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

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

September 1994

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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
CAD	Confined Aquatic Disposal
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
MLLW	Mean Lower Low Water
NCAC	Nitrogen Containing Aromatic Compounds
NCP	National Contingency Plan
NOAA	National Oceanic and Atmospheric Administration
NPDES	National Pollutant Discharge Elimination System
NPL	National Priorities List
O&M	Operations and Maintenance
PAH	Polynuclear Aromatic Hydrocarbon
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
TPAH	Total Polynuclear Aromatic Hydrocarbons
UST	Underground Storage Tank

DECLARATION
FOR THE
RECORD OF DECISION

SITE NAME AND LOCATION

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

STATEMENT OF BASIS AND PURPOSE

This decision document presents the final remedial action selected by the U.S. Environmental Protection Agency (EPA) for the East Harbor operable unit (East Harbor) of the Wyckoff/Eagle Harbor Superfund site, 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. This decision is based on the Administrative Record for this site.

As described in Section 9.3 of this document, concurrence on the selected remedy by the State of Washington Department of Ecology is under consideration.

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, may present an imminent and substantial endangerment to public health, welfare, or the environment.

DESCRIPTION OF THE REMEDY

The selected remedy described in this Record of Decision addresses contaminated sediments in the East Harbor, one of four operable units at the Wyckoff/Eagle Harbor site. This is the second Record of Decision to be completed for the site.

Sediments in the East Harbor are contaminated with polynuclear aromatic hydrocarbons and other hazardous substances. The principal threat is defined as sediments containing free-phase oily contamination. The selected remedy addresses the principal threat and other sediments contaminated at levels which cause significant adverse effects on marine organisms, by combining sediment capping in subtidal areas with monitoring in intertidal areas to confirm the predicted recovery of intertidal sediments through natural processes.

Over fifty acres of heavily contaminated subtidal sediments in the East Harbor were recently capped under CERCLA removal authorities to address documented adverse biological effects and free-phase oily contamination. The selected remedy incorporates the existing cap and addresses remaining areas of contamination in the East Harbor with a phased cleanup approach.

The first phase will be completed concurrent with ongoing EPA efforts to control sources of contamination from the adjacent Wyckoff Facility operable unit, an inactive wood-treating facility. Initial East Harbor actions include:

- enhancement of existing institutional controls to reduce public exposure to contaminated fish and shellfish and to protect the existing cap;
- monitoring and maintenance of the existing cap;
- environmental monitoring to assess the effectiveness of source control efforts; and
- other actions necessary to ensure protection of human health and the environment, such as demolition of in-water structures, identification of potential nearshore sediment hotspots, and evaluation of contaminant breakdown rates.

Final sediment cleanup actions are to be completed after a determination that sources of contamination at the adjacent Wyckoff Facility operable unit have been sufficiently controlled. Final sediment cleanup actions include:

- additional capping in remaining subtidal areas of concern for adverse biological effects;
- monitoring the success of natural recovery in intertidal areas predicted to achieve the long-term sediment cleanup objective without sediment remedial action; and
- monitoring contaminated areas where active remediation cannot be implemented due to engineering feasibility or sensitive ecological conditions.

EPA will be the lead agency for implementing sediment remediation in the East Harbor and will coordinate activities in the East Harbor with ongoing cleanup work at other operable units.

STATUTORY DETERMINATIONS

The selected remedy is protective of the marine environment and human health, complies with federal and state requirements that are legally applicable or relevant and appropriate to the remedial action, and is cost-effective. This remedy uses permanent solutions and alternative treatment technologies to the maximum extent practicable for this operable unit. However, because treatment of the principal threat of this operable unit was not found to be practicable, this remedy does not satisfy the statutory preference for treatment as a principal element.

Areas of sediment containing free-phase oily contamination constitute the principal threat at this operable unit. For low volumes of subtidal sediment containing free-phase oily contamination, treatment could be an appropriate remedy but would require dredging. Dredging was judged to pose

a significant short term risk to the environment due to potential releases of oily contamination and contaminated fine particles. Treatment or disposal of dredged sediments at an upland facility would involve complex implementability issues, high costs, and extended time frames for effective treatment. Subtidal areas containing free-phase contamination were successfully capped under CERCLA removal authorities. Other areas of sediment contamination in the East Harbor, while potentially toxic to marine organisms, contain relatively low levels of contamination. Containment is an appropriate remedy for such areas, which represent high volumes at low levels of contamination.

Because this remedy will result in hazardous substances remaining on site above health-based and environmentally-based cleanup levels, 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.

9/29/94
Date

Chuck Clarke
Regional Administrator
U.S. Environmental Protection Agency
Region 10

1. OVERVIEW

This Decision Summary provides a description of the site-specific factors and analyses that led to selection of the remedy for the East Harbor operable unit (East Harbor) 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 the identification and evaluation of remedial alternatives.

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 1994 Proposed Plan and the remedy selected in the ROD.

Documents supporting this Decision Summary are included in the Administrative Record for the East Harbor. Key documents include the following: the Remedial Investigation (RI) Report (November 1989), subsequent technical memoranda, the Revised Risk Assessment (May 1991), and the Feasibility Study (FS) (November 1991), which provide the results of the overall Eagle Harbor RI/FS; the initial Eagle Harbor Proposed Plan (December 16, 1991), which addressed both East and West Harbor sediments and proposed an interim cleanup plan for heavily contaminated areas of the East Harbor; the Action Memorandum (June 15, 1993), which authorized implementation of this plan through placement of a sediment cap in the East Harbor; the On-Scene Coordinator's report (COE, July 1994 Draft), which describes the completed cap; and the subsequent East Harbor Proposed Plan (June 8, 1994), which proposed a final cleanup plan for remaining areas of contamination in the East Harbor.

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, contaminated sediments in adjacent Eagle Harbor, and other upland sources of contamination to the harbor, including a former shipyard (Figure 2). The site is currently divided into four administrative areas, known as "operable units" (Figure 3).

Sediments in areas of Eagle Harbor are contaminated with polynuclear aromatic hydrocarbons (PAHs) and other organic compounds, as well as with metals, primarily mercury. EPA's Remedial Investigation (RI) of sediment contamination in Eagle Harbor (CH2M Hill, November 1989) initially addressed the harbor as a single unit concurrent with enforcement activities at the Wyckoff Facility. After completion of the Eagle Harbor Feasibility Study (FS) (CH2M Hill, November 1991), EPA proposed the administrative separation of the Harbor into East Harbor and West Harbor operable units (Eagle Harbor Proposed Plan, 1991).

Groundwater and soils at the wood-treating facility (the Wyckoff Facility operable unit) are contaminated with chemicals from the wood treatment process, primarily creosote-derived 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. Although wood-treating operations at the Wyckoff Facility ceased in 1988, contamination from the Wyckoff Facility continues to affect areas of the East Harbor through groundwater movement and oily seeps. In 1993, under CERCLA removal authorities, EPA implemented the initial sediment cleanup proposed for the East Harbor, placing a sediment cap in a heavily contaminated subtidal area. The cap, relatively distant from ongoing intertidal seeps, addressed areas where sediment contamination was shown to cause significant adverse biological effects in biological tests, including areas of free-phase oily contamination.

EPA recently divided the Wyckoff Facility into separate operable units for soil and groundwater and has proposed an interim decision to support source control efforts (Wyckoff Facility Proposed Plan, July 1994). These efforts are expected to control seepage of oily contamination and groundwater to the East Harbor. Final remedies for soils and groundwater will be selected following completion of the ongoing Wyckoff Facility RI/FS.

This ROD specifically addresses East Harbor sediments, including the existing cap and remaining contaminated sediments.

2.2 Current Land Use

More than 15,000 people live on Bainbridge Island. Land use on Bainbridge Island, recently incorporated as the City of Bainbridge Island, is principally residential, with some commercial and industrial use (Figure 4). An urban area, formerly the City of Winslow (population 2,800), lies on the north shore 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

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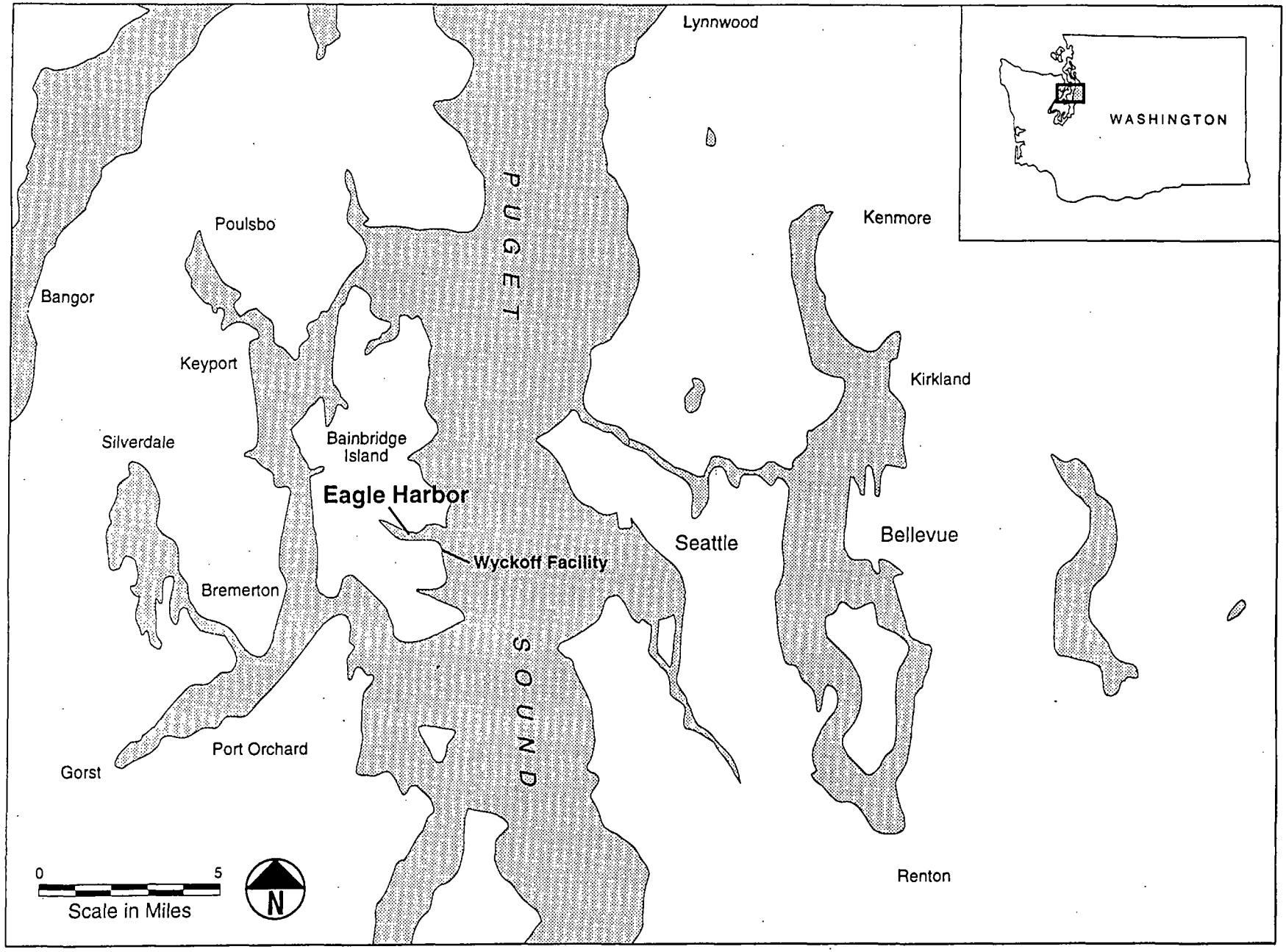

Figure 1
REGIONAL SETTING

NPE69206.02.04 / Area Map / 8-3-94 / LKW

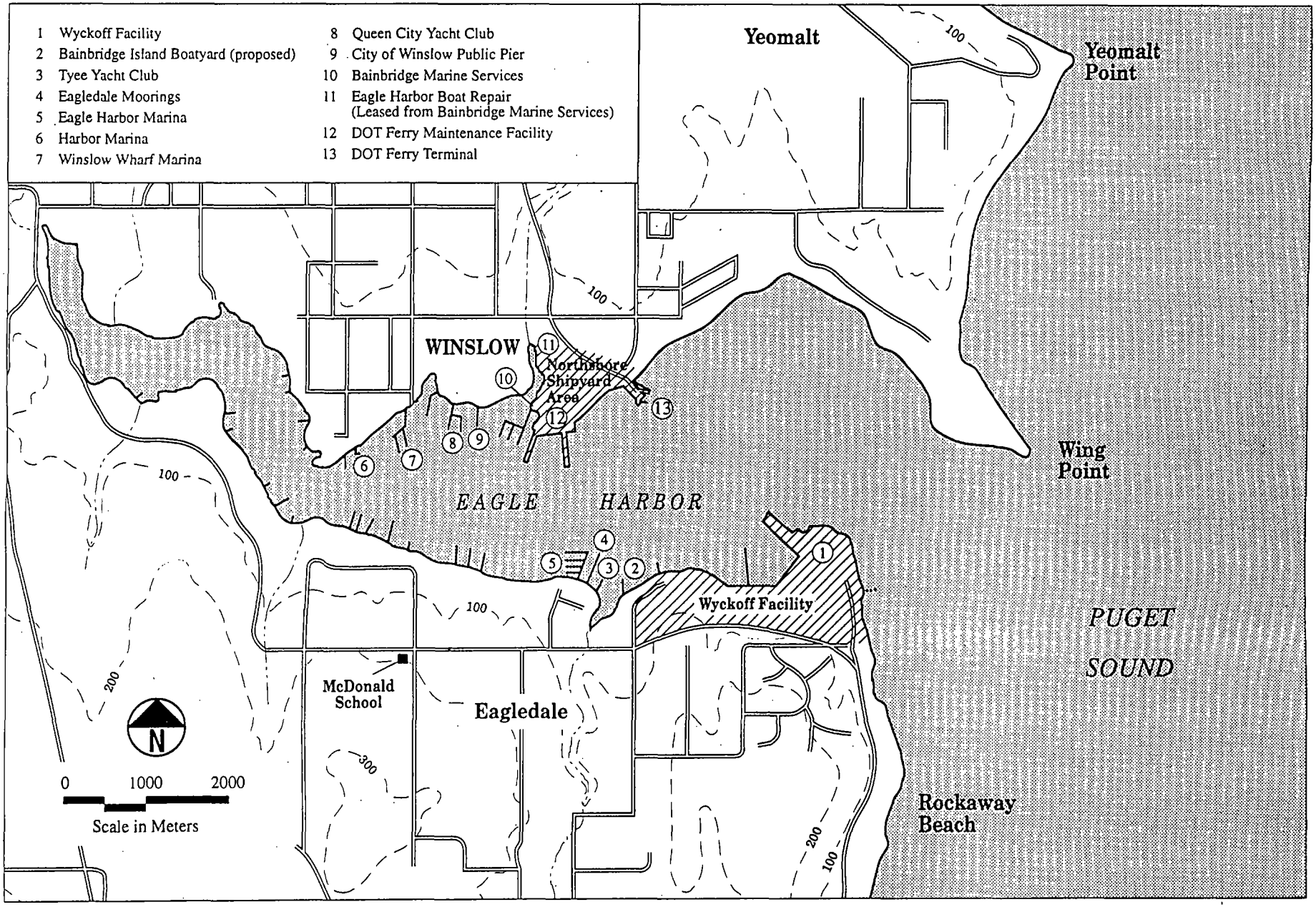

Figure 2
AREA MAP

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.

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 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 usual and accustomed fishing area.

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 1,327 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 named 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 have been released there periodically. The creek at the head of the harbor is a salmon nursery, and it is possible that the drainage on the south side is used as a chum 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, the closest bald eagle nesting location is approximately three miles from the site. Although habitat for marbled murrelet may exist on Bainbridge Island, there have been no reported sightings. No critical habitats are formally designated near the site.

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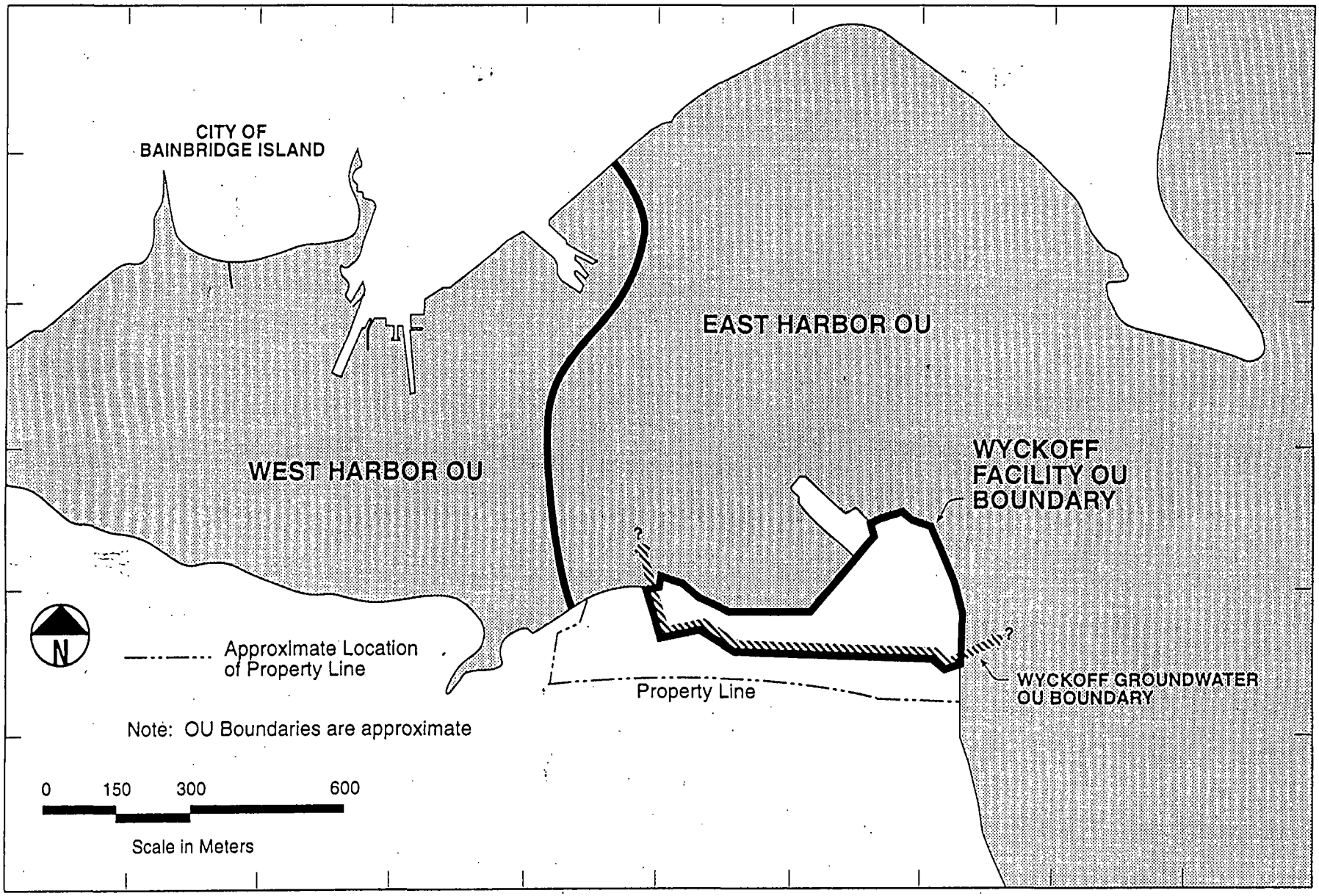


Figure 3.
WYCKOFF/EAGLE HARBOR SUPERFUND SITE OPERABLE UNITS

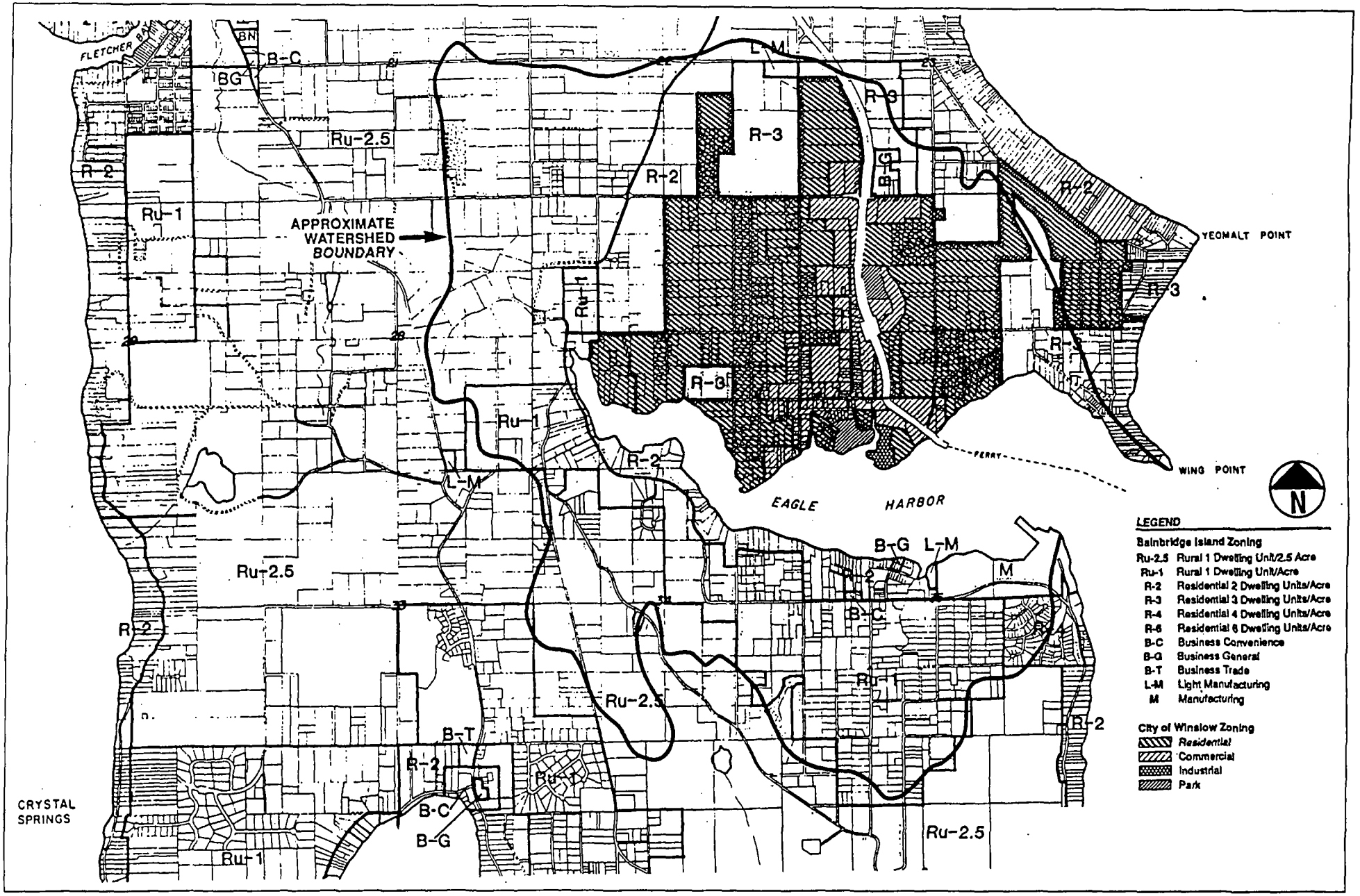


Figure 4
LAND USE MAP

3. SITE HISTORY AND ENFORCEMENT ACTIVITIES

3.1 Site Background

Prior to non-Indian development of Bainbridge Island in the mid-nineteenth century, a Suquamish Indian village and burial site were located on the north shore of Eagle Harbor, and the harbor 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 1950's, and in 1961 the property was sold and subsequently divided.

Wood treating operations at the Wyckoff Facility 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 Facility 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 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 with EPA for further investigation of the facility.

The site was added to the NPL in July 1987, with EPA as lead agency. EPA initially separated the site into two operable units, 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 Administrative Order on Consent, 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 Unilateral Administrative Order 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 Facility.

- A November 1993 Administrative Order on Consent, under which potentially responsible parties are completing remedial design pursuant to the West Harbor ROD.

- A Consent Decree resolving Pacific Sound Resources' liability at this and another Superfund site. This agreement was lodged and entered in court in 1994.

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. In addition to the Consent Decree with Pacific Sound Resources, another PRP resolved its liability in a bankruptcy settlement with EPA. Four parties have been notified that EPA does not currently consider them PRPs.

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.

3.5 East Harbor Removal Action

As noted previously, after completion of the RI/FS, EPA proposed initial cleanup actions in the East Harbor operable unit (Eagle Harbor Proposed Plan, 1991). The proposed cleanup was a clean sediment cap over heavily contaminated sediments in the East Harbor, including at a minimum a

sediment hotspot in the central channel, and extending if possible to other areas where acute toxicity of the sediments to marine organisms had been documented during the RI/FS. EPA documented its decision to complete the cap under CERCLA removal authorities in an Action Memorandum (June 15, 1993). The cap was completed by the U.S. Army Corps of Engineers and their contractors over a six-month period starting September 1993. Cap materials were obtained from the Snohomish River as part of a federal navigation project and placed in over 54 acres of subtidal sediments in the East Harbor. Completion of the cap cost approximately $1.5 million, a significant savings relative to costs estimated in the FS for a comparable area. Cap placement and monitoring results are described in the draft On-Scene Coordinator's Report (COE July 1994).

Table 1. List of Technical Memoranda for Eagle Harbor

Memorandum Title	OU[b]	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] These documents are included as part of the Administrative Record for the East Harbor.
[b] The focus of each document is noted as EH (East Harbor) or WH (West Harbor) Operable Unit (OU).

4. COMMUNITY RELATIONS ACTIVITIES

Sections 113(k)(2)(B) and 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 the 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.

Section 4 of the West Harbor ROD describes community relations activities during the RI/FS for Eagle Harbor. These activities culminated in the issuance of a Proposed Plan (December 1991) for final cleanup in the West Harbor and capping of a portion of the East Harbor under an interim decision. Two community meetings were held to answer questions and accept public comments. Community comments were divided between support for EPA's preferred alternative and preference for lower cost alternatives or combinations of alternatives.

Since then, EPA has completed the first phase of cleanup in the East Harbor, as proposed. The work was conducted under CERCLA removal authorities over a six-month period ending in March 1994. EPA made the determination that the community relations requirements for non-time critical removal actions were satisfied by the RI/FS processes. EPA's response to comments on the 1991 Proposed Plan is attached to the June 15, 1994 Action Memorandum documenting EPA's decision to complete the removal action. Between July 1993 and March 1994 additional outreach was completed. EPA published a newspaper announcement, sent out a public notice and several fact sheets, and held a community meeting to respond to questions and concerns. An Administrative Record is on file at the public library on Bainbridge Island.

After completing the removal action, EPA issued a Proposed Plan for final cleanup of remaining contaminated areas of the East Harbor on June 8, 1994. A thirty-day public comment period ran from June 8 through July 8, 1994. A community meeting was announced in the local papers and held on June 22, to answer questions and accept public comment. Five people attended this meeting. In addition to verbal comments provided at the meeting, EPA received five letters commenting on the Proposed Plan. Comments generally supported EPA's preferred alternative, suggesting that clarification or additional detail be provided in the ROD. The Responsiveness Summary (Appendix B of this ROD) outlines and responds to public comments provided during the comment period.

The remedy 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 have led to the division of the Wyckoff/Eagle Harbor site into operable units.

Coordination between the operable units is an important element of the overall site cleanup. The current division of the site is as follows:

- East Harbor subtidal and intertidal sediments (Operable Unit 1)
- Wyckoff Facility soils (Operable Unit 2)
- West Harbor subtidal and intertidal sediments and upland sources (Operable Unit 3)
- Wyckoff Facility Groundwater (Operable Unit 4)

A ROD was completed for West Harbor sediments (Operable Unit 3) in 1992. This ROD presents the final selected remedy for cleanup of the East Harbor only and is intended to address chemical contamination of marine sediments, impacts to marine organisms, and related human exposure pathways.

Other types of environmental or public health problems not caused by hazardous substances, pollutants, or contaminants (as defined by CERCLA) within the site boundaries are beyond the scope of CERCLA authorities and are the responsibility of other federal, state, tribal, or local programs. Examples of problems beyond the scope of this ROD 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. It describes site conditions prior to placement of the recently completed East Harbor sediment cap, described in Section 3.5.

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 were promulgated in April 1991 and 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 analyses to determine the nature and extent of contamination;
- shellfish tissue sampling and analyses 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 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 the Preliminary Investigation (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 Compounds (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 a detection limit of 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 Facility 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

This section summarizes the nature and extent of contamination in Eagle Harbor intertidal and subtidal sediments, first for inorganic contaminants, then for organic contaminants.

For a number of metals, intertidal samples from Eagle Harbor were found to exceed the maximum concentrations measured at background locations (Figure 7). The greatest number of metals detected and the highest concentrations were detected in the West Harbor near the former shipyard. 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

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]
Metals (mg/kg dry weight; ppm)				
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[e]	390
Lead	660	660	450[e]	530
Mercury	2.1[g]	0.59	2.1[e]	0.41
Nickel	>140[h,e,g]	*	>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
Organic Compounds (µg/kg dry weight; ppb)				
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[e]	>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[e]	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[e]	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[e]	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 anomalous stations from the AET dataset.
[g]The value shown exceeds AET established from Commencement Bay Remedial Investigation data (Barrick et al., 1985) because 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.

NPE69206.02.04/EH Sample Locations/8-3-94//GFA/LKW

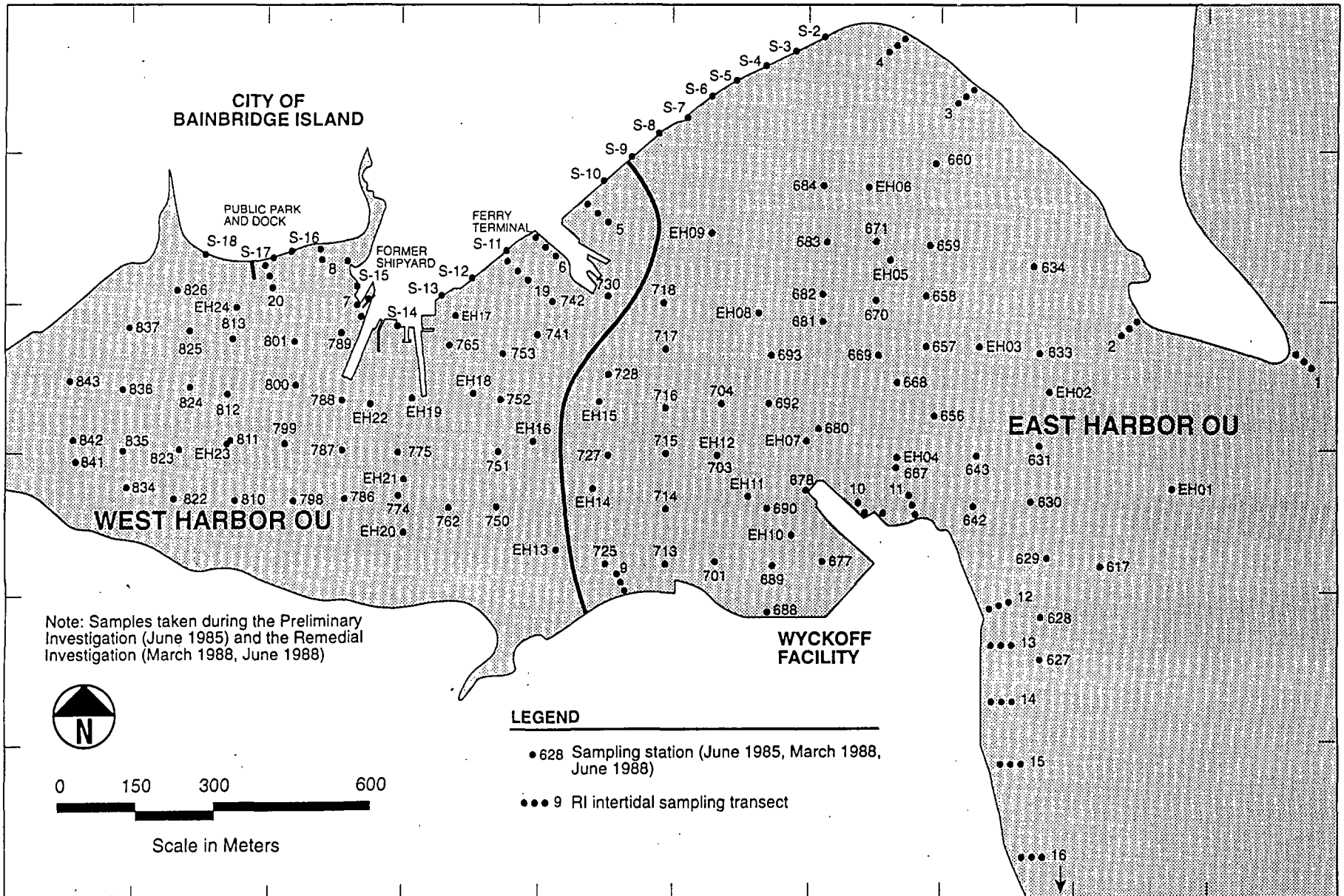
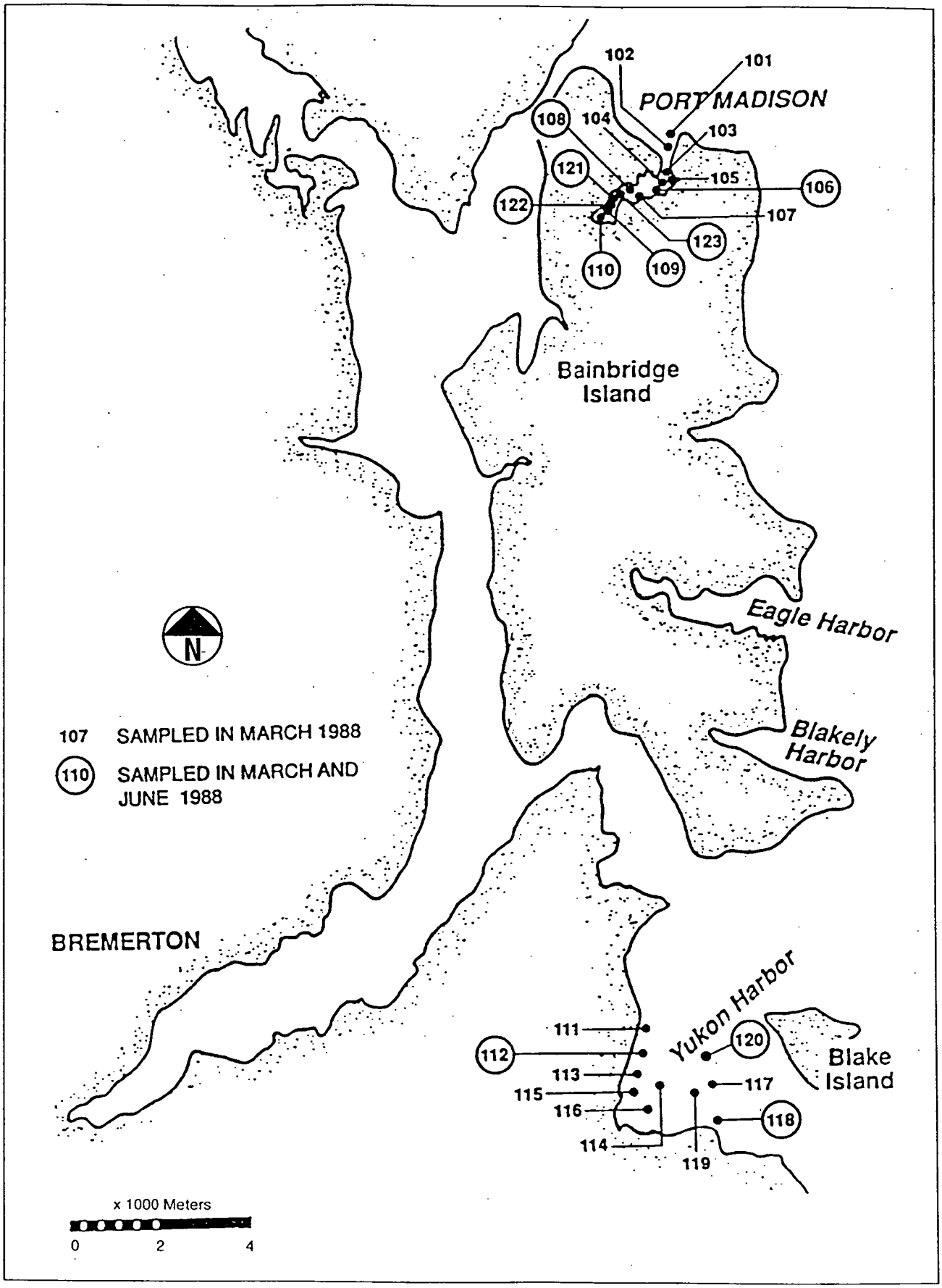
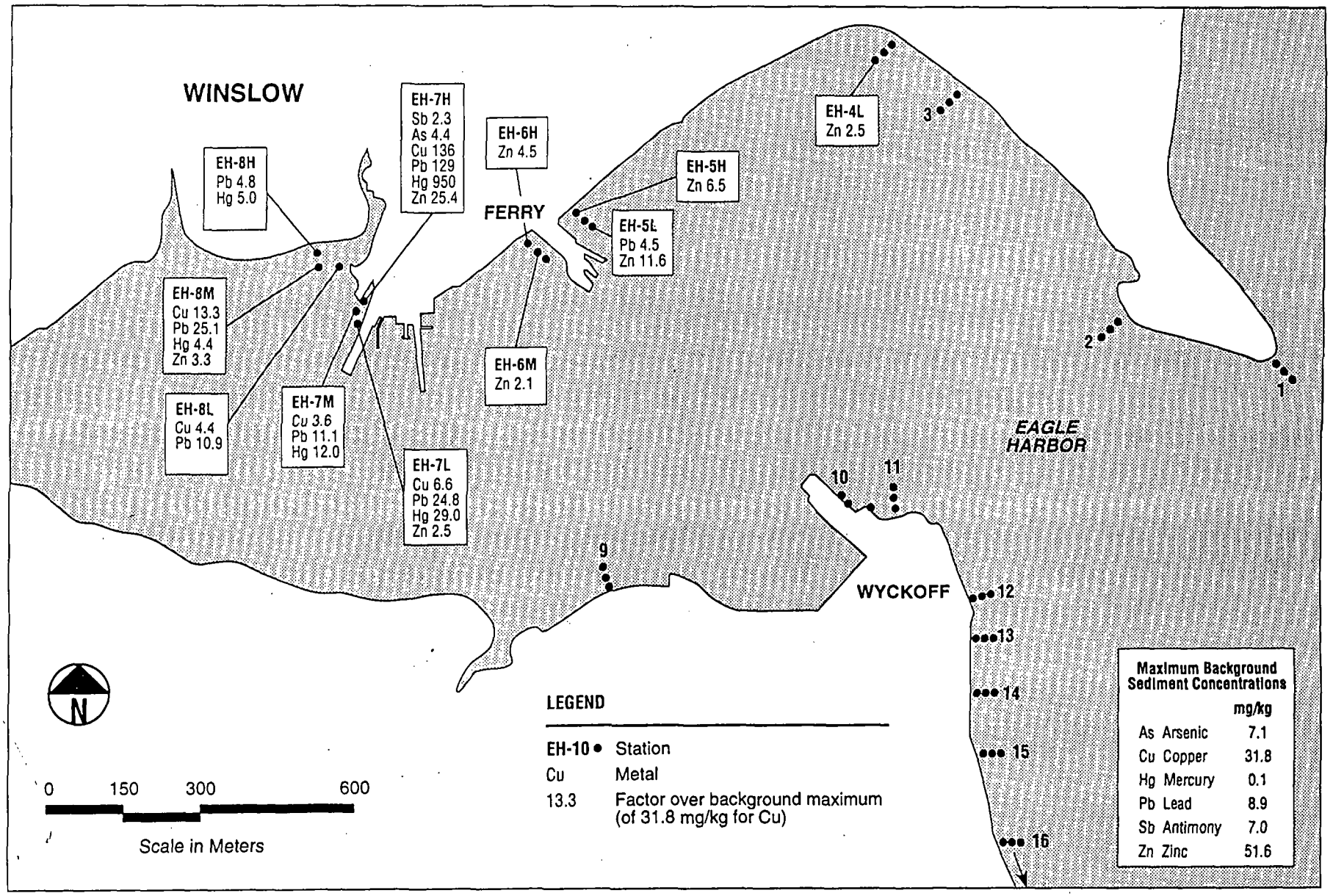


Figure 5
EAGLE HARBOR SAMPLE LOCATIONS



NPE69206 02.04/Subtidal Background Loc./8-4-94/LKW

Figure 6
SUBTIDAL BACKGROUND LOCATIONS



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

Figure 7
METALS IN INTERTIDAL SEDIMENT RELATIVE TO BACKGROUND

concentrations exceeded maximum background values by between two and twenty times throughout the harbor and were particularly high near the former shipyard (Figure 8).

PAHs, the predominant group of organic contaminants, were extremely high in intertidal sediments adjacent to the Wyckoff Facility in the East Harbor. In the West Harbor, PAHs were elevated in intertidal sediments near the ferry terminal and the former shipyard. Subtidal samples showed widespread, heavy PAH contamination in the East Harbor and to a lesser extent in the West Harbor. Estimated average concentrations of HPAH, the high molecular weight subgroup of PAH compounds, were significantly higher than background values, and were highest in sediments north of the Wyckoff Facility. Concentrations of total PAH (TPAH), low molecular weight PAH (LPAH), and NCACs followed the same general pattern. Figure 9 shows ranges of TPAH concentrations measured in subtidal sediments. Although chlorophenols were detected, it appears that contamination by pentachlorophenol is not widespread.

On the basis of their widespread prevalence above AETs, mercury and the sixteen PAH were selected as indicator contaminants to define areas for remediation. Contamination by other organic compounds and metals in sediments is encompassed within areas of elevated 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 Facility. 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.

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

NPE69206.02.04/Subtidal Mercury Concent./8-3-94/Sam/LKW

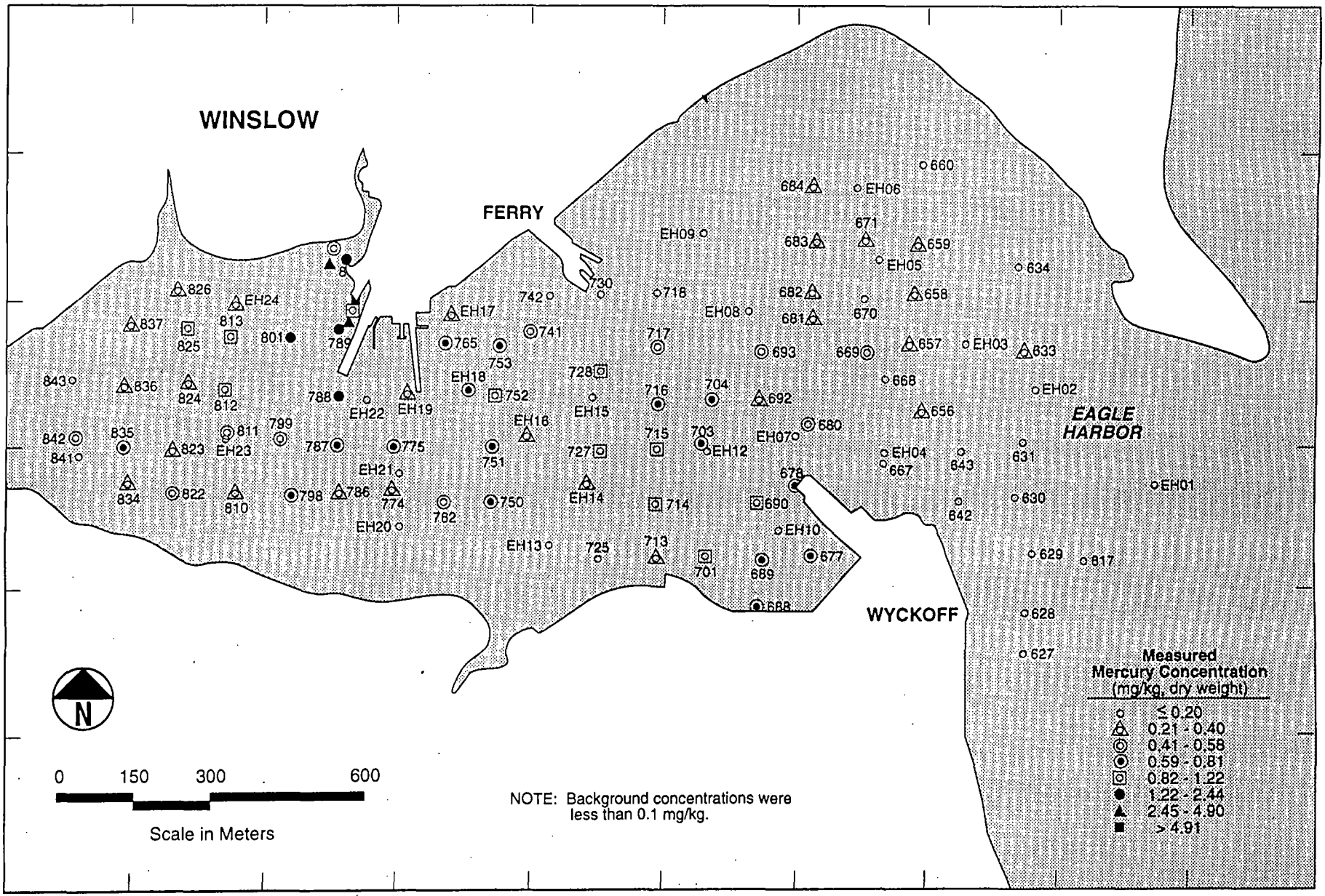
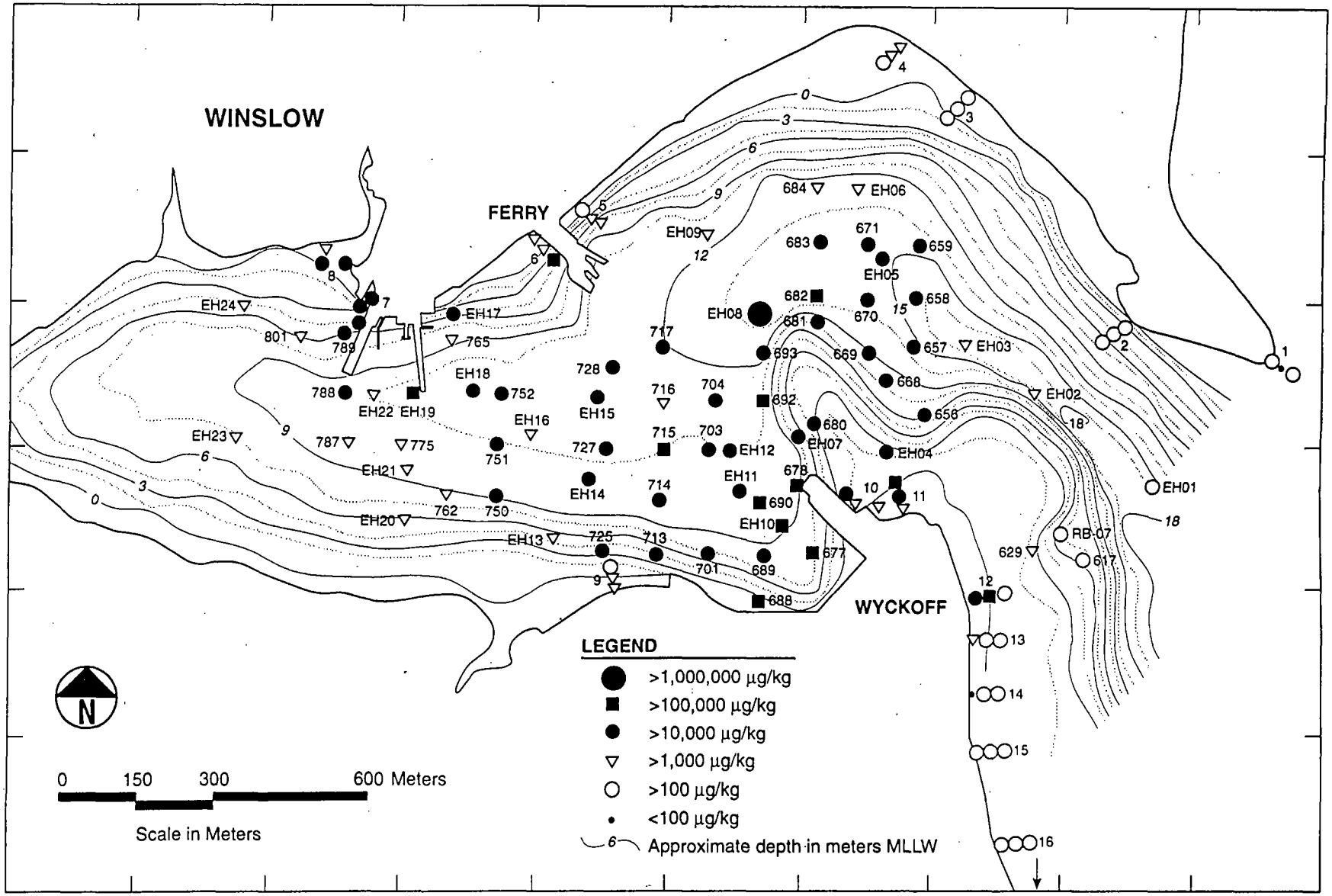


Figure 8
SUBTIDAL MERCURY CONCENTRATIONS



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 (June 1988) AND PI (1986)

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 (Appendix B3 of the FS) did not exceed water quality criteria.

Wyckoff Facility groundwater, intertidal seeps, and soil contamination have been, and may continue to be, sources of contamination for areas of the East Harbor. These sources are being addressed as part of the ERA, other early actions, and ongoing remedial studies at the Wyckoff Facility. Groundwater will not be directly addressed by cleanup actions in the East Harbor and therefore is not identified as a medium of concern at this operable unit. Coordination of East Harbor activities with work at the two Wyckoff operable units is critical to successful sediment remediation and is factored into the phasing of East Harbor remedial actions.

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

The depth of concern for protection of the environment is the biologically active zone. In Eagle Harbor, this zone is defined as the top ten centimeters of marine sediment. RI sediment sampling focused primarily on contamination in these surface sediments. Sampling to evaluate the depth of contaminated sediment was limited, particularly in the West Harbor, where contamination arrived through surface transport. In the East Harbor, more extensive work was completed to assess potential subsurface contaminant migration.

While the top ten centimeters is where remedial action objectives must be met to minimize the exposure of marine organisms to the contamination, volume estimates for dredging alternatives took into account the precision of available dredging technologies and the need to leave clean sediments exposed after dredging.

Contamination in the East Harbor appears to be concentrated in the upper meter of sediments but has been found at lower concentrations at depths up to 20 feet in borings collected close to the Wyckoff Facility (Technical Memorandum No. 11). At the edge of the intertidal zone north of the Facility, visible contamination was noted sporadically at depths up to 60 feet (CH2M Hill, March 1994).

6.7 Routes of Migration

PAH and mercury in the environment tend to adsorb to soils or sediments, particularly if they contain high organic carbon content. Modeling of the fate and transport of sediment-bound contamination was conducted during the RI/FS.

In the 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 can be mobilized and, depending on the

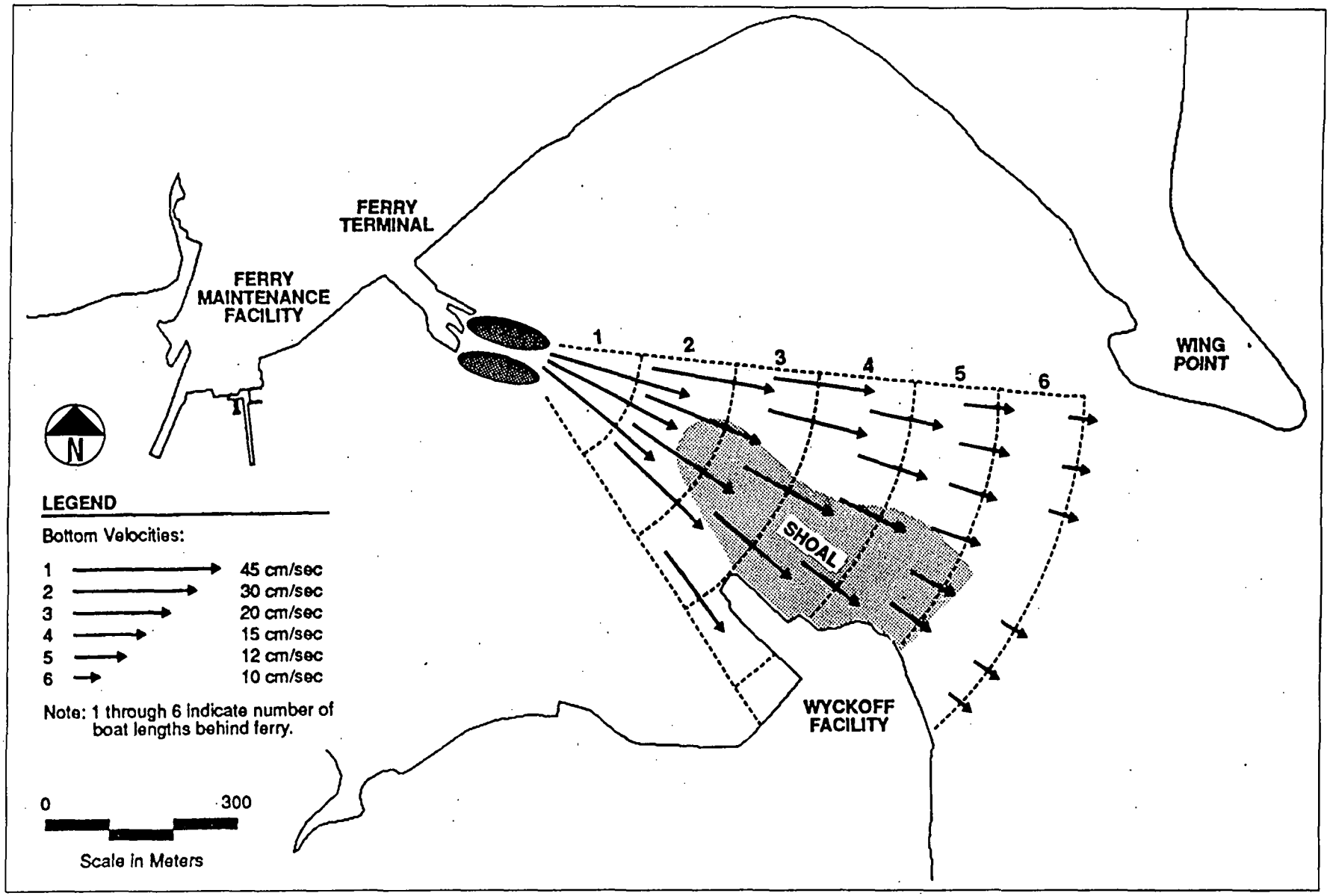


Figure 10
AREAS OF FERRY PROPELLER INFLUENCE

direction of predominant currents, may settle further into the harbor or out of the harbor mouth. Coarser-grained material stirred up by propeller-induced currents 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 intertidal areas, wave action can suspend fine sediments and in some locations moves larger particles. This is the case for Rockaway Beach, outside the harbor mouth, where currents tend to move particles along the shoreline toward the harbor.

Mercury and PAHs can also be distributed in the environment through uptake by plant and animal species and accumulation in tissues; for mercury, this requires the microbial transformation of inorganic mercury into bioavailable forms. PAHs, although generally metabolized by vertebrates, can accumulate in invertebrate tissues. While metals do not break down, PAHs are subject to photodegradation, chemical decay, and microbial action. These breakdown processes are most effective in intertidal areas, due to the aerobic conditions and exposure to sunlight. Breakdown rates differ among the PAHs and tend to be fastest for the LPAHs.

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, through sediment transport and biological uptake.

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 this 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). EPA has defined sediments containing free-phase oily contamination as the principal threat in the East Harbor. Free-phase oily contamination contains very high levels of PAHs. Near the surface it becomes available to marine organisms and may be remobilized by biological activities or other disturbances of surface sediments.

7. SUMMARY OF SITE RISKS

CERCLA response actions at the East 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 East Harbor.

To assess the risk posed by site contamination, EPA completed human health and environmental risks assessments 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 East Harbor.

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, because dermal contact with and ingestion of contaminated sediments is possible. Consumption of contaminated fish and shellfish harvested in Eagle Harbor 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	Phenol			Benzoic acid	2,4,5-Trichlorophenol		
Dibenzofuran	2,3,4,5-Tetrachlorophenol			2-Methylphenol			
Pentachlorophenol				4-Methylphenol			
Polycyclic Aromatic Hydrocarbons (PAH)							
Acenaphthene	Dibenzo[a,h]anthracene						
Acenaphthylene	Fluoranthene						
Anthracene	Fluorene						
Benzo[a]anthracene	Indeno[1,2,3-cd]pyrene						
Benzo[a]pyrene	2-Methylnaphthalene						
Benzo[b]fluoranthrene	Naphthalene						
Benzo[g,h,i]perylene	Phenanthrene						
Benzo[k]fluoranthene	Pyrene						
Chrysene							
Nitrogen-Containing Aromatic Compounds (NCACs)							
Acridine	Indole	Quinoline					
Benzoquinoline	Isoquinoline						
Carbazole	Methylcarbazole						
Volatile Organic Compounds (VOCs)							
Chloroform				Acetone	Carbon disulfide	Methylene chloride	Toluene
Chloromethane				2-Butanone	Ethylbenzene	Styrene	Xylenes
Metals							
Antimony	Cadmium	Nickel	Zinc	Aluminum	Cobalt	Manganese	Silver
Arsenic	Chromium	Thallium	Mercury	Barium	Iron	Potassium	Sodium
Beryllium	Lead	Copper		Calcium	Magnesium	Selenium	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. As this is not the case for dermal and oral cancer endpoints, 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 Assessment 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 six 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 three 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

Table 5 - Human Toxicity Factors of Chemicals Retained for Risk Quantification

COMPOUND	Weight of Evidence[a]	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

[a] 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[a]	0.059[a]	0.076[a]	0.097[a]	0.122[a]	0.138[a]	0.151[f]
FI:	Fraction ingested (unitless)[c]	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)[e]	12	17	25	36	51	671	70
ATn:	Averaging time for noncarcinogenic effects (days)[c]	730	1,095	1,095	1,095	1,095	1,095	20,805
ATc:	Averaging time for carcinogenic effects (days)[c]	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[a]	0.260[a]	0.336[a]	0.428[a]	0.540[a]	0.609[a]	0.668[g]
FI:	Fraction ingested (unitless)[c]	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)[e]	12	17	25	36	51	61	70
ATn:	Averaging time for noncarcinogenic effects (days)[c]	730	1,095	1,095	1,095	1,095	1,095	20,805
ATc:	Averaging time for carcinogenic effects (days)[c]	27,375	27,375	27,375	27,375	27,375	27,375	27,375

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

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

[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).

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, lower than the hazard index based on 1988 data.

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. The highest risk of 10^{-3} was associated with clams collected from adjacent to the Wyckoff Facility. Background clam tissues collected near the mouth of Eagle Harbor produced risks from 1×10^{-4} to 5×10^{-4}.

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 1×10^{-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 fish tissue data for the PAH contributing most to the risk 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 presence in seafood of other contaminants that may not be site-related, 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. However, human health risk estimates for exposure to sediment contaminants through dermal contact and sediment ingestion are within or below EPA's range of acceptable risks. 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 East Harbor areas near the former Wyckoff Facility) results in risks above 10^{-4}. While similar cancer risk estimates were obtained for tissues such as whole perch, sole muscle, and crab hepatopancreas, uncertainties in these data should be considered. Noncancer hazard indices for seafood consumption at both Eagle Harbor and background locations were as high as 1 based on 1988 data, but subsequent data resulted in significantly lower values, suggesting similar uncertainties in data.

Human health risks for Eagle Harbor are thus primarily associated with the consumption of contaminated shellfish. For the East Harbor, specifically, cancer risks in the 10^{-3} range were associated with clam tissues from beaches adjacent to the Wyckoff Facility.

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 benthic organisms demonstrate biological responses at different concentrations, leading to a range of AETs (e.g., for benthic effects, amphipod acute toxicity, oyster larvae acute toxicity, 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 the lowest AET (generally for either oyster larvae or microtox) in most of the contaminated areas. In the East Harbor particularly, sediments exceeded the benthic AET for at least two individual PAHs at numerous stations. 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. Such locations fall 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 were statistically compared with control samples and background samples. 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.

The bioassays for acute toxicity indicated that sediments from many sampled locations in the East Harbor were toxic to amphipods, oyster larvae, or both. The bioassay responses were most severe in areas of high PAH contamination, such as areas of the East Harbor north of the Wyckoff Facility. Bioassays on benthic infauna are valuable indicators because the organisms live in direct contact with the sediments, are relatively stationary, and 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, samples of benthic infauna were collected to assess the impacts of contamination on resident benthic communities. As replicates were not collected at each station in Eagle Harbor, however, statistical comparisons of benthic abundance data between individual stations were 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 in abundance 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 benthic AET for large areas of the harbor, adverse effects on benthic communities at the level of major taxa (polychaeta, molluscs, amphipods, other crustacea) may not be occurring except in the more heavily contaminated areas close to the Wyckoff Facility.

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 risk 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, ecological risks due to contamination in the East Harbor are evidenced by documented acute toxicity of sediments near the former wood treating facility, by the predicted toxicity of other sediments with contaminant concentrations above AETs, and by the presence of mercury and PAHs, which can accumulate in the tissues of food chain organisms.

7.3 Summary of Risk Assessment

Actual or threatened releases of hazardous substances from this site, if not addressed by implementing the response 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 East Harbor is warranted. Consumption of shellfish from intertidal locations of the East Harbor adjacent to the Wyckoff Facility 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.

Adverse biological effects were documented in much of the East Harbor. Most of the biological effects previously observed were associated with heavy sediment contamination. Potential redistribution of contaminants through sediment redistribution from these heavily contaminated areas was also of concern, as well as the potential for uptake by marine organisms. These heavily contaminated areas were addressed by the cap completed as the first phase of cleanup, under CERCLA removal authorities. Other areas of the East Harbor contain levels of contamination predicted to cause minor or, in some areas, significant biological effects. Cleanup is warranted to address sediments where significant biological effects are predicted, unless biological data indicating the absence of such effects is obtained.

7.4 Special Site Characteristics

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

- 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;

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

- 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;

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

- 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, 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 key elements of the FS (November 1991), including the identification of cleanup areas in the East Harbor, the screening of alternatives, and the development of individual alternatives for the East Harbor, including cost estimates and time frames. Descriptions of the alternatives are provided in Section 8.4.

The FS identified cleanup alternatives for sediments in intertidal and subtidal areas of Eagle Harbor, including technologies effective for PAH contamination, for metals contamination, and for both. The alternatives spanned a range of costs and complexity, from no action to treatment. For East Harbor sediments, where the predominant contaminants are PAHs, seven alternatives were carried forward for detailed evaluation, including the no action alternative as required. Six other alternatives were eliminated for East Harbor sediments due to issues of effectiveness, waste characteristics, process complexity, implementability, and the availability of more suitable options. Table 7 lists all of the alternatives considered and identifies those carried forward for East Harbor sediments.

8.1 Applicable or Relevant and Appropriate Requirements

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

The Sediment Standards, described in Section 6, are a primary ARAR for this site, and are used in defining the overall site cleanup objective. Clean Water Act Sections 401 and 404, relating to dredging and fill activities in the waters of the United States, are potential ARARs for all active remedial alternatives. Compliance with these ARARs would require monitoring of water quality during dredging or capping, and would involve habitat mitigation if the cleanup results in an unavoidable loss of aquatic habitat. Section 10 of the federal Rivers and Harbors Act, as well as the state Hydraulic Code Rules and Shoreline Management Act could also be ARARs for active alternatives.

Other potential ARARs are associated with specific alternatives. RCRA and the State of Washington Dangerous Waste Regulations could apply for on-site alternatives involving disposal of sediments. For consolidation and containment without treatment within an area of contamination these would not be applicable but could be relevant and appropriate. For alternatives involving dredging and treatment of East Harbor sediments, these laws would be applicable for sediments determined to be dangerous or hazardous wastes. For *in situ* alternatives, such as Capping, No Action, and Institutional Controls, these regulations would not be ARARs.

Discharges of wastewater generated by dredging or treatment of the sediments could be subject to the state Water Pollution Control Act and Water Quality Standards, as well as the National Pollution Discharge Elimination System (NPDES). For wastewater discharged to a publicly-owned treatment works, the state Waste Discharge Permit Program could apply. For alternatives with potential air

Table 7
Screening of Alternatives

	Alternative	East Harbor PAH Areas	
		Intertidal Sediments	Subtidal Sediments
A.	No Action/Natural Recovery	●	●
B.	Institutional Controls/Natural Recovery	●	●
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		

● Alternative carried forward for area indicated.

Not carried forward.

releases, such as incineration, the federal Clean Air Act and Puget Sound Air Pollution Control Agency regulations are potential ARARs.

8.2 Estimated Cleanup Areas

As described in Section 3.5, part of the East Harbor was covered with a clean sediment cap after completion of the RI/FS and issuance of the 1991 Proposed Plan. This section describes remaining East Harbor areas which may require cleanup, as proposed in the 1994 Proposed Plan, and explains the relationship between these areas and areas used to develop FS cost estimates.

The Sediment Standards provide a process for defining sediment cleanup sites by comparing site chemical data to chemical criteria. As shown in Tables 8 and 9, the Sediment Standards provide two levels of biological and chemical criteria, the more stringent level corresponding to the sediment quality standards (SQS), below which sediments pose no significant risk and do not require further study, and the less stringent level corresponding to the minimum cleanup level (MCUL), above which cleanup must be considered. Between the two levels, chemical concentrations are associated with minor adverse biological effects. Collection of biological data is optional, but if specific biological information is collected, comparison of these results to the biological criteria of the Sediment Standards determines whether or not sediments meet the Sediment Standards. At least three different biological measures--two acute and one chronic--are required for comparison to the biological criteria.

Figure 11 shows Eagle Harbor sediments contaminated above the chemical criteria for one or more of the contaminants of concern based on RI/FS data. A larger area exceeds the more stringent SQS chemical criteria than the MCUL chemical criteria. Table 10 provides estimated areas of East Harbor subtidal surface sediments with contaminant concentrations above the MCUL chemical criteria and the more stringent SQS chemical criteria. Figure 11 also shows the existing cap in the East Harbor. The cap was placed over areas where subtidal sediments failed both chemical and biological criteria at the MCUL level, indicating significant adverse biological effects in these areas.

Because biological tests were performed at Eagle Harbor before the Sediment Standards were promulgated, available biological data for remaining areas of the East Harbor cannot be compared to the Sediment Standards biological criteria with the completeness necessary to override chemical results. Biological data collected during the RI/FS can be compared to two acute toxicity criteria of the Sediment Standards, but data on chronic biological effects are not sufficient for comparison to a third, chronic criterion. Thus, remaining potential cleanup areas in the East Harbor are defined based on the comparison of chemical data to the Sediment Standards.

Cleanup areas estimated in the FS prior to completion of the cap are also shown in Table 10. These estimates were used to support FS cost estimates and were developed based on an interpretation of both chemical and biological data, rather than chemical data alone. As shown in Table 10, the FS area estimates are comparable to the remaining cleanup areas based on chemical criteria alone. For this reason, existing FS cost estimates can be used in the evaluation of cleanup alternatives for the remaining subtidal areas defined by the MCUL and SQS chemical criteria.

For intertidal PAH areas, the FS developed cost estimates for the combined East and West Harbor. The East Harbor area estimate is listed in Table 10. Cleanup costs for intertidal areas in the East Harbor only would be approximately two thirds of the FS cost estimates.

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).

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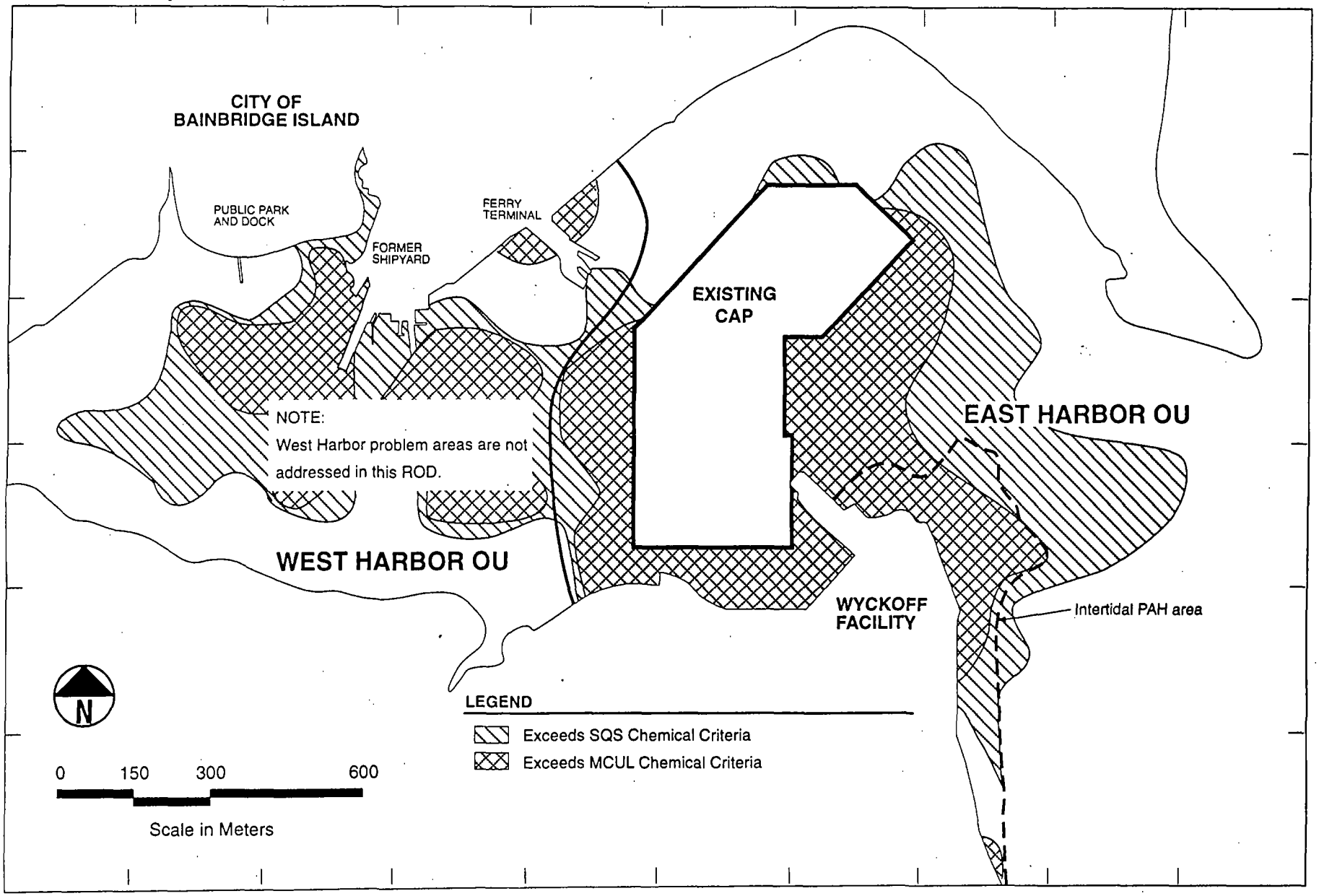

Figure 11
EAST HARBOR AREAS DEFINED BY SEDIMENT MANAGEMENT STANDARDS

Table 10
Area Estimates for the East Harbor

Potential Cleanup Area	Area (square meters)	Area (acres)
Remaining Subtidal PAH Areas[a]		
above the MCUL	259,000	64
above the SQS	488,000	121
Subtidal PAH Areas Estimated in FS[b]		
Lower-bound estimate	235,000	58
Upper-bound estimate	420,000	103
FS Intertidal PAH Area[c]	35,000	9

[a] These areas are derived by comparison of RI data to the Sediment Standards chemical criteria, after the 222,000 m^2 area (55 acres) subsequently covered by the existing cap is deducted.
[b] FS areas were developed prior to the existing cap, using the same RI chemical data but reflecting EPA interpretation of available RI biological data. These are the basis for cost estimates in Table 12B.
[c] PAH intertidal areas were estimated separately in the FS for East Harbor and West Harbor sediments. The combined areas are the basis for estimated costs of the remedial alternatives in Table 12A.

As noted above, available biological data did not allow comparison to the Sediment Standards biological criteria for the full complement of three biological measures. Figure 12 shows the results of the two acute toxicity tests completed during the RI/FS, relative to the SQS and MCUL biological criteria (Table 9). As shown, some areas with contaminant concentrations above the MCUL demonstrated minor or no acute effects in acute toxicity testing. If further testing shows that such areas meet all three biological criteria, they will not require cleanup under the Sediment Standards. Without this testing, however, cleanup areas must be based on chemical data only.

8.3 Common Components of Alternatives

A number of remedial alternatives evaluated in the FS share certain components. Table 11 shows which elements are common to alternatives considered for the East Harbor. Further detail is provided in the FS. Potential navigational constraints were considered for all of the active remedial alternatives.

The following elements are also important to all of the alternatives:

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

A brief discussion of each is provided in the following sections.

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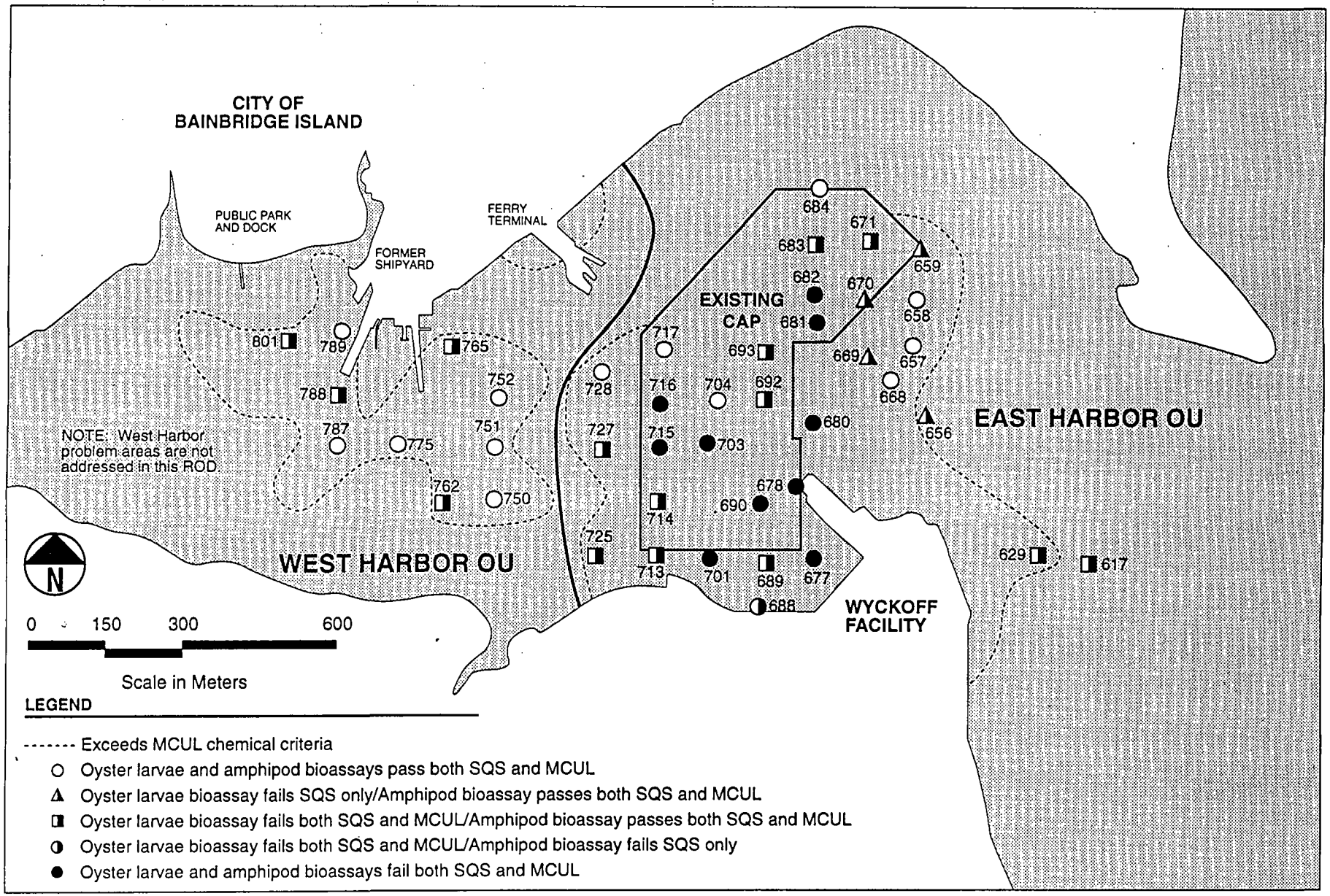


Figure 12
COMPARISON OF EAGLE HARBOR JUNE 1988 SUBTIDAL OYSTER LARVAE AND AMPHIPOD BIOASSAY RESULTS TO WASHINGTON STATE SEDIMENT STANDARDS

8.3.1 Institutional Controls

Institutional controls are controls on the use of a site. They are generally intended to limit human or environmental exposure to contaminants or to protect completed cleanups.

For the East Harbor, institutional controls alone were considered as an individual alternative (Alternative B), consisting of continuation of the existing health advisory, fencing and additional warnings on the beach adjacent to Wyckoff Facility, community outreach, and seafood monitoring. Institutional controls would likely be necessary in conjunction with active remedial alternatives, because the design and implementation of cleanup would take several years and corresponding reductions in seafood contaminant levels could take still longer.

Institutional controls could also be necessary to prevent disturbance or damage to completed or ongoing cleanups. For example, limits on anchoring, dredging, or other sediment disturbance could be necessary for containment alternatives which leave contamination on site.

8.3.2 Source Control

Source control is an important element of any cleanup. For the East Harbor further source control is necessary prior to final sediment remediation. East Harbor sediment cleanup alternatives include monitoring to verify source control. However, they do not include efforts to control sources of contamination from other areas of the site.

In general, sources to sediments may include discharges, runoff, or spills directly to beaches or surface water, as well as releases through more indirect pathways such as groundwater transport, seepage, air deposition, or movement of contaminated sediments from one area to another. For East Harbor sediments, the chief source of contamination is the inactive Wyckoff Facility, and the bulk of sediment contamination is likely due to past operations. Oily seepage on the beach has been reduced by ongoing cleanup efforts, and additional cleanup at the Facility is likely under an interim groundwater ROD and a final ROD for soil and groundwater. These actions are expected to control continuing sources of contamination over the next three to six years.

The West Harbor is a probable continuing source of mercury contamination to the East Harbor. Implementation of sediment cleanup pursuant to the West Harbor ROD (1992) is anticipated to eliminate sources of mercury to the East Harbor.

8.3.3 Natural Recovery

The Sediment Standards allow mathematical modeling as a means to identify areas which, through natural recovery, would meet cleanup objectives without active remediation. These areas may then be designated as sediment recovery zones and monitored to verify predicted recovery.

Cleanup areas in Table 10 are based on conditions at the time of RI/FS data collection, without designation of sediment recovery zones. However, under the Sediment Standards, No Action and Institutional Controls would require designation of sediment recovery zones unless used in combination with active remedial alternatives. Even if active cleanup were selected, sediment recovery zones could be designated. The site-specific objective could incorporate a natural recovery period or could identify a basis for selecting natural recovery in specific areas. Ten years is generally

Table 11
Summary of Common Components for East Harbor 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[f]
		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]	•			•				•
H.	Removal, Treatment by Incineration, and Disposal	•		•	•	•	•	•	•	•	•
L.	Removal, Treatment by Biological Slurry, and Disposal	•		•	•	•	•	•	•	•	•

[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, temporary nearshore sediment storage may not be needed.
[f]The 5-year review would be conducted with all alternatives.
• = Component is included in alternative.

used as a reasonable time frame for natural recovery, starting when significant contaminant sources are controlled. A longer period can also be authorized.

EPA conducted mathematical modeling during the RI/FS to evaluate the potential for natural recovery of contaminated Eagle Harbor sediments within ten years of source control. The evaluation and technical references may be reviewed in Appendix D1 of the FS. Briefly, the model used RI/FS data to represent sediment contaminant levels at the time of contaminant source control, and available information from the scientific literature was used to estimate PAH degradation rates, loss by advection (sediment movement), and other natural processes. Sedimentation rates were estimated based on a watershed model (see Table 1, Technical Memorandum #4, 1989). Since Eagle Harbor is not fed by a river or other significant upland sources of sediment, estimated sedimentation rates were relatively low.

Key references for degradation rates included Cerniglia and Heitcamp (1989), Lee and Ryan, (1983) and Payne and Phillips (1985). The studies indicated that degradation of PAHs is enhanced by exposure to ultraviolet or visible light, that LPAHs tend to break down faster than HPAHs due to their solubility, that high concentrations of PAHs inhibit breakdown rates, and that aerobic conditions tend to enhance microbial breakdown processes. Thus, once sources are controlled, PAH degradation is likely to be fastest in sediments exposed to light, biological mixing, and wave action, or in areas where contaminants are at low to moderate levels in only the biologically mixed surface layer. Since metals are not degradable, natural recovery of metals-contaminated sediments would rely on sedimentation, advection, and other natural processes.

Based on the natural recovery evaluation in the FS, areas north of the Wyckoff Facility containing heavy PAH contamination and some metals contamination were not predicted to achieve the Sediment Standards without active remediation. However, less contaminated subtidal areas without metals contamination had some potential to achieve the Sediment Standards for PAHs within ten years, once sources of contamination were controlled. Natural recovery was predicted to be most effective in intertidal areas containing PAHs, due to the active water regime and exposure of sediments to light and air. Based on limited data and assumptions, these estimates of natural recovery are approximate and would require verification through monitoring.

8.3.4 Sampling During Remedial Design

Although extensive source, chemical, and biological information was collected during the RI/FS and previous studies of Eagle Harbor, additional sampling is likely to be needed during remedial design.

Remedial design sampling would be used to refine actual cleanup areas and volumes for design purposes and is included for all alternatives other than No Action and Institutional Controls. In the East Harbor, EPA expects that ongoing processes in the marine environment may have reduced contaminant levels since the RI/FS. If complete biological information is collected, comparison to the Sediment Standards may also result in reduced cleanup areas.

8.3.5 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. For FS cost

estimates, monitoring was assumed to continue for thirty years and generally included chemical and biological monitoring, seafood 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.

8.4 Description of the Alternatives

The following descriptions of cleanup alternatives considered for the East Harbor is a summary of more detailed information provided in the Eagle Harbor FS. Cost estimates for the East Harbor areas estimated in the FS (Table 10) are provided in Tables 12A and 12B. Table 13 provides estimates of the time necessary to implement each alternative. Remedial action areas, costs, and time frames for the East Harbor would 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 Facility 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 achieved cleanup objectives.

Natural recovery could occur gradually 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. As stated in Section 8.3.3 above, intertidal areas are expected to recover within ten years, once significant contaminant sources are controlled, and natural recovery processes may also significantly reduce contamination in subtidal areas with marginal contaminant levels. Most of the more heavily contaminated subtidal areas, where natural recovery could take fifty years or more, have been addressed by the existing cap.

No initial costs are incurred. 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

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 (see No Action), and 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. Fencing would be used to restrict access to beach areas near the Wyckoff Facility. 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

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 layer of clean medium- to coarse-grained sand approximately 1-meter (3-feet) thick, 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.

In order to provide full coverage of cleanup areas at the intended thickness, the side-slopes of the cap would extend into adjacent unremediated areas. For purposes of estimating quantities in the FS, approximately 3 meters (10 feet) of overlap was assumed. 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.

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 and could affect the thickness and extent of capping. Areas affected by currents induced by ferry propellers could require a coarser grained material as "armoring" to hold the cap in place.

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

ALTERNATIVE D. REMOVAL, CONSOLIDATION, AND CONFINED AQUATIC DISPOSAL

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 (three 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 four to six years. This estimate assumes a minimum of a year for design, six months to excavate the CAD basin, two years to dredge and place the contaminated sediment, six months to cover, and a year to mobilize and demobilize the operation.

ALTERNATIVE E. REMOVAL, CONSOLIDATION, AND NEARSHORE DISPOSAL

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 if necessary for post construction use, and a stormwater collection system would be installed. As the containment area would be built in nearshore areas which generally provide valuable habitat, habitat mitigation would probably be required. It is estimated that design, procurement, and construction of the nearshore disposal facility for the total volume of sediment would take four to five years.

ALTERNATIVE H. REMOVAL, TREATMENT BY INCINERATION, AND DISPOSAL

Use of this alternative would be limited to PAH-contaminated intertidal areas with concentrations 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 eight to eleven years. The volume of East Harbor sediments contaminated only with PAH is somewhat smaller, but would not take appreciably less time to incinerate. 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.

Table 12A. Estimated Costs[a] of East Harbor Sediment Cleanup Alternatives Evaluated in Feasibility Study INTERTIDAL SEDIMENTS			
Alternative	Costs in Dollars Based on FS Intertidal Area[b] 55,000 m² (14 acres)		
	Initial	O&M[c]	Total
No Action/Natural Recovery	0	300,000	300,000
Institutional Controls/Natural Recovery	24,000	376,000	400,000
Capping	5,900,000	600,000	6,500,000
Confined Aquatic Disposal	9,800,000	800,000	10,600,000
Nearshore Confined Disposal	29,500,000	1,500,000	31,000,000
Incineration	99,200,000	2,800,000	102,000,000
Biological Treatment	71,500,000	1,900,000	73,400,000

Table 12B. Estimated Costs[a] of East Harbor Sediment Cleanup Alternatives Evaluated in Feasibility Study SUBTIDAL SEDIMENTS			
Alternative	Costs in Dollars Based on FS Lower Bound Area[d] of 235,000 m² (58 acres)		
	Initial	O&M[c]	Total
No Action/Natural Recovery	0	300,000	300,000
Institutional Controls/Natural Recovery	0	400,000	400,000
Capping	13,700,000	800,000	14,500,000
Confined Aquatic Disposal	26,600,000	1,300,000	27,900,000
Nearshore Confined Disposal	46,700,000	1,000,000	48,600,000
Incineration	238,700,000	5,200,000	243,900,000
Biological Treatment	176,000,000	4,000,000	180,000,000

[a] Initial capital costs are based on 1990 dollars, and present worth of O&M was calculated using an 8% discount rate and a 30-year amortization period. Estimates are intended to be within +50% and -30% of actual costs, based on the estimated volumes.

[b] Intertidal costs are based on 55,000 square meters, an area which includes 35,000 square meters of intertidal sediments in the East Harbor and 20,000 square meters in the West Harbor. Actual costs would be lower, but relative costs would not change significantly.

[c] O & M is operations and maintenance, including monitoring.

[d] Estimated costs are based on areas developed for the Feasibility Study, for lower bound cleanup areas. This estimate is close to the estimated area of sediments not included in the capped areas of the East Harbor.but which fail one or more of the MCUL chemical criteria (259,000 m²), as shown in Table 10.

[d] Areas outside the existing cap which fail one or more of the SQS chemical criteria are estimated at 488,000 m², approximately double the lower bound areas. Estimated costs for addressing these are provided in the FS, as upper bound cost estimates.

ALTERNATIVE L. REMOVAL, TREATMENT BY BIOLOGICAL SLURRY, DISPOSAL

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 standards 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 nine to eleven years for PAH-contaminated sediments throughout Eagle Harbor. For the East Harbor only, slightly less time would be necessary.

Table 13. Estimated Time to Implement East Harbor Remedial Alternatives

Alternative	Estimated Time for Design, Procurement, and Remediation[a] (years)
A. No Action	NA
B. Institutional Controls/Natural Recovery	1 to 10
C. Capping	3 to 4
D. Removal, Consolidation, and Confined Aquatic Disposal	4 to 6
E. Removal, Consolidation, and Nearshore Disposal	4 to 5
H. Removal, Treatment by Incineration, and Disposal	8 to 11
L. Removal, Treatment by Biological Slurry, and Disposal	9 to 11

[a] Modification of FS Table 5-1, which assumed cleanup of all problem areas in Eagle Harbor (430,000 M^3). Timeframes adjusted to reflect volumes in areas for which alternative was developed for detailed evaluation.
NA = Not Applicable.

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 of the cleanup alternatives evaluated are protective of human health except No Action. However, to ensure protection of human health prior to achievement of cleanup objectives, active cleanup alternatives should be combined with institutional controls as needed.

All alternatives evaluated are protective of the environment, except for No Action and Institutional Controls. However, if the site cleanup objective incorporates a ten year recovery period, these alternatives would also be protective of the environment in areas predicted to achieve this objective in the specified time frame through natural recovery.

9.1.2 Compliance with Applicable or Relevant and Appropriate Requirements

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

All alternatives except No Action and Institutional Controls could comply with the primary ARAR (the Sediment Standards) throughout the East Harbor. No Action and Institutional Controls would comply with the ARAR only if a ten-year natural recovery period were incorporated into the cleanup objective, and then only in areas predicted to recover within this timeframe. Other potential ARARs associated with implementation of individual alternatives, such as dredging, filling, storage, treatment, or disposal, could be met. In some cases, special engineering controls, treatability testing, or habitat mitigation would be necessary to ensure compliance with these ARARs.

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 options in which treatment is a principal element over institutional controls or off-site disposal of untreated waste. In general, treatment is practicable and preferable for small volumes of highly contaminated material. Containment alternatives are appropriate when large volumes containing relatively low levels of contamination are involved, as is the case for many contaminated sediment sites.

The treatment alternatives evaluated for the East Harbor, including Biological Treatment and Incineration, would permanently destroy PAH and other organic compounds.

Alternatives involving containment, such as Capping, Confined Aquatic Disposal, and Nearshore Disposal, can be effective over the long term, but they do not permanently remove or destroy the contaminants. Long-term monitoring and maintenance are necessary to assure their continued protectiveness.

Alternatives relying on natural recovery, such as No Action and Institutional Controls, would require monitoring to verify achievement of site objectives. Depending on whether recovery was achieved

through natural contaminant breakdown or through burial by deposits of clean sediment, the effectiveness and permanence of natural recovery alternatives could be comparable to treatment alternatives or containment alternatives.

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.

Alternatives involving treatment, including Biological Treatment and Incineration, would reduce the toxicity and mobility of PAH contamination.

Alternatives involving containment of untreated sediments, such as Capping, Confined Aquatic Disposal, and Nearshore Disposal, restrict the movement of contaminated sediments and 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.

Alternatives relying on natural recovery, such as No Action and Institutional Controls, could reduce the toxicity, mobility, and volume of contaminated sediments if recovery was achieved through natural contaminant breakdown.

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.

Alternatives involving treatment, such as Biological Treatment and Incineration, would require dredging of contaminated sediments, since *in situ* treatment methods for PAH contamination have not been developed. Dredging would destroy the existing benthic community and in subtidal areas could have negative short-term impacts on the environment, particularly in areas with oily free-phase contamination. Specifically, subtidal dredging could remobilize contamination into the water, potentially spreading it to nearby areas. For intertidal areas, the short-term environmental risks associated with dredging are reduced somewhat, because sediments can be excavated at low tide to minimize remobilization of contaminants. However, changes in habitat as a result of dredging could require mitigation. In addition to risks associated with dredging, dredged sediments and treatment residuals could pose risks to the environment, workers, and the community from potential contaminant releases during subsequent storage, processing, and treatment phases. Among active remedial alternatives, implementation of treatment alternatives takes the longest (Table 13).

Alternatives involving consolidation and containment, such as Confined Aquatic Disposal and Nearshore Disposal, would also require dredging. The short-term risks to the environment due to dredging would be the same as for treatment alternatives. Creation of a containment facility in subtidal or nearshore areas would destroy the existing benthic community. The shorter time frame for implementation of the containment alternatives would pose short-term risks to the community for a correspondingly shorter time. Intertidal sediments could be excavated at low tide, posing a reduced

risk of contaminant releases. However, dredging or construction of a containment facility in intertidal areas could require mitigation for loss of or damage to valuable nearshore habitat.

The *in situ* alternative of Capping provides the greatest short-term effectiveness. A clean sediment cap can be implemented relatively quickly and poses fewer short-term risks to human health and the environment, because contaminated sediments are not dredged, stored, or processed. As with other active alternatives, placement of a cap would damage or destroy the existing benthic community, depending on placement methods and cap thickness. Capping in intertidal areas could require habitat mitigation for loss to or damage of valuable nearshore habitat.

The No Action and Institutional Controls alternatives have the least short-term impacts from implementation but do not protect the environment unless natural recovery can achieve the cleanup objectives in a reasonable time frame.

As noted, all active remedial alternatives would damage or destroy the existing benthic community. However, studies show that marine organisms soon recolonize clean sediment. This process can begin immediately after capping or removal of contaminated sediments; however, development of a mature community of sediment-dwellers can take several years. Recolonization of larger areas may be slower.

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. All of the alternatives evaluated are technically feasible, although testing would be necessary to assure the achievement of performance standards for treatment alternatives. Active alternatives would involve monitoring and engineering controls to limit releases during implementation and, with the exception of Capping, would require management of dredging and/or treatment residuals.

Administrative feasibility assesses the ability to coordinate actions with other agencies. All of the alternatives evaluated are administratively feasible. Active remedial alternatives require coordination with ferry traffic. Alternatives involving treatment, such as Biological Treatment and Incineration, involve extensive and complex administrative and regulatory requirements. In particular, Incineration is less administratively feasible because of the difficulties in locating an incinerator on site in a residential community. Alternatives involving containment, such as Confined Aquatic Disposal, Nearshore Disposal, and Capping, include dredging and clean sediment placement, which could require coordination with PSDDA agencies.

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. 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. Upland areas for on-site storage, processing, and treatment are limited to the upland Wyckoff Facility. Until completion of remedial studies at the facility, designation of such an area would be premature.

9.2.5 Cost-Effectiveness

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

Alternatives involving treatment, such as Biological Treatment and Incineration, generally entail higher initial costs. On-site containment alternatives, such as Confined Aquatic Disposal, Nearshore Disposal, and Capping, tend to have lower costs 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 both of these alternatives may not achieve the cleanup objectives or meet threshold evaluation criteria. As shown in Tables 12A and 12B, the overall costs for active remedial alternatives are highest for Incineration and lowest for Capping.

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 of Washington Department of Ecology supported the preferred alternative for the East Harbor in both the 1991 and 1994 Proposed Plans. Although Ecology has also written to support the technical aspects of the East Harbor selected remedy, formal concurrence is still under consideration and will not be provided prior to issuance of this ROD.

The Suquamish Tribe reviewed key documents such as the RI and FS and received technical memoranda issued by EPA and 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 considered all comments submitted during the public comment period on the 1991 Proposed Plan as well as the 1994 plan for final cleanup in the East Harbor. The comments have been taken into account during the selection of the remedy for the East Harbor operable unit.

The 1991 Proposed Plan identified capping of heavily contaminated sediments as EPA's preferred alternative for an interim action pending further control of contaminant sources at Wyckoff. Comments on this plan indicated that the community was divided; while many supported EPA's preferred alternative, others indicated a preference for lower cost alternatives such as No Action

(natural recovery over an indefinite period) or some combination of institutional controls, sediment source removal, and natural recovery.

The 1994 Proposed Plan identified capping as the preferred alternative for remaining contaminated areas and identified a framework for implementing other actions as necessary until further control of sources warranted implementation of the final remedy. Limited comment was received, but none indicated opposition to EPA's preferred alternative. EPA responsiveness summaries for both Proposed Plans are included in Appendix B.

10. SELECTED REMEDY

Based on CERCLA, the NCP, the comparative analysis of alternatives, and the Administrative Record, EPA has selected the following alternatives for cleanup of East Harbor sediments:

- Institutional Controls/Natural Recovery (Alternative B) for intertidal areas, and
- Institutional Controls (Alternative B) combined with Capping (Alternative C) in subtidal areas of the East Harbor, excluding subtidal sediment recovery zones to be designated for specific environmental or technical reasons.

As described in Section 3.5, subtidal capping in an area of the East Harbor heavily contaminated with PAHs was completed under CERCLA removal authorities. Figure 13 shows the approximate capped area, subtidal areas, and intertidal areas addressed by the selected remedy. The selected remedy incorporates the existing cap as an element of the final cleanup of the East Harbor.

EPA's selected remedy includes a phasing approach for implementing certain necessary actions in the East Harbor while ongoing cleanup actions at the Wyckoff Facility provide increased control of contaminant sources to Eagle Harbor sediments. This approach is shown graphically in Figure 14. Once significant sources have been sufficiently controlled, the final cleanup of remaining contaminated areas in the East Harbor will commence. The selected remedy also provides for modifications as necessary to ensure that the cleanup objectives will be achieved.

EPA has determined that for the East Harbor the selected remedy provides the best balance of the nine evaluation criteria. Relative to institutional controls alone, the selected remedy protects both human health and the marine environment. Relative to other active alternatives, the selected remedy minimizes short term effects associated with dredging and is quickly and readily implemented at a lower cost, once contaminant sources have been controlled. Long-term effectiveness can be ensured by monitoring and maintenance. State of Washington Department of Ecology concurrence on the selected remedy is under consideration.

Discussion of the East Harbor selected remedy follows, under the following main headings:

- Cleanup Objectives
- Problem Areas and Actions
- Implementation
- Estimated Costs
- CERCLA Five-Year Review

The selected remedy must achieve the project objectives described in Section 10.1, below.

10.1 Cleanup Objectives

For the East Harbor, an overall sediment cleanup objective, developed according to the Sediment Standards, is combined with a supplemental objective for intertidal areas, developed by EPA. The combined sediment cleanup objectives were developed to ensure protection of human health and the environment.

This section provides:

- A summary of the framework provided by the Sediment Standards for selection of sediment cleanup objectives,
- A description of the specific objectives selected for intertidal and subtidal areas of the East Harbor, and
- A brief rationale for their selection.

Sediment cleanup goals and objectives for the East Harbor are largely the same as those for the West Harbor; however, the subtidal cleanup objective has been modified to reflect specific conditions in the East Harbor. Cleanup in the East Harbor and West Harbor is intended to ensure that within a reasonable time frame, sediment contamination is within the range of "minor biological effects" or below, and at levels protective of human health.

10.1.1 Sediment Standards

The Sediment Standards, the primary ARAR for the East Harbor, were promulgated in April 1991 and provide a framework for developing 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 areas (referred to in the Sediment Standards as "sites") and establishing cleanup objectives for these areas is summarized in the following paragraphs.

The Sediment Standards define two levels of chemical criteria. The most stringent level corresponds to the long-term goal of "no adverse effects" on sediment biological resources, while the less stringent level corresponds to "minor adverse effects" on these resources. 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 Sediment Standards also define two levels of biological criteria based on several types of biological tests. Like the chemical criteria, the biological criteria correspond to no adverse effects and minor adverse effects levels.

The absence of adverse effects is predicted by attainment of the more stringent chemical criteria, the "marine sediment quality standards" (SQS) chemical criteria while minor adverse effects are predicted by chemical concentrations ranging from the SQS to the less stringent "minimum cleanup level" (MCUL) chemical criteria. At contaminant levels above the MCUL, more significant effects are predicted, and sediment cleanup must be considered.

Cleanup areas may be defined using chemical criteria alone; 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. The three measures must include two tests for acute toxicity to marine organisms and one for chronic biological effects. If all three biological criteria are met for a given area, this area is not included in the cleanup area and does not require cleanup under the Sediment Standards. Failure to meet the

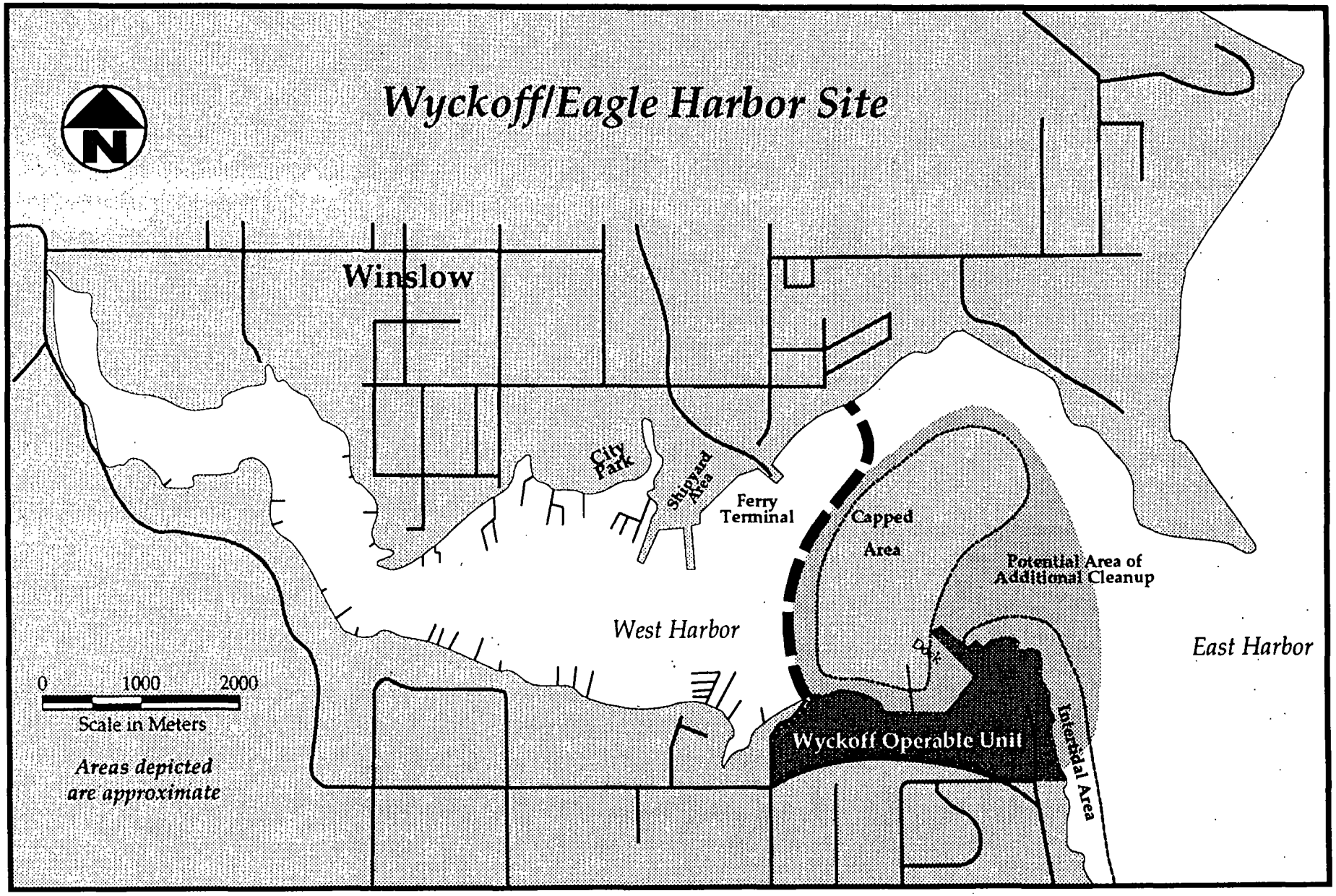


Figure 13
EAST HARBOR ROD AREAS

NPE69206.02.04 • ROD Areas • 8/16/94 • CJS

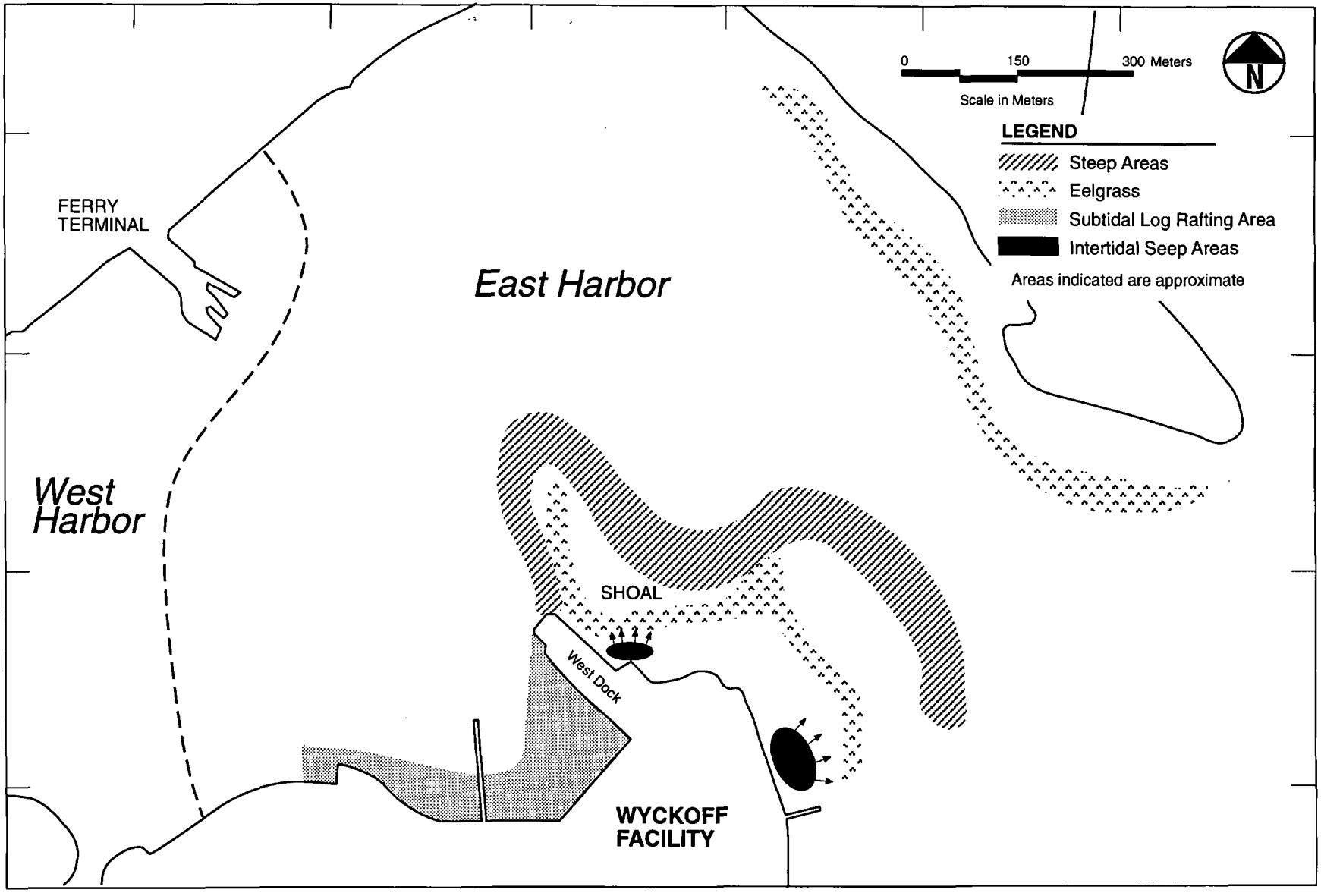
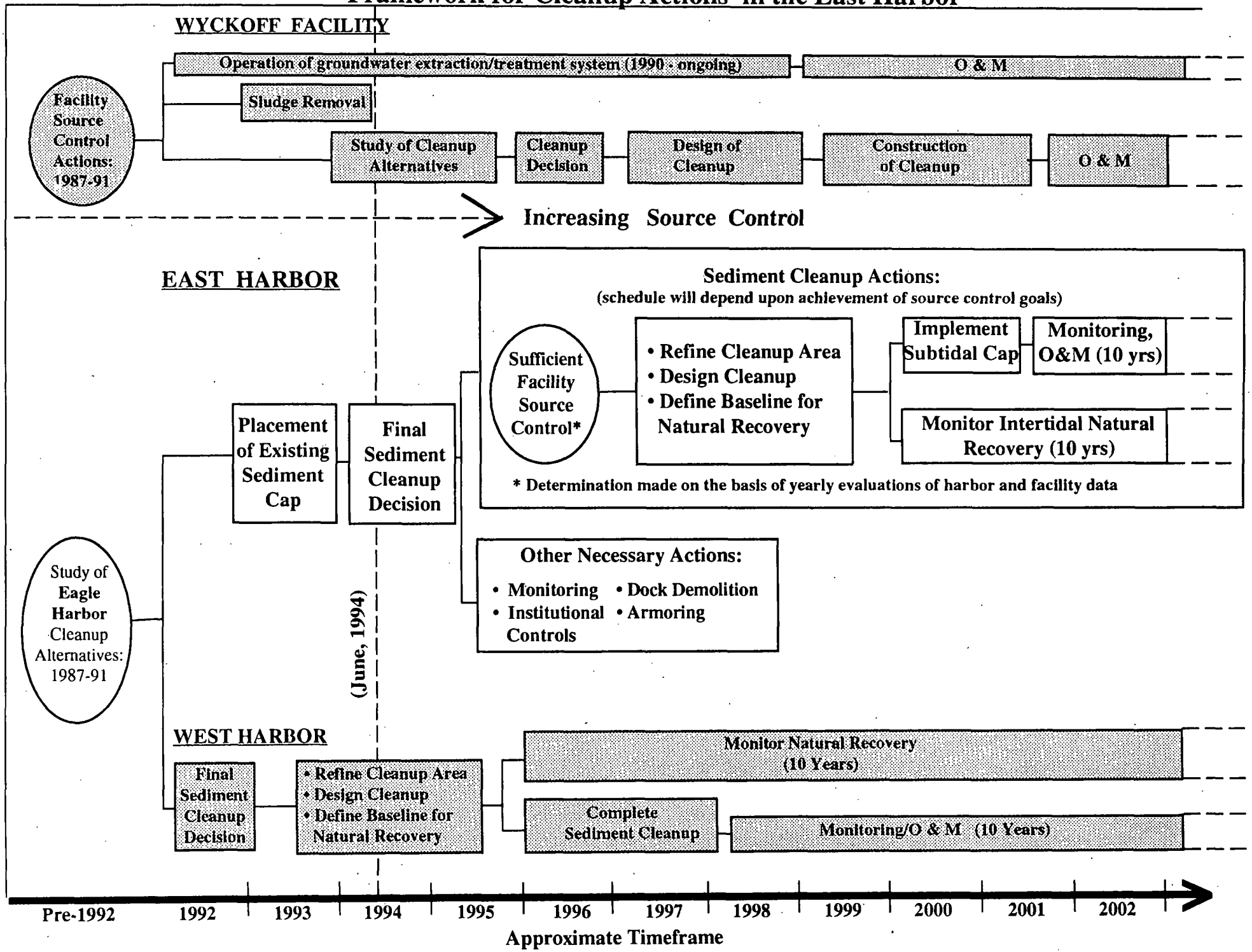


Figure 13A
OTHER SPECIFIC AREAS IDENTIFIED IN SELECTED REMEDY

Figure 14
Framework for Cleanup Actions in the East Harbor



biological criteria at the SQS or MCUL level can be demonstrated by a single biological measure. Failure of more than one criterion at the SQS level is considered equivalent to failure at the MCUL level.

The intent of the Sediment Standards is for sediments within a cleanup area to ultimately meet the sediment quality standards (SQS), the level of no adverse effects. Once a cleanup area has been defined as described above, a cleanup objective for the area is developed. The objective must be within the minor adverse effects range defined by the no adverse effects level (the SQS) and the minor adverse effects level (the MCUL). In all cases, if both biological and chemical data are obtained, the biological information determines compliance with the cleanup objective developed under the Sediment Standards.

In certain cases, natural processes such as chemical breakdown, dispersion, or sedimentation may reduce levels of sediment contamination over time. The Sediment Standards allow selection of an objective which incorporates a reasonable period of time for natural sediment recovery. A period of ten years is generally used as the natural recovery period, although extensions beyond the ten year period may be obtained if warranted. If mathematical modeling predicts that certain areas of contaminated sediment will meet the cleanup objectives within the natural recovery time frame without active remediation, natural recovery may be included among alternatives evaluated for these areas. If natural recovery is selected, the "sediment recovery areas" are delineated, and monitoring and compliance testing required to confirm the predicted recovery.

Net environmental benefits, cost, and technical feasibility of cleanup must be considered in selecting a cleanup objective, including one which may incorporate a recovery period. At a minimum, all sediments in a defined cleanup area must meet the MCUL within ten years after any active remediation is completed in the area.

10.1.2 East Harbor Cleanup Goals and Objectives

Within the framework described above, cleanup goals and objectives were developed for intertidal and subtidal sediments in the East Harbor.

Consistent with the intent of the Sediment Standards and the West Harbor ROD, 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 East Harbor. These goals represent a conceptual target condition for all Eagle Harbor sediments.

The primary measurable objective for East Harbor sediments, however, is the MCUL (WAC 173-204-570). As in the West Harbor, the main focus of remedial action in the East Harbor is achievement of the MCUL, below which minor biological effects are predicted. Compliance with the MCUL is documented by compliance with the corresponding biological criteria or, in the absence of biological data, with the chemical criteria of Table III (WAC 173-204-520). Final cleanup in the East and West Harbor operable units is intended to result in contaminant concentrations at or below the MCUL in surface sediments throughout Eagle Harbor. MCUL and SQS chemical criteria for PAHs and mercury are listed in Table 8, and corresponding biological criteria are provided in Table 9.

EPA developed a supplemental objective for intertidal areas. This intertidal cleanup objective and the MCUL for subtidal and intertidal sediments are described in the following paragraphs.

Subtidal Sediment Objective

As noted, the subtidal cleanup objectives in the two Eagle Harbor operable units differ in one respect. While subtidal sediments in both the East Harbor and West Harbor must be included as part of a cleanup area if they contain contaminant concentrations above the MCUL, in the West Harbor a natural recovery period is incorporated in the objective for a large subtidal area. Active remediation is not required for West Harbor sediments in this area if they are predicted to achieve the MCUL within ten years. For the West Harbor, however, the cleanup objective for subtidal sediments does not incorporate a recovery period, unless warranted by specific physical and ecological conditions in certain areas. Except in limited sediment recovery areas, all East Harbor subtidal sediments with contaminant concentrations above the MCUL require active remediation. The difference between the East and West Harbor subtidal objectives is further discussed in Section 10.1.4.

Identification of subtidal sediment recovery zones in the East Harbor is provided for only in areas where capping could adversely affect sensitive and valuable habitat, such as eelgrass, or where engineered cleanup is not practicable, such as areas which are too steep or too deep. Preliminary areas with steep slopes or eelgrass beds are identified in Figure 13A. Criteria for delineation of these areas will be developed during the remedial design phase, based on current environmental science and engineering information. In remaining subtidal areas, active remediation is required if the top ten centimeters of sediment contain contaminant concentrations above the MCUL at the completion of source control. This subtidal objective is termed MCUL-0 in this ROD (because cleanup is required for areas with contaminant concentrations exceeding the MCUL at "time zero," control of significant sources).

Intertidal Sediment Objectives

For East Harbor intertidal sediments, as with intertidal PAH areas in the West Harbor, the surface ten centimeters must achieve the MCUL within ten years from control of significant sources to these areas. Since this objective incorporates the ten-year recovery period, it is termed MCUL-10.

The objective of the MCUL is supplemented by an objective of 1,200 μg/kg (dry weight), developed by EPA to address human health risks from consumption of contaminated shellfish in intertidal areas (See Sections 6 and 7). This objective requires that intertidal sediment HPAH concentrations must not exceed 1,200 μg/kg (dry weight). HPAHs most closely approximate the carcinogenic PAHs evaluated in the risk assessment. The HPAH objective in sediments corresponds to the 90th percentile of Puget Sound subtidal background HPAH concentrations available at the time of the RI/FS. Clam tissue concentrations from the RI showed a moderate correlation with intertidal sediment concentrations, and carcinogenic PAH concentrations in clams from intertidal sediments with contamination above the HPAH criterion resulted in cancer risk estimates above EPA levels of concern.

Achievement of the HPAH objective in intertidal sediments is expected to result in corresponding reductions in clam tissue contamination. This additional objective does not alter the requirement of achieving the MCUL throughout the East Harbor. Because institutional controls can be used to limit human exposure in intertidal areas until the cleanup objectives are achieved, however, ten years are

allowed for sediments to meet the MCUL and the HPAH objectives. This ten year period begins once significant contaminant sources to intertidal sediments from the Wyckoff Facility have been controlled.

Intertidal sediments are an important marine habitat, and unlike subtidal sediments are very sensitive to changes in elevation. Because environmental conditions (such as wave energy, grain size, food supply, predation, and moisture) vary with minor changes in elevation in the intertidal zone, specific organisms are adapted to the habitat conditions at different elevations. Changes in elevation caused by dredging or capping in the intertidal zone would affect intertidal habitat. Conditions for natural recovery are significantly better for intertidal than subtidal sediments (See Section 8.3.3). Although some intertidal areas adjacent to the Wyckoff Facility are clearly more affected by ongoing sources of contamination than subtidal areas, natural recovery once sources are controlled is expected to eliminate the need for high-impact cleanup action. For this reason, the intertidal cleanup objective incorporates the ten-year recovery period.

10.1.3 Rationale for Selected Cleanup Objective for East Harbor

Cleanup action is not required in areas with contamination below the MCUL chemical criteria, either in the East or West Harbor. Selection of the MCUL as an objective and as a means of defining cleanup areas is supported for the following reasons:

- Uncertainty about predicted biological effects,
- Predicted contaminant reduction in areas of marginal contamination, and
- The costs and impacts of cleanup.

In the East Harbor, biological effects above the range of "minor adverse effects" were documented in contaminated sediments between the former wood treating facility and the central channel (See Figure 12). Prior to placement of the existing cap in these areas, sediment contaminant concentrations were above the MCUL by a significant margin for numerous PAHs. Available biological data for areas where contaminant concentrations exceeded the MCUL by a narrow margin or for only a limited number of PAHs did not show biological effects above the MCUL level. Since the predicted biological effects in such areas were not observed in two of the three measures, it is probable that sediments with chemical concentrations below the MCUL have minor or no biological effects.

More importantly, East Harbor areas where minor biological effects would be predicted (i.e. areas with contamination above the SQS and below the MCUL) are likely to recover without active cleanup. Over time, certain organic contaminants, including PAHs, break down in the marine environment as a result of chemical and biological processes. In addition, biological activity in the top layer can cause dilution of contaminants by clean sediment mixed in from above or below the contaminated zone. As there are no rivers or other major sources of clean sediment to Eagle Harbor, little new sediment settles in the East Harbor. However, the predominant contaminants are organic, rather than metals. Sediments with PAH concentrations below the MCUL tend to be at the margins of the contaminated areas and more distant from the primary contaminant source, the Wyckoff Facility. In these marginal areas, sediment contamination was likely caused by the transport of contaminated sediments from other more contaminated areas and is expected to be higher in surface

sediments than deeper sediments. In addition, cleanup in adjacent MCUL-0 areas is likely to introduce clean sediments to areas already below the MCUL. Such conditions are good for natural recovery processes, as described in Section 8.2.3. EPA expects that East Harbor areas with contamination levels between the SQS and MCUL will continue to improve following implementation of the remedy.

Given uncertainties about biological effects, as well as the greater potential for contaminant reduction through natural processes in East Harbor areas where contaminants are below MCUL criteria, EPA believes the potential benefits of cleanup in these areas do not warrant the costs and short-term environmental impacts of active cleanup. The MCUL represents an appropriate and achievable objective for the East Harbor and is consistent with cleanup levels required in the West Harbor.

Achievement of the MCUL will be an important step toward the SQS and considers the factors of net environmental benefit, cost, and implementability as contemplated by the Sediment Standards.

10.1.4 Comparison with West Harbor

As previously stated, the selection of the MCUL-0 for East Harbor subtidal sediments reflects different circumstances relative to the West Harbor. Specifically, the decision not to incorporate a natural recovery period for the East Harbor subtidal sediments is based on:

- the extended timeline prior to final East Harbor cleanup and
- the level of documented biological effects,

The ROD for final cleanup of the West Harbor was issued in 1992. In addition to requiring achievement within ten years of remedial action or source control, the West Harbor ROD identified three supplemental objectives related to removal of a sediment hot spot, capping of areas predicted to have more significant effects, and institutional controls combined with natural recovery in certain intertidal areas. Areas where contaminant concentrations are below these objectives but above the MCUL could be eliminated from active cleanup requirements if EPA approved modeling indicated that natural recovery would achieve the MCUL in ten years (MCUL-10). If identified, sediment recovery zones will be in areas where contamination is above the MCUL by a small margin and where RI data provided no evidence of either minor or significant biological effects. While RI data were not sufficient to eliminate areas from cleanup, they were supported by other biological studies of the West Harbor. Cleanup design for the West Harbor is in progress, and implementation of cleanup actions is anticipated in the next two or three years.

By contrast, for East Harbor sediments additional time is necessary to further control contaminant sources from the Wyckoff Facility. The East Harbor ROD establishes a phased approach to final cleanup for this reason (See Figure 14). EPA estimates that sources may be sufficiently controlled three to six years after issuance of this ROD. Although the existing cap is an important step toward addressing areas with significant biological effects, final sediment remedial action in the East Harbor may begin several years after the West Harbor cleanup. RI biological data for the East Harbor show a range of effects, unlike the West Harbor, where available data showed significant or no effects. Minor or significant adverse effects may be ongoing, particularly in remaining heavily contaminated areas close to the Wyckoff Facility. Sediments in such areas tend to contain numerous PAHs at

concentrations well above the MCUL, rather than a limited number marginally above the MCUL. Effects in these areas will continue in the years preceding final remedial action. During these years, contaminant source reduction, natural recovery processes, and the existing cap may contribute to contaminant reductions in the East Harbor. However, once sources are controlled, further extending the timeline for recovery in areas predicted to have significant biological effects (above the MCUL) is not warranted, except in limited sediment recovery zones with sensitive habitat or technical impracticability. At the time of remedial design, areas may be eliminated from active cleanup if it can be demonstrated that the predicted effects are not occurring, despite concentrations above the MCUL chemical criteria.

10.2 Problem Areas and Actions

This section describes specific remedial actions selected to achieve MCUL-0 in subtidal sediments and both MCUL-10 and HPAH-10 in intertidal sediments.

As stated previously, the selected remedy is as follows:

- Capping (with limited sediment recovery zones) in Subtidal Cleanup Areas
- Natural Recovery in Intertidal Cleanup Areas
- Institutional Controls in Both Areas

Intertidal and subtidal sediment cleanup actions and the institutional controls associated with each are discussed under separate headings below.

10.2.1 Subtidal Areas

The following paragraphs describe the selected remedy and how it applies to the existing cap, remaining cleanup areas, and sediments with contaminant levels below the MCUL. Specific actions are identified which may be implemented to ensure the success of the overall remedy.

Selected Remedy

The selected remedy for subtidal sediments which exceed the MCUL chemical criteria is capping (Alternative C). As noted, subsequent to the 1991 Eagle Harbor Proposed Plan, a sediment cap over heavily contaminated areas of the East Harbor was completed under CERCLA removal authorities to address documented adverse biological effects in heavily contaminated areas. After significant sources of contamination have been sufficiently controlled, remaining subtidal sediments with contamination above the MCUL chemical criteria will also be capped. The areas to be capped will be based on final remedial design sampling. Biological testing in accordance with the Sediment Standards may be conducted during remedial design to refine cleanup areas. Areas which meet the MCUL biological criteria for all such tests do not require cleanup.

As described in Section 8, the assumed cap design is a layer of clean sediments approximately three feet thick. Contaminant concentrations in capping material must be at or below the Sediment

Standards SQS chemical criteria. Cap materials must provide suitable habitat for recolonization by benthic organisms. Placement of capping materials will be designed to minimize impacts on existing biota and habitat while depositing three feet of clean sediment in all areas where contaminant concentrations exceed the MCUL in the top ten centimeters.

It may be appropriate to design the cap with less than the three-foot thickness in some areas. Such a modification would be considered to minimize the effects of sediment placement on the existing marine environment, provided the long-term effectiveness of the remedy is assured. Other design modifications may include the placement of coarse materials or other adjustments necessary to ensure the long-term effectiveness of the cap given the physical, ecological, and chemical conditions in and near the cleanup area. Such modifications would require prior EPA approval.

Existing Cap

While source control efforts continue, the existing cap will be monitored and any necessary work to maintain the cap completed. A portion of the cap is located in the ferry navigation path, and areas closest to the ferry terminal are subject to currents generated by docked ferries. If monitoring indicates significant erosion of cap materials due to ferry propeller wash or currents, it may be necessary to supplement the cap with additional sandy materials or to place coarser materials in some areas to limit cap erosion. These cap maintenance activities will be completed as necessary, either prior to or in coordination with design and implementation of final actions in other areas.

MCUL Areas

Once control of significant sources has been achieved, cleanup areas will be delineated for design of a cap to address remaining subtidal cleanup areas. Design of the cap will factor in the existing cap and will take into account specific conditions that may call for modifications of the three-foot cap approach, specifically habitat value, slope, depth, and currents. In certain areas, capping may be technically impracticable (for example, on steep slopes) or cause impacts to valuable and sensitive habitat (for example, eelgrass). For such areas, it may be appropriate to allow natural recovery rather than requiring active remediation. Designation of natural recovery zones in these areas will be considered only if reasonable engineering modifications to the remedy cannot effectively address these areas. Further discussion is provided below.

In areas of the East Harbor not addressed by the existing cap, a number of environmental conditions may dictate modifications to the cap (Alternative C) described in Section 8. The existing cap was completed in conditions well suited to capping. The cap was placed in gently sloping areas of the harbor 30 to 50 feet below mean lower low water level (MLLW), except for a small area of shallow sediments. Eelgrass beds rarely occur below 30 feet, and in the shallow area were extremely sparse.

North of the Wyckoff Facility, a subtidal shoal extends into the East Harbor. Sediments in this area and at the mouth of Eagle Harbor are subject to stronger currents than protected areas inside the harbor. In addition, beyond the gradually sloping intertidal area on the east side of the shoal, the harbor bottom slopes steeply and deepens to over 60 feet below MLLW. If these areas are contaminated above the MCUL at the time of remedial design, cap design efforts will evaluate technical modifications to achieve the cleanup objective. If cleanup is technically impracticable, these areas will be allowed to recover through natural processes and monitoring will be required to verify natural recovery.

Immediately adjacent to the Wyckoff Facility is a shallow subtidal area known as the log-rafting area. In addition to log-rafting, the area was used for loading creosote from barges to the Wyckoff Facility. Contamination in the sediments was likely caused by a combination of spills, surface runoff, migration from heavily contaminated facility soils, and other means. EPA has excavated and removed heavily contaminated soils adjacent to the log-rafting area, but existing sediment contamination remains severe. Near-surface pockets of free-phase oily contamination have been observed, and the sediments are very fine. Remediation in this area may require engineering modifications to minimize impacts of cap placement and to ensure the effectiveness of the cap. Modifications for effectiveness could include extra cap thickness, special capping materials, or limited excavation of sediment hotspots for consolidation with Wyckoff Facility soils.

In Puget Sound, eelgrass beds may exist in intertidal and shallow subtidal areas. Eelgrass beds provide valuable habitat for marine organisms and are difficult to restore once damaged or destroyed. In the East Harbor, eelgrass beds exist near the harbor mouth on both the north and south shores. If eelgrass beds are included or directly adjacent to areas contaminated above the MCUL, design efforts will evaluate ways to minimize impacts to this habitat. If necessary, such areas will be allowed to recover through natural processes, and monitoring will be required to verify the recovery.

Areas Failing the SQS

Areas of the East Harbor may exceed the long-term goal of the Sediment Standards SQS chemical criteria at remedial design. Although contaminant concentrations in these sediments already meet the MCUL and are predicted to continue to improve through ongoing natural recovery processes, limited monitoring will be conducted in these areas to evaluate ongoing natural recovery processes, the effectiveness of source control actions at the facility, and changes due to remedial actions in adjacent areas.

Engineering feasibility in implementing a three-foot cap in adjacent areas with contaminant concentrations above the MCUL may dictate placement of clean sediment for side slopes in adjacent SQS areas. Extending the benefits of remediation into SQS areas in this manner would hasten the achievement of the SQS in the East Harbor, consistent with the intent of the Sediment Standards.

10.2.2 Intertidal Areas

The following paragraphs describe the selected remedy for intertidal sediments, including actions that may be considered to ensure the success of the overall remedy.

Selected Remedy

The selected remedy for intertidal sediments with total HPAH concentrations of 1,200 μg/kg or more (dry weight) or with PAH concentrations above the MCUL is natural recovery combined with institutional controls (Alternative B). Contaminant concentrations in such areas must meet the HPAH objective and the MCUL within ten years from control of significant sources of contamination to these areas. Monitoring will be necessary to document natural recovery to both these objectives (HPAH-10 and MCUL-10).

Based on existing data, intertidal areas of Eagle Harbor where contaminant concentrations exceed the HPAH objective of 1,200 μg/kg correspond closely with areas where intertidal sediments exceed two or more MCUL chemical criteria for individual PAHs. Intertidal sediments adjacent to the inactive Wyckoff Facility currently exceed both the MCUL and the HPAH objective. Some East Harbor locations along the north shore may marginally exceed MCUL chemical criteria for a single PAH.

As noted previously, PAHs are rapidly degraded by exposure to ultraviolet or visible light (Payne and Phillips, 1985), while microbial degradation of PAHs is enhanced by aerobic conditions. For this reason, sediment natural recovery is most effective in intertidal areas, where sediments are exposed to air and sunlight between high tides.

Once control of significant sources to the beach adjacent to the Wyckoff Facility is achieved, beach sediments are expected to meet both the HPAH-10 and the MCUL-10 within ten years. At the start of the ten-year recovery period, the problem areas will be delineated and baseline conditions established for monitoring natural recovery. Monitoring will be necessary during the natural recovery period to document progress toward and achievement of the objectives. In locations on the north shore natural recovery is expected to achieve the MCUL chemical criteria readily.

Because the HPAH objective is intended to protect human health, biological testing according to the Sediment Standards cannot be used to eliminate or reduce cleanup requirements for sediments contaminated above this level. In intertidal areas which exceed the MCUL but are less than or equal to the HPAH objective, biological testing may be conducted to demonstrate the absence of significant biological effects. In such areas, if the MCUL biological criteria are met, no further consideration is required. Comparisons to the MCUL chemical criteria will take into account the potential for low total organic carbon content to affect results, in accordance with guidance developed for the Sediment Standards.

Prior to initiation of the ten-year recovery period, efforts to further control contaminant sources at the Wyckoff Facility will continue. During this time, monitoring of the adjacent intertidal areas will be necessary. The purpose of monitoring in such areas is to evaluate the potential for natural recovery in heavily contaminated areas and to assess the need for additional actions. Such actions may be necessary to ensure the success of the overall remedy. Specifically, for more heavily contaminated intertidal areas where monitoring indicates that natural recovery processes are insufficient to achieve the two objectives, possible additional actions include:

- Enhancement of natural recovery processes, and
- Excavation of sediment hotspots.

Due to years of oily seepage, subsurface reservoirs of contamination may exist in the intertidal zone adjacent to the Wyckoff Facility. Such sources could re-introduce contamination to surface sediments through tidal flushing, offsetting reductions in surface sediment contamination through natural recovery processes.

Subsequent to the ROD, additional sampling will be conducted to identify such reservoirs and areas where natural recovery may be inhibited. Mechanisms for enhancing or accelerating biological or photochemical breakdown processes may be sufficient to address such areas. Nutrient enhancement and tilling of the sediments are two examples of such mechanisms. Test plots or pilot tests to ensure that a specific mechanism is appropriate for site conditions may be necessary. Enhancement of

natural recovery would be implemented as necessary if tests indicate that enhancement of natural recovery is likely to accelerate hotspot contaminant reduction sufficiently. This mechanism could be extended into other contaminated intertidal areas, a decision which would be based primarily on cost-effectiveness and design considerations.

If the sampling identifies areas that will not achieve the objectives despite enhancement mechanisms, excavation of specific hotspots will be considered as a further modification of the remedy. Excavated sediments could be managed with upland soils in coordination with Wyckoff Facility cleanup actions.

The monitoring, tests, and potential additional actions will be implemented as appropriate in coordination with activities at the Wyckoff Facility and with sediment remedial design, to ensure that the sediments will achieve the objectives within the ten-year recovery period.

10.2.3 Institutional Controls/Site Use Restrictions

Institutional controls are part of the selected remedy. In combination with remedial action, they will ensure protect human health and the environment in both subtidal and intertidal areas.

Health Advisory

Consumption of clams, crabs, fish and other marine organisms from Eagle Harbor is considered a pathway of potentially significant health concern. In addition to implementation of specific institutional controls in intertidal areas, the selected remedy supports continuation of the existing health advisory described in Section 2.2, calls for efforts to increase public awareness of seafood contamination, and requires periodic monitoring of seafood contaminant levels.

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 the advisory will continue as necessary for other reasons, such as bacterial contamination.

Indicator concentrations for contaminants of concern were identified in the West Harbor ROD to evaluate potential continuing human health risks and to generally assess the success of remedial action. The same levels will be used to evaluate East Harbor data. The concentrations correspond to levels protective of human health for cancer and non-cancer effects. The indicator concentrations for methyl-mercury in fish and shellfish tissue are 0.22 mg/kg and 0.98 mg/kg (wet weight), respectively. The sum of carcinogenic PAH concentrations is 15 μg/kg and 60 μg/kg in fish and shellfish tissue, respectively. In coordination with the requirement of the West Harbor ROD and regional monitoring programs, periodic testing 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. While the indicator thresholds are among the primary considerations for continuance of the health advisory, EPA and the health agencies may establish additional thresholds for other contaminants to protect human health.

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.

Use/Access Restrictions

Some restrictions on use and access of the East Harbor may be necessary to ensure protection of human health prior to and during implementation of the selected remedy, and to ensure protection of completed remedial actions.

It is currently possible to approach the beach adjacent to Wyckoff by boat as well as by walking north from Rockaway Beach. Warning signs are posted on the fence surrounding the upland Wyckoff Facility to advise against the harvesting of seafood from the adjacent beach areas. To further minimize access to these areas, additional warning signs (using the same visual symbols and the warning in multiple languages) will be posted and maintained, and physical barriers (a fence or other barrier) will be positioned at the south end of property. To the extent possible, warning signs and physical barriers will be effective at low tides, when an extensive area is exposed. To make the warnings visible to recreational boaters, larger signs will also be posted.

In addition, restrictions on uses of remediated subtidal and recovering intertidal areas may be necessary to prevent impacts on ongoing or completed cleanup. For example, restrictions on anchoring or dredging in or near capped areas will be imposed if necessary.

10.3 Implementation

Figure 14 provides a framework for the timing of remedial activities. Detailed plans and schedules for key elements of remedial design and remedial action will be developed as appropriate information becomes available. Final sediment cleanup actions will be initiated after control of significant contaminant sources at the Wyckoff Facility. If sources to a specific area are controlled in advance of other source control, cleanup action in these areas may proceed separately, depending on the costs of separate design and implementation relative to the benefits of early cleanup. While source control efforts continue, certain actions may be necessary to ensure the protection of human health and the environment.

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, federal and state 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. Coordination with West Harbor cleanup activities and with source control and site cleanup work at the Wyckoff Facility will be necessary. Although no critical habitats have been identified in the East Harbor, EPA will continue to coordinate with the U.S. Fish and Wildlife Service to assure that remedial activities do not adversely affect threatened or endangered species. EPA will issue fact sheets and hold public meetings at key points in the implementation process, to keep the community involved and informed. Periodic meetings with interested community groups can be arranged if requested.

Key elements of implementation include the following:

- coordination with contaminant source control efforts,
- monitoring prior to final remedial design,
- potential necessary actions prior to final cleanup,
- final remedial design and remedial action, and
- post-remedial action monitoring and maintenance.

These elements are described in the following sections.

10.3.1 Coordination with Contaminant Source Control

Efforts to control Wyckoff Facility sources of contamination to the East Harbor are being managed as part of Superfund cleanup activities at the Wyckoff Facility and Groundwater operable units. The East Harbor ROD does not require specific source control actions at these operable units, but the East Harbor selected remedy will be implemented in coordination with activities at these operable units.

Current source control efforts at the Wyckoff Facility include the operation of a groundwater extraction system since 1990 and removal of sludges stored in tanks and buried at the facility. While these actions have reduced seepage of oily contamination on the beaches adjacent to the facility, the seepage has not been eliminated. Dissolved contamination in groundwater beyond reach of the extraction system may also be a source of low-level contaminant inputs to portions of the East Harbor. The existing sediment cap was completed in areas of the East Harbor where significant sources were sufficiently controlled to warrant cap placement in areas of documented biological impacts and heavy contamination.

An interim decision for the Wyckoff groundwater operable unit has been proposed (July 25, 1994) which would allow enhancement of the extraction system and other groundwater source control measures. In addition, final soil and groundwater remedies will be selected and implemented after completion of the remedial study at the Facility, and additional early actions may be identified in the coming years to enhance source control.

These actions are expected to control significant sources of contamination to nearshore and intertidal areas as well as subtidal contaminated areas of the East Harbor. Final sediment cleanup in the East Harbor will not commence until significant sources are sufficiently controlled. A report will be prepared annually as part of the East Harbor selected remedy. The report will summarize available source data, identify additional data needs, and assess the status of source control. The annual reports will be available for public review and will integrate information from the following, at a minimum:

- monitoring of dissolved and non-aqueous phase liquids in the extraction wells and groundwater treatment unit,
- systematic observations of visible seeps on adjacent beaches and nearshore subtidal areas,
- findings developed as a result of the Wyckoff Facility remedial investigation, ongoing early actions, or remedial design of interim or final facility actions,
- environmental monitoring of intertidal and subtidal sediments in the East Harbor.

This information will be generated in connection with the Wyckoff Facility operable units, except for the last element, which will be completed as part of the monitoring described in Section 10.3.2 below.

As source control efforts become increasingly effective, plans for final remedial design sampling will be developed and sources of sediment capping material will be sought. A determination of sufficient source control will be made by EPA, after issuance of a fact sheet and consultation as appropriate with natural resource and health agencies, the community, and other interested parties. Implementation of the pre-design sampling plans and design of final sediment remedial action will follow EPA's determination of sufficient source control.

10.3.2 Monitoring Prior to Source Control

Although sampling will be necessary after source control to support design of the final remedial action, limited environmental monitoring will also be conducted prior to source control to meet the following objectives, as necessary:

- to assess the conditions of the existing cap, including maintenance needs,
- to support evaluations of the status of source control,
- to identify potential contaminant hotspots in remaining cleanup areas,
- to evaluate changes in the extent of contamination due to natural recovery and placement of the existing cap,
- to refine expectations regarding implementability of the remedy in specific areas,
- to refine methods for enhancing intertidal natural recovery, and
- to assess eelgrass beds potentially affected by completed or future cleanup.

The monitoring may include physical, biological, and chemical analyses, as well as visual observations. Such monitoring would be completed under EPA approved plans and to the extent possible would be integrated to minimize costs and to ensure consistency. Monitoring results will be linked to decisions or actions in the East Harbor, such as maintenance of the existing cap, determinations of source control, decisions to implement specific elements of the selected remedy, and plans for focused design sampling.

10.3.3 Potential Necessary Actions Prior to Final Remedial Action

In addition to sediment remedial actions, other actions may be necessary to ensure protection of human health and the environment. These actions are part of the selected remedy, and as appropriate will be designed and implemented in coordination with other remedial activities. The actions may occur prior to or concurrent with final sediment remediation.

Maintenance of the Existing Cap

The existing sediment cap in the East Harbor covers over fifty acres of heavily contaminated sediments, at cap thicknesses ranging from one to three feet. Plans to monitor the cap are in preparation and will be implemented as part of the remedial design phase immediately following the ROD through final remedial action. Monitoring will be used to verify that the cap is continuing to

provide clean habitat and isolating underlying contaminated sediments, as well as to determine the need for additional actions to maintain the cap.

Sampling will focus on surface sediments in the capped area and on the cap's physical integrity. Limited use of coring or other methods which penetrate the cap may be necessary to assess the effectiveness of the cap in isolating sediment contaminants. Impacts of potential continuing sources to the cap, recolonization of the cap by benthic organisms, and effects of the cap on surrounding areas, including eelgrass habitat, will also be evaluated.

If significant erosion of cap material is observed in areas which require isolation of contaminated sediments, the selected remedy provides for resupplying cap materials, potentially in combination with placement of cap with gravel or coarser materials to protect the cap from erosion. Additionally, areas of the cap where monitoring indicates a need for thicker coverage to ensure protection of the environment may be supplemented. As with the existing cap, any additional work on the cap will require coordination with the Washington State Ferries and affected resource agencies, regarding scheduling, necessary navigation depths, and other logistical matters.

In-Water Structures near Wyckoff Facility

In intertidal and shallow subtidal areas near the Wyckoff Facility, numerous in-water structures used to support the former wood-treating operations remain. Structures include a large dock (known as the West Dock), numerous dolphins, pilings remaining from a dock to the East (known as the Milwaukee Dock), and various floating structures. The dock structures may interfere with or significantly increase the cost of active sediment remediation and may come to pose a safety hazard as they deteriorate.

Removal of these in-water structures will be required if necessary to ensure the protection of human health and the environment. The design decision regarding whether and when to remove in-water structures will consider the potential for the structures to be useful for future remedial work or other site uses at the Wyckoff Facility, the potential for the structures to release wood treating chemicals as they deteriorate or during demolition, and the potential for re-use of the structural materials.

10.3.4 Final Sediment Remedial Design and Remedial Action

Once EPA has made the determination to proceed with remedial design and remedial action for final sediment cleanup, environmental sampling and engineering work will be necessary to support the design. This will include the following work, as needed:

- chemical and/or biological testing to delineate areas exceeding the cleanup objectives,
- evaluations of existing eelgrass beds to avoid or minimize impacts from cleanup,
- engineering evaluations for work in sloped areas, areas subject to potential cap erosion, and other design issues,
- sampling to define baseline contaminant concentrations in natural recovery areas, and
- identification of volumes, characteristics, and sources of appropriate capping material.

To locate a source of available clean material suitable for capping, coordination with agencies responsible for evaluating regional dredging projects will be necessary.

Design and implementation of final sediment cleanup may take two to three years. During construction, monitoring will be conducted to evaluate short-term effects on the environment, to document construction as planned, and to ensure protection of human health and the environment.

10.3.5 Post-Remedial Action Monitoring and Maintenance

During sediment recovery and after final remediation, long-term monitoring is necessary to document progress toward, attainment of, and continued compliance with the cleanup goals and objectives described in Section 10.1. Plans for monitoring to be conducted while source control efforts continue will be supplemented to develop the long-term monitoring approach for the East Harbor once final cleanup areas have been defined.

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.

EPA will review and approve the plans in consultation with Ecology, the Suquamish Tribe, and the appropriate public health and natural resource agencies. 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.

As new information arises regarding sources, contaminants, or biological effects, sampling requirements may be modified by EPA. 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.

Monitoring efforts will be tiered and will focus primarily on the first ten years after completion of remedial action. 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. Monitoring requirements may be re-evaluated at the CERCLA Five-Year Review, described in Section 10.5.

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 10.5, below) or as appropriate.

10.4 Estimated Costs

Estimated costs associated with the selected remedy are summarized in Table 14, including the following:

- estimates from the FS for sediment capping, natural recovery, and institutional controls, and

Table 14
Estimated Costs[1] of East Harbor Selected Remedy
(In U.S. Dollars)

Cleanup Action	Low-End Cost	High-End Cost
Intertidal Natural Recovery/Institutional Controls[2]	$400,000	$800,000
Annual Monitoring Prior to Final Remedial Design	$300,000	$600,000
Maintenance of Existing Cap[3]	$500,000	$1,000,000
Removal of In-Water Structures[4]	$1,500,000	$3,000,000
Subtidal Cap Design/Implementation	$2,000,000[5]	$14,500,000
Total for monitoring and final sediment cleanup	**$2,700,000**	**$15,900,000**
Total including other necessary actions	**$ 4,700,000**	**$19,900,000**

[1] Refer to assumptions in Section 10.4 and following footnotes.
[2] High-end cost for institutional controls based on combined FS estimates for subtidal and intertidal institutional controls. Since this may duplicate some elements, actual costs should be lower.
[3] Shaded costs are for potential other necessary actions, which may or may not be implemented.
[4] High-end costs based on disposal of debris as hazardous waste. This is unlikely to be required.
[5] This estimate is derived from actual costs for the existing cap, which was placed over an area approximately equivalent area to the remaining MCUL area. The existing cap cost under $2,000,000.

- a range of estimated costs for potential other necessary actions, including monitoring, maintenance of the existing cap, and demolition of in-water structures.

During remedial design, the FS sediment cleanup volume estimates will be refined. Costs are anticipated to change accordingly. In addition, the ranges for other necessary actions will be refined prior to design and implementation of these actions.

The present worth cost estimates for capping, natural recovery, and institutional controls are intended to be within +50% and -30% of the actual costs of remediation, based on volume estimates established during the FS using the following key assumptions. Brief discussion of uncertainties associated with the assumptions follow in italics:

- Areas contaminated above MCUL chemical criteria in RI data will, if tested, fail the Sediment Standards MCUL biological criteria and require a cap as described in Section 8. *Based on existing data, it is likely that complete biological testing will identify some areas failing the MCUL chemical criteria with only minor effects. This would reduce areas requiring active cleanup. Design modifications for steep, deep, or erosional areas may also change the costs.*

- Natural recovery has not occurred in areas where contaminant concentrations exceeded the MCUL in RI sampling. *Costs may decrease if source reduction and natural recovery processes ongoing since initial data collection (1988) have reduced the area where contaminant concentrations exceed the MCUL.*

- Costs for capping material are as estimated in the FS. *As demonstrated with the existing cap, coordination of capping with planned dredging of clean sediments can significantly reduce material costs.*

- Costs for East Harbor intertidal areas are two thirds of estimated FS costs for all Eagle Harbor intertidal HPAH areas (including West Harbor areas). *While consistent with the East Harbor areas relative to overall areas, design and mobilization costs due to separating the East and West Harbor could increase the cost.*

Estimated cost ranges for other necessary actions also relied on assumptions, which may change as additional information is developed. Key assumptions include the following, with an explanation of the basis for each:

- Any armoring necessary to protect the cap will be in an area between 8 and 11 acres in areas affected by ferry wash. *Visual monitoring of the cap during and after construction indicated varying degrees of erosion in such areas. Actual areas needing armoring are unlikely to be significantly smaller or larger than this range.*

- Monitoring prior to source control will average $100,000 per year and may continue for three to six years. *This estimate is based on scoping of periodic monitoring for the existing cap and other limited monitoring averaged over a ten-year period. More extensive monitoring to identify hotspots or evaluate design modifications could increase costs. Planned actions at the facility are unlikely to result in sufficient source control in less than three years. If more than six years is necessary, monitoring may be scaled back to minimize costs.*

- Hotspot excavation will not be necessary in log-rafting and intertidal areas. *EPA does not anticipate that these actions will be necessary. Therefore, assumptions about volumes are not provided. While costs for excavation in the log-rafting area and intertidal areas can be estimated using relevant items in the FS estimate for nearshore disposal of intertidal HPAH sediments, costs for management of excavated materials could change significantly due to coordination with cleanup of Wyckoff Facility soils.*

Based on these assumptions, total costs for the selected remedy are expected to range from $6 to $20 million. Costs associated with source control activities at the Wyckoff Facility are not included in cost estimates for the East Harbor.

10.5 CERCLA Five-Year Review

The FS discussed the Five-Year Review mandated by CERCLA for remedial actions that leave contaminants at the site. For this selected remedy, the review is required at least once every five years to ensure that human health and the environment are being protected.

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 is protective of human health and the environment. Among the alternatives which are protective of human health and the environment, 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 state and community acceptance.

The selected remedy combines capping of contaminated subtidal sediments (with limited sediment recovery zones), natural recovery in intertidal areas, and institutional controls. Capping subtidal sediments with clean materials is an effective means of quickly protecting the environment with minimal short-term effects. Within subtidal areas with contaminant concentrations above the MCUL, the existing cap or additional capping after control of Wyckoff contaminant sources will limit potential redistribution of PAHs, provide clean habitat, and reduce environmental exposures up the food chain. In intertidal areas with contaminant concentrations above intertidal cleanup objectives and in subtidal areas with contaminant concentrations below the MCUL, natural recovery will continue to reduce surface sediment chemical concentrations without the unnecessary physical disturbance and costs of active remediation. Similarly, in subtidal sediment recovery zones designated for reasons of habitat value or technical feasibility, the costs and impacts of active remediation will be minimized. Institutional controls consisting of restrictions to beach access and additional warnings regarding the harvest and consumption of contaminated seafood will further ensure protection of public health, while restrictions on anchoring, dredging, or other sediment disturbance will protect capped areas.

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.

The ARARs for the East Harbor selected remedy are as follows:

By taking remedial action for sediments with contaminant concentrations above 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).** Subtidal sediments are required to meet the MCUL immediately after completion of the remedy, and intertidal sediments are required to meet the MCUL ten years after source control, unless otherwise indicated in the selected remedy.

Fill activities (e.g., capping in subtidal or intertidal areas) and dredging or excavation of contaminated sediments (for any excavated intertidal PAH hotspots) will comply with the substantive requirements of federal regulations promulgated pursuant to **Sections 401 and 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 will comply with the promulgated 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 modifications to the natural recovery alternative is necessary in the intertidal PAH areas, liquids and other wastewaters from any sediment dewatering related to excavation of sediments 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);**

- **National Pollution Discharge Elimination System (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. If sediments are excavated and taken off site, **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). RCRA hazardous waste requirements not included in the delegated State program will also be complied with. Excavated sediments managed with the upland Wyckoff Facility soils will comply with any Dangerous Waste Regulations and RCRA ARARs identified in the Wyckoff Facility ROD.

Off-site disposal must also comply with the **Amendment to the NCP, Procedures for Planning and Implementing Offsite Response Actions [aka the Off-Site Rule (40 CFR 300.440).**

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

- **Executive Orders 11990 and 11988** (40 CFR 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 polychlorinated biphenyls (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 CFR 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 CFR 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 East Harbor will reduce or eliminate the risks to human health and the environment at an expected cost between $6 and $20 million dollars. The remedy is cost-effective. It provides an overall protectiveness proportional to its costs.

By phasing the remedy to allow necessary actions to proceed while efforts to further control sources of contamination continue, and by 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.

Specific modifications of the selected remedy, coordinated with soil cleanup at the Wyckoff Facility are a cost-effective approach to ensuring that sediment cleanup will meet cleanup objectives within ten years from source control. Allowing natural recovery in limited subtidal areas and in intertidal areas where cleanup objectives will be achieved in ten years, and allowing biological testing to eliminate cleanup requirements for areas meeting Sediment Standards biological criteria 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. However, because treatment of the principal threats at the site was not found to be practicable, this remedy does not satisfy the preference for treatment as a principal element.

A number of alternative technologies were explored in the FS, particularly for PAH-contaminated sediments. *In situ* treatment alternatives for subtidal sediments are not practicable, however. Treatment alternatives necessarily involve dredging of contaminated sediments.

Although toxic to marine organisms, sediment contamination in the East Harbor is present at relatively low levels except in areas of free-phase oily contamination. For high volumes of material containing relatively low levels of contamination, containment is an appropriate remedy. For smaller volumes of subtidal sediment containing free-phase oily contamination, treatment could be an appropriate remedy, but dredging was judged to pose a significant short term risk to the environment due to potential releases of oily contamination and contaminated fine particles. Treatment or disposal of dredged sediments at an upland facility would involve complex implementability issues, high costs, and extended time frames for effective treatment. For these reasons, treatment was not judged practicable for East Harbor sediments. Subtidal areas containing free-phase contamination were successfully capped under CERCLA removal authorities.

For intertidal sediments, excavation at low tide could minimize the releases necessary for *ex situ* treatment, but since the volumes are relatively low (Table 10) and the potential for recovery without active remediation is high, natural recovery is the primary focus of the intertidal selected remedy. If portions of the intertidal area are determined not to have the potential for natural recovery, excavation may be required. Depending on the upland soil remedy selected at the completion of the Remedial Investigation and Feasibility Study for the Wyckoff Facility, treatment may be used for these soils.

Management of excavated intertidal sediments with upland soils could reduce unit costs for intertidal sediment volumes alone, due to economies of scale.

11.5 Preference for Treatment as a Principal Element

The East Harbor selected remedy for sediments does not satisfy the CERCLA preference for treatment. Treatment was not judged practicable for East Harbor sediments. The principal threat in the East Harbor is defined as subtidal sediments containing free-phase oily contamination. As stated above, treatment of these heavily contaminated sediments would have required dredging. Releases from dredging could pose significant short-term environmental risks. Treatment or disposal of dredged sediments at an upland facility would involve complex implementability issues, high costs, and extended time frames for effective treatment. Subtidal areas containing free-phase contamination were successfully capped under CERCLA removal authorities.

12. DOCUMENTATION OF SIGNIFICANT CHANGES

EPA reviewed public comments on the 1994 Proposed Plan. In response, EPA has made the changes to the Proposed Plan and has incorporated them into the selected remedy. These changes are discussed below:

1. Postponement of the decision to demolish in-water structures at Wyckoff.

Concerns raised by the community included the high costs of demolition and the potential value of existing structures for future uses at the Wyckoff Facility. If necessary to protect human health and the environment, EPA will require demolition of the structures. However, the decision will be finalized based on developing plans for future uses of the site, the condition of the structures, and their effect on sediments and cleanup plans in the East Harbor, as described in Section 10.3.4.

2. Addition of detail regarding source control determinations.

The community requested additional details regarding EPA's determination of sufficient control of significant sources. Although additional information may need to be incorporated depending on developments at the Wyckoff Facility, EPA has added a list of elements to be considered for assessing source control, as described in Section 10.3.2.

3. Addition of sediment recovery zones as an element of the selected remedy in subtidal areas.

The Proposed Plan identified eelgrass beds and steeply sloped areas as implementation issues potentially requiring modifications of a subtidal cap. The ROD formally provides for the designation of sediment recovery zones for such areas if engineering modifications cannot reasonably address them. Sediment recovery zones are factored into the subtidal cleanup objectives (Section 10.1.2) and are described as an element of the subtidal selected remedy (Section 10.2.1). Evaluation and identification of sediment recovery zones would occur during remedial design.

4. Clarification of time frames for achievement of sediment cleanup objectives in subtidal and intertidal zones and for implementation of potential additional actions to ensure protection of the overall remedy.

The selected remedy provides more detail than the Proposed Plan on the cleanup objectives in intertidal and subtidal areas of the East Harbor, and explains why different time frames are selected in each area for achievement of the cleanup objectives. It also clarifies the timing of additional actions which may be necessary to ensure the success of the overall remedy.

The above changes are logical outgrowths from information in the RI/FS and the 1994 Proposed Plan. The selected remedy, which incorporates these changes, provides a framework for major East Harbor decisions. Additional refinement of the selected remedy is anticipated during remedial design, based on physical, biological and chemical data and information developed regarding control of contaminant sources. Minor, significant, and fundamental changes to the remedy after issuance of the ROD will be evaluated and made in accordance with the NCP.

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[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

EPA

Region 10
1200 Sixth Avenue
Seattle WA 98101

Alaska
Idaho
Oregon
Washington

June 8, 1994

The Proposed Plan for Final Cleanup of the East Harbor

Wyckoff/Eagle Harbor
Bainbridge Island, Washington

Public Comment Period:
June 8 through July 8, 1994

Meeting for Public Comment:
June 22, 1994, 7-9 PM

at

The Judd Huney Room
402 Bjune Drive SW
Bainbridge Island, WA

INTRODUCTION

This proposed plan describes sediment cleanup alternatives evaluated for the **East Harbor** portion of the Wyckoff/Eagle Harbor Superfund Site on Bainbridge Island, Washington (Figure 1) and identifies the alternative preferred by the U.S. Environmental Protection Agency (EPA). The preferred alternative combines several alternatives presented in this proposed plan to cost-effectively protect human health and the environment. EPA is presenting this information for public comment in compliance with federal Superfund law.

This proposed plan describes cleanup alternatives for the East Harbor only. The East Harbor includes marine sediments north and east of the Wyckoff facility and is one of four "operable units" at the Wyckoff/ Eagle Harbor site, described in Table 1. EPA is the lead agency for the Wyckoff/Eagle Harbor site and works closely with other state and federal natural resource management agencies, health agencies, and tribes. The Washington Department of Ecology (Ecology) supports EPA's preferred cleanup alternative for the East Harbor.

Last winter, a sediment cap was placed over an area of heavily contaminated sediments in the East Harbor (Figure 2). Other sediment contamination, however, remains. The purpose of this proposed plan is to address these areas of remaining contamination in a phased cleanup and to ensure the long term effectiveness of the existing cap. Under EPA's preferred alternative, described in detail on page 16, the existing cap would be monitored and maintained, and additional capping would be completed in remaining contaminated areas. Beach sediments are predicted to recover naturally and would be monitored to document contaminant reduction. Harvest of shellfish from contaminated beaches adjacent to the Wyckoff Facility would be discouraged by a fence and warning signs to supplement the existing health advisory.

Sediment cleanup actions would not begin until contaminant sources at the Wyckoff wood-treating facility are further controlled. EPA's proposed phasing approach is further discussed on page 10. Ongoing cleanup at

the Wyckoff facility has reduced oily seepage onto the beach and will continue to reduce these sources. Over the next several years, EPA will continue to pump oil and contaminated groundwater to minimize the seepage while evaluating comprehensive cleanup alternatives for the Wyckoff facility. Under the proposed action, EPA would review the results of facility and sediment monitoring each year, until it is clear that sediment cleanup can proceed without risk of recontamination. New data would then be collected to determine final cleanup areas for cap design. Until that time, necessary work in the East Harbor would continue, such as monitoring and maintaining the existing cap, fencing of contaminated beaches, and removing aging docks at the Wyckoff facility.

EPA is seeking public comment on this proposed plan. The thirty-day public comment period will run from June 8 through July 8, 1994. Verbal comments will be accepted at a community meeting on June 22 from 7 to 9 pm (see front page), while written comments must be postmarked by July 8 and sent to:

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

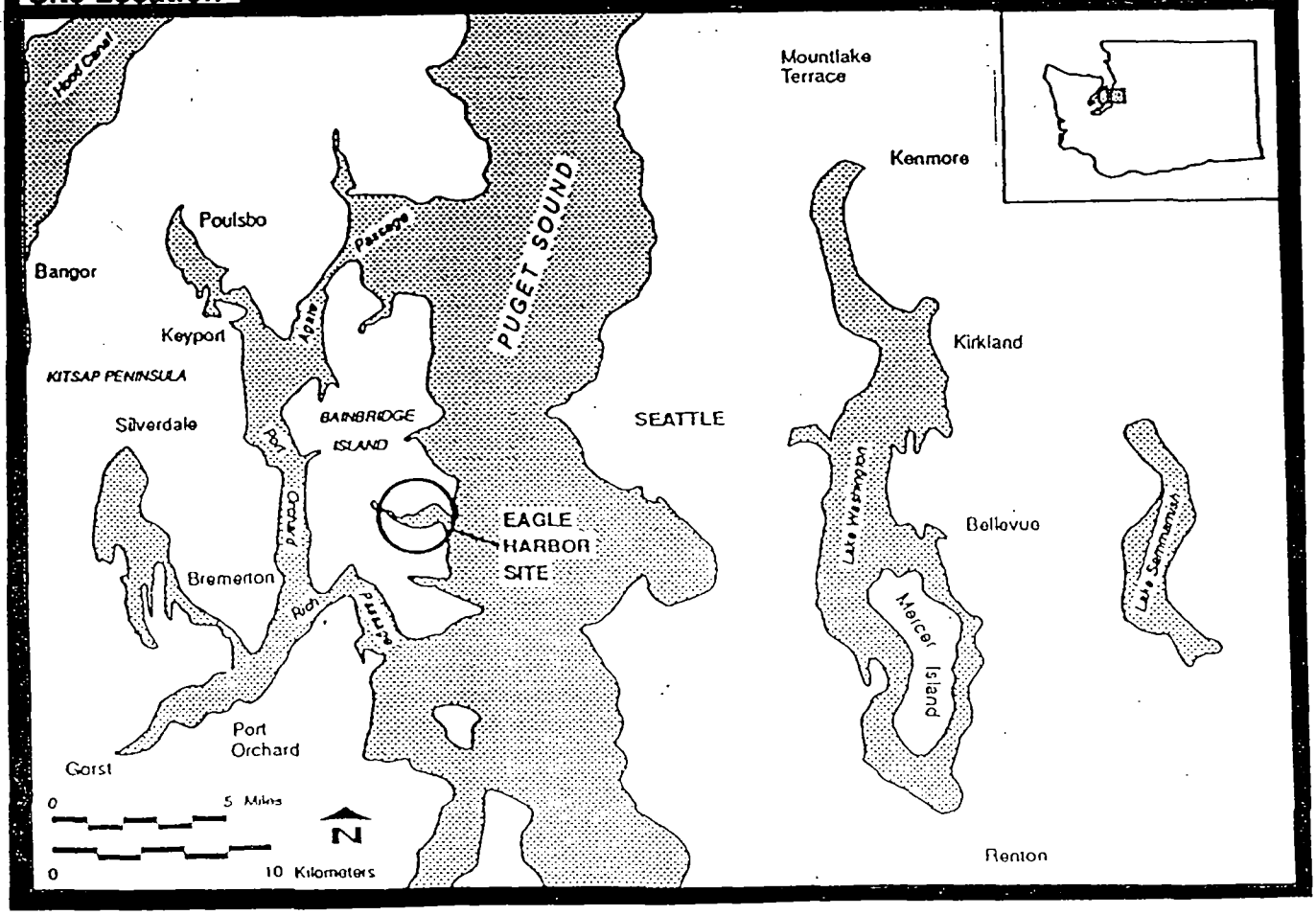
More detailed information is available for review as part of the administrative record for the site at:

Region 10 EPA
1200 6th Avenue
Seattle, Washington
Tel: 553-1215

or

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

Figure 1:
Site Location



We encourage you to comment on all aspects of the proposed plan for the East Harbor, including the alternatives evaluated, EPA's preferred alternative, and the proposed phasing of cleanup actions. Your comments will help EPA make a technically sound sediment cleanup decision that addresses the concerns of the community. EPA will consider all public comments on this proposed plan. The final decision for the East Harbor cleanup will be documented in a Record of Decision (ROD). The East Harbor ROD, together with EPA's 1992 ROD for the West Harbor, will document all of EPA's planned sediment cleanup activities for Eagle Harbor.

SITE HISTORY

This proposed plan provides background information about other parts of the site, such as the West Harbor and the Wyckoff facility, but the cleanup alternatives and EPA's preferred alternative apply only to the East Harbor. EPA will continue to coordinate activities among all of the operable units.

The Wyckoff/Eagle Harbor site, located on Bainbridge Island, Washington, 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. As shown in Figures 3 and 4, sediments in much of Eagle Harbor contain hazardous substances such as polynuclear aromatic hydrocarbons (PAHs) and mercury. PAHs are a group of chemical compounds found in creosote, used oil, and other sources. Mercury and other metals in sediment are often associated with commercial marine practices such as sandblasting and refurbishing boat bottoms. Other substances have been detected, but PAHs and mercury are the primary contaminants of concern, due to their toxicity to marine life, wide distribution, and high concentrations in Eagle Harbor sediments.

On the north shore of the harbor, ship building, maintenance, and repair activities were conducted from the turn of the century into the late 1950's. These activities have been identified as the primary source of the

Table 1

Operable Units at the Wyckoff/Eagle Harbor Superfund Site

Operable Unit (OU)	OU No.	Description	Current Phase
East Harbor	OU-1	Sediments near the Wyckoff Facility	Partial cleanup completed, public comment on proposed plan for final cleanup
Wyckoff Facility	OU-2	Soils at the Wyckoff Facility	Ongoing source control actions and remedial investigation field work
West Harbor	OU-3	Sediments near the former shipyard on the north shore	Design of 1992 cleanup decision underway
Wyckoff Groundwater	OU-4	Groundwater and saturated soils at the Wyckoff Facility	Ongoing groundwater treatment, remedial investigation field work

mercury and other metals found in the harbor.

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

In 1987, EPA made the Wyckoff/Eagle Harbor site into two separate management areas, known as operable 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 at the facility under a 1988 administrative order. In December 1991, following completion of the investigation of Eagle Harbor, EPA issued a proposed plan for phased sediment cleanup, separating the harbor into East Harbor and West Harbor operable units.

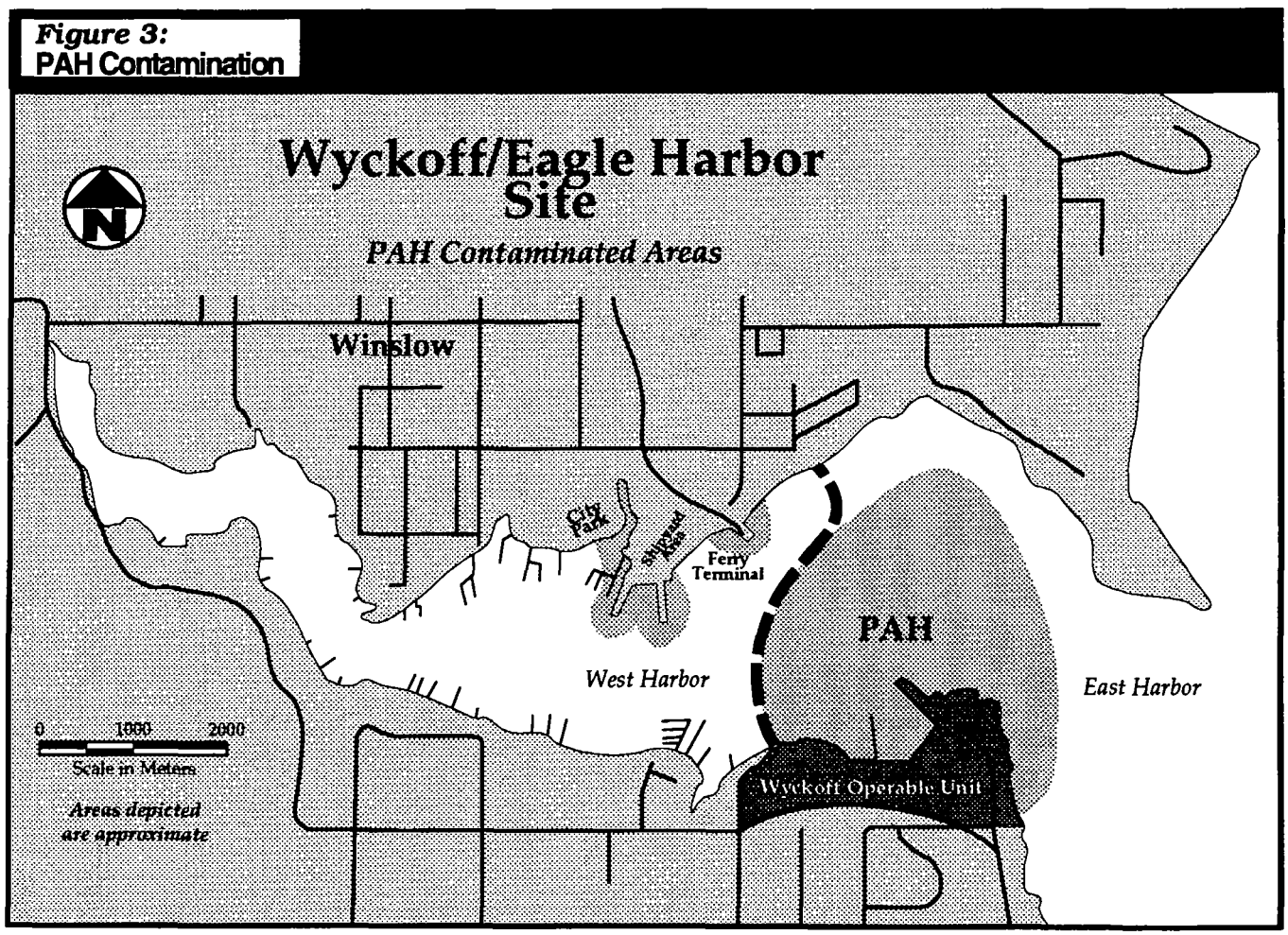
RECENT SITE ACTIVITIES

A brief update of recent cleanup activities at the site is provided below. This proposed plan refers to two types of Superfund cleanup actions: removal actions and remedial actions. Removal actions are used to address imminent threats to human health or the environment, while the remedial process leads to comprehensive site cleanup. Both types of actions apply to the Wyckoff/Eagle Harbor site as described below.

Wyckoff Facility

At the Wyckoff facility, wood treating operations ended in 1988. However, highly contaminated soils, tank sludges, and groundwater presented a significant threat to the harbor. To reduce sources, EPA required the Wyckoff Company to implement

Figure 3:
PAH Contamination



a system to pump and treat contaminated groundwater. The system has been in operation since 1990. Contaminated groundwater is pumped from on-site wells and, once stripped of oily components, is treated to meet stringent environmental requirements. EPA assumed operation of the groundwater treatment system in late 1993 and anticipates continued operation, as well as system improvements.

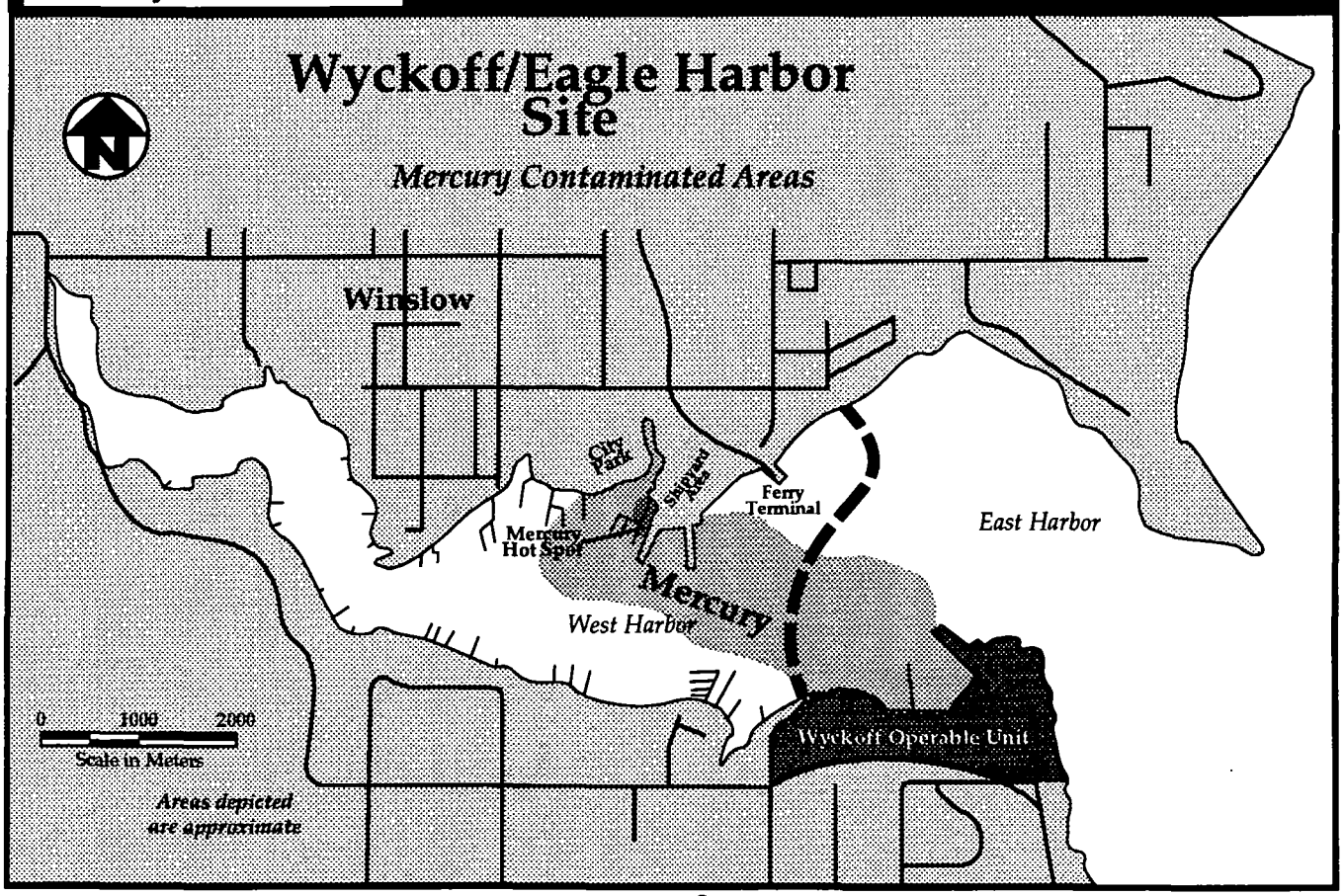
In 1993 and early 1994, to further reduce contaminant sources, EPA excavated and disposed of contaminated sludges at the facility; emptied, cleaned, and removed asbestos-insulated pressure vessels and chemical storage tanks; shored up a failing bulkhead; and treated contaminated water from runoff and storage tanks. These actions were conducted under Superfund removal authorities.

In February of this year, EPA began the remedial study phase, collecting additional data necessary to develop final soil and groundwater cleanup plans for the Wyckoff facility. Sampling of soil at different depths will indicate soil characteristics and the soil volumes which may require cleanup. Wells and water samples will determine the depth of groundwater contamination and support an evaluation of potential contaminant migration from the facility. Using the data, EPA will assess risks to human health and the environment and will develop soil and groundwater cleanup alternatives for evaluation by EPA and the public.

West Harbor

In the 1991 proposed plan for Eagle Harbor EPA proposed a combination of cleanup actions for the West Harbor tailored to the degree of contamination and environmental impact. It included the excavation of a "hotspot" of mercury-contaminated sediments near the former shipyard on the north shore and a combination of capping, thin-layer sediment placement, and natural recovery in less contaminated areas. EPA considered public comments on the 1991

Figure 4:
Mercury Contaminaton



plan and issued a Record of Decision (ROD) for the West Harbor in 1992. Currently, PACCAR Inc., one of several potentially responsible parties (PRPs), is designing the West Harbor cleanup under EPA oversight. The Washington Departments of Transportation and Natural Resources are also participating in the design phase. Sediment sampling will take place in the West Harbor this summer to better define sediment cleanup volumes and areas. Design drawings will be finalized in late 1995.

East Harbor

In 1991, EPA proposed an interim action in the East Harbor focusing on the initial cleanup of the most heavily contaminated and biologically affected sediments. Because the Wyckoff facility was a continuing source of contamination to parts of the East Harbor, EPA anticipated a later cleanup proposal for remaining contaminated areas of the East Harbor, after sufficient information about sources from the Wyckoff Facility was obtained.

EPA completed the proposed initial cleanup in the East Harbor this winter using sandy material to cover more than 50 acres of contaminated bottom sediments. Based on information developed at Eagle Harbor and at the Wyckoff Facility since 1991, EPA believes it is now appropriate to propose a final sediment cleanup plan for remaining contaminated sediments in the East Harbor.

EAGLE HARBOR RISK ASSESSMENT

Under the Superfund remedial program, a risk assessment is required to determine whether cleanup action is warranted at a site. The risk assessment for Eagle Harbor was described in the 1991 Proposed Plan and is briefly summarized again here.

EPA studied sediment and seafood contamination and evaluated risks from site contamination in the Remedial Investigation (1989) and Supplemental Risk Assessment (1991). Based on this evaluation, EPA has determined that existing human health and environmental risks warrant cleanup of the sediments.

Environmental risk in Eagle Harbor is indicated by adverse effects on organisms that live on or in the contaminated sediments. Liver and reproductive damage in Eagle Harbor bottom fish are well documented, and EPA tests show that the contaminated sediments are toxic to organisms such as small crustaceans and oyster larvae, which are important indicators of marine environmental health. Contamination was found in fish, crab, and clam tissues, indicating absorption of contaminants through the food chain or through direct contact with contaminated sediments.

To assess potential cancer and non-cancer human health risks, EPA used measurements of Eagle Harbor sediments and seafood and assumed lifetime exposure to contaminants from eating contaminated fish, shellfish, and sediments, and from skin contact with contaminated beach sediments. The primary human health risk was posed by long-term, regular consumption of PAH-contaminated crabs, clams, or other shellfish from Eagle Harbor. Data also suggested that a steady diet of Eagle Harbor fish may pose a human health concern.

Since 1985, the Bremerton-Kitsap County Health District has maintained a public health advisory cautioning against consumption of fish and shellfish from Eagle Harbor due to both chemical and bacterial contamination. Warning signs are posted around the harbor and the Health District provides a telephone hotline recording confirming the advisory.

Although a clean sediment cap has already been placed over the most heavily contaminated areas of the East Harbor, the contamination in remaining areas of the East Harbor is at a level anticipated to pose a continued risk to marine organisms and to people who may eat shellfish from beaches adjacent to the Wyckoff Facility.

CLEANUP GOALS AND OBJECTIVES

EPA's mandate under the Superfund law is to protect human health and the environment. Clean sediment provides a better habitat for marine organisms and reduces contamination

available to the food chain. The objective of this proposed plan is to address contaminated sediments in the East Harbor and to ensure that they meet state and federal criteria for the protection of human health and the environment.

EPA studied cleanup alternatives for two general sediment zones:

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

Different environmental processes occur in the intertidal zone, due to the presence of air, light, and breaking waves. In addition, intertidal sediments are readily accessible to humans. For this reason, the potential for human exposure to contamination in the intertidal zone is greater.

Washington's Sediment Management Standards

In conducting Superfund remedial cleanups, EPA is required to meet 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 constitute a significant ARAR. As with the West Harbor, EPA has used the state's sediment standards to develop a site-specific cleanup objective for the East 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 sediment cleanup areas. Sediment data from a given area are compared to a range of contaminant levels provided by the standards. Sediment contamination within the range generally causes minor biological effects. Sediments with contamination greater than the range pose a significant risk and must be included in a cleanup area, while sediments cleaner than the range require no further study.

For a given sediment site, a cleanup objective is selected from this range, considering the environmental benefits, cost, and technical feasibility of achieving the objective through cleanup action. The cleanup objective can be the most stringent end of the range, defined by the **Sediment Quality Standards** (SQS), the least stringent upper end of the range, defined by the **Minimum Cleanup Level** (MCUL), or chemical levels within the range.

Although the chemical criteria are based on the results of extensive chemical and biological testing throughout Puget Sound, the same level of contamination may not always cause the same severity of biological effects in all areas. If biological tests using sediments from a given area prove the contaminated sediments are not toxic, the standards do not require cleanup of the area. In addition, the standards recognize that continuous natural processes such as the breakdown of chemicals or their gradual burial under newly deposited sediments are a passive form of cleanup. For a given area, if natural recovery will restore sediments to the site objective within ten years, active cleanup may not be required. Monitoring is generally necessary to document the natural recovery.

East Harbor Cleanup Objectives

For Eagle Harbor, EPA followed the process of the state's sediment standards described above to select an objective. EPA proposes to use the MCUL as the primary cleanup objective for the East Harbor. The MCUL for PAH and Mercury are shown on Table 2.

In Eagle Harbor, many areas were contaminated above the MCUL for one or more contaminants (refer to Figures 3 and 4). Sediments were also tested for biological effects. East Harbor areas which showed high toxicity are now covered by the existing sediment cap (refer to Figure 2); however, remaining areas above the MCUL may pose an environmental risk. EPA proposes to address these areas with sediment cleanup, unless further testing shows that adverse biological effects are minor or are not occurring.

Active cleanup would not be required in areas where sediment contamination levels fall between the SQS and MCUL. Including all sediments in this range would double the estimated cleanup area. The costs and short term environmental impacts of dredging, capping, or other active cleanup in such a large portion of the harbor might outweigh the benefits of cleanup. In Eagle Harbor, adverse biological effects were not consistently observed where predicted by the MCUL. Although some areas of the East Harbor above the MCUL showed levels of acute toxicity as predicted, other such areas showed only minor or no acute effects. This suggests that in areas cleaner than the MCUL, the minor effects predicted may also not be occurring.

Table 2

Puget Sound Marine Sediment Minimum Cleanup Levels Chemical Criteria*

Chemical Parameter	Criteria
PAHs: (mg/kg organic carbon)	
LPAH (total)	780
Naphthalene	170
Acenaphthylene	66
Acenaphthene	57
Fluorene	79
Phenanthrene	480
Anthracene	1200
2-Methylnaphthalene	64
HPAH (total)	5300
Fluoranthene	1200
Pyrene	1400
Benz(a)anthracene	270
Chrysene	460
Total Benzofluoranthenes	450
Benzo(a)pyrene	210
Indeno(1,2,3-c,d)Pyrene	88
Dibenzo(a,h)anthracene	33
Benzo(g,h,i)perylene	78
MERCURY: (mg/kg mercury)	0.59

* See the Washington Administrative Code 173-204-520 for a full listing and footnotes.

EPA believes that the MCUL is a cleanup objective which effectively balances environmental benefits, costs, and technical feasibility for Eagle Harbor. The added impacts and costs of addressing areas cleaner than the MCUL is not justified because biological effects of contamination in such areas are minor or absent. Active cleanup of areas above the MCUL may enhance the natural recovery in less contaminated areas.

How the MCUL will be applied in East Harbor SUBTIDAL areas

EPA proposes active cleanup in East Harbor subtidal areas failing the MCUL chemical criteria, except where full biological testing shows only minor adverse effects. Once final cleanup areas above the MCUL are defined with updated sampling data, there would be no evaluation to determine whether further natural recovery is likely.

Because East Harbor sediment cleanup actions hinge upon further source control at the facility, it may be several years before final cleanup begins. By this time, six to ten years may have elapsed since the initial collection of sediment data in 1988. Although eliminating subtidal areas predicted to recover naturally could reduce the cleanup costs, EPA believes that waiting ten additional years is unacceptable.

How MCUL will be applied in East Harbor INTERTIDAL areas

In the East Harbor, EPA predicts natural recovery of PAH-contaminated intertidal sediments because conditions for natural recovery of PAHs are better in intertidal zones than subtidal. Exposure to light accelerates the chemical breakdown of PAHs, and the availability of oxygen enhances microbial breakdown.

This approach is similar to the 1992 cleanup decision for the West Harbor, which called for control of PAH sources (such as pilings and runoff from paved areas) and for monitoring to document the predicted recovery of intertidal sediments near the ferry terminal. As in the West Harbor, contaminated intertidal sediments adjacent to Wyckoff would be required to meet both

the MCUL and a cleanup objective for carcinogenic high-molecular weight PAHs (HPAH) of 1200 parts per billion. The MCUL protects the marine environment, while the HPAH objective is intended to reduce public health risk from carcinogenic PAHs in the tissue of shellfish. EPA proposes to use fencing, signs and other public outreach to limit shellfish harvest from contaminated intertidal sediments adjacent to the Wyckoff Facility. Monitoring will be necessary to document reductions in PAH contamination.

EPA recognizes that the West Harbor and East Harbor intertidal zones differ in ways that may make it difficult to achieve the cleanup objectives. Contamination of the West Harbor intertidal sediments came primarily from surface sources, such as creosoted wood structures and runoff from paved surfaces. Control of surface sources is a definable point when monitoring of natural recovery can begin. In the East Harbor, however, years of oily seepage on the beach have led to greater levels of contamination over a greater depth. Even once seepage from the facility is controlled, contamination in underlying sediments may be forced up into surface sediments through tidal action. This could affect the potential for either active cleanup or natural recovery to achieve the cleanup objectives. If monitoring or pilot studies indicate that sediments are unlikely to achieve the objectives within ten years after source control, EPA will consider active measures, such as enhancing the breakdown of PAHs or excavating heavily contaminated sediments. Cleanup of any excavated sediments would be coordinated with Wyckoff Facility soil cleanup.

SOURCE CONTROL

A major factor in any cleanup decision is control of contaminant sources. If sources are not sufficiently controlled, recontamination after cleanup can occur.

For the East Harbor the primary source of contamination is the Wyckoff facility. Active wood-treating operations ceased in 1988 and cleanup work at the facility has continued to reduce sources to Eagle Harbor. However, ongoing sources of contamination may still affect remaining areas of the East Harbor.

The existing cap in the East Harbor was warranted by the documented biological effects of the heavy contamination in this area, and was placed in areas away from active oily seeps. Oily seeps and groundwater moving from the Wyckoff wood-treating facility may continue to affect areas adjacent to the facility for some time.

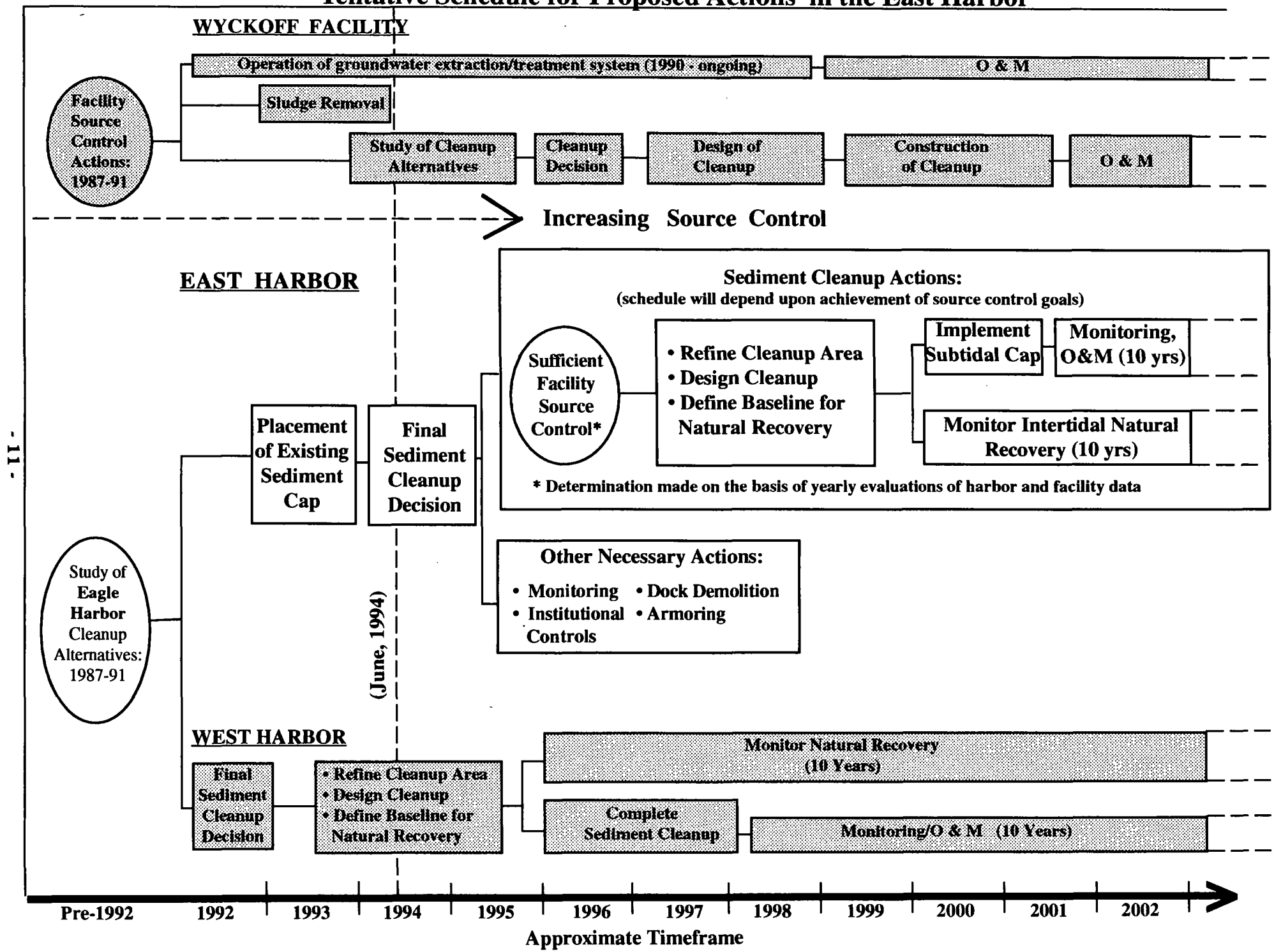
Phased Sediment Cleanup

For the above reason, EPA's preferred cleanup approach for the East Harbor links sediment cleanup to source control at the Wyckoff facility. Table 3 on the next page shows an estimated timeline for cleanup actions at the East Harbor, Wyckoff facility, and West Harbor. Over the next several years, EPA anticipates further source control due to (1) improvements to the existing groundwater extraction and treatment system (2) evaluation and selection of soil and groundwater cleanup alternatives for the facility, and (3) design and construction of the selected facility cleanup alternative. During this time, EPA proposes to conduct yearly evaluations. When data from the facility and from sediment monitoring indicate that source control is sufficient, design and implementation of East Harbor sediment cleanup would proceed.

Other Necessary Actions

Although this proposed plan focuses on cleanup alternatives for remaining contaminated sediments, certain other actions may be necessary to protect the existing sediment cap and to assure public safety. EPA proposes these actions in addition to the sediment cleanup options described in this proposed plan. The area of the East Harbor recently covered with clean sediment would be monitored to assure that the cap remains clean, to observe re-colonization by marine organisms, and to evaluate its physical integrity. Limited monitoring in other areas may be necessary to document changes in sediment contamination, evaluate the status of source control, and assess the potential for natural recovery.

Table 3
Tentative Schedule for Proposed Actions in the East Harbor



Currents created by ferry traffic may cause some loss of sandy material from the existing sediment cap. EPA monitoring over the next several years may identify areas where "armoring" (adding a layer of gravel or larger materials to hold the sand in place) is necessary or where additional cap materials should be placed. This work would proceed as necessary.

In addition, EPA proposes to demolish creosoted wood docks, piers and pilings at the inactive Wyckoff Facility. The piers pose a potential public safety hazard in their current condition, and their deterioration over time will release more PAHs into the harbor. Removing the structures prior to final sediment cleanup will also make it easier to monitor and clean up sediments close to shore.

Estimated costs for monitoring, armoring areas of the cap, and the demolition and disposal of treated wood structures range from $2 to $5 million as shown below. Actual costs depend on the time it takes for source control, how large an area (if any) needs armoring, and whether debris from the dock demolition requires disposal at a hazardous waste landfill.

Monitoring: $100 thousand per year (estimate minimum of 3 yrs)
Armoring: $0.5 - 1 million (estimate of 8 - 11 acres)
Demolition: $1.5 - 3 million

SEDIMENT CLEANUP ALTERNATIVES EVALUATED

In the Eagle Harbor Feasibility Study (FS), EPA evaluated several technologies for cleaning up Eagle Harbor sediments. This section provides an overview of the cleanup alternatives considered. Specific alternatives are described on pages 15 - 16. For more detailed information about the alternatives, the FS is available for review at the EPA office in Seattle or at the public library in Bainbridge.

The FS outlined preliminary cleanup areas and compared effectiveness, cost, feasibility, and other factors for the technologies which could be used in each cleanup area. The alternatives were summarized and compared in the 1991 proposed plan.

EPA's 1992 cleanup decision for the West Harbor combined excavation of a sediment hotspot with capping, while the partial cleanup for the heavily contaminated areas of the East Harbor was completed with a sediment cap. The following section summarizes the cleanup alternatives evaluated for remaining contaminated areas of the East Harbor. A summary of EPA's comparative analysis is provided at the end of this Proposed Plan.

Overall cleanup alternatives fall into three categories:

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

Under the Superfund remedial program, EPA always considers the "no action" alternative in developing a feasibility study. Even if no action would result in unacceptable risks, this alternative must be compared with other alternatives to weigh the benefits of institutional controls or active cleanup. In some cases, even without active cleanup, natural processes contribute to gradual environmental recovery.

Public awareness programs, fences, warning signs, and land use restrictions are examples of institutional controls. These can reduce or eliminate access or exposure to contaminants but do not clean up the site or protect marine organisms.

Active cleanup options are engineered solutions to site contamination. For East Harbor sediments, EPA evaluated a number of active cleanup alternatives. Only one, capping, would cover the contaminated sediments where they lie. All of the other active options involve dredging of contaminated sediments and management of these dredged sediments. Dredged, contaminated sediments could be contained in engineered facilities at the harbor bottom or near shore. Alternatively, dredged sediments could be treated through incineration or biological treatment, both of which require de-watering, storage, and management of waste water and the treated sediments.

Areas, Costs, and Timeframes

In the FS, EPA used available chemical and biological data collected by EPA in 1988 to estimate cleanup areas throughout Eagle Harbor. Separate estimates were developed for intertidal and subtidal areas. For subtidal areas, a range of areas was estimated to show how changes in cleanup areas might affect the costs.

The FS cost estimates are provided in Tables 4 and 5 for comparison of the relative costs of different sediment cleanup alternatives. The $2 to $5 million estimated for other necessary actions described above would be in addition to these costs.

It is important to note that cleanup of East Harbor sediments would not begin until sources of contamination to the East Harbor from Wyckoff are sufficiently controlled, potentially several years from now. Prior to detailed design of the sediment cleanup, additional sampling would be conducted to refine cleanup areas. Due to reduced seepage from Wyckoff, microbial breakdown of PAHs, and the spreading of clean sediments at the edge of the partial cap in the East Harbor, contaminant levels may have decreased. This could result in reduced cleanup areas and corresponding reductions in costs.

The description of each alternative includes a timeframe for design and implementation of the alternative, based on the estimated areas and volumes. These timeframes do not include the time--potentially several years--which may be necessary before ongoing and planned cleanup at the Wyckoff facility have sufficiently controlled sources of contamination to the East Harbor. When remedial design is initiated, changes in estimated cleanup areas may shorten the estimated timeframes for implementation.

Common Elements of the Cleanup Alternatives

The alternatives described below share certain elements. Each alternative, including "no action," would require monitoring to evaluate changes in environmental conditions after active cleanup or through natural processes. For the cleanup alternatives other than no action, EPA would link implementation of final sediment cleanup with further source control at the facility. Cap monitoring and other work described under "Other Necessary Actions" would supplement all alternatives other than no action.

In addition, all active cleanup alternatives would require the following: sampling during the design phase to refine estimates of cleanup areas or volumes; completion of detailed design plans; and mitigation for any significant habitat lost as a result of active cleanup.

During remedial design, EPA may find it necessary to modify cleanup boundaries and methods somewhat, due to steep slopes in areas of the harbor or to the presence of sensitive eel grass habitat. Subtidal slopes on the eastern side of the Wyckoff facility range up to 15%. Capping can be difficult on slopes of this nature, while dredging could expose more contaminated sediments. Special methods and/or changes in the scope of cleanup would be necessary if the final cleanup areas included such steeply sloped conditions. Between the tideline and minus thirty feet, eel grass has been noted in some areas, and may be widespread. If remedial design sampling indicated that healthy, productive eel grass beds fell near or within cleanup areas, EPA and other resource agencies would need to evaluate ways to avoid or mitigate impacts from cleanup. As replanting is often unsuccessful, these areas could be left alone, with monitoring to observe natural recovery.

Monitoring of the East Harbor after cleanup would continue as necessary to assure that the cleanup is successful and to verify reductions in seafood contamination. EPA estimated up to thirty years of monitoring, which would be included as part of operations and maintenance (O & M).

Table 4
Estimated Costs[a] of East Harbor Cleanup Alternatives Evaluated in Feasibility Study

INTERTIDAL SEDIMENTS

Estimated Costs in Dollars Based on FS Intertidal Area[b] of 55,000 m² (14 acres)

Alternative	Initial	O&M	Total
No Action/Natural Recovery	0	300,000	300,000
Institutional Controls/Natural Recovery	**24,000**	**376,000**	**400,000**
Capping	5,900,000	600,000	6,500,000
Confined Aquatic Disposal	9,800,000	800,000	10,600,000
Nearshore Confined Disposal	29,500,000	1,500,000	31,000,000
Incineration	99,200,000	2,800,000	102,000,000
Biological Treatment	71,500,000	1,900,000	73,400,000

Table 5.
Estimated Costs[a] of East Harbor Sediment Cleanup Alternatives Evaluated in Feasibility Study

SUBTIDAL SEDIMENTS

Costs in Dollars Based on FS Lower Bound Area[c] of 235,000 m² (58 acres)

Alternative	Initial	O&M	Total
No Action/Natural Recovery	0	300,000	300,000
Institutional Controls/Natural Recovery	0	400,000	400,000
Capping	**13,700,000**	**800,000**	**14,500,000**
Confined Aquatic Disposal	26,600,000	1,300,000	27,900,000
Nearshore Confined Disposal	46,700,000	1,000,000	48,600,000
Incineration	238,700,000	5,200,000	243,900,000
Biological Treatment	176,000,000	4,000,000	180,000,000

[a] Initial capital costs are based on 1990 dollars, and present worth of O&M was calculated using an 8% discount rate and a 30-year amortization period.

[b] Intertidal costs are based on 55,000 square meters, an area which includes 40,000 square meters of intertidal sediments in the East Harbor and 15,000 square meters in the West Harbor. Actual costs would be lower, but relative costs would not change significantly.

[c] Estimated costs are based on areas developed for the Feasibility Study, for lower bound cleanup areas. This estimate is close to the estimated area of sediments not included in the capped areas of the East Harbor but which fail one or more of the MCUL chemical criteria (259,000 m²). Areas outside the existing cap which fail one or more of the SQS chemical criteria are estimated at 488,000 m², approximately double the lower bound areas. Estimated costs for addressing these are provided in the FS, as upper bound cost estimates. Generally, cleanup costs would approximately double.

DESCRIPTION OF CLEANUP ALTERNATIVES

No Action/Natural Recovery

Under "no action," the East Harbor would be left in its present condition to recover over time through natural processes such as sedimentation (settling of sediment from the water column), chemical and biological breakdown of PAH, and dispersal of contaminated sediments. The combined effect of these processes is known as natural recovery.

Eagle Harbor has little new sedimentation, and it can take decades for certain PAH compounds to degrade in subtidal conditions. Based on 1988 chemical data, EPA estimates that even with complete source control, it could take several decades for heavily contaminated subtidal areas to achieve the MCUL. PAHs exposed to light and air break down faster, and surface sediments in beach areas are predicted to meet the state standards in ten years without active cleanup, if all sources to those sediments are controlled.

The estimated costs for thirty years of monitoring fish and shellfish tissue, sediment chemistry, and biological effects are included in Tables 4 and 5.

Institutional Controls/Natural Recovery

Institutional controls could include fencing contaminated beach areas, restricting commercial fish and/or shellfish harvests, and posting additional advisory signs to supplement the existing health advisory. These actions would further 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 above. 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. It would take less than a year to implement the controls.

Capping in Place

Capping involves covering contaminated sediments with clean material. In heavily contaminated subtidal areas of the East Harbor, a three-foot thick sand cap has already been placed. Capping limits movement of contaminated sediment, isolates the contaminants from the marine environment, and provides clean habitat for sediment-dwelling organisms.

Although Eagle Harbor is a protected harbor with relatively slow currents, ferry propeller wash and currents along the east shore at the mouth of the harbor may be strong enough to erode sandy cap material in some areas. In such areas, including portions of the harbor already capped, gravel or coarser materials may be needed as "armoring" on the sandy layers to keep the cap in place, or additional sand may be added to maintain the cap thickness.

An effective cap would have to be designed for long-term stability, especially in intertidal areas where waves and currents present higher energy conditions; "armoring' with coarse materials could address this concern. Where slopes are steep, it may be impracticable to place a full three feet of material; however, sufficient material could be placed to enhance recovery in the top 10 centimeters of sediment, the most biologically active zone. Design and implementation of capping are estimated to take 2 - 4 years.

Confined Aquatic Disposal

This alternative would involve dredging contaminated sediments from the subtidal and intertidal zones, placing the sediments in a pit dredged at the bottom of Eagle Harbor for a confined aquatic disposal (CAD) facility, and covering the relocated sediments with clean sediment originally dredged to make the CAD facility. The FS considered an area in the central channel of the East Harbor for a CAD facility. 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. Contaminated sediments removed from intertidal areas would be replaced with clean material to replace disturbed intertidal

habitat. Design and implementation could take 4 - 6 years.

Nearshore Confined 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, for example, the log-rafting area near the Wyckoff facility. Leaching controls and monitoring would be necessary. Design and implementation are estimated to take 4 - 5 years.

Incineration

For this alternative, contaminated sediments would be dredged, dewatered, processed to break up larger particles, and incinerated. The incinerator, a mobile rotary kiln or other design, would be equipped with air pollution control equipment. The incinerator could be located at the 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. Design and implementation are estimated to take 8 - 11 years.

Biological Treatment

Contaminated sediments would be dredged and, after dewatering, mixed in a slurry, aerated, and passed through a biological treatment system over time 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. Design and implementation are estimated to take 9 - 11 years.

EPA's PREFERRED ALTERNATIVE

EPA's preferred alternative would combine two of the above alternatives to achieve the sediment cleanup objectives: capping in place for subtidal sediments, and institutional controls/natural recovery for intertidal sediments.

Under the preferred alternative, the sediment cap placed under Superfund removal authorities would be incorporated as a component of the final remedy, as would the proposed phasing and the other necessary actions described on page 10. The subtidal cap would be extended into remaining subtidal areas contaminated above the Minimum Cleanup Level (MCUL), and would be modified as necessary to address steeply sloped areas and sensitive eel grass habitat.

Intertidal areas near the Wyckoff Facility are expected to achieve the intertidal cleanup objectives without active cleanup in ten years or less after control of significant sources. A fence and signposts at the beaches adjacent to the facility would be used to discourage harvest of shellfish. If necessary, active cleanup measures, such as nutrient enhancement or hotspot excavation, would be evaluated to ensure that intertidal areas achieve the cleanup objective. Excavated sediments could be handled in conjunction with the Wyckoff Facility soil cleanup.

The cost for sediment cleanup under the preferred alternative as estimated in the FS is $15 million, including $0.4 million for institutional controls/natural recovery (see Table 4) and $14.5 million for capping in subtidal areas (see Table 5). This includes design and construction of a cap, fencing and other institutional controls, and long-term monitoring.

As with the other active alternatives, the demolition of docks at the Wyckoff facility, monitoring of sediments, and armoring of the existing cap (if necessary) could add up to $5 million (refer to "Other Necessary Actions", page 11). This would bring the total cost range for all proposed actions in the East Harbor to an estimated $6 to $20 million.

While the $14.5 million for capping areas currently estimated to be above the MCUL (shown in Table 5) reflects a maximum cost estimate, a number of factors could result in lower capping costs. Updated EPA estimates are as low as $7 million.

In addition, definition of the cleanup areas after source control at the Wyckoff facility is likely to result in smaller cleanup areas and corresponding cost reductions. Finally, sediments available at low cost from planned navigational dredging projects in clean Puget Sound locations may also decrease costs, as they did with the existing East Harbor cap. Thus, EPA expects that final costs should approach the low end of the cost range.

WHAT'S NEXT?

A community meeting about this plan will be held as indicated on the front of this document. The meeting will be an opportunity for you to ask questions about the proposed plan and to provide your comments in person.

EPA will respond to written and verbal comments on the proposed plan in a document called a "responsiveness summary." After considering all public comments, EPA will make the cleanup decision for the East Harbor and will document the decision in a Record of Decision (ROD), with the responsiveness summary attached. The ROD will be available for review at EPA and the public library in Winslow.

Once the ROD is signed, EPA may enter into negotiations with the potentially responsible parties to implement the selected cleanup. 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.

The information summarized in this proposed plan is 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 file for the site, at the locations listed on page 2.

QUESTIONS?

contact:

Ellen Hale
EPA Project Manager
(206) 553-1215

or

Ken Marcy
EPA Community Relations Coordinator
(206) 553-6501

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

APPENDIX

COMPARISON OF THE ALTERNATIVES

The alternatives in the FS were evaluated based on the nine evaluation criteria described in Table 6. EPA believes that the preferred alternative provides the best balance of tradeoffs among the alternatives with respect to the nine evaluation criteria. The following is a summary of EPA's evaluation.

Protectiveness of Human Health and the Environment

All cleanup alternatives except No Action and Institutional Controls protect human health and the environment.

Treatment alternatives would achieve long term protection with few monitoring requirements. Alternatives involving on-site containment of contaminated sediments would require long-term monitoring and maintenance in order to assure continued protection. No Action/Natural Recovery could be protective of the environment once sediments reached the cleanup objective, a This alternative would not address process that could take more than ten years. This alternative would not address human health concerns. Institutional Controls/Natural Recovery could provide protection of human health until the sediments recovered to cleanup levels.

EPA's preferred alternative is protective of both human health and the environment. In conjunction with the existing health advisory, institutional controls (fencing, and warning signs at the Wyckoff Facility beach) will discourage consumption of contaminated seafood. Natural recovery (or other active measures as needed) will ensure that environmental protection is achieved within ten years of source control. Capping of subtidal sediments isolates contamination from marine organisms. Monitoring and maintenance will be needed.

Compliance with ARARs

All alternatives except No Action and Institutional Controls could comply with ARARs.

Certain ARARs regarding waste management would apply only for alternatives involving dredging or treatment alternatives but would not apply to capping in place, natural recovery or institutional controls. No Action and Institutional Controls would meet not meet the primary ARAR of the state sediment management standards, except for areas where natural recovery could occur in ten years.

EPA's preferred alternative meets all ARARs.

Long-Term Effectiveness and Permanence

Biological Treatment and Incineration

permanently destroy PAH and other organic compounds. For highly concentrated contaminants that are mobile in the environment, Superfund policy generally favors on-site treatment options over containment, institutional controls, or off-site disposal of untreated waste. However, containment options can be designed to provide long-term effectiveness and permanence in certain cases.

Containment alternatives (confined aquatic disposal, nearshore disposal, or capping in place) are most appropriate for large volumes of waste with relatively low contaminant concentrations, as with many contaminated sediment sites. Containment alternatives require maintenance to be effective long term.

No action and institutional controls do not permanently affect the conditions at the site, except where sediments recover naturally over time.

The preferred alternative combines capping and natural recovery, with provisions for demolition of creosote-treated structures and active remediation of some intertidal sediments. EPA believes this balances the need for containment of large areas of moderately contaminated sediments with the flexibility to take a more aggressive approach in source areas or hotspots. If sediment hotspots are excavated from the intertidal zone, they could be treated, contained, or disposed, depending on the cleanup selected for the facility soils.

Longterm monitoring and maintenance of the capped areas would be necessary to verify effectiveness.

Reduction of Toxicity, Mobility, and Volume

Biological treatment and incineration would directly reduce the toxicity and mobility of PAH contamination.

Containment alternatives do not alter the chemical nature of the contamination, but restrict the movement of sediment particles to which organic contaminants are bound.

No Action and Institutional Controls do not directly affect toxicity, mobility, or volume, but natural processes could reduce the toxicity and volume over time.

The preferred alternative does not directly affect toxicity, mobility, and volume, but in intertidal zones these processes should occur naturally. Movement of subtidal contaminated sediments would be restricted by capping.

Short-Term Effectiveness

Alternatives involving treatment (such as biological treatment or incineration) take more time to implement. Engineered containment facilities (such as nearshore or confined aquatic disposal facilities) could be completed sooner. Capping with clean sediment provides the greatest short-term effectiveness because it can be implemented most readily. Institutional controls can be implemented within a year. No action

Table 6:
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 performance** - 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?

requires the least implementation but is not effective in the short term.

Short term impacts of cleanup alternatives on the environment and human health must also be considered. Treatment and containment alternatives that require dredging of contaminated sediments risk suspension of contaminated sediments and exposure of marine organisms and humans to the sediments. Capping can be done with minimal short-term environmental impacts, as demonstrated with the existing cap in the East Harbor.

Studies show that marine organisms soon repopulate clean sediment. This process has already begun in areas of the East Harbor addressed last winter by the cap. Recolonization by these organisms can begin immediately after capping or removal of contaminated sediments, but development of a mature community of sediment-dwellers may take two years or more. Small cleanup areas can be recolonized by organisms from adjacent clean sediments. Monitoring during placement of the existing East Harbor cap shows that buildup of cap thickness in shallow layers allows some organisms living in the contaminated sediments to survive by moving upwards into the clean material.

The preferred alternative minimizes impacts on the intertidal zones by allowing natural recovery over ten years. If excavation is needed, suspension of contaminated sediments can be minimized by working at low tide. In subtidal areas, capping can be implemented readily and provide protection of the marine habitat.

Implementability

All alternatives require careful design, scheduling, and environmental monitoring, as well as coordination with ferry traffic. All can be implemented, although with varying degrees of difficulty. Treatment options require storage, extensive processing of sediments, and the management of sediment and drained water. Evaluating a suitable containment site within Eagle Harbor would require study and complex staging of dredging and transportation activities.

Capping in place requires less complex engineering controls to limit water column releases than options which involve dredging, such as treatment or confined disposal.

Institutional controls require coordination with state and local entities.

The preferred alternative is readily implemented. Capping and institutional controls/natural recovery involve no dredging, storage, dewatering, or processing of contaminated sediment. If hotspots are excavated from the intertidal zone, the sediments can be managed in coordination with soil cleanup at the facility.

Cost

The estimated cost range provided with each alternative assumes the alternative is applied wherever feasible and appropriate, given the contaminants and physical location. Actual cleanup costs could be less if cleanup areas are smaller than current EPA estimates. 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 containment (by capping) in place, natural recovery, and institutional controls.

Comparing total costs for applying each alternative in both intertidal and subtidal areas, incineration would be the most costly (approximately $345 million). Costs would be somewhat lower for biological treatment (approximately $255 million), and would decrease further for containment options such as Nearshore Disposal ($78 million) and Confined Aquatic Disposal ($30 million). Capping is the least costly active cleanup alternative (estimated at $20 million). Institutional controls ($0.8 million) and No Action ($0.6 million) are the least costly alternatives, but would not meet the cleanup objectives.

EPA's preferred sediment cleanup alternative combines subtidal capping ($14.5 million) with institutional controls/natural recovery ($0.4 million) for intertidal sediments, for a total estimate of $15 million for sediment cleanup.

Other necessary actions--monitoring, dock demolition, and cap armoring (if necessary)--could add up to $5 million to each of the alternatives, including the preferred alternative. In the case of the preferred alternative, this would bring the maximum cost for all proposed actions in the East Harbor to an estimated $20 million.

As noted in the discussion of the Preferred Alternative (page 16), EPA anticipates that the actual costs of capping will be significantly reduced.

United States
Environmental Protection
Agency

Region 10 (HW-117-CR)
1200 Sixth Avenue
Seattle WA 98101

Wyckoff/Eagle Harbor
East Harbor Proposed Plan

APPENDIX B

Responsiveness Summary
1994 Proposed Plan for Final Cleanup
East Harbor Operable Unit

Section four of the East Harbor Record of Decision (ROD) describes community relations activities leading up to the ROD. As noted, the Environmental Protection Agency (EPA) issued a Proposed Plan in 1991 for Eagle Harbor sediment cleanup, proposing final action in the West Harbor and interim action in the East Harbor. A second Proposed Plan was issued in 1994 after the interim action in the East Harbor was completed.

This responsiveness summary provides EPA responses to comments on the 1994 Proposed Plan only. EPA's response to comments on the 1991 Proposed Plan was attached to the 1993 Action Memorandum documenting EPA's decision to use Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA) removal authorities for the interim action. Because the interim action has been incorporated in the final selected remedy for the East Harbor, the responsiveness summary for the 1991 Proposed Plan is also included, as Attachment A.

Comments on the 1994 East Harbor Proposed Plan were provided at a public meeting and in five letters to EPA. Letters were received from the Washington Department of Natural Resources (DNR), the Technical Advisory Committee of the Association of Bainbridge Communities (ABC), two individual members of ABC, Pacific Sound Resources (PSR, aka the Wyckoff Company), and an unaffiliated citizen. Overall, comments supported the proposed final remedy. Several comments requested clarification of issues in the ROD or proposed minor changes in the EPA's approach.

EPA has grouped the comments under the following headings:

- Cleanup objectives,
- Cleanup alternatives,
- Implementation of the selected remedy, and
- Other Issues.

Paraphrased comments and EPA responses are provided below, under these headings.

1. Cleanup Objectives

Comment: Why is a ten-year natural recovery period acceptable in intertidal areas, but unacceptable in subtidal areas? The intertidal areas are more likely to be used by the general public.

> **EPA Response**: *Contamination by polynuclear aromatic hydrocarbons (PAHs) in the East Harbor is most amenable to natural recovery in intertidal areas, and there is a strong likelihood that natural recovery will be effective in these areas due to sunlight and wave action. Unlike subtidal habitat, intertidal habitat is sensitive to changes in elevation. Elevation changes due to capping or excavation can be avoided where natural recovery is predicted. During the sediment recovery period, human exposure in intertidal areas will be minimized by institutional controls (warning signs, access restrictions) at the beaches adjacent to the Wyckoff Facility. In subtidal*

zones, natural recovery processes will be relied on in areas contaminated below the minimum cleanup level (MCUL). However, since subtidal areas are less affected by elevation changes, the impacts of active cleanup are less significant. However, the ROD allows limited consideration of natural recovery where cleanup would damage valuable habitat, consistent with the intertidal zone, or where capping is technically impracticable. Conversely, active remediation is provided for in intertidal zones, in specific areas where natural recovery may not achieve cleanup objectives.

2. Cleanup Alternatives

Comment: EPA should ensure effective institutional controls by public education efforts and by posting and maintaining signs visible not only at the property boundary on the beach but along the beach, to notify approaching boaters.

EPA Response: *EPA agrees that signs should be posted at intervals along the beach, in case they approach by boat. Although such signs are already posted, larger signs may be more effective. The need for maintenance of the warning signs and other institutional controls is acknowledged.*

Comment: Institutional controls to restrict beach access at Wyckoff should be implemented as soon as possible.

EPA Response: *It is EPA's intent to implement these controls as a part of the remedy as soon as possible after issuance of the ROD.*

Comment: EPA should explain what methods are considered for enhancing the breakdown of PAH in sediments. EPA should plan on a pilot study and implementation of these methods as an integral part of the remedy, rather than as a contingency.

EPA Response: *A preliminary listing of such methods is provided in the 1994 Proposed Plan and the ROD, including harrowing and nutrient addition. EPA believes a ten-year timeframe for natural recovery in these areas is acceptable (provided institutional controls are implemented) and likely to be effective. Before incorporating enhancement as a component of the remedy, EPA must first assess whether such action is necessary to ensure recovery of the more contaminated sediments and must select a suitable method for site conditions. If a suitable enhancement method is necessary for certain areas and can be cost-effectively applied to a wider area, EPA may determine that recovery of the wider area should be enhanced similarly.*

Comment: More discussion of studies supporting faster PAH breakdown in intertidal areas is needed.

EPA Response: *More detailed discussion is provided in Appendix D of the Feasibility Study (FS).*

Comment: We support capping and natural recovery and would object to incineration, nearshore confined disposal, and confined aquatic disposal

EPA Response: *EPA's selected remedy reflects the same preferences.*

Comment: The 1994 Proposed Plan appears to suggest that natural recovery could still be considered for

subtidal areas. We believe that natural recovery should not be considered for cleanup of subtidal areas after source control.

> **EPA Response**: *The 1994 Proposed Plan clearly indicates that after source control further natural recovery will not be considered in subtidal areas. The Proposed Plan also notes that the processes leading to sediment natural recovery are continuous. Any changes in areas of contamination as a result of these ongoing processes will be reflected when final cleanup areas are delineated after control of significant sources. As described in the selected remedy, subtidal cleanup will be required for areas delineated at the time of source control. The only exception to this is consideration of limited sediment recovery zones where warranted due to habitat value or technical practicability.*

Comment: EPA should carefully consider the impacts of a thick cap (greater than 1 foot in thickness) on navigational access and commerce in the Harbor.

> **EPA Response**: *EPA intends to consider these impacts and to minimize them. EPA will coordinate with the appropriate agencies, including DNR, the City of Bainbridge Island, and the Washington State Ferries, in designing a final cap that is both environmentally protective and compatible with harbor uses.*

Comment: EPA has not balanced cost effectiveness with other decision criteria when it excluded natural recovery as an option for the subtidal sediments. CERCLA and the State of Washington Sediment Management Standards (Sediment Standards) require EPA to balance and weigh cost effectiveness of the remedy with other considerations. The 1994 Proposed Plan notes that natural recovery may be significantly more cost effective than capping.

> **EPA Response**: *EPA considered cost-effectiveness, as required. The Proposed Plan notes that natural recovery may cost less than active remediation. This is not a determination of cost-effectiveness. EPA weighed the alternatives using the nine CERCLA criteria, which encompass the three criteria in the Sediment Standards of cost, net environmental benefits, and technical feasibility. EPA determined that the incremental cost of cleanup for subtidal sediments which could recover within ten years of source control was justified by the extended timeframe prior to source control. Final cleanup will likely be delayed several years beyond cleanup in the West Harbor while source control efforts continue, and an additional ten years of potential significant biological effects in natural recovery zones after control of sources was not warranted by the potential cost savings. As noted in Section 11, the conditions for consideration of natural recovery are more explicit in the selected remedy than in the Proposed Plan. Sensitive habitat and technical feasibility are conditions which may alter the balance of cost, feasibility, and net environmental benefits of cleanup. For areas with eelgrass or steep slopes, sediment recovery zones may be designated, provided reasonable modifications to the remedy cannot be used to address these areas actively.*

Comment: EPA should defer plans and action on the removal of dock or piling structures until future land use at the facility has been resolved. Some future use alternatives involve docks and piling structures, and would benefit from using existing structures rather than having to build new ones. Such uses would also save the cost of demolition.

EPA Response: *The basis for the decision to demolish these structures is more clearly articulated in the selected remedy. EPA agrees that deferral of the decision may be appropriate. At this time, the docks are not interfering with remedial actions in Eagle Harbor, nor are they deteriorated to the point of posing human health risks. Deferral will allow additional time to evaluate the need to use the in-water structures for implementing Wyckoff Facility cleanup actions as well as for future uses of the property. This change to the proposed plan is identified in Section 11 of the ROD.*

Comment: We believe the creosoted docks, piers, and pilings at Wyckoff should be demolished to remove them as a source of PAH releases.

EPA Response: *EPA expects that removal of the pilings may ultimately be necessary to prevent deteriorating structures from posing physical risks, interfering with sediment capping, and releasing wood-treatment chemicals over time. If the structures are in good condition, are useable, and are not interfering with site cleanup, they may be left standing. Relative to other sources of PAHs, the impact of pilings may be localized. If retained for future uses, EPA anticipates that over time, as the structural integrity of the wooden structures decreases, maintenance of the structure will involve replacement of pilings with other materials, as is being done at the Washington State Ferries terminal.*

Comment: During remedial design, EPA should evaluate the potential impacts of subtidal capping on eelgrass beds and on currents and flushing rates of the harbor. The cap should be designed to prevent such impacts.

EPA Response: *EPA agrees that potential impacts on eelgrass should be evaluated prior to implementation of active sediment cleanup, and that impacts to functioning eelgrass habitat should be avoided, through modifications to the remedy or designation of such areas as sediment recovery zones. Regarding currents and flushing rates, the maximum volume of material which could be used to cap existing problem areas is within 1 - 3 percent of the low-tide water volume in the main basin. A slight increase of the exchange coefficient (an index of flushing) may occur, with an associated increase in the flushing rates, generally a favorable outcome. Any corresponding water quality changes would probably not be measurable. As a general rule, increasing the exchange coefficient is desirable from a water quality standpoint.*

Comment: DNR appreciates EPA's recognition that eelgrass beds require special consideration when designing and conducting remedial activities. We agree with EPA that these areas are difficult to replace if destroyed by remediation measures such as capping. We also agree that natural recovery with monitoring is a viable alternative for the remediation of eelgrass beds. In addition, eelgrass beds may qualify for an extension of the 10-year natural recovery period.

EPA Response: *During remedial design, EPA will consider potential impacts to eelgrass beds from cleanup in areas near eelgrass beds and will also consider whether cleanup is appropriate in contaminated eelgrass beds. If evaluation of the eelgrass beds indicates that sediment contamination is significantly decreasing the value of the beds as habitat and if natural recovery in ten years is unlikely, appropriate decisions as to extending the recovery period or taking active measures will be made at that time.*

3. Implementation Issues

Comment: EPA should provide information in the ROD about the monitoring schedule, methods, and decision criteria to be used in evaluating the status of source control and in evaluating the existing cap.

> **EPA Response**: *In the ROD, EPA has added details on these subjects. However, much refinement occurs in the remedial design stage or in documents separate from the ROD. Moreover, while general guidelines regarding decision-making with respect to source control can be developed at this stage, definitive technical criteria may not be appropriate, because of the complexity of the issue. Determinations regarding the status of source control will rely at least in part on professional judgment based on the combined information from inspections and site monitoring data. However, monitoring data and EPA evaluations of the status of source control will be documented in annual reports available for public review.*

Comment: EPA should clearly state when the cleanup areas will be defined.

> **EPA Response**: *Cleanup areas will ultimately be defined during final remedial design, when sources have been sufficiently controlled. Although planned and ongoing efforts are expected to further control sources, a specific time when source control will be sufficient to proceed with design plans cannot be determined in advance, based on existing information; however, planning documents for defining cleanup areas may be developed as significant sources are becoming further reduced. Agencies and other interested parties will have an opportunity to review draft plans as appropriate. It may take a year to two years to complete both the delineation of areas and the design of the cleanup.*

Comment: Prior to conducting additional investigations, EPA should undertake a single, comprehensive effort to evaluate all past data quality issues in order to avoid any mistakes or methodologies that may create uncertainty in any future data evaluation efforts.

> **EPA Response**: *Throughout the Remedial Investigation and Feasibility Study (RI/FS), EPA has considered data quality and has evaluated any data quality problems which arose. While no comprehensive evaluation of historical data is considered necessary, EPA is committed to the development of high quality data and intends to continue to follow guidance, to involve qualified reviewers, and to apply the appropriate methods for remedial design and monitoring data collection.*

Comment: High Pressure Liquid Chromatography (HPLC), a method of chemical analysis, may be appropriate for use as a screening tool, but should not be used for setting boundaries of cleanup areas that approach chemical cleanup standards listed in Ecology's Sediment Standards.

> **EPA Response**: *EPA agrees that compliance with cleanup standards may not be best assessed using HPLC only, but will consider its use as a screening tool or in combination with other methods.*

Comment: Ecology's Sediment Management Unit (SMU) should be consulted on any proposed sampling methodologies for chemical and biological tests.

> **EPA Response**: *Throughout the RI/FS, EPA has involved Ecology, including the SMU, in*

document reviews and planning, through state cooperative agreements funded by EPA. EPA will continue to involve Ecology, through reviews of planning documents, reports, and design documents as appropriate.

Comment: To overcome limitations on future uses of state aquatic lands, the ROD should be flexible enough to allow parties to propose removal of contaminants from the navigation channel if a public need arises.

EPA Response: *Dredging near remediated areas of Eagle Harbor will not be ruled out entirely. However, in reviewing permit requests, EPA and other agencies may impose additional sampling, health and safety, environmental protection, and waste management requirements to ensure the protection of human health and the environment, including ensuring that the effectiveness of completed remediation is not affected. Similarly, for dredging in areas of remediation, such requirements would be covered under CERCLA agreements.*

Comment: The cleanup action should allow state aquatic lands to continue to fulfill public trust purposes and not preclude future water-dependent uses, public access and utilization of renewable resources.

EPA Response: *EPA recognizes DNR's responsibility to protect water-dependent uses, public access, and utilization of renewable resources. EPA is responsible for protection of human health and the environment. At this time, no conflict between the missions of these agencies is foreseen.*

4. Other Issues

Comment: EPA has chosen to name DNR as a potentially responsible party for the cleanup of Eagle Harbor. DNR believes it is not an "owner/operator" for purposes of CERCLA liability. DNR has determined that it can authorize use of state resources for Superfund cleanup efforts under a mutually acceptable settlement agreement with EPA. DNR has the statutory authority to authorize or deny use of state-owned aquatic resources. Use of sediments from the Snohomish River or any other state-owned aquatic lands for Eagle Harbor capping may be viewed as beneficial to the public trust if it resolves alleged liabilities under CERCLA and provides for contribution protection.

EPA Response: *Comments regarding determinations of CERCLA liability or settlement proposals are not germane to the selection of the remedy and are therefore not addressed in this Responsiveness Summary.*

Comment: EPA needs to further assess the impacts of the interim capping action on sediment quality in areas east of the cap. Samples should be collected from previously sampled stations to determine if contamination levels have increased. Sediment trap data collected during the interim action should be used to determine contaminant loading resulting from displacement of sediments in the hotspot during capping. The analysis should identify areas that now exceed MCULs for PAHs or no longer have the potential to recover within 10 years of source control.

EPA Response: *EPA has evaluated the impacts of releases that may have been associated with completion of the existing cap in the East Harbor. This information is presented in the On-Scene Coordinator's Report regarding the completed cap (EPA, 1994). The analysis indicates that contaminant loading which occurred during the placement of the cap consisted primarily of low molecular weight PAHs (LPAHs), which are readily degraded in the marine environment. Even*

if the depth of sediment in the traps reflects the thickness of sediment deposited on the bottom, one of several conservative assumptions in the analysis, mixing of the new deposits into existing surface sediments is likely to change surface concentrations only slightly. EPA expects that the recent releases will not have an appreciable effect on the cleanup areas to be delineated after significant contaminant sources are controlled. Conversely, the placement of clean dredged material in over 50 acres has probably contributed to the recovery of contaminated areas surrounding the cap.

ATTACHMENT A

RESPONSIVENESS SUMMARY

TO
PUBLIC COMMENTS
ON THE FEASIBILITY STUDY AND 1991 PROPOSED PLAN
FOR
EAGLE HARBOR

EAST HARBOR OPERABLE UNIT

INTRODUCTION

The attached responsiveness summary is an appendix to the June 15, 1993 Action Memorandum for the planned removal action in the East Harbor Operable Unit (OU) of the Wyckoff/Eagle Harbor Superfund Site. It is intended as a supplement to a responsiveness summary issued on September 29, 1992 with the Record of Decision (ROD) for the West Harbor Operable Unit (OU) of the site. The 1992 responsiveness summary is incorporated by reference into the attached responsiveness summary for the 1993 Action Memorandum. Both responsiveness summaries respond to written and oral comments on the Eagle Harbor Remedial Investigation and Feasibility Study (RI/FS) and the December 1991 Proposed Plan.

While the initial responsiveness summary addressed general comments and comments specific to the West Harbor OU, the attached responsiveness summary responds to questions and comments relevant to the planned East Harbor OU Removal Action. Comments addressed in both documents include a reference to their section number in the 1992 responsiveness summary.

For your convenience, the table of contents for the 1992 responsiveness summary is provided below. The text of the 1992 responsiveness summary is in Appendix C of the West Harbor OU ROD and can be reviewed at the Kitsap Regional Library in the City of Bainbridge Island or at EPA Region 10 Headquarters in Seattle.

1992 RESPONSIVENESS SUMMARY
Contents

3.6.5.1
(ROD Comment Number 3.6.4.2.3): Capping is inappropriate because of the high cost and documented ecological damage associated with capping large aquatic areas.

Response: Active remediation of any large area of sediments will have short-term ecological impacts. 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. The larger the cap is, the greater the short-term impacts are expected to be; however, a more extensive cap will provide the greatest long-term environmental benefit and will decrease ecological impacts due to contamination in the East Harbor.

3.6.5.2
(ROD Comment Number 3.6.5.2.3): The alternatives should consider the impacts of grain size on the type of ecological communities that may develop. In evaluating capping materials for use at the site, the ability for supporting benthic organisms should be considered. The use of one size of substrate throughout the harbor could result in a "mono culture" and limit ecological diversity in restored habitats.

Response: EPA will evaluate available materials for sediment placement. Sand and silty sand are likely to provide the bulk of materials for sediment placement. In order to keep clean sediments in place, it may be necessary to place larger grained materials (gravel or rocks) as "armoring" in some areas. However, the likelihood of a monoculture is low, in part because the range of physical environments in Eagle Harbor, such as currents and slopes, dictate a variety of sediment physical characteristics in different areas. For example, materials in the ferry propeller scour zone are larger sized than in protected areas, such as the head of the bay. Other features, such as depth, nutrient availability, and light further distinguish ecological habitats.

3.6.5.3
(ROD Comment Number 3.6.5.1.6): The remedial actions should be designed and implemented in a manner that minimizes impacts on navigation and other uses of aquatic lands.

Response: Because the East Harbor removal action includes sediment placement, some impact on users of aquatic lands may occur. These impacts could include requirements or limitations on maintenance dredging, installation of piers, and maintenance of existing structures in the area of the sediment placement. Reasonable efforts will be made to minimize impacts on the users of aquatic lands. No significant impact on navigation is expected.

3.6.5.4
(ROD Comment Number 3.6.5.2.6): 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 for this action.

3.6.5.5
(ROD Comment Number 3.6.1.8): 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 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: For the East Harbor Removal Action, the following responses apply:

- The surface of the cap in areas affected by ferry propeller wash may be eroded somewhat after placement. Exact determinations of the nature and extent of the erosion isn't possible to determine in advance, however, and EPA intends to monitor the physical conditions of the cap during placement to identify erosional areas. These areas may require additional sediment placement and armoring, which

could be addressed pursuant to a Record of Decision (ROD) as necessary.

- Similarly, the potential compression by the cap of the most highly contaminated sediments will be monitored during and after placement. The cap will extend beyond areas of sediment containing free-phase PAHs in order to avoid releases at the edge of these localized zones. Long-term monitoring and maintenance pursuant to a ROD will provide for monitoring and additional actions as needed.

- A clay or geotextile layer will not be used due to the difficulty of applying them in these areas and their questionable utility. Some subsidence may occur initially in areas of finer, less compacted sediments. If so, the material will serve as a foundation for additional sediment to provide a suitable layer of clean material, either during this action or in subsequent placement. (A three to six foot cap is generally considered sufficient to isolate sediment contamination, and the biologically active zone in Eagle Harbor is estimated at 10 cm.)
- The material to be used for this Removal Action will be obtained through routine navigation dredging in the Snohomish River. The sediments were tested and found to meet both the Puget Sound Dredge Disposal Authority (PSDDA) criteria for open water disposal and the State of Washington Sediment Management Standards sediment quality criteria.
- Two placement methods are proposed in the East Harbor, and the methods will be evaluated through initial placements at the PSDDA disposal site in Port Gardner to determine the appropriate placement rates. In addition, after initial placement of a portion of the sediments in the East Harbor, physical monitoring will be used to evaluate and, as necessary, modify the placement methods, rates, and sequencing.

3.6.5.6
(ROD Comment Number 3.4.2.1): 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: It is difficult to quantify the impact of past sources and the rate of current sources of contamination from the Wyckoff Facility OU to the East Harbor OU. However, direct spills and discharges to the harbor associated with past wood-treating operations are believed

to be the source of a substantial portion of the existing sediment contamination in the East Harbor. With the cessation of plant operations in 1988, such direct discharges were controlled. Ongoing secondary sources such as seepage of contaminated ground water and oily contamination into the harbor have been significantly reduced since 1988 and will continue to decline through continued response actions, including extraction and treatment of contaminated groundwater, extraction of floating and sinking product, and the removal of sludges at the Wyckoff Facility OU.

Ground water measurements indicate that the ground water gradient has been reversed by the extraction system. Over 100 million gallons of contaminated groundwater have been pumped and treated, and an estimated 32,000 gallons of product have been recovered from the extraction wells. The removal of over 2,000 tons of contaminated sludges and the construction of some 300 feet of sheetpiling was completed in 1992, and continued work in 1993 will result in the excavation of over 9,000 tons of sludge from heavily contaminated portions of the transfer pit.

Geophysical data collected in Eagle Harbor, combined with information from wells and borings on land and in the harbor, point to the existence of a hard clay layer which tilts steeply away from the area to be capped in the East Harbor Removal Action. Thus, most Dense Non-Aqueous-Phase Liquid (DNAPL) migrating from the facility is expected to travel downward to this layer, then laterally along the top, rather than emerging in surface sediments in Eagle Harbor. EPA plans to conduct additional borings to verify the existence of such a layer this September.

EPA recognizes that contaminant seepage on the eastern side of the facility is still occurring. However, the importance of this seepage to the East Harbor removal action areas (west of the shoal and in the central channel) is believed to be minimal. In the meantime, continued exposure of marine life to the highly contaminated sediments in this area cannot be justified. As extraction of groundwater continues and additional response actions are completed at the facility, seepage is expected to be further reduced. Taking action in heavily contaminated subtidal areas of the East Harbor before final cleanup actions at the facility have been completed is therefore warranted, given the minimal (and decreasing) impacts of ongoing sources on these areas. Phasing cleanup and evaluating the outcome of the first phase will provide further information regarding the significance of continuing sources.

3.6.5.7
(ROD Comment Number 3.7.2.3): *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: EPA is accelerating cleanup activities at the Wyckoff OU. Since June 1992, EPA has been excavating buried sludges at the Wyckoff OU for disposal off site, and the ongoing extraction of oil and contaminated ground water by the company has reduced groundwater releases and oily seepage. EPA will continue to consider additional early actions as appropriate, but believes control of sources to the East Harbor is sufficient to justify efforts to address the most contaminated sediments of the East Harbor. The phased approach to site cleanup will allow EPA to evaluate information developed during the Wyckoff OU RI/FS in developing a final cleanup decision for the East Harbor OU. EPA recognizes this and intends to maintain appropriate coordination between the units.

3.6.5.8
(ROD Comment Number 3.7.2.2): *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 of the site to proceed as speedily as possible and therefore chose to move forward with the East Harbor removal action. The groundwater extraction on the Wyckoff OU and the sludge removal in 1992 and 1993 are examples of other early actions intended to accelerate cleanup. EPA will continue to look for ways to speed up cleanup by conducting or requiring early actions or phased actions as appropriate.

3.6.5.9
(ROD Comment Number 3.7.7.3): *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: Detailed information about the type and amount of monitoring is generally developed subsequent to a ROD or action memorandum. Plans are in development for monitoring during and shortly after implementation of the East Harbor Removal Action. Subsequent to the East Harbor ROD, plans

will be modified to address any additional sampling and monitoring needs. The plans will define monitoring objectives and the necessary data to accomplish these objectives.

3.6.5.10
(ROD Comment Number 3.7.4.3): In developing a plan for additional testing to define sediment 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 plans for testing during remedial design and monitoring after remediation.

3.6.5.11
(ROD Comment Number 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 model** 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.

5.6.5.12
(ROD Comment Number 3.4.3.3) Why isn't groundwater considered a media of concern for Eagle Harbor?

Response: Groundwater is of concern as a pathway of contaminants to sediments in the East Harbor operable unit This source of contaminants can best be addressed by response actions at the Wyckoff OU rather than the East Harbor OU. To date EPA has focused its efforts at the Wyckoff OU on control of groundwater and other sources of contamination to the harbor. Since 1990, the extraction system at the Wyckoff OU has reduced the amount of groundwater and oily seepage released to the harbor. The Wyckoff RI/FS now underway will provide information about additional actions needed. During the RI/FS for Eagle Harbor, a subsurface hydrology study was performed to investigate groundwater movement to the East Harbor OU sediments (*Technical Memorandum 7, March 7, 1990*). The study indicated that groundwater enters the harbor primarily through sediments north and east of the Wyckoff facility. While not insignificant, transport of dissolved contamination does not appear to be a major mechanism for contamination of the sediments relative to past discharges and spills. Including groundwater as a medium of concern rather than a pathway of concern for the East Harbor OU would not change the sampling approach, the risk assessment, or alternatives for sediment remediation. However, as a source, groundwater is being addressed (see also 3.6.5.6).

5.6.5.13
Comment: Data from the deep sediment sampling conducted in November 1989 indicate that contamination in the central harbor area may extend as far as 6 meters below the surface. Table 2-4 shows that a depth of only 1 meter was used to determine the volume of sediment requiring remediation. This could significantly affect the cost estimates for treatment and disposal of these sediments presented in Chapter 6.

Response: It is acknowledged that there is sediment contamination found in parts of the central harbor area to depths greater than 1 meter. However, the data indicate that contamination in much of the harbor is limited to the upper 0.5 meters. A 1-meter depth of remediation was assumed as a conservative average for calculating material volumes and costs for remediation in the PAH areas.

Comment 5.6.5.14
(ROD Comment Number 3.6.1.7): Were costs to pre-densify sediments to prevent the cap from subsiding into the underlying sediments included in the cost estimates?

Response: No predensification is planned for the East Harbor removal action. EPA's feasibility study, including the cost estimates, assumed that sediments would not be predensified. Predensification could potentially release free creosote product into the water column.

a significant short term risk to the environment due to potential releases of oily contamination and contaminated fine particles. Treatment or disposal of dredged sediments at an upland facility would involve complex implementability issues, high costs, and extended time frames for effective treatment. Subtidal areas containing free-phase contamination were successfully capped under CERCLA removal authorities. Other areas of sediment contamination in the East Harbor, while potentially toxic to marine organisms, contain relatively low levels of contamination. Containment is an appropriate remedy for such areas, which represent high volumes at low levels of contamination.

Because this remedy will result in hazardous substances remaining on site above health-based and environmentally-based cleanup levels, 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.

Date

Chuck Clarke
Regional Administrator
U.S. Environmental Protection Agency
Region 10

PROGRAM CONCURRENCES

INITIAL														
SURNAME	HALE	STONER	RUSHIN	SMITH										
DATE	9/26/94	9/26/94	9/26/94	9/29/94										

ORC CONCURRENCES

INITIAL														
SURNAME	DELANEY	BOYD	KOWALSKI											
DATE	9/26/94	9/26/94	9/26/94	9/28/94										

Concurrence — East Harbor OU ROD, dated 9-29-94
Wyckoff/Eagle Harbor Site