made. The FS notes that areas defined on the basis of this value are similar to those defined by the Sediment Standards (FS Figure 2-13).

For comparison to the Sediment Standards chemical criteria, PAH values must be normalized to total organic carbon (TOC) in the sediment (i.e., PAH concentrations in mg/kg dry weight must be divided by the percent TOC expressed as a fraction). TOC in sediments can vary widely in sediments, and, in an active beach environment, may be very low. Normalizing PAH data to TOC in this case may result in values that exceed the MCUL when 90th percentile reference values are not exceeded.

The 90th percentile reference concentration for mercury is 0.19 mg/kg DW (PTI, 1989), lower than both the MCUL and the SQS for mercury.

3.6.3.5. Cost Effectiveness

(No direct comments. See Section 3.6.3.4.)

3.6.4. West Harbor Subtidal Area

3.6.4.1. General Comments

3.6.4.1.1
Comment: Capping is acceptable in the subtidal zone beyond -10 feet mean lower low water (MLLW). Above -10 feet MLLW, removal options should be employed.

Response: The selected remedy requires removal in some areas above -10 feet MLLW, but these areas are determined on the basis of chemical concentrations. Sediments below these concentrations are to be addressed with capping, thin layer placement, or natural recovery as appropriate. Concerns about loss of intertidal habitat will be addressed through appropriate design and/or habitat mitigation.

3.6.4.2. Protection of Public Health and the Environment

3.6.4.2.1
Comment: No action is recommended for West Harbor subtidal sediments. A healthy, diverse, and abundant biological community inhabits the area, and a cap is not only unnecessary but could cause ecological damage. A cap in the West Harbor area is opposed.

Response: EPA agrees that, as indicated by the Sediment Standards, remediation is not necessary where it can be shown that the benthic community is not adversely affected and sediments are not toxic, provided other concerns such as potential sediment resuspension or biological uptake through the food chain are addressed. The selected remedy for the West Harbor includes EPA's supplemental objectives to address such concerns. In most subtidal areas of the West Harbor the remedy allows the modification or elimination of cleanup actions based on the results of biological testing.

3.6.4.2.2
Comment: Capping of large areas of the harbor seems excessive and could severely damage a healthy, diverse and abundant biological community.

Response: Available data indicate that a healthy benthic community may be present in much of the West Harbor. However, the sediments contain contaminants above the Sediment Standards MCUL, a concentration above which adverse effects are shown to occur in Puget Sound studies. Bioaccumulation and potential resuspension are also of concern to EPA. To indicate that the expected biological effects are not occurring, the State Standards biological criteria must be met for two acute bioassays and one chronic biological effects test. These tests may be run during remedial design to refine cleanup areas and requirements.

3.6.4.2.3
Comment: Capping is inappropriate because of the high cost and documented ecological damage associated with capping large aquatic areas.

Response: Any active remediation of a large area is likely to have impacts on the harbor. However, capping is one of the least costly alternatives available for managing contaminated sediments, and it provides a clean substrate for benthic organisms to recolonize. Studies of sediment caps show that benthic recolonization occurs fairly readily, although the larger the cap is, the greater the short-term impacts are expected to be. To address concerns about capping large areas of the harbor, the selected remedy for most West Harbor subtidal sediments is thin-layer placement. Thin-layer placement is expected to have less impact than other remedies on the existing benthic communities.

3.6.4.2.4
Comment: In areas proposed for capping in the West Harbor, biological indicators do not indicate significant effects. Therefore, capping is not justified.

Response: See above. Not all stations that exceed MCULs were tested for biological effects. Where testing was conducted, the data is insufficient to determine compliance with the Sediment Standards. In most areas of the West Harbor, such testing can be done during remedial design to refine cleanup areas, so that only areas with significant effects will be remediated. If no biological testing is done, areas must be defined by chemical concentrations which indicate potential biological effects.

3.6.4.3. Feasibility & Permanence of Options

3.6.4.3.1
Comment: Information in the FS indicates that natural remediation may be occurring. For example, the fish, crab, and clams which were sampled for methylmercury in 1990 did not contain concentrations which were significantly different from background stations, and these concentrations were found to be less than concentrations which were tested for in 1988.

Response: Several analytical methodologies were employed on tissue samples analyzed for mercury during the RI/FS. The differences for different years may result from natural variability and from variability of sampling, analytical methods, and data quality. Longer term data of consistent quality based on consistent methods are necessary before trends of tissue concentration can be observed. Determinations of natural recovery will continue to rely more on sediment concentrations than on tissue concentrations.

3.6.4.3.2
Comment *Explain why natural recovery for subtidal sediments containing metals is not an acceptable alternative. This alternative should not be rejected as a potentially acceptable long-term solution.*

Response: Of the natural processes that can lead to natural recovery of sediments include, some of the most significant are chemical degradation, sedimentation, and sediment mixing. Metals do not chemically degrade, although they can be redistributed in the environment through biological uptake. Mixing of the top sediment layer by benthic organisms can be important for natural recovery if the net effect is to lower concentrations. As for sedimentation, rates of sedimentation in Eagle Harbor are very low, according to EPA estimates (*RI/FS Technical Memorandum 4*, EPA, 1989), because the harbor has no major sediment source such as a river. Thus, for areas of subtidal mercury contamination, natural recovery is expected to occur very slowly.

In areas where mercury concentrations are close to the MCUL, EPA has selected a remedy to enhance natural recovery by adding sediment to the harbor in increments, rather than using a thick sediment cap. The selected remedy also allows further evaluations of natural recovery and modifications of cleanup areas based on biological test results. In any case, cleanup areas must achieve the MCUL in ten years from completion of remedial action.

3.6.4.4. Cost & Volume/Area Estimates

3.6.4.4.1
Comment: Depending on whether EPA's sediment chemistry data or Ecology's sediment chemistry data are used, the Sediment Standards MCUL chemical criterion for mercury may or may not be exceeded in the West Harbor area.

Response: Data collected by EPA in 1984, RI/FS data from 1988, and data collected on behalf of WSDOT show similar levels of mercury contamination. The 1985 Ecology data are generally lower, yet even these data are above background stations and, at one location, exceed the MCUL. EPA believes that the majority of the data support the definition of West Harbor areas above the MCUL chemical criteria shown in the FS and ROD.

3.6.4.5. Cost Effectiveness

(No Direct Comment, See Section 3.6.4.4.)

3.6.5. East Harbor Subtidal Area

[Note: Comments specific to the East Harbor Subtidal Area will be addressed in a Responsiveness Summary accompanying the release of the East Harbor ROD. The remedy for the East Harbor OU will address this area and will be described in a future ROD for the East Harbor OU.]

3.7. Remedial Design and Monitoring

3.7.1. General Comments

3.7.1.1
Comment: *Institutional controls, including public education, should be part of the plan.*

> **Response:** Institutional controls, including efforts to educate the affected community, are part of EPA's selected remedy for both the West Harbor and the East Harbor. EPA will continue to coordinate with the Bremerton-Kitsap County Health District and other health agencies on the continued health advisory and other aspects of the planned institutional controls.

3.7.1.2
Comment: *Contingency plans are lacking in the event that monitoring does not show a decline in PAH concentrations.*

> **Response:** A contingency plan will be developed during the remedial design phase and will consider further action if natural recovery in the intertidal HPAH area is not progressing appropriately. Currently, EPA anticipates that two actions are possible to enhance degradation of PAHs through microbial action and photodegradation (degradation as a result of exposure to light): periodic mechanical mixing of surface sediment and the addition of nutrients for microbes. Effectiveness, short-term environmental concerns and other considerations would be used to determine the appropriate action.

3.7.1.3
Comment: *There is significant uncertainty about major aspects of the remedial action in the West Harbor. For example, the depth and approximate areal extent of the mercury hotspot and the areas which fail the Sediment Standards MCUL biological criteria. Depending upon the results of this information the scope of remedial action could be significantly affected in intertidal and subtidal areas.*

> **Response:** EPA acknowledges the uncertainty, and has designed flexibility into the West Harbor ROD so that the appropriate remedial action is taken where necessary. Further chemical sampling, modeling of natural recovery, and optional biological testing during the remedial design phase can be used to refine actual cleanup areas and required actions, as described in the West Harbor Record of Decision.

3.7.1.4
Comment: *EPA's Proposed Plan for capping is inappropriate because of (a) the likely benefits of natural recovery; (b) the high cost and documented ecological damage associated with capping large aquatic areas; (c) the fact that there may not be exceedances of State Sediment Management Standards; (d) the presence of a healthy, diverse and abundant biological community in the affected areas; and (e) with respect to most sediment bioassay tests, the absence of any increased toxicity relative to clean reference areas.*

Response: The concerns mentioned above are either addressed in the West Harbor OU ROD or are responded to individually in other sections of the responsiveness summary.

3.7.1.5
Comment: *Any additional testing should be consistent with the Sediment Management Standards. Ecology's Sediment Management Unit and Environmental Investigations Laboratory Services should be consulted on proposed sampling methodologies for chemical and biological tests.*

Response: The biological and chemical sampling proposed will conform with requirements of the Sediment Standards. The Puget Sound Protocols will also be considered. EPA will continue coordinating extensively with Ecology and may involve other agencies, parties, or groups with technical resources to discuss remedial design issues as they come up.

3.7.1.6
Comment: *EPA should undertake a single, comprehensive effort to evaluate all past QA/QC problems in order to avoid uncertainty in any future data evaluation efforts. In particular, DNR has concerns about the use of High Performance Liquid Chromatography (HPLC) methods for estimating low levels of Polynuclear Aromatic Hydrocarbons (PAH).*

Response: At this time, no such effort is anticipated for existing data. Data was quality-assured throughout the RI/FS, and the acceptability of the data was discussed at meetings of the Technical Discussion Group and is documented in the site file. This information and available technical resources, including input from DNR, will be considered in planning future data collection activities. (See response 3.7.4.4)

3.7.1.7
Comment: *The remedial designs should have as a clear objective the creation of clean habitat suitable for supporting a natural indigenous population, and the monitoring should be consistent with the demonstration that this objective is met. Habitat characteristics (depth, slope, sediment grain size) of the remediated areas should be compared to the physical attributes of the pre-remediated area to determine if habitat has been restored.*

Response: The site-specific cleanup objectives are described in the selected remedy, and include achieving the MCUL chemical and biological criteria. In addition, some design objectives are mentioned, including the use of clean sediment for capping materials and the consideration of habitat. Detailed design objectives, performance criteria, and monitoring needs will be addressed during remedial design phase.

3.7.1.8
Comment: *The caps should be designed to allow monitoring for vertical/lateral movement of contaminants with core samples. The physical integrity of the cap can be visually monitored using cameras, or by sediment sampling at the perimeter.*

> **Response:** During remedial design, available technical information and resources will be used to develop an appropriate monitoring plan. Visual, physical, and chemical monitoring, as well evaluations of biological conditions needed to address monitoring objectives will be considered at that time.

3.7.2. Timing of Remedial Action

3.7.2.1
Comment: *EPA should consider phasing the remedial design and remedial action portions of the Eagle Harbor cleanup. Phasing remedial design and remedial action will help eliminate uncertainty in the cleanup. One scenario would involve the first phase of negotiations with the PRPs consisting of investigations to define the areas for remediation, remedial design, and appropriate interim or expedited actions. The second phase would start once the remedial design is complete, the second phase of negotiations could start for implementing the design.*

> **Response:** A Remedial Design phase will precede Construction and Implementation. The question of whether there could be separate agreements for the design and implementation phases has not been addressed by the agency or the PRPs.

3.7.2.2
Comment: *EPA should incorporate flexibility into the proposed plan and record of decision to allow consideration of mechanisms for speeding up cleanup of the site.*

> **Response:** EPA would like cleanup to proceed as speedily as possible, and ways to accelerate cleanup actions will be a topic of discussion during negotiations with responsible parties after issuance of the ROD.

3.7.2.3
Comment: *Since the Wyckoff operable unit is not as far along in the RI/FS process, the potential exists for contamination sources from the Wyckoff facility into the East Harbor to continue. Cleanup of the harbor and the Wyckoff facility should be coordinated.*

> **Response:** To the extent that continuing sources of contamination from the Wyckoff facility affect the sediments in the East Harbor, coordination between these operable units is critical. In addition, the timing of East Harbor and West Harbor cleanups could be important in achieving cleanup objectives. EPA recognizes this and intends to maintain appropriate coordination between the units.

3.7.2.4
Comment: Any additional testing needed to define the West Harbor intertidal mercury hot spot remedial area should be performed concurrently with the actual remedial work.

Response: The appropriate timing for testing during remedial design will be evaluated at the beginning of the remedial design phase. Considerations are likely to include the need for information such as sediment volumes, waste characteristics, and treatment needs for planning remedial actions including disposal options.

3.7.3. Impacts on Navigation and Commerce

3.7.3.1
Comment: Remedial actions should be designed and implemented in a manner that minimizes impacts on users of aquatic lands. Extension of the intertidal zone seaward and impacts on navigation, existing marina and park facilities and the ferry maintenance facility should be considered.

Response: These issues have been considered in the ROD. Because the selected remedy includes capping for some areas, there may be some impacts on users of aquatic lands. These impacts could include added requirements or limitations on maintenance dredging, installation of piers, and maintenance of existing structures in the area of the cap(s), as well as other minor impacts. Reasonable efforts will be made to minimize impacts on the users of aquatic lands.

3.7.3.2
Comment: Institutional protection (such as deed restrictions) of any caps should be included so that the caps are not subjected to future development, such as pile driving and dredging.

Response: Some institutional controls are presently in place, specifically the process of permit application, review, and approval for such activities. The Corps of Engineers coordinates with resource agencies and EPA on evaluating such applications individually. It is likely that additional requirements such as chemical and biological testing, turbidity controls, or other steps beyond those ordinarily required will be imposed. In some areas, permits may be denied if adverse impacts to the remedy are anticipated. Deed restrictions are not anticipated as an institutional control requirement in the ROD.

3.7.4. Baseline Monitoring

3.7.4.1
Comment: The value of monitoring benthic communities, when compared to the associated costs, did not provide a suitable return to the RI/FS effort. EPA should eliminate any plans for future monitoring of this type.

Response: Chronic adverse effects on benthic communities is one of the biological criteria which can be used to evaluate compliance with the Sediment Standards, but other chronic measures are also acceptable. Limited benthic monitoring may be a desirable component of remedial design monitoring, and has not been eliminated as a possibility.

3.7.4.2

Comment: Plans for fish monitoring are not justified, particularly since previous investigations have not shown a correlation between sediment contamination and fish tissue levels. The ROD should focus primarily on chemical testing (field screening during remediation) as a measurement of the progress of the implemented measures.

Response: Although a correlation between specific sediment locations and fish tissue concentrations has not been shown, elevated concentrations of contaminants in Eagle Harbor fish tissues relative to fish from other locations appears to be the result of exposure to harbor contaminants. The uptake of contaminants through the food chain is of potential concern for human health and for the health of the fish.

A clear relationship between the occurrence of fish lesions and tumors and PAH contamination has been observed in Puget Sound (*Chemical Contaminants and Biological Abnormalities in Central and Southern Puget Sound*, NOAA, 1980). This is especially well documented for bottom-feeding fish (e.g., English sole) in Eagle Harbor (e.g., Johnson et al., 1988; Malins et al., 1984; Myers et al., 1987). Monitoring under the Puget Sound Ambient Monitoring Program (PSAMP) continues to support the relationship between PAH in sediment and liver abnormalities in English sole (McCain et al., 1988).

For these reasons, EPA anticipates that fish tissue sampling will be considered in the monitoring of Eagle Harbor. However, the primary focus of monitoring is sediment chemistry and associated biological tests.

3.7.4.3

Comment: In developing a plan for the additional testing to define remedial areas, EPA should consider the adequacy of previous data and should maintain consistency with the Sediment Management Standards.

Response: EPA will consider these points when developing the plan for testing during remedial design and monitoring during and after remediation.

3.7.4.4

Comment: EPA should undertake a single comprehensive effort to evaluate all past QA/QC problems and develop clearly defined goals and objectives for gathering data that is relevant and is accessible to decision makers and the public during the design phase.

Response: For the PAH compounds, this comprehensive effort was done during the RI and is included in Chapter 2. Much of the discussion regarding PAH in Chapter 2 of the RI report was developed in response to comments by technical reviewers from Ecology and by others. For mercury, this comprehensive effort was done during supplemental RI studies and is discussed in Section 5 of Technical Memorandum 13. Marine Biota Tissue Sampling and

Analyses, USEPA, April 19, 1991. [Note that the statistical analysis of EPA data completed by Jim Cubbage of the Department of Ecology employed a provisional database that was subsequently revised.]

3.7.4.5
Comment: *Additional biological testing needs to be performed before cleanup begins to provide a baseline in accordance with the Sediment Standards.*

Response: Additional biological testing, prior to implementing the selected remedies, may be performed in portions of the harbor to refine areas failing the cleanup objective. If collected, this information may be used for baseline biological information. The Sediment Standards do not require the collection of confirmatory biological information.

3.7.4.6
Comment: *EPA has proposed additional testing to determine the extent of contamination in the mercury contaminated sediments. An appropriate remedy for this media cannot be selected until some reasonable estimate of material volume and location is available. The assumption that most of the intertidal mercury contaminants exist at a depth of 0.5 meters is without foundation.*

Response: Limited data from near the former shipyard indicate some attenuation in mercury concentrations with depth (*Technical Memorandum 10*, EPA, 1990), although the highest mercury concentration was measured in samples from 0.30 to 0.60 meters. The volume of 1,000 to 7,000 cubic meters estimated for the hotspot sediments provides a reasonable range of volumes, based on the available information, and an adequate basis for selection of a remedy in this area. Additional sampling to better define the extent of mercury contamination is planned for the remedial design phase.

3.7.4.7
Comment: *The distribution of mercury near the former shipyard is not clearly defined in the RI/FS. Additional testing should only be done if affirmative evidence indicates the need, and should be performed concurrent with actual remedial work.*

Response: EPA believes that there is a need for additional testing to better define the volume of contaminated sediments to be removed or otherwise remediated. Detailed aspects of the testing, such as the timing of sampling and excavation, will be developed during remedial design.

3.7.4.8
Comment: *EPA needs to provide justification for the PCB sampling proposed during the remedial design phase.*

Response: The revised risk assessment (EPA, May 1991) included an appendix which discussed potential human health risks due to PCBs. During the RI/FS, sediment samples were not analyzed for PCBs. PCB concentrations measured in a previous study (Ecology, 1986) were detected at 13 of the 34 stations sampled, but were not significantly elevated above reference areas. Recent fish tissue data from 1990 indicated that concentrations could be of concern for human health. It is appropriate to confirm the sediment and tissue results and to determine whether a continuing source exists.

3.7.5. Source Monitoring

3.7.5.1

***Comment:** EPA should not remediate the East Harbor if there is greater than 50% chance that the cap may become recontaminated.*

Response: The RI/FS included extensive sampling to determine the source of the PAH hotspot, and there is evidence to suggest that the high contamination there resulted from a spill or from redistribution of contaminants in the surface sediments. As previously stated, EPA intends to require sampling during the remedial design phase to confirm that transport of DNAPL through soils below the wood-treating facility is not a major pathway for recontamination. The percent chance of recontamination may be difficult to determine; however, EPA agrees that the benefits of remediation of this heavily contaminated area must outweigh the risk of recontamination to warrant remediation.

3.7.6. Sediment Sampling

3.7.6.1

***Comment:** It does not seem reasonable to assume that if a sediment sample passes two acute effects tests that it will necessarily pass the chronic effects test as well. It would be more conservative to assume that sediments exceeding the chemical criteria also fail the chronic effects test. How does this assumption affect the problem area boundaries and the associated costs for cleanup?*

> **Response:** The preliminary area estimates in the FS, proposed plan, and ROD are based on sediment chemistry, bioassay data, and available benthic information. In the absence of benthic information sufficient to confirm compliance with the MCUL biological criteria, the available information provided a reasonable basis for assuming compliance for the purpose of developing cost estimates. The ROD, however, requires remediation or natural recovery for all areas exceeding the MCUL chemical criteria, unless optional biological tests show that the MCUL biological criteria are met. EPA believes that the biological information collected during the RI/FS was sufficient to develop preliminary areas of probable adverse biological effect.
>
> The costs for cleanup areas defined by sediment chemistry alone were revised for alternatives used in the selected remedy. Because the relative costs based on FS area assumptions do not change enough to affect the comparative evaluation, the FS costs and areas were not modified in Section 9 of the ROD.

3.7.6.2

***Comment:** Additional sampling of sediments during remedial design to evaluate the relationship between PCB concentrations in fish and PCB concentrations in sediment does not support the FS and will most likely have no influence on the scope of remedial activities.*

> **Response:** Areas requiring remediation are unlikely to be affected by additional information about PCB concentrations in Eagle Harbor. Studies which preceded the FS indicated that sediment concentrations of PCBs in Eagle Harbor were not significantly elevated with respect to reference areas, and the MCUL for PCBs was not exceeded in data from these studies. However, the apparently elevated PCBs concentrations in Eagle Harbor fish tissues must be further evaluated, and if confirmed require an evaluation of whether PCB sources are controlled and whether sediment PCB contamination will be addressed by planned remedial actions in the harbor.

3.7.6.3

***Comment:** EPA has conducted screening of suspect source areas for dioxins and furans. If these are not contaminants of concern, why do sediments from mercury contaminated areas require dioxin and furan testing?*

> **Response:** Information about dioxins and furans in Eagle Harbor is limited, and toxicity information is still developing. Sediment data from earlier Eagle Harbor studies suggest that dioxins are mostly present in the less toxic forms. However, crab tissue samples collected from a number of Puget Sound locations indicate higher concentrations in Eagle Harbor than

at other locations. Additional information is needed to ensure that remedial actions are protective of human health and the environment. This information may be developed through remedial design sampling and monitoring.

3.7.7. Post Remedial Monitoring

3.7.7.1
Comment: *What is the purpose of post-remedial monitoring of clam tissue concentrations of PAH if a correlation between sediment and clam tissue cannot be made? If the purpose is to evaluate the need to continue the health advisory, this monitoring is more appropriate within the purview of the local health department.*

Response: There is a correlation between PAH concentrations in shellfish tissue and PAH concentrations in sediment. As stated in the FS, this correlation is simply not strong enough to develop a sediment concentration for cleanup. EPA is using the Sediment Standards and site-specific objectives to provide cleanup objectives expected to be protective of human health.

The Sediment Standards are intended to eliminate adverse effects on biological resources and significant threats to humans from sediment contamination. Monitoring of clam and other seafood tissues for contamination related to this Superfund site is necessary to measure progress toward this end. EPA intends to coordinate with the health department regarding the continuation of the health advisory.

3.7.7.2
Comment: *The emphasis on post-remediation testing of biological resources is excessive.*

Response: The cleanup of Eagle Harbor is largely driven by concerns about specific adverse effects on the marine environment. Cleanup areas, although defined on the basis of chemical information, are intended to approximate areas of biological impact. While biological testing to refine cleanup areas and actions is optional, monitoring, including some testing of biological resources, will be required to address objectives described in the ROD and to evaluate the success of remedial actions in protecting human health and the environment. The details of such testing will be developed during remedial design.

3.7.7.3
Comment: *Additional information on which contaminants will be monitored, monitoring rationale, and frequency is needed. Organisms, such as clams and fish (including small food fish) should be monitored for exposure to mercury and PAHs. Periodic verification of the structural integrity (depth, contours, configuration, thickness, and dimensions) of the caps is also recommended.*

Response: The West Harbor ROD provides information on the post remedial monitoring goals and objectives (See Section 10.5). However, detailed information about the type and amount of monitoring is generally developed during the remedial design phase. EPA expects to coordinate with resource and public health agencies in the planning of monitoring.

3.7.7.4

Comment: *The following natural resource objectives should be considered for incorporation into the post-remediation monitoring plan:*

- *to minimize or eliminate exposure of natural resources to contaminants of concern;*
- *to eliminate exposure and effects on resident biota;*
- *to support a normal, indigenous biological community.*

Response: These issues have been incorpoated in the selected remedy as appropriate. Detailed plans for monitoring of environmental conditions in Eagle Harbor will be developed during remedial design. Monitoring plans will focus on measuring the extent to which the goals and objectives of the ROD are achieved due to actions required as part of the selected remedy.

3.7.7.5

Comment: *NOAA supports the use of a monitoring measure which is integrative, i.e. which indicates conditions harbor wide and represents exposure to contaminants by more than one pathway. Flatfish bile PAH metabolites appear to be an appropriate measure. Measuring contaminant concentrations in the tissues of caged mussels may also be appropriate.*

Response: EPA agrees that monitoring improvements of overall harbor conditions is appropriate. Marine sediments, located at the bottom of the environmental gradient, are a media that tends to act as an integrator of environmental conditions. In addition, sediment contamination and toxicity can be compared to defined chemical and biological criteria. For this reason, sediment sampling and related biological tests will be the primary focus of monitoring, but the details of sediment and other environmental measures to be used in monitoring will be evaluated during the preparation of a monitoring plan in remedial design.

Section 4

Remaining Issues

4.1 C.1.1
Comment: *Concerns about fecal coliform bacteria in seafood were raised at the end of the RI/FS. Members of the community questioned the value of cleanup for chemical contamination when continuing bacterial contamination may preclude seafood harvest indefinitely. More coordination between agencies to address both concerns or reduced efforts on chemical cleanup were suggested.*

Response: Programs within EPA and in state and local governing bodies are charged with addressing the widespread public health concern of bacterial contamination in shellfish. The Superfund program was created to respond exclusively to hazardous substances, pollutants and contaminants (see definition below). It is clear that actions to control contamination of both kinds must and will continue. Better coordination between the responsible agencies and programs is desirable. However, the presence of bacterial contaminants is not a reason to ignore chemical contamination, particularly when chemical contamination of the marine environment affects not only humans, but marine organisms.

[Note] Section 101 of CERCLA, as amended states: "The term "pollutant or contaminant" shall include, but not be limited to, any element, substance, compound, or mixture, including disease causing agents, which after release into the environment and upon exposure, ingestion, inhalation, or assimilation into any organism, either directly from the environment or indirectly by ingestion through food chains, will or may reasonably be anticipated to cause death, disease, behavioral abnormalities, cancer, genetic mutation, physiological malfunctions (including malfunctions in reproduction) or physical deformations, in such organisms or their offspring; expect that the term "pollutant or contaminant' shall not include petroleum, including crude oil or any fraction thereof which is not otherwise specifically listed or designated as a hazardous substance under subparagraphs (A) through (F) of paragraph (14) and shall not include natural gas, liquefied natural gas, or synthetic gas of pipeline quality (or mixtures of natural gas and such synthetic gas)."

Section 5

Appendices

5.1. References

5.2. List of Commenters

5.1. References

Patmont, C.R., and E.A. Crecelius, 1991. Natural recovery in contaminated embayments of Puget Sound. pp. 246-255, In: Puget Sound Research, 91 Proceedings. Puget Sound Water Quality Authority, Olympia, WA.

Hart-Crowser, March 15, 1989. Draft Report Contaminant Deposition and Sediment Recovery, Eagle Harbor Site, Kitsap County, Washington, prepared for: Washington State Department of Transportation, J-2135.

Baker, E.T., 1984. Patterns of suspended particle distribution and transport in a large fjordlike estuary. J. Geophysical Research 89:6553-6566.

Romberg, G.P., et al. 1984. Toxicant Pretreatment Planning Study Technical Report C1: Presence, Distribution and Fate of Toxicants in Puget Sound and Lake Washington. Seattle Metro. October, 1984.

Weston, D.P. 1990. The Effects of Creosote Discharge on the Benthic Communities of Eagle Harbor, Washington. Prepared for USEPA, Region X, Cooperative Agreement No. CE-000408-01.

5.2. List of Commenters

1. ABC Technical Advisory Committee, 1/25/92. Comments on Proposed Plan.

2. ABC Technical Advisory Committee, 2/25/92. Comments on the Eagle Harbor Proposed Plan.

3. Ater Wynne Hewitt Dodson & Skerritt, 2/25/92. Comments on the Eagle Harbor Proposed Plan and Feasability Study. (For PACCAR)

4. Bremerton-Kitsap County Health District, 2/25/92. Comments on the Eagle Harbor Proposed Plan.

5. Citizen letters, 1992. Comments on the Eagle Harbor Proposed Plan and Feasability Study. (44 letters, numbered 1-44.)

   The Agency received letters from the following citizens:

   (b) (6) [redacted]

   (b) (6) [redacted]

6. Department of the Navy, 3/5/92. Engineering Field Activity, Northwest Naval Facilities Engineering Command. Comments on Eagle Harbor Proposed Plan.

7. Department of Ecology, Toxics Cleanup Program, 2/25/92. Comments on the Eagle Harbor Proposed Plan.

8. E. P. A. Public Hearing, January 15, 1992, Commodore School Auditorium, Bainbridge Island, WA

9. E. P. A. Public Hearing, January 30, 1992, Commodore School Auditorium, Bainbridge Island, WA

People who commented at the January 15th and January 30th Public Hearings included but were not limited to the following:

(b) (6) [redacted]

[redacted]

10. HartCrowser, 2/25/92. Comments on the Eagle Harbor Proposed Plan. (For Washington State Department of Transportation)

11. NOAA Coastal Resource Coordinator.
U.S. Department of Commerce National Oceanic and Atmospheric Administration. 2/25/92. Comments on the Eagle Harbor Proposed Plan.

12. Perkins Coie, 2/25/92. Comments on the Eagle Harbor Proposed Plan. (For Bainbridge Marine Services)

13. State of Washington Department of Ecology,
Suquamish Tribe,
National Oceanographic and Atmospheric Administration.
Jointly signed, 2/21/92. Comments on Eagle Harbor Proposed Plan.

14. United State Department of the Interior Fish and Wildlife Service, 2/24/92. Comments on the Eagle Harbor Proposed Plan.

15. Washington State Department of Natural Resources, Division of Aquatic Lands, 2/20/92. Comments on the Eagle Harbor Proposed Plan.