FINAL ENVIRONMENTAL IMPACT STATEMENT SUPPLEMENT 1
GRAYS HARBOR NAVIGATION IMPROVEMENT PROJECT

FINAL ENVIRONMENTAL IMPACT STATEMENT SUPPLEMENT 1
GRAYS HARBOR NAVIGATION IMPROVEMENT PROJECT, WASHINGTON

( ) Draft Supplemental Statement
(X) Final Supplemental Statement

Responsible Lead Agency: U.S. Army Corps of Engineers, Seattle District

Cooperating Agency: U.S. Environmental Protection Agency, Region 10

1. Name of Action: (X) Administrative ( ) Legislative

2. Purpose: The purpose of this environmental impact statement supplement (EISS 1) is to update the description of impacts that are expected to result from the channel widening and deepening of the Grays Harbor Navigation Improvement Project and to support formal designation of ocean dredged material disposal sites by EPA.

3. Abstract: Planning studies for the Grays Harbor Navigation Improvement Project began in 1957 under the U.S. Senate Committee on Public Works and the House of Representatives Committee on Public Work resolutions. A feasibility report and environmental impact statement (FR/EIS) were completed in 1982 and the project was authorized by Congress in the 1986 Water Resources Development Act.

This EISS 1 analyzes two alternatives: the no-action plan and the recommended project. The recommended project is the authorized project with design refinements based on detailed engineering, environmental, and economic studies on the authorized project. The authorized project has been reduced in scope and environmental impacts since 1982.

Analysis of alternatives to ocean dumping of dredged material has been conducted in accordance with criteria provided by the Marine Protection, Research, and Sanctuaries Act of 1972. Relevant portions of this document will be adopted by EPA, Region 10, to support formal designation of ocean dumping sites for the disposal of dredged material.

Major environmental concerns addressed in this EISS include impacts of dredging and disposal of dredged material on biological communities in terrestrial, intertidal, and subtidal habitats; on water quality; and on commercially important fish and shellfish resources. Important populations identified during scoping that could be affected include Pacific oysters, Dungeness crabs, lingcod, English sole, marine birds, and marine mammals.

Significant impacts of the recommended project include loss of about 2 acres of juvenile salmonid habitat and significant mortalities to the Dungeness crab resource. Mitigation is planned for these impacts. No other significant or long-term impacts are predicted to occur.

4. Report Coordination: This EISS 1 has been coordinated with Government agencies, citizen groups, and individuals known to have an interest in the project. On 12 November 1987 a Notice of Intent to Prepare a Supplement to the Final EISS (FEISS) was published in the Federal Register. Comments received on the DEISS were used to prepare the final supplemental EIS. The FEISS will be filed with Environmental Protection Agency and a notice of availability is expected to be published on MAY 12 1989.

5. Environmental Documentation: The Record of Decision for the final EIS was signed by the Chief of Engineers on 18 March 1987 and filed with EPA.

Send your comments to the District Engineer by JUN 12 1989

For further information contact:
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Formal adoption of the relevant portions of this EISS by EPA and publication of formal rules in the Federal Register are necessary for designation of ocean dumping sites. These actions are being pursued separately by EPA, Region 10.

For information regarding ocean dumping site designation, contact:

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NOTE: Information, displays, maps, etc. discussed in the FR/EIS or appendixes are incorporated by reference into the EISS 1.

EXECUTIVE SUMMARY

1. Major Conclusions and Findings. The recommended plan for the Grays Harbor Navigation Improvement Project consists primarily of widening and deepening the existing channel from the Grays Harbor estuary ocean bar to Cosmopolis and modification of the Union Pacific Railroad Bridge. This plan will assist in accomplishing the authorized goal of the project, which is to improve the efficiency of the present and future deep-draft vessel navigation in Grays Harbor, Washington.

The recommended project is the project authorized by Congress in the 1986 Water Resources Development Act with design refinements based on detailed engineering, environmental, and economic studies on the authorized project. The authorized project has been reduced in scope and environmental impacts since the 1982 EIS analysis.

The recommended project, in general, includes:

-deepening and widening of 23.5 miles of the existing channel from the ocean bar to Cosmopolis, Washington by dredging a total of 11.3 million cubic yards (c.y.). The portion of the channel from South reach to Cosmopolis is presently maintained by annual dredging; the Entrance reach and bar are self-maintaining as a result of the jetty systems. The channel would be dredged to the following dimensions: the ocean bar, 46 feet deep and 1,000 feet wide; harbor entrance, 46 to 38 feet deep and 600 to 1,000 feet wide; outer harbor, 36 feet deep and 350 feet wide; and inner harbor (Cow Point to Cosmopolis), 36 feet deep and 350 to 250 feet wide;

-expansion and deepening of the Cow Point and Elliott Slough turning basins:

-deepening local ship berths;

-new maintenance dredging of 1.17 million c.y. (in addition to existing maintenance dredging of 1.68 million c.y.) in the first year after construction, decreasing for the next 4 years to an additional 0.77 million c.y. in years 5 to 50 (due to 0.40 million c.y. decrease in Bar and Entrance reach maintenance dredging during first 4 years after construction);

-construction dredging to be accomplished by hopper, clamshell, and cutterhead-suction/pipeline dredges, with disposal at two ocean, two harbor open-water, and two confined disposal sites, and maintenance dredging by hopper and clamshell dredges, with disposal at one ocean and two harbor open-water sites;

-modification of the Union Pacific Railroad bridge at Aberdeen from the existing swing-span to a lift-span bridge using a surplus UPRR bridge (from Little Rock, Arkansas);

-modification of fendering around north pier of Highway 101 bridge in Aberdeen;

-designation of two ocean dredged material disposal sites (ODMDS). The Grays Harbor Southwest Navigation Lane site will be designated by EPA under Section 102 (c) of the Ocean Dumping Act for continuing use. The Eight-Mile site will be designated by the Corps of Engineers, with EPA concurrence, under Section 103 of the Act to receive initial construction material only from the Grays Harbor Navigation Project. Disposal during the initial construction is considered to be a one-time use of the site.

-removal of two old highway bridge piers on the north bank 1,500 feet upstream of the Highway 101 bridge;

-relocation of utility lines under the channel in the Aberdeen area;

-mitigation for Dungeness crab fishery losses caused by construction and incremental future maintenance dredging and disposal by the placement of oyster shell in Grays Harbor to create additional habitat for young-of-the-year crabs; and

-mitigation for loss of almost 2 acres of shallow subtidal salmon habitat by creation of 4 acres of intertidal habitat, plus 18 acres of buffer zone, in the Junction City area.

Construction and maintenance dredging schedules have been developed and ocean disposal site locations have been selected to avoid or minimize impacts to Dungeness crabs and other aquatic resources. The open-water ocean disposal sites are located 8.0 miles WNW and 3.9 miles SW of the harbor entrance. The open-water estuary disposal sites are located at Point Chehalis and South Jetty and will be officially designated by the State of Washington. The two confined disposal sites (slip 1 and Commerce Street) will be provided by the Port of Grays Harbor.

The project will cause the loss of 77,600 harvestable crabs during construction and 204,300 harvestable crabs during 50 years of incremental future operations and maintenance. Total crab loss will be mitigated for by creation of crab habitat using oyster shell. The project will also significantly adversely affect about 2 acres of subtidal habitat. This will be mitigated by creating 4 acres of intertidal habitat and 18 acres of buffer.

The project will not significantly affect water quality (turbidity or dissolved oxygen levels); dredged material is suitable for open-water disposal. The project will not significantly affect oyster, demersal fish, wetlands, demand for forest products, commercial fisheries, Indian fishing treaty rights at usual and accustomed places, or endangered species.

2. Areas of Controversy. The Corps has worked closely with resource agencies and the public to predict project impacts to the Dungeness crab fishery. The predicted losses and mitigation plan as presented have been fully coordinated with resource agencies. This EISS will provide further coordination with agencies and the public.

3. Relationship to Environmental Requirements. The compliance categories used in this evaluation were assigned based on the following definitions. Full compliance: all the requirements have been met. Partial compliance: some requirements remain to be met, but will be met prior to construction. Noncompliance: none of the requirements have been met to date, but will be met prior to construction. Not applicable (N/A): The statute, Executive Order, or other policy is not applicable to the project. The No Action Plan is generally in compliance with applicable requirements. All compliance is summarized in table EISS i-1.

TABLE EISS i-1

COMPLIANCE OF RECOMMENDED PROJECT WITH ENVIRONMENTAL REQUIREMENTS

FEDERAL STATUTES	COMPLIANCE
Clean Air Act, as amended, 42 USC 1857h-7 et seq.	Full
Clean Water Act, as amended (Federal Water Pollution Control Act), 33 USC 1251 et seq.	Full
Coastal Zone Management Act, as amended, 16 USC 1451 et seq.	Full
Endangered Species Act, as amended, 16 USC 1531 et seq.	Full
Estuary Protection Act 16 USC 1221 et seq.	Full
Federal Water Project Recreation Act, as amended, 16 USC 460-1 (12) et seq.	Full
Water Resources Act, 1976, Section 150	Full
Fish and Wildlife Coordination Act, as amended, USC 661 et seq.	Full
Land and Water Conservation Fund Act, as amended, 16 USC 4601-4601-11 et seq.	Full
Marine Protection, Research and Sanctuaries Act, 33 USC 1401 et seq.	Full
National Environmental Policy Act, as amended, 42 USC 4321 et seq.	Full

TABLE EISS i-1 (con.)

FEDERAL STATUTES	COMPLIANCE
Rivers and Harbors Act, 33 USC 403 et seq., 33 USC 401	Full
Watershed Protection and Flood Prevention Act, 16 USC et seq.	N/A
National Historic Preservation Act, 16 USC 407a et seq.	Full
Wild and Scenic Rivers Act, as amended, 16 USC 1271 et seq.	N/A
Executive Orders, Memoranda:	
Flood Plain Management, 11988	Full
Protection of Wetlands, 11990	Full
Environmental Effects Abroad of Major Federal Actions, 12114	N/A
Executive Memorandum Analysis of Impacts on Prime and Unique Farmlands in EIS, CEQ Memorandum, 30 August 1976	N/A
STATE AND LOCAL POLICIES	
Washington State Constitution	
Article XV. Harbors and Tide Waters	Full
Article XVII. Tidelands	Full
Multiple Use Concept in Management and Administration of State Owned Lands (RCW 79.68.060)	Full
State Environmental Policy Act of 1971 (RCW 43.21)	Full

TABLE EISS i-1 (con.)

STATE AND LOCAL POLICIES (con.)	COMPLIANCE
Water Resources Act of 1971 (RCW 90.54)	N/A
Shoreline Management Act of 1971 (RCW 90.58) and Grays Harbor County Shoreline Management Program	Full
Water Pollution Control Act (RCW 90.48)	Full
PERMITS	**REQUIRED**
Shoreline Substantial Development Permit	Yes (Local Sponsor Responsibility)
Shoreline Conditional Use Permit	Yes (Local Sponsor Responsibility)
Washington Departments of Wildlife and Fisheries Hydraulic Project Approval	Yes (Local Sponsor Responsibility)
Washington Department of Ecology Water Quality Certification	No (Section 404(r) of the Clean Water Act exemption applies)

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GRAYS HARBOR NAVIGATION IMPROVEMENT PROJECT

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F. Summary of Dungeness Crab Impact Model, Mitigation, and Monitoring Plan

G. Statement Recipients

H. Agency and Public Comments on the Draft EISS and, Corps Responses

I. Pertinent Correspondence

SECTION 1. PURPOSE AND NEED

1.1 Introduction. The Grays Harbor Navigation Improvement Project is located in Grays Harbor County, Washington, at the mouth of the Chehalis River (figure EISS 1-1). This Environmental Impact Statement Supplement (EISS1) addresses study results and project design refinements developed since the Corps of Engineers submitted the original Grays Harbor Navigation Channel Improvement Project Feasibility Report and Environmental Impact Statement (FR/EIS), in September 1982. The FR/EIS was subsequently approved in May 1985 and the project authorized by Congress in 1986.

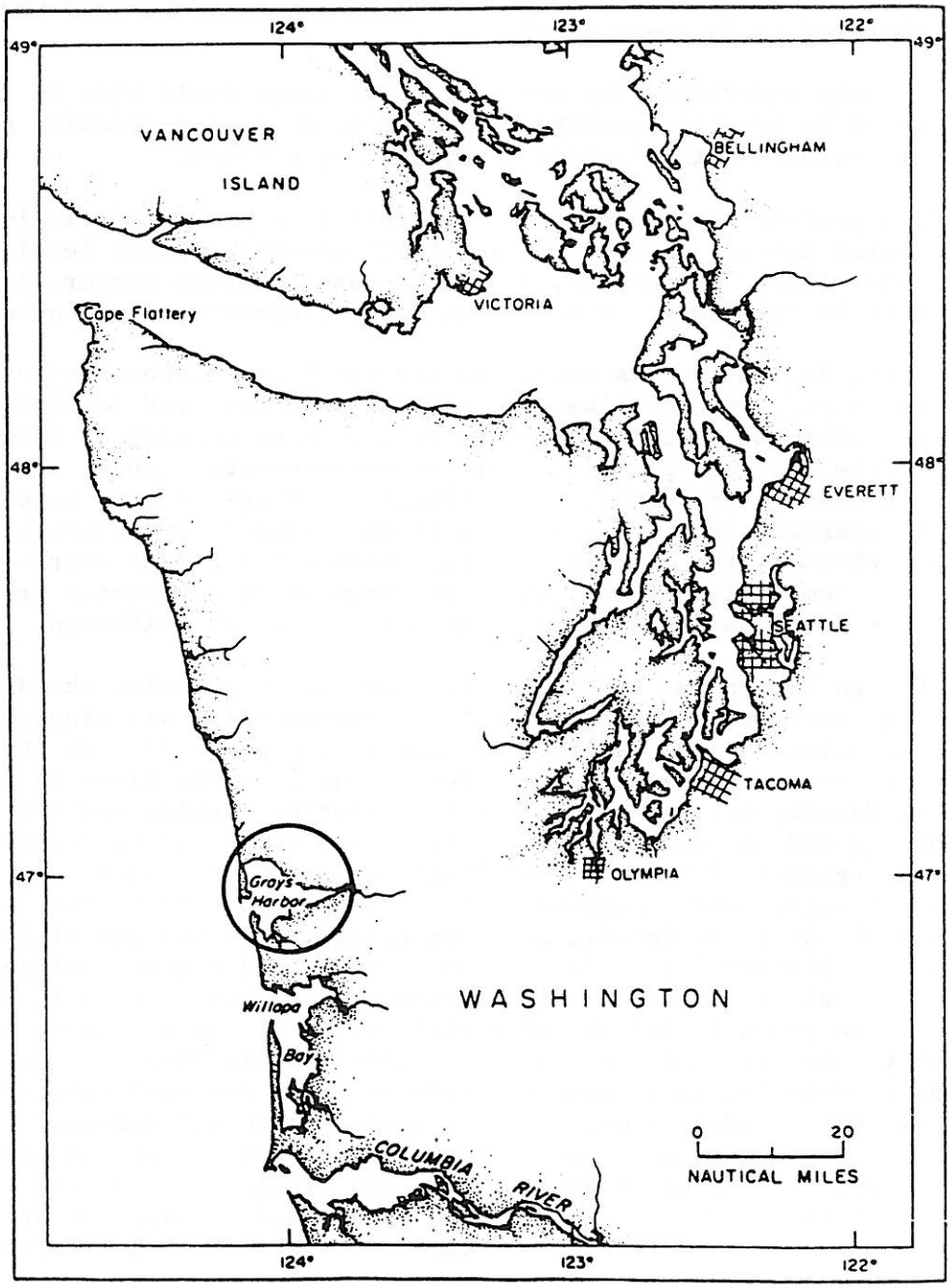
In order to fully understand the scope of the actions dealt with in this EISS, it is necessary to briefly describe the Corps of Engineers planning process and the Congressional authorization and resulting actions.

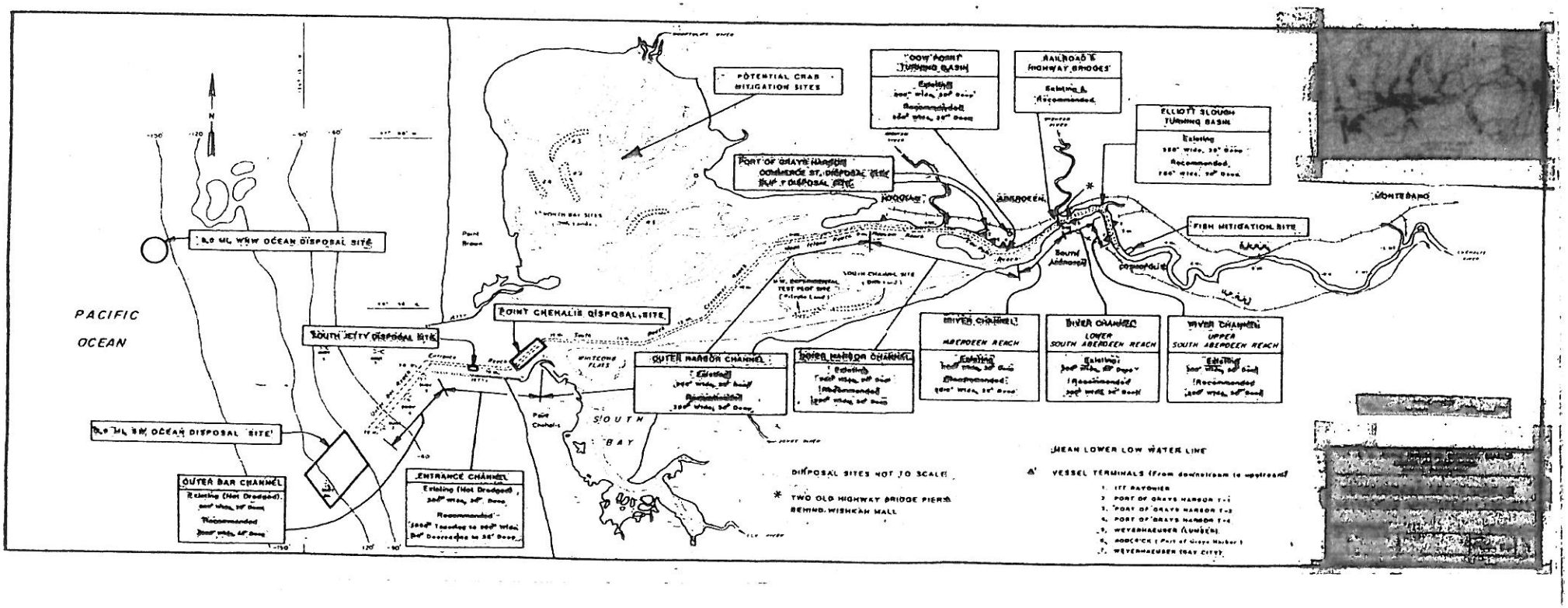
Corps studies proceed through a series of steps from pre-authorization planning to detailed design, engineering and environmental studies leading to project construction. Frequently, as in the case of Grays Harbor, later studies result in refinement or modification of proposed project alternatives.

The engineering design studies completed for the Grays Harbor Project since 1983 (and since project authorization in 1986) have resulted in improved environmental planning and design changes. These changes consist of reduction in the scope of the original project, improved environmental impact assessments of effects on natural resources, and mitigation. Congressional reauthorization is not necessary if all the changes to the authorized project are design refinements, which is the case in the Grays Harbor Navigation Improvement Project. Upon completion of this EISS, and when needed approvals are secured, plans and specifications leading to construction will be initiated.

A General Design Memorandum (GDM) has been prepared discussing the design details of the recommended project. The GDM recommends: widening and deepening of the existing Federal navigation channel (see plate 1) from the Grays Harbor estuary ocean bar east to Cow Point on the Chehalis River in the city of Aberdeen, Washington; enlargement of the existing turning basin at Cow Point; widening and deepening of the channel from Cow Point to Cosmopolis, including enlargement of the Elliott Slough turning basin; implementation of mitigation for salmon and Dungeness crab resources impacted by the dredging; modification of the Union Pacific Railroad Bridge; modification of fendering around the U.S. Highway 101 Bridge; removal of two old highway bridge piers; deepening of local ship berths; utility relocations; and changes in aids to navigation. The project also includes evaluations of the sediments to be disposed at the estuary and ocean disposal sites. This EISS1 focuses on current design details, considerations made in ocean disposal site evaluations, assessment of adverse effects to Dungeness crab and demersal fish, sediment characteristics, and needs and methods for mitigation of adverse effects. It also evaluates project impacts and mitigation relating to the modification of the Union Pacific Railroad Bridge and Highway 101 bridge fendering, removal of two old highway piers at Wishkah Mall and relocation of utilities.

FIGURE EISS-1
LOCATION OF GRAYS HARBOR




PACIFIC
OCEAN
N
8.0 ML WSW OCEAN DISPOSAL SITE
8.0 ML SW OCEAN DISPOSAL SITE
OUTER BAR CHANNEL
Existing (Not Dredged)
Recommended
ENTRANCE CHANNEL
Existing (Not Dredged)
Recommended
SOUTH JETTY DISPOSAL SITE
POINT CHEHALIS DISPOSAL SITE
POTENTIAL CRAB MITIGATION SITES
PORT OF GRAYS HARBOR COMMERCE ST. DISPOSAL SITE
COW POINT TURNING BASIN
Existing
Recommended
RAILROAD & HIGHWAY BRIDGES
Existing & Recommended
ELLIOTT SLOUGH TURNING BASIN
Existing
Recommended
FISH MITIGATION SITE
OUTER HARBOR CHANNEL
Existing
Recommended
INNER HARBOR CHANNEL
Existing
Recommended
RIVER CHANNEL
ABERDEEN REACH
Existing
Recommended
RIVER CHANNEL
LOWER SOUTH ABERDEEN REACH
Existing
Recommended
RIVER CHANNEL
UPPER SOUTH ABERDEEN REACH
Existing
Recommended
SOUTH BAY
ABERDEEN
HOQUIAM
COSMOPOLIS
MONTESANO
Point Brown
Point Chehalis
WHITCOMB FLATS
SOUTH CHANNEL SITE
DISPOSAL SITES NOT TO SCALE
* TWO OLD HIGHWAY BRIDGE PIERS BEHIND WISHKAH MALL
MEAN LOWER LOW WATER LINE
VESSEL TERMINALS (From downstream to upstream)
1. ITT RAYONIER
2. PORT OF GRAYS HARBOR T-1
3. PORT OF GRAYS HARBOR T-2
4. PORT OF GRAYS HARBOR T-4
5. WEYERHAEUSER (LUMBER)
6. RODCO INC. (Port of Grays Harbor)
7. WEYERHAEUSER (BAY CITY)

This EISS1 relies heavily on the extensive information which is still timely and useful in the 1982 FR/EIS. Although that information is not repeated, it is incorporated by reference.

1.2 Project Authorization. The original Grays Harbor Navigation Channel was authorized by Congress in the Rivers and Harbors Act of 3 June 1896. Planning studies for the Grays Harbor Navigation Channel Improvement Project were initiated under resolutions dated 21 October and 30 December 1957, of the U.S. Senate Committee on Public Works and under a resolution by the House of Representatives Committee on Public Works on 16 July 1958. A final feasibility report was completed in September 1982 and approved in May 1985 by the Chief of Engineers, with minor changes in the recommended plan. The Corps approved project was authorized by Congress on 17 November 1986, in Section 202 of the Water Resources Development Act of 1986 (Public Law 99-662). The Record of Decision for the Final EIS was signed on 18 March 1987.

1.3 Purpose and Need for the Project. The purpose of the Grays Harbor Navigation Channel Improvement Project is to improve the efficiency of present and future deep-draft vessel navigation in Grays Harbor in the State of Washington. The downstream project is needed to alleviate large vessel restrictions imposed by the insufficient channel depths. Ship transportation in the existing upstream channel is limited by depth and by the Union Pacific Railroad (UPRR) bridge which crosses the waterway at Aberdeen. Current depths are inadequate to accommodate vessels with drafts exceeding 33 feet. Railroad bridge restrictions limit the size of ships servicing the upstream channel to beams not exceeding 85 feet.

1.3.1 Existing Project. The Grays Harbor navigation channel is presently maintained at -30 feet (mean lower low water) by annual dredging of bottom material in various areas from Cosmopolis through south reach (see plate 1). The entrance reach and bar are self maintaining as a result of the jetty system. Dredged material from Grays Harbor is currently disposed at the existing Point Chehalis open-water disposal site, designated by the Washington Department of Natural Resources.

1.3.2 Purpose and Content of EISS1. This EISS has been prepared to expand on the information provided in the FR/EIS entitled "Grays Harbor, Chehalis and Hoquiam Rivers, Washington, Channel Improvements for Navigation" which was published in September 1982 and approved in May 1985. Since this is a supplement, a reanalysis of project alternatives is not included. Rather, the focus is on environmental information gained from several additional important studies and subsequent refinements in project design and construction recommendations which flowed from study results.

Information contained in the 1982 FR/EIS is incorporated by reference to avoid redundancy and to allow focus on information and project features which expand on these original documents. The most important new information presented relates to studies on crab ecological considerations, ecological surveys of ocean disposal areas, evaluations of sediments to be dredged, Native American issues, impacts of the project on Dungeness crabs and development of mitigation and monitoring plans for crabs and fish. Important changes in project design and construction relate to selection of dredged material

disposal sites, construction and maintenance dredging schedule, selection of dredging equipment, and reduction in dredging quantities. Specific studies undertaken and project refinements are discussed in greater detail in section 1.4 below. Format and content of the EISS are consistent with requirements of the National Environmental Policy Act and implementing regulations promulgated by the Council on Environmental Quality.

1.3.3 Purpose and Need for Ocean Dredged Material Disposal Sites (ODMDS). Ocean disposal of a portion of the dredged material for this project is a critical economic and environmental component of the overall navigation improvement project. This EISS contains an evaluation of the proposed ODMDS and alternatives based on the criteria and factors in the Ocean Dumping Regulations (40 CFR 228.5 and 228.6). This EISS provides documentation in support of a final designation of an ODMDS for continuing use with the Grays Harbor, Washington, Federal navigation project. The U.S. Army Corps of Engineers (Corps) is responsible for maintaining Federally-authorized navigation channels that allow water-borne access to and from port facilities located at the upper end of Grays Harbor estuary. This project provides substantial economic benefit to the region, allows vessels to safely cross the bar at the entrance to the harbor, and is one of the harbor of refuges along the coast of Washington.

Ocean disposal of Grays Harbor material has not occurred in the past. Other less expensive alternatives have been available, primarily unconfined open-water disposal within the estuary and creation of nearshore fills. As explained elsewhere in the EISS, these options have become increasingly limited. Filling of wetlands, which occupy most of Grays Harbor nearshore areas, is discouraged by existing laws where less environmentally damaging alternatives exist. Less environmentally damaging options can include open-water disposal within the estuary or the ocean and upland disposal. Unconfined, open-water disposal of a portion of the material to be dredged for this project will occur within the estuary under the navigation improvement plan. Due to the larger volumes of material that must be dredged for this project, and the fact that some of this material will be dredged from the bar, disposal of all the material within the estuary could result in significant impacts to the estuarine system. Use of upland sites has been investigated, but no sites in addition to the Slip 1 and Commerce Street sites have been identified at this time that are economically feasible or less environmentally damaging. Based on these considerations, designation of an ODMDS offshore of Grays Harbor, Washington, is considered necessary.

1.4 Environmental Studies Conducted During Preconstruction Engineering and Design (PED).

1.4.1 Scoping and Public Concerns. The FR/EIS identified a number of issues which required additional evaluation or refinement to provide a basis for detailed project design. In addition, major scoping meetings were conducted on May 2 and 10, 1984. Principal issues identified were the effects of dredging and dredged material disposal on biological communities; on terrestrial,

intertidal, and subtidal habitat; on water quality; and on commercially important fish and shellfish resources. Important populations identified during scoping that could be impacted include Pacific oysters, Dungeness crabs, lingcod, marine birds, and marine mammals. Principal respondents were all State and Federal agencies of concern, Washington Dungeness Crab Fishermen's Association, and Friends of the Earth.

1.4.2 Environmental Studies During PED. A plan of action was developed to address the issues identified as needing further investigation in the FR/EIS and identified during the scoping process. Studies included in the Plan of Action were limited to those which were project related and where additional information could be obtained cost effectively and would assist in project planning. Specific environmental studies are summarized below and listed in appendix A.

a. Point Chehalis and South Jetty Disposal Areas Circulation Studies: performed to further evaluate the fate of dredged material discharged at the mouth of the estuary. Results were used to establish designated disposal sites for material dredged from the estuary.

b. Refinement of Dungeness Crab Population Estimates: performed to assist in defining project impacts to the on the crab resource. Results were used to refine proposed mitigation for the recommended plan.

c. Additional quantification of crabs entrained by operating dredges.

d. Evaluation of providing habitat for juvenile crabs to mitigate for losses due to dredge entrainment.

e. Evaluation of effects of dredged material on crab bait perception.

f. Evaluation of dredging schedules to reduce entrainment of crabs.

g. Dredging Modification to Reduce Dredging-Related Impacts: performed to investigate and test various methods of modifying dredges to avoid or reduce entrainment of crabs and fish.

h. Importance of Grays Harbor to the Dungeness Crab Resource of the Pacific Northwest: performed to assist in defining the impact of dredging on the crab fishery. Results were used to evaluate potential avoidance and mitigation alternatives.

i. Ocean Disposal Site Designation Studies: performed to select and formally designate an ocean disposal site(s) for project dredged material.

j. Assessment of Dredging Impact on Lingcod and Other Marine Fish: performed to evaluate the impact of dredging on commercially and recreationally important fish species, in light of recently obtained life-history information. Results were used to determine need for dredge schedule modifications to avoid sensitive areas/seasons.

k. Refinement of the design of habitat to be developed for mitigation of losses in salmonid habitat.

l. Bowerman Basin Circulation Studies and Endangered Species Monitoring: performed to evaluate the alternative of disposal of dredged material at Bowerman Basin areas that may be predesignated for dredged material disposal under the Grays Harbor Estuary Management Plan, if/when adopted.

m. Distribution and Sources of Contaminants to Grays Harbor Sediments: studies included chemical testing of sediments from inner Grays Harbor channel reaches to determine the distribution and sources of contaminants and the extent and quantity of dredged material that would require confined disposal.

n. Additional Cultural Resources Surveys for Sunken Vessels. Performed to further evaluate potential sunken vessels in the project area and at the disposal sites.

o. Indian Treaty Fishing Rights and Accustomed Fishing Sites. Coordination with the Quinalt Indian Nation has resulted in identification of accustomed set-net salmon fishing sites in the project area.

These studies have resulted in decreased depths and widths of the channel and in decreased amounts of sediment to be disposed during construction (from 17.1 million c.y. to 11.3 million c.y.). These studies have also: (1) suggested measures that would avoid some adverse effects on important marine resources; (2) estimated losses to the crab and salmon fisheries, and (3) suggested mitigative measures for unavoidable losses to these fisheries.

SECTION 2. ALTERNATIVES

2.1 Introduction. The Grays Harbor, Chehalis and Hoquiam Rivers, Washington Channel Improvements for Navigation Feasibility Report and Environmental Impact Statement (FR/EIS) prepared by the Seattle District Corps in 1982 analyzed alternative plans for channel improvements in Grays Harbor and identified a recommended plan. This Environmental Impact Statement Supplement (EISS) does not reevaluate alternative project designs (the reader is referred to the FR/EIS for that discussion). Instead, it evaluates two alternatives in view of changes to the authorized project design (based on detailed studies since 1982) and additional information from new environmental studies. These alternatives are: (a) the authorized project as refined by the detailed studies and (b) no action. This EISS also compares the authorized project (recommended plan in the FR/EIS as revised by the Board of Engineers, Rivers and Harbors and Chief of Engineers) with the recommended plan (authorized project as refined). Table EISS 2-1 presents the proposed project schedule as it relates to various project actions.

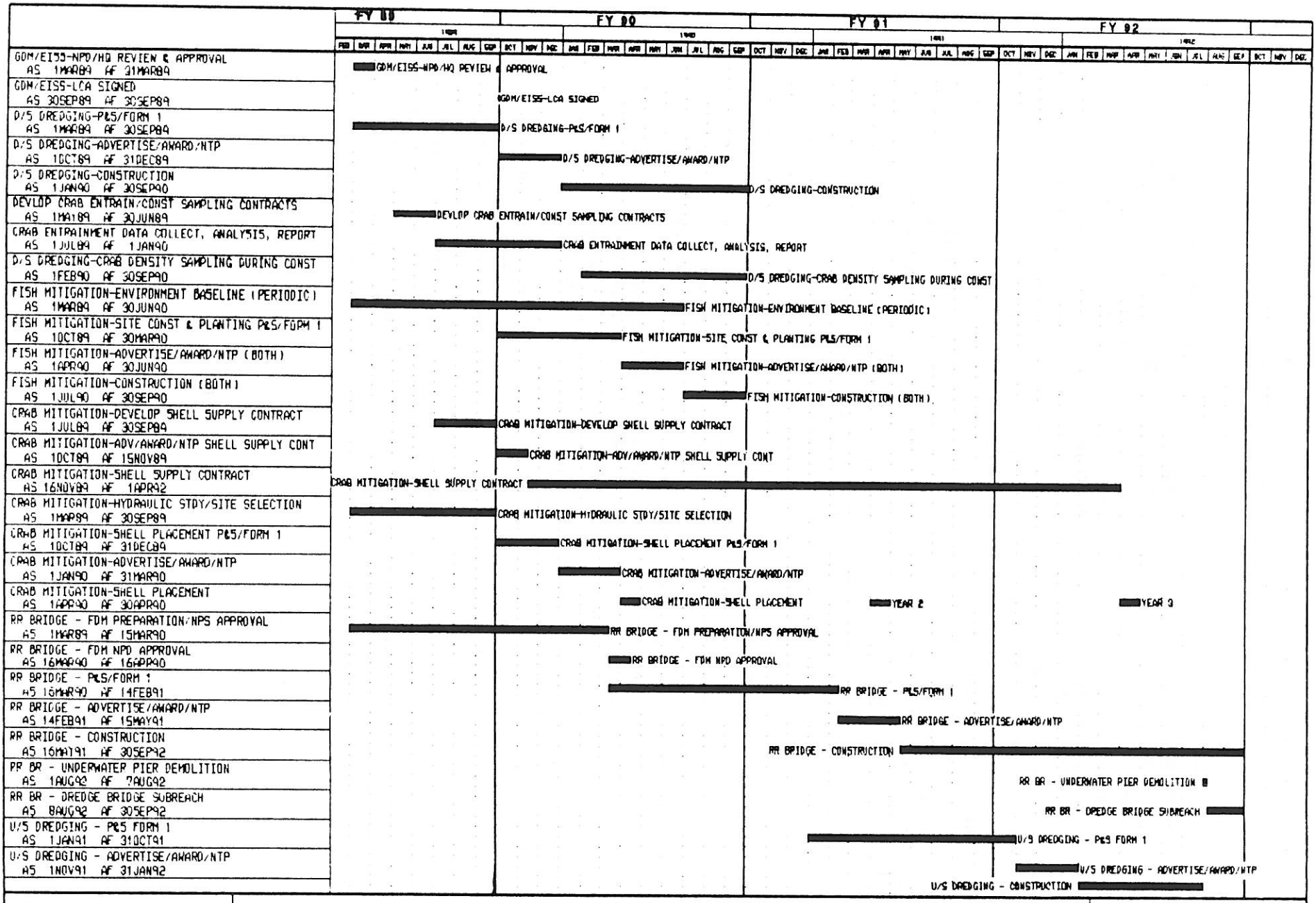
2.2 Project Alternative 1 (Recommended Project).

2.2.1 Engineering Features: Construction.

a. General. The FR/EIS considered as alternatives no action, lightering, waterfront renewal, development of other Grays Harbor sites, and development of other west coast ports, as well as improvement of the existing channel. Each alternative plan was screened using the criteria of National Economic Development (NED), Environmental Quality (EQ), Regional Development (RD), and Other Social Effects (OSE) accounts in Economic and Environmental Principles and Guidelines for Water and Related Land Resource Implementation Studies. Only the no action alternative and several variations of the recommended channel improvement plan have been retained under consideration.

The major considerations in channel design were those related to channel dimensions (width and depth) and alignment which would afford safe and efficient vessel operation. The channel should meet most current and future navigation traffic needs without undue vessel delays or unsafe conditions. The determination of optimum channel size is based upon a comparison of economic benefits of reduced transportation costs compared with the cost of providing successively larger increments of improved channel. Deep draft vessels presently calling at Grays Harbor range in size from about 15,000 dead weight tons (dwt) to 40-50,000 dwt vessels. The design vessel for the harbor has a loaded draft of 37 feet, a length of 625 feet, and a beam of 100 feet. For design vessel purposes, the channel can be divided into two segments: (1) upstream of Cow Point through the railroad and highway bridges and (2) downstream from Cow Point.

b. Initial Construction Dredging and Disposal Features. Table EISS 2-2 summarizes dredging and disposal construction features by reach. A total of 9,008,000 c.y. of material will be dredged during construction. During initial construction the downstream channel reaches from the ocean bar to Cow



SCHEDULE SUBJECT TO AVAILABILITY OF FUNDS

PROJECT SCHEDULE BAR CHART
GRAYS HBR NAVIGATION IMPROVEMENT PRJ
U.S ARMY CORPS OF ENGINEERS

PROJECT SCHEDULE BAR CHART

Date	Revision	Checked	Approved

Point (including the Cow Point turning basin, ITT-Rayonier berth, and Port of Grays Harbor berths) will be dredged with hopper dredges, clamshell dredge(s), and a cutterhead/pipeline dredge. The upstream channel reaches from Aberdeen to South Aberdeen (including the Elliott Slough turning basin, Weyerhaeuser berths, and Roderick berth (being acquired by Port of Grays Harbor) will be dredged with a clamshell dredge during the latter part of the railroad bridge construction. Sediment to be dredged is not contaminated and is suitable for open-water disposal. Sand dredged during construction from the Bar reach will be disposed at the southwest (3.9 mile) ocean disposal site. Sand dredged during construction from the Entrance reach will be disposed at the South Jetty estuary disposal site. Sand dredged during construction from South reach and silty sand dredged during construction from Crossover reach will be disposed at the Point Chehalis estuary disposal site. Silty sand dredged during construction from Moon Island reach will be disposed at the South Jetty estuary disposal site. Sandy silts dredged during construction from the Hoquiam, Cow Point, and Aberdeen reaches will be disposed at the west-northwest (8.0 mile) ocean disposal site, with gravels and some sandy silts dredged during construction from the Cow Point reach disposed at two Port of Grays Harbor confined disposal sites. Silty sand dredged during construction from South Aberdeen reach will be disposed at the Point Chehalis and South Jetty estuary disposal sites. The South Jetty estuary disposal site is to be used as a backup if the Point Chehalis site becomes filled to capacity.

TABLE EISS 2-2

CONSTRUCTION DREDGING AND DISPOSAL FEATURES BY REACH

Reach (Length in Miles)	Dredge Type	Dimensions of Channel (Feet) Existing	: Recom.	Quantity Dredged Material (C.Y.)	Disposal Site
Bar (1.7)	Hopper	(600x30)	1,000x46	2,250,000	Ocean 3.9-mile SW
Entrance (4.0) (Reach Tapers)	Hopper	(350x30)	1,000-600 x46-38	300,000	S. Jetty
South (4.3)	Hopper	350x30	350x36	1,820,000	Pt. Chehalis
Crossover (2.8)	Hopper	350x30	350x36	1,410,000	Pt. Chehalis
Moon Island (2.7)	Hopper (Clamshell alternative)	350x30	350x36	1,230,000	S. Jetty and Pt. Chehalis

TABLE EISS 2-2 (con.)

Reach (Length in Miles)	Dredge Type	Dimensions of Channel (Feet) Existing	: Recom.	Quantity Dredged Material (C.Y.)	Disposal Site
Hoquiam (2.8)	Clamshell	350x30	350x36	1,065,000	Ocean 8.0-mile WNW
Cow Point (1.4)					
-Channel	Pipeline (Silt)	350x30	350x36	585,000	Port Slip 1 (Diked)
	Pipeline (Gravel)	350x30	350x36	260,000	Commerce St. (Diked)
	Clamshell (Silt)	350x30	350x36	220,000	Ocean 8.0-mile WNW
-Turning Basin	Clamshell	800x30	900x36	*Quantities included in Cow Point	
Aberdeen (1.5)	Clamshell	200x30	250x36	913,000	Ocean 8.0-mile WNW
S. Aberdeen (2.3)					
-Highway 101 to Elliott Slough	Clamshell	200x30	300x36	1,205,000	Pt. Chehalis & S. Jetty
-Elliott Slough to 1,000 Feet Upstream of Weyerhaeuser Berths	Clamshell	200x30	250x36		Pt. Chehalis & S. Jetty
-Turning Basin (Elliott Slough)	Clamshell	550x30	750x30		S. Jetty

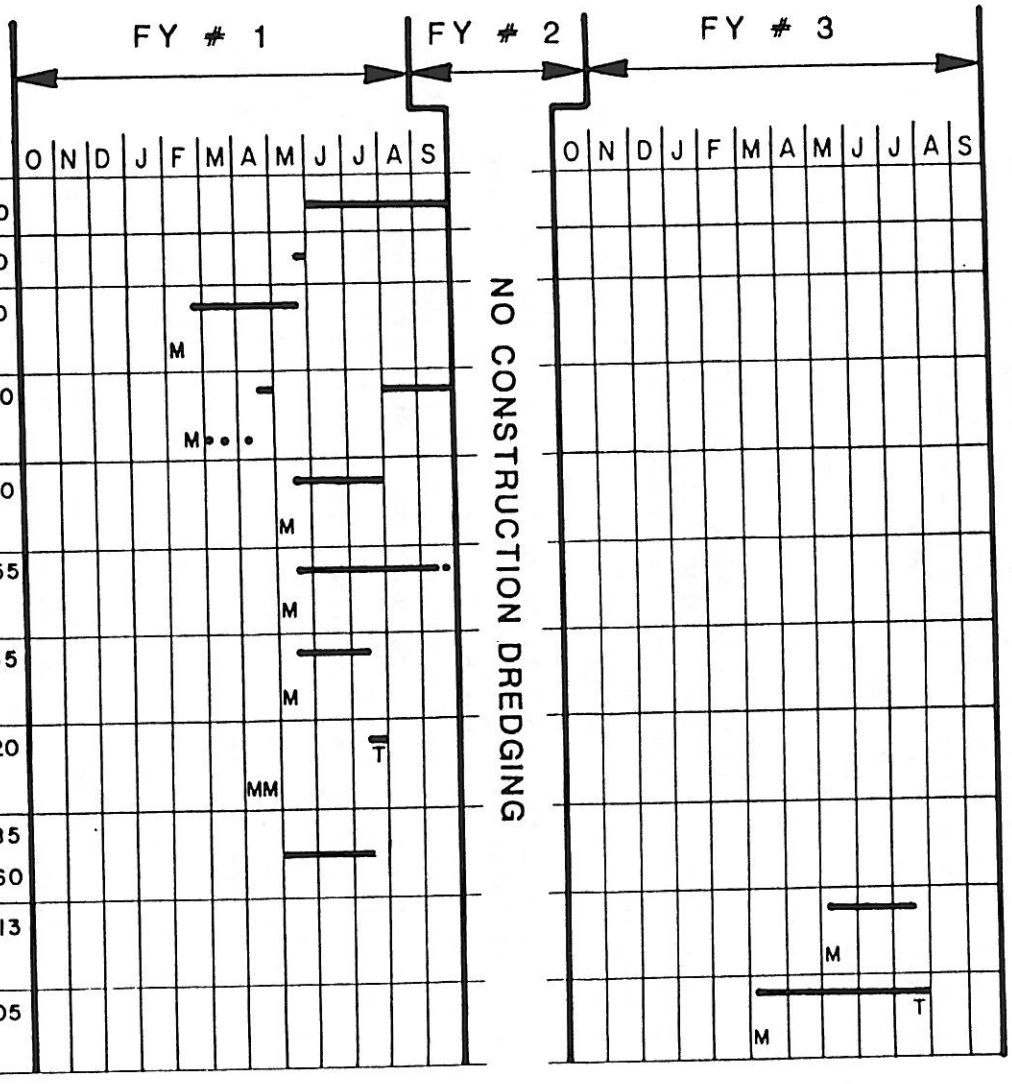
Table EISS 2-3 shows the dredging and disposal schedule for construction including maintenance during construction.

TABLE EISS 2-3

CONSTRUCTION DREDGING AND DISPOSAL SCHEDULE

(Including Existing Maintenance During Construction)

REACH		DREDGE	DREDGE NO.	DISPOSAL	MONTHS	C.Y. (000)
BAR	C	MH	1	OSW	4.0	2250
ENTRANCE	C	MH	1	SJ	0.4	300
SOUTH	C	MH	1	PC	2.8	1820
	M	CE		PC	0.5	
CROSSOVER	C	MH	2	PC	2.4	1410
	M	CE		PC	0.5	
MOON ISLAND	C	MH	2	SJ	2.6	1230
	M	MH	2	SJ	0.3	
	C	ALT. CS	(5)	SJ	4.1	1355
	M	CS	(5)	SJ	0.3	
HOQUIAM	C	CS	3	08	2.3	1065
	M	CS	3	0.8	0.2	
COW POINT	C	CS	3	08	0.5	220
	M	CS	3	PC	0.9	
SILT	C	PL	4	S1	1.5	585
GRAVEL	C	PL	4	COM	1.0	260
ABERDEEN	C	CS	6	PC	2.4	913
	M	CS	6	PC	0.1	
SOUTH ABERDEEN	C	CS	7	PC SJ	4.8	1205
	M	CS	7	PC SJ	0.1	



C=CONSTRUCTION (SHOWN BY ——); M=EXISTING MAINTENANCE DURING CONSTRUCTION; • • • • SCHEDULE CAN BE MOVED; T=INCLUDING TURNING BASIN. DREDGE TYPE: MH=MEDIUM HOPPER; CE=CORPS' ESSAYONS; CS=CLAMSHELL; PL=PIPELINE. DISPOSAL SITE: OSW=OCEAN 3.9 mi. SW AT>120'; 08=OCEAN, 8.0 mi. WNW; PC=POINT CHEHALIS; SJ=SOUTH JETTY; COM=COMMERCE STREET CONFINED DISPOSAL; S1=SLIP 1 CONFINED DISPOSAL

c. Construction Procedures for Bridge and Fendering Modifications and Utility Relocations.

(1) Railroad Bridge Modification. The existing low-level UPRR swing-span bridge at Aberdeen will be modified into a lift-span bridge at the existing bridge location (see figures EISS 2-1 and 2-2). The existing bridge is a center-pivot bridge built in 1911 and has 125 feet of horizontal clearance for navigation. This bridge will be partially demolished and replaced with a twin tower, lift-span bridge having a 140-foot-vertical lift and a 340-foot span length, sufficient to provide 250 feet of horizontal clearance for navigation (see figure EISS 2-2).

The bridge modification will be made using a surplus UPRR lift-span bridge from Little Rock, Arkansas. The surplus bridge, built in 1967, is a lift structure with a 340-foot span, two towers, and a 26-foot lift. Recent inspection determined the surplus bridge to be in excellent condition, having been used for only 10 years and parked in the raised position for the last 9 years. The span and two towers will be disassembled, floated out by barge, and transported from Little Rock to Aberdeen. The bridge sections will undergo minor rehabilitation (primarily sandblasting and painting) in the Port of Grays Harbor's Terminal 4 berth. New steel will be added to provide the increased tower height needed for the 140-foot lift. The rehabilitated liftspan and two towers will be assembled and transferred onto a floating barge tied up at the upper end of Terminal 4 berth, approximately 8,700 feet downstream of the bridge site. Two new railroad bridge piers will be constructed inside cofferdams. The assembled bridge sections will be floated to the bridge site and lifted into place on the new piers. The remaining portions of the bridge and towers and all machinery and controls will be installed at the bridge site. Construction will be accomplished with minimum interruption to navigation and rail traffic. Set net tie-ups used by Native American fishers will be replaced or retained.

The existing wooden drawrest and fenders for the railroad bridge will be removed. Sediment inside the drawrest will be removed with a clamshell dredge before the drawrest pilings are removed. This sediment contains some grease from the pivot-span mechanism. The sediment will be disposed at the Eight-Mile ocean disposal site because the sediment is still suitable for open-water disposal. Two concrete piers and a concrete pylon will be removed by blasting without the use of cofferdams, though use of cofferdams or other barriers may be required if the contractor cannot complete work within the prescribed 1-week period (see section 4.3.1c). The underwater portion of the piers will be blasted using directional charges during the last week of July and first week of August when salmon, steelhead, and sturgeon would be present in relatively low abundances. Acoustical monitoring and other safeguards will be used during the underwater blasting period to select periods when fish usage of the blasting area is very low or nonexistent. Shock absorbing materials such as bubble curtains (Malme and Colaruotolo, 1976) or cofferdams may also be employed. Concrete pieces, riprap around the piers, and sediment in the 800-foot-long bridge reach will be removed with a clamshell dredge. Concrete pieces and riprap will be disposed on the submerged rock of South Jetty, or at an approved upland site at the bridge contractor's option. The sediment will

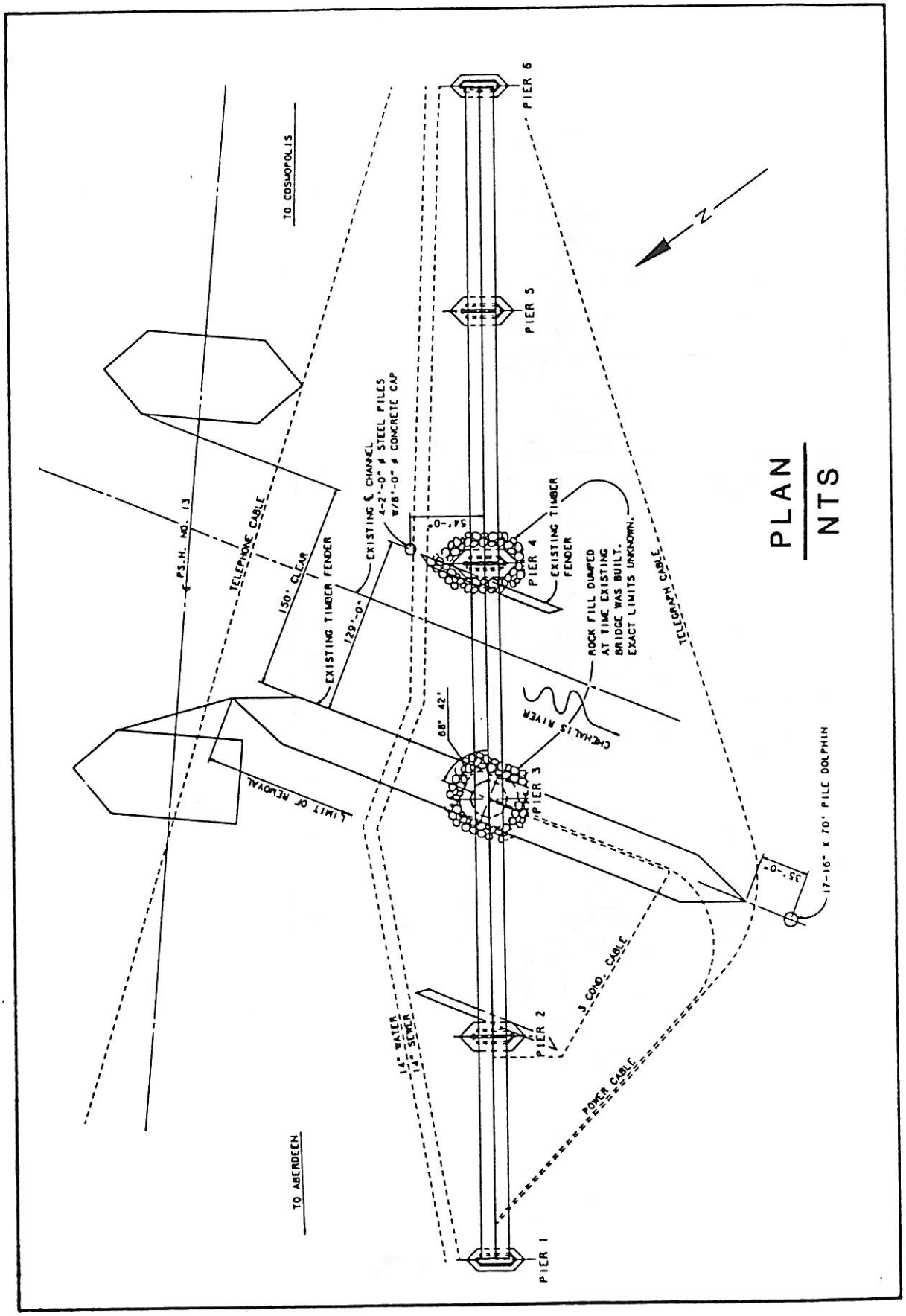
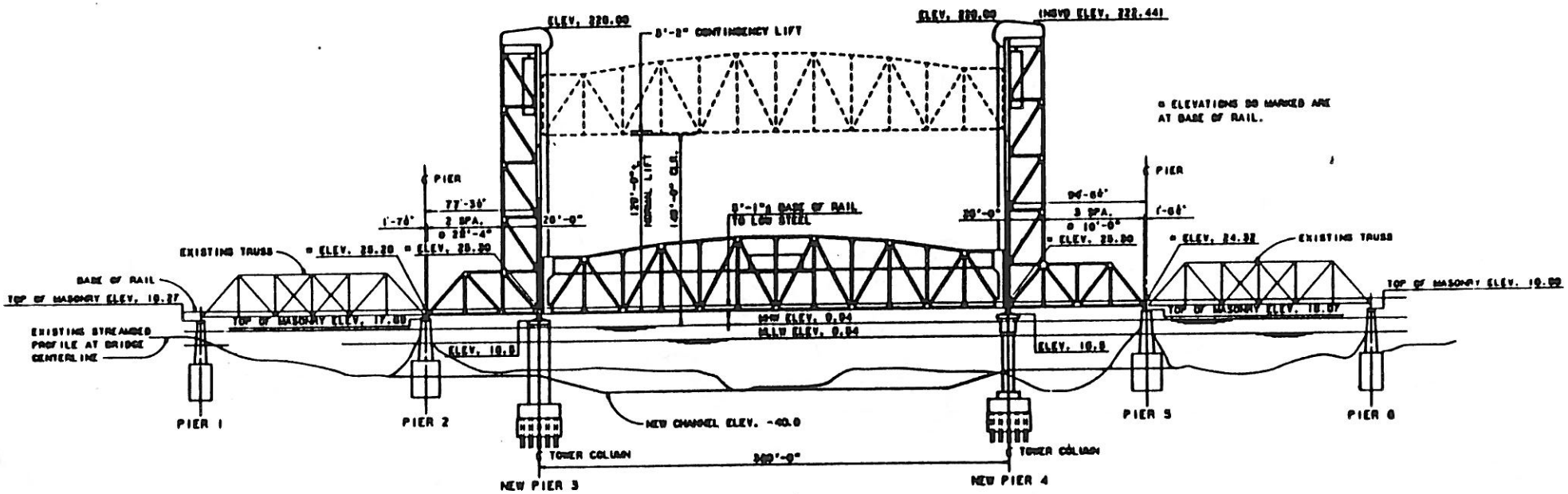


FIGURE EISS 2-1



BRIDGE ELEVATION LOOKING UPSTREAM

NTS

FIGURE EISS 2-2

MODIFICATION OF EXISTING RAILROAD BRIDGE

be disposed at the Eight-Mile ocean disposal site. Fendering will be installed around the new piers.

(2) Highway Bridge Fendering Modification. Fendering around the north pier of the Highway 101 bridge is connected to the existing railroad bridge drawrest (see figure EISS 2-3). With removal of the drawrest, the highway bridge fendering will be modified to the same design that is presently around the south pier. This fendering modification will involve removal and replacement of pilings. Disposal of piling and timbers will be at an approved upland site. This fendering modification will increase the horizontal clearance through the highway bridge from 150 to 185 feet.

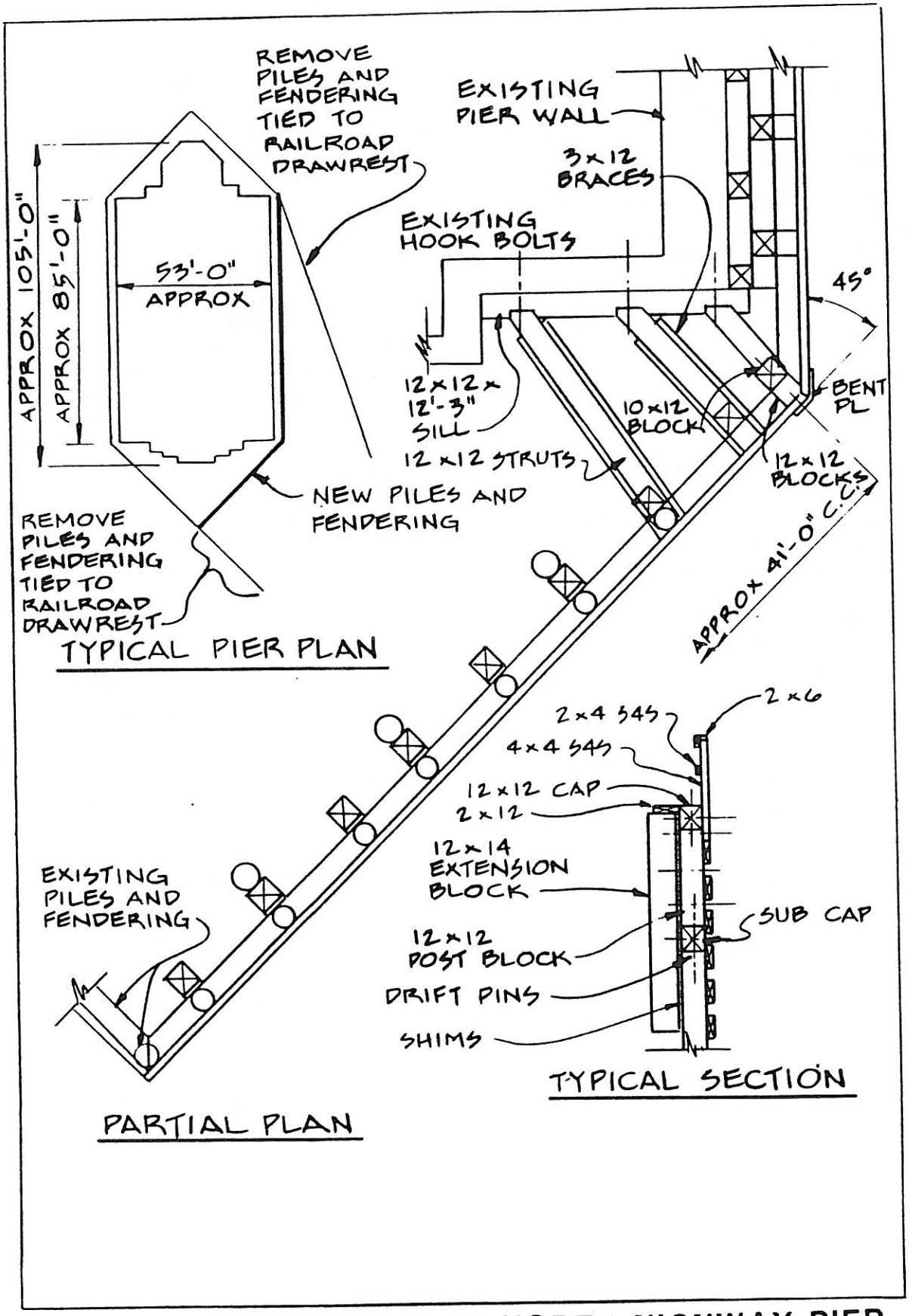
(3) Old Highway Bridge Pier Removal. Two old concrete highway bridge piers located 1,500 feet upstream of the existing highway bridge will be removed because they will pose a navigation hazard after the slight realignment of the channel upstream of the bridges (see plate 1). These old piers will be removed and disposed at the same time and in the same manner as the existing railroad bridge piers.

(4) Utility Relocations. Some utility lines crossing the river will be relocated due to channel deepening prior to commencement of work on the railroad bridge. All utility relocations are in the vicinity of the bridges and include: (1) city of Aberdeen 12-inch waterline, (2) city of Aberdeen 14-inch sewerline (both adjacent to the railroad bridge and presently in the same trench), (3) city of Aberdeen 14-inch waterline adjacent to the old highway bridge piers behind the Wiskah Mall, (4) two Pacific Northwest Bell telephone lines adjacent to the railroad bridge, and (5) Washington Department of Transportation's highway bridge powerline, and a television cable. Most of the relocated utilities will likely be placed in trenches constructed with a clamshell dredge. Trench sediment will be temporarily placed underwater adjacent to the trench and returned to the trench immediately after relocation of the utility line. The Port of Grays Harbor is responsible for relocating these lines or ensuring their relocation by the utility owners. Permits required for the utility relocation will be obtained by the parties doing the relocation.

2.2.2 Engineering Features: Dredging and Disposal Operation and Maintenance. Maintenance dredging of the deepened channel would result in an additional 1.17 to 0.77 million c.y. per year. This is an increase over the current maintenance dredging quantity (for the existing channel) of 1.68 million c.y. to a total of between 2.85 and 2.45 million c.y. per year. Hopper and clamshell dredges would be used with dredged material disposal occurring at one ocean and two estuarine harbor open-water disposal sites. The need for maintenance dredging in the Bar and Entrance reaches will decrease from 1.0 to 0.6 million c.y. during the first 4 years after construction. Table EISS 2-4 summarizes operations and maintenance features by reach.

Sediment to be dredged during maintenance is anticipated to be free of contaminants and suitable for open-water disposal (see appendix C). Sand

FIGURE EISS 2-3



FENDER MODIFICATION OF NORTH HIGHWAY PIER

TABLE EISS 2-4

DREDGING AND DISPOSAL OPERATION AND MAINTENANCE FEATURES

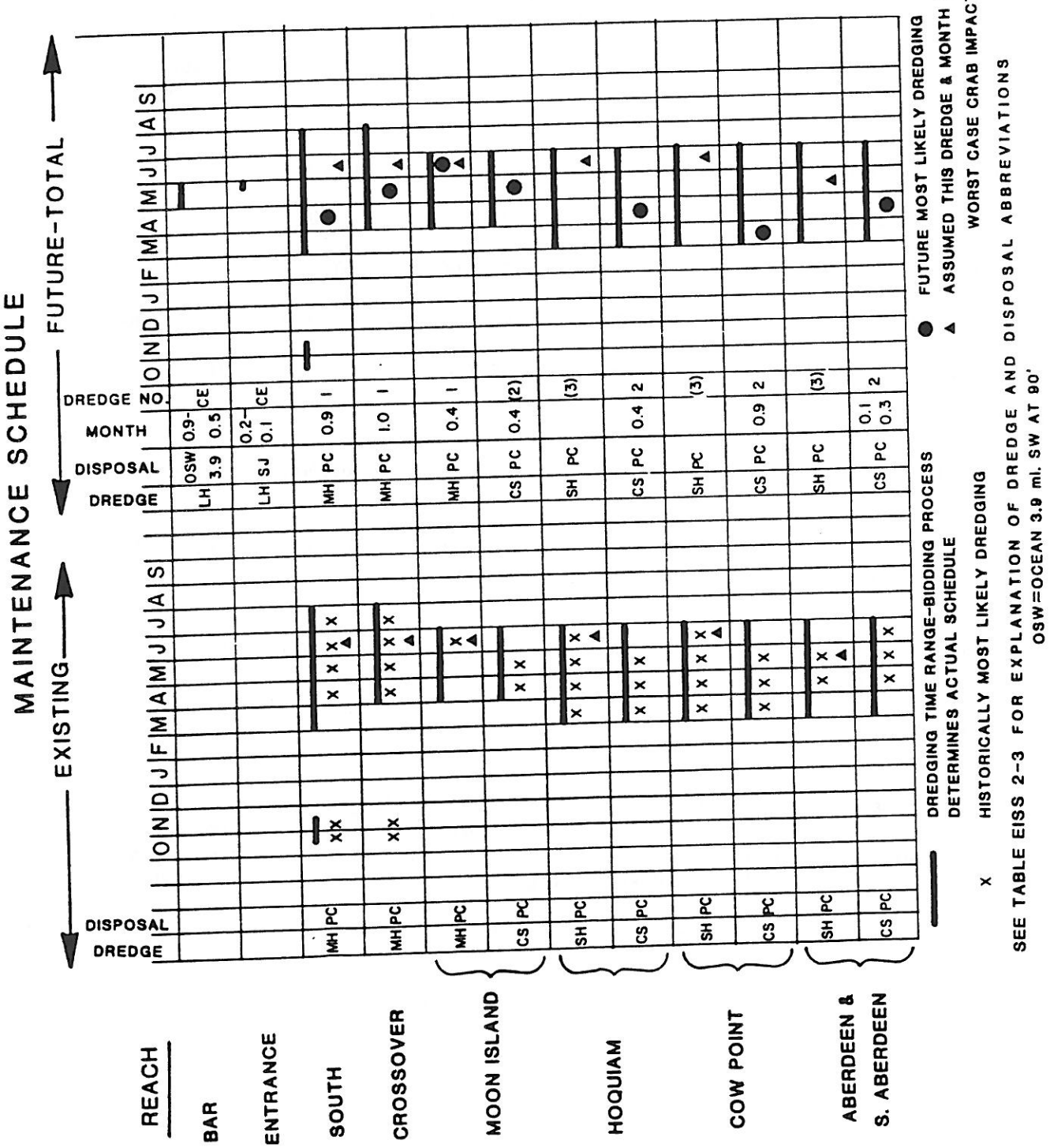
Reach (Length in Miles)	Dredge Type	Cubic Yards (Existing)	Cubic Yards Year 1 W/Project	Cubic Yards Year 5 W/Project	Disposal Site
Bar (1.7)	Hopper	0	800,000	500,000	Southwest Ocean (3.9-mile)
Entrance (4.0)	Hopper	0	200,000	100,000	S. Jetty
South (4.3)	Hopper	500,000	520,000	520,000	Pt. Chehalis
Crossover (2.8)	Hopper	520,000	550,000	550,000	Pt. Chehalis
Moon Is. (2.7)	Hopper	120,000	150,000	150,000	Pt. Chehalis
Hoquiam (2.8) (Biennial Maintenance)	Clamshell or Hopper	80,000	90,000	90,000	Pt. Chehalis
Cow Point (1.4)	Clamshell or Hopper	430,000	480,000	480,000	Pt. Chehalis
Aberdeen (1.5) (Biennial Maintenance)	Clamshell or Hopper	10,000	20,000	20,000	Pt. Chehalis
South Aberdeen (2.3) (Biennial Maintenance)	Clamshell or Hopper	20,000	40,000	40,000	Pt. Chehalis

dredged during maintenance from the Bar reach will be disposed at the southwest (3.9 mile) ocean disposal site. Sand dredged during maintenance from the Entrance reach will be disposed at the South Jetty estuary disposal site. The remaining material dredged during maintenance will be disposed at the Point Chehalis estuary disposal site, with the South Jetty estuary disposal site as a backup if the Point Chehalis site becomes filled to capacity.

Table EISS 2-5 shows the existing and future-total maintenance dredging and disposal schedule.

TABLE EISS 2-5

MAINTENANCE DREDGING AND DISPOSAL SCHEDULE
EXISTING AND FUTURE - TOTAL



2.2.3 Engineering Features: Dredging Equipment. The equipment which will be used to deepen and widen the navigation channel includes a hopper dredge for the bar, entrance, South, Crossover and Moon Island reaches; a clamshell dredge for the Hoquiam, Cow Point, Aberdeen, and South Aberdeen reaches; and a cutterhead/pipeline dredge for gravel and silt in a portion of the Cow Point reach. Dredging of the Moon Island reach with a clamshell dredge is a possible bidding option because of possible cost reductions by dredging contractors. Gravels in the Cow Point reach will be dredged with a cutterhead/pipeline dredge instead of a clamshell dredge as originally planned in the 1982 FR/EIS and disposed in confined disposal for beneficial use instead of at Point Chehalis.

2.2.4 Engineering Features: Disposal Sites. A full discussion and coordination of disposal sites is found in the FR/EIS. The following contains pertinent summary information of the relation between those sites discussed in the FR/EIS and the recommended project.

a. Confined Disposal. Several potential confined upland and nearshore disposal sites were evaluated in the FR/EIS. These were re-evaluated in conjunction with this EISS. More detailed evaluation is contained in Section 2.6: Evaluation of Alternatives to Ocean Disposal and Site Designation. Two of the sites, the South Aberdeen log storage area (upland) and the south shore industrial site (nearshore), are not considered viable at this time. The South Aberdeen log storage area is actively used by the owner and possesses very limited capacity to receive dredged material. The south shore industrial site contains extensive (100-plus acres) freshwater wetlands. Permit applications to fill the area have been submitted in the past, most recently for relocation of the existing Bowerman airfield. The application has been withdrawn. At present, there is no specific purpose to filling this site that would comply with the Section 404(b)(1) guidelines. Other, less environmentally damaging alternatives are known to exist for dredged material disposal.

Two other confined disposal sites, the Slip 1 site and the Commerce Street site, are being used to receive initial construction material (see plate 1). The Port of Grays Harbor has received all Federal, State, and local permits for filling of Slip 1 and has completed dike construction at both sites.

Use of confined disposal sites are generally not considered to be less environmentally damaging than open water disposal in Grays Harbor due to the extensive wetlands systems in the nearshore areas which could be impacted. Consequently, confined disposal is the alternative of choice when dredged sediments are found to be unacceptable for open water disposal. In the FR/EIS, a volume of dredged sediments was identified that preliminary testing indicated could be unacceptable for unconfined disposal. Additional work, conducted since the FR/EIS, has shown this material to be suitable for open-water disposal. However, the Slip 1 and Commerce Street confined disposal sites will be used because they are the least costly location for disposal of silt and gravel from the Cow Point reach. In addition, dredging volumes have been reduced due to project refinements. Discussions of project refinements is provided in the EISS and detailed discussion of Grays Harbor

sediment quality is contained in the supplemental 404(b)(1)/Section 102(a)/103 evaluation (appendix C).

b. Open-Water Estuarine Disposal. Two open-water estuarine sites for disposal of dredged material were selected in the FR/EIS. The South Jetty site and the Point Chehalis site (plate 1) occur at depths below -50 feet MLLW and were selected as disposal sites because current measurements indicate that dredged material would be effectively carried from the estuary, reducing the likelihood that material could be transported back into the harbor. Also, disposal at these sites would alleviate undercutting of South Jetty as a result of tidal scouring action. No other open-water estuarine disposal sites were considered.

The presently designated Point Chehalis disposal site near Westport, currently two adjacent areas 900 feet in radius, would, during construction, be expanded to a 2,000-foot by 5,000-foot rectangle centered on the present site. Sand would be the primary material disposed at this site.

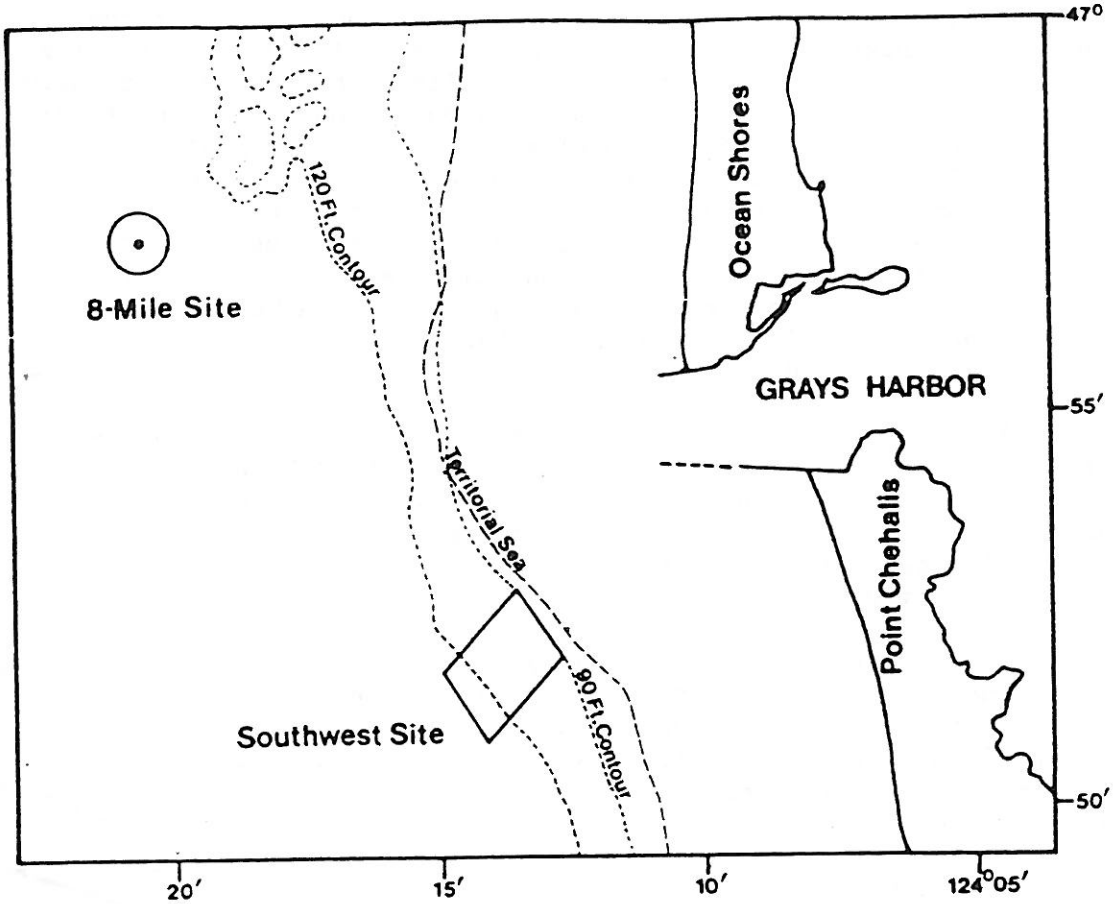
The South Jetty open-water disposal site is an 800-foot by 3,000-foot rectangle located adjacent to the exposed portion of the South Jetty. It would be the primary disposal site for construction and maintenance material (sand) from the Entrance reach and a secondary site for additional material should the Point Chehalis site be filled. Use of the Point Chehalis site and the South Jetty site will be coordinated with the Washington Department of Natural Resources.

c. Ocean Disposal. Ocean disposal was generally discussed in the FR/EIS, however, recommended sites had not been selected nor had the detailed evaluations required by the Ocean Dumping Act and Regulations occurred. This work has been completed and the results integrated into this EISS. Two sites have been selected to receive dredged material, the Southwest Navigation Lane Ocean Dredged Material Disposal Site (ODMDS) and Eight-Mile ODMDS (see figure 2-4). The Southwest Navigation Lane ODMDS is a parallelogram-shaped area with its corners at NE124°13.81'W 46°52.94'N; SE124°12.96'W 46°52.17'N; SW124°14.19'W 46°51.15'N; and NW124°14.95'W 46°51.92'N. The center of the circular 8-mile site is located at 124°20.6'W and 46°57.0'N. A process, including analysis of alternatives to ocean dumping, is contained in section 2.6.

Both ODMDSs would receive initial construction material totaling approximately 4,448,000 cubic yards (c.y.). Approximately 2,250,000 c.y. of sandy material from the bar reach would be placed at the Southwest Navigation Lane site. Approximately 2,198,000 c.y. of sandy silt and silt from the Hoquiam, Cow Point, and Aberdeen reaches would be placed at the Eight-Mile site. In addition, approximately 500,000 c.y. of sediment maintenance dredged from the bar reach would be placed at the Southwest Navigation Lane site annually starting in year 5; 800,000 c.y. will be placed in year 1, decreasing through years 2, 3, and 4. No maintenance dredged material is planned to be placed at the Eight-Mile site. Accordingly, because a continuing need for the Southwest Navigation Lane site exists, EPA will formally designate this ODMDS under

FIGURE EISS 2-4

PROPOSED OCEAN DISPOSAL SITES



Section 102(c) of the Ocean Dumping Act. Use of the Eight-Mile site is considered a one-time use of the site. The Corps will dispose of dredged material from this project at the Eight-Mile site under Section 103 of the MPRSA with concurrence of EPA, Region 10. As no further use of the Eight-Mile site is anticipated, formal designation by EPA is considered unnecessary.

2.3 Comparison of Existing Project, Authorized Project, and Recommended Project. See multipage table EISS 2-6.

2.4 Project Alternative 2: No Action. Under the no action alternative, the existing Seattle District operation and maintenance (O&M) dredging program would continue to maintain the present federally authorized 30-foot MLLW navigation channel. Maintenance dredging and disposal would continue to disturb and remove susceptible (immobile) species of the resident benthic community in the channel. Dungeness crab mortality associated with the present maintenance dredging program would continue to reduce the number of harvestable crabs in Grays Harbor by about 8,000 to 18,000 crabs per year. Opportunistic invertebrate species (organisms with high reproduction rates, short generation times, and great dispersal ability) reside in frequently disturbed areas and would continue to recolonize disturbed areas (McCauley, et al., 1977) in Grays Harbor after the annual dredging.

Juvenile salmonids are presently protected in the inner harbor by restricting maintenance dredging in waters shallower than -15 feet MLLW during the spring migration period. Some fish may be entrained by the dredge although salmonid entrainment is very low or nonexistent (Simenstad and Eggers, 1981) with hopper and clamshell dredges. Therefore, only minimal impacts to juvenile salmon would continue.

Water quality in Grays Harbor is annually impacted by maintenance dredging. Short-term increases in turbidity and decreases in dissolved oxygen have been documented near operating dredges in the inner harbor. These do not normally cause significant impacts to harbor water column organisms. Water quality is presently monitored during dredging in the inner harbor if the Chehalis River flow falls below 2,500 c.f.s. This is intended to ensure that fish and invertebrates in Grays Harbor do not suffer mortalities from low dissolved oxygen concentrations.

Impacts to ocean water quality and the ocean food web near Grays Harbor would continue to be negligible.

Continuation of the present annual maintenance dredging would have no measurable impact on terrestrial flora and fauna, wetlands, threatened and endangered species or historic and prehistoric resources. This alternative would not conflict with any existing plans, policies, or controls.

Table EISS 2-6

GRAYS HARBOR NAVIGATION IMPROVEMENT PROJECT

COMPARISON OF PROJECT

	Existing Project	Authorized Project (1)	Recommended Project (2)	Change from Authorization
DREDGING AND DISPOSAL				
Channel Dimensions	(see attached tables for further detail)			
bar	(30x600)	46x1000	46x1000	none
entrance	(30x600)	46-38 x 1000-600	46-38 x 1000-600	none
outer harbor	30x350	38x 400	36x 350	decrease depth & width; widen bends to 450' due to ship simulation results
inner harbor	30x350	38x 350	36x 350	decrease depth; width at Port's terminal 4 remains 550'
river	30x200	36x250	36x250-300	increase width from bridges to Elliott Slough turning basin due to ship simulation results; none in other areas
Turning Basins				
Cow Point	30x800W	38x1000W	36X900W	decrease depth; decrease width to reduce salmon impact
Elliott Slough	30x550W	30x750W	30x750W	none
Local Berths		deepen	deepen	none
Dredging Equipment (by reach)	(see attached tables for further detail)			
Construction				
hopper		bar-CO	bar-MI	MI by hopper has lower $/CY than clamshell
clamshell		MI-SoAb includes clamshell from Hoq & CP to confined disposal	Hoq-SoAb	MI & confined disposal not by clamshell; clamshell is bid option for MI; clamshell possible for CO but not likely
pipeline		none	CP	pipeline from CP to confined disposal instead of clamshell

(1) based on Feasibility Report & EIS approved by Chief of Engineers in May 1985; authorized by Congress in November 1986 (P.L. 99-662).
(2) based on General Design Memorandum & EISS.

Table EISS 2-6 (Cont.)

	Existing Project	Authorized Project	Recommended Project	Change from Authorization
Dredging Equipment (by reach) (continued)				
Maintenance				
hopper	So-MI	bar-MI	bar-MI	none
clamshell	Hoq-SoAb	Hoq-SoAb	Hoq-SoAb	none, but hopper is possible bid option
Dredging Quantities (1000 CY) (see attached tables for further detail)				
Construction				
reach (b=berths)				
Bar		4000	2250	
Entrance (Entr)		200	300	
South (So)		3400	1820	
Crossover (CO)		2900	1410	
Moon Island (MI)		1900	1230	
Hoquiam (Hoq) (b)		2200	1065	
Cow Point (CP) (b)		810	1065	
Aberdeen (Ab)		550	913	
South Ab. (SoAb) (b)		1380	1205	
total		17340 includes 240 for berths	11258 includes 65 for berths	decrease
equipment				
hopper		10500	7010	decrease
clamshell		6840	3403	decrease; included confined disposal
pipeline		0	845	increase for confined disposal
total		17340	11258	decrease
Maintenance (average annual)				
reach				
:New increment			yr1-yr5/50	
Bar		800	800- 500	
Entrance		0	200- 100	
South		50	20	
CO		50	30	
MI		25	30	
Hoq **		25	10	
CP		25	50	
Ab **		0	10	
SoAb **		10	20	
total		985	1170- 770	increase in years 1 & 2 due to refined estimates; decrease in remaining years

** biennial maintenance

Table EISS 2-6 (Cont.)

	Existing Project	Authorized Project	Recommended Project	Change from Authorization
Dredging Quantities (1000 CY) (continued)				
Maintenance (average annual) (continued)				
reach (continued)				
:Total future			yr1-yr5/50	
Bar	0	800	800- 500	
Entr	0	0	200- 100	
South	500	550	520	
CO	520	570	550	
MI	120	145	150	
Hoq **	80	105	90	
CP	430	455	480	
Ab **	10	10	20	
SoAb **	20	30	40	
total	1680 *	2665	2850-2450	increase in years 1 & 2 due to refined estimates; decrease in remaining years
* was 995 in feasibility report				
** biennial maintenance				
equipment				
:New increment			yr1-yr5/50	
hopper		925	1080- 680	
clamshl		60	90	
total		985	1170- 770	(see above)
:Total future			yr1-yr5/50	
hopper	1140 *	2065	2220-1820	
clamshl	540 *	600	630	
total	1680 *	2665	2850-2450	(see above)
* were 875, 120, & 995 in feasibility report				

Disposal Sites (by reach) (see attached tables for further detail)

Construction			
estuary			
Point Chehalis	1/2 So-MI	all So-CO	PC site expanded for construction;
	CP gravel	none	to confined disposal for beneficial use
South Jetty	entrance	entrance	none
	1/2 So-MI	all MI	less to SJ site & more to expanded PC site; SJ site has limited capacity & adverse weather/waves; SJ is an alternate if PC becomes filled;
	SoAb	none	to PC site (see above)

Table EISS 2-6 (Cont.)

	Existing Project	Authorized Project	Recommended Project	Change from Authorization
Disposal Sites (by reach) (continued)				
Construction (continued)				
ocean				
number		not specified	2	from 1 (or 2) site(s) to 1 site for sand and 1 site for silt
location		4.3 mi. SW or W	3.9 mi. SW with managed use	mileage changed from closest edge (3.5 mi) to center of site (4.3 mi); center of site moved slightly closer to 3.9 mi; construction disposal beyond 120' (4.3 mi)
			8.0 mi. WNW	additional ocean site for disposal of construction silts
SW		bar sands	bar sands	none
(see above)		Hoq-Ab silts	none	location changed
8.0 mi. WNW		none (was included in LED plan)	Hoq-Ab silts (constr only)	ocean disposal location changed from 4.3 mi to 8.0 mi (see above)
confined				
Slip 1		Hoq	CP	material taken from adjacent reach
SoAb (Weyco)		Hoq & CP	none	site no longer available
Comm. St.		none	CP gravel	existing site to be reused to store gravel for beneficial use instead of PC disposal
Maintenance				
estuary				
Point Chehalis	So-SoAb	So-CO plus 1/2 MI	So-SoAb	all harbor maintenance material to PC; no change from existing project
South Jetty	none	none	entrance	maintenance added from entrance reach
	none	Hoq-SoAb plus 1/2 MI	none	to PC site; no change from existing project; (see above)
ocean				
location	none	4.3 mi to SW or W	3.9 mi. SW	slightly closer (see above)

Table EISS 2-6 (Cont.)

	Existing Project	Authorized Project	Recommended Project	Change from Authorization
Disposal Quantities (1000 CY)		(see attached tables for further detail)		
Construction				
estuary		9980	5965	decrease
ocean		5360	4448	decrease
confined		2000	845	decrease
total		17340	11258	decrease
Maintenance (average annual)				
:New increment			yr1-yr5/50	
estuary		185	370- 270	
ocean		800	800- 500	
total		985	1170- 770	increase in years 1 & 2 due to refined estimates; decrease in remaining years
:Total future			yr1-yr5/50	
estuary	1680 *	1865	2050-1950	
ocean	none	800	800- 500	
total	1680 *	2665	2850-2450	increase in years 1 & 2 due to refined estimates; decrease in remaining years
* was 995 in feasibility report				
Sediment Quality		suspected contamination	sediments not contaminated; suitable for open-water disposal	some confined disposal still included but special handling of of sediments not needed

Table EISS 2-6 (Cont.)

	Authorized Project	Recommended Project	Change from Authorization
OTHER FEATURES			
Aids to Navigation (US Coast Guard)	relocate &/or add:	relocate &/or add:	
	1 buoy	3 buoys	
	5 ranges	3 ranges	
	0 lights	2 lights	
	1 daybeacon	2 daybeacons	
total	7	10	minor additional aids
UP railroad bridge modification	twin-tower, vertical-lift bridge at existing location using new steel and cofferdams for pier removal	twin-tower, vertical-lift bridge at existing location using surplus UPRR bridge parts; pier removal without coffer-dams; replace Indian set net tie-ups	same design, but use surplus UPRR bridge parts, replace Indian set net tie-ups, & give special attention during underwater blasting of piers to minimize fish impacts
Highway bridge fendering modification	around north pier	around north pier	none
Old highway bridge pier removal	none	2 piers behind Wishkah Mall; pier removal without coffer-dams; replace Indian set net tie-ups	removal required due to ship simulation results; replace Indian set net tie-ups; special attention during underwater blasting to minimize impacts to fish
Utility relocations	2 ITT-Rayonier	none	relocations not needed
	3 City of Aberdeen	3 City of Aberdeen	none
	telephone	telephone	none
	cable TV	cable TV	none
	highway bridge	highway bridge	none

Table EISS 2-6 (Cont.)

	Authorized Project	Recommended Project	Change from Authorization
Crab mitigation			
impacts (based on crab impact model developed during PED studies)			
construction (loss based on high crab population)	loss of 159,400 harvestable crabs at value of $550,400	loss of 76,200 harvestable crabs at value of $262,800	reduced due to reduced dredging CY & refined dredge scheduling using improved knowledge of crab population
incremental future maintenance (loss based on mean crab population)	loss of 427,900 harvestable crabs over 50 years at value of $1,476,100	loss of 204,300 harvestable crabs over 50 years at value of $704,900	reduced due to reduced dredging CY & refined dredge scheduling using improved knowledge of crab population
mitigation			
scheduling to minimize crab losses	included	included and refined	dredging schedule refined based on improved knowledge of crab population
hopper dredge equipment modifications	draghead modification	none	many modifications considered; draghead modified & field tested; did not reduce crab entrainment
other	none	young-of-year crab habitat creation using oyster shells	replaces draghead modification as crab mitigation; field tests showed increased crab survival in test plots; oyster shell is available; mitigation is cost effective
Fish (salmon) mitigation			
impact	4 acres subtidal habitat lost	1.8 (about 2) acres subtidal habitat lost	decrease by 1/2
mitigation	4 acres subtidal habitat replacement upstream of bridges	4 acres inter-tidal habitat replacement near Ann's Slough; 18 acres of buffer	2 for 1 out-of-kind habitat replacement offset by reduced impact; buffer with control slough added; is cost effective

Table EISS 2-6 (Cont.)

	Authorized Project	Recommended Project	Change from Authorization
PROJECT ECONOMICS			
Authorized project cost (in P.L. 99-662 at 10/86 price level)	$95.7 million (10/86)		
Project cost at 10/88 price level (economic cost)	$102.7 million (10/88)	$61.3 million (10/88)	decrease
Benefit-to-cost ratio	1.3-to-1	1.8-to-1	improved
PROJECT COST SHARING			
Full-funded project cost (financial cost; economic cost inflated to constr. contract award dates)	$112.6 million	$70.0 million	decrease $42.6 million; (both estimates based on FY 90-92 construction period)

Table EISS 2-6 (Cont.)

	Authorized Project if old law	Authorized Project new law	Recommended Project new law	Change from Authorization
PROJECT COST SHARING (continued)				
Cost sharing percentages				(changed by PL 99-662, as amended by PL 100-676)
Non-Federal				
bridge owners				
Truman-Hobbs cost share	100	100	100	
local sponsor				
LERRD	100	100	100	
gen navig. (incl bridges after owner cost share)	0	25-35	25-35	
channel maintenance	0	0	0	
utilities	100	100	100	
Federal				
Corps				
gen navig. (incl bridges after owner cost share)	100	75-65	75-65	
channel maintenance	100	100	100	
Coast Guard				
Navig. aids	100	100	100	
Construction cost sharing ($ million)				(recommended cost based on full-funded total cost)
Non-Federal				
local sponsor & utilities	$10.7	$33.4	$22.3	
RR br owner	1.1	1.1	2.2	
Hwy br owner	0.5	0.5	0.3	
total	12.3	35.0	24.8	change
Federal				
Corps	90.0	67.3	45.0	
Coast Guard	0.4	0.4	0.2	
total	90.4	67.7	45.2	reduction
Total	$102.7	$102.7	$70.0	reduction

Table EISS 2-6 (Cont.)

Comparison of Projects
Construction Dredging & Disposal
Reach by Reach

REACH	Authorized Total 1000 CY	Dredge	Estuary Disposal	Ocean Disposal	Confined Disposal	Recommended Total 1000 CY	Dredge	Estuary Disposal	Ocean Disposal	Confined Disposal
		Hopper	Point Chehalis	4.3	Slip 1		Hopper	Point Chehalis	3.9 SW W/Const > 120'	Slip 1 Comm St.
		Clamshell	South Jetty		SoAb		Clamshell	South Jetty	8.0 WWN	
		Pipeline					Pipeline			
BAR	4000	H		4000		2250	H		3.9 2250	
ENTR	200	H	SJ 200			300	H	SJ 300		
SOUTH	3400	H	PC 1700 SJ 1700			1820	H	PC 1820		
CO	2900	H	PC 1450 SJ 1450			1410	H	PC 1410		
MI	1900	CS	PC 950 SJ 950			1230	H*	SJ 1230		
HOQ	2200	CS		660	S1 690 SA 850	1065	CS		8.0 1065	
CPsilt	610	CS		150	S1 110 SA 350	805	PL CS		8.0 220	S1 585
CPgrvl	200	CS	PC 200			260	PL			Com 260
AB	550	CS		550		913	CS		8.0 913	
SoAb	1380	CS	SJ 1380			1205	CS	PC 482 SJ 732		
Total		H	PC 3150	4000	---		H	PC 3230	3.9 2250	---
			SJ 3350	---	---			SJ 1530	8.0 ---	---
		CS	PC 1150	1360	S1 800		CS	PC 482	3.9 ---	---
			SJ 2330	---	SA 1200			SJ 723	8.0 2198	---
		PL	---	---	---		PL	---	---	S1 585
			---	---	---			---	---	COM 260
	17340		9980	5360	2000	11258		5965	4448	845

* clamshell dredge possible (1,355,000 CY)

Comparison of Projects
Construction Dredging & Disposal
Summary by Dredge Type & Disposal Area

Dredge	Total 1000 CY	Estuary: Point Chehalis	Estuary: South Jetty	Estuary: Total	Ocean: W or Sw	Ocean: 8.0 mi WNW	Ocean: Total	Confined: Slip 1	Confined: Comm. St.	Confined: South Aberdeen	Confined: Total
AUTHORIZED PROJECT					4.3 W or SW						
Hopper	10500	3150	3350	6500	4000	---	4000	---	---	---	---
Clamshell	6840	1150	2330	3480	1360	---	1360	800	---	1200	2000
Pipeline	0	---	---	---	---	---	---	---	---	---	---
Subtotal		4300	5680		1360	---		800	---	1200	
Total	17340			9980			5360				2000
RECOMMENDED PROJECT					3.9 SW						
Hopper	7010	3230	1530	4760	2250	---	2250	---	---	---	---
Clamshell	3403	482	723	1205	---	2198	2198	---	---	---	---
Pipeline	845	---	---	---	---	---	---	585	260	---	845
Subtotal		3712	2253		2250	2198		585	260	---	
Total	11258			5965			4448				845

Table EISS 2-6 (Cont.)

Comparision of Projects
Maintenance Dredging & Disposal
Reach by Reach/Summary by Dredge & Disposal

Reach	Dredge	Existing 1000 CY	Existing Estuary Disposal	Incremental New 1000 CY	Incremental New Estuary Disposal	Incremental New Ocean Disposal	Total Future 1000 CY	Total Future Estuary Disposal	Total Future Ocean Disposal
	Hopper		Point Chehalis		Point Chehalis	3.9 SW >90'		Point Chehalis	3.9 SW >90'
	Clamshell				South Jetty			South Jetty	
Bar	Essayons								
Yr 1		0		800		3.9	800		3.9
Yrs 5-50		0		500		3.9	500		3.9
Entrance	Essayons								
Yr 1		0		200	SJ		200	SJ	
Yrs 5-50		0		100	SJ		100	SJ	
SOUTH	H	500	PC	20	PC		520	PC	
CO	H	520	PC	30	PC		550	PC	
MI	H*	120	PC	30	PC		150	PC	
HOQ**	CS*	80	PC	10	PC		90	PC	
CP	CS*	430	PC	50	PC		480	PC	
AB**	CS*	10	PC	10	PC		20	PC	
SoAB	CS*	20	PC	20	PC		40	PC	
Total (dredge)	H Bar & Ent	0		1000-600			1000-600		
	H harbor	1140		80			1220		
	CS harbor	540		90			630		
		====		=======			=====		
Yr 1		1680		1170			2850		
Yrs 5-50		1680		770			2450		
Total (disposal)	PC	H 1140		80			1220		
		CS 540		90			630		
	SJ	H 0		200-100			200-100		
	3.9	H 0		800-500			800-500		
		====		=======			=========		
Yr 1		1680		1170			2850		
Yrs 5-50		1680		770			2450		

* either hopper or clamshell dredge possible
** biennial maintenance - CY is average annual CY

Under the no action plan, deep draft ships using Grays Harbor will be forced to continue to wait for favorable tides or leave Grays Harbor with partial loads. As larger new ships replace smaller old ships, these factors could lead increasingly to fewer ships calling at Grays Harbor and consequent adverse effects on socioeconomic conditions in the area.

Vessels going to the upstream terminals will continue to be subject to the 85-foot beam restriction at the bridges imposed by the Grays Harbor pilots.

2.5 Comparative Impacts of Alternatives. Table EISS 2-7 displays the comparative impacts of the no action and recommended project.

2.6 Evaluation of Alternatives to Ocean Disposal and Site Designation.

2.6.1 Ocean Disposal Site Selection Procedures. Under the Marine Protection, Research, and Sanctuaries Act (MPRSA) designation of ocean sites for disposal of dredged material (MPRSA Section 102) or permitting transport of dredged material in the ocean (MPRSA Section 103) must follow specific requirements. In conjunction with the MPRSA, Environmental Protection Agency (EPA) ocean dumping regulations as well as related EPA and Corps of Engineers policies must be followed. The MPRSA requires that site evaluation be performed prior to final designation for continued use as an ocean disposal site. Accordingly, disposal of dredged material in the ocean must fully meet all five general criteria and 11 specific factors, displayed in table EISS 2-8.

The site-designation/permitting for ocean disposal was structured into three major phases according the joint EPA/Corps workbook (EPA and Corps, 1984). Phase I includes delineation of the general area or zone of siting feasibility being considered for site designation/use and identification and collection of necessary information on resources, uses, and environmental processes for the area. Phase II involves identification of candidate sites within the area based on information collected and proecssed in Phase I. Phase III is the evaluation of candidate sites and the selection of sites for EPA designation or for Corps permitting.

TABLE EISS 2-7
COMPARATIVE IMPACTS OF ALTERNATIVES

	No Action	Recommended Project
PHYSICAL ENVIRONMENT		
Estuary		
Air Quality and Noise	No change.	Temporary impacts. No significant impacts.
Sediment Characterization/ Water Quality	Continued temporary water quality decrease during O&M dredging and disposal. No impact on sediment quality.	Temporary turbidity changes during construction. No significant impact on sediment quality.
Physiography	Depth of existing channel maintained at 30 feet.	9,008,000 c.y. will be dredged creating a 36-foot-deep channel.
Littoral Process	No change.	Sediment transport will not be disrupted.
Ocean		
Air Quality and Noise	No change.	Temporary impacts. No significant impacts.
Sediment Characterization/ Water Quality	No ocean disposal.	Minor turbidity impacts during dredging and disposal.
Physiography	No bar dredging or ocean disposal.	2,250,000 c.y. will be dredged on the bar creating a 46-foot-deep channel. Minor mounding at ocean disposal sites which will be gradually reduced due to ocean currents.

TABLE EISS 2-7 (con.)
COMPARATIVE IMPACTS OF ALTERNATIVES

	No Action	Recommended Project
BIOLOGICAL ENVIRONMENT		
Estuary		
Dungeness Crabs	Loss of 8,000 to 18,000 harvestable crabs per year due to existing O&M dredging.	Loss of 76,200 harvestable crabs due to construction dredging. Loss of 204,300 harvestable crabs over 50 years of incremental future O&M dredging plus existing O&M losses (see no action). This loss will be mitigated by creation of crab habitat using oyster shells.
Oysters	No impact.	No significant impact.
Demersal Fish	No impact. Minor entrainment due to O&M dredging.	No significant impact. Minor impact due to dredging and blasting piers.
Salmon	Minimal impact. No loss of salmon fishing areas.	Loss of approximately 2 acres of subtidal habitat for juvenile salmon. This loss will be mitigated by creation of 4 acres of intertidal habitat (plus 18 acres of buffer area). Minor impact due to dredging and blasting piers.

TABLE EISS 2-7 (con.)
COMPARATIVE IMPACTS OF ALTERNATIVES

	No Action	Recommended Project
Estuary (con.)		
Endangered Species	No impact.	No impact.
Wetlands	No loss.	No wetland acreage will be lost due to project construction. Four acres will be improved as a fish mitigation site.
Endangered Species	No impact.	No impact.
SOCIOECONOMIC ENVIRONMENT		
Forest Products	No change; demand for forest products will remain the same through 2020.	No change in demand for forest products through 2020.
Tourism	No impact.	No impact.
Fisheries	Loss of 8,000 to 18,000 harvestable crabs per year due to O&M dredging.	Loss of 76,200 harvestable crabs due to construction dredging. Loss of 204,300 harvestable crabs over 50 years of incremental future O&M dredging plus existing O&M losses (see no action). Minimal impacts to fin fisheries from blasting and demolition. No loss of fin fishing areas.

TABLE EISS 2-7 (con.)
COMPARATIVE IMPACTS OF ALTERNATIVES

	No Action	Recommended Project
SOCIOECONOMIC ENVIRONMENT (con.)		
Shipping Activities	Large ships (greater than 30,000 dwt) will continue to be restricted from departing the harbor fully loaded. Smaller vessels will continue to be used for shipping, until those vessels are phased out of the trade and then traffic would disappear.	A greater proportion of larger log ships will use port. Fewer log ships will enter port due to economies of scale. Short-term traffic delays due to construction; no significant impact.
Rail Service	No change.	Short-term traffic delays. No significant impact.
Cultural Resources	No change.	No submerged cultural resources in the Point Chehalis and South Jetty area. Impacts at the fish mitigation site to be monitored during construction.
Native American Concerns	No change.	Set net tie-ups will be replaced. Consultation plans will be modified as necessary to prevent loss of set net fishing grounds in the vicinity of the bridges.

TABLE EISS 2-8

REQUIRED CONSIDERATIONS IN THE EVALUATION AND DESIGNATION OF OCEAN DREDGED MATERIAL DISPOSAL SITES

The EPA ocean dumping criteria (40 CFR, Part 228) state that final site designation under Section 102(c) (applicable to Section 103) of the Marine Protection, Research, and Sanctuaries Act of 1972 must be based on environmental studies of each site and on historical knowledge of the impact of dredged material disposal on areas similar to such sites in physical, chemical, and biological characteristics. The following are the general criteria (40 CFR 228.5) and the specific factors (40 CFR 228.6) that must be considered prior to site designation.

General Criteria for the Selection of Sites

(1) The dumping of materials into the ocean will be permitted only at sites or in areas selected to minimize the interference of disposal activities with other activities in the marine environment, particularly avoiding areas of existing fisheries or shellfisheries, and regions of heavy commercial or recreational navigation.

(2) Locations and boundaries of disposal sites will be so chosen that temporary perturbations in water quality or other environmental conditions during initial mixing caused by disposal operations anywhere within the site can be expected to be reduced to normal ambient seawater levels or to undetectable contaminant concentrations or effects before reaching any beach, shoreline, marine sanctuary, or known geographically limited fishery or shellfishery.

(3) If at anytime during or after disposal site evaluation studies, it is determined that existing disposal sites presently approved on an interim basis for ocean dumping do not meet the criteria for site selection set forth in 228.5-228.6, the use of such sites will be terminated as soon as suitable alternative disposal sites can be designated.

(4) The sizes of ocean disposal sites will be limited in order to localize for identification and control any immediate adverse impacts and to permit the implementation of effective monitoring and surveillance programs to prevent adverse long-range impacts. The size, configuration, and location of any disposal site will be determined as part of the disposal site evaluation or designation study.

(5) EPA will, wherever feasible, designate ocean dumping sites beyond the edge of the continental shelf and other such sites that have been historically used.

TABLE EISS 2-8 (con.)

Specific Factors for the Selection of Sites

(1) Geographical position, depth of water, bottom topography, and distance from coast.

(2) Location in relation to breeding, spawning, nursery, feeding, or passage areas of living resources in adult or juvenile phases.

(3) Location in relation to beaches and other amenity areas.

(4) Types and quantities of wastes proposed to be disposed of and proposed methods of release, including methods of packaging the waste.

(5) Feasibility of surveillance and monitoring.

(6) Dispersal, horizontal transport, and vertical mixing characteristics of the area, including prevailing current direction and velocity.

(7) Existence and effects of current and previous discharge and dumping in the area, including cumulative effects.

(8) Interference with shipping, fishing, recreation, mineral extraction, desalination, fish and shellfish culture, areas of special scientific importance, and other legitimate uses of the ocean.

(9) Existing water quality and ecology of the site as determined by available data or by trend assessment or baseline surveys.

(10) Potential for the development or recruitment of nuisance species in the disposal site.

(11) Existence of or in close proximity to the site of significant natural or cultural features of historical importance.

2.6.2 Need for Ocean Disposal. The U.S. Army Corps of Engineers (Corps) is responsible for maintaining Federally-authorized navigation channels that allow waterborne access to and from port facilities located at the upper end of Grays Harbor estuary. This project provides substantial economic benefit to the region, allows vessels to safely cross the bar at the entrance to the harbor, and is one of the harbor of refuges along the coast of Washington. Elsewhere in this EISS, and in previous documents, improvements of the navigation channel have been discussed.

Ocean disposal of Grays Harbor maintenance dredged material has not occurred in the past. Other, less expensive alternatives have been available, primarily unconfined, open-water disposal within the estuary and creation of nearshore fills upon which much of the Harbor's urban development has occurred. These options have become increasingly limited. Filling of wetlands, which occupy most of Grays Harbor nearshore areas, is discouraged by existing laws where less environmentally damaging alternatives exist. Less environmentally damaging options can include open-water disposal within the estuary or the ocean and upland disposal. Unconfined, open-water disposal of Grays Harbor dredged material within the estuary at approved DNR open-water sites north of Point Chehalis has occurred in the past and is expected to continue in the future under the navigation improvement plan. In the absence of the navigation improvements project, there appears to be sufficient capacity within the estuary to accommodate maintenance dredging volumes. Ocean disposal is not "needed," although there may be instances where ocean disposal would be less environmentally damaging than in-estuary disposal.

Specific evaluation of ocean disposal alternatives is contained in subsequent paragraphs. The Grays Harbor navigation improvements project was authorized by Congress on 17 November 1986, in Section 202 of the Water Resources Development Act of 1986 (Public Law 99-662). Disposal of the dredged sediments is a necessary component of the authorized project. The no action alternative would mean not constructing the authorized project. Filling of wetlands areas continues to be discouraged. Unconfined, open-water disposal within the estuary of a portion of the material to be dredged for this project will occur under the current navigation improvements plan. However, due to the much larger volumes of material that must be dredged for initial construction and continued maintenance of this project, disposal of all the material within the estuary could result in significant impacts to the estuarine system. Use of upland sites has been investigated, but no sites have been identified that are economically feasible or less environmentally damaging. However, Slip 1 and Commerce Street confined disposal sites will be used because they are the least costly location for disposal of silt and gravel from the Cow Point reach. The ability to dispose of project sediments in the ocean is critical to the feasibility of the authorized navigation improvement project.

Two sites have been identified to receive dredged material from initial construction of the project: the Eight-Mile site and Southwest Navigation Lane site. Evaluation of future maintenance dredging volumes, however,

suggests that only one site would be needed once initial construction is complete. The majority of future maintenance material destined for the ocean is expected to come from the bar channels. Disposal of this material at the Southwest Navigation Lane site is considered environmentally and economically preferable to the Eight-Mile site. Accordingly, use of the Eight-Mile site is considered a one-time use of the site. As no further use of the Eight-Mile site is anticipated, formal designation by EPA is considered unnecessary. Based on these considerations, designation of a single ODMDS offshore of Grays Harbor, Washington, is considered necessary.

2.6.3 Alternatives to Ocean Disposal.

a. No Action. The Grays Harbor navigation improvements project was authorized by Congress on 17 November 1986, Section 202 of the Water Resources Development Act of 1986 (Public Law 99-662). Disposal of the dredged sediments is a necessary component of the authorized project. The merits of project construction have been thoroughly examined and documented in previous Corps documents (see 1.3.2 Purpose and Content of EISS1). These documents acknowledged the need for ocean disposal of some of the project sediments as a critical component to feasibility of the project. The no action alternative for the navigation improvements project is thoroughly discussed.

From EPA's perspective, the no action alternative for ocean disposal would be that EPA Region 10 would decline to designate an ODMDS under Section 102(c) of the MPRSA because the site failed to meet the five general criteria and eleven specific factors. Should that occur, then the Corps could designate these sites using their Section 103 authority. Such designation by the Corps requires EPA concurrence. Should EPA not concur with the Corps' Section 103 determination, then the Secretary of the Army may seek a waiver from the Administrator of EPA under Section 103(d). Accordingly, no action for designation of an ocean disposal site would not necessarily be the same as no action for the navigation improvement project. Based on evaluation of the site studies performed, EPA Region 10 has concluded that the five general criteria and eleven specific factors have been met.

b. Upland and Confined Nearshore Disposal. Upland disposal of entrance channel material along the Pacific coast typically is not feasible for economic and environmental reasons. Upland sites with large capacity seldom exist at such locations. More distant upland sites incur substantially greater costs for rehandling and transportation of the material and alteration of the sites normally involves some environmental impact. No large expanses of uplands exist near the mouth of Grays Harbor that are easily accessed by hopper dredges. Point Brown, to the north, contains the city of Ocean Shores. Point Chehalis, to the south, contains the city of Westport. Both areas contain undeveloped lands that are typically a mixture of beach dune complex and salt- and fresh-water wetlands which have important value as fish and wildlife habitat. Use of these areas is not considered a less environmentally damaging alternative to ocean disposal. Where permitted for filling (typically through Section 404 of the Clean Water Act), use of dredged material has been considered appropriate.

Hopper dredges must be used for initial construction and maintenance work across the bar and in the entrance channel because the rough seas encountered are not safe for operation of pipeline dredges or clamshell dredges. With a hopper dredge, dredged material disposal would normally occur at an in-water site. Hopper dredges have a limited pumpout capability, although with booster pumps, their capability can be increased; although at greater economic cost. One option would be to bottom-dump the hopper-dredged material close to shore within the estuary, and then pipeline dredge the material to a final site further inland. A sump could also be created to hold the extra material. Another option would be to create a rehandling area on shore, but within the hopper dredges' limited pumping distance, allow the sediments to dewater and then excavate the material and transport it elsewhere by truck or rail. These options do not necessarily reduce environmental effects (e.g., valuable habitat may be impacted to create the rehandling area), but do substantially increase the cost of the operation.

In the upper estuary, there are fewer options for upland disposal of the silty material that would be removed during initial construction. Most of the dredging for the upper reaches is done by pipeline and clamshell dredges, although some hopper dredging occurs. Hydraulic cutterhead pipeline dredges are able to discharge directly to an upland site, although direct pumping distance is limited to about a mile. Almost all of the nearshore area has been filled in the past for development of the cities of Aberdeen, Hoquiam, and Cosmopolis. What remains is largely wetlands. Upland sites that are more distant, but still within reasonable pumping distance, typically have very limited capacities or have other constraints (e.g., unable to handle the volumes of return waters, need to fill site has not been justified, etc.). Under the current dredge plan, approximately 585,000 c.y. of silty material will be dredged by pipeline dredge from the Cow Point reach and disposed of at the Port of Grays Harbor's Slip 1 diked disposal site. This site has been permitted via Section 404. Another approximately 260,000 c.y. of gravel, also from the Cow Point reach, will be dredged using a pipeline dredge and placed at the Commerce Street disposal site.

All other silty dredged material will be removed using a clamshell dredge in order to minimize entrainment and mortality of Dungeness crab and fish, and to minimize resuspension. The crab entrainment rate for clamshell dredges is 95 percent less than for a hopper dredge (Armstrong, et al. 1981). As clamshell dredges cannot directly place material to upland sites, rehandling of the material is necessary, with increased costs and logistic problems similar to hopper dredges.

Upland alternatives are not considered feasible for the large volumes of material that will be associated with this project. No economic or environmentally acceptable upland sites have been identified. The alternative of upland disposal will have to be revisited as part of individual Section 103 evaluations and permits for future disposal operations.

c. Estuarine Open-Water Disposal. Traditionally maintenance dredged material from the entrance has been disposed inside or within the mouth of the

estuary where the currents will move the material out to the ocean. Disposal of the material inside the estuary increases the risk of the material eroding and reshoaling the channel, potentially increasing dredging requirements. Evaluation of currents and sediment movement in the mouth of Grays Harbor have indicated no significant problems that could be associated with previous disposal operations. Two in-water estuarine sites, the South Jetty and Point Chehalis sites, were proposed for disposal of dredged material in the FR/EIS. Impacts associated with the use of those sites were addressed in the EIS and the appended Section 404(b)(1)/Section 102(a)/103 evaluation. The sites are located near the mouth of Grays Harbor to minimize impacts within the estuary by allowing deposited sediments to be transported to the ocean. These sites do not have sufficient capacity to accommodate the volumes of material to be dredged during initial construction. In addition, concern has been expressed by State and Federal resource agencies that the large quantity of fine material from initial construction may move back into the estuary where it could deposit in sensitive aquatic areas, such as oyster beds and eelgrass beds. The extent and volume of such movement is unknown, but can be avoided by placing most of the silty construction material at the Eight-Mile site or in the westward portion of the South Jetty site.

Establishment of additional estuarine open-water sites is not considered to be potentially less-environmentally damaging than ocean disposal. Attempting to locate any sites more eastward in Grays Harbor could substantially impact a variety of important resources.

2.6.4 Ocean Disposal Alternatives. Based on the evaluation of need, designation of an ODMDS is necessary for construction and maintenance of the Grays Harbor navigation improvement project. Typically, the evaluation process would give strong consideration to formally designating existing interim sites. Ocean disposal of dredged material from the mouth of Grays Harbor has not been an ongoing practice in recent historic times and no interim site was designated. The evaluation process has therefore focused on identifying candidate sites, following the procedures described in section 2.6.1. After an extensive series of studies, the Corps selected two preferred sites out of seven potential ones (Pearson et al. 1987). EPA Region 10 was consulted regarding those studies and has made an independent evaluation of the results.

a. Disposal Sites Beyond the Continental Shelf. The Ocean Dumping Regulations indicate a preference for locating ocean dumping sites off of the Continental Shelf. The purpose of such a site preference is to minimize environmental impacts from ocean dumping. The shelf offshore of Grays Harbor extends 30 nautical miles from the coastal shoreline. Transportation of the dredged material beyond the Continental Shelf was evaluated, but eliminated as a preferred option for the following reasons:

- The dredged sediments from Grays Harbor have been tested and determined to be acceptable for in-water disposal for either estuarine or ocean disposal.

- Transportation costs for a disposal site beyond the shelf would be extremely high.

- Site sampling and testing costs for designation and post-disposal monitoring would be difficult and substantially more costly due to the distance and depths.

- Environmentally-acceptable sites were identified closer to Grays Harbor.

In summary, designation and use of a site off the Continental Shelf did not offer any environmental advantages over sites located closer to the shore, but did involve substantially greater economic disadvantages.

b. Disposal Sites on the Continental Shelf. The FR/EIS evaluated possible locations of ocean disposal sites on the continental shelf. Additional studies for this EISS aided in identification of the best sites for disposal based on the environmental criteria in the MPRSA. Site selection was conducted in the three phases described below.

In Phase I of the site selection process, the geographical area of consideration was defined by establishing the reasonable haul distance considering factors such as available dredging equipment, energy use constraints, costs, and safety concerns. This geographical area was termed the zone of siting feasibility (ZSF), an area where disposal is economically and technically feasible. Existing information on resources, uses, and environmental concerns within the ZSF were reviewed. Boundaries of critical resources as well as areas of incompatibility were identified and mapped. General types of expected dredged material and the physical processes affecting each type during and following disposal were considered. Also, bottom areas were delineated that appeared to be compatible with the sediments that would be disposed. Areas that contained critical resources were also identified. Three disposal areas within the ZSF were identified as likely to contain suitable disposal sites and were selected for further evaluation. The three areas evaluated were the Eight-Mile, the West Navigation Lane, and the Southwest Navigation Lane (SW) areas.

During Phase II, preliminary issues affecting site location, critical areas, and resources were evaluated. Additional studies were conducted and field data were collected within the three disposal areas to further evaluate environmental and other factors (such as disposal site management considerations). The West Navigation Lane disposal area was eliminated from further consideration because of its proximity to the heavily utilized crab fishery area north of Grays Harbor, the unexpected discovery of sand lance and razor clams within the lane, and evidence of episodic sediment transport. Several candidate sites were identified within the two remaining disposal areas. Phase II was considered complete when adequate data and information were available to evaluate each candidate site in view of the five general criteria and 11 specific factors (EPA ocean dumping criteria, 40 CRF, part 228).

Phase III consisted of evaluating the candidate sites and final selection of the two sites for EPA designation (Section 102) and/or Corps permitting for disposal (Section 103). Based on the five general criteria and 11 specific factors previously referenced, the environmental suitability of each site for designation/permitting was determined. Ease of site management, including physical and biological monitoring, was considered a major factor.

(1) Candidate Sites Selected. Originally a total of seven candidate sites were identified. Numerous studies were undertaken to address concerns about impacts on resources and resource use. A major concern in site selection was locating the sites to avoid high concentrations of Dungeness crab. As a result of the studies and evaluation by the Corps, the Ocean Disposal Review Board, and EPA, two preferred sites were selected to receive project sediments. Site boundaries were defined to eliminate potential impacts on resources or resource use around the sites.

(a) Southwest Navigation Lane Site. The proposed site is a parallelogram covering approximately 1.66 square miles and is located approximately 3.9 nautical miles off the entrance to Grays Harbor along the Southwest Navigation Lane (see figure EISS 2-4). During initial construction, approximately 2,250,000 c.y. of clean sand from the bar reach would be disposed at this site at depths greater than -120 feet MLLW to avoid impacting an area where high densities of small crab may occur (between -100 and -120 feet MLLW in early summer). Approximately 500,000 c.y. of clean sand from maintenance dredging of the bar would also be disposed at this site annually starting in year 5; 800,000 c.y. will be placed in year 1, decreasing through years 2, 3, and 4. Dredged material would not be placed near the edges of the site.

Site management strategies (appendix B) include buoy movement within the disposal site to disperse dredged sediments and prevent or reduce any mound development. Disposal will also be planned to avoid impacting juvenile crabs. As the juveniles are normally found between the -100- and -120-foot MLLW contours, disposal during initial construction will occur only beyond the -120-foot contour (since dredging will occur over a 3.5-month period, including the early summer when high densities of juvenile crabs might be present). Maintenance dredging will require approximately 1 month and the disposal area can be expanded to include shallower areas between -120 feet and -90 feet MLLW if monitoring results are positive.

Site monitoring (appendix B) will consist of post-disposal bathymetric surveys to determine the behavior of the disposal mound. If mounding is greater than expected, the disposal positions may have to be distributed through the disposal site differently to improve dispersal. Underwater TV sled tows and possibly trawls will be conducted to determine if there is a significant change in use of the site by crabs. The results will be used to determine if any changes in the time restrictions on disposal within the -120-foot contours are required in the future.

(b) Eight-Mile Site. The proposed Eight-Mile disposal site is a circular site located 8 nautical miles west-northwest of the harbor entrance

(see figure EISS 2-4). The site is located within a relict gravel deposit and depths range from approximately -140 to -190 feet MLLW. Sediments characterized as sandy silt and silt would be deposited at this site. Approximately 1,060,000 c.y. from the Hoquiam reach, 220,000 c.y. from the Cow Point Reach, and 913,000 c.y. from the Aberdeen Reach would be deposited at this site during the first and third years of construction. Material from maintenance dredging of these reaches would be disposed at the Port Chehalis and South Jetty open-water disposal site.

Monitoring (appendix B) at the Eight-Mile site will consist of post-disposal bathymetric surveys, side-scan sonar surveys, and sediment sampling to determine the size and shape of the disposal mound and detect any movement from the site. Results will be used to verify the accuracy of predictions concerning mounding and sediment transport.

2.6.5 Compliance with MPRSA Site Selection Criteria.

a. Five General Criteria (40 CFR 228.5).

- The two proposed ocean disposal site locations were selected to minimize the interference of disposal activities with other activities in the marine environment. The Southwest Navigation Lane site was located in the navigation lane to reduce conflicts between dredged material transport and disposal operations and commercial crab fishing operations, especially crab pot placement. Potential conflicts with navigation will be minimized by notifying ocean vessel users of dredging operations through the Notice to Mariners. The Eight-Mile site is not important for fisheries or shellfisheries because of its low productivity. Although the Eight-Mile site is not located within a navigation lane, disposal operations will still be announced through the Notice to Mariners so the site can be avoided by vessels using the open seas.

- Both of the proposed sites are located far from shore and there are no marine sanctuaries or known geographically limited fisheries or shellfisheries in the area. Temporary water quality decreases due to increased suspended solids and decreased dissolved oxygen at the sites will be localized and rapidly diluted, therefore no water quality impacts to regional sanctuaries or sensitive fisheries are expected to occur.

- The proposed sites do not fall into the category of interim approved sites. In addition, the Eight-Mile site is only proposed to be used during construction. Site management and monitoring will be conducted at the proposed Southwest Navigation Lane site, however, and if it is determined that the site does not meet the criteria outlined in MPRSA, corrective measures will be taken or use of the site will be terminated as soon as an alternative disposal site can be located.

- The size of the sites are limited to more easily localize and control any immediate adverse impacts and permit the implementation of effective monitoring and surveillance programs.

- The alternative of disposal beyond the continental shelf was evaluated and eliminated from further consideration for the reasons given in 2.6.4.a (p. 2-40).

b. Eleven Specific Factors (40 CFR 228.6).

- Geographical position, water depth, bottom topography, and distance from the coast were all considered in selecting the locations of the proposed ocean disposal sites. The effects of these factors on movement and impacts of dredged material disposed at the sites were important in their selection.

- Site locations relative to breeding, spawning, nursery, feeding, or passage areas of fish and benthic invertebrate resources also played an important role in the selection of the proposed sites. The Southwest Navigation Lane site was selected over West Navigation Lane site because of substantially reduced impacts to resources (especially Dungeness crabs, sand lance, and razor clams), less interference to navigation, and lower costs. The actual site is located beyond the -90-foot MLLW contour, with construction disposal going beyond the -120-foot contour, to avoid an area where high crab densities seasonally occur (between -100 and -120 MLLW) and where razor clams are normally located (shoreward of the -90-foot MLLW). The proposed Eight-Mile site is located within a relict gravel deposit which contains no significant benthic fish or invertebrate community (i.e., relatively low numbers of organisms, low biomass, and low taxa richness).

- Location in relation to beaches and other amenities was evaluated. Both proposed sites are far enough removed that use of the sites would not affect these amenities.

- Types and quantities of dredged material to be disposed of, and the proposed methods of release have been evaluated. Material to be deposited would not be treated in any way. Clean sand from the bar reach would be deposited at the Southwest Navigation Lane site. This material is compatible with the sediments at this site. The large quantity of sandy silts from construction would be disposed at the Eight-Mile site. While this material is not similar to the sediments present at the site, disposal in the relict gravel deposit would have substantially less impacts than disposal in more productive areas with sandy or silty sand sediments. Silty material disposed there would also be less likely to migrate towards shore or the harbor with resultant adverse ecological impacts.

- Feasibility of surveillance and monitoring were considered.

- Dispersal, horizontal transport and vertical mixing characteristics of the area, including prevailing current direction and velocity, were considered to predict the likely movement of sediment from the sites.

- As neither of the proposed sites has been previously used for disposal of dredged material, effects of previous discharges could not be evaluated.

• Potential for interference with shipping, fishing, recreation, mineral extraction, desalination, fish and shellfish culture, areas of special scientific importance and other legitimate uses of the ocean were evaluated. The southwest site was located within the navigation lane to minimize conflicts between dredged material transport and disposal and crab fishing operations. Potential interference with shipping will be minimized by informing shippers of dredging and disposal operations through the Notice to Mariners. No other uses of the ocean in the general project region would be affected by disposal at the proposed sites.

• Existing water quality and ecology of the sites was determined largely by baseline ocean surveys and other studies conducted for the Seattle District. Information from these studies/surveys was critical in selecting the proposed sites. Based on these studies, it was concluded that use of these sites would not have a significant adverse impact on water quality or the ecology of the sites.

• Potential for the development or recruitment of nuisance species was considered. The dredged material to be disposed at these sites is not known to contain any nuisance species, nor is it expected to attract nuisance species since it is very similar, both chemically and physically to sediments naturally occurring in the ocean.

• No known significant natural or cultural features of historical importance have been identified in or near the proposed disposal sites. Shipwrecks are the cultural resource most likely to occur in the project vicinity but they are found much closer to shore than the proposed sites.

2.6.6 Designation of Ocean Dredged Material Disposal Sites. Based upon the information contained in this EISS and site survey documents, formal designation of the Southwest Navigation Lane ODMDS off Grays Harbor, Washington, is considered necessary. This site will receive dredged material from the initial construction and will continue to be used into the foreseeable future for maintenance dredged material from the project's bar and entrance channels. By separate action, EPA Region 10 will pursue formal designation of this site under Section 102 of the MPRSA. Because the Eight-Mile ODMDS will be used only for initial construction, formal designation by EPA under Section 102 is not considered necessary. The Corps will identify both the Southwest Navigation Lane site and Eight-Mile site using their Section 103 authority with the concurrence of EPA. Both sites have been evaluated and their uses have been determined to comply with the five general and eleven specific criteria.

SECTION 3. AFFECTED ENVIRONMENT

3.1 Introduction. The affected environment of Grays Harbor is generally described in the FR/EIS and will not be repeated in this EISS. The reader is referred to the FR/EIS for the general description of this environment. This EISS focuses on new information related to significant environmental resources or issues investigated after the FR/EIS. Dungeness crab populations and entrainment, lingcod and other demersal fish, salmon habitat mitigation plan, sediment characterization, and ocean disposal sites.

The three resource sections are categorized as physical, biological, or socio-economic. The sections for physical and biological resources are divided into two subsections: estuary and ocean. The socioeconomic section relates to both the estuary and ocean.

3.2 Physical Environment.

3.2.1 Estuarine.

a. General Description. At low tide the Grays Harbor estuary is characterized by mudflats, which comprise 63 percent of the surface area at Mean Lower Low Water (MLLW). The mudflats, sandbars, and low islands are interspersed with a dendritic pattern of channels formed by numerous rivers and creeks as well as ebb tide discharge. The North Channel, which extends from Cow Point to the entrance of Grays Harbor, has been maintained as a navigation channel by the Corps of Engineers since 1905.

The principal routes of waterborne commerce in Grays Harbor are the Chehalis River, which contributes 80 percent of the total freshwater flow within the estuary, and the lower reach of the Hoquiam River.

Various wetlands, such as mudflats and eelgrass-vegetated shallows and shrub-scrub swamps, border much of the harbor and form a transition zone between the estuary and adjacent uplands. Surrounding Grays Harbor are forests dominated by second-growth Douglas fir, Western Red cedar, Western hemlock, and Sitka spruce.

Timber harvest, processing, and export have traditionally formed the economic base of the area. Other major sectors of the local economy include commercial and recreational fishing, fish processing, tourism, and boating.

b. Air Quality and Noise. Grays Harbor meets primary air quality standards. Ambient noise levels in the harbor vicinity are not considered to be high levels by the Environmental Protection Agency (EPA). Analysis of air quality and noise in the Grays Harbor vicinity are in the FR/EIS.

c. Sediment Characterization/Water Quality. Chemical pollutants in water and sediment have been a concern in Grays Harbor for several years, especially in the inner harbor area around Hoquiam and Aberdeen, where past and present

industrial discharges have caused degradation of water quality and possible deposition and accumulation of contaminants in the sediment. In response to these concerns, the Corps of Engineers conducted several sediment contamination studies during the feasibility study phase to determine the chemical and biological characteristics of sediment in the Grays Harbor Navigation Channel. These results suggested that open water disposal of some inner harbor material could result in sublethal chronic toxic effects. Accordingly, the EIS proposed that sediment containing unacceptable amounts of those compounds be placed in a confined disposal site. Those studies are discussed in the Section 404(b)(1) evaluation included in the combined FR/EIS (Corps of Engineers, 1982).

Following publication of the FR/EIS in 1982, further studies were conducted to evaluate potential sediment contamination. These included field or in-situ bioaccumulation tests in 1983-1984 on clams and amphipods collected from 10 "worst" sites in the inner harbor, chemical analyses of the sediments, and comparison with animal health indices from and sediment collected from reference stations in Puget Sound (Pacific Northwest Laboratory, 1986). Tests showed that concentrations of aromatic hydrocarbons and chlorinated hydrocarbons in the animals and sediment from Grays Harbor were not significantly different from those found in reference areas and nonurban areas of Puget Sound. Based on these results, a determination was made that all dredged material was suitable for open-water disposal. These issues are discussed and the most recent test data are included in the Section 404(b)(1)/Section 102(a)/103 Supplement appended to this document (appendix C).

In addition to the in-situ bioaccumulation studies, other investigations examined the relationship of suspended fecal coliform bacteria to dredging and disposal operations (Cirone-Storm, 1983). The major concern was the potential for bacterial contamination of oyster beds during disposal of dredged material at Point Chehalis. Results showed that the greatest number of fecal coliform bacteria were found in the inner harbor during peak river discharge periods (winter and spring) and, except for periodic failures of pulp and paper mill treatment facilities, the majority of the bacteria are contributed from nonpoint sources, combined sewer overflows, and outflows from sewage treatment plants. Some of these bacteria settle into the sediments and are subsequently suspended and transported during dredging operations. After disposal at Point Chehalis, the bacteria may settle out or be transported via currents. Studies at Point Chehalis showed that the proportion of bacteria contributed by disposal activities is quite low compared to other point and nonpoint sources in the bay and that disposal operations do not significantly contribute to the bacterial load.

Sediment chemistry tests were also done on sediment accumulated in the railroad bridge drawrest. Analysis focused on metals, oils and grease, total organic carbon (TOC), volatile solids (VS), and grain size (Word, 1987). The sediments consisted of approximately 50 percent sand with nearly equal portions of silt and clay, and very little gravel. Volatile solids were relatively high (approximately 13 percent), probably due to the presence of wood chip material in the sediment, as were oil and grease concentrations

(1404 ppm). Other contaminant levels were substantially lower than gu: developed by EPA for the Four-Mile Rock disposal site in Puget Sound. sediment quality analyses will be conducted prior to construction on tl material inside the drawrest. If the sediment is suitable for open-wat disposal, it will be disposed at the 8-mile disposal site. If the sediment is not suitable for open-water disposal, it will be disposed in the Slip 1 confined disposal site. If necessary, special oil slick collection systems will be used when sediment is removed from the drawrest to prevent any oil residues from spreading.

d. Disposal Sites.

(1) Confined.

(a) Slip 1. Slip 1 is an abandoned terminal slip owned by the Port of Grays Harbor. The slip is 28.0 acres in size and is located on the north side of the Chehalis River in the port industrial area in Aberdeen. Access to the site is from the Port Industrial Road, the main access through the port area, and from the adjoining industrial areas, which have been developed primarily for log export operations by the Port. Frye Creek used to flow into the upper end of Slip 1. As part of the Grays Harbor Navigation Improvement Project, the Port has already diked the Slip 1 area and diverted Frye Creek around the disposal area. Prior to diking, this area had a maximum depth of -30 feet with a mean depth of -10 feet. Salinity was lowered by freshwater inflows from Frye Creek. The sediments have been characterized as medium fine sediment. Disposal has been permitted under Section 10/404 evaluation procedures (Public Notice No. 071-0YB-2-008671).

(b) Commerce Street. The Commerce Street confined disposal area is an 11.5-acre site owned by the Port of Grays Harbor. The diked area is on industrial land located inland from the Chehalis River at the Port Industrial Road and Commerce Street and adjacent to the Burlington Northern Railroad. The area has been used previously by the Port to stockpile gravel dredged from the channel. There will be no change in the condition of the Commerce Street site before and after the dredging project.

(2) Open-Water.

(a) Point Chehalis. This site is generally below -50 feet MLLW and consists of subtidal estuarine habitat. It is a high energy area with predominantly westward currents. The bottom type is irregular with areas of high relief, and consists of fine- to medium-sized sand grains of marine origin. A portion of the proposed disposal area, a 900-foot diameter circle, is currently a designated disposal site; designation for the expanded area (a 2,000-foot by 5,000-foot rectangle) will be coordinated with Washington Department of Natural Resources (DNR).

(b) South Jetty. This site is adjacent to the exposed portion of the South Jetty and is also subtidal estuarine habitat below -50 feet MLLW. Bottom type is predominantly cobble and shell substrate. It is in a moderate to high current area with net flow at the bottom out of the estuary. The proposed site would be a 800-foot by 1,500-foot rectangle. Designation of this disposal site will also be coordinated with DNR.

3.2.2 Ocean.

a. General Description.

(1) Climate and Ocean Current Conditions Offshore of Grays Harbor. The summer atmospheric condition is characterized by a relatively constant high pressure system over the East Pacific, whereas during winter, a series of eastward moving lows results in a mean low-pressure cell over the Gulf of Alaska. As a result, the California current (one of the two Pacific Ocean current systems north of the tropics; the other is the Alaska current) originates further to the north during summer than winter. The summer atmospheric condition results in predominantly northerly coastal winds, while winter conditions result in southwesterly winds of relatively larger magnitude. Winds from the north during summer result in offshore drift of surface waters due to the Coriolis effect. A depression of the water surface occurs near the coast which results in upwelling, whereby relatively dense and cold bottom waters are brought onshore and to the surface in the pycnocline. Mean surface currents are southward with an onshore component. Winds from the southwest during winter cause a pileup of water next to the coast due to the Coriolis effect, which results in a northward flowing current with an offshore component near the sea bottom in deeper water (40-50 m depth) due to the effects of surface waves. Toward the end of the winter season, the southerly winds decrease and the southward-flowing California current becomes increasingly influential. The spring transition to a southward surface flow can typically be reestablished by the first strong northerly wind event lasting more than 2 days, followed by a redevelopment of the summer upwelling condition as northerly winds are reestablished. Net overall flow and sediment movement is to the north.

(2) Air Quality and Noise. See paragraph 3.2.1b.

(3) Sediment Quality at Ocean Disposal Areas. Neither of the proposed ocean disposal areas have been used for disposal of dredged material. Analysis for contaminants at the ocean disposal areas revealed little or no elevation of contaminant levels above expected background levels (Pearson et al., 1987). The sedimentary concentrations of metals generally reflected crustal abun- dances. In the box core samples within the proposed sites, sulfides, poly- chlorinated biphenyls (PCBs), and chlorinated pesticides were not detected, and only traces of polyaromatic hydrocarbons (PAHs) were observed. Sulfide odor was detected at only one station, at the nearshore end of the Southwest Navigation Lane. Analysis of that box core sample showed a sulfide level of 57 parts per million (ppm). The source of the sulfide odor appeared to be clumps of decaying vegetation among hard-packed sand. Offshore sediments were generally observed to lack the high sulfide levels that characterize the muddy estuarine sediments inside Grays Harbor.

b. Ocean Disposal Zones/Sites. During the ocean disposal site selection process, zones of siting feasibility (ZSF) were identified first and then the best site within that ZSF was selected based on the results of further studies. The selected candidates sites are proposed for designation. Information collected during the ocean surveys (Pearson et al., 1987) pertaining to both the ZSF's and proposed sites is presented below.

(1) Southwest Navigation Lane ZSF. The sediment in the Southwest Navigation Lane ZSF consists generally of very fine sand (23-69 percent) with some fine sand (10-73 percent) and coarse silt (1-13 percent) (Pearson et al., 1987). Gravelly bottoms and rock outcroppings are not present in the Southwest Navigation Lane ZSF. The silt and clay content of the sand in the Southwest Navigation Lane increases with depth from an average of 3 percent at depths less than -80 feet MLLW to a peak of 13 percent between -120 and -140 feet MLLW, and then falls slightly to an average of 9 percent beyond -140 feet. The silt and clay content at the shallower depths may be higher during spring than fall. Beyond the -120-foot contour, the silt and clay content appears to have less seasonal variation than at shallower depths. The TOC and water content increases with silt and clay content and averages 0.28 percent and 38.4 percent, respectively. Sedimentary levels of metal and organic contaminants show little or no elevation above background.

The hydrographic structure of the western (deeper) end of the Southwest Navigation Lane is comparable to that at the Eight-Mile area, whereas the hydrographic structure in the shallower portions of the Southwest Navigation Lane is more complex since it is influenced by the tidal jet from Grays Harbor. The water column is stratified from spring through fall with the thermocline deeper in the spring. In general, the bottom water temperature and salinity closely match those recorded by Conomos et al. (1972) for the Subsurface Oceanic Water (8 degrees C and 33.4 $^{o}/oo$ salinity); however, the surface water readings differed slightly from those given by Conomos for surface oceanic water. Dissolved oxygen (DO) content of bottom water is low during spring and fall stratification. This hydrographic structure breaks down in October and November with the onset of seasonal gales.

Depth profiles of light transmission showed subsurface minimum levels of light transmission; this may be attributable to suspended material carried out of Grays Harbor by the tidal jet which accumulates at the thermocline during settling (Pearson et al., 1987). Near-bottom turbidity layers are also present.

The bottom of the selected candidate Southwest site is composed primarily of very fine marine sands with a silt and clay content slightly more than 10 percent. The hydrographic features of the site are typical of the region, with a stratified water column and bottom water containing low DO from late spring through early fall. Near-bottom turbidity layers are also common at the site.

(2) Eight-Mile ZSF. The Eight-Mile ZSF consists of a relict gravel deposit surrounded by sandy bottom (Pearson et al., 1987). Within the deposit, the bottom is uniform rather than a mixture of types and has conspicuous wave forms running north and south. The sediment is predominantly gravel (42-87 percent) with coarse sand (12-53 percent). The peaks of the wave forms contain sand and the troughs gravel. Sandy bottom surrounds the gravel deposit, and projections or fingers of sand extend over the gravel into the deposit. The sediment around the deposit is composed of predominantly fine marine sand (74-98 percent) with about 10 percent silt and clay content. The average TOC

and water content values of the sandy sediments at the Eight-Mile area are 0.22 percent and 27.5 percent, respectively. Underwater TV observations and comparisions to previous benthic mapping surveys indicate that the positions of the sandy fingers are stable (Williamson and Associates, 1984 and Pearson et al., 1987).

The water column at the Eight-Mile ZSF is stratified during both spring and fall, with a deeper thermocline in the spring. The bottom water mass contains low amounts of dissolved oxygen in the spring and fall. The surface and bottom water characteristics are typical of those reported in other studies (Conomos et al. 1972). The water column showed lower levels of turbidity than the other areas nearer shore, and no near bottom turbidity layers were observed over gravelly bottoms.

The selected candidate Eight-Mile site is contained within a portion of the relict gravel deposit west-northwest of Grays Harbor. Depth at the site is -150 feet MLLW. The site does not contain any of the sandy projections found in the ZSF and sediment type is uniformly gravel. The hydrographic features appear typical of the general coastal region and include a stratified water column and low levels of dissolved oxygen in bottom water from late spring through early fall.

3.3 Biological Environment.

3.3.1 Estuarine. The following discussion is based on new information obtained since publication of the FR/EIS, during the PED phase of project planning. For a general description of the Grays Harbor aquatic environment, refer to the EIS.

a. Dungeness Crabs.

(1) Summary and History of Coastal Dungeness Crab Fishery. Dungeness crab (*Cancer magister*) constitute one of the largest crustacean fisheries, in pounds landed, on the western coast of the United States. In Washington State, the 1987 wholesale dollar value of Dungeness crab was about $7.0 million, compared to $9.6 million for shrimp. The majority of crab landings for the State are made in coastal ports, with Westport, in Grays Harbor, the major receiving port.

Coastal Dungeness crab landings have fluctuated widely over the last 30 years and exhibit a cyclic pattern of high-low abundance occuring about every 9-10 years. Total poundage for the Washington State coastal crab fishery has ranged from a high of 18.4 million pounds in 1968-69 to a low of 2.5 million pounds in 1981. Although landings for the 1988 season suggest that it may be a record year, perhaps as high as 20 million pounds, landings for the previous 6 years (1982-1987) have been very low, with an average of 5.4 million pounds landed annually at a value of approximately $4.6 million per year, and there has been concern about the future of the fishery. The causes for the decline prior to 1988 are unknown; hypotheses include changes in temperature as a result of El Nino, overfishing, and dredging activities. Therefore, crab fishers in the Grays Harbor area are apprehensive about potential impacts to the crab resource which may occur from project construction.

The majority of the coastal Dungeness crab fishery is located nearshore in relatively shallow water (less than 65 fathoms) between Point Grenville and the Columbia River (Barry, 1985). The Washington State Department of Fisheries is responsible for managing the Dungeness crab resource in this state.

Since the early 1970s the crab fishing season has been set as December 1 through September 15, with a 15-day extension when conditions warrant. The season is closed in the fall to minimize mortalities to molting male crabs (i.e., "soft-shells") and to lessen the harvest of crabs which are in poor condition (newly molted crabs do not contain as much meat).

Basic regulations for the fishery include a minimum carapace width of 6-1/4 inches (160 mm) and a provision that traps must have two circular 4-1/4-inch diameter escape ports. Only male crabs may be harvested. There are no "limited entry" restrictions on licenses, vessels, or the amount of gear in the coastal fishery.

The major concern expressed by crabbers is entrainment of crabs by dredges, with associated mortality, the amount of which varies according to the type of dredge used. Another potential problem posed was the "souring" of crab pots due to disposal of dredged material and the inability of crabs to perceive bait due to interference with their chemoreceptive organs. Studies were conducted to address all of these concerns to the extent possible and results are presented in section 4.3.1.

(2) Summary of Dungeness Crab Life History. Extensive review of the literature on Dungeness crab that pertain primarily to population dynamics in Grays Harbor and along the southern Washington coast have been provided by Stevens and Armstrong (1984, 1985), Armstrong and Gunderson (1985), and Armstrong et al. (1984, 1985, 1986). The following is a brief synopsis of those reviews.

Dungeness crab are found nearshore along the open coast and in estuaries from central California through southeastern Alaska. Mature crab and all reproductive events occur along the open coast and there is no evidence of reproductive activities in estuaries.

Females usually molt to maturity in the nearshore (figure EISS 3-1) during the spring, where they are inseminated by males. They carry the sperm for about 6 months and extrude an egg mass the following fall, which is carried on the abdomen of the female for approximately 3 months of embryonic development. Larvae hatch in the winter, between December and February and progress through five larval stages called zoeae as plankton in the water column. The next molt produces a pelagic stage called a megalopa, which returns onshore either by swimming and/or by favorable current regimes.

Megalopae may then enter the Grays Harbor estuary or remain in the nearshore area to settle to the bottom and metamorphose into juvenile crabs. The extremely high abundances of megalopae (juvenile crab) observed in Grays Harbor at various times indicate the importance of estuaries such as Grays Harbor to the development of juvenile crabs. Growth of young-of-the-year crabs (YOY) in the estuary is substantially faster than nearshore.

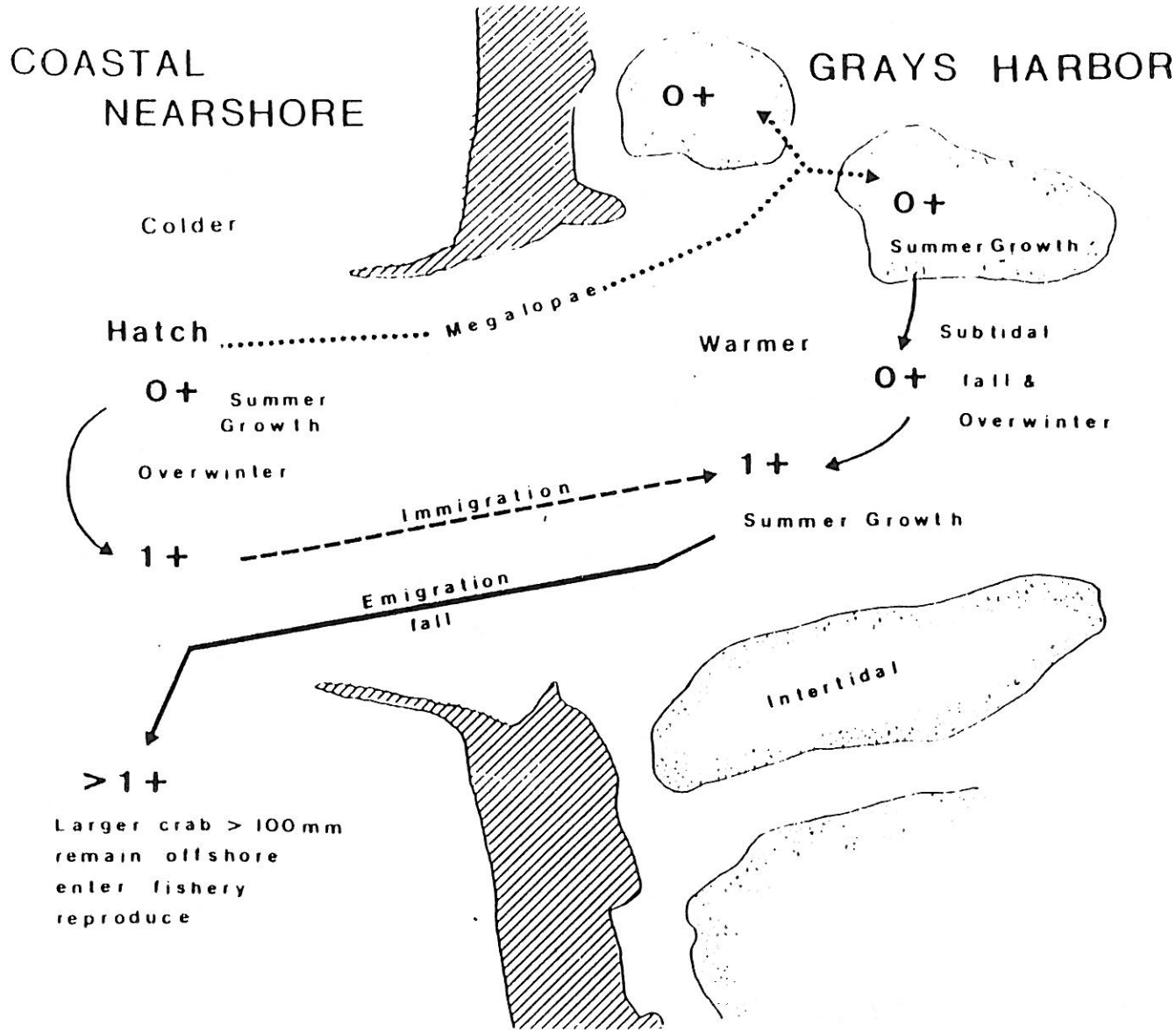


Figure EISS 3-1. Schematic showing generalized movements of juvenile Dungeness crabs to and from Grays Harbor and the nearshore environment.

Juvenile crabs which settle in the estuary remain there until the following summer when most migrate as 1+ crabs out of the estuary to the nearshore area. The YOY or 0+ crab enter the estuary in the spring and survive best on intertidal flats in shell habitat. During late summer (or earlier, depending on size) the 0+ crab leave the intertidal and move to adjacent subtidal channels where they overwinter and their growth rate decreases. Toward the end of the second summer, or as crab reach sizes near or greater than 100 mm in carapace width, they emigrate from the estuary. Females approximately 100 mm will molt and breed the following spring in the nearshore area (as 2+ crab); males larger than approximately 110-120 mm will remain in nearshore coastal waters but may migrate into the outer portions of the estuary later.

Both male and female crabs reach sexual maturity at about two years of age although males may not breed until age 3 or older. A large proportion of the nearshore 1+ crab migrate into the estuary in early summer, joining the resident 1+ population, and return offshore in late summer or early fall.

(3) Dungeness Crab Population Studies (1983-1986). Much of the data on Dungeness crab populations in Grays Harbor estuary and adjacent nearshore waters are from a program sponsored by Washington Sea Grant from 1983 through 1986 (Armstrong and Gunderson 1985; Armstrong et al. 1984, 1985, and 1986), and from Corps of Engineers sponsored studies from 1984 through 1986.

Estimates of crab population abundance in the subtidal portion of the estuary and in nearshore areas were based on samples collected with a plumb staff beam trawl (Gunderson et al, 1985). Subtidal estuarine stations were established according to a randomized survey design which divided the estuary into four strata. Nearshore stations were established from Leadbetter Point off Willapa Bay northward to Copalis Beach along three transect lines which extended from shore to a depth of 73 m (two additional transect lines were added for Corps studies from 1984 to 1986).

The Corps of Engineers sponsored a program of intertidal surveys which were conducted through the summer from 1985 through 1987. These samples augmented the Sea Grant data. Nearshore sampling efforts were also funded by the Corps in September 1984, August 1986, and August 1987.

(a) Subtidal Estuary. Total estimates of crab abundance (all strata combined) show high variability over the 4-year sampling period (figure EISS 3-2). Most notable features are: (1) an increase in abundance from mid-spring through early summer in some years; (2) high initial recruitment of YOY or 0+ crab followed by rapid mortality and decline of the population; and (3) an apparent decline in population abundance toward the end of summer through fall in several years (e.g., 1983, 1985, 1986). Comparison of abundance of 0+ and 1+ crabs showed that much of the total resident subtidal crab population in Grays Harbor during summer months is composed of 1+ crabs. Abundance of 1+ crabs was higher in 1983 (range = 8 to 13 million), and relatively low in 1984 through 1986 (approximately 5 million crabs). Additionally, the estimated population of 1+ crabs in Grays Harbor was greater than in nearshore areas for all years except 1985, which emphasizes the importance of the estuary for young juvenile crabs during the second summer following metamorphosis.

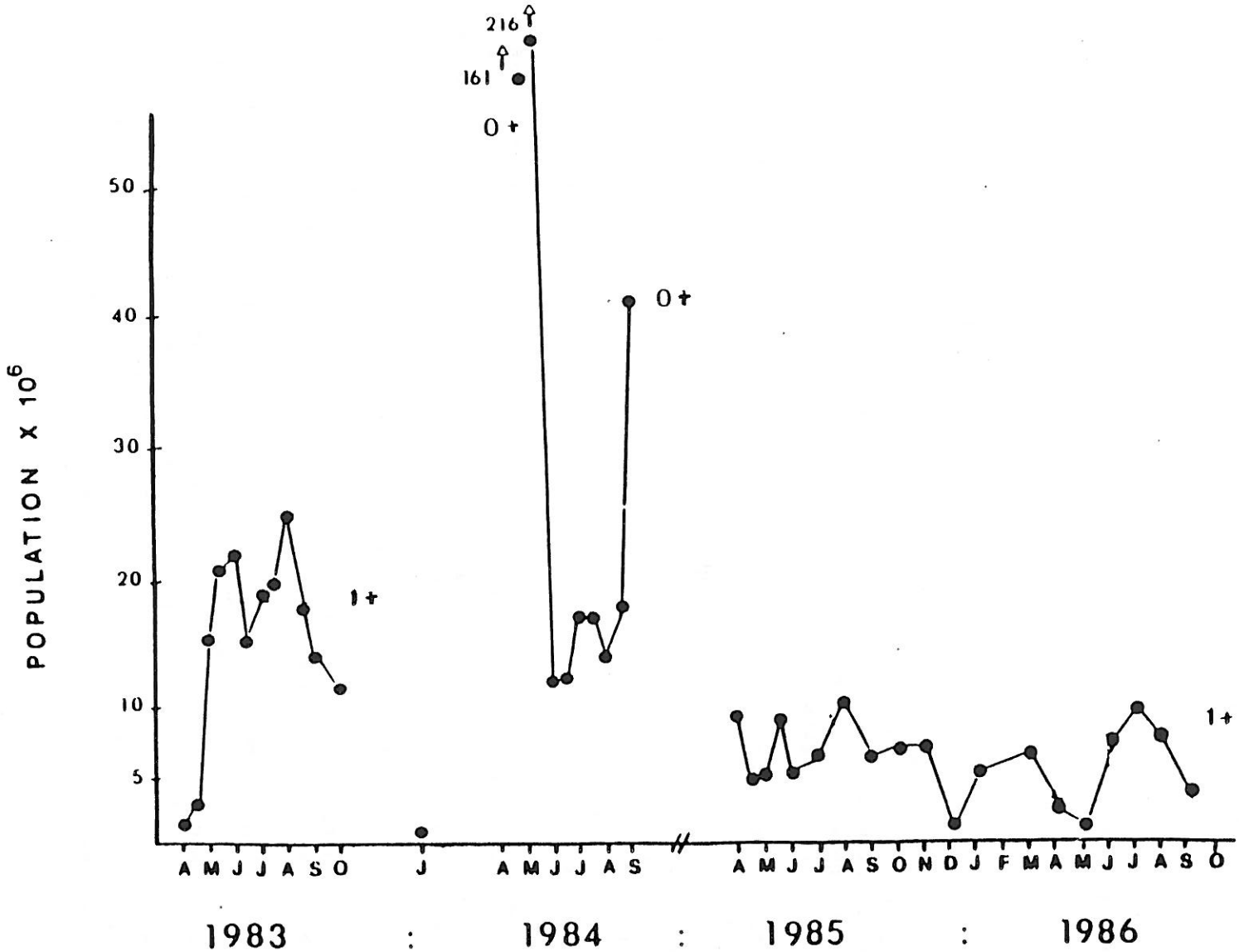


Figure EISS 3-2. Trend in estimated total population abundance of Dungeness crab in Grays Harbor. Age classes that dominate the population are shown at points throughout the year.

(b) Intertidal Estuary. The intertidal crab population comprises an important portion of the total estuarine population. It is composed almost entirely of 0+ crab that settle there directly from the megalops stage and apparently survive in high densities within certain types of benthic refuge, notably empty bivalve shells ("shellhash"). Surveys over 4 years show that settlement and relative year class strength can be quite variable and initially very high (figure EISS 3-3).

In May, when 0+ crab settle to the bottom, density can range from 3 to 300 crabs/m^2, equating to population estimates between 300 million and one billion 0+ crabs in Grays Harbor intertidal areas. However, the mortality rate is extremely high for 0+ crabs (approximately 94-97 percent) during the first year, and the summer (June through September) densities range from 20 to 40 crabs/m^2. The population level of 0+ crab in the subtidal is about an order of magnitude lower than that of the intertidal area during most of the summer; by the end of the summer, however, both areas have similar population levels, indicating a migration of the small crabs from the intertidal flats to the subtidal area.

(c) Nearshore. Assessments of nearshore crab populations from 1983 through 1986 indicate tremendous variability in settlement and survival of 0+ crab, which comprise about 99 percent of the population. Populations are often low in spring and increase rapidly from May to June, as megalopae metamorphose and settle to the bottom. As with the estuarine cohort, the nearshore population of 0+ crab experiences substantial mortality, and numbers are significantly reduced by September.

There is good evidence of migration of older crabs (1+ and older) to and from estuarine and nearshore areas. Since the average sizes of nearshore and estuarine crabs are different for the first 2 years of life (nearshore crabs are smaller), it is possible to discriminate between the two groups when a migratory event occurs. Migration has been detected by the recurrence of two phenomena: (1) crabs smaller than expected appear suddenly in estuarine samples during summer months; and (2) crabs larger than expected appear in nearshore samples in mid and late summer, indicating emigration of older crabs from the estuary to the nearshore area. Most of the 1+ crabs obtained in the estuary during the summers of 1984 and 1986 were of nearshore origin, and about 50 percent of those sampled in 1983 and 1985.

Mixing of nearshore and estuarine YOY crabs may begin as early as October in areas close to the mouth of the estuary. This "nearshore wave" was detectable in the estuarine samples at varying times from June to August during the 4-year study.

b. Demersal Fish.

(1) Lingcod. Potential impacts to lingcod (*Ophiodon elongatus*) were addressed as a major concern at interagency scoping meetings. Hence, lingcod studies were conducted during the PED phase of the project. Studies included a literature review and annotated bibliography of Grays Harbor juvenile

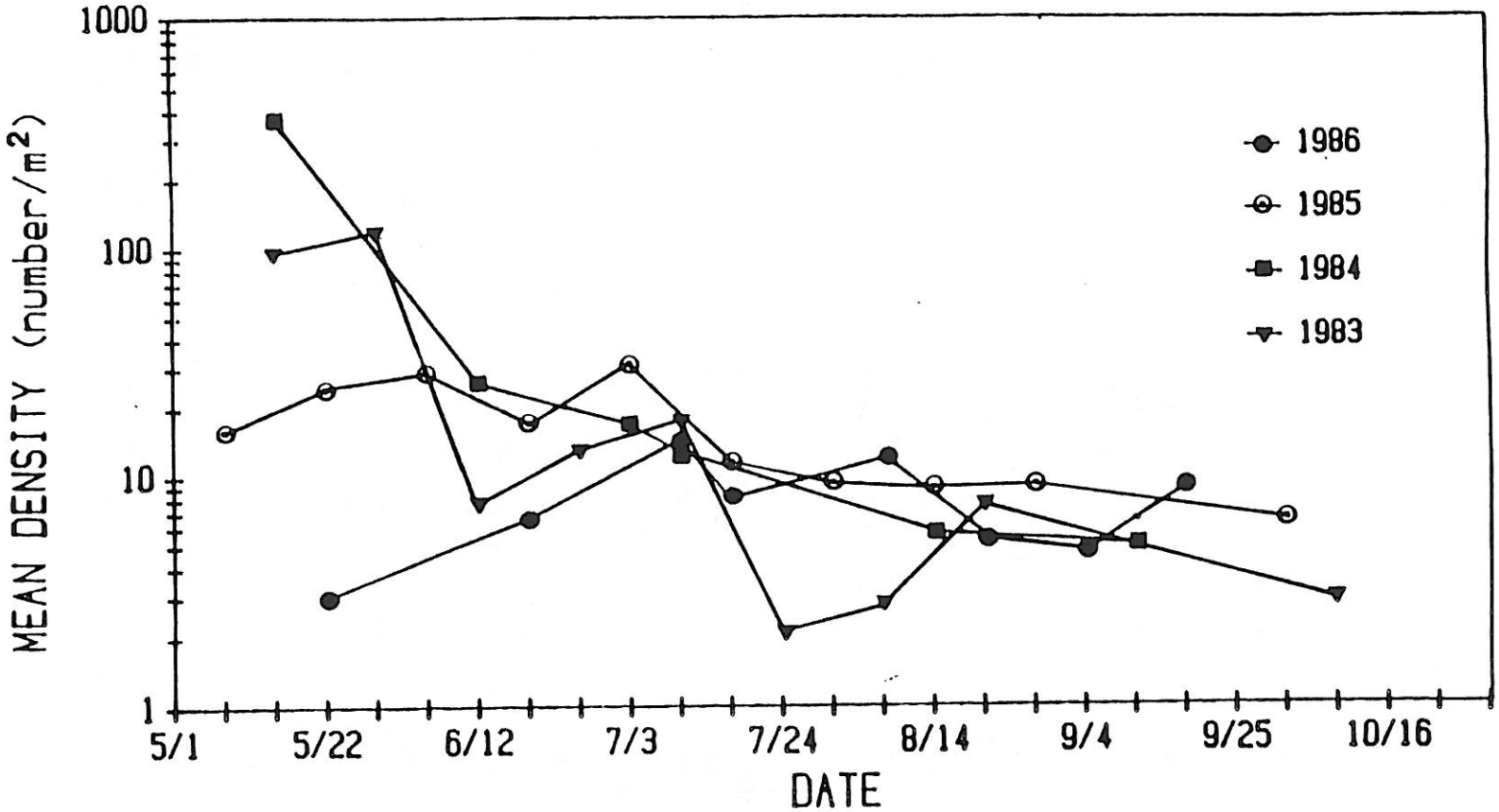


Figure EISS 3-3. Seasonal density of 0+ Dungeness crab in the intertidal area of Grays Harbor, 1983-1986. (Note logarithmic scale).

lingcod and flatfish population data (Day, et al., 1986), and two field surveys for lingcod in Grays Harbor (Coley et al., 1986; Tagart and Short, 1987).

Grays Harbor is believed to be an important nursery ground for juvenile lingcod. Adult lingcod spawn in nearshore rocky areas in water depths from 3 to 30 meters. Spawning usually occurs from late November through April, peaking in January. The incubation period is about 6 weeks. In late February and early March, newly hatched lingcod are generally found in nearshore areas, particularly in the upper 3 meters of lower salinity runoff plumes. The larvae then swim against the current and direct themselves toward the shore, where abundance peaks in late May and early June. In mid to late June, the larvae settle to the bottom in shallow nearshore bottoms of sand, shell and eelgrass in areas of abundant food. These areas generally are associated with freshwater runoff and lower salinities. After settling, abundances fluctuate among areas within Grays Harbor for the rest of the summer months. In the fall the juvenile fish move to deeper water and utilize rock habitats after the age of 1 year.

Despite these previous findings, however, no lingcod were caught by Tagart and Short (1987) during their 5-month (May through September) field study, and Coley et al. (1986) caught only 15 juvenile lingcod from 1 through 9 October 1985. All lingcod caught were young of the year, and were caught inside Grays Harbor in shell/cobble habitat off of Damon Point and Whitcomb Flats.

The consistent absence of lingcod in samples may have been due to sampling gear inefficiency. Lingcod are very fast-growing, mobile epibenthic fish and may be able to escape or avoid a trawling net, whereas buried and slower moving epibenthic fish are caught. Another hypothesis is that there was a year-class failure which resulted in extremely low densities of lingcod.

Armstrong et al. (1982) estimated rates of entrainment for lingcod and four flatfish species in Grays Harbor. Estimated entrainment values for lingcod were .002 fish/cubic yard at South Reach, and 0 fish/cubic yard at Crossover, North Channel, and Cow Point. No size or mortality information was given for entrained fish. In addition, no lingcod were ever observed during intensive entrainment sampling in October 1985, August 1986, and August 1987 (McGraw, 1989). These low entrainment estimates and observations might be primarily due to the high mobility of lingcod (Day et al., 1986) and the preferred habitat of young-of-the-year (shallow-water, shell/cobble substrate).

(2) Flatfish. Data on flatfish species were also collected in the three (two field and one literature search) lingcod studies conducted during PED. English sole (*Parophrys vetulus*) was the most abundant species in both field studies. Other abundant species were speckled sanddab (*Citharichthys stigmaeus*), butter sole (*Isopsetta isolepis*), and sand sole (*Psottichthys melanostictus*). Due to the commercial importance of the English sole, and large numbers caught during these studies, the discussion will focus only on this species.

In their study, Coley et al. (1986) observed English sole densities ranging from 0 fish/ha to 3478 fish/ha; abundances were higher on the outer bar, North Bay, and South Reach. Lower densities were obtained at Point Chehalis and along the coast north and south of the harbor entrance. Tagart and Short (1987) found that English sole constituted approximately 88 percent of all fish caught in their study and that abundance varied with depth, tidal stage, and season. English sole were found at all depths sampled, but were less abundant in deeper waters. Highest densities were found on the south side of the existing channel and abundances were greater at high tide than at low tide at all sampling stations. Fewer English sole were caught in late summer and fall. These tidal and seasonal changes in abundance corroborate earlier studies conducted in Grays Harbor (for a detailed discussion refer to Day et al., 1986).

Armstrong et al. (1982) estimated entrainment rates for English sole in Grays Harbor to be 0.035 fish/cubic yard at South Reach and no entrainment at Crossover, North Channel and Cow Point. While keeping in mind that these estimates are based on limited data, and by no means conclusive, one may attribute these low entrainment rates to the ability of the fish to swim away before becoming entrained (Day et al., 1986).

(3) Sturgeon. Both green (*Acipenser medirostris*) and white (*A. transmontanus*) sturgeon are anadromous, long-lived (white sturgeon mature when they are between 11 and 34 years old), bottom feeding fish. Adult sturgeon prefer deep water; juveniles can be found in both deep and shallow water. Within the Grays Harbor system, green sturgeon are found predominantly in estuarine and marine waters; and white sturgeon are found almost exclusively in freshwater, particularly in the Chehalis River. Little information is currently available on sturgeon populations in Grays Harbor and the Chehalis River. Tagging studies conducted by Washington Department of Fisheries indicate that sturgeon in Grays Harbor and Chehalis River are Columbia River brood stock that have migrated to this area, most likely for food (Randy Mackintosh, WDF, personal communication). Currently there is no evidence of sturgeon spawning grounds in the Chehalis River, but more fieldwork needs to be done before any conclusive statements can be made about their abundance.

c. Salmon. The estuarine habitat of Grays Harbor is crucial to the six species of salmon found there. A detailed report on salmonid utilization of Grays Harbor and the Chehalis River is given in the 1982 FEIS.

d. Oysters. The introduction of Pacific oysters, *Crassostrea gigas*, into Grays Harbor by the oyster industry has resulted in the presence of approximately 392 hectares of shell and live oysters on State and privately owned land. The location and extent of these areas change periodically as oysters are harvested, new seed is planted, and ground becomes unsuitable for culture.

The typical type of oyster culture employed in Grays Harbor is bottom culture (about 80 percent). Stake and rope culture, both off-bottom methods of oyster culture, constitute the remaining 20 percent. Growth rates vary according to

location, but Grays Harbor oysters generally reach market size in 2 to 2-1/2 years. Harvesting occurs in the spring and early summer, with yields of about 1,000 gallons of oysters per acre of cultivation.

Oyster growers in Grays Harbor have expressed concern that the project will allow larger ocean swells and stronger currents to penetrate the inner harbor, resulting in increased wave action and scour on Whitcomb Flats and the erosion of the middle portion of that sand barrier. This would cause their oyster beds south of Whitcomb Flats to become exposed to wave action and subsequently sanded in, rendering them unsuitable for growing oysters.

e. Endangered Species. Within the estuary, bald eagles, peregrine falcons, brown pelicans, and gray whales are the only listed species sighted regularly. The bald eagle, a threatened species, nests in the forests along the shorelines of Grays Harbor. Only four nests are known in the vicinity of the estuary. Feeding behavior of these birds in Grays Harbor is not well understood, but it is assumed they feed on waterfowl and surface-swimming fish. Up to 10 bald eagles also winter in the vicinity of the estuary. Peregrine falcons are not known to nest in the immediate vicinity of Grays Harbor, although at least one eyrie is known on the coast, several miles north of the estuary. Peregrines make heaviest use of Grays Harbor during the spring shorebird migration, when they prey on the hundreds of thousands of shorebirds that concentrate at Bowerman Basin. Peregrine falcons have also been observed along the south shore of Grays Harbor, Westport, Ocean Shores, and Pt. New. Peregrines are also sighted during fall and winter, also feeding primarily on shorebirds. Brown pelicans are only observed during late summer and fall, when juveniles (and rarely and adult) wander from their southern California nesting areas. Usually the birds arrive in discrete flocks of about 10 birds and generally stay only a week or two. Gray whales annually migrate along the coast; in February and March they move north toward Alaskan waters, then in September and October they return southward to the Mexican calving waters. Some whales have remained through the summer near Neah Bay (Calombokidis et al., 1986) and may remain elsewhere along the coast. They feed sparingly while in Washington waters, and occasionally enter the Grays Harbor estuary.

f. Disposal Sites.

(1) Slip 1 Confined. This site has been continually disturbed for a number of years and has been diked off from the harbor since 1984. As a result, it has a depauperate biological community.

(2) Commerce Street Confined. Disturbance due to industrialization has resulted in this site having a limited biological community.

(3) Open-Water Point Chehalis and South Jetty. The Point Chehalis and South Jetty sites are both located in subtidal estuarine habitats (-50 ft. MLLW) in a high-energy area. The sites are periodically disturbed by storm generated waves, turbulence from ship propellers, and swells. The biological community that exists at these sites consists of invertebrate and fish adapted to this particular type of environment. More detailed information is found in the FR/EIS, the Grays Harbor Dredging Effects Study (GHDES) (U.S. Army Corps of Engineers, 1976), and Albright and Bouthilette (1982).

3.3.2 Ocean. The discussion of fish, coastal and sea birds, marine mammals, and endangered species is given for the general offshore area of Grays Harbor containing the proposed ocean disposal sites. Benthic infauna and epifauna are described for each site since these features vary considerably more between sites and are most likely to be affected by dredged material disposal.

a. Fish. The most abundant species of demersal fish off the Washington coast are English sole, sanddabs, rex sole (*Glyptocephalus zachirus*), and Pacific hake (*Merluccius productus*). Other important species include Dover sole (*Microstomus pacificus*), petrale sole (*Eopsetta jordani*), rockfish species (*Sebastes* spp.), skates (*Raja* spp.), and lingcod. Economically and recreationally important nonanadromous fishes inhabiting the area are Pacific herring (*Clupea harengus*), northern anchovy (*Engraulis mordax*), and four species of surfperch. Anadromous fish found in the area include salmon (pink, chum, coho, sockeye and chinook); and trout (steelhead, cutthroat and dolly varden), American shad, white and green sturgeon, eulachon, and Pacific lamprey.

b. Coastal and Sea Birds. Marine birds use the ocean areas along the shore and off the coast (Shapiro and Associates, 1986). The nearshore area, from extreme high water to 10 fathoms, is relatively small, and large populations of birds use it throughout the year. Many of the species using the nearshore habitat prey on benthic organisms such as bottom fish and invertebrates. During the fall migration season, thousands of shearwaters use the nearshore area. Common murres inhabit the area during fall and winter. Heermann's gulls are abundant in the Grays Harbor area. Caspian terns, which nest on the channel islands, forage in the channel and nearshore areas to feed their young.

The area from 10 to 30 fathoms is termed the inner shelf and is a major migration area for most mobile marine species, including marine birds such as loons, shearwaters, cormorants, waterfowl, gulls, terns, and alcids. High numbers of birds are present during the fall and spring migrations, with the largest populations occurring in the fall due to the additional presence of juveniles. The area is especially important to phalaropes as evidenced by localized foraging activity during the spring migration. The inner shelf is also important for common murres during all seasons and for shearwaters in the spring and fall.

The beach area extending 2.5 miles from the north jetty is an important roosting area for shorebirds and gulls in winter and during fall and spring migrations. This stretch of beach was opened to motor vehicles in 1981, and traffic may be disturbing the birds. This area is also used by thousands of sanderlings and dunlin which forage along the beach in the intertidal zone during the spring and fall migrations. Gulls, often in large numbers, also forage along the beach. Grays Harbor is host to more shorebirds during the spring migration, mid-April to late May, than any other estuary on the Pacific coast south of Alaska. Many of these birds move between the inner harbor marshes and mudflats and the outer beaches during this period. Approximately 1 million shorebirds of at least 25 species migrate along the coast and into the harbor. The most abundant species are western sandpiper, dunlin, and long-billed dowitchers, and red knots.

c. Marine Mammals. Several species of marine mammals occur in the coastal waters off Grays Harbor (Shapiro and Associates, 1986). Of these, the harbor seal, California sea lion, and northern sea lion are the most abundant and important of the pinniped species. The gray whale, which is seasonally abundant during its annual migration, and the harbor porpoise are the most frequently sighted cetacean species.

Harbor seals feed in the study area all year and migrate north and south between the Columbia River and Grays Harbor. Grays Harbor is also a major pupping area for harbor seals with a peak population of adults and pups of about 3,700 animals in June. Sea lions also migrate both north and south in the nearshore and inner shelf habitats of the coast. The area is also important for harbor porpoise and killer whale. Harbor porpoise occur throughout the area in all seasons. These porpoises occasionally are sighted within Grays Harbor.

d. Endangered Species. The gray whale, federally listed as endangered, is a pelagic species which migrates within a few miles of shore and occasionally strays into Grays Harbor. Populations in the eastern North Pacific were estimated in 1980 at 15,647 animals. The peak of the northward migration occurs between early March and early May. The southward migration peaks in late December. Dead gray whales are occasionally found on Washington coastal beaches and estuaries; some of these have been found in the Grays Harbor area. Gray whales are known to feed in the area, especially from May through November; feeding is reduced or nonexistent during the southward migration. Amphipods, the main food source, are obtained by feeding on the bottom in shallow water. Other cetaceans federally listed as endangered which are known to migrate off of Grays Harbor include the sei, blue, humpback, right, sperm, and fin whales. Leatherback sea turtle, bald eagle, peregrine falcon, and brown pelican are the other listed species found near Grays Harbor. They are addressed in detail in appendix D which includes biological assessments of the potential impacts to these species.

e. Disposal Sites.

(1) Southwest Navigation Lane ZSF. Surveys of the proposed ocean disposal sites were conducted in the fall of 1984 and the spring and fall of 1985 (Pearson et al., 1987b). The infauna of the SW Navigation Lane ZSF were sampled at selected station during all three surveys. Infaunal biomass averaged 10.4g ash-free dry weight per m^2 over all surveys and, where followed at one station, increased progressively through the three surveys. In the SW Navigation Lane, numbers and taxa richness over all surveys averaged 6.06 X 10^4 individuals and 219 taxa per m^2. The tube-building polychaete, *Owenia fusiformis*, was by far the most abundant taxon at all stations in all surveys in the SW Navigation Lane. The small offshore species of razor clam, *S. sloati*, occurred in densities of 0 to 408.7 clam per m^2 in the SW Navigation Lane during the spring 1985 survey. The presumed morphological variant of the intertidal and subtidal razor clam, *Siliqua patula*, was found in still lesser numbers (2.2 clam/m^2) at one station from the east end of the SW Navigation Lane.

The epifauna in the SW Navigation Lane averaged 32.1 kg/ha over the three surveys. Dungeness crab were the major component of the epifauna during the fall 1984 and spring 1985 surveys but not the fall 1985 survey. Round fish and flatfish dominated the macroepifauna during the fall 1985 survey.

The salient biological feature of the Southwest Navigation Lane was the high density of juvenile crabs found in a limited portion of the lane during the spring 1985 survey. Juvenile crab averaged 90 percent of the total number of Dungeness crab in the SW Navigation lane, and the average juvenile crab density in the lane rose from 2,502 crab/ha during the fall 1984 survey to 30,086 crab/ha during the spring 1985 survey and then fell to 283 crab/ha during the fall 1985 survey. Juvenile crab densities averaged over 400,000 crab/ha at stations between 100 and 120 feet deep in the northern portion of the lane, whereas average juvenile crab densities in other portions ranged from 165 to 19,800 crab/ha. During the fall 1985 survey, this northern portion of the SW Navigation Lane had juvenile crab densities of about 10 crab/ha. This region of the SW Navigation Lane may be settling ground or passage area, but its significance to the crab population cannot be assessed from the Ocean Survey data alone.

The biological features of the candidate Southwest Site did not appear unique of unusual. The dominant taxon within the candidate site, O. fusiformis, was abundant not only within the SW Navigation Lane but also in portions of the other two ZSFs. Within the candidate site, infaunal biomass, numbers, and taxa richness for all surveys averaged 13.3g ash-free dry weight per m^2, 8.3 X 10^4 individuals per m^2, and 13.3 taxa per m^2, respectively.

For the surveys for which comparison was possible, biomass within the Southwest Site was comparable or less than that in other parts of the SW Navigation Lane. During the fall 1984 survey, taxa richness (74 taxa/m^2) within the candidate site was higher than the average for the whole navigation lane (214 taxa/m^2) but was not the highest in the lane (330 taxa/m^2). The taxa richness of the candidate site may be related to the site's slightly higher silt and clay content.

The macroepifauna had an average catch weight of 29.4 kg/ha. Dungeness crab were a substantial macroepifaunal component in the fall 1984 and spring 1985 surveys but not the fall 1985 survey. The candidate site did not contain the region of high juvenile crab densities seen in the spring 1985 survey. Over the three surveys, juvenile and adult crab densities averaged 2017 and 12 crab/ha, respectively. The epifauna in the Southwest Navigation Lane Site averaged 32.1 kg/ha over the three surveys. Dungeness crabs were the major component of the epifauna during the fall and spring 1985 surveys (Pearson et al., 1987). Ground fish and flatfish dominated the macroepifauna during the fall 1985 survey.

(2) Eight-Mile ZSF. The infauna in the Eight-Mile ZSF was sparse in numbers (861 individuals/m^2), biomass (2.06 g ash-free dry weight/m^2), and taxa richness (119 taxa/m^2). Polychaetes, Mediomastus spp., were the most abundant taxa in gravelly bottoms, whereas other polychaetes were the dominant taxa in the sandy bottoms about the relict gravel deposit.

The epifauna in the Eight-Mile ZSF were also sparse, averaging 8.4 kg/ha over three surveys and bottom types. Flatfish and other groundfish dominated the epifauna. Sand lance caught by beam trawl never achieved 1 percent of the total catch weight (kg/ha) and were caught in greatest numbers (380 fish/ha) outside the relict deposit at one station with a sandy bottom. Dungeness crab comprised an average of only 10 percent of the total catch weight for the three surveys. The Eight-Mile ZSF supported low densities of Dungeness crab, averaging 449 crab/ha for the three ocean surveys and all bottom types.

The candidate Eight-Mile site within the ZSF had no unusual biological features and appeared to be less productive than surrounding sandy areas. The infaunal community was dominated by the polychaetes, Mediomastus spp., and had low biomass (1.54 g ash-free dry weight/m^2), abundance (974 individuals/m^2), and taxa richness (96 taxa/m^2). Razor clams were not detected within the site. The average total catch weight of the macroepifauna was low (2.2 kg/ha), and Dungeness crab were a minor component. No adult Dungeness crab were observed within the site, and juvenile crab had a low average density (237 crab/ha). Sand lance occurred primarily around the site, and the TV tows and trawls did not indicate that the gravelly bottom of the Eight-Mile candidate site has high value as a resource for sand lance.

3.4 Socioeconomic Environment.

3.4.1 Introduction. Grays Harbor County population ranks 13th in Washington State and contains 1.3 percent of the State's population. Residents in the county numbered approximately 63,900 in 1985. The area remains lightly populated with a 1985 density of 33 persons per square mile, substantially below the State average of 66 per square mile. Slightly more than half of the county population resides in the industrialized area in the eastern portion, which includes the two largest cities, Aberdeen and Hoquiam, and the town of Cosmopolis. Population growth in the county, while increasing at a rate of 0.6 percent annually between 1975 and 1985, has lagged behind the 2.3 percent average annual increase in State population during the same period. During the 1985-2000 period, the county is projected to grow at a 0.85 percent average annual rate (14 percent increase over the 15-year period), as opposed to 1.4 percent per year for the entire State over the same period.

3.4.2 Local Area Economy. The economic development of Grays Harbor County has been tied historically to the region's timber resources, and the economic base of the cities has been their position as manufacturing and rail-water centers for shipping forest products to domestic and international markets. Next in importance are the diversified seafood and cranberry processing industries, together with a substantial tourist industry for recreational beaches and sport fishing activities. The area also has extensive ship supply services, ship and boatbuilding and repair, and related services. Agriculture occupies approximately 4 percent of the land in the county, with dairying being the predominate activity.

In 1985, the forest products industry and the trade sector each accounted for approximately 21 percent of the nonagricultural jobs in the county. The

service sector and the government sector each accounted for 20 percent of the nonagricultural jobs in the county.

a. Forest Products Industry. Within the forest products industry, the largest subsector is logging and logging contractors, accounting for approximately one-half of the total forest products employment, owing in large part to the high proportion of logs shipped to export markets. Approximately 20 percent of employment in the forest products industry is with pulp and paper firms. Sawmills and planing mills account for about 15 percent, and millwork and plywood firms for the remaining 15 percent of forest products employment. In terms of wages and salaries, pulp and papermills account for 25 to 26 percent of the industry total, a higher proportion relative to employment than for lumber and wood products firms.

The major market for processed forest products is the national housing construction industry, subject to cyclical patterns that affect the demand for forest products directly. There are also two localized situations affecting the industry in the Grays Harbor region. Limited supplies of cedar are preventing growth in the shake and shingle subsector, a significant portion of the region's industry. Also, many of the area mills need replacing with modern, more efficient processing facilities, a shift that is expected in the future provided adequate sites are available. Pulp and paper production, on the other hand, has increased annually in a fairly consistent pattern and this trend is forecast to continue if adequate water supplies are available and water quality requirements can be met.

Shipments of logs to foreign markets have become increasingly important to Grays Harbor. Log exports to China, Japan, and South Korea over the last 6 years have moved to record levels. Overseas log shipments amounted to 681 million board feet (MBF) in 1985 according to Port of Grays Harbor data; a record year; 1987 was also a record year. During the 1982 to 1985 period, log exports averaged 584 million board feet (MBF) annually, compared to an average annual volume of 502 MBF during 1976 to 1980. According to waterborne commerce data, as well as Port of Grays Harbor annual reports, Grays Harbor accounts for 25 to 34 percent of the total log exports from the state and, in terms of tonnage, is the largest log exporting area in the state. Grays Harbor is also the largest North American exporter of logs to mainland China.

b. Tourism. The tourist industry of the Grays Harbor area is based on recreational aspects of the ocean beaches and sports fishing. Ocean Shores has extensive recreation and housing facilities to accommodate a growing volume of tourists, clam diggers, and permanent residents. During the 1974 to 1984 period, the volume of visitors to the ocean beaches increased at an annual average rate of 7.5 percent.

Westport, on the other hand, is a major state sport and commercial fishing center. Of particular importance is chartered salmon fishing out of Westport, located at the mouth of Grays Harbor, but tuna and deep sea bottom fishing are also gaining in popularity. The volume of visitors to Westport peaked in 1976-1977 before a series of setbacks adversely impacted charter and commercial fishing activities. The biggest problem has been the dwindling salmon stocks,

leading to smaller catch limits and shorter fishing seasons. High fuel costs have also seriously affected the tourist trade and the costs of operating fishing vessels. Charter business dropped substantially over the 1979 to 1984 period and prospects for the immediate future are not favorable unless bottom fishing can attract more tourists. By promoting off season visits, effective promotion of convention facilities at Ocean Shores, improving highway access to the ocean beaches, and developing charter fishing for species other than salmon, the area should experience significant tourism growth.

c. Fisheries. The major landing and fish processing facilities are at Westport, while the majority of oyster processing takes place in South Bay. Commercial landings in Grays Harbor include salmon, rockfish, flounder, sole, Pacific cod, sablefish, albacore tuna, halibut, lingcod, and sturgeon. Commercial shellfish species include crab, shrimp, and oysters. In 1985, fishers from the Grays Harbor coastal area landed over $7 million in catches; of the total, 23 percent was derived from crab fisheries, 18 percent from salmon fishing, 29 percent from rockfish and shrimp, and the remaining 30 percent from other shellfish, groundfish, sole, and flounder. This catch represents a dramatic shift from the 1974 fishery when over one-half the value to fishers was from the salmon harvest, 13 percent from crab, about 6 percent from rockfish and shrimp, and 12 percent from albacore tuna. Due to dwindling salmon runs there has been a large shift in emphasis from catching salmon to more bottomfish and shellfish. Commercial salmon landings in the Washington Coastal District have dropped by 85.2 percent, from almost 9.4 million pounds in 1974 to less than 1.4 million pounds in 1985. By contrast, sole and flounder landings increased by almost 20 percent, other groundfish by 57.3 percent, other shellfish by 55.9 percent, and rockfish by 187.6 percent. Oyster production in Grays Harbor increased 117 percent, from a 1974 low of 29,000 gallons to 63,000 gallons in 1984.

The Chehalis River and tributaries attract both local and out-of-area anglers, who come to fish for salmon, steelhead, and other anadromous fish. Increasing Federal and State commitments to rebuild salmon runs, in conjunction with local Grays Harbor efforts, will provide a basis from which to increase the salmon resource and fishery. In addition, increasing emphasis on utilizing nontraditional fishery resources will lend added stability to this Grays Harbor industry. Furthermore, the potential exists for expanded aquaculture which could broaden the future base of Grays Harbor seafood production.

d. Shipping Activity. The Port of Grays Harbor reported a record year in terms of total tonnage in 1985, moving almost 4.1 million short tons in waterborne commerce; 1987 was a new record year with 4.5 million tons. Log exports in 1985 totaled almost 3.9 million tons; lumber totaled 145,000 tons, while 50,000 tons of lignin liquor and petroleum products were also moved. Over the 1981 to 1985 period, total annual tonnage moving through the harbor averaged over 3.6 million tons compared to an average of about 3.3 million tons during the 1976 to 1980 period. This growth in harbor tonnage reflects a strong upward trend in log exports over the last decade, primarily to the Orient. Exports to Turkey were begun in 1987. Future growth of waterborne commerce

moving through the Port and other Grays Harbor facilities will depend on a variety of factors, including demand for U.S. wood and wood products, adequate industrial land for expansion, and diversification of the export base.

e. Rail Service. Rail service to South Aberdeen and Cosmopolis is via the existing UPRR bridge from Aberdeen. A limited number of trains with a few cars transport materials to and from the Weyerhaeuser pulp mill in Cosmopolis and timber facility in South Aberdeen, Ocean Spray cranberry plant in Markham, and other small users.

3.4.3 Cultural Resources. A review of historic properties listed on the National Register of Historic Places and a records check at the Washington Archaeological Research Center indicate that no known historic or archeological sites are located within the areas proposed for dredging, fish mitigation, or disposal of dredged material. A literature search was made to determine the presence of potential shipwrecks at the mouth of Grays Harbor in the vicinity of the proposed dredged material disposal sites. This search did not identify any known ships within the proposed ocean disposal areas. However, the literature search identified four potentially significant sunken vessels within the vicinity of Point Chehalis and South Jetty proposed disposal sites. These vessels are: KING CYPRUSS, J. C. FORD, MILDRED, and the WAHKEENA all of which sank between 1893 and 1929. No known shipwrecks are present within the channel widening areas. The M. S. SIERRA, a National Register property, is located adjacent to the channel but will not be affected by channel improvements. Further, this ship has been abandoned by its owner and is rapidly deteriorating on the mudflats west of the Chehalis River bridge. A side-scan sonar search of all project impact areas was undertaken in fall 1988 to identify significant sunken historic properties. No vessels were found in the project areas. The State Historic Preservation Officer was notified and has concurred that no historic sunken vessels will be affected by the project.

Sediment cores taken from harbor dredge sites were examined for prehistoric cultural material, but none was found. The Commerce Street disposal site at Aberdeen has been examined by a professional archeologist; the site was heavily altered by previous disturbances and no cultural materials were identified. An archeological reconnaissance of the proposed fish mitigation site upstream from Elliott Slough has revealed the presence of a prehistoric archeological site adjacent to the fish mitigation site, but not specifically on the fish mitigation site. Cultural materials at this adjacent site are very scattered and the deposit was not discernable in the cut bank. Because of the low density of cultural materials and the lack of diagnostic cultural materials at this location, it has been determined that the portion of the site where the cultural materials are located is not significant and appears not to meet the criteria for inclusion on the National Register of Historic Places. A report summarizing this investigation has been transmitted to the SHPO who has concurred with this determination.

A recent study of historic structures within the Aberdeen-Hoquiam area by the Office of Archeology and Historic Preservation revealed that the UPRR bridge across the Chehalis River at Aberdeen is not eligible for inclusion on the National Register of Historic Places.

3.4.4 Native American Concerns. Indian tribes that may have concerns about this project include the Quinault Indian Nation (QIN) based at Taholah, Washington, the Chehalis Indian Tribe located at Oakville, Washington, and the Shoalwater Bay Indians at Tokeland, Washington.

The concerns of greatest importance include treaty rights, especially rights to fish in the Grays Harbor area, access to plant materials used in making traditional crafts, preservation of sacred sites important in the practice of traditional Indian religion, and preservation of habitat for fish propagation. Traditional Indian usage of the Grays Harbor area has been documented in a Corps-sponsored ethnohistory of the project area (James and Martino, 1986). Only the Quinault Indians have a reservation established by treaty, and they have adjudicated (legally guaranteed) rights to off-reservation usual and accustomed fishing sites within Grays Harbor. The other groups have reservations established by executive order, but they do not have the same off-reservation treaty rights to take fish at usual and accustomed locations. The Chehalis have filed suit to obtain such rights to fish in Grays Harbor, but the issue is unresolved in the courts.

Consultation with the Quinault and Chehalis tribes was initiated for this project by written notification in 1986. In December 1987 and January 1988, Corps of Engineers representatives met with tribal leaders of both groups to describe the project and its effects on Grays Harbor. The principal result of these meetings was the anticipated concern about project effects upon fish resources and fishing rights. The Quinaults inquired about possible adverse effects during the fishing season because of increased numbers of deep-draft vessels and oceangoing barges passing through Grays Harbor into the Chehalis River at that time. The Corps investigated the extent of this type of water traffic with the Port of Grays Harbor in January 1988, and determined that there would be no increase in interruption to Indian fishing in the short term since there is no near term anticipated increase in ship and barge movements. An additional concern was raised with regard to modification of the existing railroad bridge or moving the railroad bridge to another location and the impact this might have on the set net and drift fishery. With the recommended plan, the bridge will retain the existing alignment and will not significantly change from the current configuration. Other concerns that since have emerged in meetings with QIN officials and fishers are possible losses to set net fishers resulting from changes in channel location and characteristics that affect fish or flotsom movement or loss of tie points. Interviews with potentially affected fishers have been held, and more are planned, to identify specific concerns. Project plans have been altered to prevent losses at individual grounds.

For fishery management purposes, the Grays Harbor Estuary is divided into four management subareas (Areas 2A through 2D) (figure EISS 3-4). Fishing in Area 2A, extending from the railroad bridge at RM 0.0 of the Chehalis River to Cosmopolis, is exclusive to the Quinault Tribe. Area 2D, encompassing the eastern one-half of the estuary to the railroad bridge is co-fished by Quinault Tribal members and non-Indian commercial fishermen. Fish harvested in these two areas are predominantly Chehalis River stocks.

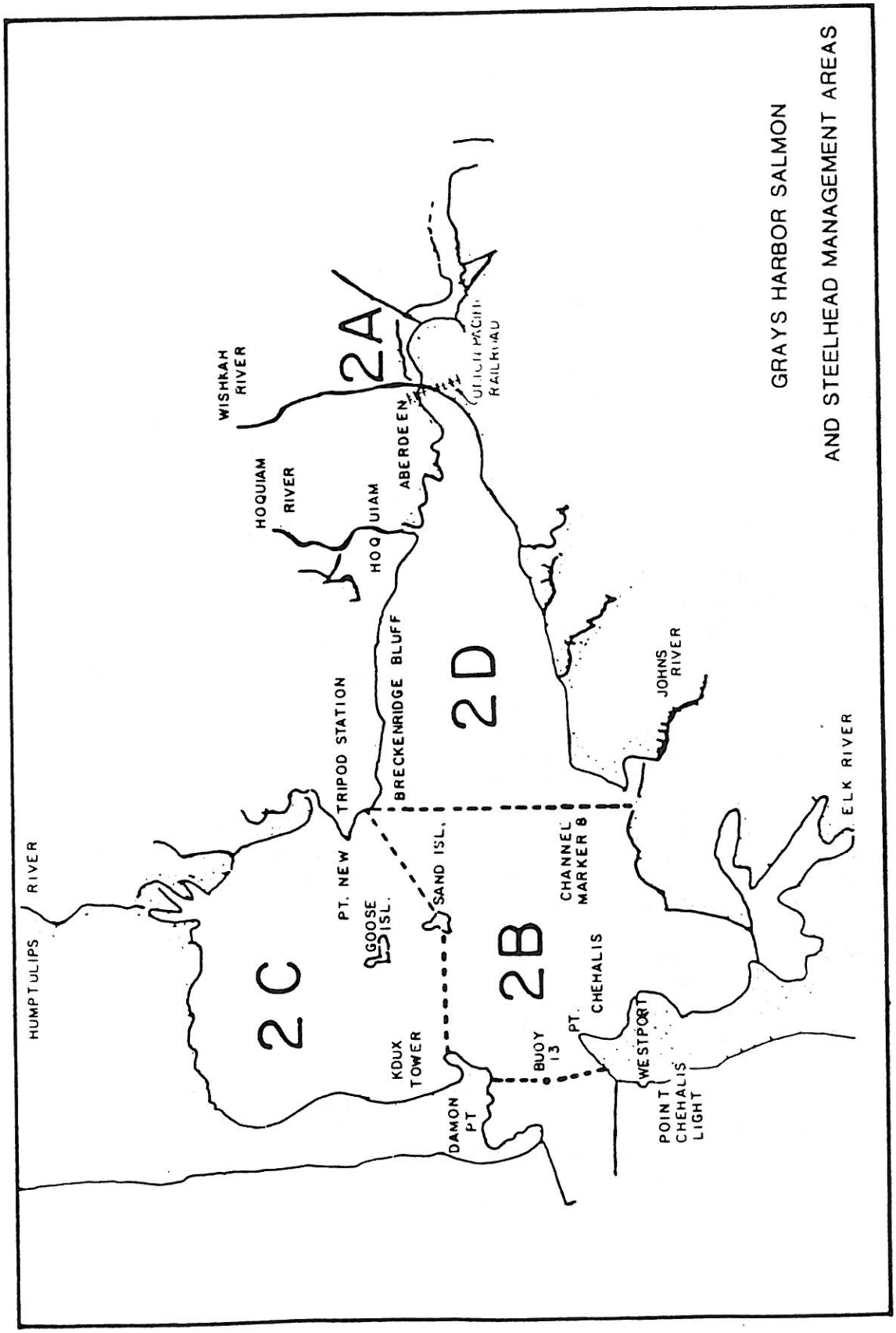


FIGURE EISS 3-4

No fish harvesting is conducted in Area 2B. This is primarily a mixed stock area. Harvest of Chehalis River fish is limited to the eastern portion of the estuary and the river; activities concentrated in these areas thus have the potential to affect the harvest of all the runs of the Chehalis River, since there are no other areas of terminal area fishing for the Chehalis River stocks.

In 1976, the Quinault Tribe began developing its salmon and steelhead planting, harvesting and marketing operations for the Grays Harbor-Chehalis River fish stocks. Allocations are dependent upon the projected run, timing and size; seasons are set and regulated to ensure that Tribal members are provided the opportunity to harvest their allocation. Management decisions dictate the level of harvest and escapement reaching the spawning grounds; the exception to this may occur when a short term disruption occurs during a particularly rapid run, i.e., during the 2-week time period that chum salmon are passing through the fish management areas in Grays Harbor.

Fishing gear in Area 2D is exclusively drift gill nets of lengths up to 1,200 feet in length. Indian and non-Indian commercial fishermen harvest coho and chum and, incidental to these species, chinook. Tribal fishermen also harvest winter steelhead. Area 2A is fished exclusively by Quinault Tribal members using both drift gill nets and set nets.

The season for fishing begins about October 1 and extends until the end of January. Depending upon the strength of any specific run, fishing may take place 5 days per week, 24 hours per day. Drift net fishermen typically fish from 1-1/2 hours prior to high slack water to 1-1/2 hours after high slack water. This coincides with the timing of preferred ship movements, and fishermen are often required to pull their nets until a ship has passed. It is estimated that, during the open fishing periods, approximately 15 percent of the drift net fishery is interrupted due to vessel and barge movements.

Since 1976, following the Boldt decision, catch statistics on the fishery in Areas 2A and 2D have been maintained by the Quinault Tribe. Largely through improved management and fishery enhancement, catches in these areas have been increasing. Numbers of fish caught for the past 5 years have been:

Species	Mean	Range
Steelhead	2,600	819-4,300
Coho	13,100	5,000-24,000
Chum	5,680	300-13,800
Chinook	2,720	100-5,000

Catch, fishing seasons, and duration of fishing are determined by Tribal fisheries managers and the Washington Department of Fisheries. These two entities are the co-managers of the resource and determine the allocation of each species to be harvested by treaty and nontreaty fishermen. Loss of fishing time due to ship movements currently affect the duration of drift net sets in Areas 2A and 2D; fish not caught during these interruptions may be caught by lengthening the seasons only if the run is of sufficient duration to allow for such an extension.

SECTION 4. ENVIRONMENTAL CONSEQUENCES

4.1 Introduction. This section discusses and analyzes expected impacts to the Grays Harbor environment due to widening and deepening the navigation channel.

4.2 Effects on the Physical Environment.

4.2.1 Estuarine.

a. Air Quality and Noise. Project impacts to air quality and noise will be temporary and not significant.

b. Dredged Material Quantities. During construction, 9,008,000 c.y. of material will be dredged from the estuary. Of this amount, 6,810,000 c.y. of material will be disposed at four harbor or estuary/upland disposal sites. The remaining 2,198,000 c.y. will be disposed of at the two ocean sites. To maintain the existing and improved channel, 2,850,000 to 2,450,000 c.y. of material will be dredged from the estuary per year (an increase of 770,000 to 1,170,000 c.y. per year).

c. Sediment Characterization/Water Quality. The sediment in Grays Harbor is composed of sands, silty sands, sandy silts, and gravel. Grays Harbor sediments in the outer portion of the estuary are predominantly marine sands. These materials meet the exclusion criteria for both the MPRSA and Clean Water Act. Sediments from the mid- to upper estuary have been chemically characterized and biologically tested. Results of those tests were reported in the FR/EIS (1982). Additional testing of Grays Harbor sediments have occurred since the FR/EIS, focusing on maintenance dredged material. Much of this information has been included in the Supplemental Section 404(b)(1)/ Section 102(a)/103 Evaluation (appendix C). The determination has been made that the material to be dredged is suitable for open-water disposal and would not have any significant adverse impacts to the environment.

In addition, sediment will be removed from inside the drawrest of the UPRR bridge and disposed of at the Eight-Mile open-water site. During utility relocation, material will be dredged in the Chehalis River during excavation of the new utilities trench. This sediment will be placed on the riverbed just adjacent to the trench and will be returned into the trench as soon as utility lines are laid.

d. Water Column Effects. Effects of the authorized project on the water column are described in detail in the FR/EIS. No information has been obtained during PED to change the analysis contained therein. All tests conducted to date on sediment from Grays harbor estuary and the railroad bridge drawrest have confirmed that the material is suitable for open-water disposal and will not have any significant adverse impacts on the environment (appendix C).

e. Disposal Sites.

(1) Confined. In two confined disposal areas (Commerce Street and Slip 1), 845,000 c.y. of material will be disposed.

(2) Open-Water Point Chehalis and South Jetty. During construction, 5,965,000 c.y. of material will be deposited in two estuary open water areas (South Jetty and Point Chehalis). During incremental maintenance, 100,000 to 200,000 c.y. of material will be disposed in the South Jetty site.

4.2.2 Ocean.

a. Air Quality and Noise. Project impacts to air quality and noise will be temporary and not significant.

b. Dredged Material Quantities. Current calculations are that 2,250,000 c.y. of material will be dredged from the bar area, and 4,448,000 c.y. of dredged material will be disposed in two ocean disposal sites (Eight-Mile and Southwest Navigation Lane Site).

c. Sediment Characterization/Water Quality. Disposal at either of the proposed ocean disposal sites would result in temporary reductions in water quality. These will include minor depression of dissolved oxygen, increased turbidity, and release of organic matter. These effects will be primarily associated with the disposal plume. Though they may be measurable throughout the water column, the effects will be most noticeable in the bottom layer, near the sediment/water interface (the nepheloid layer). The silty material going to the Eight-Mile disposal site is expected to remain consolidated in clumps which would settle rapidly to the bottom. This will help to reduce the extent and duration of the turbidity and other impacts below what they would be if the silt were unconsolidated. The risk of incidental oil spills associated with the disposal equipment would be increased at the disposal sites. These short-term, adverse effects to water quality will be minor and would typically be rapidly diluted or dispersed following disposal.

Some resuspension would likely occur at either site, resulting in turbidity near the bottom. Near-bottom turbidity occurs naturally in the offshore area at the Southwest site during storm periods so this impact would not be significant. No near-bottom turbidity was observed at the Eight-Mile site during the ocean surveys, but may occur during storm conditions. This site contains only limited biological resources, therefore, any increased turbidity is not expected to affect any populations or species of concern.

Based on testing, both the sandy silt and the sandy material are acceptable for ocean disposal and do not contain contaminants of concern which would adversely affect water quality. Additional sediment testing will be conducted in the future as Section 103 evaluations are prepared for the maintenance dredging program. Therefore, any changes in contaminant levels will be detected and no unacceptable materials will be disposed at the new sites. The Eight-Mile disposal site would be used only for construction material from the upper reaches of the navigation channel; future sediment from upstream

maintenance dredging would be disposed at the estuarine disposal sites (i.e., Point Chehalis or South Jetty). Dredged material from the bar maintenance dredging is predominantly fine sand and would continue to be disposed at the 3.9-mile ocean disposal site.

d. Disposal Sites.

(1) Southwest Navigation Lane Site. There would be no significant change in sediment type at the candidate Southwest disposal site. Clean ocean sand from the entrance and bar reaches of the navigation channel would be disposed on a primarily sand substrate in a high-energy environment. The estimated quantitites to be disposed are 2,250,000 c.y. during initial construction and an average of 500,000 c.y. of bar material annually from maintenance dredging. Some mounding of material may occur following disposal. Mounding will be kept to a minimum by disposing in a dispersive manner, i.e., dumping at different locations throughout the site selected to distribute the material evenly. This mounding is expected to be reduced or erased by storm activity with the material moving in a generally north and onshore direction with the littoral drift system over time.

(2) Eight-Mile Site. The existing substrate at the candidate Eight-Mile site is gravel. Approximately 2,198,000 c.y. of sandy silt and silt would be disposed at the site during initial construction. This silty material is expected to settle in clumps and form a cloddy mound (Pearson, 1987) which would remain at the site for a short time following disposal. Not all of the sediments would be consolidated and some sloughing and short-term movement of silts to the south would likely occur with summer currents. Prior experience with disposal of silty sediments at a site in Coos Bay, Oregon, suggests that the clumps would break down with winter storm activity and the material would disperse (Turner, pers. comm., 1987). Two years following disposal in Coos Bay, the clumps were gone and most of the silt had mixed with the natural substrate. Small clay balls were scattered over the bottom in the site and they broke up easily when handled. It is expected that the sediments to be disposed at the Eight-Mile site will behave in a similar manner. The material is expected to gradually move with the bottom currents in a predominantly north or northwesterly direction.

4.2.3 No Action. No new impacts to the physical environment would occur with this plan. There would be continued temporary perturbations in water quality during operations and maintenance dredging and disposal.

4.3 Effects on the Biological Environment.

4.3.1 Estuarine.

a. Dungeness Crabs.

(1) Dredging Impacts. Dredging impacts to Dungeness crabs in Grays Harbor from the proposed project were quantified using an impact model (Armstrong et al., 1987) developed by University of Washington biologists (see

appendix F for brief summary). Model predictions were based on projected dredging schedules for construction, and crab abundances in different areas of Grays Harbor in different seasons of the year.

Population data were used in the model to estimate impacts from two different results, a "worst" case (with high crab population) and "mean" case using the 4-year mean for all population data. All runs of the model reflected the actual dredging construction schedule over 2 years (years 1 and 3), which had been refined previously to mitigate crab loss on the basis of preliminary results of the model. A matrix of results using the high and mean populations is presented in tables EISS 4-1 and EISS 4-2 for immediate crab mortality, relative loss of crabs projected to age 2+, loss of harvestable size crabs (age 3+), and percent loss to the population or resource for each year of construction. In this discussion, no distinction is made between male and female crabs, and the term "harvestable size" crab refers to age 3+ crabs of both sexes. Also, values for female crabs are assumed to be equal to males, even though female crabs are not actually harvested in the fishery.

For the mean and high populations, respectively, predicted total losses (all sizes projected to age 2+) from the first year of construction range from 96,928 crabs up to 169,240 crabs. These crab mortalities are the equivalent of losses of harvestable size crabs (over a 4-year period) ranging from 43,618 to 76,158 for the mean and high populations, respectively (table EISS 4-1). Because dredging on the bar and outer reaches occurs during the first year of construction, estimated crab mortality from that year is higher than that from the second year of construction. Dredging on the bar, both during construction and maintenance dredging thereafter, accounts for a relatively large proportion of the impacts: approximately 51 to 56 percent of construction impacts, and 33 to 36 percent of annual maintenance dredging impacts.

Relative losses to the resource, in terms of percent loss of the population, were estimated using two population data sets, one for Grays Harbor proper (intertidal and subtidal) and another which also includes the nearshore Grays Harbor area (tables 4.1 and 4.3 from Armstrong et al., 1987). Crab mortality during the first year of construction, which includes dredging the bar, is much higher than the second year. Depending on whether the mean or high population is used to predict crab mortalities from the first year of construction, percent losses to the resource (table EISS 4-1) vary from a 0.27 percent loss to the combined nearshore and Grays Harbor population, up to a 2.62 percent loss to the Grays Harbor proper population. However, impacts to certain age groups are quite high. For example, using the mean Grays Harbor proper population as a basis, the loss for 1+ crabs (167,343 crabs) is about 13 percent of that segment of the population. The loss is even greater (288,031 crabs), or 13.7 percent, for the same age group using the high population for Grays Harbor. Total crab losses from the 2 years of construction are found in table EISS 4-3 and range from 43,634 to 76,185 (all crabs projected to age 3+) for the mean and high population estimates, respectively. Losses of up to 13.7 percent constitute a significant impact to this commercially valuable resource.

Maintenance dredging is required annually in Grays Harbor to maintain the channel at proper depths. Existing maintenance dredging averages about 1.68 million cubic yards of material per year, mostly from the South and Crossover reaches. More maintenance dredging will be necessary after construction, and this extra amount or increment is termed "incremental" maintenance dredging. Although some crab impacts result from existing maintenance dredging, only those resulting from the project (e.g., construction dredging and incremental maintenance dredging) are applicable to the mitigation process for this project.

Total maintenance dredging after construction (i.e., existing plus additional, or incremental) would result in estimated crab mortalities (table EISS 4-4) ranging from 27,015 to 51,790 crabs per year (all sizes projected to age 2+). These losses are the equivalent of 12,156 to 23,305 harvestable size crabs per year for the mean and high populations, respectively. Percent loss to the > 1+ crab population within Grays Harbor is estimated to be significant, at 4 to 4.5 percent per year.

The incremental maintenance dredging after construction will be about 170,000 c.y. per year inside the Harbor and 600,000 c.y. per year in the Bar and Entrance reaches, or an additional 770,000 c.y. per year to the existing maintenance dredging. However, incremental maintenance dredging will be slightly higher for the first 4 years of the project and stabilize in subsequent years. Crab impacts from the first 4 years of incremental maintenance dredging are summarized in table EISS 4-5. Thereafter, approximately 8,821 to 18,936 crabs (all sizes projected to age 2+) will be killed annually due to incremental maintenance dredging (table EISS 4-6) or the equivalent of about 4,000 to 8,500 harvestable size crabs per year for the mean and high populations, respectively. Therefore, losses from 50 years of incremental maintenance dredging would range from about 204,000 harvestable size crabs (for the mean population) up to 439,000 (for the high population). Of these mortalities, approximately 87 percent will occur from dredging the bar and entrance reaches.

The most reasonable prediction of total crab losses due to the project (table EISS 4-7) is based upon a combination of the high population estimate for construction losses (76,185 harvestable size crabs) and the mean population estimate for incremental maintenance losses (204,326 harvestable size crabs). The high population estimate is used for predicting construction impacts because the majority of the impacts occur during the first year of construction and it is possible that a high crab population could occur during that relatively short period of time. Although monitoring will occur during construction to more accurately assess impacts, the higher estimate is used in order to plan for adequate mitigation (see section 4.5.1.). However, mitigation will be based on actual losses computed from data on dredge quantities, crab densities, dredge type, and dredging schedule.

Conversely, the mean population estimate is used for predicting losses from incremental maintenance dredging because of the duration (50 years) of the project. In this instance, the long-term average, or mean, is the more appropriate figure on which to base estimates of crab loss and mitigation.

TABLE EISS 4-1. Predicted Dungeness crab loss from the first year of construction (1990)

YEAR 1 CONSTRUCTION (1990)

CRAB MORTALITY — MEAN POPULATION ESTIMATE

IMMEDIATE LOSS FOR ALL REACHES

AGE GROUPS	# CRABS	TABLE 4.1 * GRAYS HBR INT/SUBTDL (MILLIONS)	% LOSS OF GRAYS HARBOR POPULATION	TABLE 4.3 ** GRAYS HARBOR AND NEARSHORE (MILLIONS)	% LOSS OF GH AND NEARSHORE POP'N
0+	143,110	22.6	0.63	195.4	0.07
1+	274,756	6.9	3.98	17.3	1.59
>1+	167,343	1.3	12.87	3.4	4.92
TOTAL***	585,210	30.8	1.90	216.1	0.27

HIGH (WORST) POPULATION ESTIMATE

IMMEDIATE LOSS FOR ALL REACHES

AGE GROUPS	# CRABS	TABLE 4.1 GRAYS HBR INT/SUBT (MILLIONS)	% LOSS OF GRAYS HARBOR POPULATION	TABLE 4.3 GRAYS HARBOR AND NEARSHORE (MILLIONS)	% LOSS OF GH AND NEARSHORE POP'N
0+	56,343	22.0	0.26	24.2	0.23
1+	595,274	11.8	5.04	12.9	4.61
>1+	288,031	2.1	13.72	3.8	7.58
TOTAL***	939,648	35.9	2.62	40.9	2.30

* Population estimates are from Armstrong et al., 1987, Table 4.1

** Population estimates are from Armstrong et al., 1987, Table 4.3

*** % of total of all crabs at all ages

RELATIVE LOSS OF AGE 2+ CRABS

AGE GROUPS	MEAN POPULATION ESTIMATE	HIGH POPULATION ESTIMATE
0+	868	404
1+	22,723	46,597
>1+	73,338	122,239
TOTAL	96,928	169,240

LOSS OF HARVESTABLE SIZE CRABS (AGE 3+)

(MALES)	21,809	(MALES)	38,079
(FEMALES)	21,809	(FEMALES)	38,079
TOTAL	43,618		76,158
VALUE ($) *	$150,480.72		$262,745.10

* Value is based on $3.45 per crab.

TABLE 4-2. Predicted Dungeness crab loss from the second year of construction (1992)

YEAR 3 CONSTRUCTION (1992)

CRAB MORTALITY — MEAN POPULATION ESTIMATE

IMMEDIATE LOSS FOR ALL REACHES

AGE GROUPS	# CRABS	TABLE 4.1 * GRAYS HBR INT/SUBTDL (MILLIONS)	% LOSS OF GRAYS HARBOR POPULATION	TABLE 4.3 ** GRAYS HARBOR AND NEARSHORE (MILLIONS)	% LOSS OF GH AND NEARSHORE POP'N
0+	1,349	22.6	0.01	195.4	0.00
1+	174	6.9	0.00	17.3	0.00
>1+	48	1.3	0.00	3.4	0.00
TOTAL***	1,571	30.8	0.01	216.1	0.00

HIGH (WORST) POPULATION ESTIMATE

IMMEDIATE LOSS FOR ALL REACHES

AGE GROUPS	# CRABS	TABLE 4.1 GRAYS HBR INT/SUBT (MILLIONS)	% LOSS OF GRAYS HARBOR POPULATION	TABLE 4.3 GRAYS HARBOR AND NEARSHORE (MILLIONS)	% LOSS OF GH AND NEARSHORE POP'N
0+	200	22.0	0.00	24.2	0.00
1+	364	11.8	0.00	12.9	0.00
>1+	82	2.1	0.00	3.8	0.00
TOTAL***	645	35.9	0.00	40.9	0.00

* Population estimates are from Armstrong et al., 1987, Table 4.1

** Population estimates are from Armstrong et al., 1987, Table 4.3

*** % of total of all crabs at all ages

RELATIVE LOSS OF AGE 2+ CRABS

AGE GROUPS	MEAN POPULATION ESTIMATE	HIGH POPULATION ESTIMATE
0+	5	1
1+	12	26
>1+	19	34
TOTAL	36	60

LOSS OF HARVESTABLE SIZE (AGE 3+) CRABS

(MALES)	8	(MALES)	14
(FEMALES)	8	(FEMALES)	14
TOTAL	16		28
VALUE ($) *	$55.89		$96.60

* Value based on $3.45 per crab.

TABLE EISS 4-3. Predicted total Dungeness crab loss from the first two years of construction (i.e., 1990 and 1992)

CONSTRUCTION YEARS 1 AND 3

CRAB MORTALITY

IMMEDIATE LOSS FOR ALL REACHES

AGE GROUPS	MEAN POPULATION ESTIMATE No. of crabs	HIGH POPULATION ESTIMATE No. of crabs
0+	144,459	56,543
1+	274,930	595,638
>1+	167,391	288,113
TOTAL	586,780	940,294

RELATIVE LOSS OF AGE 2+ CRABS

AGE GROUPS	MEAN POPULATION ESTIMATE	HIGH POPULATION ESTIMATE
0+	873	405
1+	22,735	46,623
>1+	73,357	122,273
TOTAL	96,965	169,301

LOSS OF HARVESTABLE SIZE CRABS (AGE 3+)

(MALES)	21,817	(MALES)	38,093
(FEMALES)	21,817	(FEMALES)	38,093
TOTAL	43,634		76,186
VALUE ($)*	$150,538.16		$262,841.70

* Value based on $3.45 per crab.

TABLE EISS 4-4. Predicted Dungeness crab loss per year due to total annual maintenance dredging (i.e., existing plus incremental)

TOTAL ANNUAL MAINTENANCE DREDGING (EXISTING PLUS INCREMENTAL)

CRAB MORTALITY — MEAN POPULATION ESTIMATE

IMMEDIATE LOSS FOR ALL REACHES

AGE GROUPS	# CRABS	TABLE 4.1 * GRAYS HBR INT/SUBTDL (MILLIONS)	% LOSS OF GRAYS HARBOR POPULATION	TABLE 4.3 ** GRAYS HARBOR AND NEARSHORE (MILLIONS)	% LOSS OF GH AND NEARSHORE POP'N
0+	117,311	22.6	0.52	195.4	0.06
1+	81,113	6.9	1.18	17.3	0.47
>1+	51,571	1.3	3.97	3.4	1.52
***TOTAL	249,995	30.8	0.81	216.1	0.12

HIGH (WORST) POPULATION ESTIMATE

IMMEDIATE LOSS FOR ALL REACHES

AGE GROUPS	# CRABS	TABLE 4.1 GRAYS HBR INT/SUBT (MILLIONS)	% LOSS OF GRAYS HARBOR POPULATION	TABLE 4.3 GRAYS HARBOR AND NEARSHORE (MILLIONS)	% LOSS OF GH AND NEARSHORE POP'N
0+	15,334	22.0	0.07	24.2	0.06
1+	180,687	11.8	1.53	12.9	1.40
>1+	96,829	2.1	4.61	3.8	2.55
***TOTAL	292,850	35.9	0.82	40.9	0.72

* Population estimates are from Armstrong et al., 1987, Table 4.1

** Population estimates are from Armstrong et al., 1987, Table 4.3

*** % of total of all crabs at all ages

RELATIVE LOSS OF AGE 2+ CRABS

AGE GROUPS	MEAN POPULATION ESTIMATE	HIGH POPULATION ESTIMATE
0+	78	70
1+	6,224	13,680
>1+	20,713	38,040
TOTAL	27,015	51,790

LOSS OF HARVESTABLE SIZE CRABS (AGE 3+)

(MALES)	6,078	(MALES)	11,653
(FEMALES)	6,078	(FEMALES)	11,653
TOTAL	12,157		23,306
VALUE ($)*	$41,940.79		$80,403.98

* Value based on $3.45 per crab.

TABLE EISS 4-5. Predicted crab loss from the first four years of incremental maintenance dredging (1991, 1992, 1993, and 1994).

ITEM: INCREMENTAL MAINTENANCE DREDGING FOR 1991, 1992, 1993, 1994, INCLUSIVE

CRAB MORTALITY

IMMEDIATE LOSS FOR ALL REACHES

AGE GROUPS	MEAN POPULATION ESTIMATE No. of crabs	HIGH (WORST) POPULATION ESTIMATE No. of crabs
0+	23,449	24,339
1+	91,372	234,082
>1+	131,988	280,290
TOTAL	246,809	538,711

RELATIVE LOSS OF AGE 2+ CRABS

AGE GROUPS	MEAN POPULATION ESTIMATE	HIGH POPULATION ESTIMATE
0+	78	82
1+	5,121	12,865
>1+	42,824	90,648
TOTAL	48,023	103,596

LOSS OF HARVESTABLE SIZE CRABS (AGE 3+)

(MALES)	10,805	(MALES)	23,309
(FEMALES)	10,805	(FEMALES)	23,309
TOTAL	21,610		46,618
VALUE ($)*	$74,555.71		$160,832.79

* Value based on $3.45 per crab.

TABLE EISS 4-6. Predicted annual Dungeness crab loss from incremental (additional) maintenance dredging.

ANNUAL INCREMENTAL MAINTENANCE DREDGING FOR 1995 THRU END OF PROJECT

CRAB MORTALITY — MEAN POPULATION ESTIMATE

IMMEDIATE LOSS FOR ALL REACHES

AGE GROUPS	# CRABS	TABLE 4.1 * GRAYS HBR INT/SUBTDL (MILLIONS)	% LOSS OF GRAYS HARBOR POPULATION	TABLE 4.3 ** GRAYS HARBOR AND NEARSHORE (MILLIONS)	% LOSS OF GH AND NEARSHORE POP'N
0+	4,554	22.6	0.02	195.4	0.00
1+	17,453	6.9	0.25	17.3	0.10
>1+	23,813	1.3	1.83	3.4	0.70
TOTAL***	45,820	30.8	0.15	216.1	0.02

HIGH (WORST) POPULATION ESTIMATE

IMMEDIATE LOSS FOR ALL REACHES

AGE GROUPS	# CRABS	TABLE 4.1 GRAYS HBR INT/SUBT (MILLIONS)	% LOSS OF GRAYS HARBOR POPULATION	TABLE 4.3 GRAYS HARBOR AND NEARSHORE (MILLIONS)	% LOSS OF GH AND NEARSHORE POP'N
0+	4,568	22.0	0.02	24.2	0.02
1+	44,113	11.8	0.37	12.9	0.34
>1+	50,394	2.1	2.40	3.8	1.33
TOTAL***	99,075	35.9	0.28	40.9	0.24

* Population estimates are from Armstrong et al., 1987, Table 4.1

** Population estimates are from Armstrong et al., 1987, Table 4.3

*** % of total of all crabs at all ages

RELATIVE LOSS OF AGE 2+ CRABS

AGE GROUPS	MEAN POPULATION ESTIMATE	HIGH POPULATION ESTIMATE
0+	15	16
1+	1,011	2,496
>1+	7,795	16,424
TOTAL	8,821	18,936

LOSS OF HARVESTABLE SIZE CRABS (AGE 3+)

(MALES)	1,985	(MALES)	4,261
(FEMALES)	1,985	(FEMALES)	4,261
TOTAL	3,970		8,522
VALUE ($) *	$13,696.50		$29,400.90

* Value based on $3.45 per crab.

TABLE EISS 4-7

PREDICTED TOTAL LOSSES OF HARVESTABLE SIZE
DUNGENESS CRABS FROM THE RECOMMENDED PROJECT

Project Element	Predicted Loss Harvestable Size Crabs****	Value*
Construction Yr 1** (see table EISS 4-1)	76,158	$262,745.10
Construction Yr 2** (see table EISS 4-2)	28	96.60
Incremental O&M***		
Yr 1 (1991)	6,264	21,610.80
Yr 2 (1992)	5,960	19,630.50
Yr 3 (1993)	5,116	17,650.20
Yr 4 (1994)	4,544	15,676.80
Yr 5 - 50 (1995 through 2040 @ 3,972 crabs/yr)	182,712	630,356.40
TOTAL	280,512	$967,766.40

*Value is based on $3.45 per crab and has not been discounted ($1.50/lb x 2.3 lbs/crab).
**Construction impacts are based on high (worst) population estimate.
***Incremental (additional) maintenance dredging impacts are based on the 4-year mean (average) population estimate.
****Harvestable size crabs refers to age 3+ crabs of both sexes (i.e., immediate loss projected to age 3+).

The total estimated crab loss from the project is the equivalent of approximately 281,000 harvestable crabs at a value of about $968,000 (see section 4.5.1.b).

(2) Disposal Impacts. Concerns about potential impacts on Dungeness crab from disposal operations during the project were in the following categories: (1) habitat loss; (2) toxic effects; (3) burial effects; and (4) effects on crab fishing.

Concern for potential loss of habitat important to the newly settled YOY crab pertains to the Southwest Navigation Lane Site. The Southwest Navigation Lane Site has been located and the disposal operations designed to avoid the area of high crab densities observed north of the site during the Ocean Surveys (Pearson, et al. 1987). Because the operations have been designed to avoid the area of high crab density and to monitor the situation during construction, and because movement of material from the site is unlikely to change the habitat value of the similar substrates around the site, significant loss of habitat for the YOY crab does not appear likely.

Regarding the issue of potential toxic effects,the material from the Grays Harbor is relatively uncontaminated and is therefore suitable for open-water disposal. Consequently, there is no reason to believe that crabs will be impacted from exposure to the sediments. No significant bioaccumulation or other toxic effects are expected.

For the two open-water estuarine sites, concerns have been raised that disposal in the mouth of the estuary could disrupt entry of 1+ juvenile crab entering Grays Harbor from the ocean in the spring. Little is known concerning the pathways and processes sustaining migration of the juvenile crab in and out of the Grays Harbor estuary; however, the depth and high current velocity of the two sites do not favor migration through the sites. Sandy material does not appear to offer an obstacle to crab migration either through avoidance or disruption of piloting cues. Silty materials may offer some potential for disrupting migration if migration is based on chemosensory cues similar to those used by crab in bait odor tracking. Laboratory studies have shown the bait tracking response to be impaired by silty materials with high sulfide content (Pearson and Woodruff, 1987). However, because the silty materials dredged from the upper reaches of Grays Harbor during construction are destined for the Eight-Mile site, construction impacts on migration are not likely.

Burial effects on Dungeness crab are expected to be minimal and transient. Crabs would easily escape from or avoid the disposal site during disposal activities. Crabs would be expected to recolonize the area within a relatively short period of time.

Concerning the effects of disposal operations on crab fishing, there are two issues: "souring of crab pots" and "sanding-in of crab pots." Laboratory studies have shown that silty material with high silt and clay content doubles the time taken by adult male crab to find the source of a bait odor plume

(Pearson and Woodruff, 1987). Sandy materials showed no effect. Because sandy materials show no effect and because the silty materials during construction are destined for the Eight-Mile site far from crab fishing areas, the disposal operations have been designed to avoid any potential impact on the efficiency of crab pots. Some silty material is destined for disposal at the Point Chehalis site during maintenance. Because in the laboratory the silty material was effective in impairing the bait odor tracking only when in suspension, potential effects on crab fishing from disposal operations at Point Chehalis should only be intermittent and transient. Most silty material in suspension is not expected to be carried from the disposal site to the crab pots.

Another explanation for "pot souring" may be the occurrence of large amounts of decaying organic matter. Off the Washington coast, declines in Dungeness crab catches have been reported due to the presence of decaying mats of tube-dwelling polychaetes in the pots (Pearson and Woodruff, 1987). Apparently, a particularly severe storm off the Washington coast caused a massive mortality of the polychaete Owenia fusiformis through burial following large scale sediment transport. Further transport evidently brought the decaying material into crab pots where presumably the odor prevented entry by the crabs either through an avoidance response or through inhibition of chemoreception.

Burial of crab pots by sand transported in winter storms occurs naturally off Grays Harbor. By moving material from shallower to deeper depths off Grays Harbor, the disposal operations may actually decrease the potential for crab pot burial. Because of the natural occurrence of sediment transport, reports of buried crab pots are possible; however, it will be unlikely that such burial can be unambiguously attributed to disposal operations (Pearson, 1987).

In summary, the impacts of the project on the Dungeness crab resource and, therefore, the crab fishery, in the Grays Harbor area is an issue of prime importance. Although the impacts due to disposal activities are anticipated to be negligible, significant crab mortalities will occur from dredging. Because Dungeness crabs constitute a valuable fishery, the losses of Dungeness crab are considered significant and will be mitigated by the creation of shell habitat (see section 4.5.1).

b. Demersal Fish.

(1) Lingcod. No significant impacts to lingcod are anticipated as a result of dredging in Grays Harbor. Observations of entrained lingcod have been few, despite extensive sampling. Due to the slow (1 knot) speed of the dredge combined with the mobility and epibenthic nature of these fish, it appears unlikely that appreciable numbers of lingcod could be entrained. There is no information available on the mortality of entrained lingcod. However, juvenile lingcod which are small enough and slow enough to be entrained would probably survive entrainment with no serious injury, as do other small fish (Kay McGraw, U.S. Army Corps of Engineers, pers. comm.). In addition, the only time they would be susceptible to entrainment from dredging activities would be during the summer months when juveniles are typically

typically found in shallower, shoreline areas. Dredging during summer months will occur on the Bar, and in the deep-water areas, Crossover, Moon Island, Hoquiam, Cow Point, Aberdeen, and South Aberdeen reaches. Dredging of South reach will occur in February to May when juvenile lingcod are not present in the demersal habitat. None of these areas are documented as supporting large numbers of juvenile lingcod. No dredging will occur at Whitcom Flats and Damon Point, areas that are reported to have had the highest numbers of juvenile lingcod (see Day et al., 1986 for summary).

Distribution data for juvenile lingcod obtained by Coley et al. (1986) and Day et al. (1986), showed highest concentrations in areas of shell/cobble bottom. Therefore, it is expected that a positive project impact will be the provision of rearing habitat for juvenile lingcod at the crab mitigation site (see section 4.5.1).

(2) Flatfish. Based on results of the PED studies, dredging will not have a significant adverse impact on the English sole population or habitat. This conclusion is based on the mobility of this species, their wide distribution within Grays Harbor, and their comparatively lower abundance in deep waters (Tagart and Short, 1987; Day et al., 1986).

All in-water construction associated with the railroad bridge modifica- tion (floating bridge sections, clamshell dredging and trenching, piling removal, and pier demolition) have potential to impact resident and migrant flatfish either directly by vibration, impact or shock, or secondarily through water quality degradation. Steps taken to minimize this potential impact are identical and concurrent with those developed to minimize adverse impacts to salmon (see c. below).

(3) Sturgeon. All of the in-water construction associated with the railroad bridge modification (floating bridge sections, clamshell dredging and trenching, piling removal, and pier demolition) also have the potential to impact resident and migrant sturgeon either directly by impact or shock, or secondarily through water quality degradation. Sturgeon populations will be protected during blasting using the same methods developed for protection of salmon (see below).

c. Salmon. Enlargement of the turning basin at Cow Point and Elliott Slough will result in the removal of 1.8 to 2 acres of shallow subtidal (-10.0 to 0.0 feet MLLW) feeding and rearing habitat that is critical to juvenile salmon survival. Although sedimentation of the deauthorized turning basins will result in replacement of some lost habitat value, the area to be deepened is located in a region where this critical subtidal habitat has limited availability.

Mitigating measures to reduce or eliminate impacts to salmonid fisheries have been developed through coordination with the resource agencies. Construction dredging will be by clamshell and/or pipeline dredge, and turbidity plumes should be confined to the main river channel and will avoid shore areas where juveniles would be present in largest numbers. Coordination with agency and tribal representatives has resulted in agreement to confine dredging to the

window of mid-June through July. This should avoid most of the outmigrants. Mitigation for losses of subtidal habitat is described in 4.5.2.

All of the in-water construction associated with the railroad bridge modification (floating bridge sections, clamshell dredging and trenching, piling removal, and pier demolition) have potential to impact migrant juvenile and adult salmon either directly by vibration impact or shock, or secondarily through water quality degradation. The Corps, in coordination with agency and tribal representatives, has selected a window when underwater blasting will be allowed and which should pose minimal danger to fish. This window will be the first week in August, with a period of one-half week before and after this time when underwater blasting could also occur with more stringent safeguards, such as a cofferdam or bubble curtain. Above-water blasting could start as early as 15 June and extend to the first week in August. Blasting of all structures might not take place in the same year. Thus, the contractor might be less constrained to meet a tight schedule for all the work; additionally, it would allow better refinement of techniques, and more careful monitoring. If all blasting is done in the same year, it would be done almost simultaneously on all structures, to better safeguard against fish moving in between blasts. There will be actual delays of fractions of a second between individual detonations in the holes drilled in the piers, and perhaps a few seconds between the detonations in the different piers, so as to minimize total shock. Shielding methods such as bubble curtains and foam-cushioned hanging steel plates are being investigated as potential methods of reducing shock. Hydroacoustic monitoring will be carried out starting in 1989 to refine estimates of time and fish presence. It will also be carried out in conjunction with the blasting to ascertain the time with fewest fish in the area, and to determine actual impacts. Significant mortalities from blasting are not expected, due to the timing provisions. Mitigation, if needed, will be by payment to the State to replace fish killed or injured due to blasting, and will be based on the reproductive potential of the lost fish. The Corps will provide for the hatchery production of a number of fish agreed on with the State of Washington.

d. Oysters. The project is not expected to have any significant adverse impacts on existing oyster growing areas in Grays Harbor, either due to increased wave action from channel deepening or due to siltation from disposal activities. Although wave and current actions are continuing to erode portions of Whitcomb Flats, this is most likely a result of ocean swell, wind-generated waves from a northwesterly direction, and tidal currents. Erosion and accretion at various points on Whitcomb Flats appears to be a naturally occurring phenomenon within a dynamic estuarine system, unrelated to dredging activities. However, since the precise cause has not been determined, observation of Whitcomb Flats erosion would continue under routine maintenance activities.

Any siltation effects to oyster grounds during construction would be minimal and of short duration. Most of the material to be disposed at the Point Chehalis and South Jetty disposal sites is from the South and Crossover reaches and consists predominantly of medium-to-fine grain marine sands.

Therefore, dispersal of material is expected to be minimal. In addition, silty material from upstream reaches is scheduled for disposal at the Eight-Mile ocean disposal site, eliminating any potential for increase (i.e., beyond background levels) in fecal coliform bacteria in waters around oyster beds. Furthermore, studies conducted on silty material containing fecal coliform bacteria have shown that when the material is disposed at Point Chehalis, dispersion and dilution of bacteria greatly reduces their numbers before they reach oyster grounds and that levels of bacteria are generally lower at Point Chehalis than at other sites in the harbor (Cirone-Storm, 1983a,b). Therefore, it is unlikely that the project would have a significant adverse physical, chemical, or bacteriological effect on oyster growing areas.

e. Disposal Sites.

(1) Confined. No significant impacts to biological resources are expected to occur at the confined disposal sites. The sites presently contain no biological resources.

(2) Open-Water. Open-water disposal is not expected to significantly affect crab populations. Immobile benthic infauna at Point Chehalis and South Jetty will probably be smothered, while mobile epibenthic organisms will escape the immediate impact area. Recolonization of benthic infauna should be typically rapid following construction. Communities would be typical of pre-project conditions as there will be no significant change in sediment particle size.

f. Endangered Species. Biological assessments (BA) were prepared concluding that the project, including ocean disposal, would have no adverse impacts to the endangered or threatened species. The National Marine Fisheries Service and U.S. Fish and Wildlife Service concurred with these findings. Copies of the BA's and concurrence letters are found in appendix D. The BA's did not include discussion of the fish mitigation and its potential impacts to threatened and endangered species. Construction of the fish mitigation site would alter 4 acres of a forested swamp (see section 4.5.2). There is a small potential that bald eagle and peregrines could use the trees for roosting. As stated in the BA, and confirmed by recent discussions with WDW, no such roosts are known from the vicinity of the fish mitigation. Furthermore, the majority of the forested swamp will remain essentially intact, so the mitigation will not preclude use by bald eagles or peregrine falcons.

4.3.2 Ocean.

a. Disposal Sites.

(1) Southwest Navigation Lane Site. Disposal at the 3.9 mile Southwest site will result in the direct mortality of sessile benthic organisms due to smothering. Some organisms would survive, however, especially near the outer edge of the actual disposal area. Species that would be affected are common in sandy sediment areas offshore at project area depths (esp. *Owenia fusiformis*). The Southwest site was selected to avoid any commercially or

recreationally important populations or geographically limited species. Population densities and species richness are lower at this site than in an alternative area in the West navigation lane. Recolonization of benthic infauna should be typically rapid following construction. Communities would be typical of pre-project conditions as there will be no significant change in sediment particle size.

Disposal during initial construction would occur in summer at depths beyond the -120 foot MLLW contour to avoid potential high crab densities observed north of the site at depths between 100 and 120 feet during the spring ocean surveys. Maintenance dredging disposal beyond the 90-foot contour will avoid important razor clam populations that occur shallower than -90 feet MLLW. Disposal will occur in late summer when YOY crab densities are low. The parallelogram shape of the site was designed to follow contours which would avoid these resources.

Most fish and crabs are sufficiently mobile to escape burial, though some mortalities would likely occur. Marine mammals, birds, and pelagic fish in the area are also likely to avoid disposal sites. Short-term, reduced visibility could affect feeding success of some fish, and suspended particles could result in irritation to gills and other membranous tissues. Loss of sessile benthic invertebrates would also reduce food availability to higher food web organisms in the immediate disposal area. Increased competition for food resources in surrounding areas would result; however, this would diminish with the recruitment of new organisms.

(2) Eight-Mile Site. Disposal would impact resident biota; however, the Eight-Mile Site contains limited resources and no identified species of concern. Sessile benthic organisms in the immediate vicinity of the disposal site would be buried resulting in some mortalities as a result of disposal activities. Other organisms may colonize the bottom after disposal, and species abundance and diversity could be greater due to the introduction of silt containing higher total organic carbon (TOC) to the substrate. In time, however, most of the silt would likely move out of the site with ocean currents so it is not known how long this condition would be present. As benthos population densities, biomass, and taxa richness are all low at this site, especially when compared to areas with a silt or sand bottom, impacts to benthic communities in the general vicinity would be minimal.

Impacts to other fish and wildlife resources would be similar to those described for the Southwest site, however, the impacts associated with turbidity could last somewhat longer at this site, due to the increased depth and greater silt content of the dredged material.

b. Endangered Species. No impacts to threatened or endangered species or their critical habitat are expected. Biological assessments (BA's) were prepared concluding that the project, including ocean disposal, would have no adverse impacts to the endangered and threatened species present. The National Marine Fisheries Service and U.S. Fish and Wildlife Service concurred with these findings. Copies of the BA's and concurrence letters are found in appendix D.

4.3.3 No Action. Should the recommended project not be implemented, none of the additional crab mortality or loss of salmonid habitat would occur. However, the present loss of crabs and other benthos due to maintenance dredging of the existing channel would continue.

4.4 Effects on Socioeconomic Environment.

4.4.1 Local Area Economy. The proposed project would create additional jobs during construction in the tasks involved in completing the dredging and bridge relocation. No significant changes to the makeup of the local area economy are anticipated. Project benefits are expected to be derived mainly from savings in transportation costs due to economies of scale.

a. Forest Products Industry. No significant changes in the composition of the forest products industry are anticipated due to the proposed project. Log exports are expected to remain at approximately the present level. The proposed project is not expected to increase harvesting of local timber resources.

b. Tourism. The proposed project is not anticipated to have significant impacts on the Grays Harbor tourist industry. Disposal of dredged material is not expected to affect the local sport-fishing industry or disrupt other recreational activities such as bird- or whale-watching. Appropriate notice will be given to vessel operators so they can avoid the disposal area during disposal operations.

c. Fisheries. The proposed project is not anticipated to have significant impacts on most of the area's fisheries, or to treaty fishing rights (see section 4.4.3). However, the project could result in the mortality of approximately 281,000 harvestable crabs with a value of $968,000 (construction and incremental maintenance dredging combined). Salmonid habitat loss through widening and deepening at turning basins will result in an estimated loss of 105,221 (an adult equivalent at 5,621 of which 80 percent would be harvestable) juvenile salmonids. Some loss of adult salmonids and other fish may occur from bridge pier blasting. These losses will be mitigated.

d. Shipping Activity. Significant benefits due to transportation cost savings are anticipated to occur if the proposed project is built. Transportation savings due to economies of scale realized from the improved channel would average $14,045,000 per year. The modified railroad bridge will allow elimination of the pilots' vessel restriction.

Railroad bridge modification, utility relocation, and highway fendering work will have short-term adverse impacts to navigation in the Chehalis River. There will be traffic disruptions and delays in the channel. The completed project will facilitate navigation and reduce risks of collision with bridge structures and other mishaps with their related secondary effects (spills, fires, injuries). Although the project is specifically to accommodate larger ships, the smaller ships of the size currently using this channel will use the channel with a reduced risk. In general, the new railroad bridge will have the same amount of maintenance as the present one and will facilitate navigation.

e. Rail Service. The railroad bridge modification will have short-term adverse impacts to rail service during construction due to disruption in traffic.

4.4.2 Cultural Resources. No National Register-eligible cultural resources are known at any of the dredging, mitigation, or disposal sites.

Because one prehistoric archeological site is near the proposed fish mitigation site, the Corps will monitor clearing and excavation during the construction of the fish mitigation site. If unknown cultural materials are identified during construction, excavations will be halted and the State Historic Preservation Officer will be consulted to aid in evaluation of the find and to review plans for subsequent action pursuant to 36 CFR Part 800.11. Dependent upon the results of this coordination, appropriate Section 106 compliance will occur.

4.4.3 Native American Concerns. In 1986, drafts of 72 percent of the ships using Grays Harbor facilities exceeded the authorized project depth. The proposed project will provide adequate depths and widths for these ships and may in the future lead to the use of larger ships. Of concern to the tribal fishermen is the potential for an increase in the numbers of ships and the increase of ship movements. Ship movements currently reduce the potential net drift fishery by approximately 15 percent; any increase in ship movements could increase this lost fishing time.

The project, as proposed, will not lead to an immediate increase in the number of ship movements. Modifications to the existing railroad bridge will not significantly alter available fishing stations. Thus, existing harvest of allocated fish will not be affected in the short term. However, if the number of ship movements increases and additional disruptions to drift net fisheries occur, the ability of the treaty fishermen to harvest their proportion of each species will be affected. The degree of this impact will depend upon a number of factors including: the location of the increased ship movements, technology developments which may decrease ship loading time, additional berthing facilities which may be constructed, and changes in the commodities being shipped.

Management practices of the Quinault Tribe dictate the length of each fishing season by species and by timing. Seasons can, generally, be adjusted to ensure adequate harvest. Exceptions to this can occur when predicted run sizes underestimate actual run sizes and/or when disruption to fisheries extend through most of a very short run time. This project will not, in the short term, extend any of the existing disruptions to the term of the harvest management.

Consultation with affected Indian tribes residing on the Chehalis, Quinault, and Shoalwater Bay reservations has identified the main concern of Indian people as fishing rights in the Chehalis River in Grays Harbor. Concerns for effects on individual set net grounds have been addressed through a study of fishing practices on those grounds and modification of project plans to avoid effects.

Enlargement of the Elliott Slough turning basin could affect several known set net grounds, either directly, or through alteration of current patterns in the area. Alteration of current patterns could cause adult salmonids to change their passage patterns through the turning basin, potentially resulting in lower catch rates at current set net sites. Planned changes are not expected to affect tie or anchor points for these nets. If points are affected, they will be replaced in kind at the grounds; replacement will be coordinated with the Quinault Indian Nation (QIN) and ground user. The effect of the enlargement on fish passage patterns is difficult to predict, and will need to be determined by observing catch records through several seasons.

Changes to piles, widening of the railroad bridge, and removal of the two concrete highway piers near the Wishkah Mall could affect up to eight known individual set net grounds. Equivalent ties/anchors will be provided at the grounds, with replacement coordinated with the ground user.

4.4.4 Relationship of Plan to Existing Plans, Policies, and Controls:

a. Estuary.

Grays Harbor Estuary Management Plan. The Grays Harbor Regional Planning Commission has prepared, in cooperation with local, state and Federal agencies, a land use plan for the Grays Harbor estuary. Funding for this work was provided by the Office of Coastal and Ocean Resource Management under Section 306 of the Coastal Zone Management Act. The final plan and Federal EIS has been approved by all local communities. This plan provides a framework for local land use decisions. All aspects of construction of the Grays Harbor Navigation Improvement project are consistent with the final plan.

Department of Natural Resources Open-Water Disposal Site Management. The state Department of Natural Resources (DNR) has designated sites throughout the marine waters of Washington for open-water disposal of dredged material. If dredged material is approved for open-water disposal it may be deposited in the DNR sites; Grays Harbor material is considered by the Corps to be suitable for open-water disposal (see 3.2.1c.). The Point Chehalis and South Jetty disposal sites are not currently designated sites. The Point Chehalis site to be used for construction will be an expansion of the existing site presently used for maintenance of the existing project. Thus, both of these sites will be reviewed by the DNR-chaired interagency site selection committee. Disposal of dredged material for navigation improvement would be consistent with DNR policies and is expected to be approved for use in construction of the authorized project.

Clean Water Act, Section 404. In compliance with the Clean Water Act a supplemental Section 404(b)(1)/Section 102(a)/103 evaluation of the effects of disposal of construction dredged material in waters of the United States has been prepared (appendix C). The initial 404(b)(1) evaluation was based on a tentative conclusion that a portion of the construction dredged material would not be acceptable for unconfined in-water disposal. However, additional data obtained during PED have demonstrated that the dredged material is

for disposal at the proposed open-water sites. The additional data and their relevance to this conclusion are presented in appendix C. Pursuant to Section 404(r) of the Clean Water Act, an exemption from further requirements of the Clean Water Act was obtained when the FR/EIS was approved by Congress. Further coordination with EPA as outlined in the EPA comment letter (appendix H) will ensure compliance.

E.O. 11988, Flood Plain Management. Potential flood plain effects described in the FR/EIS will not occur by implementation of this alternative since slip 1 has already been diked. Therefore, project construction would have no effect on flood plain conditions in Grays Harbor.

E.O. 11990, Protection of Wetlands. The only wetlands (by Corps definition) that could be affected by the project are in the Slip 1 area and at the fish mitigation site. Slip 1 wetland areas have been altered due to diking and disposal in Slip 1 is permitted under a separate Section 404 permit. The altered wetlands would be lost, but the loss is not considered significant. Construction of the fish mitigation site would result in the enhancement of 4 acres of forested wetland, as it is replaced by 4 acres of productive intertidal marsh wetland. Therefore, project construction would have no significant effect on wetlands of Grays Harbor during Phase I of construction.

Coastal Zone Management Act. Conditions are unchanged since preparation of the FR/EIS. Thus, the project will be consistent with all applicable provisions of the state Coastal Zone Management program and the Coastal Zone Management Act.

Water Resources Development Act (WRDA) of 1976 (Public Law 94-587). During preparation of the FR/EIS a determination was made regarding the feasibility of establishing wetland areas by using dredged material. This is consistent with section 150 of the Act which requires evaluation of the potential for wetland creation in association with water resource development projects involving dredging. Alternative sites were evaluated but studies were terminated when the local sponsor withdrew support for the site selected for detailed study and offered alternative sites. The establishment of wetlands with dredged material in Grays Harbor will be further evaluated under the operations and maintenance program.

Endangered Species Act (ESA). Section 7 of the ESA (as amended, 16 U.S.C. 1531, et seq. 1973) requires all Federal agencies to ensure that any action they authorize, fund, or carry out will not jeopardize the continued existence of any endangered or threatened species or result in the destruction or adverse modification of any critical habitat of such species. Coordination with the U.S. Fish and Wildlife Service and the National Marine Fisheries Service, and related Corps assessment have resulted in the prediction that no endangered or threatened species will be adversely impacted as a result of the project.

National Historic Preservation Act (NHPA). Section 106 of the NHPA of 1966 (16 U.S.C. 407, et seq.) requires that all Federal agencies consider historic preservation in all federally funded projects. The general intent of this consideration is to protect those sites in the project area that are listed in or eligible for listing in the National Register. An archeological reconnaissance of the proposed fish mitigation site found no cultural resources at the site, but did reveal evidence of a nearby prehistoric archeological site. This adjacent site is not considered to be significant and does not appear to meet criteria for inclusion on the National Register of Historic Places. Monitoring for cultural resources at the fish mitigation site will continue throughout construction. A report documenting monitoring actions will be transmitted to the State Historic Preservation Officer.

A recent study of historic structures within the Aberdeen-Hoquiam area by the Office of Archeology and Historic Preservation revealed that the UPRR bridge across the Chehalis River at Aberdeen is not eligible for inclusion on the National Register of Historic Places. Literature search and side-scan sonar investigations of channel dredging and disposal sites located no cultural resources. The project is not expected to affect cultural resources.

National Environmental Policy Act (NEPA). Section 102(c) of NEPA (as amended, 42 U.S.C. 4341, et seq.) requires that Federal agencies prepare an EIS on proposal for major Federal actions significantly affecting the quality of the human environment. The object of NEPA is to incorporate into agency decisionmaking processes careful consideration of all environmental aspects of proposed actions and to provide an opportunity for public response. As such, this EISS has been prepared to address aspects of the proposed widening and deepening of the Grays Harbor channel that were not addressed in the 1982 EIS. Significant impacts to salmon habitat and Dungeness crabs are identified in this EISS.

b. Ocean.

Marine Protection, Research, and Sanctuaries Act (MPRSA) (Public Law 92-532. Commonly referred to as the Ocean Dumping Act, the MPRSA and implementing EPA Ocean Dumping Regulations (ODR) (40 CFR Parts 220-229) regulates the disposal of all types of materials, including dredged material, into the territorial seas of the United States. Primary requirements of the MPRSA and ODR define procedures for identifying appropriate ocean dumping sites, officially designating the sites, and determining the acceptability of the material to be placed at the sites. The purpose is to limit the disposal into ocean waters of any material which would adversely affect human welfare or amenities, the marine environment, ecological systems, or economic potentialities. The process is discussed in section 2.6 of the EISS. Designation of ocean dumping sites is the responsibility of EPA. On October 1, 1986, the authority to designate sites was delegated from the Administrator to the Regional Administrator of the Region in which the site is located. EPA Region 10 is the responsible agency for ocean dumping in the Pacific Northwest.

With regards to dredged material, the Corps of Engineers, under Section 103 of the MPRSA can permit the disposal of dredged material in the ocean subject to the restrictions contained in the ODR and subject to independent evaluation and concurrence by EPA. Seattle District and EPA Region 10 have coordinated closely regarding the ocean dumping components of this Federal project. Studies conducted during preparation of the FR/EIS and during PED established that the dredged material is suitable for in-water disposal either within estuarine or marine waters. The results of those studies are described in appendix C. Detailed site studies were conducted during PED to locate and evaluate suitable ocean disposal sites are discussed in chapter 2 of the EISS. These studies and documents will provide the basis for designation of the Southwest Navigation Lane ODMDS by EPA through formal rulemaking under Section 102 of the MPRSA. In addition, EPA is a cooperating agency on this EISS and will formally adopt the pertinent ocean disposal portions. The Corps will utilize their authority under Section 103 to authorize use of both sites with the concurrence of EPA. This process parallels that of EPA but does not require formal rulemaking. On completion of the designation process, all requirements of the MPRSA for site designation will have been met. The Corps and EPA will share management responsibilities of the designated Southwest Navigation Lane site pursuant to requirements of the MPRSA and ODR.

Clean Water Act (CWA). The CWA applies to those activities in inland waters and within the territorial sea. The territorial sea is defined as coastal waters from the baseline of the territorial sea (mean lower low water) seaward to 3 nautical miles. (Where the Grays Harbor estuary is encountered, the baseline starts along a line drawn from the seaward end of both harbor entrance jetties.) Since the proposed ocean disposal sites are seaward of the 3-mile territorial sea limit, the CWA does not apply to the ocean disposal aspects of the Grays Harbor widening and deepening project.

Coastal Zone Management Act. The project will be consistent with applicable provisions of the State Coastal Zone Management program and the Coastal Zone Management Act.

Endangered Species Act (ESA). Section 7 of the ESA (as amended, 16 U.S.C. 1531, et seq. 1973) requires all Federal agencies to insure that any action they authorize, fund, or carry out will not jeopardize the continued existence of any endangered or threatened species or result in the destruction or adverse modification of any critical habitat of such species. Corps biological assessments have predicted that no endangered or threatened species will be impacted as a result of dredging the channel, transport of dredged material, and disposal of that material in the ocean at designated disposal sites. Coordination with the U.S. Fish and Wildlife Service and the National Marine Fisheries Service, has resulted in letters of concurrence from both agencies. Collisions with gray whales could occur due to their characteristic lack of vessel avoidance; however, the likelihood of this occurring is remote. Dredge/disposal vessel captains will be instructed to be on the lookout for and attempt to avoid gray whales.

National Historic Preservation Act (NHPA). Section 106 of NHPA of 1966 (16 U.S.C. 407, et seq.) requires that all Federal agencies consider

historic preservation in all federally funded projects. The general intent of this consideration is to protect those sites in the project area that are listed in or eligible for listing in the National Register. During literature surveys (Shapiro and Assoc., 1986), records were found identifying vessels that sank just off of Grays Harbor. However, during ocean surveys at zones-of-siting-feasibility, no vessels or other archeological, cultural, or historic features were found at the proposed ocean disposal sites. This finding has been confirmed by side-scan sonar surveys designed to identify shipwrecks in impact areas.

National Environmental Policy Act (NEPA). Section 102(c) of NEPA (as amended, 42 U.S.C. 4341, et seq.) requires that Federal agencies prepare an EIS on proposals for major Federal actions significantly affecting the quality of the human environment. The object of NEPA is to incorporate into agency decisionmaking processes careful consideration of all environmental aspects of proposed actions and to give the public an opportunity to respond. As such, this EISS is prepared to address aspects of the proposed widening and deepening of the Grays Harbor channel, including ocean disposal of dredged material, that were not addressed in the recent project EIS (1982). EPA is a cooperating agency for the ocean dumping components of this EISS. EPA will formally adopt the final EISS to support their rulemaking package for designation of ocean disposal sites under Section 102(c) of the MPRSA. The EISS evaluates the ocean disposal sites proposed for use in conjunction with this project based on criteria and factors set forth in the MPRSA and ODR.

4.4.5 No Action. Under this alternative, transportation cost savings would not be realized. Trade and the local economy would not receive the expected benefits from the project.

4.5 Mitigation and Site Monitoring/Management Plans.

4.5.1 Dungeness Crabs. The approach to crab mitigation was developed over several years through coordination with resource agencies, biologists, and crab fishermen, and is also based on the results of several field studies conducted since 1982 by Seattle District Corps of Engineers, the University of Washington, and Battelle Marine Laboratory. Details of the mitigation and monitoring plan are given in appendix F.

a. Introduction and Background. Mitigation proposed in the 1982 EIS for losses of Dungeness crab from the Grays Harbor Navigation project focused on avoidance of entrainment by modification of dredging equipment. Because this method was shown in field tests to be unsuccessful, a combination of other approaches was considered.

The following adjustments were made in project plans to minimize adverse impacts to crabs: (1) scheduling of dredging to the extent practicable, to avoid times and areas of high crab densities; (2) locating offshore disposal sites to avoid high concentrations of crabs and interference with the crab fishery; and (3) use of clamshell dredges instead of hopper dredges wherever cost-effective to avoid entraining crabs.

Although these actions are embodied in the project schedule (see Table 2-1), some unavoidable losses will still occur. In order to mitigate for these, oyster shell habitat for juvenile crabs will be established in portions of Grays Harbor. This method has been shown to be effective in increasing the density of young-of-the-year (YOY) crabs (Dumbauld and Armstrong, 1987).

b. Recommended Crab Mitigation Plan. The project would result in an estimated crab loss (construction plus incremental maintenance dredging for 50 years) equivalent to approximately 281,000 crabs of harvestable size (see section 4.3.1 a(1) for impacts). The recommended plan for mitigation of these losses would require the purchase, transportation, and distribution of approximately 1.8 million bushels (82,000 c.y.) of oyster shell over a period of 50 years (the economic life of the project). If the mitigation techniques prove effective during the life of the project, mitigation after the end of the 50-year period will continue, commensurate with the level of incremental maintenance dredging occurring each year.

The oyster shell will be distributed among selected sites in the North Bay area of Grays Harbor and monitored over a period of 11 years after initial construction to evaluate the effectiveness of the shell as crab habitat, the location of the mitigation site, and the stability of the shell plots. After each year of monitoring, the mitigation plan will be evaluated by the Corps. The evaluation will be coordinated with resource agencies and other interested parties to determine whether or not mitigation efforts have been successful (see Appendix F for details). The amount of shell and/or frequency of mitigation may be adjusted based on factors such as crab density and shell longevity/density. If, at any time through the monitoring period, surveys and/or evaluation of impacts indicate that the mitigation plan is not practicable, the Corps of Engineers, in consultation with State and Federal agencies, Indian tribes, and local scientists, will determine what practicable corrective measures, if any, to implement.

The amount of shell needed for construction impacts will be determined by monitoring during construction. The monitoring will consist of trawl samples taken from February-September at 13 stations located in the navigation channel from the Entrance to Moon Island Reach. At least 2 replicate samples at each station will be collected for each month during the first year of construction. The data obtained will be used in conjunction with the crab impact model (Armstrong et al. 1987) to assess crab impacts from construction dredging in the outer harbor reaches. Because some shell habitat mitigation (based on present estimates) will occur in April of the first year of construction (before trawling is completed), any necessary adjustments in shell amount due to data collected from channel monitoring will occur in later mitigation efforts.

Seattle District has requested the use of the Yaquina for entrainment sampling (i.e., with concurrent trawl samples) during August 1989 to augment the crab impact model (see Appendix F); however, approval of this request depends upon modification of a previously established schedule. The ESSAYONS will be used for maintenance dredging of the Bar, and time-specific, site specific samples will be collected on the Bar, for which a discrete data set will be generated apart from the model.

Attenuation of impacts from maintenance dredging will be sought through continued evaluation of specific schedules for maintenance dredging in the harbor and gathering information from other Corps districts, Waterways Experiment Station (WES), and publications on dredging technology which may provide alternative ways to minimize impacts. Funding will be sought through the Dredging Research Program at WES to pursue behavior studies on Dungeness crabs for a better understanding of avoidance behavior in crabs, as well as methods to repel crabs from the dredge. Consideration will be given not only to the timing of dredging, but especially to dredges (e.g., larger clamshell dredges) which may be cost effective for use in the outer reaches of the harbor and would minimize impacts on Dungeness crabs.

The recommended mitigation site (plate 1) are located in the North Bay area of Grays Harbor in the vicinity of Ned's Rock. Criteria for site selection include: (1) state-owned (i.e., Washington Department of Natural Resources) intertidal and; (2) reasonably firm substrate; (3) gently sloping intertidal area; (4) low siltation rate and current velocity; (4) accessible by barge at high tide; (5) area of high crab density; (6) absence or low density of ghost shrimp; (7) absence or low density of eelgrass.

4.5.2 Salmon Habitat. Extensive research has shown that juvenile salmonids require sufficient shallow-water habitat along their migratory route through brackish portions of estuaries to feed, avoid predators, and complete physiological changes required for successful transition from fresh water to saltwater. Availability of shallow-water areas are, therefore, considered to be directly related to juvenile salmonid survival and indirectly related to percent adult return. State and Federal agencies, local Indian groups, academic experts, environmental interest groups, and the Seattle District, Corps of Engineers concur that shallow-water estuarine habitat provides a critical link in salmonid survival. As a result, a mitigation site plan has been developed to mitigate for loss of juvenile salmonid habitat. The loss of about 2 acres of shallow subtidal habitat due to turning basin widening and deepening will be mitigated by the construction of 4 acres of valuable intertidal habitat. The proposed project utilizes the most cost-effective, technically feasible mitigation site design that provides replacement habitat of equivalent biological value and was selected by the Corps as the design most likely to succeed. Full details of the mitigation plan are given in the USFWS Coordination Act Supplemental Report (appendix E).

The current mitigation site plan includes construction of an artificial slough, placement of large organic debris (LOD), or logs, and planting of Lyngbys sedge (*Carex lyngbye*). Monitoring will occur to verify the utilization of the constructed site by juvenile salmonids. Due to funding considerations, pre-construction monitoring as recommended in the USFWS Coordination Act Report (Appendix E) will take place immediately prior to construction and not in the year prior to construction. Pre-construction monitoring will be done for juvenile salmonid abundance, predator prey abundance, and water quality. Monitoring will be done in post-construction years 1, 2, 4, 7, and 9 for large organic debris, sedimentation, water quality; post-construction years 0, 1, 2, 4, and 9 for juvenile salmonid

abundance, predator abundance, and prey abundance; and 2, 3, 4, 7, and 9 for sedge. Additionally, LOD and sedimentation will be monitored every 5 years throughout the remainder of the 50-year project life. Monitoring will occur at the new channel site and at a control site, an existing slough (Ann's Slough) located east of the mitigation site. To protect these sloughs from external factors which could affect their suitability for salmonid habitat, 100-foot buffers will be provided around the mitigation site and control slough. The Corps of Engineers will be responsible for protection and maintenance of the 4-acre fish mitigation channel; the Port of Grays Harbor will be responsible for protection and maintenance of the 18-acre buffer and the Ann's Slough control site. All key resource agencies will be kept informed of monitoring progress and results. Success will be determined by statistical analysis of data from the two sloughs. If, at any time through the monitoring period, surveys and/or evaluation of impacts indicate that the mitigation plan is not practicable, the Corps of Engineers, in consultation with State and Federal agencies, Indian tribes, and local scientists, will determine what practicable corrective measures, if any, to implement. If water quality problems or distressed fish are observed during construction, practicable corrective measures will be taken. A detailed description of the mitigation and monitoring design can be found in appendix E.

4.5.3 Ocean Disposal Site Management and Monitoring Plan. A conceptual ocean disposal site management and monitoring plan for the two candidate Eight-Mile and Southwest ocean disposal sites appears in appendix B. This conceptual plan describes the sites, the disposal operations, and the monitoring plan.

4.5.4 Native American Concerns. The QIN fishing right at the project is a tribal right, not held by individuals even though it is exercised by individuals. Impacts to Native American fishing rights will be minimized through a combination of construction modifications and post-construction coordination. As previously stated, every effort to duplicate the ties and anchors for set nets would be made as part of the construction process of the Elliott Slough turning basin and the changes to the piers and pilings of the railroad bridge and highway piers. Should these techniques prove insufficient to provide QIN fishers with pre-project conditions, any claims must be attributable to project construction and substantiated by fisheries data on losses by species for the claim period. Seasonal catch data from set net locations unaffected by the project would be compared to loss claims to correct for normal variation in run sizes by year. Other factors, such as weather or floating debris impacts to the individual site, changes in fishing practices or level of fisher effort, would have to be eliminated as well to validate a claim. Compensation arrangements would be addressed through coordination if a claim is substantiated, and responsibility for such compensation would depend on the nature of the problem.

4.6 Unavoidable Adverse Environmental Effects.

4.6.1 Dungeness Crab Mortality. The construction dredging schedule for the proposed project has been carefully considered to minimize impacts to crabs wherever practicable. It is based on the best available data on Dungeness

crab life history, ecology, and population dynamics and estimates of crab losses derived from a mathematical impact prediction model. However, some crabs will be killed as a result of construction dredging as well as incremental maintenance dredging.

Predicted losses from construction range from about 44,000 to 76,000 harvestable size (age 3+) crabs (based on mean and high crab populations, respectively). Crab losses from incremental maintenance dredging over the life of the project range from about 204,300 (based on the mean population) up to 438,600 harvestable crabs (high population estimate, see section 4.3.1.a.1). The most reasonable prediction of crab losses from the project is a combination of the high, or worst case, estimate for construction impacts (i.e., 76,000 harvestable size crabs) and the loss based on the mean population estimate for incremental maintenance dredging losses (i.e., 204,300 harvestable-size crabs).

The rationale for combining these two different estimates is as follows. Construction will occur over a relatively short period of time, with most impacts resulting from the first year of construction, and it is possible that a high crab population would be present at that time. In order to adequately plan for mitigation, the worst case estimate is being used to predict construction impacts. Conversely, incremental maintenance dredging will occur over a 50-year period and the long-term average, or mean, is the more appropriate basis for loss prediction. The combination of these estimates, 76,000 harvestable-size crabs (construction losses) and 204,300 harvestable-size crabs (incremental maintenance dredging losses) results in a total predicted loss of approximately 281,000 harvestable-size crabs valued at $968,000. Annual incremental (i.e., in addition to existing) maintenance dredging after construction will result in losses of approximately 46,000 crabs per year (all sizes), which is equivalent to 4,100 crabs of harvestable size (i.e., age 3+). These losses will be mitigated through establishment of oyster shell crab habitat (see section 4.5.1).

4.6.2 Other Dredging Impacts. In addition to losses of crabs, dredging associated with the proposed project would remove or destroy some sessile and motile species of macroinvertebrates in the navigation channel. Some of these invertebrates (e.g., ghost shrimp) are important food sources for sport and commercial fish species in Grays Harbor, however, recolonization of disturbed areas by these invertebrates is expected to be rapid. Two acres of shallow subtidal fish feeding and rearing area in the inner harbor would be changed to deeper subtidal habitat through dredging but will be mitigated by converting 4 acres of nearby forested wetland to productive intertidal marsh habitat. Some minor, temporary decrease in water quality would occur in the immediate vicinity of dredging operations.

4.6.3 Disposal Sites. Temporary reductions in water quality at and around the disposal sites will occur during disposal operations. These will include minor depression of dissolved oxygen, increases in turbidity, and release of organic matter. These effects will be primarily associated with the disposal plume. Though they may be measurable throughout the water column, the effects will be most noticeable in the bottom layer, near the sediment/water interface

(the nepheloid layer). Any releases of floatable particles could reside at least temporarily the sea-surface microlayer. Additionally, the risk of incidental oil spills associated with the disposal equipment will be increased at the disposal sites. These adverse effects on water quality will be minor and temporary, largely due to rapid dilution and dispersion of suspended sediment.

Sessile benthic species at the disposal sites will be smothered during dispersal of dredged material. A few may survive at the outer edge of the site where the deposition is thin enough to allow them to resurface. Some species, such as the razor clam, may survive burial, even at the disposal center, depending on depth, pattern, and timing of sediment discharged. The Southwest Navigation Lane site will be recolonized by benthic species after disposal, but this recolonization will not likely lead to establishment of a mature benthic community because of yearly use of the site for disposal of bar sand. As such, benthic community composition at the site would likely be permanently modified. However, the most prominent species found at the site, Owenia fusiformis, is one typical of disturbed areas and may continually recolonize the site.

Intermittent disruption of the water column during disposal operations will temporarily displace pelagic species from the disposal site. Those individuals located within and immediately adjacent to the discharge zone during dispersal may experience added stress during avoidance reactions. However, given the short-term, temporary, and localized nature of the water column impacts, these effects would not be considered significant. Bottom-feeding fish and crabs that utilize the site will be temporarily displaced from the area. By limiting the size of the disposal site, species displacement impacts will be minimized. Disposal activities will intermittently disturb birds and marine mammals in the area during the disposal period, but are not expected to have any significant impacts on those species.

Use of the site will result in temporary, localized, and intermittent disruption of navigation. Coordination via a Notice to Mariners is expected to minimize these disruptions. Commercial fishing, primarily commercial crab fishing and trolling, in the disposal areas would be temporarily interrupted by disposal activities. Minor decreases in water quality would occur at and near the disposal sites. The dredged material, however, is similar in sediment particle size to disposal site sediments, therefore, long-term changes in disposal area biota are not anticipated.

4.7 Relationship Between Local Short-Term Uses of the Environment and Maintenance and Enhancement of Long Term Productivity. The recommended project would enhance commercial and industrial shipping opportunities in the local area by providing more efficient means of transporting goods.

Two acres of intertidal and shallow subtidal salmon habitat would be removed but would be mitigated via construction of a 4-acre intertidal fish mitigation site and provision of 18 acres of buffer.

Four acres of forested wetland would be lost at the fish mitigation site, but would be replaced by four acres of productive intertidal marsh wetland.

Dredging and dredging-related activities will have a significant impact on the crab population, which could affect the overall commercial crab fishery in the Grays Harbor area. The income of some Grays Harbor residents is dependent on the commercial crab fishery. Mitigation of this impact is critical. If successful, crab production will not be significantly altered in the long-term. The full extent of project impacts and mitigation to the fishery are discussed in sections 4.3.1 and 4.5.1.

Removal and disposal of some sediments in the confined disposal site will result in creation of additional upland areas. Shortly after filling, Slip 1 will be converted into a log storage area.

Expansion of local industrial development is not predicted as a result of the implementation of the recommended plan. Long-term, indirect project effects to local resources are not expected to occur.

4.8 Irreversible or Irretrievable Commitment of Resources. The capital and labor necessary to dredge the channel, modify the bridge, fendering, and relocate utilities would be committed irreversibly and irretrievably. This includes the capital and labor associated with construction activities, administration, personnel, operations, maintenance, and petroleum products used. In addition, subtidal lands to be dredged and materials used will be irreversibly committed through the life of the project. Restoration of the substrate and reuse of discharged dredged material would not be possible.

SECTION 5. PUBLIC INVOLVEMENT

5.1 Public Involvement Program. Extensive public and agency coordination was completed during preparation of the final FR/EIS in September 1982. The previous coordination detailed in the report is incorporated by reference into this supplement. Coordination during the PED phase of the Grays Harbor study represented a continuation of the interactions which were initiated during preparation of the FR/EIS. Invitation to participate in project planning and design was extented to an extensive list of Federal, state, and local agencies, Indian tribes, organized environmental groups, and interested individuals. Those who chose to regularly participate include the U.S. Environmental Protection Agency, the National Marine Fisheries Service, the U.S. Fish and Wildlife Service, the State departments of Fisheries, Wildlife, and Ecology, the Friends of the Earth, and the crab fishermens association. Several mechanisms, both formal and informal, were utilized during CP&E to provide opportunity for input to the project planning process.

Coordination was initiated in April 1984 via a scoping process to obtain input in developing a plan of action to address issues of concern during the PED phase of the project. Scoping resulted in identification of a number of issues and concerns which were addressed through appropriate studies, analyses and evaluations throughout PED. The principal issues addressed are summarized in section 1 of this EISS.

Workshops were held on an as needed basis to update study participants on the status of individual technical studies and to solicit their input regarding potential adjustment in study direction. At times workshops were scheduled to discuss in detail a specific issue or issues. For example, an intensive one-day workshop was held in October, 1985 to discuss the issues of sediment transport from the Point Chehalis disposal site and the status of studies on contaminant characteristics of sediments to be dredged. This workshop included invited experts from the University of Washington and consulting firms as well as the regularly participating agencies identified above. In other cases, workshops were organized to provide status and solicit input on all aspects of the project. Major workshops of this second type were held in October, 1986, and November, 1987, when most technical studies were nearing completion and a preliminary project plan could be presented. A number of smaller meetings were also held to apprise agency representatives, or interested groups, of the status of particular studies.

Informal dialogue was maintained via informal memoranda, meetings and telephone contact with interested agencies throughout the planning process. This interaction was very important in obtaining opinions to assist in adjusting study direction on a daily or weekly basis. Virtually all project features and issues were discussed over a 3-year study period.

The several technical studies undertaken during project development resulted in preparation of technical reports. These reports were routinely provided to

study participants in draft form to obtain their input and to provide them with information on study status. Final reports were also provided to participants.

5.2 Special Technical Coordination. There were two issues to be addressed during the PED phase that necessitated the formation of panels or committees of experts so that best available expertise could be obtained. These two issues were impacts on Dungeness crabs and designation of ocean disposal sites.

a. Crab Study Panel. The crab study panel consisted of regional and national experts in Dungeness crab ecology, fisheries management and crabbing as well as experts in dredging equipment and operations. This panel held three meetings (August, 1984; September, 1984 and December, 1986). The first two meetings focused on evaluation of 26 potential options for avoiding or mitigating crab losses during construction of the Grays Harbor project with eventual recommendation of options for further study. These options in order of priority included: (1) evaluation of operational scheduling changes to reduce crab losses; (2) modification of hopper dredge draghead; (3) evaluation of shell cover habitat to mitigate for crab losses; (4) use of attractants to lure crabs out of the dredging area; and (5) monetary compensation for crab losses as a last resort. The draghead modification was regarded by the panel as the most promising option to investigate after scheduling and operational changes. Items 1, 2, and 3 above were addressed in detail through special studies whereas the last issue is a matter of policy rather than a technical consideration. The third crab study panel meeting was devoted to evaluation of crab study results. Results of studies recommended by the panel as well as entrainment, population, and impact analyses were reviewed by the panel and conclusions were documented. Major conclusions were that: (1) studies do not indicate that crab losses can be significantly reduced by modifying the dredge draghead; (2) the approach by Seattle District and its contractor to evaluation of crab impacts is the best available method; (3) it is of much higher priority to protect the 1+ and older crabs than the young-of-the-year crab; (4) estimated crab losses could have an economic effect on the crab fishery; (5) provision of additional shell cover is a technically viable method of increasing crab habitat; and (6) disposal of dredged material in the ocean beyond the 100-foot contour would better minimize impacts to the crab fishery than disposal at shallower locations. Monetary compensation for crab losses is not authorized at this time.

b. Ocean Disposal Review Board. The Ocean Disposal Review Board was established to insure that the approach (including technical studies) pursued to designate ocean dredged material disposal sites was consistent with comparable projects nationwide. Representation included nationwide experts on dredging procedures and effects, EPA national and regional offices, Corps national office, division office, and research laboratory, and an expert in Washington state fisheries resources. Board meetings were held in September 1984, April 1985, and January 1987. Helpful and important recommendations were provided by the board which have been incorporated into the ocean disposal site selection and management strategy described in section 2.

5.3 Required Coordination. In addition to the public workshops and meetings described above, extensive coordination with other agencies, as required by Corps regulations, has been accomplished in this EISS. In particular, the Fish and Wildlife Coordination Act (FWCA) requires that the FWS prepare a report which evaluates the fish and wildlife aspects of Federal water resource development projects. Such a report was prepared for the Grays Harbor Navigation Improvement project and is included in the FR/EIS. During PED, coordination was continued with the FWS, who prepared planning aid letter reports to assist in project planning and design for minimizing impacts to fish and wildlife resources and also completed a supplement to the FWCA report (appendix C). In addition, the FWS was responsible for preparing and coordinating the design of new salmon habitat mitigation sites. Results of this effort are contained in appendix C.

A public information meeting was held on 17 May 1988 jointly by the Corps and Port of Grays Harbor. The purpose of the meeting was to discuss the recommended project and its impact on the local community and for the public to make comments on the draft EISS. Comment letter on the draft EISS received in May and June 1988 are in appendix H. Over 30 people spoke in favor of the project, and a few expressed concerns about environmental impacts. Copies of statements made at the public information meeting and letters of support for the project are presented in appendix E of the GDM. In addition the Port conducted a public information meeting on 13 August 1987 to provide the public an opportunity to make comments on the Port's role in the recommended project and discuss impacts of the project. On 23 January 1989, the Quinault Indian Business committee unanimously passed a resolution supporting the project.

A Notice of Intent to Prepare a Draft Supplemental Environmental Impact Statement was published in the Federal Register on 12 November 1987. The EISS was formally filed with the Environmental Protection Agency at that time and a Notice of Availability placed in the Federal Register on 29 April 1988. The public and agency 45-day review period will be from 29 April to 13 June 1988. The report was provided to those parties listed in Section 5.4, as well as those who requested a copy in response to the Notice of Availability.

As a separate action, EPA Region 10 will publish a proposed rule in the Federal Register for formal designation of the Southwest Navigation Lane ODMDS. There is a 45-day public review period for the draft rule. Comments received on the draft rule will be responded to in the final rule. It is anticipated that the draft rule will appear in the Federal Register approximately 45 days after filing of the final EISS.

5.4 Statement Recipients. Comments on the draft EISS1 were requested of the agencies, groups, and individuals listed in appendix G.

5.5 Response Letters. Comment letters on the draft EISS 1 are included in appendix H, along with proponent responses to these comments.

SECTION 6. LIST OF PREPARERS

Principle Contributors	Discipline/Expertise	Experience	Role in Preparing EISS
Marcia Geidel, M.S.	Outdoor Recreation/ Environmental Planner	7 yrs. recreation/ environmental planning Corps of Engineers; 10 yrs. recreation research and programs.	Environmental Coordinator (1987 to present).
Kay McGraw, Ph.D.	Biologist	Biologist, Corps of Engineers (IPA)/ University of Washington, 4 yrs. Marine Biologist, Gulf Coast Research Laboratory, Mississippi, 6 yrs; Naturalist, National Park Service, 2 yrs.	Effects on crab resource; formulation of crab mitigation plan; environmental coordination; editing; water quality/sediment evaluation.
J. Anne Shaffer, M.A.	Marine Biologist/ Zoologist	Biologist, Corps of Engineers, 6 mo; Biologist, U. Of W., 1-1½ yrs; Biologist, Moss Landing Marine Laboratory, 3 yrs.	Technical coordinator for fish mitigation; impacts to crab resources.
Fred Weinmann, Ph.D.	Biologist/Ecologist	Biologist, Corps of Engineers, 15 yrs; Marine Biologist, State of Washington, 1 yr; U.W. Research Assistant, 3 yrs.	Overall EISS overview and 404 evaluation.
David Munsell, Ph.C.	Cultural Resources/ Archeologist	Archeologist, Corps of Engineers, 15 yrs. Archeologist, Univ. of Washington, 8 yrs.	Evaluation of cultural resources/project impacts.
Jeff Laufle, M.S.	Fisheries Biologist	3½ yrs., Corps of Engineers, ½ yr. BioSonics, Inc., 3 yrs. Univ. of Washington, ½ yr. U.S. Fish and Wildlife Service, 1½ yrs. Univ. of Michigan.	Effects on fish resources, technical coordination.

Lawr Salo, B.S.	Archeologist	Corps of Engineers, 13 yrs., State, 9 yrs.	Coordinator of Quinault Indian Fishery Study. Technical coordinator.
Karen Bowers, M.S.	Natural Systems Analyst	2 yrs., Shapiro and Associates; 3 yrs. U.W. School of Fisheries; 1 yr., UNC-Chapel Hill Institute of Marine Science	Final Report Preparation/ Coordination.
Dave DesVoigne, Ph.D.	Biologist	Corps of Engineers, 1 yr.; Tulalip Tribes, 4 yrs.	Technical input to fisheries resource sections of EISS.
Ken Brunner	Wildlife Biologist	13 yrs., Corps of Engineers	Wildlife and Endangered Species.
Michael Scuderi, Ph.C.	Geographer	5 yrs., Corps of Engineers.	Contributed to socio-economic analysis and document organization.
John Wakeman, Ph.C.	Biologist	7 yrs., Corps of Engineers	Contributed to document preparation and organization.
Mike McNeely	Biologist/Planner	Biologist Planner, Corps of Engineers, 18 yrs; Aquatic Biologist, Wash. Dept. of Game, 2½ yrs., Heath Tecna (CRITON) Quality Control Laboratory Technician, 2½ yrs.	Document organization, editing, bridge environmental analysis.
Stephen Martin, Ph.D.	Biologist	Corps of Engineers, 13 yrs; Puerto Rico Nuclear Center, 2 yrs.	Overall review of environmental input to EISS.

Ann R. Uhrich B.S.	Environmental Planner	Environmental Planner, Corps of Engineers; 3 yrs; Environmental Impact Study Corporation, Hawaii, 3½ yrs., EPA 1 yr.	Environmental coordinator (1985-1987).
Gail M. Arnold, B.S.	Biologist/Environmental Planner	Environmental Coordinator, Corps of Engineers, 3 yrs.	Environmental coordinator (1987), contract manager.
Eric Braun	Wildlife Biologist	Biologist/Environmental Planner, Corps of Engineers, 8 yrs.	Ocean disposal environmental analysis.
James O. Waller, Ph.D.	Water Resources Planning/Geohydrologist	Life Cycle Project Manager, Corps of Engineers, 17 yrs; Water Resources Specialist, State of Virginia, 2 yrs.	Project Manager, Formulation of Alternatives Needs Assessment, Economic Evaluation, Public and Agency Coordination.
Claudia Delacoeur, A.S.	Engineering Technician	Corps of Engineers, 5 yrs.	Technical Support.
Louie Read B.S.	Engineering Technician	3 yrs., NOAA: 11 yrs., Corps of Engineers.	Technical Support
David Rice Ph.D.	Archeologist/ Planner	Corps or Engineers 7 yrs.; Professor, University of Idaho, 10 yrs.	Technical Review of Cultural Resources/Native American Concerns
John Malek M.A.	Environmental Planner	Ocean Dumping Coordinator, EPA Region 10, 2 years; Environmental Planner, Corps of Engineers, 13 yrs.	Ocean Disposal Site Designation Analysis; Environmental Coordinator (1977-1980)

SECTION 7. REFERENCES

Armstrong, D. A., B. G. Stevens, and J. C. Hoeman. 1982. Distribution and abundance of Dungeness crab and Crangon shrimp, and dredging-related mortality of invertebrates and fish in Grays Harbor, Washington. Technical Report by School of Fisheries, University of Washington to Washington Department of Fisheries and U.S. Army Corps of Engineers, 349 pp.

Armstrong, D. A. and B. Gutermuth. 1984. Juvenile Dungeness crab distribution and population abundance offshore of Willapa Bay and a comparison to other areas along the Washington coast. Report to the U.S. Army Corps of Engineers, Seattle District, 22 pp.

Armstrong, D. A., D. R. Gunderson, C. Rogers, and K. R. Carrasco. 1984. Juvenile Dungeness crab population dynamics offshore and in estuaries: Review of literature and analysis of data (1983). Report to the U.S. Army Corps of Engineers, Seattle District, 75 pp.

Armstrong, D. A., and D. R. Gunderson. 1985. The role of estuaries in Dungeness crab early life history: A case study in Grays Harbor, Washington. Pp. 145-170 In: Proc. Symp. on Dungeness Crab Biology and Management. Univ. of Alaska, Alaska Sea Grant Rpt. No. 85-3.

Armstrong, D. A., D. R. Gunderson, and J. L. Armstrong. 1985. Juvenile Dungeness crab population dynamics in the offshore of the Grays Harbor estuary, spring and summer, 1984. Report to the U.S. Army Corps of Engineers, Seattle District, 59 pp.

Armstrong, D. A. and J. L. Armstrong. 1985. Juvenile Dungeness crab distribution and population abundance offshore of Grays Harbor, proposed ocean disposal area, June 1985. Report to the U.S. Army Corps of Engineers, Seattle District and Battelle Pacific Northwest Laboratories, 15 pp.

Armstrong, D. A. and J. L. Armstrong. 1986. Juvenile Dungeness crab distribution and population abundance offshore of Grays Harbor, proposed ocean disposal area, September 1985. Report to the U.S. Army Corps of Engineers, Seattle District and Battelle Northwest Laboratories, 21 pp.

Armstrong, D. A., J. L. Armstrong, and D. R. Gunderson. 1986. Juvenile Dungeness crab population dynamics in Grays Harbor and Willapa Bay and along the adjacent coast, spring and summer, 1985. Report to the U.S. Army Corps of Engineers, Seattle District, 43 pp.

Armstrong, D. A., T. C. Wainwright, J. Oransanz, P. A. Dinnel, and B. R. Dumbauld. 1987. Model of Dredging impact on Dungeness crab in Grays Harbor, Washington. Report to U.S. Army Corps of Engineers, Seattle Disrict Office, and Battelle, Pacific Northwest Laboratories. 152 pp.

Armstrong, D. A., L. Botsford, and G. Jamieson. 1989. Ecology and population dynamics of juvenile Dungeness crab in Grays Harbor estuary, Washington, and adjacent nearshore waters. Report to U.S. Army Corps of Engineers, Seattle District, and Battelle, Pacific Northwest Laboratories.

Barry, S. 1985. Overview of the Washington coastal Dungeness crab fishery. Pp. 33-36 In: Proc. Symp. on Dungeness Crab Biology and Management. Univ. of Alaska, Alaska Sea Grant Rpt. No. 85-3.

Brown, D. W., S. L. Chan, A. J. Friedman, K. L. Grams, D. G. Burrows, and W. D. MacLeod, Jr. 1985. Bioaccumulation Study: organic compounds in sediment and biota from Grays Harbor and reference area. Report by National Marine Fisheries Service, NOAA, for U.S. Army Corps of Engineers, Seattle District, 90 pp.

Calambokidis, J., G. H. Steiger, and J. C. Cubbage. 1987. Marine mammals in the southwestern Strait of Juan de Fuca: Natural history and potential impacts of harbor development in Neah Bay. Final report for Seattle District, U.S. Army Corps of Engineers. Seattle, Washington. 103 pp.

Cirone-Storm, P. 1983a. The relationship of fecal coliform distribution to dredging and disposal operations at Grays Harbor, Washington. Volume I. Tech. Report. U.S. Army Corps of Engineers, Seattle District, 62 pp.

Cirone-Storm, P. 1983b. The relationship of fecal coliform distribution to dredging and disposal operations at Grays Harbor, Washington. Volume II. Tech. Report. U.S. Army Corps of Engineers, Seattle District, 125 pp.

Coley, T. C., G. T. McCabe, R. I. Emmett, and R. J. McConnell. 1986. Juvenile lingcod outer harbor field survey. Grays Harbor Navigation Improvement Project. Final Report for U.S. Army Corps of Engineers, 43 pp.

Conomos, T. J., M. G. Gross, C. A. Barnes, and F. A. Richards. 1972. In River-Ocean Nutrients Relations in Summer, pp. 151-175. In: A. T. Pruter and D. L. Averson (eds.) The Columbia River Estuary and Adjacent Ocean Waters. Bioenvironmental Studies. University of Washington Press. Seattle, Washington.

Day, M. E., C. A. Coomes, P. L. Striplin, and D. Grosse. 1986. Review and annotated bibliography of juvenile lingcod and flatfish populations inhabiting Grays Harbor with reference to potential adverse impacts caused by dredging. Report prepared by Evans-Hamilton, Inc. for U.S. Army Corps of Engineers, Seattle District. 140 pp.

Dinnel, P. A., D. A. Armstrong, and B. R. Dumbauld. 1986a. Impact of dredging and dredged material on Dungeness crab, Cancer magister, in Grays Harbor, Washington during October 1985. Final report to the U.S. Army Corps of Engineers, Seattle District, 30 pp.

Dinnel, P. A., D. A. Armstrong, B. R. Dumbauld, and T. C. Wainwright. 1986b. Impact of dredging on Dungeness crab, Cancer magister, in Grays Harbor, Washington during August 1986. Final report to U.S. Army Corps of Engineers, Seattle District, 34 pp.

Dumbauld, B. R. and D. A. Armstrong. 1987a. A pilot study for the introduction of intertidal shell habitat to mitigate potential dredging impact on juvenile Dungeness crab populations in Grays Harbor, Washington. Report to the U.S. Army Corps of Engineers, Seattle District, 50 pp.

Dumbauld, B. R.., D. A. Armstrong, and A. R. Black. 1987b. Distribution and abundance of Dungeness crab, Cancer magister, in Grays Harbor, Washington, and in the adjacent nearshore during fall/winter 1985/1986. Report to the U.S. Army Corps of Engineers, Seattle District, 84 pp.

Evans-Hamilton, Inc. 1989. The identification and evaluation of potential historic properties in the Grays Harbor, Washington navigation improvement project. Draft report submitted to U.S. Army Corps of Engineers, Seattle District.

Gunderson, D. R., D. A. Armstrong and C. Rogers. 1985. Sampling design and methodology for juvenile Dungeness crab surveys. Pp. 135-144 In: Proc. of the Symposium on Dungeness Crab Biology and Management. Univ. of Alaska, Alaska Sea Grant Rept. No. 85-3.

James, K. and V. Martino. 1986. Grays Harbor and Native Americans. Report submitted to U.S. Army Corps of Engineers, Seattle District, 175pp.

McGraw, K., L. L. Conquest, J. O. Waller, P. A. Dinnel, and D. A. Armstrong. 1988. Entrainment of Dungeness crabs, Cancer magister DANA, by hopper dredge in Grays Harbor, Washington. Journal of Shellfish Research, Vol. 7, No. 2, 219-231.

Malme, C. I., and C. F. Colaruotolo. 1976. Results of blast pressure measurements, drill rig, George F. Ferris, removal project, Kachemak Bay, Alaska. Report by Bolt, Beranek, and Newman, Inc., to Dames and Moore, Anchorage, Alaska.

Moulton, L. L. 1977. An ecological analysis of fishes inhabiting the rocky nearshore regions of northern Puget Sound, Washington. Ph.D. Thesis, University of Washington, 181 pp.

Pearson, W. H. 1984a. Effects of dredged materials from Grays Harbor on crab chemoreception. Progress report prepared by Pacific Northwest Laboratory for U.S. Army Corps of Engineers, Seattle District, 5 pp.

Pearson, W. H. 1984b. Summary of the second meeting of the crab study panel examining options for the avoidance or mitigation of crab losses during dredging of Grays Harbor, Washington. Preliminary report prepared by Battelle/Marine Research Laboratory for U.S. Army Corps of Engineers, Seattle District, 5 pp.

Pearson, W. H. 1985a. Options for avoidance and mitigation of crab losses during dredging of Grays Harbor, Washington. Summary of the first two meetings of the crab study panel in August 1984 and September 1984. Report to the U.S. Army Corps of Engineers, Seattle District, 21 pp.

Pearson, W. H. 1985b. Effects of dredged materials from Grays Harbor on crab chemoreception. Second Progress Report prepared by Battelle/Marine Research Laboratory for U.S. Army Corps of Engineers, Seattle District, 7 pp.

Pearson, W. H. 1987a. Conclusions of the third meeting of the crab study panel examining issues related to Dungeness crab for the Grays Harbor Navigation Improvement Project. Report prepared by Battelle Pacific Northwest Laboratory for U.S. Army Corps of Engineers, Seattle District, 22 pp.

Pearson, W. H. 1987b. Qualitative assessment of impacts on Dungeness crabs from disposal of dredged materials from Grays Harbor, Washington. Final report prepared by Battelle/Marine Research Laboratory for U.S. Army Corps of Engineers, Seattle District, 29 pp.

Pearson, W. H. and D. L. Woodruff. 1987. Effects of dredged materials from Grays Harbor on bait odor response in Dungeness crab (Cancer magister). Final report prepared by Battelle/Marine Research Laboratory for U.S. Army Corps of Engineers, Seattle District, 48 pp.

Pearson, W. H., D. L. Woodruff, P. Wilkinson, and J. S. Young. 1987. Data report for the 1984-1985 ocean surveys to investigate potential ocean disposal sites off Grays Harbor, Washington. Report prepared by Battelle/Marine Research Laboratory for U.S. Army Corps of Engineers, Seattle District, 183 pp.

Phipps, J. P. 1982. Coliform-sediment relationships in the Cow Point turning basin dredged materials. Report prepared by Grays Harbor College for U.S. Army Corps of Engineers, Seattle District, 44 pp.

Pierson, K. B., J. W. Nichols, G. C. McDowell, and R. E. Nakatani. 1983. Grays Harbor, Washington, dredged sediments: an assessment of potential chemical toxicity and bioaccumulation. Report by Fisheries Research Institute, University of Washington, for U.S. Army Corps of Engineers, Seattle District, 96 pp.

Pierson, K. B., B. D. Ross, and R. E. Nakatani. 1984. Review: The effects and occurrence of pthalate esters in aquatic organisms and sediments. Report by Fisheries Research Institute, University of Washington, for Seattle District, U.S. Army Corps of Engineers. 196 pp.

Shapiro and Associates, Inc. 1984. The relative distribution and abundance of Dungeness crab on major ocean bottom types off Grays Harbor in Fall 1984. Report to U.S. Army Corps of Engineers, Seattle District, 15 pp.

Shapiro and Associates, Inc. 1986. Grays Harbor Navigation Improvement Ocean Disposal Site Selection Studies. Appendix A: Marine plant, invertebrate, waterbird, and mammal resources and human user activities off Grays Harbor, Washington, pp. A1-A27.

Soike, H. E. 1987. Port of Grays Harbor Annual Report for the Year 1986. Report submited to the Board of Commissioners of the Port of Grays Harbor.

Stevens, B. and D. A. Armstrong. 1985. Distribution, abundance and growth of juvenile Dungeness crabs, Cancer magister, in Grays Harbor estuary, Washington U.S.A. Fish. Bull. 82(3): 469-483.

Stevens, B. G. and D. A. Armstrong. 1985. Ecology, growth and population dynamics of juvenile Dungeness crab, Cancer magister Dana, in Grays Harbor, Washington, 1980-1981. Pp. 119-134 In: Proc. Symp. on Dungeness Crab Biology and Management. Univ. of Alaska, Alaska Sea Grant Rpt. No. 85-3.

Tagart, J. V. and B. E. Short. 1987. Grays Harbor Lingcod Study. Report prepared by Battelle Pacific Northwest Laboratory for U.S. Army Corps of Engineers, Seattle District. 63 pp.

Williamson and Associates, 1985. Grays Harbor Navigation Improvement Project Ocean Disposal Studies: Ocean Benthic Survey and Mapping. Report submitted by Williamson and Associates, Inc., Seattle, Washington to U.S. Army Corps of Engineers, Seattle District, 21 pp.

Word, J. Q. 1987a. Results of sampling and sediment testing beneath the Union Pacific Railroad Bridge located in the Grays Harbor Navigational Channel, Grays Harbor County, Washington. Letter report from Battelle/Marine Research Laboratory to Seattle District, U.S. Army Corps of Engineers, Seattle, Washington. 9 pp.

Word, J. Q. 1987b. Results of sampling and sediment testing from selected sites in the Grays Harbor Navigation Channel, Grays Harbor County, Washington. Letter report from Battelle/Marine Research Laboratory to Seattle District, U.S. Army Corps of Engineers, Seattle, Washington. 14 pp.