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of Engineers®**

Portland District

Columbia River Channel Improvement Project

Final Supplemental Integrated Feasibility Report
and Environmental Impact Statement

January 2003

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Abbreviations and Acronyms

AMT	Adaptive Management Team
BA	biological assessment
BRT	Biological Review Team
BPA	Bonneville Power Administration
CERCLA	Comprehensive Environmental Response, Compensation, and Liability Act
cfs	cubic feet per second
CFR	Code of Federal Regulations
Corps	U.S. Army Corps of Engineers
CPUE	catch per unit effort
CZMA	Coastal Zone Management Act
CRD	Columbia River datum
CRFM	Columbia River Fish Mitigation
CRM	Columbia River mile
dwt	deadweight tonnage
DPS	distinct population segment
DMMP	Dredged Material Management Plan
EIS	environmental impact statement
ESA	Endangered Species Act
EFH	Essential Fish Habitat
ESU	evolutionarily significant unit
FCRPS	Federal Columbia River Hydropower System
g/L	grams per liter
HEP	habitat evaluation procedures
IFR	integrated feasibility report
km	kilometer(s)
LCREP	Lower Columbia River Estuary Program
MCR	mouth of the Columbia River
mg/L	milligram(s) per liter
mm	millimeter(s)
mcy	million cubic yards
NEPA	National Environmental Policy Act
NMFS	National Marine Fisheries Service (NOAA Fisheries)
NTU	nephelometric turbidity unit
ODFW	Oregon Department of Fish and Wildlife
ppt	parts per thousand
SEPA	State Environmental Policy Act (Washington)
SEI	Sustainable Ecosystems Institute
SEIS	Supplemental Environmental Impact Statement
TEU	twenty-foot equivalent units
USEPA	U.S. Environmental Protection Agency
USFWS	U.S. Fish and Wildlife Service
WDFW	Washington Department of Fish and Wildlife
WDNR	Washington Department of Natural Resources
WRM	Willamette River mile

**COLUMBIA RIVER CHANNEL IMPROVEMENTS PROJECT
FINAL SUPPLEMENTAL INTEGRATED FEASIBILITY REPORT
AND ENVIRONMENTAL IMPACT STATEMENT**

() DRAFT
(X) FINAL

Lead Agency. U.S. Army Corps of Engineers, Portland District; Port of Longview (SEPA)

Cooperating Agency. U.S. Environmental Protection Agency (USEPA), Region 10, Seattle WA

Type of Action. Administrative

Abstract. The Columbia River Channel Improvements Project was originally presented in the Final *Integrated Feasibility Report for Channel Improvements and Environmental Impact Statement*, dated August 1999. In December 1999, Congress authorized the deepening of the Columbia and Lower Willamette Rivers Federal Navigation Channel to 43 feet [Section 101(b)(13) of the Water Resource Development Act of 1999]. The authorized plan modifies the existing federal navigation project for the Columbia and Willamette Rivers and provides for construction of ecosystem restoration features.

The purposes of this Final *Supplemental Integrated Feasibility Report and Environmental Impact Statement* (Final SEIS) are to document additional information, environmental analyses, and project modifications resulting from consultation of the project under Section 7 of the Endangered Species Act; to update the disposal plan; to update the project economics; and to comply with National Environmental Policy Act (NEPA) requirements and with the Washington State Environmental Policy Act (SEPA).

Several additional ecosystem restoration features and evaluation actions are proposed for implementation to benefit the recovery of listed salmonids and other fish and wildlife resources, to avoid impacts to marine resources by ocean disposal of channel material, and to retain sand in the estuary. Creating these restoration features will use sand that would have been disposed of in the Deep Water Site. Under the revised plan, the need for ocean disposal is delayed for at least 20 years following construction. Construction volumes were updated using 2001-2002 hydrographic survey data. Other items updated include a reduction in rock excavation; utility relocations; additional information for crab, smelt, sturgeon, and fish stranding gained from data collection conducted with federal and state resource agencies; additional information on sediment transport and consistency with coastal programs; and modification to some of the upland disposal sites to avoid impacts to resources and habitat. Project economics are reexamined to evaluate the sensitivity of the fleet and commodity forecasts, and changes to shipping operations in the Portland area.

Although the lower Willamette River was originally addressed in the August 1999 final report, and included in the Congressional authorization, this portion is not addressed in detail in the Final SEIS. The project features for the lower Willamette River will be reevaluated in a subsequent NEPA document after resolution of cleanup issues associated with its being named to the federal National Priorities List by the USEPA under the Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA).

Entity Making Proposal: U.S. Army Corps of Engineers

Final Copy. The final copy of this report was officially filed with the Director, Office of Federal Activities, USEPA on _____. Copies may be obtained at no cost from the Corps' Portland District website (<https://www.nwp.usace.army.mil/>).

Comments. Comments on the final report are due 30 days from the date of USEPA's publication of *Notice of Availability* in the *Federal Register*, which is expected to be on _____. Comments are to be directed to the following:

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List of Known Licenses and Permits:

Coastal Zone Consistency
Clean Water Section 401 Water Quality Certification
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Critical Area Approvals
Grading Permits

Principal Authors: See List of Preparers.

Other Environmental Review: The project features for the lower Willamette River have been deferred at this time and will be reevaluated in a subsequent NEPA document after resolution of cleanup issues associated with its being named to the federal National Priorities List under CERCLA.

Further Information. Additional information on the Final SEIS and related documents also may be obtained from the above.

EXECUTIVE SUMMARY FOR THE FINAL SUPPLEMENTAL INTEGRATED FEASIBILITY REPORT AND ENVIRONMENTAL IMPACT STATEMENT

The Columbia River Channel Improvements Project was originally presented in the August 1999 *Final Integrated Feasibility Report for Channel Improvements and Environmental Impact Statement* (1999 Final IFR/EIS). The U.S. Army Corps of Engineers, Portland District (Corps), with the cooperation of the lower Columbia River Ports (Portland, and St. Helens in Oregon; Kalama, Longview, Vancouver, and Woodland in Washington) completed the 5-year IFR/EIS process in August 1999. The U.S. Environmental Protection Agency (USEPA), Region 10, is a cooperating agency for this project.

This Final Supplemental EIS (SEIS) supplements the 1999 Final IFR/EIS. The scope of the 1999 Final IFR/EIS included the following actions: 1) improvements to the navigation channel for the Columbia and Willamette Rivers; 2) ecosystem restoration features; and 3) the long-term disposal needs for continued maintenance of the Mouth of Columbia River (MCR) project, maintenance of the existing 40-foot channel, and the disposal requirements for construction and maintenance of the proposed channel improvement alternatives. The Corps is the federal agency with primary responsibility for navigation improvements and ecosystem restoration actions. The USEPA is the federal agency responsible for designating ocean disposal sites necessary to address long-term disposal needs. The USEPA expects to initiate formal rulemaking on the Shallow Water and Deep Water Sites in February 2003, with the designations becoming effective by summer 2003.

A SEIS typically focuses on project changes and/or new information. To understand the scope of this Final SEIS, it may be helpful to explain how this document is intended to address changes in the proposed action and new information for each of the three types of actions that were the subject of the 1999 Final IFR/EIS.

Navigation channel improvements. The Final SEIS reflects the decision to defer action on deepening the Willamette River until after USEPA decisions have been made regarding the clean up of the parts of the river listed as a Superfund site. The Final SEIS, therefore, focuses on the Columbia River; impacts regarding the Willamette River are discussed to a lesser extent in Section 6.12. With regards to new information, much of the new information presented in the Final SEIS pertains to impacts of deepening the Columbia River, hereafter referred to as the channel improvements project.

Restoration projects. The Final SEIS reflects the incorporation of five new restoration features and analyzes the environmental impacts associated with implementing these features. The new restoration features result in a minor change to long-term disposal needs.

Long-term disposal needs for MCR and channel improvements projects. The Final SEIS discusses revisions to upland disposal sites for the channel improvements project that resulted from the consultation process with NOAA Fisheries. In addition, implementation of the proposed restoration features at the Lois Mott embayment and Millar Pillar are anticipated to significantly reduce the need for ocean disposal of river channel material. The

Final SEIS addresses this change in the disposal plan. Because the channel improvement project amounted to only a small fraction of sediments proposed for ocean disposal as analyzed in the 1999 Final IFR/EIS, the use of this material for ecosystem restoration, while significant in the context of the Corps' decision regarding the channel improvement project, does not fundamentally change the need for or sizing of the ocean disposal sites selected in the 1999 Final IFR/EIS. The Final SEIS also presents new baseline information collected for the ocean disposal sites selected in the 1999 Final IFR/EIS; however, the Final SEIS has less new information regarding this action than the other two actions discussed above.

The purposes of this Final SEIS are to document additional information, environmental analyses, and project modifications resulting from consultation of the project under Section 7 of the Endangered Species Act; to update the disposal plan; to update the project economics; and to comply with National Environmental Policy Act (NEPA) requirements and with the Washington State Environmental Policy Act (SEPA). Several additional ecosystem restoration features and evaluation actions are proposed for implementation to benefit the recovery of listed salmonids and other fish and wildlife resources, to avoid impacts to marine resources at the Deep Water Site, and to retain sand in the estuary. Creating the Lois Island restoration feature during construction will use sand that would have been disposed of in the ocean. Under the revised plan, no ocean disposal is proposed during construction and the first 20 years of maintenance. Construction volumes were updated using 2001-2002 hydrographic survey data. Other items updated include a reduction in rock excavation; utility relocations; additional information for crab, smelt, sturgeon, and fish stranding gained from data collection conducted with the federal and state resource agencies; additional information on sediment transport and consistency with coastal programs; and modification to some of the upland disposal sites to avoid impacts to resources and habitat. Project economics are reexamined to evaluate the sensitivity of the fleet and commodity forecasts, and changes to shipping operations in the Portland area.

Although the lower Willamette River was originally addressed in the 1999 Final IFR/EIS, and included in the Congressional authorization, this portion is not addressed in detail in the Final SEIS. The project features for the lower Willamette River have been deferred at this time and will be reevaluated in a subsequent NEPA document after resolution of cleanup issues associated with its being named to the federal National Priorities List by USEPA under the Comprehensive Environmental Response, Compensation, and Liability Act.

In December 1999, NOAA Fisheries (National Marine Fisheries Service) issued a 'No Jeopardy' Biological Opinion on the expected impacts to salmonids, and the U.S. Fish and Wildlife Service (USFWS) completed its 'No Jeopardy' Biological Opinion on the potential impacts to wildlife and plant species. In August 2000, NOAA Fisheries withdrew their opinion citing the availability of new information regarding impacts to bathymetry (water depths) and flow on estuarine habitat, and resuspension of contaminants. However, the USFWS Biological Opinion remains valid. Because a Biological Opinion meeting ESA requirements for listed salmonids must be in place before the project can proceed, the Corps and NOAA Fisheries began a consultation process to resolve the issues; the USFWS also reentered the process for two aquatic species, coastal cutthroat trout and bull trout.

In February 2001, Sustainable Ecosystems Institute (SEI) was hired to facilitate a series of workshops and guide participants to possible solutions for environmental concerns based on the best available scientific knowledge. The Corps, NOAA Fisheries, and USFWS jointly agreed to use SEI's experience to help resolve the issues. The SEI process included formal and informal review of scientific materials by SEI staff and an independent panel of seven scientific experts. This process included five workshops from March to August 2001, which were open to the public, to review the science underlying the project. It also included ad hoc meetings between panelists and project managers and agency scientists, as well as a questionnaire completed by all the panelists. Based on their comprehensive discussion of all relevant issues (numeric and conceptual modeling, fisheries, sediment and water quality, and monitoring and adaptive management), the panel determined that the knowledge base is adequate to resolve environmental concerns through the consultation process.

Outcomes of the SEI workshops and informal discussions among the agencies provided input for the new Biological Assessment (BA) prepared by the Corps in response to the NOAA Fisheries request to reinitiate consultation on listed species potentially affected by the project. This BA (Corps 2001) also addressed two Distinct Population Segments (DPS) for two fish species under the purview of the USFWS. The new BA addresses 13 evolutionary significant units (ESU; a distinctive group of Pacific salmon or steelhead) including 12 listed ESUs, 1 listed DPS, 1 DPS proposed for listing, and 1 candidate ESU. Thirteen ESUs were evaluated during the previous consultation process. The following were considered during preparation of the 2001 BA: SEI workshop materials, information, and summaries; numerical and conceptual modeling; salmonid biological requirements; NOAA Fisheries December 1999 Biological Opinion and administrative record; NOAA Fisheries new information; and other existing and new information.

In January 2002, the Corps submitted the BA (Corps 2001) to the NOAA Fisheries and USFWS. The 2001 BA included actions associated with dredging and deepening, including compliance measures to minimize incidental take of listed species; monitoring actions to ensure deepening and disposal have minimal effects on listed fish and their habitats; and adaptive management to respond to impacts discovered through the monitoring program. The BA also included ecosystem restoration features and evaluation actions involving numerous proposals to improve existing habitat conditions in the lower Columbia River and estuary, and evaluation activities to increase knowledge of the river and estuary ecosystem.

On May 20, 2002, NOAA Fisheries and the USFWS transmitted their final Biological Opinions to the Corps. These opinions determined that the channel improvement project, including dredging, disposal, monitoring, adaptive management, evaluation, and ecosystem restoration is not likely to jeopardize the continued existence of 13 listed and one proposed fish species, bald eagles, or Columbian white-tailed deer. The additional project features or actions would not affect other species addressed in the 1999 BA for the channel improvement project. In addition, the NOAA Fisheries concurred that the project is not likely to adversely affect Steller sea lions.

Several other steps remain before project construction would begin. The Washington Department of Ecology and the Oregon Department of Environmental Quality must issue Section 401 Water Quality certifications under the Clean Water Act, and the Washington Department of Ecology and Oregon Department of Land Conservation and Development must evaluate the proposed action for consistency under the Coastal Zone Management Act (CZMA). Both states initially denied Section 401 certification and CZMA consistency in 2000. Since then, the Corps and Sponsor Ports have met repeatedly with officials from Washington and Oregon to understand and work to address the issues identified by the agencies. The Corps has applied for 401 Certification and has submitted CZMA Consistency Determinations. Coordination between the Corps and these state agencies is ongoing.

This Final SEIS also includes an updated benefit-cost analysis for the project. The updated analysis was conducted between January and June 2002, and focuses on confirming what are the benefits and costs of the 43-foot channel. Each of the inputs to the benefit and cost calculations were reviewed and updated using the most current data available.

In August 2002, the Corps convened two technical review teams to evaluate the reasonableness of the economic analysis. An open and transparent technical review of the costs and the benefits was conducted. The technical review process was facilitated by a neutral, non-profit organization. The technical review process resulted in a published assessment of the Corps' economic analysis, responses to which are incorporated in this Final SEIS. The Corps consideration of the technical review has been included in the Final SEIS and also is available on the Corps' website (<https://www.nwp.usace.army.mil/>).

TABLE OF CONTENTS

This Final SEIS follows the same format as the 1999 Final IFR/EIS. For the Final SEIS, those sections that have been updated (^{revised}), or where new sections have been added (^{new}) are clearly marked. Also, a CD-ROM of the 1999 Final IFR/EIS is provided with the Final SEIS.

*COVER SHEET

*EXECUTIVE SUMMARY

*1.	^{revised} INTRODUCTION	1-1
1.1.	^{revised} Purpose and Need	1-9
1.1.1.	^{new} Purpose and Need for the Additional Ecosystem Restoration Features	1-9
1.2.	^{revised} Study Authority	1-9
1.3.	^{revised} Study Area	1-9
1.3.1.	^{new} Action Area	1-9
1.4.	^{revised} Scope of Study	1-10
1.4.1.	^{new} Ecosystem Restoration Features Developed During Consultation	1-10
1.5.	^{revised} Study Participants and Coordination	1-13
1.6.	Previous Studies	1-13
*2.	STUDY AREA DESCRIPTION	2-1
2.1.	^{revised} Existing Project Description	2-1
2.2.	Historic Channel Development	2-1
2.3.	^{revised} Navigation Practices	2-1
2.4.	^{revised} Channel Maintenance Practices	2-1
2.5.	^{revised} Summary of Environmental Conditions	2-1
3.	NEEDS AND OPPORTUNITIES	3-1
3.1.	^{revised} Introduction	3-1
3.2.	^{revised} Commodity Forecast	3-2
3.2.1.	^{revised} Containers	3-2
3.2.2.	^{revised} Wheat	3-3
3.2.3.	^{revised} Corn	3-5
3.2.4.	^{revised} Barley	3-5
3.2.5.	Alumina	3-6
3.2.6.	^{new} Soybeans	3-6
3.3.	^{revised} Fleet Forecast	3-7
3.3.1.	^{revised} Container Vessel Fleet	3-7
3.3.2.	^{revised} Bulk Carrier Fleet	3-8
3.3.2.1.	^{revised} Wheat	3-10
3.3.2.2.	^{revised} Corn	3-12
3.3.2.3.	^{revised} Barley	3-13
3.3.2.4.	^{revised} Alumina	3-13
3.3.2.5.	^{new} Soybeans	3-14
3.4.	^{revised} Future Port Development	3-14

NOTE: * Indicates information required for National Environmental Policy Act compliance.

TABLE OF CONTENTS (continued)

*4. ALTERNATIVES	4-1
4.1. Formulation and Screening of Alternatives	4-1
4.2. No Action Alternative	4-1
4.3. ^{revised} Non-Structural Alternative	4-1
4.4. ^{revised} Structural Alternatives	4-1
4.4.1. Regional Port Alternatives	4-1
4.4.2. Channel Deepening Alternatives	4-2
4.4.3. ^{revised} Disposal Alternatives	4-2
4.4.3.10. ^{new} Disposal Plan Modifications Following Consultation	4-2
4.5. ^{revised} Comparison of Alternatives	4-14
4.5.1. ^{revised} Environmental Comparison	4-15
4.5.1.1. ^{revised} Physical Impacts	4-15
4.5.1.2. ^{revised} Biological Impacts	4-15
4.5.1.3. ^{revised} Socio-Economic Impacts	4-21
4.5.2. ^{revised} Economic Comparison	4-22
4.6. ^{revised} Plan Selection	4-23
4.6.1. Turning Basins	4-24
4.6.2. Anchorages	4-24
4.6.3. ^{revised} Berthing Areas	4-24
4.7. ^{revised} Selected Plan	4-24
4.7.1. ^{revised} Channel Optimization Measures	4-25
4.8. ^{revised} Ecosystem Restoration Plan	4-25
4.8.1. ^{revised} Shillapoo Lake	4-25
4.8.2. ^{revised} Tide Gate Retrofits for Salmonid Passage	4-27
4.8.3. Improved Embayment Circulation	4-27
4.8.4. ^{revised} Restore Shallow Water Habitat	4-27
4.8.5. ^{revised} Summary	4-28
4.8.6. ^{new} Additional Ecosystem Restoration Features	4-31
4.8.6.1. ^{new} Lois Island Embayment Habitat Restoration	4-32
4.8.6.2. ^{new} Purple Loosestrife Control Program	4-34
4.8.6.3. ^{new} Miller-Pillar Habitat Restoration	4-35
4.8.6.4. ^{new} Tenasillahe Island Phased Restoration	4-36
4.8.6.5. ^{new} Bachelor Slough Restoration	4-43
4.8.7. ^{new} Cost Effectiveness-Incremental Cost Analysis for the Ecosystem Restoration Features	4-46
4.9. ^{new} Ecosystem Evaluation Actions	4-51
*5. AFFECTED ENVIRONMENT	5-1
5.1. ^{revised} Physical Resources	5-1
5.2. ^{revised} Biological Resources	5-1
5.3. ^{revised} Threatened and Endangered Species	5-1
5.3.1. ^{revised} Aquatic Species	5-1
5.3.2. ^{revised} Wildlife Species	5-1

NOTE: * Indicates information required for National Environmental Policy Act compliance.

TABLE OF CONTENTS (continued)

5.4. Socio-Economic Resources	5-1
5.4.1. Port-Related Economy	5-1
5.4.2. ^{revised} Land Use	5-1
5.4.3. Aesthetics	5-1
5.4.4. Recreation	5-1
5.4.5. Cultural Resources	5-1
 *6. ENVIRONMENTAL CONSEQUENCES	6-1
6.1. Introduction	6-1
6.1.1. ^{new} Introduction for the Final SEIS	6-1
6.1.1.1. ^{new} Ecosystem Model	6-1
6.1.1.2. ^{new} Other Sources of New Information Since the Final IFR/EIS	6-5
6.2. ^{revised} Physical Impacts	6-6
6.2.1. No Action Alternative	6-6
6.2.2. ^{revised} 43-foot Channel Deepening Alternative	6-6
6.2.2.1. ^{revised} Riverbed and Sedimentation	6-6
6.2.2.2. ^{revised} Water Surface Elevations	6-10
6.2.2.3. ^{revised} Salinity	6-11
6.2.2.4. ^{new} Accretion/Erosion	6-12
6.2.3. ^{revised} Proposed Disposal Alternative	6-14
6.2.3.1. ^{revised} Upland Disposal	6-14
6.2.3.2. ^{revised} In-Water Disposal	6-15
6.2.3.3. ^{new} Ocean Disposal	6-15
6.2.4. ^{new} Ecosystem Restoration Features	6-16
6.3. ^{revised} Water Quality Impacts	6-17
6.4. Sediment Quality Impacts	6-18
6.4.1. ^{revised} Navigation Channel	6-18
6.4.2. Ocean Disposal	6-19
6.4.3. ^{new} Ecosystem Restoration Features	6-19
6.5. Hazardous, Toxic, and Radiological Waste Impacts	6-19
6.5.1. No Action Alternative	6-19
6.5.2. ^{revised} 43-foot Channel Deepening Alternative	6-19
6.5.3. ^{revised} Least Cost and Proposed (Sponsors') Alternatives	6-20
6.5.3.1. ^{new} Ecosystem Restoration Features	6-20
6.6. Biological Impacts	6-20
6.6.1. ^{revised} Aquatic Resources	6-20
6.6.1.1. ^{revised} No Action Alternative	6-20
6.6.1.2. ^{revised} 43-foot Channel Deepening Alternative	6-27
6.6.1.3. ^{new} Ecosystem Restoration Features	6-29
6.6.2. ^{revised} Wildlife Resources	6-30
6.6.2.1. ^{revised} No Action Alternative	6-30
6.6.2.2. ^{revised} 43-foot Channel Deepening Alternative	6-31

NOTE: * Indicates information required for National Environmental Policy Act compliance.

TABLE OF CONTENTS (continued)

6.6.2.3. ^{revised}	Least Cost Disposal Alternative	6-31
6.6.2.4. ^{revised}	Proposed (Sponsors' Preferred) Disposal Alternative	6-31
6.6.2.5. ^{new}	Ecosystem Restoration Features	6-32
6.7.	Threatened and Endangered Species	6-34
6.7.1. ^{revised}	Aquatic Species	6-34
6.7.1.1. ^{new}	ESA Consultation Results for the 43-foot Channel Deepening Alternative	6-34
6.7.1.2. ^{new}	ESA Consultation Process Results for the Ecosystem Restoration Features	6-54
6.7.1.3. ^{new}	Biological Opinions for the Final SEIS	6-55
6.7.2. ^{revised}	Wildlife Species	6-57
6.8.	Socio-Economic Resources	6-61
6.8.1. ^{revised}	Economic Impacts	6-61
6.8.2. ^{revised}	Land Use	6-62
6.9. ^{revised}	Secondary Impacts	6-63
6.10. ^{revised}	Mitigation	6-63
6.10.2.2. ^{revised}	Proposed (Sponsor's Preferred) Disposal Alternative	6-64
6.11. ^{revised}	Unavoidable Adverse Impacts	6-64
6.12. ^{revised}	Cumulative Impacts	6-64
6.12.1 ^{new}	Channel Improvement Project	6-66
6.12.2 ^{new}	Past, Present, and Reasonably Foreseeable Future Actions	6-69
6.12.2.1 ^{new}	Mouth of the Columbia River Federal Navigation Project	6-69
6.12.2.2 ^{new}	Willamette River Navigation Channel	6-76
6.12.2.3 ^{new}	Upper Columbia/Snake River Navigation Channel	6-78
6.12.2.4 ^{new}	Federal Columbia River Power System	6-82
6.12.2.5 ^{new}	Port, Industrial, Urban and Agricultural Development	6-85
6.12.2.6 ^{new}	Large-scale Restoration and Recovery Efforts	6-91
6.12.3 ^{new}	Cumulative Impact of the Channel Improvement Project When Added to All Past, Present, and Reasonably Foreseeable Future Actions	6-93
6.13. ^{revised}	Relationship Between Short-term Uses of the Environment and Maintenance and Enhancement of Long-term Productivity	6-100
6.14.	Irreversible and Irretrievable Commitments of Resources	6-100
*7.	COORDINATION AND PUBLIC INVOLVEMENT	7-1
7.1.	Required Coordination	7-1
7.2. ^{revised}	Public Workshops	7-1
7.3. ^{revised}	Specialized Coordination Activities	7-1
7.3.8. ^{new}	ESA Consultation and SEI Workshops	7-1
7.3.9. ^{new}	State and Local Coordination	7-2
7.4. ^{revised}	Compliance with Environmental Laws and Executive Orders	7-3
7.4.2. ^{revised}	Clean Water Act of 1977, as Amended	7-3
7.4.3. ^{revised}	Coastal Zone Management Act of 1972, as Amended	7-3

NOTE: * Indicates information required for National Environmental Policy Act compliance.

TABLE OF CONTENTS (continued)

7.4.4.	^{revised}	Comprehensive Environmental Response, Compensation and Liability Act	7-4
7.4.5.	^{revised}	Endangered Species Act of 1973, as Amended	7-4
7.4.8.	^{revised}	Fish and Wildlife Coordination Act	7-4
7.4.10.	^{revised}	Marine Protection Research and Sanctuaries Act of 1972	7-4
7.4.14.	^{revised}	Cultural Resources Acts	7-4
7.4.17.	^{revised}	Executive Order 11988, Floodplain Management.....	7-5
7.4.19.	^{new}	State Environmental Policy Act.....	7-5
7.4.20.	^{new}	Magnuson-Stevens Fisheries Conservation and Management Act.....	7-5
7.5.	^{revised}	Other Related Programs.....	7-6
7.5.3.	^{new}	Columbia River Fish Mitigation	7-6
7.5.4.	^{new}	Section 536	7-6
7.5.5.	^{new}	Federal Columbia River Power System.....	7-7
8.		PROJECT IMPLEMENTATION	8-1
8.1.		Identification of Sponsors	8-1
8.2.	^{revised}	Cost Allocation and Apportionment.....	8-1
8.3.		Non-Federal Cost Sharing.....	8-2
8.4.		Division of Responsibilities	8-2
8.5.		Sponsor's Support	8-2
8.6.	^{revised}	Implementation Process.....	8-2
8.7.	^{new}	Changes to the Real Estate Plan	8-3
8.7.1	^{new}	Disposal Plan Modifications	8-4
8.7.2	^{new}	Modifications to the Original Ecosystem Restoration Features	8-5
8.7.3	^{new}	Modifications for the Additional Ecosystem Restoration Features	8-6
8.7.3.1.	^{new}	Lois Island Embayment Habitat Restoration	8-6
8.7.3.2.	^{new}	Purple Loosestrife Control Program	8-6
8.7.3.3.	^{new}	Miller-Pillar Habitat Restoration	8-6
8.7.3.4.	^{new}	Tenasillahe Island Phased Restoration	8-7
8.7.3.5.	^{new}	Bachelor Slough Restoration	8-8
8.7.4	^{new}	Ecosystem Evaluation Actions	8-9
8.7.5	^{new}	Monitoring Actions Associated with Dredging and Disposal	8-9
8.8.	^{new}	Royalty Fees for State-owned Dredged Material	8-10
9.		CONCLUSIONS AND RECOMMENDATIONS.....	9-1
9.1.	^{revised}	Conclusions	9-1
9.1.1	^{new}	Additional Conclusions.....	9-3
9.2.	^{revised}	Recommendations	9-4

*List of Preparers

*Glossary

*Index

*Literature Cited

NOTE: * Indicates information required for National Environmental Policy Act compliance.

TABLE OF CONTENTS (continued)

LIST OF TABLES (revised or added for the Final SEIS)

Table S1-1. Columbia River Channel Improvement Project Comparison.....	1-8
Table S3-1. Export Projections for Containers	3-3
Table S3-2. Historic Wheat Exports	3-3
Table S3-3. Export Projections for Wheat (short tons).....	3-4
Table S3-4. Export Projections for Corn.....	3-5
Table S3-5. Historic Barley Exports	3-6
Table S3-6. Export Projections for Barley	3-6
Table S3-7. Export Projections for Soybeans	3-7
Table S3-8. U.S. Northwest Routes, 1990-2044 Outbound Cargo Projections	3-9
Table S3-9. 2000-2001 Wheat Vessel Movements by Design Draft Region.....	3-11
Table S3-10. 2000-2001 Corn Exports by Design Draft to Taiwan and South Korea.....	3-12
Table S3-11. 2000-2001 Barley Exports by Design Draft and Country	3-13
Table S4-1. Proposed Disposal Plan Including Beneficial Use Sites, Ecosystem Restoration and Wildlife Mitigation (Martin Island Embayment)	4-4
Table S4-2. Disposal Volumes for the Proposed Alternative from CRM 3-29	4-8
Table S4-3. Updated Summary of Environmental Impacts	4-16
Table S4-4. Average Annual Transportation Benefits, 43-foot Channel Improvement ...	4-22
Table S4-5. Current Costs and Benefits, 43-foot Channel Improvement Project	4-23
Table S4-6. Updated Costs, 43-foot Channel Improvement Project.....	4-23
Table S4-7. Current Estimated Costs, 43-foot Channel Improvement Project	4-25
Table S4-8. Ecosystem Restoration Features	4-30
Table S4-9. Average Annual Environmental Outputs, Average Annual Costs, and Average Annual Cost per Environmental Output.....	4-49
Table S4-10. Cost-effective, Least-cost Combinations - Average Annual Environmental Outputs and Average Annual Cost.....	4-49
Table S4-11. Summary of Final Incremental Cost Analysis.....	4-50
Table S6-1. Conceptual Model Pathways and Indicators for Juvenile Salmonid Production in the Lower Columbia River	6-2
Table S6-2. List of Evaluation Reports	6-5
Table S6-3. Study Results on Potential Sturgeon Impacts and Responses	6-23
Table S6-4. Federally Listed Salmonid ESUs/DPSs in the Action Area	6-35
Table S6-5. Risk and Uncertainty Conceptual Framework.....	6-45
Table S6-6. ESA Section 7(a)(2) Monitoring Actions for Dredging and Disposal	6-48
Table S6-7. Minimization Practices and Best Management Practices for Dredging	6-50
Table S6-8. Best Management Practices for Disposal	6-52
Table S8-1. Executive Fully Funded Cost Summary	8-1
Table S8-2. Proposed Project Implementation Schedule	8-3

NOTE: * Indicates information required for National Environmental Policy Act compliance.

TABLE OF CONTENTS (continued)

LIST OF FIGURES (revised or added for the Final SEIS)

Figure S1-1. Action Area for ESA Consultation.....	1-11
Figure S3-1. Dry Bulk Builds by Year and Deadweight Tonnage.....	3-10
Figure S4-1. Martin Island Embayment Wetland Mitigation Plan (revised)	4-3
Figure S4-2. Ocean Disposal Area	4-7
Figure S4-3. Lois Island Embayment Ecosystem Restoration Feature (191 acres)	4-10
Figure S4-4. Lois Island Embayment Bathymetry, Temporary Sump with Pipeline.....	4-11
Figure S4-5. Miller-Pillar Implementation Plan	4-13
Figure S4-6. Shillapoo Lake Embankment, Conveyance, and Control Structures	4-26
Figure S4-7. Fish Passage Improvements at Tidegates.....	4-29
Figure S4-8. Tenasillahe Island Interim Ecosystem Restoration Feature	4-37
Figure S4-9. Tenasillahe Island Long-term Ecosystem Restoration Feature.....	4-38
Figure S4-10. Phase 2—Reintroduction of Columbian White-tailed Deer to Cottonwood-Howard Islands.....	4-41
Figure S4-11. Bachelor Slough Ecosystem Restoration Feature	4-44
Figure S6-1. Conceptual Model for Juvenile Salmonids in the Lower Columbia River	6-4

VOLUME 2 – LIST OF EXHIBITS

- *Exhibit A – Correspondence (no revision necessary)
- *Exhibit B – Scoping Documentation (no revision necessary)
- *Exhibit C – Fish and Wildlife Coordination Act Report (no revision necessary)
- *Exhibit D – Section 103 Evaluation (no revision necessary)
- *Exhibit E – Section 404(b)(1) Evaluation (revised)
- *Exhibit F – Coastal Zone Management Act Consistency (revised)
- *Exhibit G – Biological Assessment for Wildlife and Plants (no revision necessary)
- *Exhibit H – ESA Consultation Documents (new) - on Corps' website
 - 2001 Biological Assessment (fish and wildlife)
 - April 22, 2002 Amendment to Biological Assessment
 - May 2002 NOAA Fisheries Biological Opinion
 - May 2002 USFWS Biological Opinion
- *Exhibit I – Revised Essential Fish Habitat Assessment (new)
- *Exhibit J – Revised Columbia River Sediment Impacts Analysis (new)
- *Exhibit K-1 – Evaluation Report White And Green Sturgeon (new)
- *Exhibit K-2 – Evaluation Report Smelt (new)
- *Exhibit K-3 – Evaluation Report Fish Stranding (new)
- *Exhibit K-4 – Evaluation Report Dungeness Crab (new)
- *Exhibit K-5 – Wildlife And Wetland Mitigation (new)
- *Exhibit K-6 – Royalty Fees For State-owned Dredged Material (new)

NOTE: * Indicates information required for National Environmental Policy Act compliance.

TABLE OF CONTENTS (continued)

VOLUME 2 – LIST OF EXHIBITS (continued)

- *Exhibit K-7 – Evaluation Report Floodplains (new)
- *Exhibit K-8 – Part I - Consistency With Critical Areas Ordinances Including Wetland Mitigation Plan (new)
Part II - Wetland Mitigation Plan (new)
- *Exhibit K-9 – Consistency with Washington Local Shoreline Master Programs (new)

VOLUME 3 – LIST OF EXHIBITS (continuation)

- Exhibit L – Revised Cost Estimate Summary (new)
- Exhibit M – Revised Economic Analysis (new)
- Exhibit N – Physical and Biological Studies of the Deep and Shallow Water Sites (new)

VOLUME 4 – COMMENT LETTERS ON THE DRAFT SEIS AND CORPS RESPONSES

VOLUME 5 – PUBLIC TESTIMONY

NOTE: * Indicates information required for National Environmental Policy Act compliance.

CHAPTER ONE

INTRODUCTION

***1. revised INTRODUCTION**

The Columbia River Channel Improvements Project was originally presented in the Final *Integrated Feasibility Report for Channel Improvements and Environmental Impact Statement* (Final IFR/EIS, August 1999). The U.S. Army Corps of Engineers, Portland District (Corps), with the cooperation of the lower Columbia River Ports (Portland, and St. Helens in Oregon; Kalama, Longview, Vancouver, and Woodland in Washington) completed the 5-year IFR/EIS process in August 1999. The U.S. Environmental Protection Agency (USEPA), Region 10, is a cooperating agency for the project.

This Final Supplemental EIS (SEIS) supplements the 1999 Final IFR/EIS. The scope of the 1999 Final IFR/EIS included the following actions: 1) improvements to the navigation channel for the Columbia and Willamette Rivers; 2) ecosystem restoration features; and 3) the long-term disposal needs for continued maintenance of the Mouth of Columbia River (MCR) project, maintenance of the existing 40-foot channel, and the disposal requirements for construction and maintenance of the proposed channel improvements alternatives. The Corps is the federal agency with primary responsibility for navigation improvements and ecosystem restoration actions. The USEPA is the federal agency responsible for designating ocean disposal sites necessary to address long-term disposal needs. The USEPA expects to initiate formal rulemaking on the Shallow Water and Deep Water Sites in February 2003, with the designations becoming effective by summer 2003.

A SEIS typically focuses on project changes and/or new information. To understand the scope of the Final SEIS it may be helpful to explain how the Final SEIS is intended to address changes in the proposed action and new information for each of the three types of actions that were the subject of the 1999 Final IFR/EIS.

Navigation channel improvements. The Final SEIS reflects the decision to defer action on deepening the Willamette River until after USEPA decisions have been made regarding the clean up of the parts of the river listed as a Superfund site. The Final SEIS, therefore, focuses on the Columbia River; impacts regarding the Willamette River are discussed to a lesser extent in Section 6.12. With regards to new information, much of the new information presented in the Final SEIS pertains to impacts of deepening the Columbia River, hereafter referred to as the channel improvements project.

Restoration projects. The Final SEIS reflects the incorporation of five new restoration features and analyzes the environmental impacts associated with implementing these features. The new restoration features result in a minor change to long-term disposal needs.

Long-term disposal needs for MCR and channel improvements projects. The Final SEIS discusses revisions to upland disposal sites for the channel improvements project that resulted from the consultation process with NOAA Fisheries. In addition, implementation of the proposed restoration features at the Lois Mott embayment and Millar Pillar are anticipated to significantly reduce the need for ocean disposal of river channel material. The

Final SEIS addresses this change in the disposal plan. Because the channel improvement project amounted to only a small fraction of sediments proposed for ocean disposal as analyzed in the 1999 Final IFR/EIS, the use of this material for ecosystem restoration, while significant in the context of the Corps' decision regarding the channel improvement project, does not fundamentally change the need for or sizing of the ocean disposal sites selected in the 1999 Final IFR/EIS. The Final SEIS also presents new baseline information collected for the ocean disposal sites selected in the 1999 Final IFR/EIS; however, the Final SEIS has less new information regarding this action than the other two actions discussed above.

The purposes of this Final SEIS are to document additional information, environmental analyses, and project modifications resulting from consultation of the project under Section 7 of the Endangered Species Act (ESA); to update the disposal plan; to update the project economics; to comply with National Environmental Policy Act (NEPA) requirements; and to comply with the Washington State Environmental Policy Act (SEPA).

Several additional ecosystem restoration features and evaluation actions are proposed for implementation to benefit the recovery of listed salmonids and other fish and wildlife resources. Material proposed for ocean disposal in the 1999 Final IFR/EIS will be used to construct two of the ecosystem restoration features. Therefore, it is the intention of the Corps not to use the Deep Water Site in disposing of materials dredged for the channel improvement project. Construction volumes also were updated using December 2001 and January 2002 hydrographic survey data. Other items updated include a reduction in rock excavation; utility relocations; additional information for crab, smelt, sturgeon, and stranding gained from data collection conducted with federal and state resource agencies; additional information on sediment transport and consistency with coastal programs; and modification to some of the upland disposal sites to avoid impacts to resources and habitat. Project economics are reexamined to evaluate the sensitivity of the fleet and commodity forecasts, and changes to shipping operations in the Portland area.

Authorized Project

In December 1999, Congress authorized the deepening of the Columbia and Lower Willamette Rivers Federal Navigation Channel to 43 feet [Section 101(b)(13) of the Water Resource Development Act of 1999]. However, additional funds must still be appropriated before the channel improvement project can begin. The authorized plan would deepen the existing federal navigation project for the Columbia and Willamette Rivers and provide for construction of ecosystem restoration features. The recommended plan presented in the 1999 Final IFR/EIS consisted of the following:

- The existing 600-foot-wide, 40-foot-deep navigation channel would be deepened from 40 feet to -43 feet Columbia River datum (CRD), from Columbia River mile (CRM) 3 to CRM 106.5, including advanced maintenance dredging for overwidth and overdepth (authorized and approved actions) in the reaches where this practice is currently performed in the maintenance program.

- The existing 600-foot-wide, 40-foot-deep navigation project channel would be deepened from -40 feet to -43 feet CRD, from Willamette River mile (WRM) 0 to WRM 11.6 (see next section on *Willamette River Construction*).
- Three of the existing five turning basins on the Columbia River (located at CRM 13, 73.5, and 101.5, respectively) would be deepened to -43 feet CRD.
- The three turning basins located at WRM 4, 10, and 11.7 on the Willamette River would be deepened to -43 feet CRD (see next section on *Willamette River Construction*).
- A total of 29 upland sites (with a total land area of 1,681 acres), 3 shoreline sites, 2 ocean sites, and 1 gravel pit would be required for the disposal of construction materials and subsequent channel maintenance dredged material.
- Ecosystem restoration features include the use of a combined pump/gravity water supply for restoring wetland and riparian habitat at Shillapoo Lake. Tidegate retrofits with fish slides for salmonid passage would be installed at selected locations along the lower Columbia River. Connecting channels would be constructed at the upstream end of Walker-Lord and Hump-Fisher Islands to improve juvenile salmonid access to their embayment-rearing habitats.
- Environmental mitigation features would be constructed on a total of 740 acres of land purchased for mitigation efforts located at the Woodland Bottoms, Martin Island, and Webb mitigation sites.

The location of the dredging will be limited to selected areas from CRM 3, near the mouth of the Columbia River, to CRM 106.5, near the I-5 Bridge in Portland. Because significant reaches of the Columbia River navigation channel are naturally deeper than what the new channel requires, only specific areas will require dredging. The shallower reaches subject to deepening activities represent approximately 3.5% of the total river area between CRM 3-106.5, or 56% of the navigation channel. Three of the five turning basins on the Columbia River (located at CRM 13, 73.5, and 101.5) also would be deepened to 43 feet.

Willamette River Construction (Deferred)

Although 11.6 miles of the lower Willamette River were addressed in the 1999 Final IFR/EIS, and included in the Congressional authorization, the Willamette River portion is not addressed in detail in this Final SEIS. The project features for the lower Willamette River will be reevaluated in a subsequent NEPA document after resolution of sediment cleanup issues associated with its inclusion on the federal National Priorities List by USEPA under the Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA).

Background and Update

In December 1999, after issuance of the 1999 Final IFR/EIS, the NOAA Fisheries (National Marine Fisheries Service) issued a 'No Jeopardy' Biological Opinion on the expected impacts to ESA-listed salmonids, and the U.S. Fish and Wildlife Service (USFWS) completed its 'No Jeopardy' Biological Opinion on the potential impacts to listed wildlife and plant species. In August 2000, NOAA Fisheries withdrew their Biological Opinion citing the availability of new information regarding impacts to bathymetry (water depths) and flow

on estuarine habitat, and resuspension of toxics. The Biological Opinion by the USFWS remains valid, however. Because a Biological Opinion meeting ESA requirements for listed salmonids must be in place before the project can proceed, the Corps and NOAA Fisheries began a consultation process to resolve issues connected with the project. The USFWS also reentered the process for two aquatic species, bull trout and coastal cutthroat trout.

Shortly after NOAA Fisheries withdrew its Biological Opinion in 2000, the States of Washington and Oregon denied certification of the project under Section 401 of the Clean Water Act and consistency under the Coastal Zone Management Act (CZMA). Three of their major concerns were sediment transport, Dungeness crab, and consistency with coastal programs. Since then, the Corps and sponsor ports have met with officials from Washington and Oregon to understand and work to address the issues identified by the agencies.

As a result of meetings with Washington agencies, the Washington Ports agreed to prepare a Supplemental EIS (a supplement to the IFR/EIS prepared by the Corps and USEPA) under SEPA to address issues identified in Washington's letters, including those regarding Section 401 and the CZMA. When the Corps and USEPA determined that it would prepare a SEIS under NEPA, the Federal Government and the Washington Ports agreed to issue a joint document. As discussed below, both NEPA and SEPA strongly encourage this approach.

Oregon does not have a state law comparable to NEPA or SEPA. However, many of the issues identified by Oregon, such as impacts to sturgeon and smelt and royalties for sand extraction, have received additional analysis. Oregon agency staff have participated in a number of these efforts. Information that results from these studies is included in the Final SEIS. Issues such as coastal zone consistency and 401 certification for water quality have been the subject of a number of meetings and will be addressed in documents related to those applications as well as in information included in this Final SEIS.

The NEPA encourages federal agencies to cooperate with state and local agencies to reduce duplication between NEPA and state and local requirements. This cooperation includes joint planning, environmental evaluation, public hearings and environmental assessments. In addition, NEPA encourages federal agencies to join with state or local agencies to prepare joint EIS's. Where state laws or local ordinances have EIS requirements in addition to, but not in conflict with, those in NEPA, the NEPA encourages federal agencies to cooperate in fulfilling these requirements as well as those of federal laws so that one document will comply with all applicable laws.

The SEPA similarly encourages state agencies to avoid duplication of paperwork and allows agencies to use environmental analyses prepared under NEPA. When a state agency uses a federal EIS for the same proposal, the state agency is not required to adopt the federal NEPA document. Consistent with these provisions of NEPA and SEPA, the Federal Government and the Washington Ports are issuing the Final SEIS as a joint document for purposes of complying with NEPA and SEPA for the scope of activities specified above. Subsequent references in this document to NEPA are intended to include SEPA, where applicable.

The ESA consultation procedure for a federal action may be reinitiated if new information reveals potential effects to listed species not previously considered during an earlier consultation [50 Code of Federal Regulations (CFR) Section 402.16]. The Corps worked closely with NOAA Fisheries and USFWS to address new information, as well as resolve concerns in the NOAA Fisheries withdrawal letter (August 2000). Coordination included discussion on specific areas of concern, proposed actions, and modifications to those actions to ensure protection of listed species and habitats. Work was aimed at reaching agreement among agencies on a foundation of best available science (how to obtain and apply it) to be used in developing the new Biological Assessment (BA) and Biological Opinions.

In February 2001, the Sustainable Ecosystems Institute (SEI) was hired to facilitate a series of workshops to provide an independent, scientific peer-review process to evaluate the potential environmental issues using best available scientific knowledge. The Corps, NOAA Fisheries, and USFWS jointly agreed to use SEI. The SEI process included formal and informal review of scientific materials by SEI staff and an independent panel of seven scientific experts. The process included five workshops held from March to August 2001, which were open to the public, to review the science underlying the project and meetings between panelists and project managers and agency scientists, as well as a questionnaire completed by all panelists. Based on comprehensive discussion of all relevant issues (numeric and conceptual modeling, fisheries, sediment and water quality, monitoring and adaptive management), the panel determined that the knowledge base represented “best available science” and no other sources were identified. Also, a Biological Review Team (BRT) made up of federal representatives (NOAA Fisheries, USFWS and Corps) was formed for the consultation process. The BRT met weekly for about 8 months to address biological concerns and identify ecosystem restoration features and evaluation actions to further resource recovery and enhance baseline information on ESA salmonids and their habitats.

Outcomes of the SEI workshops and discussions among the agencies provided input for the new BA prepared by the Corps in response to NOAA Fisheries request to reinitiate consultation on listed species potentially affected by the project. This BA addresses Distinct Population Segments (DPS) for two fish species (one listed DPS, one DPS proposed for listing) under the purview of the USFWS plus reviewed the potential for impacts arising from added features and actions to species originally listed by the USFWS for the project. The 2001 BA also addresses 13 evolutionary significant units (ESU; a distinctive group of Pacific salmon or steelhead) including 12 listed ESUs, and one candidate ESU, as well as Steller sea lions. Thirteen ESUs were evaluated during the previous consultation process. The following were considered during preparation of the 2001 BA: SEI workshop materials and summaries; additional numerical and conceptual modeling; salmonid biological requirements; NOAA Fisheries December 1999 Biological Opinion and administrative record; NOAA Fisheries and USFWS new information; and other existing and new information.

In January 2002, the Corps submitted the BA (December 2001) to NOAA Fisheries and USFWS. This BA included actions to address concerns associated with dredging and deepening, including compliance measures to minimize incidental take of listed species; monitoring actions to ensure project actions have minimal effects on listed fish and their

habitats; and adaptive management to respond to impacts discovered through the monitoring program. The BA also included ecosystem restoration features involving numerous proposals to improve existing habitat conditions in the lower Columbia River and estuary, and evaluation actions to increase knowledge of the river and estuary ecosystem.

On May 20, 2002, NOAA Fisheries and USFWS transmitted their final Biological Opinions to the Corps. These opinions determined that the project, including dredging, disposal, monitoring, adaptive management, evaluation, and ecosystem restoration is not likely to jeopardize the continued existence of, or adversely modify or destroy, designated critical habitat of 12 federally listed salmonid ESUs, one listed DPS, one DPS proposed for listing, and one candidate ESU, bald eagles, or Columbian white-tailed deer. In addition, NOAA Fisheries concurred that the project is not likely to adversely affect Steller sea lions.

In order to address the concerns of the States of Washington and Oregon as expressed in their 401 certification and CZMA consistency denial letters (August 2000), a rationale of producing evaluation reports was developed. These reports (Exhibits K-1 to K-9) cover the following subjects: white and green sturgeon, smelt, fish stranding, Dungeness crab, wildlife and wetland mitigation, state royalties, floodplains, and consistency with the Washington State Critical Area Ordinances and Shoreline Master Programs. Also, the Corps developed a comprehensive evaluation report on sediment transport, titled *Columbia River Sediment Impacts Analysis* (Exhibit J).

Between January and June 2002, the Corps conducted a reassessment of the economic and environmental information reported in the 1999 Final IFR/EIS for the channel improvement project. The economic reanalysis focused on confirming what are the benefits and costs of the 43-foot channel. Each of the inputs to the benefit and cost calculations were reviewed and updated using the most current data available.

In August 2002, the Corps convened two technical review teams to evaluate the reasonableness of the economic analysis: one review team to evaluate the benefit analysis and the other to evaluate the cost analysis. The technical review process was facilitated by a neutral, non-profit organization. The panel's meetings were open and transparent and the public was invited to attend. All information provided to the panel was posted on the Corps' website prior to the meeting. All presentations made by the Corps' facilitator, Corps, Port of Portland, and consultants were posted to the Corps' website after the event. The panel's findings also were posted to the Corps' website prior to the close of the public comment period. The technical review process resulted in a published assessment of the Corps' economic analysis, responses to which are incorporated in this Final SEIS.

Revised Project

Table S1-1 provides a comparison of the Columbia River 43-foot channel improvement project as presented in the 1999 Final IFR/EIS and as modified in the Final SEIS. As noted above, the Willamette River portion of the authorized project has been deferred and is not being addressed in detail in the Final SEIS. For the purposes of this Final SEIS, the

authorized Columbia River project, as modified and shown in Table S1-1, will be referred to as ‘the project’ including all enforceable conditions of NOAA Fisheries and USFWS Biological Opinions. As noted in the 1999 Final IFR/EIS, the without project condition (the No Action Alternative) is maintenance dredging and disposal as described in the *Dredged Material Management Plan and Supplemental Environmental Impact Statement* (Corps 1998) for the 40-foot channel.

The Final SEIS discusses revisions to upland disposal sites for the channel improvement project that resulted from the consultation process with NOAA Fisheries and USFWS. With implementation of the proposed restoration features at Lois Island embayment and Miller-Pillar, and subsequent use of existing disposal sites (e.g., flowlane, Miller Sands Spit, Rice Island, Pillar Rock Island) for maintenance dredged materials, the project should not require ocean disposal for construction and the first 20 years of maintenance. The Final SEIS discloses this change in the disposal plan. The Final SEIS also presents new information regarding ocean disposal. Because the channel improvement project accounted for a small fraction of the sand proposed for ocean disposal as analyzed in the 1999 Final IFR/EIS, the reduced use of the Deep Water Site, while significant in context of the Corps’ decision regarding the channel improvement project, does not fundamentally change the need for the ocean disposal site as documented in the 1999 Final IFR/EIS. The Final SEIS only addresses potential use of the ocean disposal site associated with the channel improvement project in the event the Lois Island embayment and Miller-Pillar ecosystem restoration features are not fully implemented. This Final SEIS does not address any use of ocean disposal sites that may occur as a result of maintenance of the MCR project or maintenance of the Columbia River navigation channel in the absence of this project.

Several other steps remain before construction of the project could begin. The Washington Department of Ecology and the Oregon Department of Environmental Quality must issue 401 Water Quality certifications under the Clean Water Act, and the Washington Department of Ecology and Oregon Department of Land Conservation and Development must evaluate the proposed action for consistency under the CZMA. The Corps has applied for 401 Certification and CZMA Consistency Determinations. Coordination between the Corps and these state agencies is ongoing. The sponsor ports are also working with local jurisdictions on applicable local permitting requirements for the upland disposal sites.

The Final SEIS follows the same format as the 1999 Final IFR/EIS. Sections of the final report that have been updated, or new sections added for the Final SEIS, are clearly marked. However, because much of the information and analysis contained in the 1999 Final IFR/EIS has not changed, the entire text of that report is not repeated here. Accordingly, for complete analysis of any aspect of the project, the reader should refer to both the 1999 Final IFR/EIS and to the corresponding section of this Final SEIS. A CD-ROM of the 1999 Final IFR/EIS is provided with the Final SEIS.

The revisions to the channel improvement project by the Corps and the collection of additional, baseline information also triggered reevaluation by USEPA of the ocean disposal element contained in the 1999 Final IFR/EIS, Appendix H.

Table S1-1. Columbia River Channel Improvement Project Comparison

Action	1999 Final IFR/EIS for the Columbia River	Final SEIS for the Columbia River
Navigation Feature		
Dredging Volume (construction)	18.4 million cubic yards	14.5 million cubic yards
Rock Volume	590,000 cubic yards	490,500 cubic yards
Basalt	173,000 cubic yards	50,500 cubic yards
Cemented Cobbles	417,000 cubic yards	440,000 cubic yards
Disposal		
Upland Disposal Sites Areas	1,681 acres	1,630 acres
Agricultural Crop Land	200 acres	172 acres
Wetlands	20 acres	16 acres
Riparian Habitat	67 acres	50 acres
Ocean disposal site use	Construction and maintenance, 37 mcy over 20 years	None during construction if the Lois Island ecosystem restoration feature is fully implemented; none anticipated during the first 20 years of maintenance if Miller-Pillar and existing disposal sites in the estuary are used.
Utility Relocations	5 on the Columbia River	None on the Columbia
ESA Consultation		
Monitoring Actions	Included	Strengthened and clarified
Minimization and BMPs	Included	Strengthened and clarified
In-water Work Windows	None	Specified
Adaptive Management	Included	Strengthened and clarified
Ecosystem Restoration Features		
Shillapoo Lake	1,250 acres	470-839 acres
Miller-Pillar	Not Included	235 acres
Lois Island	Not Included	191 acres
Purple Loosestrife Control	Not Included	CRM 18-52
Tenasillahe Island (Phased Implementation)	Not Included	New
Interim (Phase 1)	Not Included	92 acres
Cottonwood-Howard (Phase 2) Columbian White-tailed Deer Reintroduction	Not included	650 acres Columbian white-tailed deer; 60 acres tidelands
Long-term (Phase 3)	Not Included	1,778 acres
Bachelor Slough	Not Included	85 acres of in-stream restoration, 6 acres shoreline riparian restoration, 46 acres of riparian restoration upland
Ecosystem Evaluation	Not Included	6 actions added
Adaptive Management	Not Included	Included
Costs and Benefits		
Columbia River NED Costs	\$154,224,000	\$118,924,000
Columbia River NED Average Annual Benefits	\$28.0 million	\$18.8 million
NED Benefit-to-cost Ratio	1.9	1.7
Columbia River Costs - Proposed Plan	\$160,884,000	\$133,629,000

1.1. ^{revised} Purpose and Need

Subsection 1.1.1 has been added to this section to provide updated information since completion of the 1999 Final IFR/EIS.

1.1.1. ^{new} Purpose and Need for the Additional Ecosystem Restoration Features

The purpose of these ecosystem restoration features is to restore habitat conditions, which would contribute to the recovery and long-term viability of the listed species and other natural resources. The need for these ecosystem restoration features arises from historic activities that have resulted in population declines requiring listing, and from the Corps' ESA responsibility to assist with listed species conservation. These additional ecosystem restoration features, as well as evaluation and monitoring actions, resulted from consultation of the project under Section 7 of the ESA. The additional features and actions are based on opportunities identified to enhance juvenile salmonid feeding and rearing habitat for listed salmonid ESUs and wildlife species. These features also would provide benefits to many other species of fish and wildlife.

1.2. ^{revised} Study Authority

The following information was added to this section for the Final SEIS. In December 1999, Congress authorized the deepening of the Columbia and Lower Willamette Rivers Federal Navigation Channel to 43 feet [Section 101(b)(13) of the Water Resource Development Act of 1999]. As discussed above, deepening of the Lower Willamette River (and associated turning basins) has been deferred at this time and will be reevaluated in a subsequent NEPA document after resolution of sediment cleanup issues associated with its inclusion on the federal National Priorities List under CERCLA.

1.3. ^{revised} Study Area

Subsection 1.3.1 has been added to this section to provide updated information resulting from the ESA consultation process since completion of the 1999 Final IFR/EIS.

1.3.1. ^{new} Action Area

The NOAA Fisheries, USFWS, and the Corps defined the action area in the 2001 BA to extend beyond the actual location of proposed activities to include areas that may potentially be directly or indirectly affected by the project (50 CFR Section 402.02). For purposes of this Final SEIS, this area is adopted as the study area, and includes the following:

- A bank-to-bank run of the Columbia River from Bonneville Dam down to the river's mouth, which includes adjacent port terminals and berths and certain ecosystem restoration and wildlife mitigation sites, as well as from the river mouth extending 12 miles out into the Pacific Ocean in a fan shape.
- Upland disposal, ecosystem restoration, and wildlife mitigation sites.

The bank-to-bank run of the river includes formerly designated and recently proposed ESA Critical Habitat for the listed ESUs.¹ For discussion purposes, the action area is divided into three general habitat or reach types. The first is riverine, which begins at Bonneville Dam and runs downstream to the start of the estuary at approximately CRM 40. The second is estuarine and runs from CRM 40 downstream to CRM 3. The third is the river mouth, which starts at a wide area at CRM 3 and encompasses the outer boundary of the Deep Water Site (approximately 12 miles beyond the CRM 3 boundary of the channel improvement project) in a fan shape (Figure S1-1). The reach numbering system used in the 1999 Final IFR/EIS runs from Reach 1 at CRM 106.5 to Reach 7 at CRM 3. To avoid renumbering the original reaches in the action area, the Bonneville reach is designated as Reach A, while the river mouth reach is designated Reach B (Figure S1-1). The seven reach maps for the project, which show areas to be dredged, disposal areas, ecosystem restoration sites, mitigation sites, and other pertinent information, are found at the end of Chapter 4.

1.4.^{revised} Scope of Study

Subsection 1.4.1 has been added to this section to provide updated information on the ecosystem restoration component developed during the ESA consultation process.

1.4.1.^{new} Ecosystem Restoration Features Developed During Consultation

As a result of the ESA consultation process, five additional ecosystem restoration features were added to the channel improvement project. These actions are described in detail in Chapter 4 of this Final SEIS. The Lois Island embayment and Miller-Pillar restoration features will be constructed to beneficially use dredged material to attain establishment of tidal marsh habitat. Target elevations, representing tidal marsh elevations determined from adjacent tidal marsh habitat, will be used to guide tidal marsh development. Miller-Pillar also requires construction of a pile dike field (five pile dikes) to hold material in place.

These two ecosystem restoration features were initially proposed in 1995 when the Corps, USEPA, and sponsor ports initiated Columbia River environmental roundtable meetings with state and federal resource agencies, resource and commercial fishing interest groups and interested members of the public, but were not included in the preferred alternative described in the 1999 Final IFR/EIS.

All ecosystem restoration features were further developed during the ESA consultation with NOAA Fisheries and USFWS. The Corps, with the assistance of NOAA Fisheries and USFWS, has determined these features to be important to aid in the recovery of listed salmonids and in some cases, address habitat concerns that were the subject of much discussion and analysis throughout the consultation process.

¹ NOAA Fisheries has recently withdrawn its designation of critical habitat for listed salmonids. USFWS has recently proposed but not yet formally designated critical habitat for bull trout.

Figure S1-1. Action Area for ESA Consultation



**Figure S1-1
Action Area**

In addition, the Lois Island embayment and Miller-Pillar habitat restoration features were discussed at the 2001 “Lower Columbia River and Estuary Habitat Conservation and Restoration Workshop” held cooperatively by the Corps, Columbia River Estuary Study Task Force, Lower Columbia River Estuary Program, and American Rivers in Astoria to identify ecosystem restoration projects. For further information on the screening criteria, see Chapter 6, Section 6.2.4, *Ecosystem Restoration Features*. These two ecosystem restoration features were modified after the consultation process had been concluded based upon comments received on the Draft SEIS and recommendations from ODFW, Oregon Division of State Lands, and others. These modifications were coordinated further with NOAA Fisheries and USFWS to obtain their concurrence.

The Bachelor Slough restoration feature includes deepening an existing side channel by dredging and disposal of material at one to three upland location(s) plus restoration of riparian forest along Bachelor Slough (6 acres). Upland disposal of Bachelor Slough sediments allows for the additional development of riparian forest habitat (approximately 46 acres) within the ESA Critical Habitat zone for listed salmonids.

The purple loosestrife control program would use an integrated pest management approach that includes introduction of biological control agents, use of herbicides, and/or mechanical pulling of this plant for restoration of estuarine marshes between CRM 18-52. Purple loosestrife is an introduced exotic plant that is spreading throughout emergent tidal marshes in the Columbia River estuary. Native vegetation such as Lyngby’s sedge, tufted hair grass, and softstem bulrush are being displaced. Currently, more than 10,000 acres of estuarine tidal marsh are infested, although the degree of infestation varies widely among locations

The Phase 1 interim restoration at Tenasillahe Island includes improving existing tidegates and construction of inlets, complete with water control structures at the head of these interior sloughs to improve fish accessibility, water quality, and circulation in the sloughs. Under Phase 2 interim restoration, Columbian white-tailed deer will be reintroduced to Cottonwood-Howard Islands near Longview, Washington, where habitat will be secured via purchase and deed restrictions. Over the long term, Phase 3 improvements at Tenasillahe Island would include breaching of exterior dikes to return tidal circulation to 1,778 acres.

Phase 1 interim actions at Tenasillahe Island are contingent on hydraulic engineering analyses demonstrating the feasibility of the proposed actions, and that no adverse impacts would occur to Columbian white-tailed deer. Implementation of Phase 3 at Tenasillahe Island is contingent on delisting of Columbian white-tailed deer and determination that such actions are compatible with the purposes and goals of the refuge. The Bachelor Slough restoration is contingent on securing use agreements from the Washington Department of Natural Resources (WDNR) and favorable sediment testing results. The Phase 2 Tenasillahe Island (Cottonwood-Howard) deer reintroduction also is contingent on acquisition of the site by the sponsor ports.

1.5. ^{revised} Study Participants and Coordination

The following information was added to this section for the Final SEIS. Since 1999, discussions have continued with federal and state agencies. In addition, working groups were formed for smelt and sturgeon research. Numerous meetings with state resource agencies have been held to discuss issues of concern including Dungeness crab, fish stranding, sediment budget, and consistency with coastal programs.

1.6. Previous Studies

No updating of the existing information in this section was necessary for the Final SEIS (see the Final IFR/EIS, August 1999).

CHAPTER TWO

STUDY AREA

DESCRIPTION

***2. STUDY AREA DESCRIPTION**

2.1. ^{revised} Existing Project Description

The following information has been added to this section for the Final SEIS. The study area has been expanded through the ESA consultation and now includes the area from bank to bank and from Bonneville Dam to the Deep Water Site, as well as upland disposal, ecosystem restoration, and mitigation sites.

2.2. Historic Channel Development

No updating of the existing information in this section was necessary for the Final SEIS (see the Final IFR/EIS, August 1999).

2.3. ^{revised} Navigation Practices

The following information has been added to this section for the Final SEIS. New analysis of the LoadMax system, which helps maximize departure depths through use of detailed river flow information, indicates that it is unlikely any significant benefit can be obtained through further refinement of the system. In addition, the Technical Review Panel convened in August 2002 concluded that any benefits derived through the LoadMax system were already being utilized to the maximum extent practicable.

2.4. ^{revised} Channel Maintenance Practices

The following information has been added to this section for the Final SEIS. Since issuance of the 1999 Final IFR/EIS, continued maintenance dredging for both the MCR project and the Columbia River project have been approved. Approvals include a Biological Opinion (September 1999) and Section 401 water quality certifications (June 2000) for Columbia River operations and maintenance, as well as Section 401 certifications, dated April 2002, for 1 year from Washington and for 5 years from Oregon for the MCR project.

2.5. ^{revised} Summary of Environmental Conditions

For the Final SEIS, the following updated information has been added to this section. The ESA consultation process analyzed existing and new information regarding environmental conditions in the project area, including information on water and sediment quality (Section 2.5.1, 1999 Final IFR/EIS), aquatic resources (Section 2.5.2, 1999 Final IFR/EIS) and wildlife resources (Section 2.5.3, 1999 Final IFR/EIS). That analysis is reported in the Corps' 2001 BA (Exhibit H on the Corps' website) and in the NOAA Fisheries and USFWS 2002 Biological Opinions (Exhibit H on the Corps' website), which are incorporated herein by reference and discussed in more detail in Chapter 6. Additional information and analyses regarding essential fish habitat, sediment transport, white and green sturgeon, lamprey, smelt, juvenile salmon, fish stranding, Dungeness crab, wildlife and wetland mitigation, and floodplains has been revised from the Draft SEIS. This information is presented in Exhibits I, J and K-1 through K-9 to this Final SEIS, and is discussed in more detail in Chapter 6.

CHAPTER THREE

NEEDS AND

OPPORTUNITIES

3. NEEDS AND OPPORTUNITIES

3.1. ^{revised} Introduction

This chapter has been revised in its entirety to provide revised economic information for the 43-foot channel improvement project since completion of the 1999 Final IFR/EIS. This chapter also has been revised since issuance of the Draft SEIS to incorporate responses to several issues suggested by the Technical Review Panel and other comments. Additional information also is found in Exhibit M to this Final EIS satisfying the requirement of a limited reevaluation. The benefits are based on a number of elements, and each is addressed in this update. The needs and opportunities are based on benefits accruing to the nation.

- Commodity and fleet projections have been updated. In general, a number of factors have led to depressed Columbia River exports, and updated commodity projections address the likelihood and potential timing of a recovery of those exports.
- The interest rate used to evaluate the project is now 5.875% as set by the Office of Management and Budget. The Office of Management and Budget changes this interest rate annually, and it is considered conservative.
- Vessel operating costs change annually and this update uses current vessel operating costs. Vessel operating costs have declined, which tends to decrease benefits.
- The Willamette River portion of the project is deferred, and the costs and benefits of deepening the Willamette have been excluded from this update (see Chapter 1).
- The distance used to calculate the benefits for the bulk commodities has been refined to more accurately reflect the destinations.

Waterborne commerce on the Columbia River has continued to show steady growth, along with an increase in the size of commercial vessels using the navigation channel. Average vessel size has increased due to the efficiencies gained by shippers using larger vessels to transport both bulk and containerized commodities. With the increased use of larger vessels for transporting bulk commodities such as wheat and corn, limitations posed by the existing channel dimensions occur with greater frequency. Container vessels are showing a rapid increase in size, and competition exerts pressure to fully load these vessels. Ships with design drafts approaching or greater than the 40-foot depth constraint cannot fully utilize their design drafts. This often results in reduced efficiency in the shipping process.

This analysis identifies potential efficiencies to shipping from modifying the existing channel. Such efficiencies are a function of the projected volume of commodities expected to move to and from the ports on the lower Columbia River and the projected fleet of vessels expected to call on the ports. The projected volume of commodities was matched to the projected fleet in order to evaluate transportation costs under various conditions.

The major benefit categories associated with the channel improvement would be transportation and delay savings. Transportation savings result from economies of scale that could occur when deeper draft vessels carry more tonnage per vessel. These savings would accrue up to the point where vessels would be constrained by channel depth. In a deeper channel, greater savings would accrue. Transportation benefits measure the magnitude of economies of scale savings between the without- and with-project conditions. Vessel delay costs measure the time delay and associated operating costs that deep-draft vessels could incur when approaching the maximum draft accommodated by the channel depth. Vessel delay benefits would reflect the savings in operating costs between the without- and with-project conditions.

3.2. ^{revised} Commodity Forecast

Commodity forecasts comprise one critical element of the feasibility study. The forecasts estimate the amount of tonnage that would be moved on the waterway in the future. The commodity forecasts are used in conjunction with fleet forecasts to determine transportation costs for the channel improvement project. It is assumed that existing navigation operating practices are utilized in both the without- and with-project conditions. Commodity projections were made for a 50-year project life (year 2007 to 2057) and include containers, wheat, corn, barley, alumina, and soybeans. Wheat, corn, barley, and soybeans are export commodities, alumina is an import commodity, and containers are import and export commodities (although containers are primarily exported). The projections for each commodity was estimated for each major trade route (region), and no tonnage was induced or transferred by the channel improvement project.

3.2.1. ^{revised} Containers

Container cargo represents a significant percentage of the total tonnage moved through the Columbia River. According to the Columbia River Transit Data Base provided by the Port of Portland, container exports from the Columbia River in 1993 were 1,873,020 short tons or approximately 7% of the total export tonnage. Added to this were 148,322 short tons of imported container cargoes. The only container port in the lower Columbia River is the Port of Portland. Portland is somewhat unique among the West Coast ports in that it is almost exclusively an outbound container port. Outbound movements are dominated by more resource-based, lower value-added products than are inbound movements, which is consistent with the pattern throughout the West Coast. The Port of Portland has traditionally been a last port-of-call on outbound container voyages across the Pacific Ocean. As a result, exports account for about 90% of total container throughput.

The commodities and origins/destinations handled by the Port of Portland would be very similar to those handled in Puget Sound. On the export side, much of the cargo base is composed of forest products (paper, paperboard, lumber, fiberboard, particleboard) and agricultural products (hay, animal feeds, potatoes, corn and meat), as well as wastepaper and other manufactured products (such as auto parts). On the import side, consumer goods dominate container trade and include products such as toys, tires, footwear, apparel, computer parts, consumer electronics, and furniture, as well as manufactured goods.

Table S3-1 displays updated projections for Columbia River container exports for the period of analysis (2007 to 2057). From 1991 to 2000, outbound (full) container traffic increased from 114,000 to 175,000 containers. In 1995, container exports peaked at over 210,000, while in 1997 and 1998 figures reflect the economic problems in Asia and exports dipped to 157,700 containers in 1998. The analysis projects an annual growth rate of 2.7% for the first decade of the analysis (2007 to 2017), declining to 1.9% in the second decade. From 2007 to 2057, the annual growth rate would be 1.03%.

Table S3-1. Export Projections for Containers

Year	Outbound TEUs*
2007	221,000
2017	279,000
2027	339,000
2037	358,000
2047	358,000
2057	358,000

* Twenty-foot Equivalent Units, full.

3.2.2. revised Wheat

Table S3-2 displays more recent information on historic wheat shipments from Columbia River ports. Wheat is the leading commodity, in terms of tonnage, moved by the deep-water ports of Portland, Vancouver and Kalama on the Columbia River.

Table S3-2. Historic Wheat Exports

Year	Tons Exported*
1991	12.1
1992	12.5
1993	12.2
1994	15.3
1995	14.9
1996	13.9
1997	12.4
1998	12.2
1999	11.6
2000	11.3

*millions of short tons

Table S3-3 displays updated export projections for wheat for the period of analysis (2007 to 2057). Wheat exports are projected to remain relatively flat over the period of analysis. In 2007, exports are expected to be 11.5 million short tons. Although this is much lower than export levels in the 1990s, it is close to what was exported in the most recent years. Wheat

exports would be projected to grow at an average annual rate of 0.7% for the first decade of the analysis, would drop to 0.6% over the second decade, and would level off at 2030. About 12% of the wheat would be exported to countries outside of the Rapidly Developing Asia and Other Asia regions. These exports to countries in Africa, Latin America, and the Middle East are expected to remain at a steady share of total exports from the Columbia River.

Table S3-3. Export Projections for Wheat (short tons)

Year	Tons Exported*
2007	11,529,000
2017	12,395,000
2027	13,215,000
2037	13,230,000
2047	13,230,000
2057	13,230,000

*short tons

There are three major trade routes used in the wheat export projection. The 'Rapidly Developing Asia' region includes South Korea, Taiwan, Singapore, Malaysia, Indonesia, and Thailand. This region is expected to see a rapidly rising demand for wheat until 2035 when it should level off. In the near term, this is driven largely by strong economic growth, rising incomes, rapid industrialization and urbanization, and limited ability to produce wheat domestically. The economic growth, which has been fueled largely by exports, provides the foreign exchange necessary to expand wheat imports.

In the 'Southeast Asia' region, wheat use has increased by nearly 50% in the 1990s, growing at a rate of almost 10% per year from 1990 to 1994. Rising disposable income has resulted in a more diverse diet with the substitution of Japanese-style noodles for rice. Many regional experts believe that the per capita wheat use ceiling for the region would likely be similar to Japan. However, Malaysia is already at this level with one-tenth the per capita income. Indonesia could experience the most rapid growth in import demand since the country's largest flour miller and noodle processor has started a large expansion program. If fully utilized, processing capacity would require nearly 7.0 million tons of wheat, more than doubling the 3.25 million tons imported in 1994 to 1995.

Although the 'Other Asia' region contains more than thirty countries in Asia, the Philippines, Pakistan, and Sri Lanka are the three major destination countries. These countries currently receive more than 30% of Columbia River wheat exports. Wheat export growth to the Philippines would be expected to remain strong. The Philippines imports its total supply of wheat, and most comes from the United States (91.2% market share in 1993-1994). Growth in Philippine wheat consumption is steady and high. Population growth is strong (2.2% from 1990-1995) and would likely continue to be among the highest in Asia until slowing to 1.4% in 2010 to 2015 (Faucett 1996). Per capita consumption has also

grown steadily, up 50% over the last 10 years to about 26 kilograms (about 57 pounds). Although this trend could continue through the end of this century, it should experience some slowing as consumption rates exceed that of the Japanese.

3.2.3. ^{revised} Corn

Table S3-4 displays updated export projections for corn for the period of analysis (2007 to 2057). After wheat, corn represents the second largest grain tonnage commodity shipped through the Columbia River ports. According to the Portland Merchants Exchange, Columbia Snake River Marketing Group, in 1993 corn accounted for 12.9% of total export tonnage from the ports, which was a relatively weak year for corn exports. Exporting of corn through the ports is a relatively recent phenomenon. The first year of significant corn exports was 1984, with the opening of the Peavey grain elevator at the Port of Kalama.

Table S3-4. Export Projections for Corn

Year	Tons Exported
2007	3,833,000
2017	4,536,000
2027	4,842,000
2037	5,017,000
2047	5,017,000
2057	5,017,000

Growth in corn exports from the Columbia River is tied to the high growth in feed grain consumption in the Rapidly Developing Asia region and Japan. Corn exports from the Columbia River are very concentrated, with Japan, Korea, and Taiwan accounting for all but a very small percentage. Japan's share of Columbia River corn exports would eventually drop to 15%, while rapidly developing Asian countries would eventually receive approximately 85% of the total.

Although China could become a net corn importer at some point in the future, it has been assumed for this analysis that Columbia River corn exports would continue follow current trade patterns. In the Rapidly Developing Asia region, Taiwan, South Korea, and Malaysia would be expected to experience economic growth, leading to increased meat consumption and increased demand for feed grains. Many of these countries also are improving infrastructure to allow efficient use of large grain carrying vessels, which may increase the competitive status of United States exports.

3.2.4. ^{revised} Barley

Barley represents the fourth largest tonnage commodity shipped through the Columbia River ports of Portland, Vancouver and Kalama. As shown in Table S3-5, exports of barley from the Columbia River can be highly volatile. Typically, barley exports were between 450,000 and 950,000 short tons per year. This volatility mirrored United States barley export behavior during the same period. Barley is used primarily as an alternate feed grain in the

world market as well as for malting. Typically, barley represents a relatively small fraction of total United States coarse grain production (5% to 10%). Destinations and volume vary from year to year. Table S3-6 displays updated export projections for barley, which represent a flat growth rate over the period of analysis (2007 to 2057).

Table S3-5. Historic Barley Exports

Year	Tons Exported
1985	350,000
1986	911,000
1987	1,872,000
1988	871,000
1989	664,000
1990	722,000
1991	603,000
1992	332,000
1993	461,000
1994	225,000

Table S3-6. Export Projections for Barley

Year	Tons Exported*
2007	550,000
2017	550,000
2027	550,000
2037	550,000
2047	550,000
2057	550,000

*short tons

3.2.5. Alumina

No updating of the existing information in this subsection for alumina is necessary for the Final SEIS (see the Final IFR/EIS, August 1999).

3.2.6.^{new} Soybeans

Soybeans are a new commodity in the benefit analysis, and were not included in the original analysis in the Final IFR/EIS (1999). In 2001, exports of soybeans exceeded one million short tons, and 2002 shows a similar trend. Table S3-7 displays export projections for soybeans. Columbia River soybean exports are projected to range between 880,000 short tons and 2.3 million short tons 2030, or at average annual rates of growth of 2.3% (low) and 6.6% (high) between 2000 and 2030. The initial range of exports is projected to be between 514,000 short tons and 846,000 short tons in 2007. Over the first 30 years of the analysis, the expected average annual growth rate is 2.9%.

Table S3-7. Export Projections for Soybeans

Year	Short Tons
2007	680,230
2017	1,088,770
2027	1,450,065
2037	1,598,677
2047	1,598,677
2057	1,598,677

3.3. ^{revised} Fleet Forecast

The fleet forecast attempts to determine the extent that vessels calling at the Columbia River ports will make use of the channel improvement. The fleet forecast reflects the trade-route specific analysis performed for the commodity projections. For each commodity, each major trade route has been examined to determine what forces would dictate the size of vessels calling on the ports.

3.3.1. ^{revised} Container Vessel Fleet

Container vessels calling at the Columbia River ports typically would be vessels on a liner trade, stopping first in Los Angeles or the Puget Sound before heading to Portland to load export cargo destined for Japan and Southeast Asia. The size of these vessels is being dictated by world market forces, which are rapidly pressing the world container fleet into larger vessels with increasing capacity and drafts.

Currently there are three transpacific carriers that use Portland as a last port of call on the west coast. These carriers are primarily using vessels that are 41 feet, 44 feet, and 46 feet in freshwater design draft. This represents a significant shift in vessel size over the last decade. Container vessels serving Portland would continue trafficking predominantly the transpacific routes. Currently, 94% of Portland container traffic is transpacific. The major transpacific trade routes would not be expected to change significantly over time.

The Port of Portland would continue to be primarily for export and would continue to be a last port-of-call for 78% of cargo loaded. The remaining 22% would move on middle port-of-call vessels. These vessels have historically departed at shallower depths and would likely continue this practice in the future. These vessels typically call Puget Sound (+49 feet depth) as their last port-of-call, and are not currently approaching Columbia River draft constraints. There could be some small benefit for this group of vessels in the future, particularly if they shift to larger Panamax class vessels. However, for the purposes of this analysis, it has been assumed that mid-port vessels would not benefit from channel deepening.

Like all container movements in general and more specifically transpacific movements, competition between ports and lines would continue to be intense. Rationalization among carriers should continue and expand in scope. Lines calling Portland would change ports, order of calls, and routing patterns in an attempt to increase profits. Carriers would seek to utilize economies of scale by moving to faster vessels with more carrying capacity. In 1993, average vessel capacity was 2,700 TEUs. Today, the smallest vessels are 3,500 TEU vessels, and larger 4,000 and 4,400 TEU vessels are moving on the river.

Most container vessels would continue to depart at drafts less than the design draft because of cargo capacity constraints, depth constraints, and the availability of cargo. A decade ago, container lines calling Portland used 4 to 5 feet of underkeel clearance. Today, two of the three existing carriers commonly use 2 feet of underkeel clearance. It is assumed that 2 feet of underkeel clearance will become the standard in the future. Although this assumption reduces benefits, it reflects the competitive nature of the container business.

In the without-project condition, vessels strive to have a departure draft of 38 feet. Most departure drafts would not increase beyond 38 feet in the without-project condition, as few container lines are willing to wait to ride the tides. With a 43-foot channel, few vessels would be expected to depart significantly beyond 41 feet for the same reason. The time dependency of container traffic would not lend itself to delays in operations caused by tides in the without- and with-project conditions.

Container ships operate on demanding schedules that usually require them to arrive at a particular port at a specific time on a specific day of the week. Any delay could have a negative effect on the coordinated rail and truck transportation of cargoes. A ship delay could have a domino effect delaying other ships scheduled to call at this and other berths. Also, delays could cause unacceptable congestion in the marine terminal. Because of the severe impacts of delays, container ship operators strive to avoid them at the expense of loading the ship less deeply to ensure an unrestricted transit.

3.3.2. ^{revised} Bulk Carrier Fleet

In projecting a future bulk carrier fleet for the Columbia River, the world bulk fleet, draft constraints, and other operating constraints would need to be considered. Trends in the world fleet would generally be followed for the Columbia River, as allowed by various draft constraints, institutional constraints, and other market forces. For the purposes of this analysis, two major industry expert sources were used to project the trends for the Columbia bulk fleet (DRI/McGraw Hill 1996; Drewry 1996). Also, for each commodity and each major destination for that commodity, a fleet forecast was constructed that reflects the trends of the world fleet and the particular characteristics of the trade route.

Of particular interest to the Columbia River fleet projection is the category of bulk carrier termed panamax. These vessels are typically 50,000 tons to 80,000 tons, and represent approximately 25% of the world dry bulk fleet. In the grain trades, the use of panamax vessels would likely grow to dominate world markets. While the Japanese wheat trade is

institutionally restricted, most other markets would be expected to develop for use of panamax carriers. In discussing the future of bulk vessels, Drewry Shipping Consultants mentions some of the emerging markets, which would be particularly important to the Columbia River fleet.

For the panamax sector of the shipping market, a good deal of attention needs to be taken of the “emerging markets” for grain as many of these have geared themselves up (or intend to do so) in terms of port facilities, cargo handling capabilities, and storage/silo capacities to accept shipments of around 50-55,000 cargo tonnes. In this respect, attention needs to focus on North Africa, the Asian Middle East, Pakistan and South Asia.

Table S3-8 displays a projection of outbound vessel movements from the Pacific Northwest by vessel size. Much of the cargo continues to move in vessels of the 40,000 to 80,000 deadweight tonnage (dwt) sizes, and there is a slight shift from vessels in the 20,000- to 40,000-dwt size to the 80,000- to 100,000-dwt size.

Table S3-8. U.S. Northwest Routes, 1990-2044 Outbound Cargo Projections

1,000s dwt	1990	1991	1992	1993	1994	1995	2000	2004	2010-2044
20 - 40	51%	51%	52%	51%	50%	48%	43%	39%	33%
40 - 80	49%	49%	48%	48%	49%	49%	51%	51%	50%
80 - 100	0	0	0	1%	1%	2%	6%	8%	11%
100 – 175	0	0	0	0	0	0	1%	3%	5%
>175	0	0	0	0	0	0	0	0	1%
Totals	100%	100%	100%	100%	100%	100%	100%	100%	100%

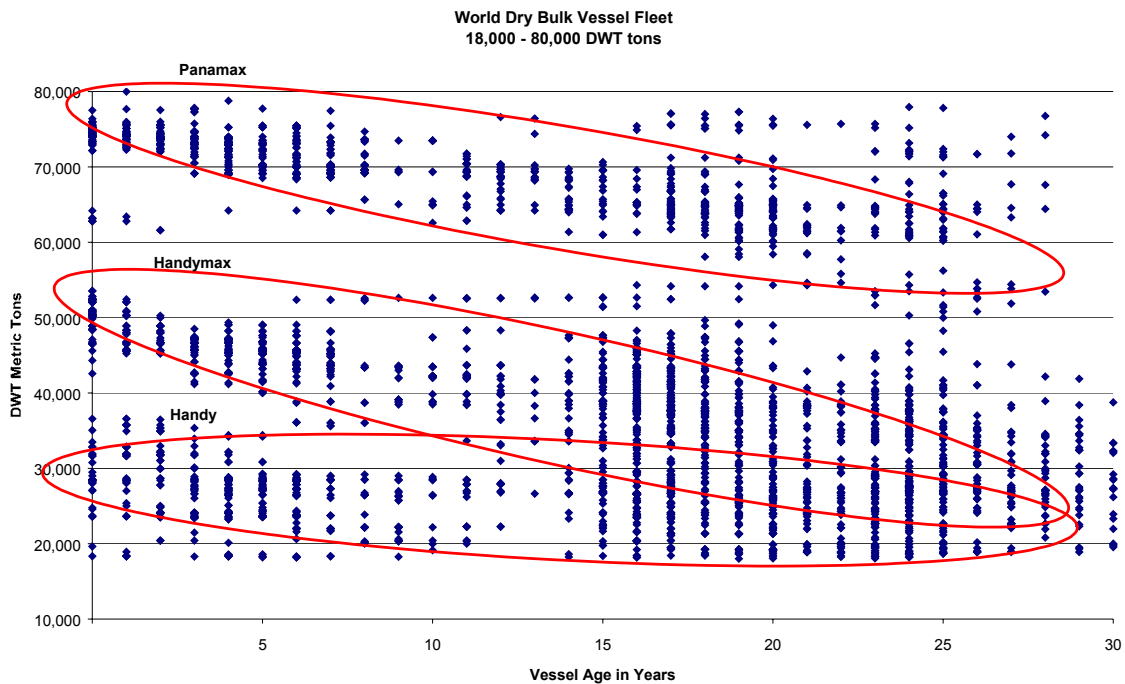
Source: DRI/McGraw Hill 1996; numbers do not add because of rounding.

In the 40,000- to 80,000-dwt ranges, there would be a variety of vessels in terms of size, draft, and grain carrying capacity. Of interest is whether the vessels calling on Columbia River ports in the future would be of a deep enough draft to benefit from channel improvement. The Drewry report discusses the increasing size of panamax vessels.

Also evident is the progressive increase in the size of the ‘representative’ panamax dry bulk carrier. Initially, development centered around 50-55,000 tonners, which were essentially ore carrier derivatives. By the mid-1970s, the typical unit was moving around 60,000 dwt. However, the new building boom seen during the first half of the 1980s took the expectations of the typical panamax unit to 64-65,000 dwt. The late 1980s saw this figure edge toward 68-69,000 dwt while current ideas now centre around 72,000 dwt.

Figure S3-1 displays panamax-class builds by year and deadweight tonnage. The database clearly displays the tendency in recent years toward the 72,000- to 78,000-dwt range. Vessels of this size typically have design drafts ranging from 44 to 47 feet. In 1993, more than 5.5 million short tons of grain left the Columbia on vessels greater than 65,000 dwt.

Figure S3-1. Dry Bulk Builds by Year and Deadweight Tonnage



The following sections provide a general description of the vessels projected to move on each trade route by commodity. For most grain trade routes, existing traffic includes vessels with design drafts greater than the current channel depth. This practice would be expected to continue in the future.

3.3.2.1. ^{revised} Wheat

Table S3-9 displays 1993 wheat vessel movements by departure draft and destination. The three major destinations were Japan, South Korea, and the Philippines. Historically, the Japanese have purchased wheat in relatively small lot sizes (approximately 22,000 short tons). The Japanese wheat market is highly regulated, and, while there is significant pressure to change the current system, it has been assumed the Japanese system does not change throughout the period of analysis.

The Rapidly Developing Asia region would have increasing importance in Columbia River exports. Unlike Japan, these countries do not impose institutional constraints on lot sizes. This region is expected to increase total net imports from 9.7 million metric tons in 2000 to 13.6 million metric tons in 2010. As these countries experience economic growth, the consumption of wheat also would be expected to grow. Economic forces would push towards utilization of larger and more efficient grain handling facilities serviced by vessels drafting 41 to 44 feet. In the Other Asia region, a deep-draft grain facility in Mariveles, Bataan (Philippines) has the capacity to handle panamax vessels. In 2000 and 2001, the

Philippines received over 3.5 million short tons of wheat, primarily in vessels with 38- and 39-foot design drafts. As milling capacity consolidates and expands, it is likely that these vessels would eventually increase in size beyond the current channel constraint.

Table S3-9. 2000-2001 Wheat Vessel Movements by Design Draft Region

Design Draft (freshwater feet)	Japan	Other	Other Asia	Rapidly Developing Asia	Grand Total
31	1.19%	---	0.13%	---	1.32%
32	13.76%	0.13%	0.23%	0.86%	14.99%
33	12.71%	---	0.11%	3.15%	15.97%
34	1.32%	0.15%	0.45%	1.08%	3.01%
35	0.15%	0.24%	0.59%	7.19%	8.17%
36	0.16%	0.89%	0.70%	5.49%	7.23%
37	0.63%	1.80%	1.83%	1.84%	6.10%
38	0.43%	1.71%	6.71%	4.24%	13.09%
39	0.01%	0.60%	5.12%	3.91%	9.64%
40	---	0.49%	1.14%	0.86%	2.49%
41	0.58%	---	1.52%	1.14%	3.24%
42	0.11%	0.62%	0.87%	0.50%	2.09%
43	0.43%	0.30%	---	0.58%	1.30%
44	---	---	1.24%	---	1.24%
45	---	2.23%	0.26%	0.58%	3.07%
46	---	0.89%	0.26%	0.61%	1.76%
47	0.13%	2.10%	0.28%	0.61%	3.13%
53	---	0.13%	1.32%	0.34%	1.79%
59	---	---	0.13%	---	0.13%
(blank)	---	---	---	0.24%	0.24%
Grand Total	31.61%	12.28%	22.88%	33.22%	100.00%

Sources: Port of Portland, PIERs (Port Import Export Reporting Service), and Lloyd's Registry

The Philippines accounted for almost 75% of the Columbia River wheat exports in 2000 and 2001, and the remaining share has primarily gone to Pakistan, Bangladesh, and North Korea. About half of this tonnage has moved in vessels with design drafts in excess of 40 feet, which would be expected to continue in the future.

About 10% to 15% of wheat tonnage would go to countries in Africa and the Middle East, including Egypt, South Africa, Sudan, Ethiopia, Jordan, Kuwait, Saudi Arabia, and Yemen. In 2000 and 2001, about half of this tonnage moved in vessels with design drafts of 41 feet or greater. Egypt and Yemen accounted for approximately 90% of this tonnage. Exports to Egypt move on panamax-size vessels in about 62,000 ton lot sizes, with design drafts of 42 to 47 feet and dead weight tonnage in the 65,000 to 76,000 ranges. Exports to Yemen move primarily in handymax vessels, with the majority of the tonnage moving in vessels of 36 to 39 feet in design draft.

In the without-project condition, there would likely be little change in these movements other than the expected growth in the size of handymax vessels. Many vessels are already of greater capacity than the current channel can fully utilize. Panamax vessels are expected to take full advantage of the additional 3 feet in channel depth, and the larger handymax vessels would take advantage of the increased depth to some extent as well.

3.3.2.2. ^{revised} Corn

Corn is a low-value feed grain and economic forces would always be strong to minimize transportation and processing costs. There is strong pressure to move corn in large quantities in order to take advantage of economies of scale. However, factors such as existing facilities and infrastructure could limit the size of shipments. The majority of increases in corn exports over the period of analysis would likely result from increases in demand from countries such as Taiwan, Korea, Malaysia, Indonesia, and Thailand (Rapidly Developing Asia region). Japan is currently a major importer, but is expected to decline in share over time, partly due to growth in other regions, but also due to a declining livestock sector.

Exports to Taiwan and South Korea move primarily in Panamax vessels, departing at the channel constraint. In 2000 and 2001, more than 80% of the tonnage to these two countries moved in vessels that were constrained by the channel depth (Table S3-10). This is expected to continue in the future.

Japan has historically utilized the existing channel depth with a fair degree of efficiency. From 2000 to 2001, almost three-quarters of the Columbia River corn exports to Japan moved in vessels with design drafts of 39 feet or deeper. While it is expected that there will always be some portion of this tonnage that will move in smaller handymax vessels, it is also expected that a large portion of this tonnage will be moving in either panamax vessels or the largest handymax vessels.

Table S3-10. 2000-2001 Corn Exports by Design Draft to Taiwan and South Korea

Design Draft (freshwater feet)	Taiwan	South Korea	Grand Total
36	3.82%	---	3.82%
37	3.33%	---	4.55%
38	7.14%	---	7.14%
39	1.09%	---	1.09%
40	1.51%	---	1.51%
42	---	9.50%	9.50%
44	---	12.55%	12.55%
45	23.83%	6.36%	30.19%
46	11.82%	3.18%	15.00%
47	5.45%	---	5.45%
48	2.86%	6.36%	9.22%
Grand Total	60.84%	37.94%	100.00%

Sources: Port of Portland, PIERS, and Lloyd's Registry

3.3.2.3. ^{revised} Barley

In terms of volume, barley represents a lesser export commodity for the Columbia River. Over 2000 and 2001, exports averaged a little over 700,000 short tons per year. About 40% of that tonnage moved in vessels that were constrained by the channel depth (Table S3-11). This trend is expected to continue in the future.

Table S3-11. 2000-2001 Barley Exports by Design Draft and Country

Design Draft (freshwater, feet)	Taiwan	Japan	Jordan	Morocco	S. Arabia	Grand Total
31	---	5.59%	---	---	---	5.59%
32	---	17.11%	---	---	---	17.11%
33	---	19.64%	---	---	---	19.64%
34	1.84%	1.10%	---	---	---	2.93%
35	---	1.30%	---	---	---	1.30%
36	---	1.19%	---	---	---	1.19%
37	---	1.96%	---	---	---	1.96%
38	2.56%	5.69%	---	---	---	8.24%
39	---	3.07%	---	---	---	3.07%
40	---	0.61%	---	---	---	0.61%
41	---	1.77%	---	---	---	1.77%
42	---	---	---	3.94%	---	3.94%
43	---	---	---	---	7.98%	7.98%
44	---	---	---	---	4.50%	4.50%
45	---	---	3.80%	---	8.32%	12.12%
46	---	---	---	---	8.02%	8.02%
Grand Total	4.39%	59.04%	3.80%	3.94%	28.82%	100.00%

Sources: Port of Portland, PIERS, and Lloyd's Registry

3.3.2.4. ^{revised} Alumina

Alumina represents an import commodity to the Columbia River for Pacific Northwest smelters. Alumina is generally imported from Australia in lot sizes from 30,000 to 40,000 short tons. Industry sources have stated that the Columbia River channel depth would not be a constraint to their operations. Currently, off-loading and storage facilities limit useful vessel size. In this case, unlike the grain bulk commodities, local infrastructure would need to change in order for alumina vessels to make use of a deeper channel.

Forecasts from the Bonneville Power Administration and the Northwest Power Planning Council predict that Pacific Northwest smelters would operate at approximately 85% to 90% of their current capacity throughout the next 30 years. While some plant modernization would occur to meet environmental regulations and to become more competitive internationally, this forecast assumes no expansion of local capacity. It is anticipated that channel improvement would not affect alumina imports.

3.3.2.5.^{new} Soybeans

In 2000 and 2001, 67% of the soybeans exported moved in vessels that could have benefited from a deeper channel. The fleet projections for soybeans have been modeled to reflect that data. Currently, China, Taiwan and the Philippines are the three biggest markets for Columbia River soybean exports, combining for 85% of the exports in 2000 and 2001, and would continue to be so in the future.

3.4.^{revised} Future Port Development

For the Final SEIS, the following updated information is being added to this section. The 1999 Final IFR/EIS described a number of potential port development projects that were either planned or underway. Since issuance of the 1999 Final IFR/EIS, several of these projects have been completed, one has been withdrawn, and others have been planned.

Through the ESA consultation process, the Corps received updated information from the sponsor ports regarding potential future development, including new information about the projects discussed in the 1999 Final IFR/EIS, as well as information about some new potential projects. This information indicates that, aside from the berth deepening analyzed in the 1999 Final IFR/EIS, the BA, the Biological Opinions, and in this report, such development will be caused by regional market factors such as commodity demand and not by channel improvements, and will occur independent of channel improvement. Therefore, such development is not an action connected with, or an indirect effect of channel improvement (see Exhibit H, *ESA Consultation Documents*, available on the Corps' website).

Projects that were described in the 1999 Final IFR/EIS and that have since been completed include the Port of Portland's Terminal 6 improvements, the Port of St. Helens' sheetrock wallboard plant (now owned by US Gypsum), and the Port of Longview's bulk import facility improvements and its industrial park development. In addition, the Port of Longview has completed construction of a new log unloading area and the Port of Kalama has completed development of the Kalama River Industrial Park.

One of the potential development projects described in the 1999 Final IFR/EIS has since been withdrawn. At the end of 2000, in response to updated market analyses and concerns raised by some members of the public, the Port of Portland withdrew its development plans and permit applications for its proposed West Hayden Island development. The Port is now simply holding its West Hayden Island property in long-term strategic reserve capacity.

Current information on reasonably foreseeable future port development is as follows:

Port of Kalama. The Port of Kalama is planning to expand its marine facilities at North Port by adding another deep draft berth. The Port is currently conducting environmental review of the potential new berth but has not yet begun any permitting. The Port will seek permits for the project, but does not intend to construct it until securing an appropriate client. At this time, the Port is not in discussions with any potential clients.

Port of Longview. The Port of Longview has begun permitting a potential new auto import facility at property the Port recently acquired from International Paper. The Port submitted a permit application (Joint Aquatic Resources Permit Application or JARPA) for the marine aspects of the auto terminal project in 2000 and ESA consultation for the project is currently underway. Actual development of the proposed auto import terminal is entirely dependent upon the Port securing a tenant for the property. The Port does not intend to develop the project without a tenant, and none has been identified to date. The precise form and timing of project development is therefore not certain at this time.

The Port also has two berths in need of some repairs (berths 1 and 4). However, the Port does not intend to make repairs until tenants are secured for the facilities. The only other activity the Port is engaged in that is related to marine development is maintenance dredging of its berths. The Port conducts maintenance dredging on an as-needed basis. Any such dredging is reviewed and conducted under the Corps' nationwide permits and the associated programmatic BA. At this point, the Port does not foresee the need to deepen any of its berths or access channels after completion of the channel improvement project.

Finally, the Port is currently undertaking some non-marine infrastructure development. The project is a rail corridor improvement project that is located over 0.5-mile from the Columbia River and is unrelated to channel improvement.

Port of Portland. The Port of Portland is obtaining permits for planned improvements to its existing auto import facility at Terminal 4 on the Willamette River. These improvements are scheduled for construction in the summer of 2003. The improvements are currently in the process of review under the Corps' nationwide permits and associated programmatic BA. The Port also regularly engages in routine maintenance of its marine terminals (such as fender pile replacement), much of which is reviewed and conducted under the Corps' nationwide permits and the associated programmatic BA.

While other future changes to or redevelopment of the Port's marine terminals is possible, the scope and timing of any such improvements cannot be predicted at this time. The Port is in the midst of a master planning process for all of its marine terminals that will take approximately 4 months to complete. After the master planning process is complete, actual implementation of any major capital improvements is typically dependent on the needs of identified tenants for the facilities, which is in turn dependent on regional and national economic and market factors.

Port of St. Helens. Several potential development projects are proposed for the Port of St. Helens' Port Westward property. These projects are either permitted or currently going through the Oregon Energy Facility Siting Council permitting process. These projects consist of a grain loop track under development by the Port for a grain/ethanol facility being developed privately, and two gas-fired generating projects also under private development. The grain project does not involve any significant changes to or development of wharves or berths. The proposed power projects are not marine uses.

Port of Vancouver. The Port of Vancouver has several maintenance and development projects that are planned or underway. The first is expansion of the dock at Terminal 2, which has been permitted, including ESA consultation, and should be completed early in 2003. The second is maintenance work at Terminal 3, which consists mostly of asphalt, rail and warehouse repairs and upgrades, and for which permitting has just begun. Finally, the Port has recently prepared properties on Parcel 1A, which is more than 0.25 mile from the Columbia River, for lease as industrial property. Any further improvements to these properties will depend on securing appropriate tenants.

The Port of Vancouver also is continuing work on its development plans for the Columbia Gateway project. Information received from the Port demonstrates that their development plans are independent of the Corps' channel improvement project and will, depending on regional market conditions, proceed regardless of whether channel improvement occurs. The Port's Gateway property is among only a handful of large industrial parcels (over 100 acres) in the region, and is the largest industrial property under one ownership in the Portland metropolitan area. As such, the Gateway property represents a scarce regional resource that, regardless of channel improvement, the Port is committed to developing consistent with good environmental stewardship. Detailed information on the Port's proposed development can be found in the *Port of Vancouver Columbia Gateway Subarea Plan Draft Environmental Impact Statement (DEIS)* (City of Vancouver, August 2002).

Information provided by the Port during reconsultation regarding fill requirements and available sources of fill for the Gateway development project further demonstrates the independence of Gateway development and channel improvement. The Gateway development does not depend upon channel improvement dredge material as a source of fill and can readily proceed without it. While channel dredge material represents one potential source of cost-effective fill for implementing Gateway development, it is by no means the only source. Other sources of fill are available in sufficient quantities and at acceptable costs to accomplish the Port's development objectives.

Port of Woodland. The Port of Woodland currently has no specific development plans for its marine properties.

Other Potential Future Port Development. Other marine and industrial development is likely at Columbia River ports over time in response to regional and national economic trends and in response to regional commodity demand. However, the timing, nature, and extent of such development are not reasonably foreseeable at this time.

CHAPTER FOUR

ALTERNATIVES

***4. ALTERNATIVES**

4.1. Formulation and Screening of Alternatives

No updating of the existing information in this section was necessary for the Final SEIS (see the Final IFR/EIS, August 1999).

4.2. No Action Alternative

No updating of the existing information in this section was necessary for the Final SEIS (see the Final IFR/EIS, August 1999).

4.3. ^{revised} Non-Structural Alternative

For the Final SEIS, updated information has been added to this section concerning LoadMax. An analysis for the theoretical maximum potential benefits of LoadMax was included in the 1999 Final IFR/EIS. Since the 1999 analysis, the computer models providing LoadMax forecasts have been substantially updated, although there was not a significant change in the accuracy of the forecast. Accordingly, at this time, it is clear that the maximum potential benefits of LoadMax improvements would be essentially zero.

The National Weather Service's Northwest River Forecast Center provides the basic data for LoadMax. The center provides a forecast of river stages to the Port of Portland once a day. In addition to the six gauge points previously noted in the 1999 Final IFR/EIS, there are now gauge points at Portland Harbor, Kelso and Woodland. The center's models have been updated and now include four river systems (Willamette, Columbia, Lewis and Cowlitz). The center is now sharing modeling systems with the Corps, and has improved the hydraulic model with additional cross sections and more refined roughness factors. The center utilizes the Corps' quarterly information on channel bottom profiles to forecast water surface elevations. Therefore, improvements to LoadMax were evaluated and implemented; even with all of these improvements, there has been no significant change in the accuracy of the LoadMax forecast. Also, since these improvements were found to have no monetary benefit, they are not included in the benefit-to-cost analysis. The Technical Review Panel convened by the Corps to review benefit and cost projections concurred with the conclusion that no further benefits are likely to be obtained from further refinements to the LoadMax system (Casavant et al. 2002). This analysis, therefore, confirms the decision in the 1999 Final IFR/EIS to not carry forward the non-structural alternative for further detailed analysis.

4.4. ^{revised} Structural Alternatives

4.4.1. Regional Port Alternatives

No updating of the existing information in this subsection was necessary for the Final SEIS (see the Final IFR/EIS, August 1999).

4.4.2. Channel Deepening Alternatives

No updating of the existing information in this subsection was necessary for the Final SEIS (see the Final IFR/EIS, August 1999).

4.4.3. ^{revised} Disposal Alternatives

No updating of the existing information in Subsections 4.4.3.1 to 4.4.3.9 was necessary for the Final SEIS (see the Final IFR/EIS, August 1999). However, Subsection 4.4.3.10 has been added to provide updated information on the disposal plan modifications.

4.4.3.10. ^{new} Disposal Plan Modifications Following Consultation

This subsection addresses disposal plan modifications resulting from the ESA consultation process and using updated 2001-2002 hydrographic survey data. The construction dredging volume has been reduced from 18.4 million cubic yards (mcy) to 14.5 mcy for the 43-foot channel improvement project. The rock removal volume was reduced from 590,000 to 490,500 cubic yards. Of this amount, blasting is needed to remove about 50,500 cubic yards of rock at Warrior Rock near St. Helens; the remaining 440,000 cubic yards of loose rock at Longview, Vancouver Bar, and Vancouver turning basin will be removed by mechanical dredge. The maintenance dredging volumes in the 1999 Final IFR/EIS have not changed.

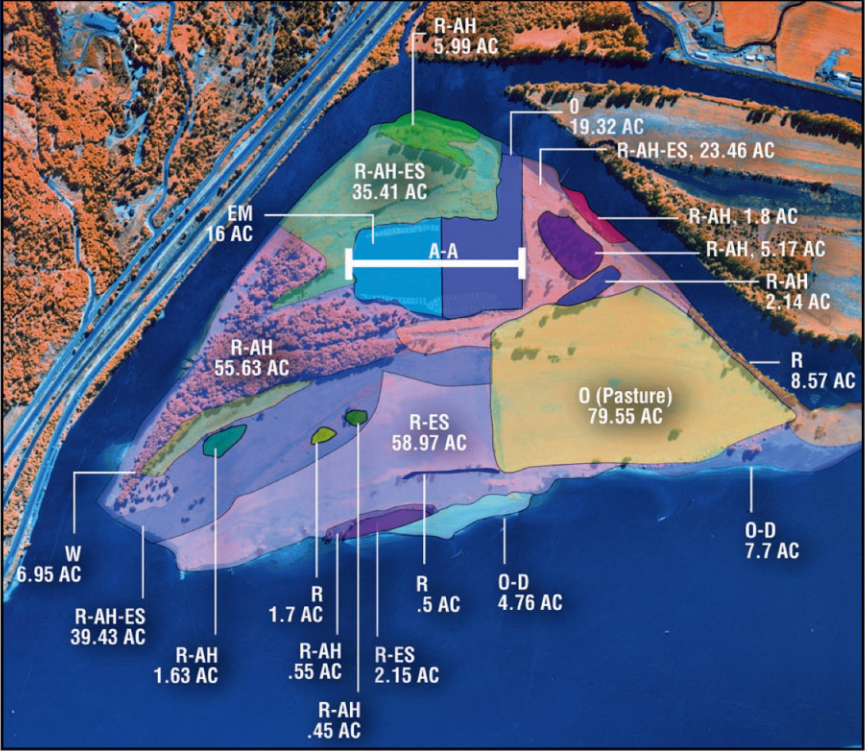
The disposal plan changes result from new information regarding volumes to be dredged, changed plans for the use of previously identified sites, and the addition of new ecosystem restoration features that involve beneficial use of dredged material. The following changes to project impacts have occurred:

- Reduction in impact to riparian forest from 67 acres to 50 acres (approximately 25%) due to reduced disposal site acreage at Lord Island (O-63.5).
- Reduction in impact to agricultural lands from 200 acres to 172 acres (approximately 14%) primarily due to reduced disposal site acreage required at Gateway (W-101) and Mt. Solo (W-62).
- Reduction in impact to wetlands from 20 acres to 16 acres (approximately 20%) due to a reduction at the Mt. Solo site resulting from correcting a mapping inconsistency.
- The Martin Island embayment wetland mitigation site was reduced from 32 acres to 16 acres in order to comply with the Cowlitz County Shoreline Master Plan provisions regarding recreational use and to respond to public comments received (Figure S4-1).

Table S4-1 provides revised information on all disposal sites as modified following consultation, including information on prior disposal history, anticipated timing of usage during construction and the first 20 years of maintenance, site acreage, site capacity, anticipated disposal volume, and final height. In addition, due primarily to the beneficial use of dredged materials at the Lois Island embayment and Miller-Pillar ecosystem restoration features under the preferred option discussed in this Final SEIS, it is projected that use of the Deep Water Site will not be necessary for construction and should not be necessary for the first 20 years of maintenance of the channel improvement project.

Figure S4-1. Martin Island Embayment Wetland Mitigation Plan (revised)

Martin Island



Martin Island
Mitigation Habitat

Martin Island Embayment Marsh Development

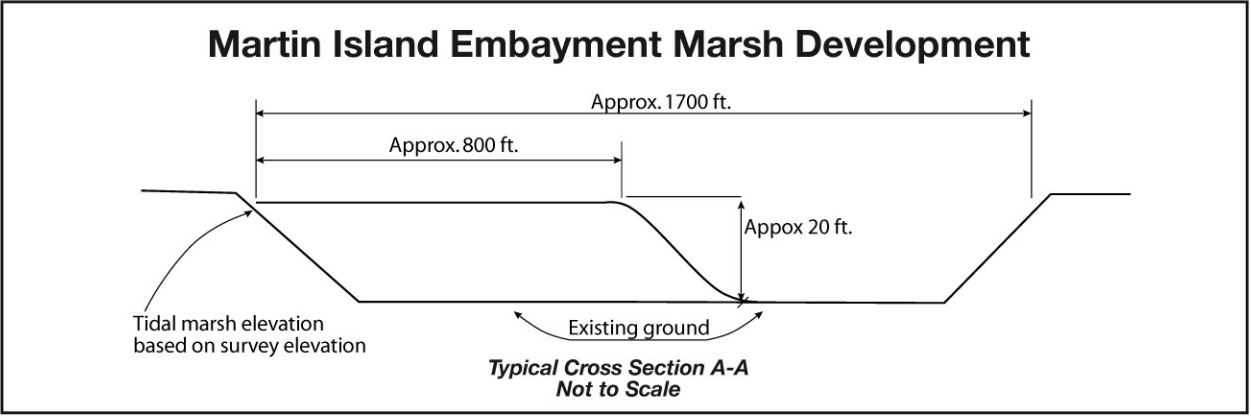


Figure S4-1 Martin Island Embayment Wetland Mitigation Plan (Revised)

Table S4-1. Proposed Disposal Plan Including Beneficial Use Sites, Ecosystem Restoration and Wildlife Mitigation (Martin Island Embayment)

Disposal Site *	Disposal History**	Location/Name	Site Acres (rounded)	Site Capacity (cu yds)	Construction Disposal Volume Rounded (cu yds)	O&M Use for 20-year Term	43-foot O&M Disposal Volume Rounded (cu yds)	Total Disposal Volume Rounded (Construction and O&M) ^a	Final Height for Total Volume Placed (feet CRD)
In-water	DMMS	CRM 3-106 - 50'-65' deep, in or adjacent to channel***	NA	NA	2,000,000	20	26,000,000	28,000,000	NA
O-105.0	DMMS	West Hayden Island	102	5,750,000	600,000	20	3,900,000	4,500,000	60
W-101.0	New	Gateway	40	2,300,000	587,000	20	1,600,000	2,300,000	65
W-97.1	DMMS	Fazio Sand & Gravel	27	650,000	112,000	20	1,000,000	1,200,000	Varies due to resale
W-96.9	New	Adjacent to Fazio	17	475,000	0	6-20	As needed	Varies	Varies due to resale
O-91.5	New	Lonestar	45	5,350,000	900,000	20	3,200,000	4,400,000	NA; gravel pit
O-87.8	New	RR Corridor	12	540,000	300,000	20	0	400,000	46
W-86.5	Used	Austin Point	26	1,645,000	136,000	20	1,500,000	1,700,000	Varies due to resale
O-86.2	Used	Sand Island	28	1,250,000	150,000	20	860,000	1,000,000	Shoreline; varies due to erosion
O-82.6	Used	Reichold	49	1,285,000	320,000	20	2,300,000	2,600,000	Varies due to resale
W-82.0	Used	Martin Bar	32	1,500,000	46,000	20	700,000	760,000	51
W-80.0	New Mitigation Site	Martin Is. Mitigation	16	550,000	370,000	Not used	0	460,000	-8
O-77.0	Used	Lower Deer Island	29	1,498,000	440,000	20	700,000	1,200,000	44
O-75.8	DMMS	Sandy Island	30	1,100,000	120,000	20	860,000	1,000,000	42
W-71.9	Used	Northport	27	900,000	189,000	20	1,800,000	1,900,000	Varies due to resale
W-70.1	Used	Cottonwood Is.	62	3,200,000	240,000	20	1,300,000	1,500,000	49
W-68.7	DMMS	Howard Island	200	6,400,000	0	20	600,000	600,000	29
O-67.0	Used	Rainier Beach	52	1,095,000	450,000	20	2,400,000	3,000,000	65
W-67.5	Used	International Paper	29	1,000,000	140,000	20	2,700,000	2,900,000	Varies due to resale
O-64.8	DMMS	Rainier Industrial	53	2,235,000	270,000	20	2,400,000	2,700,000	64
O-63.5	DMMS	Lord Island Upstream	25	1,255,000	0	20	600,000	600,000	63
W-63.5	Used	Reynolds Aluminum	13	500,000	180,000	20	0	200,000	Varies due to resale
W-62.0	New	Mt. Solo	47	2,500,000	300,000	20	2,100,000	2,400,000	49
W-59.7	DMMS	Hump Island	69	1,500,000	400,000	6	900,000	1,500,000	42
O-57.0	DMMS	Crims Island	46	1,600,000	30,000	20	1,100,000	1,200,000	40

COLUMBIA RIVER CHANNEL IMPROVEMENTS PROJECT
FINAL SUPPLEMENTAL INTEGRATED FEASIBILITY REPORT AND ENVIRONMENTAL IMPACT STATEMENT

Disposal Site *	Disposal History**	Location/Name	Site Acres (rounded)	Site Capacity (cu yds)	Construction Disposal Volume Rounded (cu yds)	O&M Use for 20-year Term	43-foot O&M Disposal Volume Rounded (cu yds)	Total Disposal Volume Rounded (Construction and O&M)^a	Final Height for Total Volume Placed (feet CRD)
O-54.0	Used	Port Westward	50	1,875,000	150,000	20	1,500,000	1,700,000	46
W-46.3/ 46.0	DMMS	Brown Island	72	4,700,000	1,200,000	20	3,400,000	4,700,000	66
W-44.0	New	Puget Is. (Vik Prop.)	100	3,500,000	500,000	20	2,700,000	3,300,000	41
O-42.9	DMMS	James River	53	1,280,000	240,000	20	830,000	1,070,000	39
O-38.3	DMMS	Tenasillahe Island	42	2,300,000	0	10	2,300,000	2,300,000	60
O-34.0	DMMS	Welch Island	42	446,000	0	³ (18-20)	400,000	400,000	25
W-33.4	Used	Skamokawa	11	250,000	0	As needed	varies	varies	Shoreline; varies due to erosion and resale
O-27.2	DMMS	Pillar Rock Island	56	2,555,000	0	20	1,000,000	1,000,000	34
	New Restoration	Miller-Pillar Ecosystem Restoration Feature	235	5,500,000	0	15	5,500,000	5,500,000	Surveyed reference (tidal marsh & intertidal flat) elev.
O-23.5	DMMS	Miller Sands	151	NA	0	20	7,000,000	7,000,000	Shoreline; varies due to erosion
W-21.0	DMMS	Rice Island	228	5,500,000	0	20	5,500,000	5,500,000	53
	New Restoration	Lois Island Embayment Ecosystem Restoration Feature	191	6,200,000	4,000,000	20	2,000,000	6,000,000	Surveyed reference (tidal marsh) elev.
Shallow Water Site	Used	Ocean	580	NA	MCR O&M(1)	20	0	0	NA
Deep Water Site	New	Ocean	8,980	225,000,000	0	20	0	0	NA

(1) Between 2.0-2.5 mcy per year in Site E and North Jetty Site per year.

(2) Construction plus 20 years channel project only; additional material from MCR operations and maintenance (O&M) as needed. 50-year volume 37 mcy.

* "W" and "O" refer to the Washington or Oregon shoreline. The number refers to the approximate river mile on the navigation channel.

** DMMS = site is in the No Action Alternative (existing 40-foot channel maintenance)

New = site is new for this study

Used = site previously used by Corps for disposal

*** Disposal would occur in depths over 65 feet at CRMs 5, 29-35, 36.5-37.5, 39-40, 54-56.3, and 72.2 - 73.2

a - Total includes 40-foot O&M volume that is included in material dredged with 43-foot construction material.

Joint USEPA and Corps guidance for designation of ocean dredged material disposal sites was published in 1984. It provides procedures for the identification, evaluation, and selection for final designation of the ocean disposal sites. A management plan that includes monitoring is mandatory. The USEPA and Corps followed the procedures and conducted/reviewed studies with information on living resources, physical processes, geology, sediment quality, water quality, cultural resources, and recreation. In total, 143 separate studies are found in Appendix H of the 1999 Final IFR/EIS.

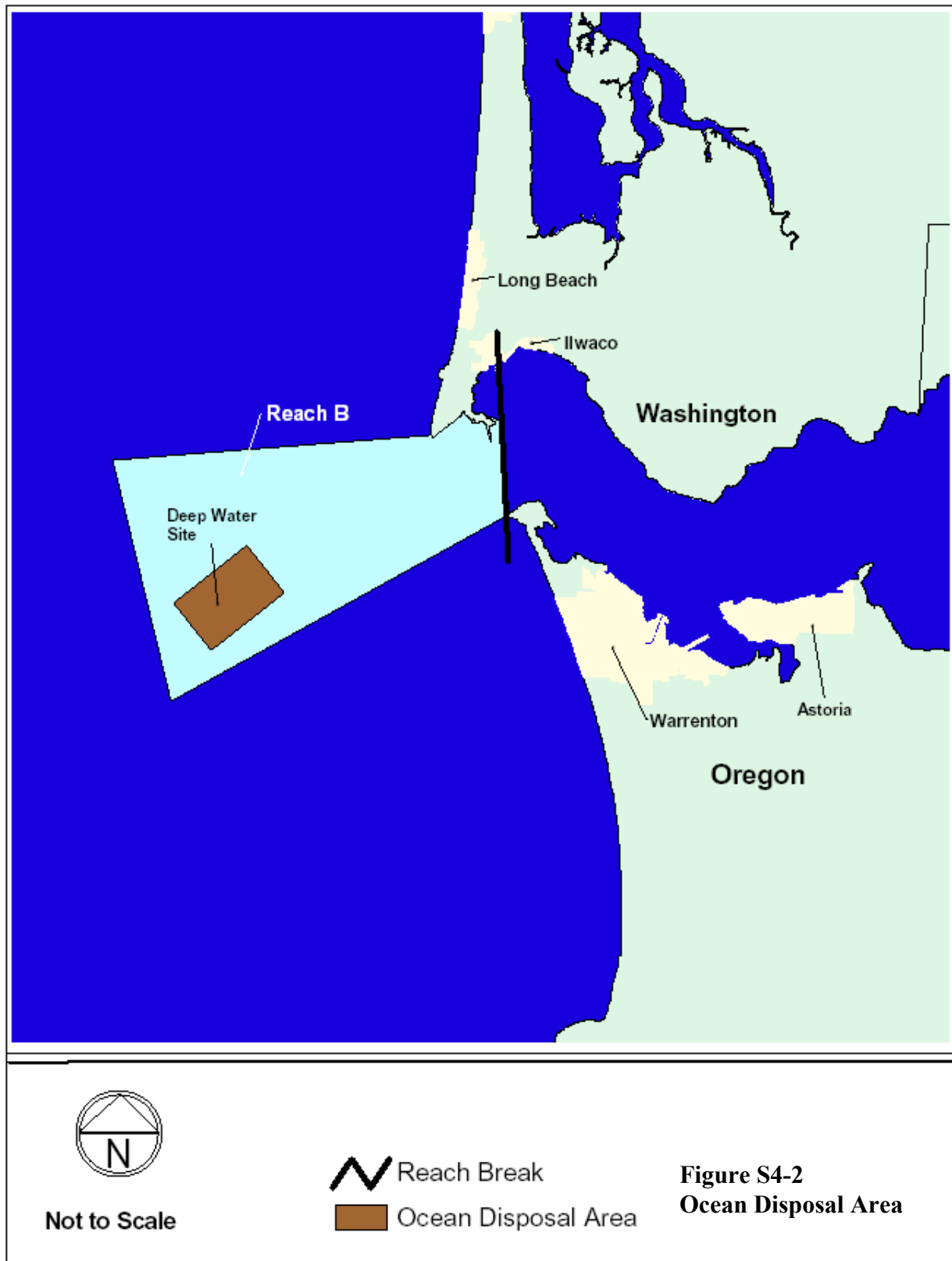
The USEPA is responsible for designation and administration of ocean disposal sites under the Marine Protection, Research, and Sanctuaries Act of 1972, as amended. The Corps is the primary user of those sites. The Corps and USEPA cooperated throughout the IFR/EIS study process leading to identification of the Shallow Water and Deep Water Sites as candidates for formal designation by USEPA in the 1999 Final IFR/EIS. The USEPA is a cooperating agency on the 1999 Final IFR/EIS and this Final SEIS, and intends to adopt the pertinent portions of these documents.

Additional environmental information (e.g., baseline characterizations) has been collected by the Corps and USEPA and included in Exhibit N of the Final SEIS. In addition, the Final SEIS discusses new channel improvement project alternatives, such as the identification and evaluation of ecosystem restoration elements as the preferred disposal alternative for river material that was identified in the 1999 Final IFR/EIS for ocean disposal. The USEPA concurs with the preferred use of channel improvement material. The Corps' preferred plan does not utilize ocean disposal for construction and the first 20 years of maintenance, due primarily to the beneficial use of dredged material at the Lois Island embayment and Miller-Pillar ecosystem restoration features. Under the preferred option in this Final SEIS, it is projected that use of the Deep Water Site will not be necessary for construction and should not be necessary for the first 20 years of maintenance of the channel improvement project. If the restoration features in the estuary are not fully implemented, then the alternative would be to dispose of material into USEPA-designated ocean sites as described in the 1999 Final IFR/EIS. The primary need for new ocean sites is driven by maintenance of a separate Corps project, the MCR navigation channel. With regard to diversion of the channel improvement material for the restoration projects, that volume amounts to approximately 7% of the site capacity. The USEPA regards this as reducing the overall height of material placed in the Deep Water Site, as well as increasing the potential life of this site by a few years. However, it does not significantly alter the need for the site or its size.

The need for designating new ocean disposal sites off of the MCR remains fundamentally unchanged and will proceed as discussed in the 1999 Final IFR/EIS to formal rulemaking by USEPA. The USEPA expects to initiate formal rulemaking on the Shallow Water and Deep Water Sites in February 2003, with the designations becoming effective by summer 2003.

The Deep Water Site is located about 4.5 miles west of the MCR, with depths ranging from 200-300 feet (Figure S4-2). The Deep Water Site is 17,000 by 23,000 feet (8,980 acres) and consists of an inner rectangle measuring 11,000 by 17,000 feet (inner dumping zone), surrounded on all sides by a 3,000-foot buffer zone. The overall site dimensions were developed based on volumes from the MCR project and up to CRM 29 of the inner channel.

Figure S4-2. Ocean Disposal Area



Dredged material disposal will only be allowed in the inner dumping zone, which has a total area of 4,293 acres and a static disposal capacity of 225 mcy. Material placed is expected to create a mound about 40 feet high in the inner zone over the estimated 50-year life of the site. The buffer zone allows for the sloughing of material from the mound. No dredged material generated by the project is scheduled for disposal at the Shallow Water Site.

In this Final SEIS, two options have been identified for disposal of dredged material originating from CRM 3-29 for the channel improvement project. The first option was discussed in the 1999 Final IFR/EIS, which stated that during construction of the 43-foot alternative, about 7 mcy of material (5 mcy new work plus 2 mcy of O&M materials from the 40-foot channel maintenance) would be disposed of in the Deep Water Site. An additional 9 mcy derived from channel maintenance would be placed in the site during years 1-20, and an additional 21 mcy from years 21-50. The total volume estimated from the channel improvement project for ocean disposal was 37 mcy.

The project as defined in Chapter 1 includes the second option for treatment of CRM 3-29 material for disposal, which is the construction of two restoration features beneficially using sand that otherwise would have been disposed of in the ocean. The Lois Island embayment and Miller-Pillar restoration features are described in Subsection 4.8.6 and in the Biological Opinion (Exhibit H available on the Corps' website). As part of the ESA consultation, the three federal agencies identified these two restoration features as being beneficial to listed salmonid stocks. The Corps' preferred plan in this Final SEIS does not utilize ocean disposal (Deep Water Site) for construction and the first 20 years of maintenance for the channel improvement project, due to the beneficial use of dredged materials at the Lois Island embayment and Miller-Pillar ecosystem restoration features. Should either of these restoration features be substantially modified or discontinued through the public review process for this NEPA document, the Deep Water Site option described in the 1999 Final IFR/EIS would be used for disposal of the balance of the dredged material.

Table S4-2 displays the construction volumes and O&M for the proposed alternative from CRM 3-29 for the 1999 IFR/EIS and Final SEIS. Under the second option also described in Subsection 4.4.3.10, the Corps would dispose of the material using a combination of ecosystem restoration, flowlane disposal, and existing upland and shoreline sites.

Table S4-2. Disposal Volumes for the Proposed Alternative from CRM 3-29

Document	Construction	Years 1-20 of O&M	Years 21-50 of O&M
1999 Final IFR/EIS	7 mcy (5 mcy new work; 2 mcy 40-foot O&M) Deep Water Site	9 mcy Deep Water Site	21 mcy Deep Water Site
Final SEIS	6 mcy Lois Island Embayment (4 mcy new work; 2 mcy 40-foot O&M)	5.5 mcy Miller Pillar, 15 years (additional material would go to a combination of Rice Island, Pillar Rock, Miller Sands, and flowlane disposal)	Rice Island, Pillar Rock, and Miller Sands, and Flowlane disposal; potential for ocean disposal and/or beneficial use

Both the Lois Island embayment and Miller-Pillar restoration features have been modified since the Draft SEIS in response to comments and coordination with stakeholders and state and federal resource agencies. The modifications for these features focus on establishing tidal marsh and intertidal habitat, which is one of the most impacted habitat types in the Columbia River estuary.

The Lois Island embayment feature would restore about 191 acres of tidal marsh habitat by placement of dredged material to a target elevation of approximately 6.5 feet mean lower low water (MLLW). The target elevation is predicated on the approximate elevation break between low and high tidal marsh plant communities (Figure S4-3). Based on current hydrographic surveys, it is estimated that 6 mcy would be available for placement at the Lois Island embayment in the 2-year construction period. This material would originate from the navigation channel between CRM 3-29.

Construction of this feature would occur in two related operations (Figure S4-4). Material dredged would be transported via hopper dredge to a temporary location (sump), located within 600 feet of the federal navigation channel between CRM 18-20 on the Oregon side. Hopper dredges would use this location as a temporary construction sump. A pipeline dredge would then be used to pump dredged materials to the embayment. Hopper dredges would charge this sump prior to the in-water work period (November 1 to February 28). Hopper and pipeline dredges would then work concurrently throughout the in-water work period to sustain material delivery to the sump and embayment. Should additional material be required during the in-water work period of construction in year two, the sump would again be charged with material beforehand and the same scenario would be implemented to complete the ecosystem restoration.

Figure S4-3. Lois Island Embayment Ecosystem Restoration Feature (191 acres)

Columbia River Channel Improvement Project

LOIS ISLAND EMBAYMENT
BATHYMETRY (2 foot contour interval)
ECOSYSTEM RESTORATION FEATURE
Columbia River, Miles 18 – 20

- Proposed Disposal Sites
- Critical Riparian Habitat-300'
- Setback from Shoreline
- Levees
- Areas Requiring Dredging
- Areas Not Requiring Dredging
- State Boundary
- County Boundary
- National Wildlife Refuge Boundary

625 0 625 1250 1875
SCALE IN FEET
CENWP-EC-HM

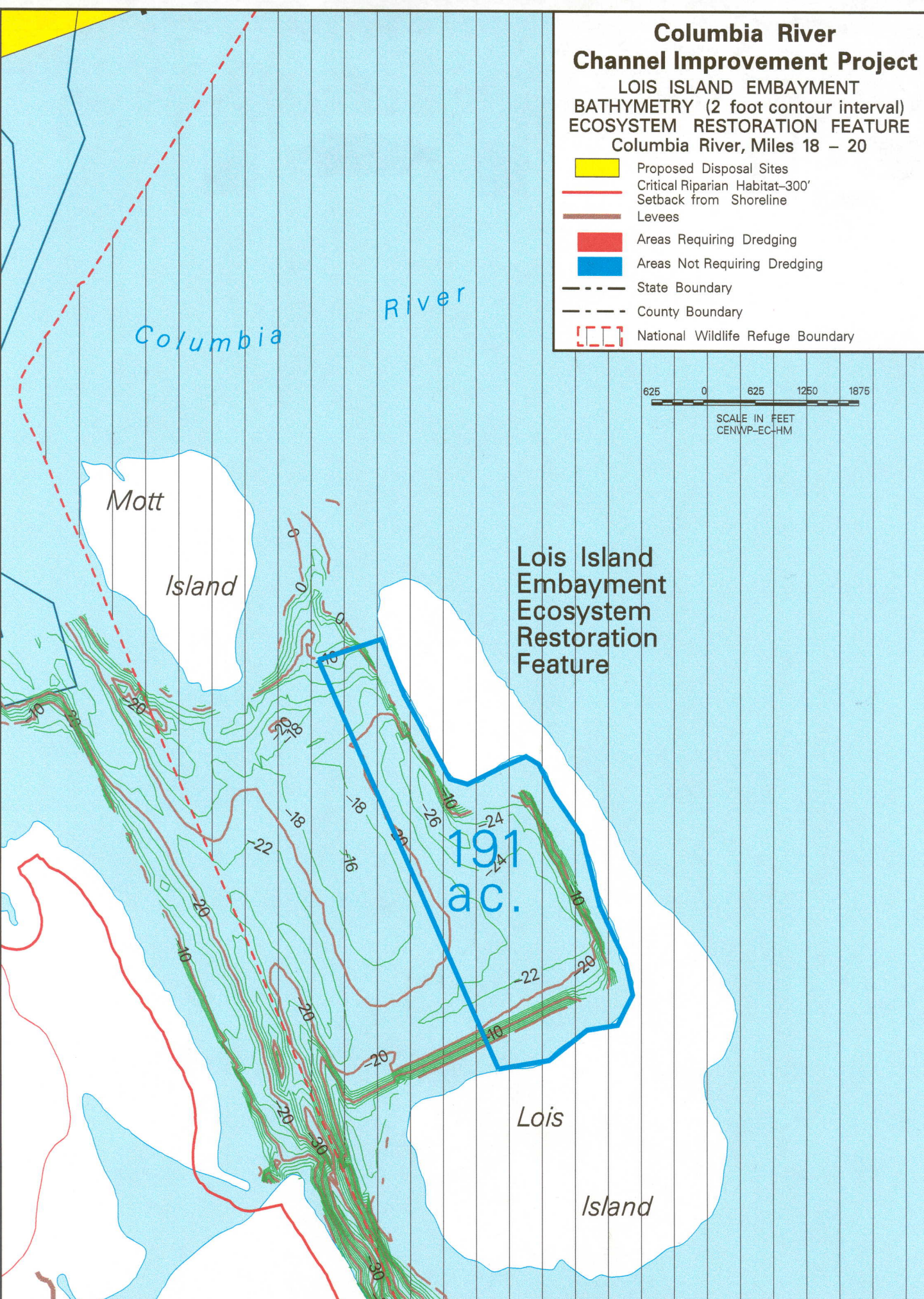


Figure S4-3

Figure S4-4. Lois Island Embayment Bathymetry, Temporary Sump with Pipeline

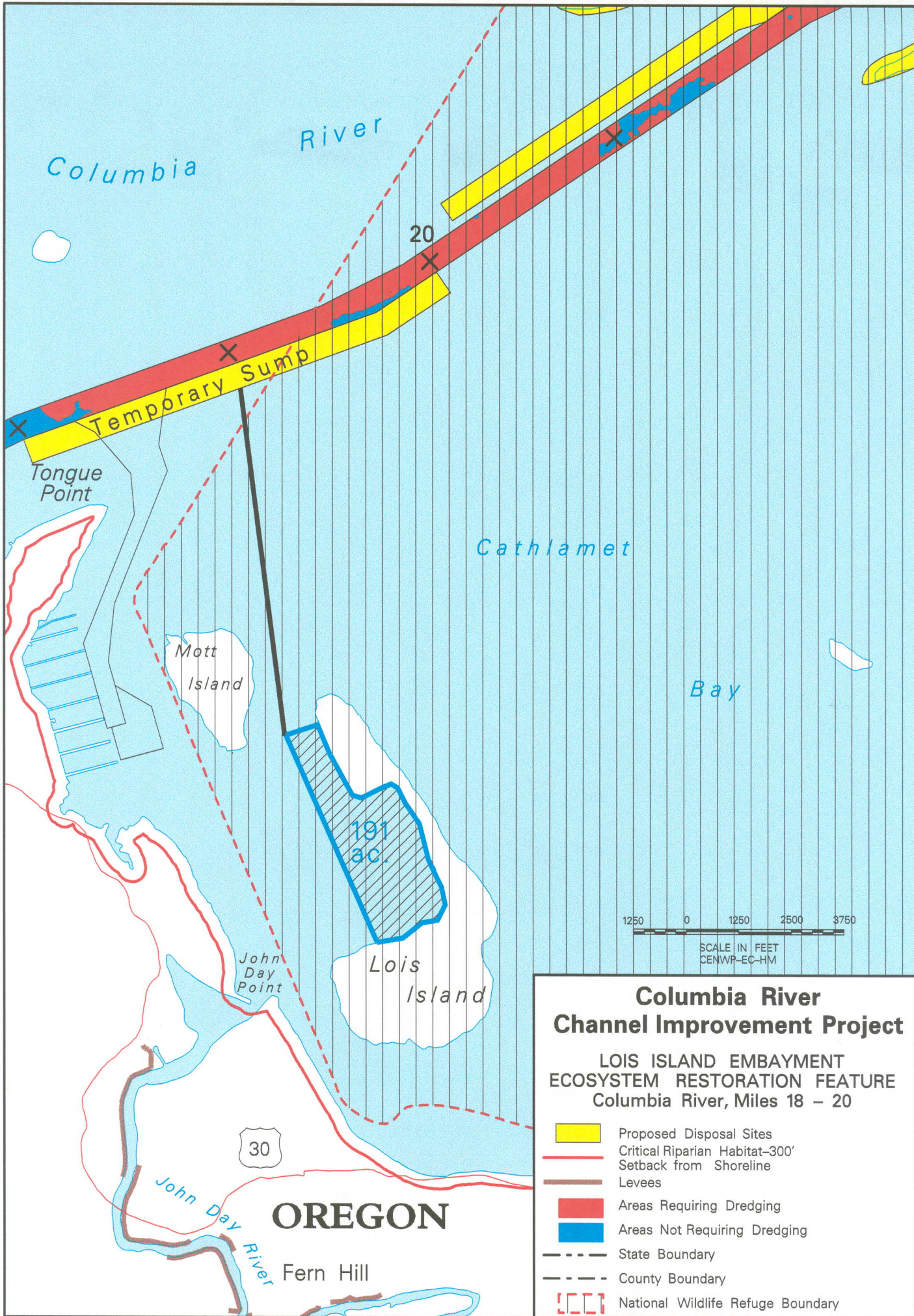


Figure S4-4

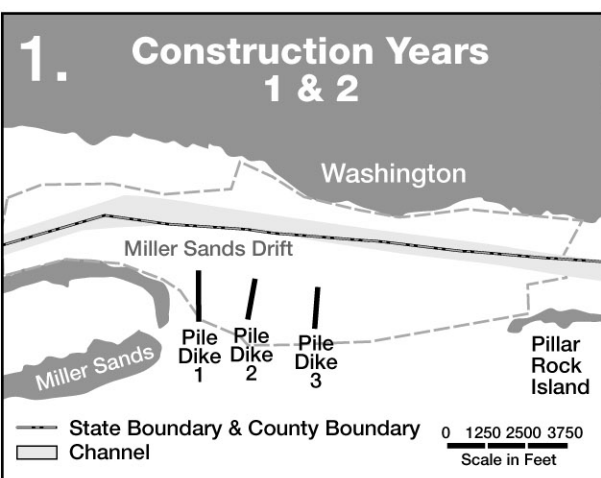
The Miller-Pillar restoration feature is located between Miller Sands and Pillar Rock Islands (CRM 25-26) and restores approximately 235 acres of tidal marsh and intertidal flat habitat at a presently erosive, subtidal location (Figure S4-5). Natural processes are currently eroding material south of the navigation channel and redepositing it in the navigation channel. This erosive action has been occurring since 1958 at an average annual rate of about 70,000 cubic yards. The erosion is affecting productive, shallow subtidal habitat (0 to 5.9 feet CRD) and converting the area to less productive, deep subtidal habitat (a minimum depth of 24.9 feet CRD; Hinton, et al. 1995). Based upon coordination with the Oregon Department of Fish and Wildlife (ODFW) and Oregon Department of Land Conservation and Development among others, the restoration emphasis at this location is directed toward tidal marsh and intertidal flat habitat. Tidal marsh represents one of the most impacted habitat types in the Columbia River estuary.

The Miller-Pillar restoration feature requires construction of a pile dike field. Three pile dikes would be constructed initially to implement the tidal marsh-intertidal flat habitat restoration; ultimately the restoration effort would consist of five pile dikes to hold material in place. The dredged material would be obtained from the maintenance of the deepened channel (approximately 15 years). This restoration feature would be accomplished with fill placed to the target elevation derived from the adjacent tidal marsh-intertidal flat habitat immediately upstream of Miller Sands Island and abutting a portion of the restoration area. The restoration action would be phased, beginning at the downstream border and moving upstream. Fill would be placed initially in the cell between the first and second pile dikes until the target depths for tidal marsh-intertidal flat habitat are reached. At that time, the downstream cell would no longer receive dredged material and monitoring for tidal marsh plant establishment and productivity would begin. Subsequently, dredged material would be placed between the second and third pile dikes until target depths are reached and this segment was complete. Monitoring would then be initiated to evaluate productivity of this section.

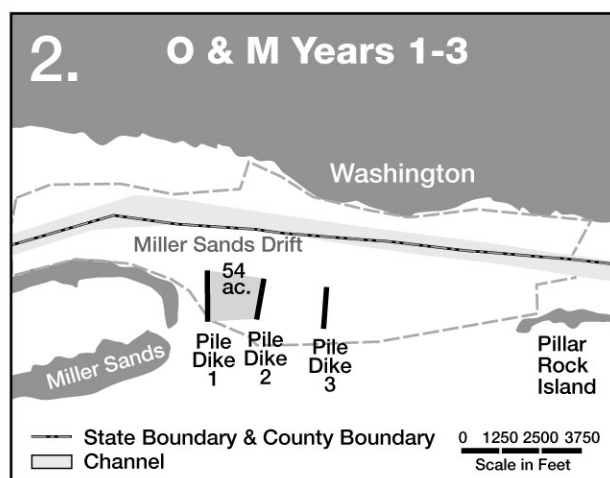
Results of the monitoring effort will be reviewed by an Adaptive Management Team (AMT), composed of interagency representatives, who will determine if modifications of the restoration effort are required to attain tidal marsh-intertidal flat habitat. The construction of this feature would continue incrementally, with modification if deemed necessary, until the entire 235 acres of tidal marsh-intertidal flat habitat was created. This approach creates tidal marsh-intertidal flat habitat that would be available to salmonids and other aquatic species and more importantly, generates detrital export to the estuary, which provides a forage base for benthic invertebrates, an important prey resource for juvenile salmonids and other aquatic species. The timeframe to accomplish this restoration depends on the volume of maintenance material that accumulates in the navigation channel, but is currently estimated to be approximately 15 years. Once this ecosystem restoration feature is completed, no further dredged material would be placed at this location. Bird excluders would be placed on top of the pilings and spreaders comprising the pile dikes to preclude fish-eating birds from perching there.

Figure S4-5. Miller-Pillar Implementation Plan

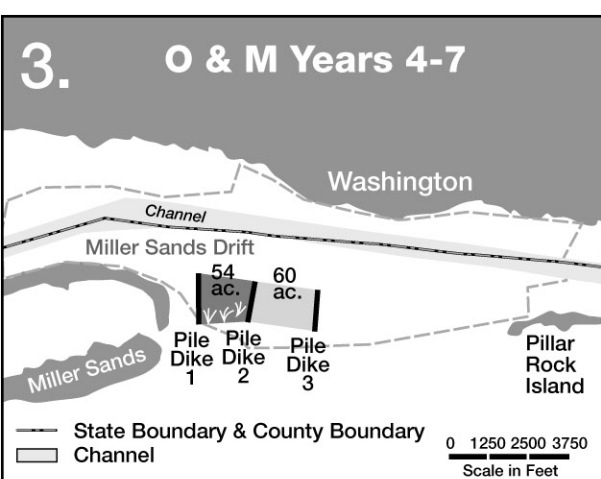
Miller-Pillar Ecosystem Restoration Feature Implementation Plan



/ Pile dikes

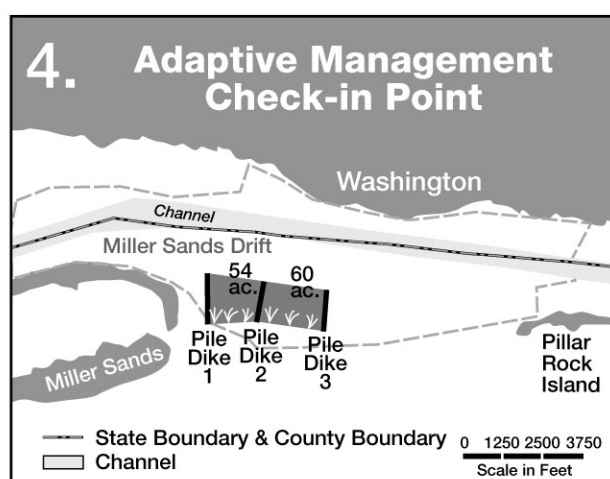


Dredged material placed to tidal marsh elevation

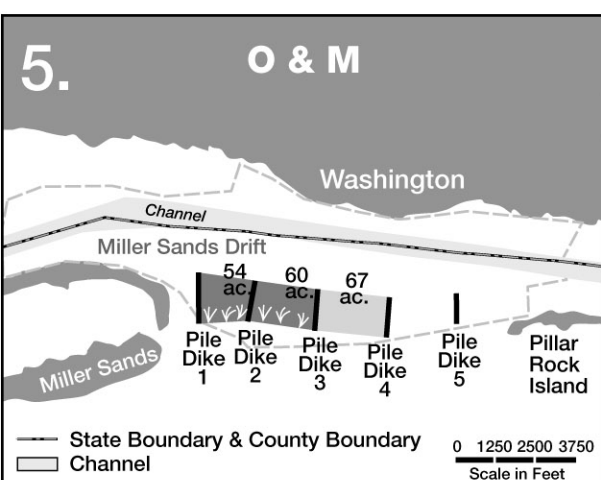


Tidal marsh vegetation

Dredged material placed to tidal marsh elevation

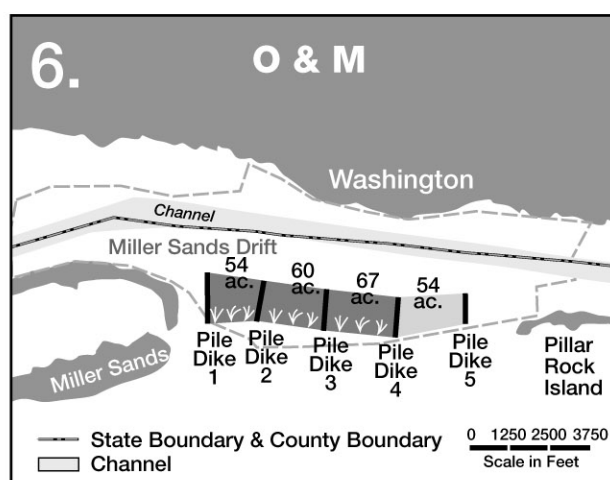


Tidal marsh vegetation



Tidal marsh vegetation

Dredged material placed to tidal marsh elevation



Tidal marsh vegetation

Dredged material placed to tidal marsh elevation

Figure S4-5 Miller-Pillar Ecosystem Restoration Feature Implementation Plan

The Corps' preferred option is to beneficially use the dredged material from construction of the channel improvement project from CRM 3-29 for tidal marsh development at Lois Island embayment. The first 15 years of project maintenance would be used for the Miller-Pillar ecosystem restoration feature, as well as placement at those disposal sites that have historically been used during O&M of the 40-foot channel including flowlane, Miller Sands Spit, Rice Island and Pillar Rock Island (instead of exclusively using the Deep Water Site). Once the Miller-Pillar restoration feature is completed, no additional material will be placed there and maintenance material from years 15-20 would be placed at a combination of sites including flowlane, Miller Sands Spit, Rice Island and Pillar Rock Island.

With the use and implementation of the two estuarine restoration sites, and subsequent use of traditional estuarine disposal sites, placement of material in the ocean disposal site should not be necessary for construction of the channel improvement project and the first 20 years of maintenance. In the event dredge material from the channel did go to the ocean because the ecosystem features were not fully implemented, it would go to a site designated for ocean disposal under Section 102 of the Ocean Dumping Act. At this time, we fully anticipate that the site proposed for designation under the Ocean Dumping Act for potential use for this project will be the Deep Water Site. Compliance with applicable provisions of Goal 19 and the Oregon Territorial Sea Plan, Part II Resource Inventory and Effects Evaluation, will be met once the requirements and criteria contained in Parts 227 and 228 are completed. Remaining actions to be completed include a biological baseline study and further analysis of potential Dungeness crab impacts. Additional discussion of effects on ocean resources and activities is included in the following section.

4.5. ^{revised} Comparison of Alternatives

The NEPA and SEPA require a comparison of alternatives in an EIS. Corps regulations for navigation projects require additional analysis of benefits and costs for such projects. To address both of these requirements, this chapter is structured as follows. Sections 4.5 through 4.7 pertain only to those measures that Corps regulations require as part of the benefit-to-cost analysis for a navigation project. For the purposes of the project as defined in Chapter 1, this includes all navigation features (dredging, disposal, wildlife mitigation, terms and conditions of the Biological Opinions, berthing areas, utility relocations) and Lois Island embayment and the Miller-Pillar ecosystem restoration features. These two restoration features are included in the benefit-to-cost analysis because they have been identified as a beneficial use of dredged material, provide ecosystem benefits, and are less expensive than the selected disposal alternative in the 1999 Final IFR/EIS. All other ecosystem restoration features are discussed in Section 4.8 and are not included in the benefit-to-cost analysis per Corps regulations.

In addition to the alternatives identified in the 1999 Final IFR/EIS, this Final SEIS carries forward for detailed evaluation the modified disposal plan discussed in Section 4.4.3.10, including the revisions to the Lois Island embayment and Miller-Pillar ecosystem restoration features developed in response to comments on the Draft SEIS.

4.5.1. ^{revised} Environmental Comparison

Table S4-3 has been updated to provide information on the anticipated environmental impacts discussed in this Final SEIS resulting from the Columbia River Channel Improvement Project. Additional discussion of these impacts is included in Chapter 6, *Environmental Consequences*. While this section generally pertains only to those measures that Corps regulations require as part of the benefit-to-cost analysis for a navigation project, the comparison of alternatives in Table S4-3 covers all aspects of the project, including the other ecosystem restoration features discussed in Section 4.8.

4.5.1.1. ^{revised} Physical Impacts

See Subsection 4.4.3.10, *Disposal Plan Modifications Following Consultation*, for updated information on dredging volumes and disposal of dredged material for the 43-foot alternative. Additional studies, discussed in detail in Chapter 6, confirm the analysis and conclusions presented in the 1999 Final IFR/EIS regarding the impacts of the 43-foot alternative on estuarine salinity and circulation, sedimentation, water quality, erosion and sediment quality, as compared to the No Action Alternative.

4.5.1.2. ^{revised} Biological Impacts

For the Final SEIS, the following updated information has been added to this subsection. Disposal plan changes result from new information regarding volumes to be dredged, changed plans for the use of previously identified sites, and the addition of new ecosystem restoration features that involve beneficial use of dredged material. The following changes to project impacts have occurred:

- Reduction in impact to riparian forest from 67 acres to 50 acres (approximately 25%) due to reduced disposal site acreage at Lord Island (O-63.5).
- Reduction in impact to agricultural lands from 200 acres to 172 acres (approximately 14%) primarily due to the reduced disposal acreage required at Gateway (W-101) and Mt. Solo (W-62).
- Reduction in impact to wetlands from 20 acres to 16 acres (approximately 20%) due to a reduction at the Mt. Solo site resulting from correcting a mapping inconsistency.

As discussed in Chapter 1, subsequent to issuance of the 1999 Final IFR/EIS, the Corps, NOAA Fisheries and USFWS conducted an extensive reconsultation process, focused primarily on ESA-listed fish species. The results of that consultation are discussed in detail in Chapter 6. After conducting detailed analysis of potential impacts on listed species, the Services concluded that any expected impacts to key physical processes potentially affecting listed fish species would be limited and short-term in nature. They further concluded that there is some low level of risk and uncertainty surrounding the long-term biological response to physical change, but that monitoring and adaptive management will address the limited risk and uncertainties. The consultation process also resulted in substantial information on the No Action Alternative, which is presented in more detail in Chapter 6 and included in Table S4-3.

Table S4-3. Updated Summary of Environmental Impacts

Affected Resources	No Action	43-foot Channel (Least Cost Disposal)	Proposed Disposal (Sponsor Preferred)	Ecosystem Restoration
Physical				
Salinity Intrusion	No effect	Increase salinity (< CRM 30) by up to 0.5 ppt in shallow embayments & up to 5 ppt in navigation channel under low flow conditions.	Same as Least Cost	No effect
Shoreline Erosion	Erosion at former shoreline disposal sites.	Same as No Action	Same as No Action	No effect
Sediment Quality	All dredged material suitable for unconfined in-water disposal	Same as No Action	Same as No Action	Sediment testing and analysis to be performed at Bachelor Slough ecosystem restoration feature.
Water Quality	Minor turbidity & sediment suspension created by dredging/disposal	Short-term increase in turbidity & sediment suspension from initial deepening.	Same as Least Cost	Short-term increase in turbidity & sediment suspension from initial restoration implementation.
Ocean	Use of this site by the MCR project results in bathymetric & sediment changes over a 4,293-acre area.	Use of this site not anticipated.	Same as Least Cost	The Corps' preferred plan does not utilize ocean disposal for construction and first 20 years of maintenance, primarily to the beneficial use of dredged materials at Lois Island embayment and Miller-Pillar restoration features. Under the preferred option, it is projected that use of the Deep Water Site will not be necessary for construction and should not be necessary for the first 20 years of maintenance of the project.
Biological				
Riverine Aquatic	Temporary, short-term habitat alteration & disturbance from dredging/disposal.	Comparable to No Action but additional bottom habitat disturbed by dredging.	Same as Least Cost	Improve water circulation at Bachelor Slough (85 ac.) & Lord-Walker & Fisher-Hump embayments (335 ac.); preserve 60 acres tidelands (Cottonwood-Howard); improve fish access to 38 tributary mi. & 92 ac. of backwater channel (Tenasillahe Is. interim); restore tidal connection to ~1,800 ac. (Tenasillahe Is. long-term), restore 426 ac. of tidal marsh-intertidal flat habitat (Miller-Pillar & Lois Island).

Affected Resources	No Action	43-foot Channel (Least Cost Disposal)	Proposed Disposal (Sponsor Preferred)	Ecosystem Restoration
Ocean	Ocean disposal from MCR project would affect 4,293 acres of benthic habitat and impacts commercial fishing.	Reduced impacts to commercial fishing by beneficial use sites in the estuary.	Same as Least Cost	The Corps' preferred plan does not utilize ocean disposal for construction and first 20 years of maintenance, primarily to the beneficial use of dredged materials at Lois Island embayment and Miller-Pillar restoration features. Under the preferred option, it is projected that use of the Deep Water Site will not be necessary for construction and should not be necessary for the first 20 years of maintenance of the project.
Riparian	Minor effects to riparian fringes at some upland disposal sites	50 acres affected at 7 disposal sites.	50 acres affected at 7 disposal sites.	Restore 52 acres of riparian habitat (Bachelor Island).
Wetland	No effect	24 acres affected at 3 disposal sites.	16 acres affected at 2 disposal sites.	Restore 470-839 acres of emergent wetlands (Shillapoo Lake), 191 acres of tidal marsh at Lois Island embayment, 235 acres of tidal marsh-intertidal flat at Miller-Pillar and 1,778 acres of intertidal marsh (Tenasillahe Is. long-term); implement 5-yr. control program for purple loosestrife from CRM 18-52
General Wildlife	About 1,165 acres of upland habitat affected by past disposal actions.	Impacts 287 additional acres at 5 new disposal sites.	Impacts 195 additional acres at 4 new disposal sites.	Secures 650 acres of habitat for Columbian white-tailed deer (Cottonwood-Howard Is.), provides 191 acres of tidal marsh at Lois Island embayment, 235 acres of tidal marsh-intertidal flat at Miller-Pillar and 1,778 acres of intertidal marsh (Tenasillahe Is. long-term); maintains natural tidal marsh communities through implementation of 5-yr. control program for purple loosestrife from CRM 18-52.
Mitigation	None required	Mitigation for 257 acres agricultural, 50 acres riparian, & 24 acres wetland losses.	Mitigation for 172 acres agricultural, 50 acres riparian, & 16 acres wetland losses.	None required

Affected Resources	No Action	43-foot Channel (Least Cost Disposal)	Proposed Disposal (Sponsor Preferred)	Ecosystem Restoration
Socio-Economic				
Cultural Resources	No effect	No effect	No effect	No effect
Land Use	Use existing disposal sites only.	Forested land/open space changed to disposal site use. Agricultural land changed to disposal site use at 5 locations. No change in port-industrial use.	Forested land/open space changed to disposal site use. Agricultural land changed to disposal site use at 4 locations. No change in port-industrial use	Converts agriculture land to fish & wildlife use at Shillapoo Lake.
Recreation	Minor impacts to recreational fishery.	Same as No Action	Same as No Action	Long-term fishery & waterfowl hunting improvement with implementation of features; some impact to recreational fishing at Lois Island.
Aesthetics	Minor impact from upland disposal actions.	Minor additional impact in rural agricultural setting.	Same as No Action	Change of open space perspective from agriculture to wetland habitat (Shillapoo).
Air Quality	Minor impact from wind borne sand and dredge operation.	Minor additional impact at new upland disposal sites.	Same as Least Cost	No change
Noise	Minor impact from dredge operation.	Minor additional impact from dredge operation.	Same as Least Cost	No change
Commercial Fishery	Minor impact from dredging and disposal.	Minor impacts to drift fishery and crab fishing.	Same as Least Cost	Impact to Select Area Fishery at Tongue Point and drift net fishery at Miller Sands Drift.

Subsequent to issuance of the 1999 Final IFR/EIS, the Corps and state resource agencies engaged in coordinated efforts to evaluate potential impacts to other aquatic resources, including sturgeon, smelt and crab. Results of these efforts are presented in detail in Chapter 6 and are summarized in Table S4-3. For purposes of comparing alternatives, this effort indicates that the impacts of the preferred alternative and the No Action Alternative are similar in kind, with some impacts being slightly larger quantitatively under the preferred alternative due to the higher quantity of dredging activity associated with construction and early maintenance of the channel improvement project. However, it appears that any increased effects of the project from higher dredge quantities (such as crab entrainment) can be avoided or minimized using information developed since issuance of the 1999 Final IFR/EIS (such as the crab-salinity information).

Implementation of the Lois Island embayment and Miller-Pillar ecosystem restoration features will result in temporary adverse impacts to fish and wildlife resources associated with habitat modification and disturbance during construction. Certain species would incur habitat losses with implementation of these features. However, over the long term, these ecosystem restoration features would produce beneficial, direct effects substantially greater than baseline conditions. The features are geared toward restoration of tidal marsh habitat, a habitat that has incurred significant losses in acreage. Tidal marsh and associated intertidal flat restoration (Miller-Pillar) will benefit salmonids, waterfowl, other aquatic birds, shorebirds, benthic invertebrates, and estuarine fish species. Additionally, implementing these features avoids any impacts that would result from ocean disposal.

Impacts to terrestrial species under USFWS jurisdiction for the three original ecosystem restoration features and Miller-Pillar were previously addressed in the BA to the USFWS for the project (Exhibit G, 1999 Final IFR/EIS). Those determinations are incorporated by reference. Also, impacts to marine mammals and sea turtles were addressed in the BA for the *Dredged Material Management Plan* (DMMP; Corps 1998). The conclusion of “no effect” for marine mammals and sea turtles from that document is incorporated by reference and applies to the ecosystem restoration features and evaluation actions described here.

Ten listed terrestrial species (Columbian white-tailed deer, bald eagle, marbled murrelet, western snowy plover, brown pelican, Oregon silverspot butterfly, *Howellia*, golden paintbrush, Bradshaw’s lomatium, and Nelson’s checkermallow) occur in the project area. For detailed information on these species, see the BAs and Biological Opinions published for the DMMP (Corps 1998) and the 1999 Final IFR/EIS. Two species, the peregrine falcon and the Aleutian Canada goose, have been delisted since the Final IFR/EIS was completed. A summary of the previous Corps’ determinations is presented below.

Seven of the 10 species listed above (marbled murrelet, western snowy plover, Oregon silverspot butterfly, *Howellia*, golden paintbrush, Bradshaw’s lomatium, and Nelson’s checkermallow) do not occur in the areas identified for the ecosystem restoration features and evaluation actions or were addressed in the previous BA (Exhibit G of the 1999 Final IFR/EIS). Therefore, it is our determination that there will be “no effect” to these species from the five proposed ecosystem restoration features and the evaluation actions set forth in the 2001 BA. The ecosystem restoration features and evaluation actions would have no

effect on hump-backed, right, fin, sei, blue, or sperm whales, or on Pacific leatherback, loggerhead, green, or Pacific Ridley sea turtles. These species do not occur in the area for the restoration features or evaluation actions. Biological impacts for 12 federally listed salmonid ESUs, one listed DPS, one DPS proposed for listing, and one candidate ESU, Columbian white-tailed deer, bald eagles, brown pelicans and northern sea lions associated with the additional ecosystem restoration features and evaluation actions are addressed in the 2001 BA.

Dredged material disposal sites will occur within the formerly designated critical habitat zone for NOAA Fisheries-listed salmonids along the Columbia River. While the critical habitat designation for NOAA Fisheries-listed species has since been withdrawn, the reconsultation process evaluated potential effects on critical habitat, and concluded that the project would not destroy or adversely modify designated critical habitat. On November 14, 2002, the USFWS proposed to designate critical habitat for threatened bull trout in the Columbia River Basin. Critical habitat is proposed for the Mainstem Columbia River Critical Habitat Unit, from the MCR (CRM 0) to Chief Joseph Dam (CRM 545). This proposed critical habitat unit includes the Columbia River within the channel improvement project action area. Section 7(a)(4) of the ESA requires, when critical habitat is proposed, federal agencies to confer with the Service on any action which is likely to adversely modify or destroy proposed critical habitat.

The proposed Mainstem Columbia River Critical Habitat Unit serves as a migration corridor, provides foraging habitat, and is an overwintering area for bull trout. Three primary Constituent Elements are provided by the Columbia River to bull trout in the project area: water quality, migratory corridor, and an abundant food supply. The Corps believes that, based on the extensive analysis found in the Corps' 2001 BA and the USFWS's 2002 Biological Opinion, the project will not adversely modify or destroy proposed critical habitat in the action area. Therefore, no additional conferencing is necessary. Upon finalization of the bull trout critical habitat rule, and if the Columbia River within the project's action area is formally designated as critical habitat, the Corps will reinitiate ESA consultation with the USFWS. The AMT will remain updated on the USFWS's progress in finalizing the critical habitat rule, and ensure that coordination between the Corps and USFWS continues.

Habitat development, principally riparian and wetland habitats, is the principal management objective for mitigation actions. Mitigation actions at Webb and Woodland Bottoms locations would occur behind flood control levees under the current prescription. Insect, detrital and large woody debris export from these locations under their present conditions is negligible. An increase in insect faunal export under the wildlife mitigation prescription to the mainstem Columbia River or side channels is forecast with the mitigation feature in place and operational. This would be attributable to the development of riparian forest at these locations. Insect faunal export from these mitigation locations would not be as substantial as for locations directly connected to the Columbia River.

Creation of intertidal marsh habitat (16 acres) at the Martin Island navigation site would occur in an embayment excavated for I-5 construction fill. Dredged material would be placed in the embayment to attain the proper depths for development of an emergent marsh

plant community. Adjacent intertidal marsh habitat would be surveyed to determine a reference target elevation. Riparian forest habitat development at Martin Island would occur on lands directly connected to the Columbia River. The direct effect of these actions at Martin Island would be beneficial to listed ESA salmonids and their Critical Habitat. Insect and detrital export from riparian and emergent marsh habitat along with large woody debris export would be expected from Martin Island mitigation actions.

The determinations for Lois Island embayment and Miller-Pillar ecosystem restoration features were *may affect and is likely to adversely effect*. The ecosystem restoration features proposed at in-water sites (Miller-Pillar and Lois Island embayment) would result in initial, temporary adverse direct effects to ESA salmonids or their Critical Habitat, but over the long-term would produce beneficial direct effects substantially greater than baseline conditions.

The introduction of Columbian white-tailed deer to Cottonwood-Howard Island is intended to assist development of another secure and viable population of this listed species. The feature would assist attainment of the recovery plan goals and objectives and aid efforts to delist this species. Implementation of the Tenasillahe Island long-term restoration feature, which is dependent upon delisting of Columbian white-tailed deer, would provide a substantial acreage base (~1,800 acres) for habitat restoration for ESA salmonids.

4.5.1.3. ^{revised} Socio-Economic Impacts

For the Final SEIS, the following updated information has been added to this subsection. Implementation of the ecosystem restoration features at Lois Island embayment and Miller-Pillar will impact commercial fishermen. A net-pen program and associated select area fishery has been established at Tongue Point with other select area fisheries upstream at South Channel and Blind Slough. Restoration of the Lois Island embayment would reduce the available acreage for commercial fishing by 191 acres or about 19% of the select area fishery at Tongue Point. The restoration action would create tidal marsh habitat, which is not conducive to commercial fishing as compared to the uniform depth, open water area that currently exists. For the 2002 spring gillnet season, a total of 2,440 spring chinook salmon and 159 white sturgeon [preliminary ODFW results] were harvested in the Tongue Point select area fishery. Coho salmon landings from 1996 through 2000 ranged from 900 to 10,700 fish; chinook salmon landings were 50 to 431 fish and white sturgeon 59 to 106 fish (ODFW 2001, *Fall Select Area Fisheries Fact Sheet*).

Implementation of the Miller-Pillar restoration feature would eliminate a portion of the drift net (gill and/or tangle net) fishing site. The construction of the pile dike field plus restoration of site bathymetry to tidal marsh-intertidal flat habitat elevations would preclude commercial fishing activity at this location. This ecosystem restoration feature would impact approximately 14% (when fully implemented) of the area within the Miller Sands Drift for commercial fishermen. Long term, the proposed restoration features are intended to aid the recovery, and ultimately assist in the delisting of Columbia River ESA listed ESUs. The ecosystem restoration features represent increments in the regional efforts to recover these ESUs and will not achieve recovery by themselves.

4.5.2. ^{revised} Economic Comparison

This subsection is updated for the Final SEIS to show revised benefits and costs for the 43-foot channel improvement project and to exclude benefits and costs associated with the Willamette River portion of the authorized project, which has been deferred (see Chapter 1). The other alternatives (non-structural/LoadMax, regional port; 41- and 42-foot alternatives) were not updated because they were screened out in Chapter 4 of the 1999 Final IFR/EIS, which was adopted in the December 1999 Corps of Engineers Chief's Report.

The benefits of improving the navigation channel would result from reductions in transportation costs for each benefiting commodity. As shown in the fleet projections (Chapter 3), there are a number of vessels that load at less than their maximum capacity due to current channel depth constraints. For those vessels, a 3-foot deepening would essentially allow an increase in capacity of 6,000 to 7,400 tons. For example, a bulk carrier with a 43-foot maximum draft typically has a maximum cargo capacity of approximately 65,000 short tons. In a 40-foot channel, the capacity of this vessel is reduced to 58,000 tons. Round-trip vessel operating costs for that vessel carrying a load of corn out of the Columbia River would average \$670,000 per trip. Therefore, a 3-foot deepening can reduce transportation costs from \$11.23 to \$10.13 per ton, or \$1.09 per ton.

As shown in the fleet projections, each commodity and trade route combination is expected to make varying use of the deepening. For wheat, the additional 3-foot channel depth would result in an initial average transportation cost per-ton reduction of \$0.27 on a per ton basis. Corn is projected to take greater advantage of the deepening, with an initial cost reduction of about \$0.79 per ton. Soybeans, like corn, would take advantage of the deeper channel, saving about \$0.85 per ton. Container transportation benefits are greater than for bulk commodities, with cost reductions of \$2.68 per ton.

Table S4-4 displays the average annual transportation benefits for the 43-foot channel improvement project by commodity. The annual benefits total \$18.8 million. Container traffic provides about two-thirds of the benefits, and corn and wheat benefits make up most of the remainder. More detailed information, including destination regions, can be found in the revised Economic Analysis located in Exhibit M of this Final SEIS.

Table S4-4. Average Annual Transportation Benefits, 43-foot Channel Improvement

Commodity	Average Annual Benefit
Corn	\$3,842,000
Wheat	\$2,054,000
Barley	\$185,000
Soybeans	\$976,000
Containers	\$11,748,000
Total	\$18,806,000

Benefits were not allocated by reach because this is an update to a Congressionally authorized project. The revised analysis shows 62% of the benefits accrue from container traffic, which requires a channel to the Portland/Vancouver area.

4.6. ^{revised} Plan Selection

This section has been updated for the Final SEIS. Table S4-5 shows the current estimated costs and benefits for the 43-foot channel improvement project. The updated costs for the project are shown in Table S4-6. This section describes the Federal Government's least cost option for navigation improvement to the Columbia River portion of the project. The costs of the channel improvement project include costs for turning basins, anchorages, and berthing areas that must be deepened in order to achieve the benefits of the project.

Table S4-5. Current Costs and Benefits, 43-foot Channel Improvement Project

Category	43-foot Channel Improvement Project*
First Cost	\$118,625,000
Annualized First Costs	\$7,395,000
Annual Operation and Maintenance Cost**	\$3,619,000
Total Average Annual Cost**	\$11,014,000
Benefits	\$18,806,000
Benefit-to-cost Ratio	1.7
Net Benefits	\$7,792,000

* Federal Government least cost option.

** Costs represent the incremental cost over No Action.

Table S4-6. Updated Costs, 43-foot Channel Improvement Project

First Costs Item	Total Cost* (\$)
Construction	97,618,000
Land Acquisition	17,436,000
Berthing Areas	843,000
Interest During Construction	2,728,000
Total First Cost (rounded)	118,625,000
Annualized Costs	
First Costs (5 7/8%, 50 years)	7,395,000
O&M Dredging	3,334,000
Mitigation Site Management/Monitoring	250,000
Real Estate required throughout O&M	35,000
Total Average Annual Costs	11,014,000

* Federal Government least cost option.

The revised benefit and cost information, in combination with the new information on and revised analysis of environmental impacts of the project (see Chapter 6), confirms the analysis in the 1999 Final IFR/EIS and demonstrates that the benefits of the 43-foot channel alternative, as modified following ESA consultation, provides significant economic benefit that exceeds economic cost, and is consistent with protection of the environment. In contrast, the other alternatives analyzed in detail, including the No Action Alternative, would not result in significantly reduced environmental impacts. Further, as discussed in more detail in Chapter 6, compared to the No Action Alternative, the restoration features, including the new ecosystem restoration features discussed below in Section 4.8.6, provide substantial habitat benefits for fish and wildlife resources and have only limited, short-term environmental impacts.

4.6.1. Turning Basins

No updating of the existing information in this subsection was necessary for the Final SEIS (see the Final IFR/EIS, August 1999).

4.6.2. Anchorages

No updating of the existing information in this subsection was necessary for the Final SEIS (see the Final IFR/EIS, August 1999).

4.6.3. ^{revised} Berthing Areas

For the Final SEIS, the following updated information has been being added to this subsection. Current information indicates that the U.S. Gypsum sheetrock facility (formerly Port of St. Helens) near Rainier, Oregon will require berth deepening to benefit from channel deepening. Impacts from deepening at U.S. Gypsum are anticipated to be similar to those projected for deepening other berths analyzed in the 1999 Final IFR/EIS. Any such deepening will be subject to additional environmental review and permitting, including sediment sampling, under NEPA, the Clean Water Act, and the ESA.

4.7. ^{revised} Selected Plan

This section has been updated for the Final SEIS. Under Corps regulations, the non-federal sponsors (sponsor ports) can modify the Federal Government's least cost option for navigation improvement provided they pay all incremental costs. The costs displayed in Table S4-7 represent the sponsor ports selected plan.

Table S4-1 provides revised information on all disposal sites in the selected plan, including information on prior disposal history, anticipated timing of usage during construction and the first 20 years of maintenance, site acreage, site capacity, anticipated disposal volume, and final height.

Table S4-7. Current Estimated Costs, 43-foot Channel Improvement Project

First Costs Item	Total Cost* (\$)
Construction	\$99,840,000
Land Acquisition	\$18,215,000
Berthing Areas	\$843,000
Interest During Construction	\$2,817,000
Total First Cost (rounded)	\$121,714,000
Annualized Costs	
First Costs (5 7/8%, 50 years)	\$7,588,000
O&M Dredging	\$3,450,000
Mitigation Site Management/Monitoring	\$150,000
Real Estate required throughout O&M	\$35,000
Total Average Annual Costs	\$11,222,000

* Sponsor Ports selected plan.

4.7.1. ^{revised} Channel Optimization Measures

Since the analysis in the 1999 Final IFR/EIS, the computer models providing the LoadMax forecasts have been substantially updated, although there was not a significant change in the accuracy of the forecast. The Technical Review Panel convened by the Corps to review benefit and cost projections concurred with the conclusion that no further benefits are likely to be obtained from further refinements to the LoadMax system (Casavant et al. 2002).

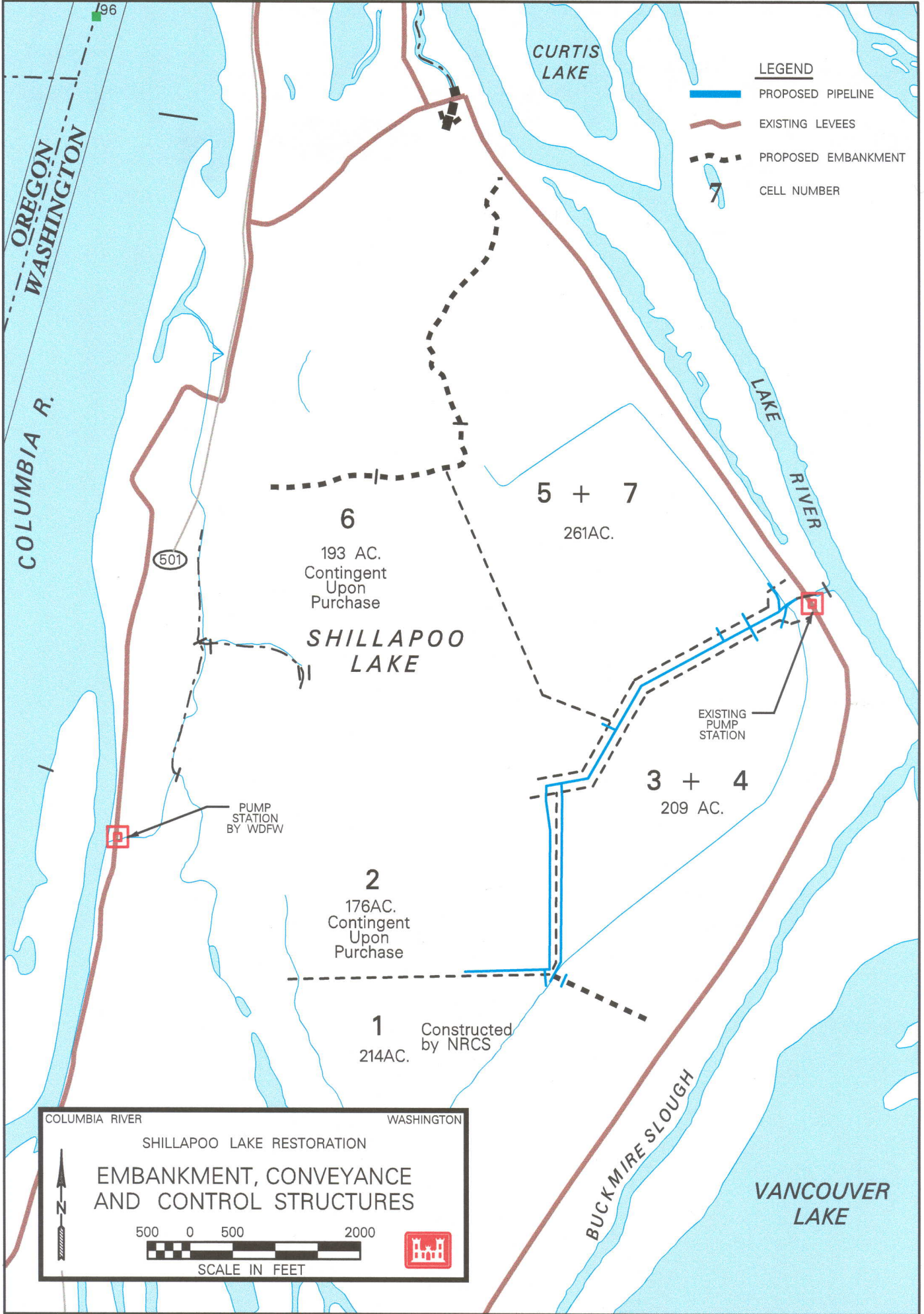
4.8. ^{revised} Ecosystem Restoration Plan

Additional information has been added to Subsections 4.8.1, 4.8.2, 4.8.4 and 4.8.5 for the Final SEIS. Subsection 4.8.6 has been added to address the ecosystem restoration features developed during the ESA consultation for the project. Also, Subsection 4.8.7 has been added to provide a cost effectiveness and incremental cost analysis for the ecosystem restoration features.

4.8.1. ^{revised} Shillapoo Lake

The Shillapoo Lake restoration feature will substantially improve waterfowl and wildlife habitat management capabilities on 470 to 839 acres (Figure S4-6). It will be done in collaboration with the Washington Department of Fish and Wildlife (WDFW). Once completed, the WDFW will perform all maintenance. The concept for the Shillapoo Lake ecosystem restoration feature in the 1999 Final IFR/EIS (eight cells hydraulically separated by levees, but interconnected by water control channels and structures) has been modified. These modifications are a result of a value engineering study, actions by other agencies, and the presence of private real estate. Cell 8 (195 acres) will not be constructed because the WDFW will pursue other management options in the cell to accomplish their objectives. The Natural Resource Conservation Service will construct Cell 1 (214 acres) in partnership with the WDFW. The proposed restoration feature will complement management actions in Cell 1 through an enhanced capability to provide or drawdown water.

Figure S4-6. Shillapoo Lake Embankment, Conveyance, and Control Structures



Cells 3 and 4 (209 acres) will be combined as will be Cells 5 and 7 (261 acres) based upon results of the value engineering study. Their combination will reduce construction, operation, and maintenance costs. A large central pump and underground pipe system (rather than the system of channels and water control structures) will manage water supply and withdrawal. Lastly, Cell 2 (176 acres) and Cell 6 (193 acres) are privately held and would not be constructed until acquired in the future. Drainage capability for the private land will be provided via pumps and pipelines.

The modified action retains a controlled hydraulic connection to Lake River via a tidegate and pumping station. The modified feature will encompass 470 to 839 acres, depending upon purchase of the remaining private lands by WDFW commensurate with the construction timeframe for the channel improvement project. As currently designed, this restoration feature will not provide for juvenile salmonid access. A porous rock fill dike will be constructed as part of the feature at the tidegate/pump station outlet as a means to preclude carp, and thus other fish, from the management area. Carp compromise emergent and aquatic plant management objectives because of their foraging actions that reduce sunlight penetration of the water column and their consumption of the plants.

4.8.2. ^{revised} Tide Gate Retrofits for Salmonid Passage

Except for the Burris Creek tidegate retrofit, there has been no revision to the tidegate ecosystem restoration feature as detailed in the 1999 Final IFR/EIS (see Figure S4-7). The tidegate at the downstream end of the Cowlitz County Consolidated Diking Improvement District No. 2, through which Burris Creek waters were formerly exhausted to the Columbia River, has been plugged with concrete. The District currently uses their pump station to exhaust Burris Creek and internal drainage waters. Implementation of the Burris Creek tidegate component of this ecosystem restoration feature would entail construction of a new culvert with tidegate through the flood control levee. Burris Creek waters would be directed to flow through this new tidegate. Flood flows from Burris Creek that exceed the flood storage capacity of the immediately adjacent 97 acre wetland development (a wildlife mitigation feature) would be directed through an overflow structure in the wetland perimeter levee to the current pumping station. The proposed action would allow for restoration of coho and coastal cutthroat trout runs to the stream.

4.8.3. Improved Embayment Circulation

No updating of the existing information in this subsection was necessary for the Final SEIS (see the Final IFR/EIS, August 1999 and the Reach 4 map at the end of this chapter).

4.8.4. ^{revised} Restore Shallow Water Habitat

No updating of the existing information in this subsection was necessary for the Final SEIS. While restoration of shallow water habitat at Miller-Pillar was evaluated in the Draft SEIS, the Corps has revised the proposal for the Miller-Pillar ecosystem restoration feature in response to comments and in coordination with state and federal resource agencies (see Section 4.8.6.3).

4.8.5. revised Summary

The following updated information has been added for the Final SEIS. As discussed in more detail in Chapter 6, compared to the No Action Alternative, the restoration features (including the new ecosystem restoration features discussed below in section 4.8.6) provide substantial habitat benefits for fish and wildlife resources and have only limited short-term environmental impacts. Short-term impacts are associated with implementation of these features that will result in disturbance to fish and or wildlife resources in the immediate area of the construction action. Disposal operations for Lois Island embayment and Miller-Pillar will initially result in the loss of benthic invertebrate populations in the feature construction area. Recolonization by benthic invertebrates is anticipated upon completion of the features although the species complex may change with the alteration in depth and conversion to a tidal marsh habitat. Detrital export from these tidal marshes is expected to improve benthic invertebrate productivity in the estuary and thereby improve foraging and rearing conditions for juvenile salmonids, sturgeon and other fisheries resources for the long term. Fisheries resources will incur short-term impacts from construction of these features that would be more than offset by the long-term productivity of the features.

Implementation of these ecosystem restoration features, particularly tidal marsh and riparian forest restoration, will provide long-term environmental benefits, as most have no limitation to their effectiveness. Tidal marsh primary productivity will continue indefinitely, as it has for the natural tidal marshes in the estuary, which can be recognized on the basis of their shape and location from the maps of the early explorers to the Columbia River estuary. Some restoration features, such as tidegates and Shillapoo Lake, will require periodic O&M but those actions are not dissimilar to those ongoing in the many diking districts that have existed in the estuary since the early 20th century. Thus, they are perceived as relatively stable, long lasting, productive features.

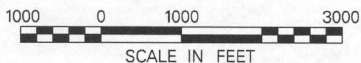
These restoration features also represent important contributions to the recovery of ESA-listed and proposed salmonid stocks in the Columbia River. Wetland and riparian habitats have significantly declined along the lower Columbia River since the 1880s because of agricultural and urban/industrial development. While much has been done to improve salmon passage at Columbia River dams, relatively little has been done to improve juvenile salmonid rearing habitat and therefore, survival on the Columbia River below the dams. The restoration of 2,200 acres of tidal marsh habitat with its associated long-term productivity represents a substantial effort to recapture the juvenile salmonid rearing capability formerly associated with the estuary.

Table S4-8 provides information on type, function, value and area impacted by all of the proposed ecosystem restoration features currently included in the project.

Figure S4-7. Fish Passage Improvements at Tidegates



FISH PASSAGE IMPROVEMENTS AT TIDEGATES



GIS, SURVEY AND MAPPING SECTION

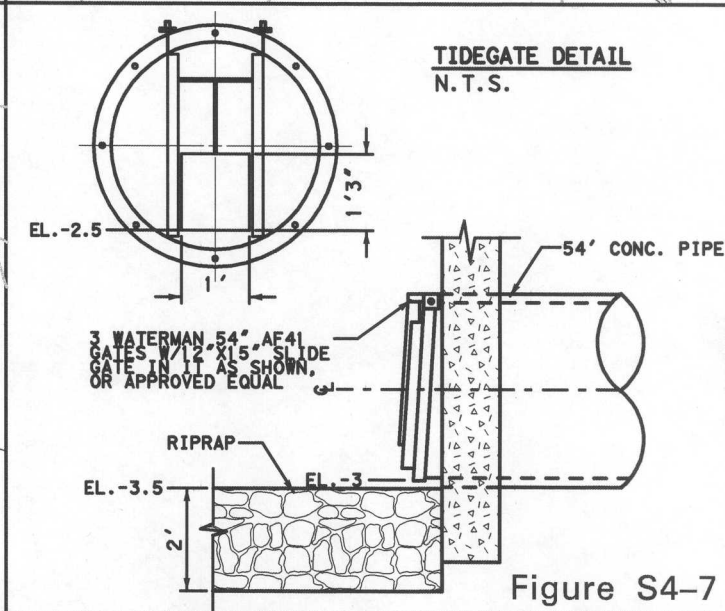
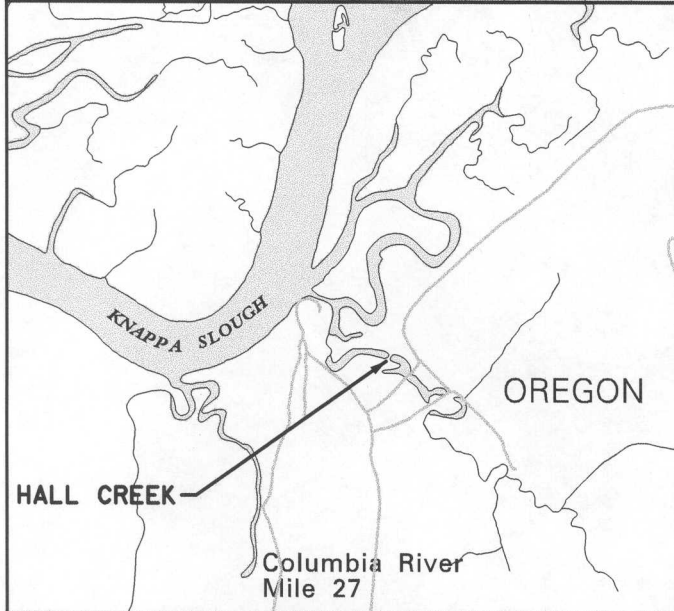
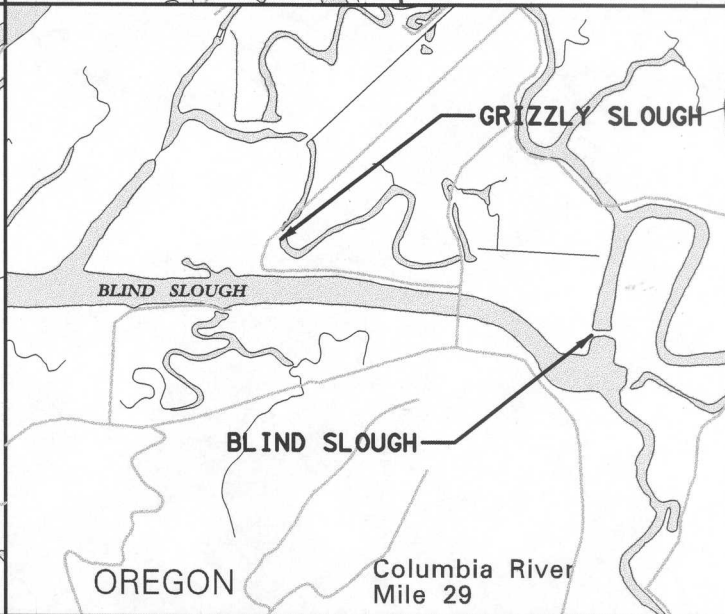
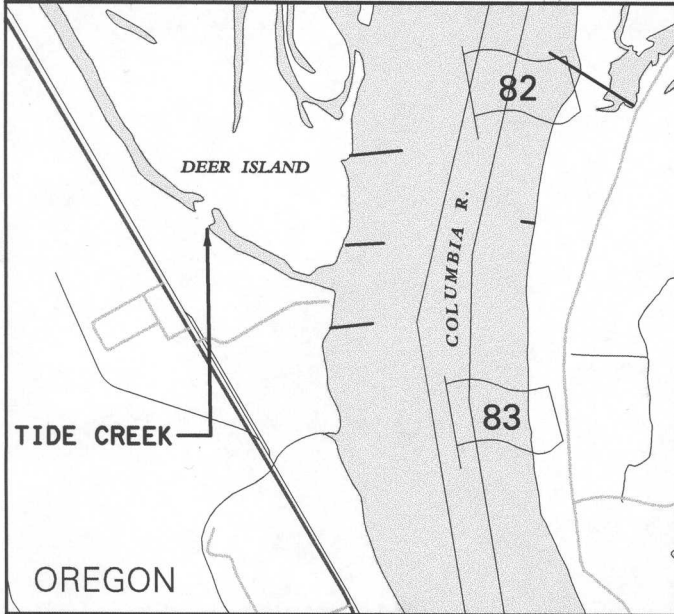
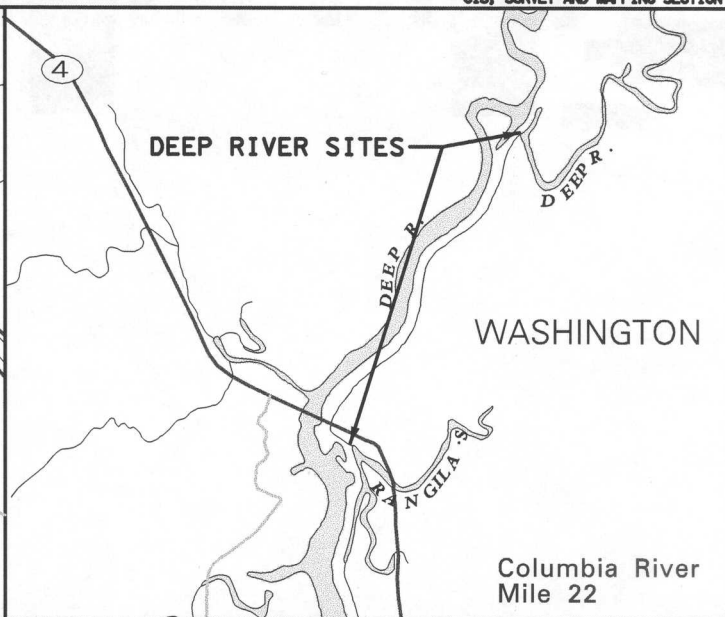
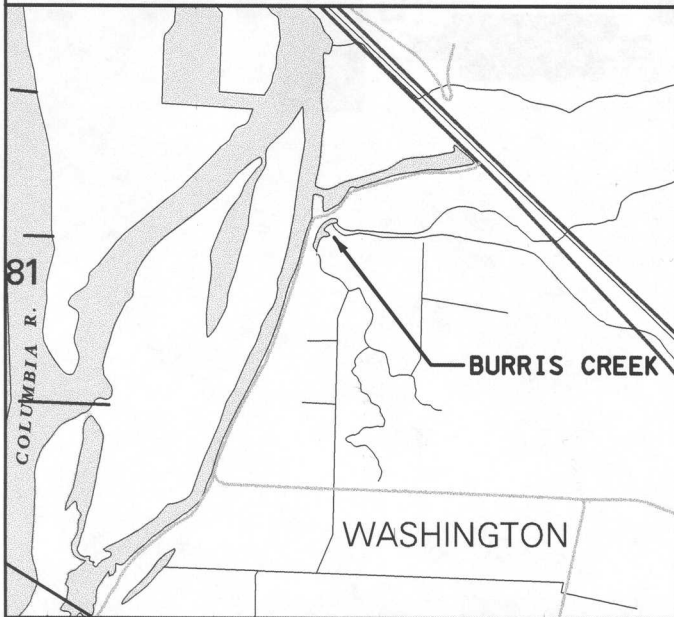


Table S4-8. Ecosystem Restoration Features

Feature	Area Affected by Restoration	Type, Function, and Value
Lois Island Embayment Habitat Restoration	191 acres	Type: Tidal marsh habitat Function: Provide rearing habitat for ocean-type salmonids; increase detrital export Value: High
Purple Loosestrife Control Program	CRM 18-52	Type: Tidal marsh Function: Maintain native Tidal marsh plant community; increase detrital export Value: High
Miller-Pillar Habitat Restoration	235 acres	Type: Tidal marsh and flats habitat Function: Provide rearing habitat for ocean-type salmonids; increase benthic invertebrate productivity Value: High
Phase 1: Tenasillahe Island Interim Restoration ¹ (Tidegate/Inlet Improvements)	92 acres	Type: Backwater/side channel reconnection to Columbia River Function: Increase access/egress for ocean-type salmonids Value: Moderate
Phase 2: Cottonwood-Howard Island Proposal ² Columbian white-tailed Deer Introduction	650 acres (Columbian white-tailed deer; 60 acres tidelands)	Type: Translocation of Columbia white-tailed deer Function: Establish secure, viable subpopulation of Columbian white-tailed deer Value: High
Phase 3: Tenasillahe Island Long-term Restoration ³ (Dike Breach)	1,778 acres	Type: Tidal marsh/swamp; shallow water/flats habitat Function: Provide rearing habitat for ocean-type salmonids; increase detrital export Value: High
Tidegate Retrofits for Salmonid Passage (1999 Final IFR/EIS)	38 miles	Type: Tributary reconnection to Columbia River Function: Increase access/egress for ocean-type salmonids; improve access for adults to headwaters for spawning Value: High
Walker-Lord and Hump-Fisher Islands Improved Embayment Circulation (1999 Final IFR/EIS)	335 acres	Type: Marsh/swamp; shallow water/flats habitat Function: Provide rearing habitat for ocean-type salmonids; increase benthic invertebrate productivity Value: Moderate
Bachelor Slough Restoration ⁴	85 ac. (instream restoration); 6 ac. (Bachelor Slough riparian restoration); 46 ac. (riparian restoration using Bachelor Sl. sediments - old disposal location and 2 add'l upland locations)	Type: Shallow water/flats habitat; riparian forest Function: Provide rearing habitat for ocean-type salmonids; increase detrital export Value: Moderate (side channel); high (riparian forest)
Shillapoo Lake Restoration ⁵ (1999 Final IFR/EIS)	470-839 (acreage restored depends on private land acquisition and prior restoration by others)	Type: Managed wetlands Function: Increase waterfowl, shorebird, wading bird, and raptor habitat Value: High

Notes: The Tidegate Retrofits for Salmonid Passage, Walker-Lord and Hump-Fisher Islands Improved Embayment Circulation, and Shillapoo Lake Restoration features were proposed in the Final IFR/EIS. The remaining restoration features were added during the ESA consultation process.

¹ This restoration is contingent on hydraulic analysis results.

² This restoration primarily benefits Columbian white-tailed deer.

³ This restoration feature is contingent on the delisting of Columbian white-tailed deer.

⁴ This restoration feature is contingent on sediment testing and approval by WDNR.

⁵ This restoration primarily benefits waterfowl, but would create detrital input to the Columbia River.

4.8.6. ^{new} Additional Ecosystem Restoration Features

This new subsection for the Final SEIS addresses the ecosystem restoration features developed during the ESA consultation process. It also reflects modifications to the Lois Island embayment and Miller-Pillar ecosystem restoration features developed in response to comments on the Draft SEIS and in conjunction with state and federal resource agencies.

Pursuant to Section 7(a)(1) of the ESA, the federal agency (Corps), “shall utilize their authorities in furtherance of the purposes of this chapter by carrying out programs for the conservation of endangered species and threatened species” [16 U.S. Code §1536(a)(1)]. These actions are measures that the Corps, with the assistance of the NOAA Fisheries and USFWS, has determined to be important to aid in the recovery of listed salmonids and, in some cases, address habitats that were the subject of much discussion and analysis during the consultation process. Columbian white-tailed deer and bald eagles also would benefit from some of the proposed ecosystem restoration features.

The Corps, USFWS, and NOAA Fisheries developed lists of potential ecosystem restoration alternatives during the ESA consultation. The USFWS list was based on information received from managers of the Julia Butler Hansen and Lewis and Clark National Wildlife Refuge, and the Ridgefield National Wildlife Refuge. The information pertained to acreage, habitats, and species that would benefit from the potential restoration alternatives. The NOAA Fisheries suggested that consideration be given to the list that was developed at the 2001 Lower Columbia River and Estuary Habitat Conservation and Restoration Workshop. All of these potential alternatives were evaluated based on a set of criteria that included habitat type, function and value to the species; location; implementability; and land acquisition requirements. The agencies agreed that the ecosystem restoration features proposed for addition to the project best fit the set of criteria.

The Corps proposes to implement these ecosystem restoration features under Section 7(a)(1) of the ESA. They will be cost-shared by the sponsor ports and are considered part of the project. The restoration features will create or improve salmonid habitats, specifically tidal marsh and shallow water/flats habitats plus certain features provide benefits to bald eagles and Columbian white-tailed deer.

In addition to the original ecosystem restoration features in the 1999 Final IFR/EIS (Shillapoo Lake, tidegate retrofits and improved embayment circulation), the Corps proposes to implement additional restoration features: Lois Island Embayment Habitat Restoration, Purple Loosestrife Control Program, Miller-Pillar Habitat Restoration, Tenasillahe Island Tidegate/Inlet Improvements (interim action) and Dike Breach (long-term action), Cottonwood-Howard Island Columbian White-tailed Deer Reintroduction, and Bachelor Slough Restoration. Tenasillahe Island interim and long-term actions, plus Cottonwood-Howard Island Columbian White-tailed Deer Reintroduction are discussed as phased actions of one overall feature below due to their interrelationship. The interim action at Tenasillahe Island is contingent on hydraulic engineering analyses demonstrating its feasibility and that no adverse impacts would occur to Columbian white-tailed deer.

Implementation of the long-term action at Tenasillahe Island is contingent on delisting of Columbian white-tailed deer and the determination that such actions are compatible with the purposes and goals of the refuge. The Cottonwood-Howard Restoration also is contingent on site acquisition by the sponsor ports. The Bachelor Slough Restoration is contingent on securing easements from the WDNR and sediment testing results that are below established threshold limits for contaminants. The additional restoration and evaluation actions are described in the following subsections.

4.8.6.1. ^{new} Lois Island Embayment Habitat Restoration

This ecosystem restoration feature is located between Lois and Mott Islands in the Columbia River estuary (CRM 19-20; Figures S4-3 and S4-4). Approximately 191 acres of tidal marsh habitat will be restored as described in section 4.4.3.10 (*Disposal Plan Modifications Following Consultation*; Figures S4-2 and S4-3). The embayment between Lois and Mott Islands was dredged during the World War II era to provide moorage for decommissioned naval ships. Prior to construction of the embayment, the area contained intertidal mudflats and shallow subtidal flats plus a centralized subtidal channel 12-18 feet in depth running from northwest to southeast across much of the area. The average depth of the area was minus 5-6 feet with substantial area above zero feet in elevation [Columbia River Estuary Data Development Program (CREDDP) 1983: 1935 bathymetric map]. Intertidal habitat would have ranged from -2 to 10 feet in this area of the Columbia River. Lois and Mott Islands and South Tongue Point were formed from material dredged from this location.

Post-construction of the moorage area, an embayment with rough dimensions of 3,750 feet by 4,375 feet was formed, with depths ranging from 12-30 feet and averaging 25-26 feet (CREDDP 1983). The eastern portion of the embayment is wider and juts slightly into Lois Island. By 1982 (CREDDP 1983: 1982 bathymetric map), depths in the embayment were approximately 21 feet on average, ranging from 18-24 feet. Lois and Mott Islands have developed narrow, fringing intertidal marsh habitat post-dredging on their interior shorelines bordering the embayment. Bathymetry for Lois Island embayment obtained in 2002 demonstrates that the majority of the 191-acre area proposed for this ecosystem restoration feature is 20-22 feet deep. There is also a substantial area along the Lois Island shoreline that is 10 feet or less in depth. A small portion of the restoration area near the center of the feature is 24-26 feet deep (see Figure S4-3).

The restoration feature includes restoration of the area to tidal marsh habitat elevations using dredged material from the Columbia River navigation channel. The target elevation for this habitat would be based upon surveyed reference elevations in adjacent tidal marsh habitat to maximize the potential success of the development. The original feature proposed for Lois Island embayment entailed restoration of shallow subtidal habitat to mimic pre-moorage conditions at this location. Comments on the Draft SEIS and subsequent discussion with the resource agencies led to the determination that tidal marsh-intertidal flat habitat was preferred over shallow subtidal habitat because of the significant historical losses of the former habitat and abundance of the latter. Thus, the Corps modified the ecosystem restoration feature accordingly. Disposal operations will be comparable although the target elevation for the new habitats is at an increased elevation.

The tidal marsh habitat proposed for restoration is more productive than the current, moderately deep, subtidal habitat. Gross benthic productivity for the fringing intertidal mudflat habitat at the embayment was 31-46 grams of carbon per square meter per year (CREDDP 1983), which is comparable to other highly productive intertidal mudflat habitat in Cathlamet Bay. Tidal marsh plant density at South Tongue Point was slightly above average for Cathlamet Bay (CREDDP 1983).

Cates (1983) conducted fish sampling operations in the Tongue Point area in 1979 and again in 1981. Five of his seven sampling locations were within the Lois Island embayment. These sampling locations were just beyond the intertidal marsh/mudflat interface on the periphery of the embayment. Cates (1983) captured 14 species, including four anadromous salmonids (chinook salmon, coho salmon, chum salmon, and cutthroat trout) in 1981, the year for which he provided the most detailed results. Chinook salmon were the most abundant salmonid captured in 1981, 3,411 individuals of the 3,619 salmonids captured (94%). Chinook salmon juveniles were present in the area from March to late August, with peak abundance in May. Based on their size and period of occurrence, most of the fish captured were subyearling fall chinook salmon.

Chum salmon (147 fish), coho salmon (61 fish), and cutthroat trout (2 fish) were of lesser abundance based on beach seine results. Cates (1983) indicated that chum salmon were thought to be of wild origin as their occurrence preceded hatchery releases. He also captured juvenile chinook and coho salmon with coded wire tags at Tongue Point sampling locations. These included chinook salmon from the Klaskanine River, which empties into Youngs Bay immediately downstream of Astoria, and one coho salmon from the Grays River, Washington. These captures were an indication of upstream movement of chinook salmon to the Tongue Point area for estuarine rearing and cross-river movement for coho salmon.

Tongue Point waters and the embayment are used to harvest salmon through the Select Area Fishery program. Juvenile salmonids are reared currently in net pens located at the old Corps dock at South Tongue Point, then released as smolts into the estuarine waters at Tongue Point/Lois Island embayment to which they will return as adults. Commercial gill netting also occurs for sturgeon in the embayment. Sport fishing in the embayment is limited. Most sport fishing boats that launch from the nearby John Day boat ramp fish for sturgeon on the channel side of Mott Island and off Tongue Point proper.

Emmett et al. (1986) investigated benthic invertebrates in Cathlamet Bay, including the embayment between Lois and Mott Islands. They identified 28 benthic invertebrate species or groups (order, family, genus) as occurring within the embayment. Eight species [*Cumacea*, *Corophium salmonis*, *Harpacticoida*, *Helidae* (larvae), *Insecta*, *Diptera* (adult), *Scottolana canadensis*, and *Chironomid*] are preferred prey resources of juvenile salmonids. The sampling occurred at depths of 16-20 feet. These species also are expected to be present in the intertidal mudflat habitat that would be present after restoration.

The area for the restoration is approximately 191 acres. It runs from approximately the mid-point of the southern portion of Lois Island on a northwest-bearing line to Mott Island. The inner channel from John Day Point along South Tongue Point to Tongue Point and

approximately 166 acres of the embayment would not be affected by the restoration. The edge of the restoration area is about 3,000 feet off the South Tongue Point shoreline. See Subsection 4.4.3.10 for a description of the activities that would occur to create this ecosystem restoration feature. The Corps will:

- Fund and implement construction effort, and
- monitor post-construction benthic productivity and fish species composition and density on the restoration site and an adjacent control site.

4.8.6.2.^{new} Purple Loosestrife Control Program

This ecosystem restoration feature will implement an integrated pest management approach, including bio-control of purple loosestrife in the Columbia River estuary (CRM 18-52). Purple loosestrife is an introduced exotic plant that is spreading throughout emergent tidal marshes in the Columbia River estuary. Native vegetation such as Lyngby's sedge, tufted hair grass, and softstem bulrush are being displaced. Currently more than 10,000 acres of estuarine tidal marsh are infested, although the degree of infestation varies widely among locations. Large, dense stands, totaling perhaps 300 acres, are found at Karlson Island (CRM 26), Miller Sands (CRM 22.5), and North Wallace Island (CRM 50).

Loosestrife densities range from light (a few scattered plants) to moderate in other areas of the estuary. Given its history in other regions of North America, it is likely that loosestrife, if left unchecked, will dominate the emergent marsh habitat of the estuary to the exclusion of native vegetation. This would greatly reduce biological diversity and negatively affect most estuarine wildlife, including salmonids and other native fish, waterfowl, water birds, shorebirds, neotropical migrant birds, bald eagles, native mammals, and amphibians.

Purple loosestrife occurs in the vegetated, upper intertidal marsh zone. Typically, marsh vegetation in this zone is very dense and tall during the summer growing season and vegetative covers remains well into the fall. Incised tidal channels bisect the intertidal marsh habitat. Juvenile salmonid utilization is primarily associated with these incised tidal channels and the vegetative zone on their perimeter during high tides. Juvenile salmonid use of the densely vegetated intertidal marsh habitat is considered relatively minimal due to the dense vegetation. Presence of juvenile salmonids in intertidal marsh habitat probably coincides with the primary out-migration period, principally spring and early summer.

Purple loosestrife control efforts using the herbicide Rodeo[®], a USEPA-registered herbicide approved for over-water application, would be targeted for application from June to October. Application would follow label instructions and would occur during low tide periods when the plant is exposed. Rodeo[®] would be wicked onto the plants (dispersal of herbicide through direct contact between plant and fabric containing with Rodeo herbicide) and spot sprayed when the plants are actively growing. Translocation of the herbicide throughout the plant would occur and result in a lethal effect. Although application of herbicide during the in-water work period (November 1-February 28) has been suggested, it would be ineffective because plants would be dormant and difficult to recognize given the loss of above ground vegetative structure.

Wicking the herbicide onto the plants results in a target specific application with minimal transfer to non-target species and would be used when plants are sparsely distributed and occur as individuals or small clusters of individuals. Spot spraying would be used for denser populations of plants, as it is more efficient relative to time and coverage. Given the considerable acreage involved and the intertidal nature of the marsh habitats, there is only a limited timeframe both seasonally and daily for implementation of herbicide and/or mechanical treatments. Complete spraying of blocks of intertidal marsh is not proposed. Spot spraying and wicking will limit the total amount of herbicide applied as compared to a complete (full coverage) spraying operation.

The ongoing effort to establish bio-control in the Columbia River estuary for purple loosestrife will be supported and expanded, as warranted, by implementation of this feature. Concurrent with the control operation, evaluation actions will be conducted to determine geographic spread and plant density of purple loosestrife, and to evaluate efficacy of integrated pest management actions. The Corps with assistance from USFWS and sponsor ports will provide:

- Project funding for field implementation of survey and control actions, including equipment and personnel expenses, for a 5-year period.
- All necessary coordination with local, state, and federal government agencies to accomplish the effort.
- Annual and final reports describing the nature and extent of the effort and results.

4.8.6.3.^{new} Miller-Pillar Habitat Restoration

This ecosystem restoration action is located between Miller Sands and Pillar Rock Islands in the Columbia River estuary (CRM 25-26; Figure S4-5). Approximately 235 acres of tidal marsh-intertidal flat habitat will be restored as described in section 4.4.3.10 (*Disposal Plan Modifications Following Consultation*). Natural processes are currently eroding material south of the navigation channel and redepositing the material in the navigation channel. This erosive action has been occurring since 1958 at an average annual rate of approximately 70,000 cubic yards. The erosion is affecting productive, shallow water and flats habitat (0 to 5.9 feet CRD) and converting the area to less productive, deep subtidal habitat (a minimum depth of 24.9 feet CRD; Hinton et al. 1995).

The original feature proposed for Miller-Pillar entailed restoration of shallow subtidal habitat to mimic historic conditions at this location. Subsequent discussion with resource agency representatives led to the determination that tidal marsh-intertidal flat habitat was preferred over shallow subtidal habitat because of the significant historical losses of the former and abundance of the latter habitat. Thus, the Corps has modified the ecosystem restoration feature accordingly. Disposal operations will be comparable although the target elevation for the new target habitats is at an increased elevation. Pile dikes to retain the dredged material will still be required.

Restoration of the erosive area to a productive, tidal marsh and intertidal flats habitat can be accomplished by placement of dredged material at the location to mimic substrate elevations in the adjacent Miller Sands tidal marsh-intertidal flat habitat. Approximately 5.5 mcy of material will be placed at this location to attain the habitat objectives. Dredged material used would be comparable to *in situ* materials. Dredged material retention will require the construction of pile dikes to reduce water velocities, preclude erosion and thus maintain the desired substrate elevations. Snag Island, immediately south of the proposed Miller-Pillar location, features pile dikes and associated tidal marsh-intertidal flat habitat. Three pile dikes would be constructed during the initial construction phase of the project.

Monitoring of the habitat restoration feature would begin upon completion of the first cell between the downstream most pile dikes. The interagency AMT would review monitoring results and recommend any necessary modifications to the habitat restoration feature to attain the desired results. The attainment of successful results and the completion of the first two cells would trigger construction of the last two pile dikes and completion of the necessary fill actions for the upstream two cells.

Concerns were previously raised that construction of pile dikes would create perches that aid bird predation of juvenile salmonids, particularly by double-crested cormorants. To address this concern, the Corps has placed bird excluders on top of numerous Columbia River estuary pile dikes. These excluders are placed on top of pilings and spreaders on pile dike structures to preclude perching. In 2000 and 2001, Oregon State University researchers monitored these devices and their efficacy in precluding cormorants. The monitoring indicates that the bird excluders effectively preclude cormorants from perching on pile dikes, and also significantly reduces the number of cormorants foraging in the water column in the vicinity of the pile dikes. See Subsection 4.4.3.10 for a description of the activities that would occur to create this ecosystem restoration site. The Corps with the assistance of the sponsor ports will:

- Fund and implement the construction effort.
- Monitor post-construction benthic productivity and fish species composition and density on the restoration site and an adjacent control site.
- Operate and maintain pile dikes and associated bird excluders for project life.

4.8.6.4. ^{new} Tenasillahe Island Phased Restoration

Three specific, phased actions are associated with this ecosystem restoration feature; Tenasillahe Island interim, reintroduction of Columbian white-tailed deer at Cottonwood-Howard Island and the long-term restoration action at Tenasillahe Island. The two interim and long-term actions, which would occur on Tenasillahe Island, are shown on Figures S4-8 and S4-9. The interim action would be directed at improving connectivity and water exchange between sloughs and backwater channels interior to the flood control levees that encompass Tenasillahe Island and the Columbia River. For the long-term action, the levees would be breached to restore full tidal circulation to former intertidal marsh/mudflat and forested swamp habitats.

Figure S4-8. Tenasillahe Island Interim Ecosystem Restoration Feature

Tenasillahe Islands



Outlet Improvement

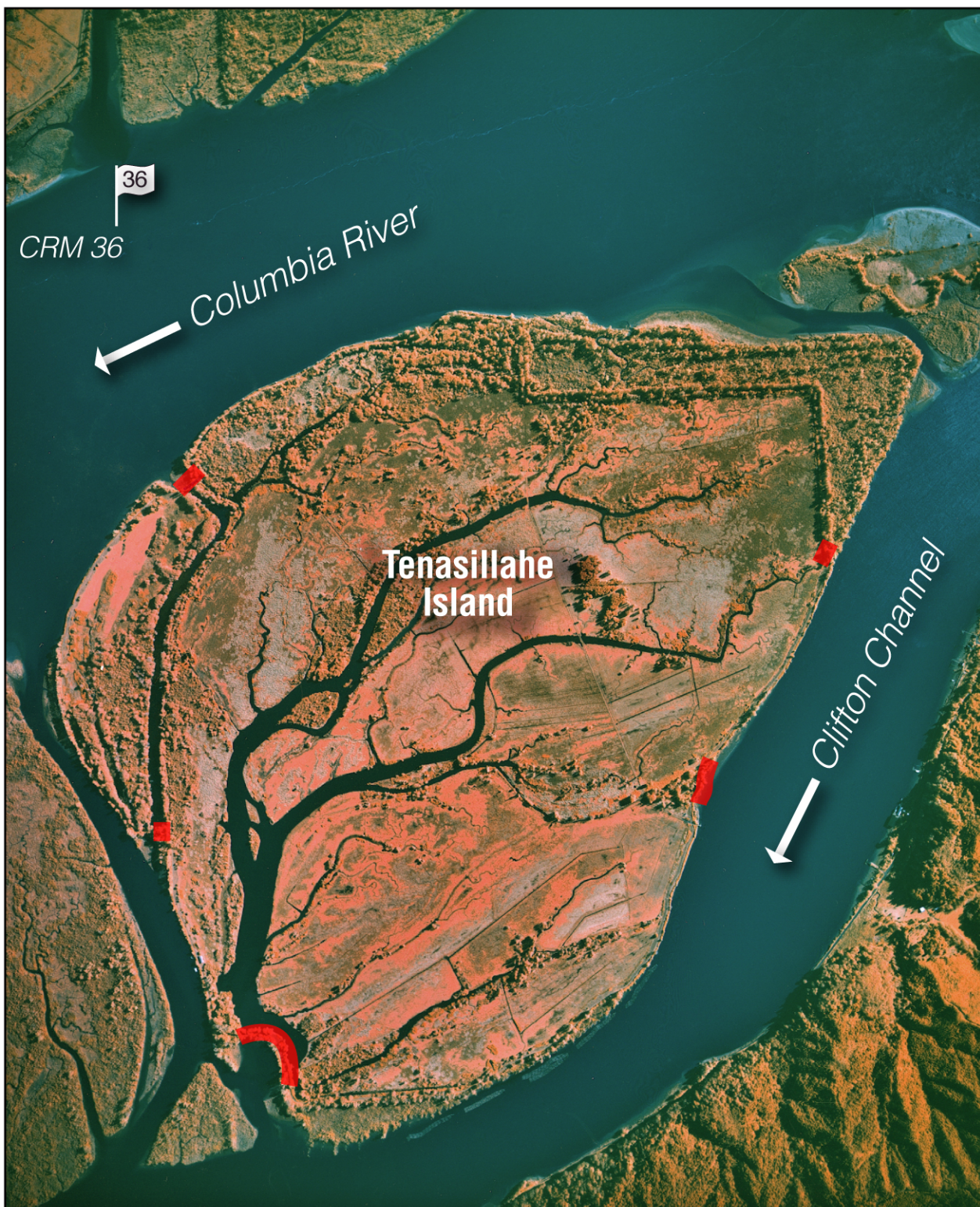


Inlet Improvement

Figure S4-8 Tenasillahe Island Phase 1 - Interim Ecosystem Restoration Feature

Figure S4-9. Tenasillahe Island Long-term Ecosystem Restoration Feature

Tenasillahe Islands



 Remove Levee

Figure S4-9 Tenasillahe Island Phase 3 - Long-Term Ecosystem Restoration Feature

Interim improvements to tidegates and provision of controlled inlets to improve water movement and accessibility for juvenile salmonids would be implemented only if hydraulic engineering analyses determine that any improvement will not compromise habitat integrity for Columbian white-tailed deer that inhabit Tenasillahe Island.

For the long-term action, the levees on Tenasillahe Island would be breached to restore full tidal circulation to approximately 1,778 acres of former intertidal marsh/mudflat and forested swamp habitats. Implementation of this action is contingent on delisting of the Columbian white-tailed deer and determination that such actions are compatible with the purposes and goals of the refuge, to include restoration of intertidal marsh/mudflat and forested swamp habitat for ESA Critical Habitat for salmonids.

Tenasillahe Island is a large natural island in the Columbia River estuary between CRM 35 and 38 and immediately downstream of Puget Island. Actions to place levees around the bulk of the island began around 1910. Currently, about 1,778 acres of Tenasillahe Island are protected from inundation by the Columbia River. A flood protection levee encompasses the majority of the island except for a parcel at the upstream tip. Tidegates, located at the downstream tip of the island, drain interior waters to Clifton Channel. Prior to construction of the levees, the island was primarily intertidal in nature, with three major and numerous minor natural drainage channels bisecting the island. Intertidal marsh and mudflats, subtidal channels, and forested swamp historically would have been the principal fish and wildlife habitat on the island. Juvenile salmonids use of this historical habitat was likely extensive given the large extent of subtidal channels. The intertidal marsh and mudflat habitat would have supported substantial populations of various waterfowl and shorebirds, plus many other species, and would have exported considerable detritus to the Columbia River estuary.

Tenasillahe Island is currently a component of the Julia Butler Hansen Columbian White-tailed Deer National Wildlife Refuge. The island is managed to provide habitat for the deer, a federal endangered species. The levees, tidegates, and other associated infrastructure are maintained to aid in deer management. Interior lands are primarily maintained as wet pastures through mowing and grazing activities to provide adequate quantity and quality of forage for the deer.

The USFWS recovery goal for Columbian white-tailed deer is a minimum of 400 deer occurring in three secure and viable subpopulations (e.g., 50 deer with 32 breeding adults). There are currently four recognized subpopulations of white-tailed deer located at Tenasillahe Island, Oregon, private lands around Westport, Oregon, the mainland portion of the Julia Butler Hansen Refuge (Washington), and Puget Island, Washington. However, only the subpopulations on the Julia Butler Hansen Refuge and Tenasillahe Island are considered secure and viable since both are refuge lands owned by the USFWS. Consequently, one additional secure and viable population is required to meet the recovery plan goal. Prior to implementation of the long-term restoration feature at Tenasillahe Island, two additional secure and viable populations of Columbian white-tailed deer would have to be established. The reintroduction of Columbian white-tailed deer to Cottonwood-Howard Island, plus ongoing USFWS reintroduction efforts at Crims Island and Fisher Island, represent attempts to establish additional secure and viable populations of this deer.

Phase 1–Tenasillahe Island Interim Restoration Action. This action includes retrofitting tidegates and introduction of Columbia River flows to the heads of two sloughs in order to reintroduce juvenile salmonids to the interior sloughs and assure their viability. Tidegates would be retrofitted with aluminum doors or other suitable structures to allow fish access and egress over longer periods of time and tidal flows. Controlled inlet structures could be placed at the heads of sloughs to allow for ingress of Columbia River waters, thus drawing juvenile salmonids into the slough system. About 92 acres of backwater channel habitat would be affected by this interim action to improve tidegates for fish access/egress and to install water control structures to improve flow and circulation.

Implementation of this action would occur in the August-September timeframe. Although outside the in-water work period for the Columbia River, the proposed timeframe would allow construction when levees are dry and firm, thus minimizing sediment runoff. Further, interior waters of the Tenasillahe Island sloughs would be too warm for salmonid use at that time, thus lessening the potential for impacts to juvenile salmonids that had managed to enter the system through the current tidegates.

The north interior slough that separates the main portion of Tenasillahe Island from the small island abutting the Multnomah Slough and the Columbia River could be improved by placement of a controlled inlet structure at the Columbia River and improvements to the tidegates at Multnomah Slough. The headwaters of the main western slough channel, in the interior of Tenasillahe Island, are adjacent to Clifton Channel. Historically, there was a pump house and tidebox at this location. The tidebox is no longer functional. A controlled inlet could be constructed at this location for importation of Columbia River flows and thus, juvenile salmonids. Similar to the north slough, improvements to the tidegates would be required to ensure flows are exhausted and juvenile salmonids can readily exit the system. The Corps with the assistance of the sponsor ports will:

- Conduct hydraulic engineering analyses of inlet and tidegate structures to ensure water control structures are of sufficient design and capacity to safeguard Columbian white-tailed deer habitat interior to the main flood control levees.
- Fund and implement construction efforts for the interim action.
- Monitor post-construction benthic productivity and fish species composition and density on the restoration site and an adjacent control site.
- Prepare annual reports of post-construction results to the AMT (includes the Corps, NOAA Fisheries, USFWS, and sponsor ports).

Phase 2–Reintroduction of Columbian White-tailed Deer to Cottonwood-Howard Islands. This restoration action is intended to provide secure habitat for Columbian white-tailed deer (Figure S4-10). Securing habitat at Cottonwood-Howard Islands allows Columbian white-tailed deer to be moved from elsewhere in their range so that Tenasillahe Island can ultimately be restored to tidal marsh habitat with inherent benefits for salmon, waterfowl, shorebirds, and many other species. This restoration action, located at CRM 68-71.5, will occur on the remainder of the Port-owned lands (outside the disposal site boundaries).

Figure S4-10. Phase 2—Reintroduction of Columbian White-tailed Deer to Cottonwood-Howard Islands

Howard and Cottonwood Islands

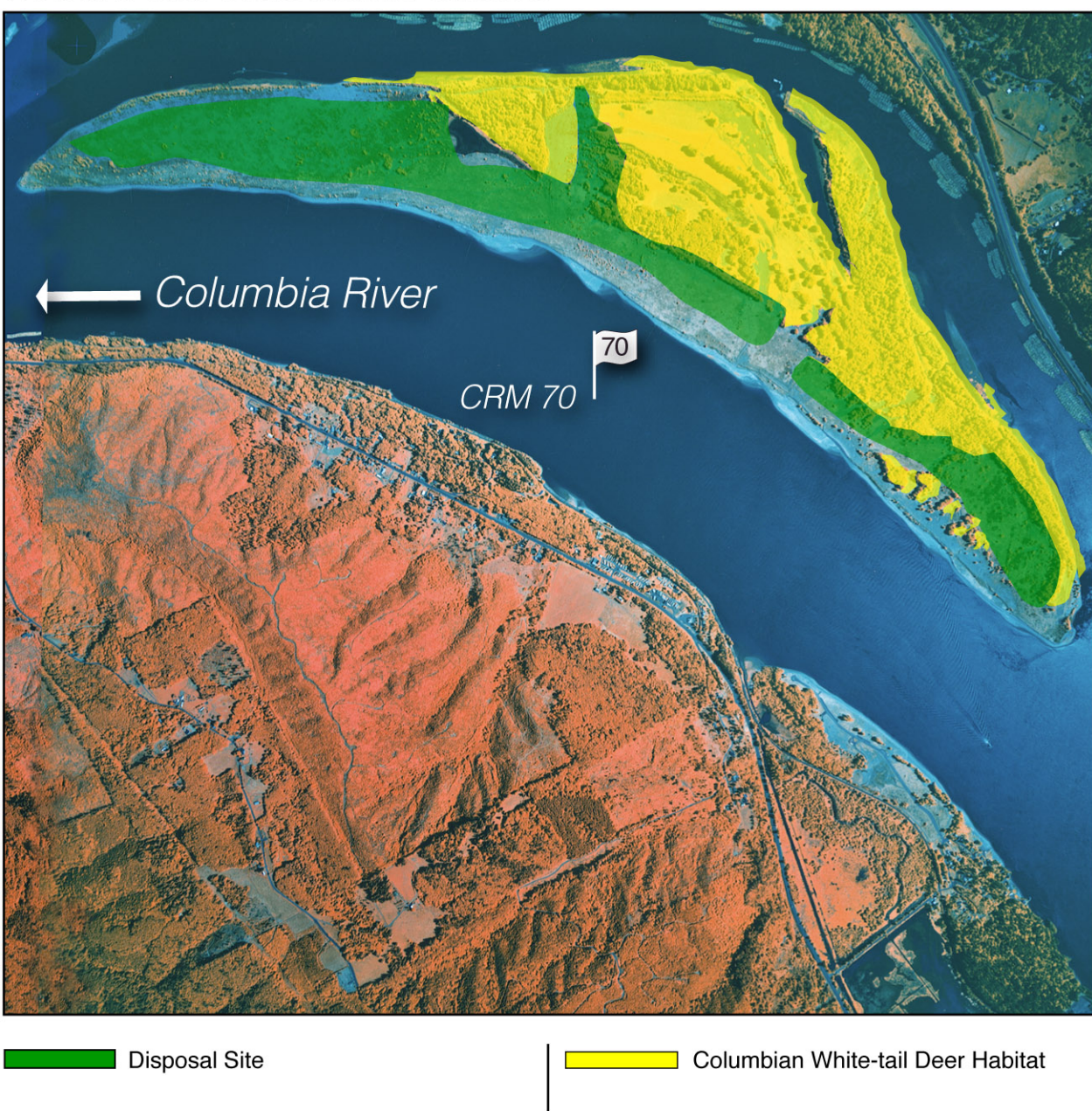


Figure S4-10 Tenasillahe Island Phase 2 - Reintroduction of Columbian White-tail Deer to Cottonwood-Howard Islands

There are approximately 650 acres at Cottonwood-Howard Islands outside the disposal site boundaries for preservation as Columbian white-tailed deer habitat. Approximately 60 acres of tidal lands would also be acquired. Riparian forest currently exists in a relatively large block on the Carroll's Channel side of the island. Buffer zones (300 feet wide per agreement with NOAA Fisheries) have been established around the selected disposal sites to allow for natural development of riparian forest. Given the large size of these islands, which are presently joined as one island, and the presence of large blocks of riparian forest, the re-introduction of Columbian white-tailed deer is considered viable at this location. Post-introduction monitoring will be required to determine the success of the re-introduction and whether a secure, viable population of Columbian white-tailed deer has been established. Those areas designated for dredged material disposal and access of dredging-related equipment in the 1999 Final IFR/EIS will be retained for that category of use for the life of the project. Only lands exterior to the designated disposal site will be considered for restoration purposes. The Corps with the assistance of the sponsor ports will provide:

- Land acquisition.
- Funding of 50 percent of translocation costs for deer.

The USFWS will provide:

- Funding of 50% of translocation costs for deer.
- All actions necessary to accomplish translocation of Columbian white-tailed deer to Cottonwood-Howard Island, including NEPA/ESA coordination.
- Habitat operations and maintenance.
- Monitoring efforts to assess Columbian white-tailed deer translocation, including preparing an annual report for the AMT.

Phase 3—Tenasillahe Island Long-term Restoration Action. This action includes restoring Tenasillahe Island to its historical habitat mix. It is contingent on obtaining two (for a total of three) secure and viable Columbian white-tailed deer habitat sites. Options include obtaining lands in the subpopulation areas previously identified and possible acquisition of lands and habitat development at Lord-Walker, Fisher-Hump, and/or Cottonwood-Howard Islands (Cottonwood-Howard is discussed above). These deer habitat acquisition actions are proceeding at various paces and entail a number of governmental resource agencies and non-governmental organizations acting independently of this project. However, the time frame for obtaining two additional secure and viable white-tailed deer habitat sites is unknown.

Obtaining three secure and viable subpopulations of Columbian white-tailed deer, not to include Tenasillahe Island, would provide an excellent opportunity to restore 1,778 acres of ESA critical habitat for salmonids in the Columbia River estuary. The restoration action requires removal of the downstream plugs on the interior drainage channels and reconnection via open channels of historical upstream connections. Construction actions could be easily implemented in a short timeframe at a minimal cost. The Corps with the assistance of the sponsor ports will:

- Develop a plan to remove downstream plugs on the interior drainage channels and reconnect upstream connections via open channels through the flood control dike when Columbian white-tailed deer are delisted.
- Monitor post-construction benthic productivity and fish species composition and density on the restoration site and an adjacent control site.
- Submit annual reports of post-construction results to the AMT.

4.8.6.5.^{new} Bachelor Slough Restoration

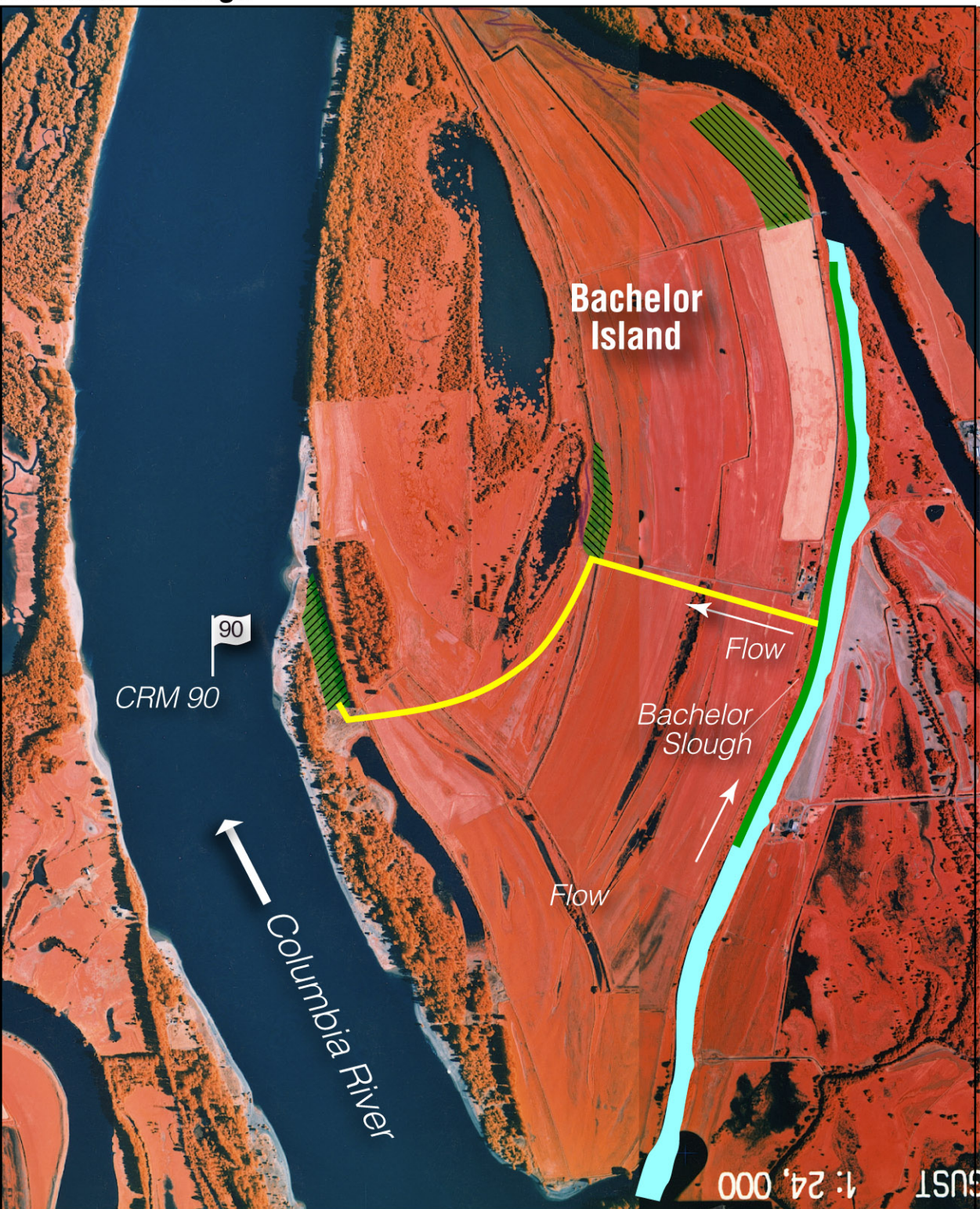
Implementation of the Bachelor Slough ecosystem restoration feature is contingent on the Corps' evaluation of sediment chemistry to determine suitability for upland disposal and approval by WDNR and/or the USFWS to dispose of dredged material on their property. Sediment sampling to determine contaminant levels is planned in federal Fiscal Year 2003. Backwater channels are more likely to contain fine-grained sediments (silts) with a high organic content and a greater likelihood of contaminants (e.g., PCBs, DDT, DDE) than the coarser-grained sands with low organic content found in the main navigation channel. If sediment samples fail to meet established thresholds, or an upland dredged material disposal site on Bachelor Island is unavailable, this restoration feature would not be implemented.

Two principal actions compose this restoration proposal feature: improving in-stream salmonid habitat and restoration of riparian habitat (Figure S4-11). The first action was proposed by the USFWS Ridgefield National Wildlife Refuge and includes dredging of Bachelor Slough to increase depth and through flow of Columbia River waters in order to restore and improve in-stream salmonid habitat. Increased depth and flow should also address water temperatures in Bachelor Slough, which currently exceed the temperature tolerance of salmonids from mid-summer until fall. The second action includes the restoration of riparian forest habitat on about 6 acres of Bachelor Slough shoreline, primarily downstream of the bridge crossing; and establishment of up to 46 acres of riparian forest on the upland disposal site(s).

The Bachelor Slough restoration feature is located within the boundaries of the Ridgefield National Wildlife Refuge near Ridgefield, Washington. Bachelor Slough is a 2.75-mile-long side channel of the Columbia River, branching off the mainstem at CRM 91.5. The slough empties into Lake River, which opens into the Columbia River at CRM 87.5. Bachelor Slough delineates the east boundary of Bachelor Island. The instream action would affect 85 acres along the length of the slough. An estimated 132,000 cubic yards of material would be dredged from the slough. Bathymetric surveys will be implemented to verify dredging quantities prior to implementation of this feature. Bachelor Slough submerged lands and the upland disposal site adjacent to the Columbia River are the property of WDNR. Discussions are under way to secure appropriate use agreements from WDNR for use of their property for disposal. Two upland disposal sites on USFWS refuge lands are proposed, one adjacent to Bachelor Slough downstream of the confluence with Lake River and one adjacent to the dike near Wigeon Lake.

Figure S4-11. Bachelor Slough Ecosystem Restoration Feature

Bachelor Slough



-  Riparian Forest Disposal Site
-  Riparian Forest

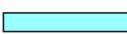
-  Pipeline Route
-  Bachelor Slough Dredging

Figure S4-11 Bachelor Slough Ecosystem Restoration

The slough provides salmonid rearing habitat and possibly minor habitat for adult migration. The slough currently is heavily silted, which impedes seasonal water flow, elevates water temperatures, reduces vegetation growth, and inhibits fish passage. The restoration action will remove silt approximately 300 feet north of the slough mouth (south tip of Bachelor Island) to the north end of the slough (where it merges with Lake River). The first 300 feet of the slough mouth will not be dredged completely so as to discourage recreational boating. Recreational boating, including jet skis, is a recognized source of wildlife disturbance and erosion in the slough.

Current conditions (i.e., shallow water and minimal access at the mouth) limit boating activities to relatively small watercraft and seasonal use. Removing some silt while retaining some of the natural barriers to boat traffic will enhance fish habitat. This restoration feature also includes removing invasive tree species and reed canarygrass on about 6 acres along the Bachelor Island shoreline of the slough and establishing native willows, ash, and cottonwoods on these lands.

Dredging of Bachelor Slough would be implemented from July 1 to September 15 to comply with in-water work timeframes. Work is anticipated to be completed by a small pipeline dredge with dredged material placed in diked, upland cells with return water discharge via weirs to the Columbia River, Lake River, Bachelor Slough and/or interior lands. Potential areas for dredged material disposal include an upland portion (about 23 acres) of Bachelor Island immediately downstream of the junction of Bachelor Slough and Lake River and inland of the flood protection dike. A second location, approximately 6 acres, is an upland site adjacent to the dike near Wigeon Lake. The third location is an old dredged material disposal location on WDNR land that abuts the Columbia River at about the center of the island. This site is approximately 17 acres. The WDNR site would be prepared prior to disposal to scarify the Scots broom from the site. Low levees would be constructed from sandy dredged material that comprises the substrate of the area.

Natural establishment of riparian forest trees would be relied on for stand development on the disposal locations. The presence of bare mineral soil in May through early June during seed dispersal by cottonwoods and willows will result in natural establishment of riparian forest stands. Dredged material will provide that type of substrate. Minor tillage in spring prior to seed dispersal would be sufficient to control weeds or other competitive vegetation that may develop between disposal and spring.

The slough will be dredged to a bottom depth of approximately zero feet NGVD, with approximate slopes of 7:1 to the adjacent embankments. About 85 acres of Bachelor Slough would be dredged. The Ridgefield National Wildlife Refuge has three pump stations along Bachelor Slough. Deeper excavations will occur around these intake pumps to improve pump efficiency. Each pump intake is screened to prevent entrainment of juvenile salmonids.

Restoration of approximately 6 acres of riparian forest along the shoreline of Bachelor Slough would be implemented via scarification and sloping of the bank line. The preferred timeframe for this work would be early May and would provide for a bare soil environment

that coincides with seed dispersal by cottonwoods and willows from mid-May into June. Scarification would be used to remove the reed canary grass and false indigo bush vegetation, roots and/or rhizomes. Native shrubs (willows and red-osier dogwood) and trees that are present would be left in place. The bank line would be sloped, with side slopes as gentle as 1 vertical to 6 horizontal. Presently, there is a sharp cut bank 4 to 6 feet in height at the water's edge. Where adequate width is available outward of the levee toe, scarified vegetation will be placed in an excavated trench and buried. If inadequate width for burial and/or burial would compromise the levee's integrity, the scarified vegetative material will be hauled to an upland location and buried. Excavated soil free of vegetation would be graded into the levee or bank slope as appropriate.

This overall effort is a collaborative effort with the USFWS to create this habitat restoration feature. Involvement by the Corps and sponsor ports is limited to 5 years. At that point, maintenance of the restoration site will be performed by the USFWS. The Corps with the assistance of the USFWS and the sponsor ports will:

- Conduct sediment chemistry evaluation.
- Obtain real estate instruments in order to place materials at an upland location.
- Conduct dredging of Bachelor Slough.
- Provide initial tillage of upland dredged material disposal site, if necessary, to provide suitable substrate for riparian tree seedling establishment.
- Restore 52 acres of riparian forest habitat.
- Perform riparian forest operations and maintenance.
- Monitor fisheries use of Bachelor Slough for a 3-year period, including providing annual and final reports on findings to the Corps, NOAA Fisheries, and WDFW.

The USFWS will perform maintenance dredging, as required, to maintain restoration depths in the slough.

4.8.7. ^{new} Cost Effectiveness—Incremental Cost Analysis for the Ecosystem Restoration Features

This new subsection for the Final SEIS addresses a cost effectiveness and incremental cost analysis conducted for the ecosystem restoration features. This incremental analysis does not include Lois Island or the Miller-Pillar ecosystem restoration feature because they both use dredged material beneficially. The non-monetary benefits of the ecosystem restoration alternatives are measured in average annual environmental outputs. In this case, the average annual environmental outputs are measured as weighted acres. It should be noted that the average annual outputs listed represent the net increase in output above and beyond the without-project condition.

The value of each ecosystem restoration feature was evaluated during the ESA consultation phase. During the consultations, the Biological Review Team decided on the high, medium, and low weighting process. The assignment of high, medium or low values for each feature was predicated upon the habitat type being restored and the functional value of that habitat

type to fish and wildlife species, particularly listed salmonid stocks. The valuation was used to weight the habitat acreage encompassed by each feature; thus a high value provides a weight of three times the habitat acreage; medium weight is a factor of two times and low has a factor of one.

Ecosystem restoration at Tenasillahe Island has three phases. The Tenasillahe Island interim ecosystem restoration feature (Phase 1) was assigned a moderate value. While the feature does provide for juvenile salmonid access to rearing and refugia habitat, that access is not unimpeded nor is the associated habitat returned to its natural state (tidal marsh), thus allowing juvenile salmonids an increased area for rearing and foraging activities.

Establishment of a secure and viable population of Columbian white-tailed deer on Cottonwood-Howard Island (Tenasillahe Island Phase 2) was assigned a high weighting factor. Reintroduction of deer to their native habitat, present on these islands, will aid their de-listing as a federal endangered species. Further, their de-listing leads to implementation of the long-term feature at Tenasillahe Island (Phase 3) that has substantial benefit for listed salmonids, bald eagles, waterfowl, shorebirds and other species.

The Tenasillahe Island long-term ecosystem restoration feature (Phase 3) was given a high weighting factor due to the importance of the habitat to be restored. This feature would produce tidal marsh habitat that is an important contributor to the primary production, via detrital export, of the estuarine ecosystem. Benthic invertebrates, which forage on this detrital export, are an important prey resource for juvenile salmonids, including those of the 13 ESA listed ESUs that migrate through and/or rear in the estuary. Tidal marsh habitat also provides refugia during high tide to juvenile salmonids.

The purple loosestrife control effort was also ranked high in value in the BA. This exotic plant species has attained dominance in some tidal marsh locations in the lower Columbia River (e.g., Wallace Island and Pillar Rock Island). The species is now dispersed throughout the tidal marshes of the lower river and may become the dominant tidal marsh plant species in the next few decades. Purple loosestrife dominance of the tidal marsh plant community substantially decreases plant species diversity and utilization by wildlife resources, thus compromising their presence and abundance in the area. If not compatible with detritivores (benthic invertebrates), then forage resources for juvenile salmonids would be compromised resulting in decreased survival and/or fitness.

Tidegate retrofits for salmonid passage were assigned a high value because they would allow easier access/egress by juvenile and adult salmonids. Adult salmonid passage allows fish to access spawning habitat, in some cases restoring runs and in others improving runs.

The Walker-Lord and Hump-Fisher Islands embayment circulation improvements were assigned a moderate value. The action is intended to improve flow, circulation and water temperature conditions in these embayments formed via dredged material deposition. These water quality improvements would improve conditions for benthic invertebrates and juvenile salmonids, thus improving juvenile salmonid production, fitness and survival.

The Bachelor Slough ecosystem restoration feature was assigned a moderate value for the channel portion of the feature. While improving habitat conditions through modest water quality improvements, it did not result in the addition of habitat. The riparian forest component of this feature was assigned a high weighting factor because there would be an increase in this habitat component; it benefited multiple species, in addition to listed species; and it provide detrital and ultimately large woody debris input to the ecosystem.

Shillapoo Lake also was assigned a high value because the managed wetland habitat provides habitat improvements in quality and quantity of wetlands. The action also would benefit a diverse array of species.

The costs of implementation include all costs associated with the potential projects, such as development costs, real estate costs, monitoring costs, and operation and maintenance costs. In order to compare costs with average annual environmental outputs, it is necessary to convert implementation costs to average annual costs. All costs were amortized at the Fiscal Year 2003 federal discount rate of 5.875% over the 50-year project life, to develop equivalent average annual costs.

For determining the economic cost of the potential projects and various components, a calculation is made to determine the cost of interest during construction. This interest is added to the other costs of the project, and included as part of the average annual cost. Interest during construction is included as an economic cost, but it is not included as a financial cost. It is calculated using the Fiscal Year 2003 discount rate of 5.875% for costs incurred during construction of the project. The project costs are expressed in terms of average annual dollars per average annual environmental output.

In conjunction with the environmental analysis of potential projects, cost effectiveness and incremental cost analyses are required. The following explanations clarify the difference between cost effectiveness and incremental cost analyses, and the purpose for each analysis.

- *Cost effectiveness analysis* is conducted to ensure that the least cost solution is identified for various levels of environmental output. Its purpose is to eliminate inefficient alternatives, based on comparing environmental outputs with the *average cost* of an alternative.
- *Incremental cost analysis* is conducted to show changes in costs for increasing levels of environmental outputs. It provides data for decision-makers to address the question, Is the next level worth it? It measures the incremental or *additional cost* of the next additional level of environmental output.

Table S4-9 summarizes the net gains in average annual environmental outputs, the average annual costs, and the average annual cost per environmental output for each of the sites. As the table shows, the average annual cost per environmental output is directly associated with the number of environmental outputs gained by development of each alternative. Note that the average annual environmental outputs represent the gain over the no action condition.

Table S4-9. Average Annual Environmental Outputs, Average Annual Costs, and Average Annual Cost per Environmental Output

Sites	Average Annual Output	Average Annual Cost	Average Annual Cost per Output
No Action*	0	\$0	\$0
Walker-Lord & Hump-Fisher	670	\$10,466	\$16
Tidegate Retrofits	276	\$33,616	\$122
Bachelor Slough	262	\$188,517	\$720
Purple Loosestrife	22,440	\$154,707	\$7
Shillapoo Lake	1,410	\$326,850	\$232
Tenasillahe Island	6,254	\$342,339	\$55

*The no action condition represents the base conditions at each of the sites considered for ecosystem restoration. The without project condition serves as the basis for comparison for alternative with-project conditions.

Table S4-10 displays the cost-effective, least-cost alternatives listed in ascending order of average annual environmental outputs. Alternatives that had a higher cost for a given level of environmental outputs were not cost-effective, and were dropped from further consideration. Table S4-10 also displays the supply schedule of the average annual cost for each level of output, which serves as the basis from which to derive the incremental cost analysis.

Table S4-10. Cost-effective, Least-cost Combinations - Average Annual Environmental Outputs and Average Annual Cost

Alternative	Average Annual Output	Average Annual Cost
No Action	0	0
Walker-Lord/Hump-Fisher	670	\$10,466
Walker/Hump, Tidegates	946	\$ 44,082
Purple Loosestrife	22,440	\$154,707
Walker/Hump, Purple Loosestrife	23,110	\$165,173
Walker/Hump, Purple Loosestrife, Tidegates	23,386	\$198,789
Walker/Hump, Purple Loosestrife, Bachelor Slough, Tidegates	23,648	\$387,306
Purple Loosestrife, Shillapoo Lake	23,850	\$481,557
Walker/Hump, Purple Loosestrife, Shillapoo Lake	24,520	\$492,023
Tenasillahe, Purple Loosestrife	28,694	\$497,046
Tenasillahe, Purple Loosestrife, Walker/Hump	29,364	\$507,512
Tenasillahe, Purple Loosestrife, Walker/Hump, Tidegates	29,640	\$541,128
Tenasillahe, Purple Loosestrife, Walker/Hump, Bachelor Slough, Tidegates	29,902	\$729,645
Tenasillahe, Purple Loosestrife, Shillapoo Lake	30,104	\$823,896
Tenasillahe, Walker/Hump, Purple Loosestrife, Shillapoo Lake	30,774	\$834,362
Tenasillahe, Purple Loosestrife, Walker/Hump, Tidegates, Shillapoo Lake	31,050	\$867,978
Tenasillahe, Purple Loosestrife, Walker/Hump, Bachelor Slough, Shillapoo Lake, Tidegates	31,312	\$1,056,495

Table S4-11 shows the final incremental cost analysis. Incremental cost analysis is required to address whether the incremental or additional cost of the next level of output is cost effective. In environmental studies, the comparison is between dollar incremental costs and non-dollar incremental units of output.

In order to facilitate the required calculations, the Institute of Water Resources “Cost Effectiveness and Incremental Cost Analysis” (Eco-Easy) software program was used to do the calculations necessary to eliminate the irregular, non-continuously increasing cost changes that occur in the incremental average annual cost per output calculations. To get to the final incremental cost table, it was necessary to do a series of calculations to determine the lowest average cost for additional output from amongst the remaining levels of output. Each of the recalculations begins with the previous step’s lowest average cost level of output set as the new “zero level.” The calculation in this step uses the additional cost and additional outputs above those of the previously identified level of output with the lowest average cost (for further details on this process, refer to *Cost Effectiveness Analysis for Environmental Planning: Nine Easy Steps*, Institute of Water Resources Report 94-PS-2, October 1994).

Table S4-11 summarizes the results of the final incremental cost analysis. The column on the right summarizes the incremental average annual cost per output.

Table S4-11. Summary of Final Incremental Cost Analysis

Alternative	Total Average Annual Cost	Total Average Annual Output	Added Average Annual Output	Added Average Annual Cost	Incremental Average Annual Cost/Output
Without Project	\$0	0	0	\$0	\$0
Purple Loosestrife	\$154,707	22,440	22,440	\$154,707	\$7
Purple Loosestrife, Walker-Lord/ Hump-Fisher	\$165,173	23,110	670	\$10,466	\$16
Purple Loosestrife, Walker-Lord/ Hump-Fisher, Tenasillahe	\$507,512	29,364	6,254	\$342,339	\$55
Purple Loosestrife, Walker-Lord/Hump-Fisher, Tenasillahe, Tidegates	\$541,128	29,640	276	\$33,616	\$122
Purple Loosestrife, Walker-Lord/ Hump-Fisher, Tenasillahe, Tidegates, Shillapoo	\$867,978	31,050	1,410	\$326,850	\$232
Purple Loosestrife, Walker-Lord/Hump-Fisher, Tenasillahe, Tidegates, Shillapoo, Bachelor Slough	\$1,056,495	31,312	262	\$188,517	\$720

Based on the results of the cost effectiveness and incremental cost analyses, of the combinations evaluated above, the alternative including Tenasillahe, Walker-Lord/Hump-Fisher, Tidegates, Shillapoo Lake, and Purple Loosestrife (all sites except Bachelor Slough) are the best economic investment for the National Ecosystem Restoration plan.

The original project authorization included three ecosystem restoration features (Shillapoo, Lord-Walker/Hump-Fisher embayment, and tidegate retrofits). As a result of the consultation with NOAA Fisheries and USFWS under Section 7 of the ESA, and in consideration of the mandate by Congress under Section 7(a)(1) of the ESA to exercise agency authorities to carry out programs for the conservation of listed species, three additional ecosystem restoration features (Bachelor Slough, Tenasillahe Island Phased and Purple Loosestrife) were added to the project to provide increased benefit to listed species in the project area. Therefore, all of the ecosystem restoration features are considered part of the proposed alternative, including the two that use dredged material beneficially (Lois Island embayment and Miller-Pillar ecosystem restoration features).

4.9.^{new} Ecosystem Evaluation Actions

This new section for the Final SEIS addresses the ecosystem evaluation actions developed during the ESA consultation process. Ecosystem evaluation actions are measures taken by the Corps as part of the project to assist the efforts of the Corps, NOAA Fisheries, USFWS, and others in the broader issues of understanding the lower Columbia River ecosystem. The evaluation actions address indicators of the salmonid conceptual model (see Chapter 6) and will advance the knowledge base for the conservation and recovery of salmonid species. The NOAA Fisheries strongly supports implementation of these ecosystem evaluation activities.

Effects to ESA-listed salmonids are expected to occur from implementation of some of the ecosystem evaluation activities. Therefore, these activities may require the issuance of permits authorizing direct take of ESA-listed salmonids by NOAA Fisheries under Section 4(d) or 10(a)(1)(A) of the ESA. Otherwise, the ecosystem evaluation activities are not anticipated to have any adverse effect on listed species or any significant adverse effect on the physical environment.

Why Evaluation Actions are Needed

Six ecosystem evaluation actions were identified as a result of the ESA consultation and the risk and uncertainty associated with the proposed project. Evaluation actions will provide background information on habitat parameters, including bathymetric information, for listed ESUs; specifically tidal marsh, shallow water and flats, and water column habitat. The SEI expert panel recommended that the Corps, NOAA Fisheries and the USFWS include specific actions to address contaminant issues potentially related to the channel improvement project even though no direct link between contaminants in listed ESUs and the material to be dredged were ascertained. As a result, the three federal agencies developed two specific evaluation actions to assess sublethal effects of contaminants on fish growth, disease and resistance, and juvenile salmonids and their prey. These contaminant data would be used to modify future project-related dredging or disposal actions. Even

though there did not seem to be a link between contaminants and fish at this time, the risk of advancing with project implementation in the absence of better data was considered too high. Data collected on an annual basis will be reviewed annually by the three federal agencies to determine whether any project actions should be altered to preclude detrimental effects to listed ESUs. The duration of these evaluation actions is variable and specific evaluation actions can be discontinued when warranted by analyses of data collected as decided by the AMT.

Evaluation Action 1 pertains to obtaining additional information on salmonid habitat and distribution in the estuary. This action would entail 1 or 2 additional transects in different habitats similar to those for NOAA Fisheries studies underway for the Anadromous Fish Evaluation Program. One of these transects would be in Cathlamet Bay. The numerical modeling completed for this project has identified Cathlamet Bay as an important area to evaluate pre- and post-project construction regarding juvenile salmonid use and habitat.

It is anticipated that this data would be obtained prior to construction and for three years after project completion. The estimated cost for this action is \$2.8 million. The data would aid decisions regarding project modification should adverse impacts to the listed ESUs be determined. Additionally, the data could be used to modify/improve the proposed ecosystem restoration features and an enhancement of the environmental benefits associated with these features.

Evaluation Action 2 pertains to ascertaining coastal cutthroat trout use of tidal marsh habitat in the Columbia River estuary. Juveniles of this species rear in the estuary for an extended period of time as compared to other anadromous fish species. One year of data for this evaluation action has already been collected. One more year of pre-construction and two years of construction period data are to be collected. The estimated cost for this action is \$1.1 million. These data would aid decisions regarding project modification should adverse impacts to the listed ESUs be determined. Additionally, these data could be used to modify/improve the proposed ecosystem restoration features and an enhancement of the environmental benefits associated with these features.

Evaluation Action 3 pertains to a bank-to-bank hydrographic survey of the estuary. This survey would provide valuable information on bathymetry and shallow water-flat habitat in the estuary. These data have not been collected since the mid-1980s and will aid development, construction and/or modification of the proposed ecosystem restoration features. The estimated cost for this action is \$0.25 million.

Evaluation Actions 4 and 5 address contaminant issues in juvenile salmonids and their prey species plus sub-lethal impacts of contaminants on juvenile salmonids. These actions address the risks identified above regarding contaminants and the project. One year of pre-construction data has been collected (2002). Further data will be collected during construction and for three years post-construction. The estimate cost for these actions are \$0.18 million and \$0.16 million, respectively.

Evaluation Action 6, a term and condition of the NOAA Fisheries and USFSW Biological Opinions, requires convening of an “Estuary Turbidity Maximum Workshop.” The purpose of the workshop is to better understand and propose meaningful management actions to conserve the ETM. The action is anticipated to cost \$0.04 million.

Although some of these evaluation actions are costly and exceed the Corps policy threshold on monitoring costs for the project, they are consistent with a number of the Corps’ Environmental Operating Principles. These evaluation actions proactively consider the environmental consequences of the channel improvement project and represent an appropriate response to the circumstances at hand. They represent an attempt to seek a balance and synergy between the proposed improvement project and the Columbia River estuary through designing economic and environmental solutions that support and reinforce one another. It represents an integrated effort by the Corps Portland District, the sponsor ports, NOAA Fisheries and the USFWS to build and share an integrated scientific, economic and social knowledge base that supports a greater understanding of the environment, particularly as it relates to juvenile salmonids of listed ESUs, and the channel improvement project. This effort reflects a unity of purpose amongst the principal parties. These evaluation actions represent a continuing effort by these parties to develop the scientific, economic and sociological measures to judge the effects of this project on the environment and to seek better ways of achieving environmentally sustainable solutions.

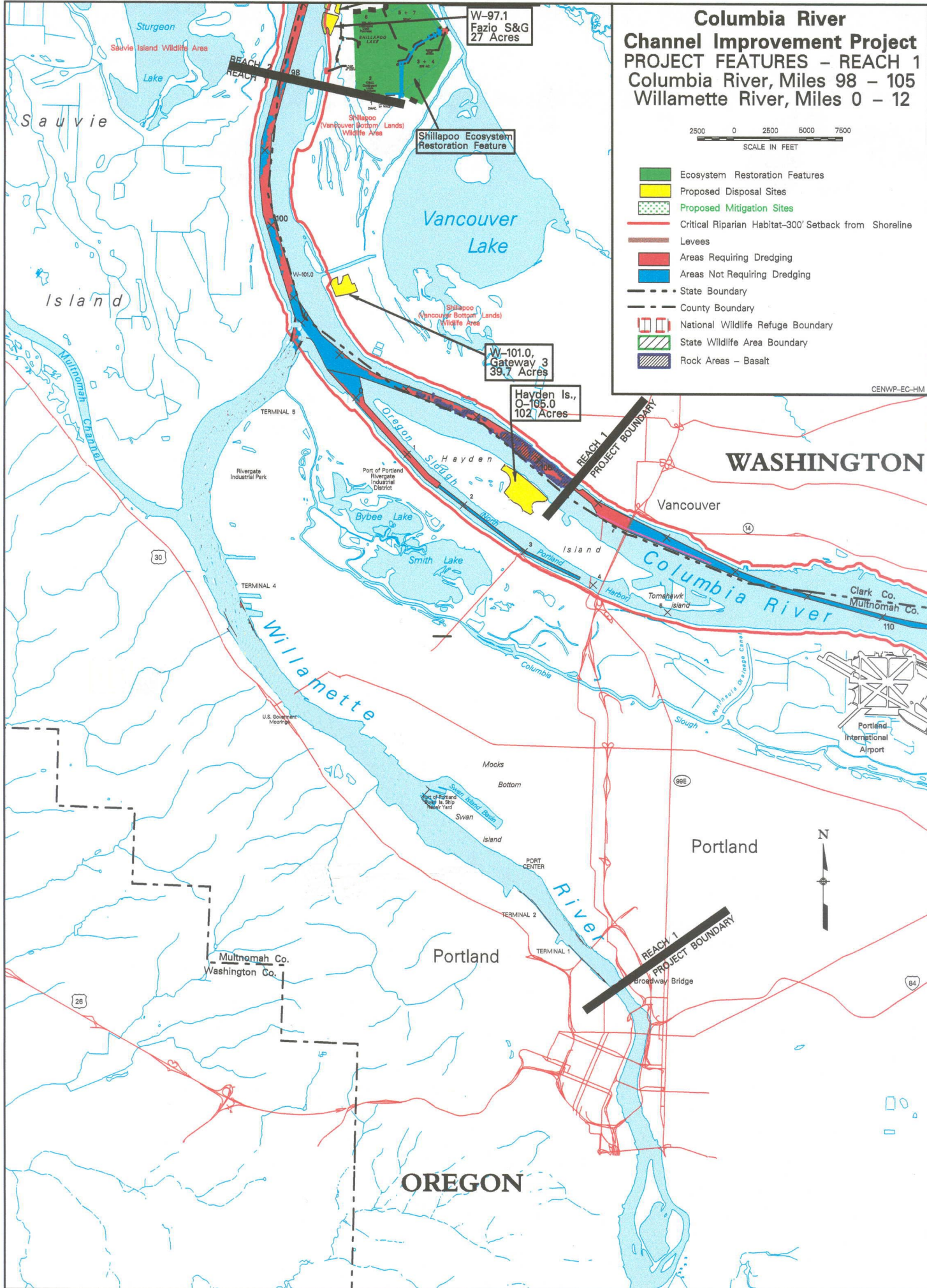
The region and the Corps have demonstrated their commitment to the recovery of these ESUs by investing over \$1.5 billion on improvements to fish passage at the hydroelectric facilities on the Columbia/Snake System. The national importance in these ESUs warrants and justifies the evaluation actions being applied in this project to further safeguard the federal investment made to date. Emphasis on recovery of these ESUs is now shifting to the lower Columbia River (below Bonneville Dam to the mouth).

Columbia River
Channel Improvement Project
PROJECT FEATURES – REACH 1
 Columbia River, Miles 98 – 105
 Willamette River, Miles 0 – 12



-
- Legend:
- Ecosystem Restoration Features
 - Proposed Disposal Sites
 - Proposed Mitigation Sites
 - Critical Riparian Habitat-300' Setback from Shoreline
 - Levees
 - Areas Requiring Dredging
 - Areas Not Requiring Dredging
 - State Boundary
 - County Boundary
 - National Wildlife Refuge Boundary
 - State Wildlife Area Boundary
 - Rock Areas - Basalt

CENWP-EC-HM



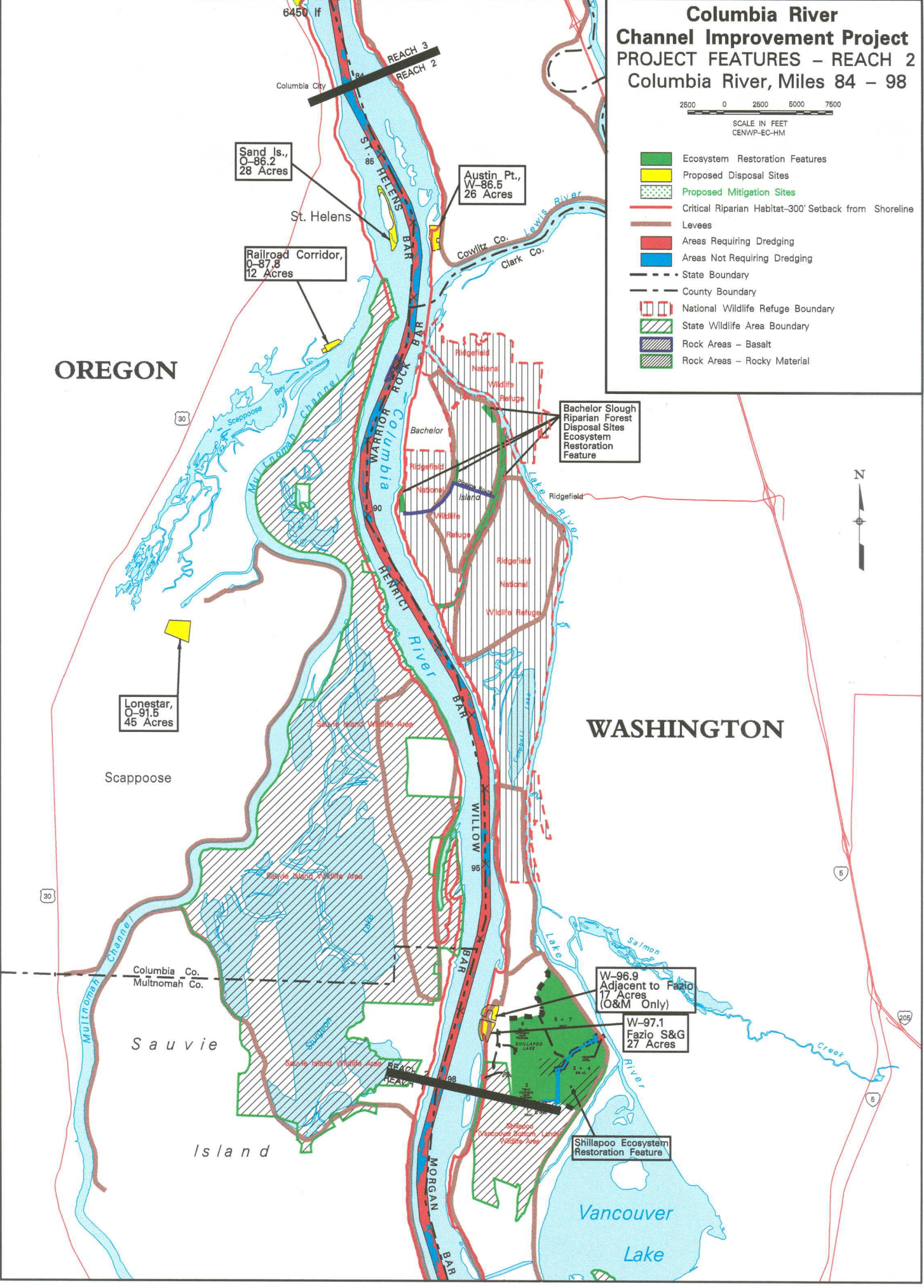
Columbia River Channel Improvement Project PROJECT FEATURES – REACH 2 Columbia River, Miles 84 – 98

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SCALE IN FEET
CENWP-EC-HM

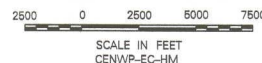
- Ecosystem Restoration Features
- Proposed Disposal Sites
- Proposed Mitigation Sites
- Critical Riparian Habitat-300' Setback from Shoreline
- Levees
- Areas Requiring Dredging
- Areas Not Requiring Dredging
- State Boundary
- County Boundary
- National Wildlife Refuge Boundary
- State Wildlife Area Boundary
- Rock Areas – Basalt
- Rock Areas – Rocky Material

OREGON

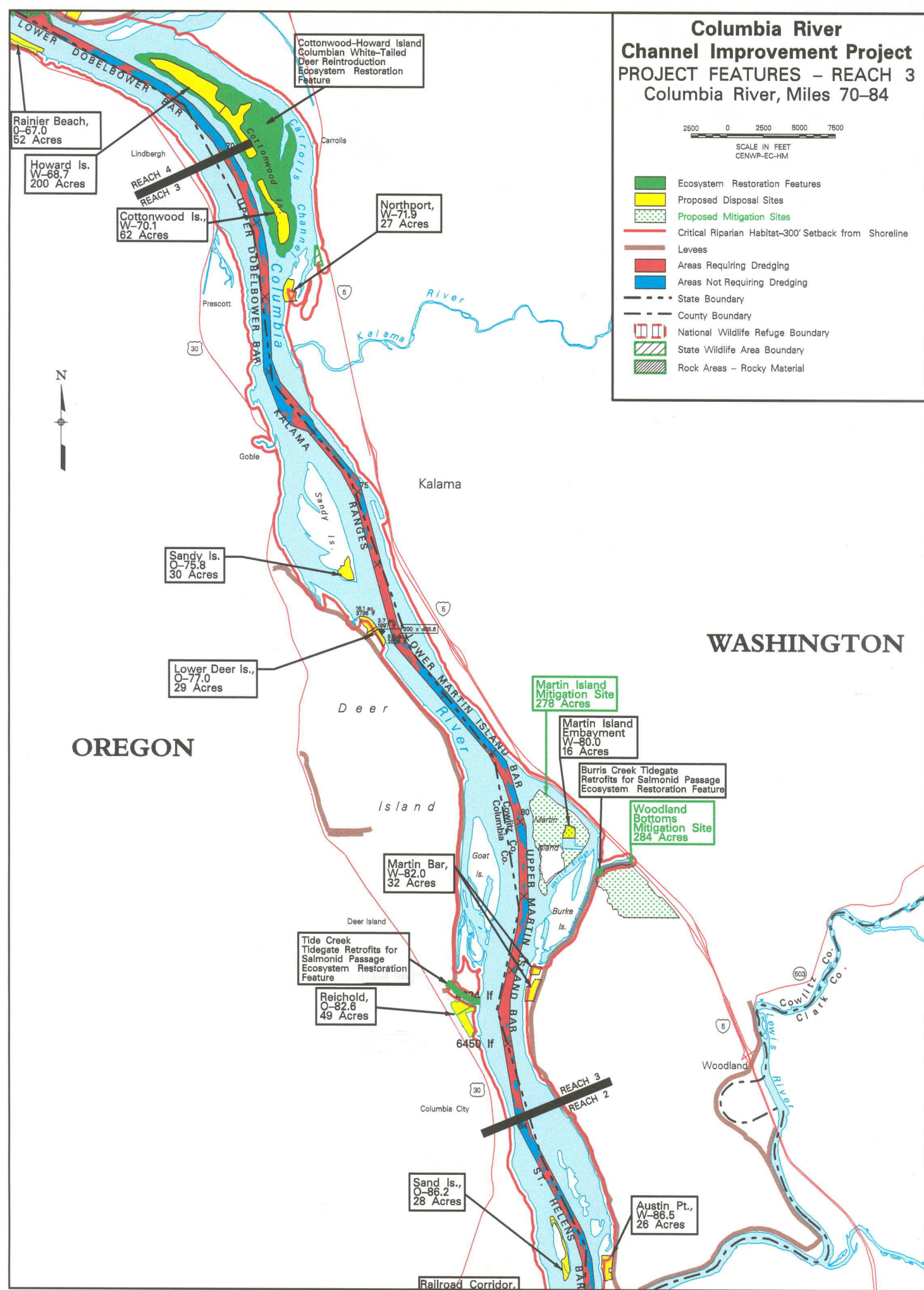
WASHINGTON



**Columbia River
Channel Improvement Project**
PROJECT FEATURES – REACH 3
Columbia River, Miles 70–84



-
- Legend:
- Ecosystem Restoration Features
 - Proposed Disposal Sites
 - Proposed Mitigation Sites
 - Critical Riparian Habitat-300' Setback from Shoreline
 - Levees
 - Areas Requiring Dredging
 - Areas Not Requiring Dredging
 - State Boundary
 - County Boundary
 - National Wildlife Refuge Boundary
 - State Wildlife Area Boundary
 - Rock Areas - Rocky Material



Columbia River Channel Improvement Project PROJECT FEATURES – REACH 4 Columbia River, Miles 56–70

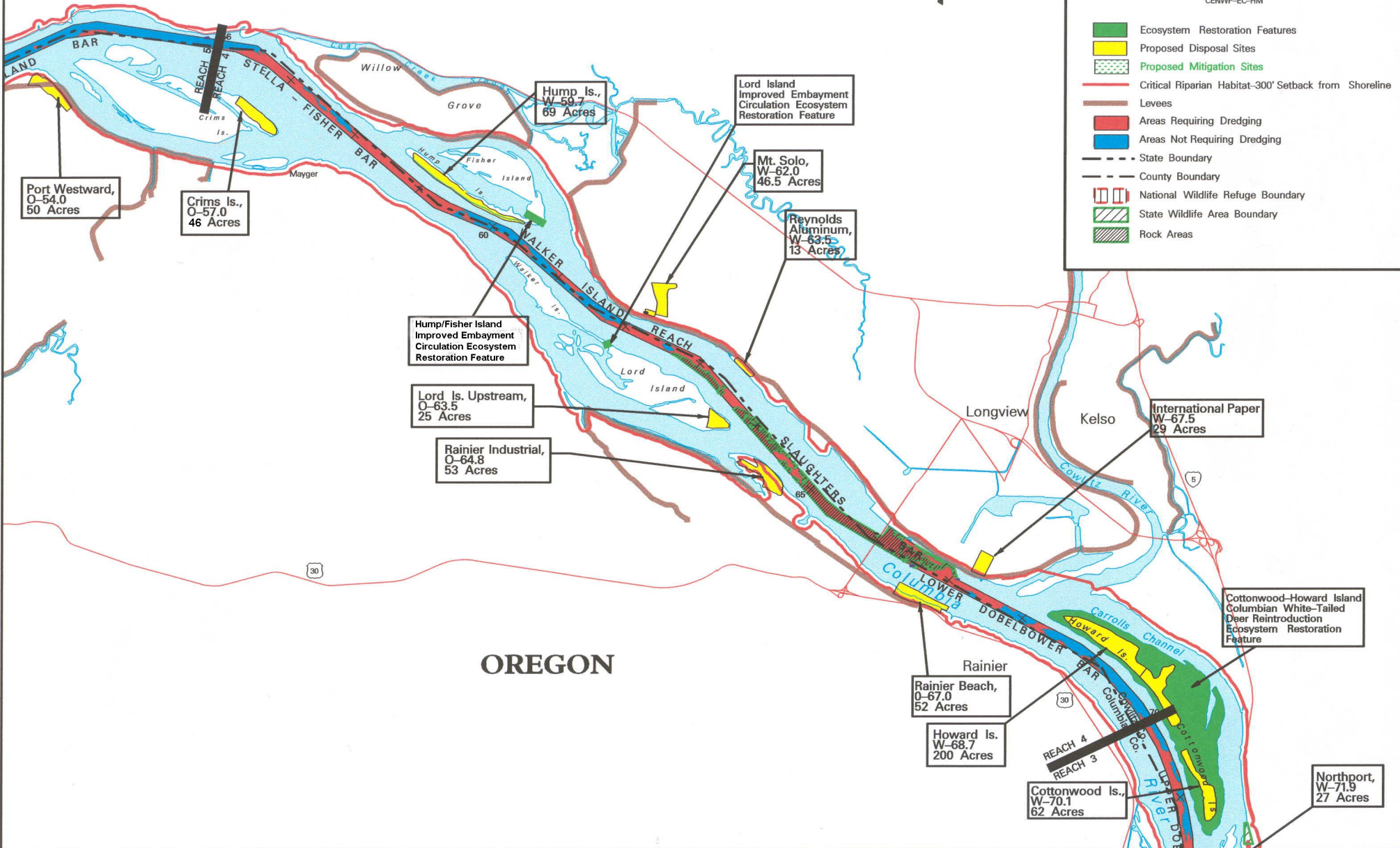
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SCALE IN FEET
CENWP-EC-HM

- Ecosystem Restoration Features
- Proposed Disposal Sites
- Proposed Mitigation Sites
- Critical Riparian Habitat–300' Setback from Shoreline
- Levees
- Areas Requiring Dredging
- Areas Not Requiring Dredging
- State Boundary
- County Boundary
- National Wildlife Refuge Boundary
- State Wildlife Area Boundary
- Rock Areas



WASHINGTON

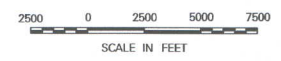
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Columbia River Channel Improvement Project

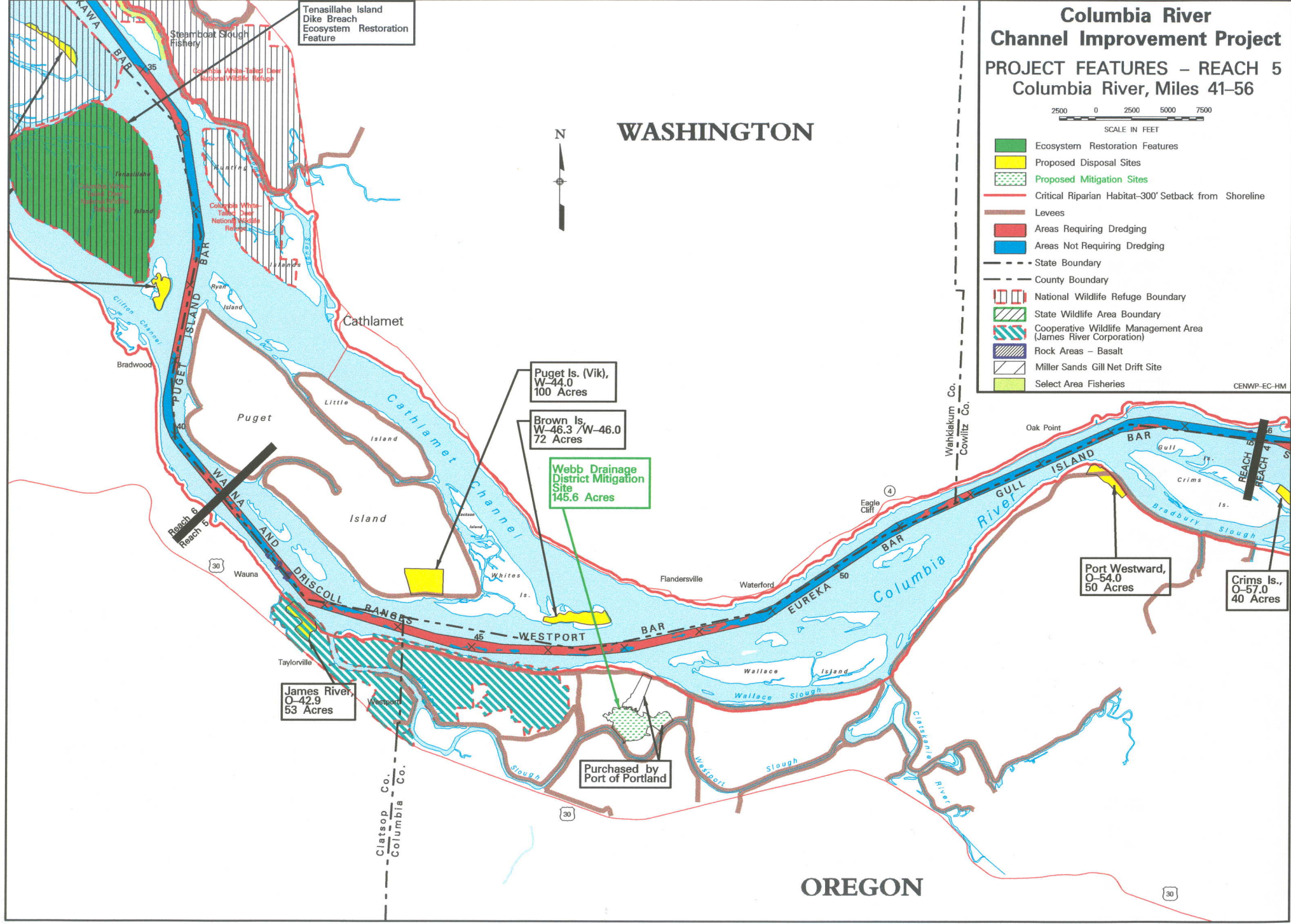
PROJECT FEATURES – REACH 5

Columbia River, Miles 41–56



- Ecosystem Restoration Features
- Proposed Disposal Sites
- Proposed Mitigation Sites
- Critical Riparian Habitat-300' Setback from Shoreline
- Levees
- Areas Requiring Dredging
- Areas Not Requiring Dredging
- State Boundary
- County Boundary
- National Wildlife Refuge Boundary
- State Wildlife Area Boundary
- Cooperative Wildlife Management Area (James River Corporation)
- Rock Areas – Basalt
- Miller Sands Gill Net Drift Site
- Select Area Fisheries

CENWP-EC-HM



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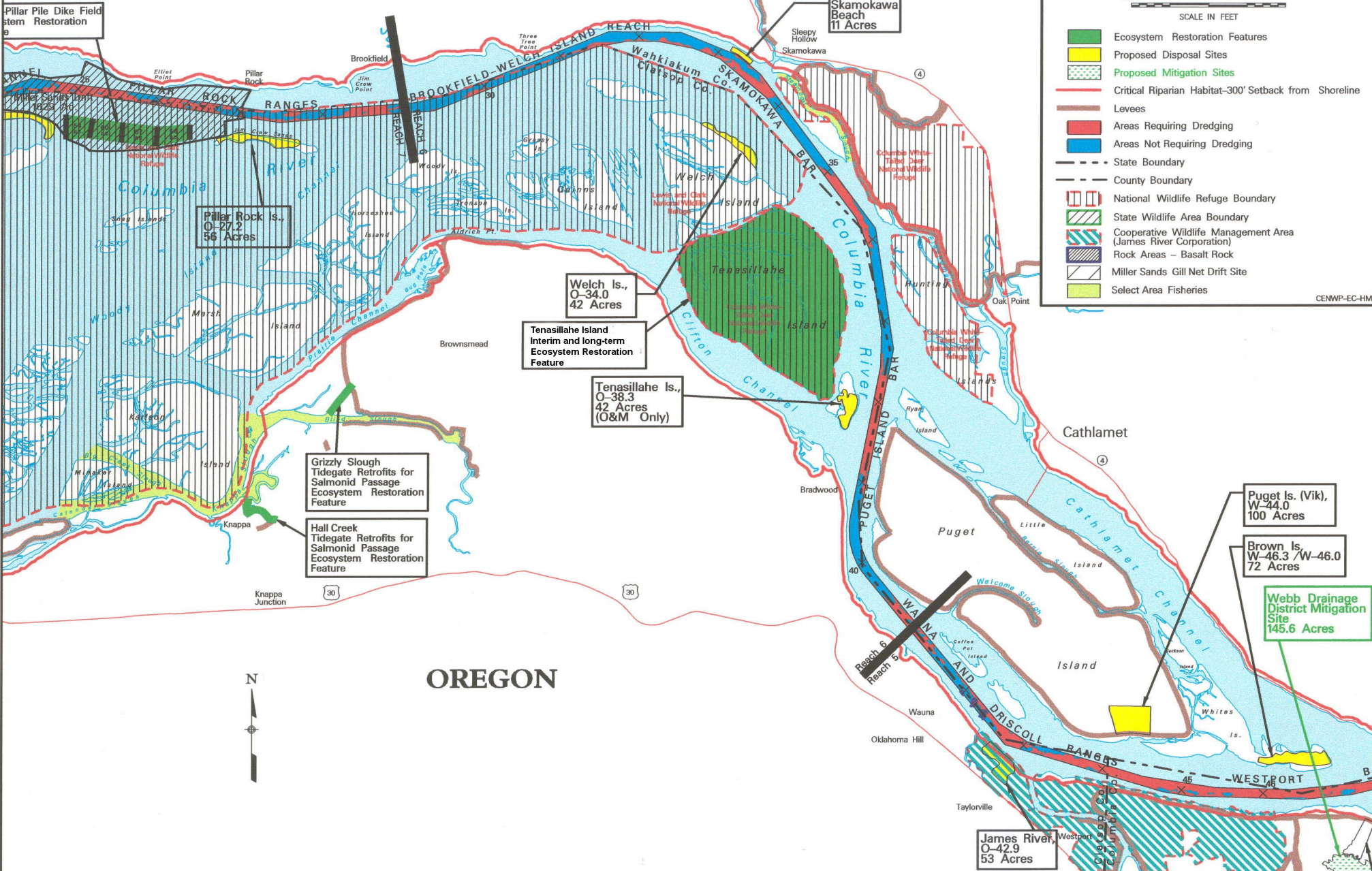
Columbia River Channel Improvement Project PROJECT FEATURES – REACH 6 Columbia River, Miles 29 – 41

2500 0 2500 5000 7500

SCALE IN FEET

- Ecosystem Restoration Features
- Proposed Disposal Sites
- Proposed Mitigation Sites
- Critical Riparian Habitat-300' Setback from Shoreline
- Levees
- Areas Requiring Dredging
- Areas Not Requiring Dredging
- State Boundary
- County Boundary
- National Wildlife Refuge Boundary
- State Wildlife Area Boundary
- Cooperative Wildlife Management Area (James River Corporation)
- Rock Areas – Basalt Rock
- Miller Sands Gill Net Drift Site
- Select Area Fisheries

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Columbia River Channel Improvement Project PROJECT FEATURES – REACH 7 Columbia River, Miles 3 – 29

2500 0 2500 5000 7500
SCALE IN FEET

- Ecosystem Restoration Features
- Proposed Disposal Sites
- Proposed Mitigation Sites
- Critical Riparian Habitat-300' Setback from Shoreline
- Levees
- Areas Requiring Dredging
- Areas Not Requiring Dredging
- State Boundary
- County Boundary
- National Wildlife Refuge Boundary
- State Wildlife Area Boundary
- Rock Areas – Rocky Material
- Miller Sands Gill Net Drift Site
- Select Area Fisheries

Tidegate Retrofits for
Salmonid Passage
Ecosystem Restoration
Feature

Rice Is.,
W-21.0
228 Acres

Miller-Pillar Pile Dike Field
Ecosystem Restoration
Feature

Harrington Sump,
CRM 21.0
118 Acres

Temporary
Construction
Sump

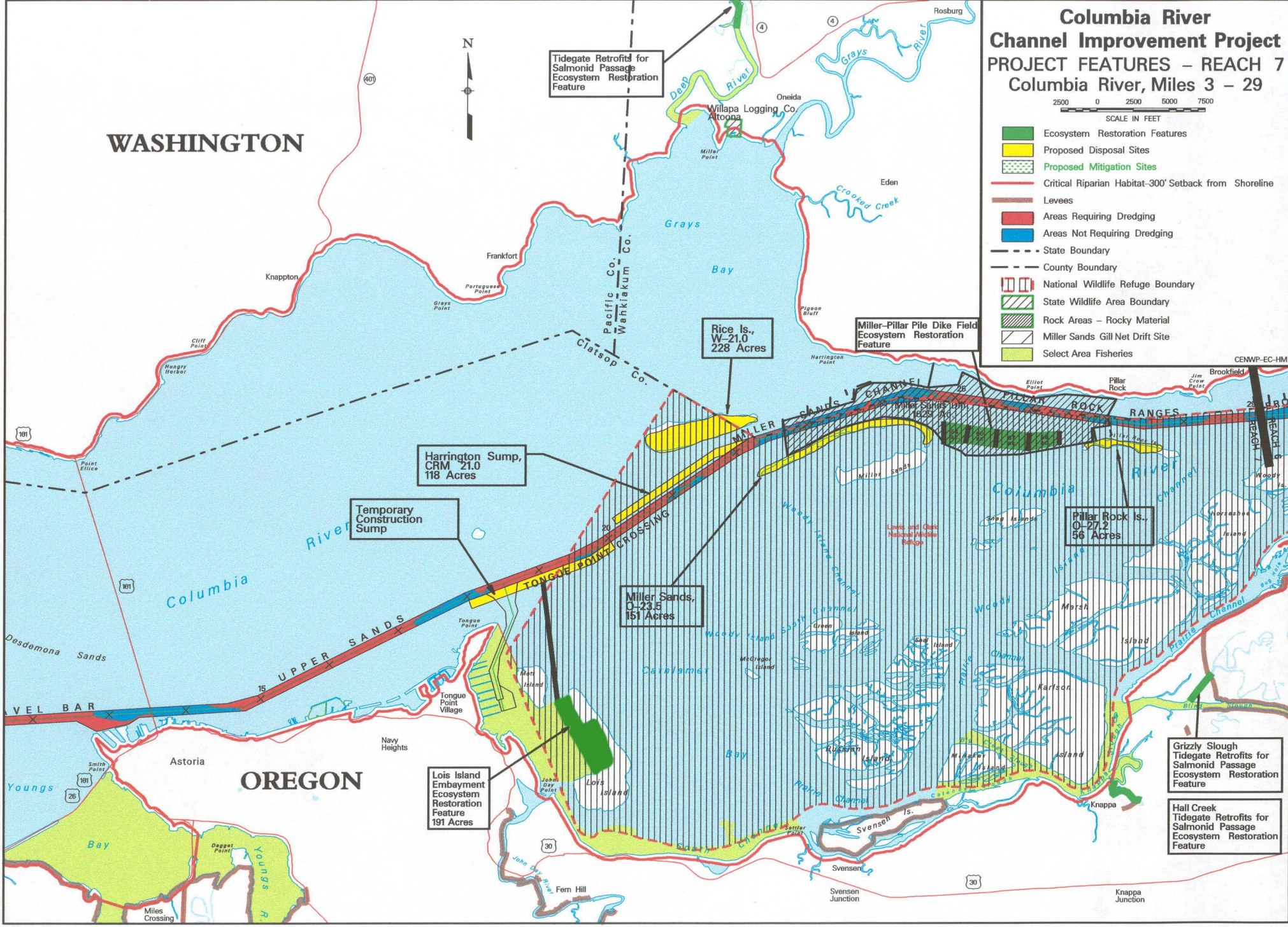
Miller Sands,
O-23.8
151 Acres

Pillar Rock Is.,
O-27.2
56 Acres

Lois Island
Embayment
Ecosystem
Restoration
Feature
191 Acres

Grizzly Slough
Tidegate Retrofits for
Salmonid Passage
Ecosystem Restoration
Feature

Hall Creek
Tidegate Retrofits for
Salmonid Passage
Ecosystem Restoration
Feature



Columbia River Channel Improvement Project PROJECT FEATURES – REACH 7 Columbia River, Miles 3 – 29

2500 0 2500 5000 7500

SCALE IN FEET

- Ecosystem Restoration Features
- Proposed Disposal Sites
- Proposed Mitigation Sites
- Critical Riparian Habitat-300' Setback from Shoreline
- Levees
- Areas Requiring Dredging
- Areas Not Requiring Dredging
- State Boundary
- County Boundary
- National Wildlife Refuge Boundary
- State Wildlife Area Boundary
- Rock Areas – Rocky Material
- Miller Sands Gill Net Drift Site
- Select Area Fisheries

CENWP-EC-HM



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CHAPTER FIVE

AFFECTED

ENVIRONMENT

***5. AFFECTED ENVIRONMENT**

To assist the reader, updated information for the Final SEIS regarding Chapter 5 is presented in the applicable sections of Chapter 6, *Environmental Consequences*. Also, updated information on pile dikes is located in Subsection 4.8.6.3.

5.1. ^{revised} Physical Resources

See Section 6.2 of the Final SEIS.

5.2. ^{revised} Biological Resources

See Section 6.6 (and Subsection 4.8.6.3 for pile dikes) of the Final SEIS.

5.3. ^{revised} Threatened and Endangered Species

See Section 6.7 of the Final SEIS.

5.3.1. ^{revised} Aquatic Species

See Subsection 6.6.1.1 of the Final SEIS.

5.3.2. ^{revised} Wildlife Species

See Subsection 6.7.2 of the Final SEIS.

5.4. Socio-Economic Resources

See Section 6.8 of the Final SEIS.

5.4.1. Port-Related Economy

No updating of this subsection was necessary for the Final SEIS.

5.4.2. ^{revised} Land Use

See Section 6.8.2 of the Final SEIS.

5.4.3. Aesthetics

No updating of subsection was necessary for the Final SEIS.

5.4.4. Recreation

No updating of this subsection was necessary for the Final SEIS.

5.4.5. Cultural Resources

No updating of this subsection was necessary for the Final SEIS.

CHAPTER SIX

ENVIRONMENTAL

CONSEQUENCES

***6. ENVIRONMENTAL CONSEQUENCES**

6.1. Introduction

Subsection 6.1.1 has been added to this section for the Final SEIS to provide updated information since completion of the Final IFR/EIS (August 1999).

6.1.1. ^{new} Introduction for the Final SEIS

This subsection provides new information and analyses regarding environmental conditions and consequences. This information results from a number of sources and activities since issuance of the 1999 Final IFR/EIS, including the ESA consultation, additional evaluation or analyses regarding sturgeon, smelt, crab, fish stranding, and coastal erosion to respond to state agency comments on the project, and new hydrographic survey data. This section also provides information about project modifications (e.g., revised disposal plans), and new ecosystem restoration features added to benefit the recovery of listed salmonids and other fish and wildlife resources. As discussed in Subsection 4.4.3, the preferred alternative modifies the disposal plan by using existing upland disposal sites, Lois Island embayment and Miller-Pillar ecosystem restoration features, and flowlane disposal sites, rather than ocean disposal for construction and the first 20 years of maintenance for CRM 3-29. The Corps has considered the effects of this modification in the following sections.

6.1.1.1. ^{new} Ecosystem Model

A conceptual model was developed for the lower Columbia River ecosystem relationships that are significant for juvenile salmonids. The model was used during the ESA consultation process to evaluate the potential effects of the channel improvement project. The model provides an integrated diagram of the major ecosystem links that affect ecosystem structure and function as related to juvenile salmonid production and ocean entry. The model: (1) provides an ecosystem-level scientific framework for evaluating the project; (2) identifies links among physical, chemical and biological indicators; (3) aids in identifying ecosystem-based processes that link salmon and potential effects of the project; and (4) provides a systematic methodology to evaluate monitoring and adaptive management opportunities.

The model presents a scientifically based diagram that illustrates major connections among processes, indicators, and pathways within the system. Because of the complexity of the ecosystem, these connections are illustrated in a series of figures representing a set of linked submodels based on the functional pathways of the system. These pathways include processes within the river system (e.g., habitat formation, tides, bedload transport, accretion-erosion); specific components, or indicators, within the system (e.g., habitat types, food types, physical properties); and the pathways through which these processes and indicators combine to affect the ecosystem (e.g., primary productivity, food web). The basic habitat-forming processes, physical forces of the ocean and river, create the conditions that define habitats. The habitat types, in turn, provide an opportunity for the primary plant production

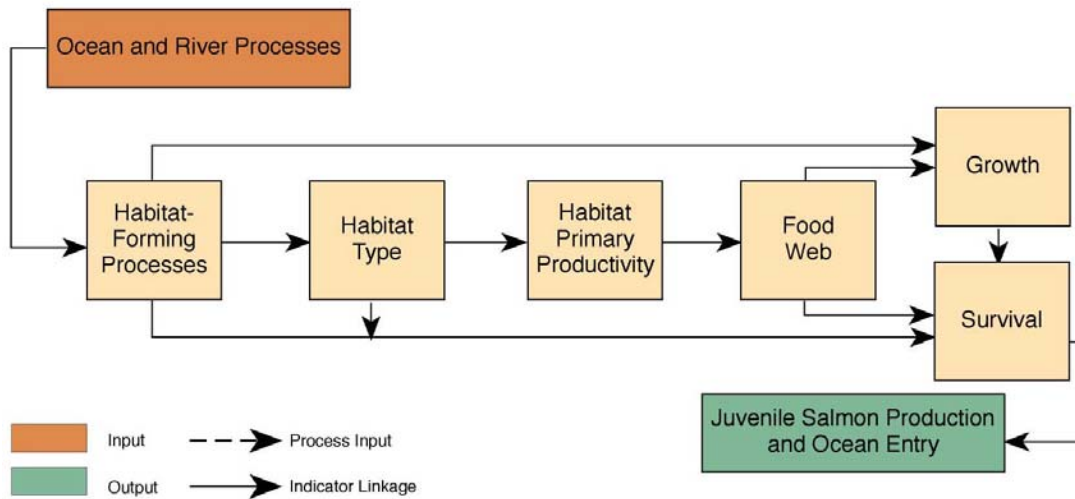
that gives rise to complicated food webs. All of these pathways combine to influence the growth and survival and, ultimately, the production and ocean entry of juvenile salmonids moving through the lower Columbia River. These processes and pathways are developed in the model and outlined in Table S6-1 and shown in Figure S6-1. Table S6-1 also describes the indicators for the functioning of the system.

Table S6-1. Conceptual Model Pathways and Indicators for Juvenile Salmonid Production in the Lower Columbia River

Model Pathways	Pathway Description	Model Components (Indicators)	Indicator Description
Habitat-Forming Processes	Physical processes that define the living conditions and provide the requirements fish naturally need within the river system are included in this pathway.	Suspended Sediment	Sand, silt, and clay transported in the water column
		Bedload	Sand grains rolling along the surface of the riverbed
		Woody Debris	Downed trees, logs, root wads, limbs
		Turbidity	Quality of opacity in water, influenced by suspended solids and phytoplankton
		Salinity	Saltwater introduced into freshwater areas through tidal ocean process
		Accretion/Erosion	Deposited/carved sediments
		Bathymetry	Topographic configuration of the riverbed
Habitat Types	This pathway describes definable areas that provide the living requirements for fish in the Lower Columbia River.	Tidal Marsh and Swamp	Areas between mean lower low water (MLLW) and mean higher high water (MHHW) dominated by emergent vegetation (marsh) and low shrubs (swamp) in estuarine and riverine areas
		Shallow Water and Flats	Areas between 6-foot bathymetric line (depth) and MLLW
		Water Column	Areas in the river where depth is greater than 6 feet
Habitat Primary Productivity	This pathway describes the biological mass of plant materials that provides the fundamental nutritional base for animals in the river system.	Light	Sunlight necessary for plant growth
		Nutrients	Inorganic source materials necessary for plant growth
		Imported Phytoplankton Production	Material from single-celled plants produced upstream above the dams and carried into lower reaches of the river
		Resident Phytoplankton Production	Material from single-celled plants produced in the lower reaches of the river
		Benthic Algae Production	Material from simple plant species that inhabit the river bottom
		Tidal Marsh and Swamp Production	Material from complex wetland plants (hydrophytes) present in tidal marshes and swamps
Food Web	This pathway shows the aquatic organisms and related links in a food web that supports growth and survival of salmonids.	Deposit Feeders	Benthic organisms such as annelid worms that feed on sediments, specifically organic material and detritus
		Mobile Macroinvertebrates	Large epibenthic organisms such as sand shrimp, crayfish, and crabs that reside/feed on sediments at the bottom of the river

Model Pathways	Pathway Description	Model Components (Indicators)	Indicator Description
		Insects	Organisms such as aphids and flies that feed on vegetation in freshwater wetlands, tidal marshes, and swamps
		Suspension/Deposit Feeders	Benthic and epibenthic organisms such as bivalves and some amphipods that feed on or at the interface between sediment and the water column
		Suspension Feeders	Organisms that feed from the water column itself, including zooplankton
		Tidal Marsh Macrodetritus	Dead and decaying remains of tidal marsh and tidal swamp areas that are an important food source for benthic communities
		Resident Microdetritus	Dead and decaying remains of resident phytoplankton and benthic algae, an important food source for zooplankton
		Imported Microdetritus	Dead remains of phytoplankton from upstream that serve as a food source for suspension and deposit feeders
Growth	This pathway highlights the factors involved in producing both the amount of food and access by fish to productive feeding areas.	Habitat Complexity, Connectivity, and Conveyance	Configuration of habitat mosaics that allow for movement of salmonids between those habitats
		Velocity Field	Areas of similar flow velocity within the river
		Bathymetry and Turbidity	River bottom and water clarity conditions that influence the ability of salmonids to locate their prey
		Feeding Habitat Opportunity	Physical characteristics that affect access to locations that are important for fish feeding
		Refugia	Shallow water and other low energy habitat areas used for resting and cover
		Habitat-Specific Food Availability	Ability of complex habitats to provide feeding opportunities when fish are present
Survival	This pathway is a summary of key factors controlling or affecting growth and migration.	Contaminants	Compounds that are environmentally persistent and bioaccumulative in fish and invertebrates
		Disease	Pathogens (viruses, bacteria, and parasites) that pose survival risks for salmon
		Suspended Solids	Sand, silt, clay, and organics transported within the water column
		Stranding	Trapping of young salmonids in areas with no connectivity to water column habitat
		Temperature and Salinity Extremes	Temperature or salinity conditions that are problematic to salmonid survival
		Turbidity	Water clarity as it pertains to potential for juvenile salmonids to be seen by predators
		Predation	Potential for piscivorous mammals, birds, and fish to prey on salmonids
		Entrainment	Trapping of fish or invertebrates into hopper or pipeline dredges

Figure S6-1. Conceptual Model for Juvenile Salmonids in the Lower Columbia River



Much of the conceptual model also is relevant for understanding potential impacts to non-listed species and their habitat. For example, the links between the physical/chemical indicators and many biological indicators provide information regarding basic ecosystem functions that are relevant to listed and non-listed species alike. As Table S6-1 indicates, the model provides basic information regarding:

- Habitat-forming Processes (suspended sediment, bedload, woody debris, turbidity, salinity, accretion/erosion, bathymetry).
- Habitat Types (tidal marsh and swamp, shallow water and flats, water column).
- Habitat Primary Productivity (light, nutrients, imported and resident phytoplankton production, benthic algae production, tidal marsh and swamp production).
- Food Web (deposit feeders, mobile macroinvertebrates, insects, suspension/deposit feeders, tidal marsh macrodetritus, resident microdetritus).

For example, if someone was interested in understanding the project's effects on tidal marsh and swamp, they could use the portion of the model that addresses habitat types. Similarly, a question regarding deposit feeders, mobile macroinvertebrates or insects could be answered by reviewing the model's discussion of those indicators. Because the model was developed to review impacts to salmon, there may be some components of the ecosystem that the model does not address; however, the model provides the best available information regarding the lower Columbia River ecosystem.

The new information provided in this chapter of the Final SEIS reflects application of the conceptual model to the project and its anticipated effects on the physical and biological environment. Also included is new information on the anticipated effects of new aspects of the project (e.g., new ecosystem restoration projects), and on the effects of the overall project on other environmental resources (e.g., crab, smelt, sturgeon and other fisheries).

6.1.1.2.^{new} Other Sources of New Information Since the Final IFR/EIS

Exhibits J through K-9 were developed to respond to comments received from the resource agencies in Washington and Oregon in 2000. The general methodology and approach was developed with valuable input from these agencies. Coordination continued after issuance of the Draft SEIS, and the Final SEIS addresses additional agency comments. Table S6-2 lists each evaluation report by subject and gives a short description of its content. Specific findings of the reports are discussed in the relevant sections in the remainder of this chapter.

Table S6-2. List of Evaluation Reports

Subject	Description
Sturgeon (Exhibit K-1)	The Corps funded an ODFW/WDFW study to determine sturgeon abundance and distribution in deeper areas of the channel, and their behavior/feeding habits in these areas by using acoustic telemetry (Romano and Rien 2001; Marine Taxonomic Services 2002). The Corps funded USGS to do acoustic tagging to determine sturgeon behavior in deep-water areas, and during dredging/disposal. The report included is the progress report for 2002 work. The final report will be available after 2003 work.
Smelt (Exhibit K-2)	The Corps funded a ODFW and WDFW study to determine: • Presence or absence of smelt spawning areas in the navigation channel to assess the importance of channel spawning areas to the overall production of smelt. • Distribution and abundance of larval migrants within & adjacent to the navigation channel to assess entrainment potential during dredging. • If measures were necessary to minimize the potential effects of dredging to the overall smelt population (Howell et al. 2001; Ward and Rien, 2001).
Fish Stranding (Exhibit K-3)	The Corps contracted with S.P. Cramer & Associates, Inc. for a pilot study on juvenile salmon stranding at three locations in the lower Columbia River.
Dungeness Crab (Exhibit K-4)	The Corps funded Pacific Northwest National Laboratory to conduct additional studies about impacts of dredging to crabs. New information from this work includes: • Statistical analysis to develop a rigorous sampling design for determining entrainment rates in the Columbia River. • Measurement of crab entrainment during dredging. • Conduct an assessment of entrainment impacts to crab population levels and the crab fishery (Pearson et al. 2003). • Develop a crab distribution/salinity model to use in avoiding and minimizing the effects of dredging through scheduling (Pearson et al. 2003).
Sediment Transport (Exhibit J)	The Corps developed a comprehensive evaluation report, <i>Channel Deepening Sediment Impacts Analysis</i> (Exhibit J), to address concerns expressed by Oregon and Washington agencies on physical processes in the lower Columbia River. Three distinct areas were analyzed: the river to the estuary, the estuary to the river's mouth, and the littoral zone off the coasts of Oregon and Washington.
State Royalties (Exhibit K-6)	A notification process for sand placement to both the WDNR and Oregon Division of State Lands is described.
Wetlands/Mitigation	Habitat Evaluation Procedures (HEP).
Floodplains (Exhibit K-7)	Detailed floodplain information is provided for all of the least cost and proposed disposal sites.
Washington Critical Area Ordinances (Exhibit K-8)	Compliance with the Critical Areas Ordinance of the local jurisdictions in which activities take place (RCW 36.70B) and details for local jurisdictions within Washington for wetland impacts and mitigation.
Washington Shoreline Master Plan (Exhibit K-9)	Compliance with the Shoreline Master Plan Program of the local jurisdictions in which activities take place

6.2. ^{revised} Physical Impacts

This subsection is being updated for the Final SEIS and addresses new information on project effects from the analysis conducted during the ESA consultation, updated hydrographic survey data, disposal plan modifications resulting from the ESA consultation process, and ecosystem restoration modifications and additions. This section also includes updated and new information pertinent to Chapter 5, *Affected Environment*.

6.2.1. No Action Alternative

No updating of the existing information in this subsection was necessary for the Final SEIS (see the Final IFR/EIS, August 1999).

6.2.2. ^{revised} 43-foot Channel Deepening Alternative

This subsection has been updated for the Final SEIS. The construction dredging volume has been reduced from 18.4 mcy to 14.5 mcy for the 43-foot channel improvement project (approximately 20% reduction). The rock removal volume was reduced from 590,000 to 490,500 cubic yards (approximately 15% reduction). Of this amount, blasting is needed to remove about 50,500 cubic yards of rock at Warrior Rock near St. Helens, and about 440,000 cubic yards of loose rock will be removed by mechanical dredge at Longview, Vancouver Bar, and Vancouver turning basin. The maintenance dredging volumes presented in the 1999 Final IFR/EIS have not changed.

6.2.2.1. ^{revised} Riverbed and Sedimentation

For the Final SEIS, updated information developed by the Corps has been added to this subsection. The Corps also prepared a sedimentation impact assessment, *Columbia River Sediment Impacts Analysis* (Exhibit J) to evaluate the potential changes in sedimentation that may occur with the 43-foot navigation channel project. The conclusions from this assessment are provided below. More information is found in Exhibit J and Exhibit H, *ESA Consultation*, available on the Corps' website.

The historical sediment budgets for the lower Columbia River, estuary, and littoral cell were examined to identify system responses to past natural and human activities. The main focus was on changes to the lower river's sand transport, estuarine sand accretion, and the movement of sand between the estuary and the MCR. It is concluded that there have been decreases in the rates of all three of those processes due to changes in the river flows and the changes in entrance conditions that followed the construction of the MCR jetties. The analysis in Exhibit J concludes that deepening of the Columbia River navigation channel upstream of CRM 3 should not have a significant impact on those processes.

Construction and 20 years of maintenance of the proposed 43-foot navigation channel will likely remove around 70 mcy of sand from the Columbia River and place it upland. Another 40 mcy of dredged sand would be disposed of back in-water, mostly in the estuary. This will cause increased riverbed depths and slight changes in river hydraulics between CRM 3-106.

Deepening will not reduce the available sand supply and the expected hydraulic changes are too small to measurably alter sand transport or erosion/accretion in the river or estuary. There will be no measurable change in hydraulic conditions or sedimentation processes at the MCR. There will continue to be the transport of sand both landward and seaward at the MCR. Although large freshets will continue to have the potential to discharge larger volumes of sand from the estuary to the MCR, flow regulation has made such freshets less likely to occur. The proposed deepening is not expected to impact the littoral sand budgets north or south of the MCR.

Over the last 120 years, navigation channel development has noticeably altered the Columbia River's channel configuration in the river, estuary and the MCR. However, past dredging and channel modifications have not measurably altered sand supply or sand transport in the river or estuary. Excluding the effects of the MCR jetties, past navigation channel development also has not altered the estuary's overall erosion/accretion and bedload transport patterns. The reductions in the Columbia River's net sand discharge to the MCR since the early 1900s are related to lower Columbia River discharges caused by natural climate variations and upstream flow regulation. The potential channel modifications in the Columbia River and estuary from the proposed 43-foot navigation channel are similar to, but much smaller than, those caused by navigation development over the past 100 years. The sedimentation impacts from the proposed 43-foot navigation channel are thus expected to likewise be indiscernibly small.

In addition, the following sections summarize the updated information developed during the ESA consultation process concerning suspended sediment and bedload (more information is contained in Exhibit H, *ESA Consultation*, available on the Corps' website).

Suspended Sediment

The project is not expected to cause changes to sediment (sand) supply or river hydraulics that would alter the rates of suspended sediment transport. The Columbia River bed consists of alluvial sand deposits that vary in thickness from 400 feet in the estuary to 100 feet at Vancouver (Gates 1994). The dredging would remove 3 feet or less of that riverbed material from approximately 56% of the 600-foot-wide navigation channel. The hydraulic effects of dredging 3 feet deeper are very small. Given the consistency in suspended sediment measured at different times and locations, the small hydraulic changes would not likely affect suspended sediment transport rates. Therefore, the volume and rate of suspended sediment transport in the Columbia River will not be changed by the project.

Some temporary increases to suspended sediment concentrations are expected to occur during construction and maintenance dredging activities, as the result of both dredging and the disposal of dredged materials. These dredging and disposal activities will occur in both estuarine and riverine environments. Disposal also will occur in the open ocean, beyond the river mouth. No anticipated actions would cause effects to suspended sediment in the area above Vancouver.

Settling of suspended sediment caused by dredging, disposal, and ship wakes is expected to be rapid. Based on the data indicating that less than 1% of the dredged material is fine enough to remain in suspension following disposal, the Corps estimates that disposal of construction-related dredging will contribute up to 180,000 cubic yards of suspended sediments over the 2-year construction period. Background suspended sediment loads for the same 2-year period have been estimated at 4 mcy. This is a maximum increase of 4.5% in the suspended sediment load and generally equates to less than a 1 milligram per liter (mg/L) increase in suspended sediment concentrations.

In riverine areas where neither dredging nor disposal is occurring, there should be no observable increase in suspended sediment concentration. In areas where dredging and disposal activities occur, there may be noticeable, short-term increases in suspended sediment near hopper dredges and in-water and beach nourishment operations. Dredging operations are likely to cause temporary suspended sediment increases downstream from 0-2 mg/L, depending on the number and type of dredges operating. Flowlane disposal and beach nourishment also are likely to result in temporary suspended sediment increases in the immediate vicinity of these activities (0-20 mg/L for flowlane disposal and 10-30 mg/L for beach nourishment). Those suspended sediment concentrations will diminish to near background levels as the plume moves away from the disposal sites. The Corps' intention is for the channel improvement project to not utilize ocean disposal. If the restoration features in the estuary are not fully implemented, then the alternative would be to dispose of material into the ocean as described in the 1999 Final IFR/EIS. If disposal of sediments occurs at open-water ocean sites beyond the river mouth, it could release discrete sediment plumes of fine suspended sediment that would slowly disperse.

Ship wakes breaking on shore can erode sediment and then suspend the eroded material. Larger waves contain more energy and have greater capability to mobilize sediment. Accordingly, during the ESA consultation process, there was an analysis of whether the proposed activities would lead to more frequent or larger ship wakes. The analysis indicates that little, if any, change is expected (Hermans, SEI Presentation 2001). Hermans analyzed several mechanisms by which ships generate waves. The analysis found that for deep-draft vessels the most important wave mechanism in the Columbia River would be the primary or "suction" wave generation. This mechanism depends on the "blockage" ratio, which is the ratio of the cross-sectional area of the ship to that of the channel. Given the proposed increase in channel depth and the expected increase in vessel draft, the ratio changes very little. The blockage ratio of a 43-foot draft vessel in a 43-foot channel is only 1% to 5% higher than that of a 40-foot draft vessel in a 40-foot channel. However, for the much more numerous smaller ships that would not increase their draft, there would be a slight decrease (in the range of 1% to 5%) in the blockage ratio with the deeper channel. Therefore, while 43-foot draft ships may generate slightly larger wakes than occur now, this would be offset by most ships producing slightly smaller wakes. As a result, the overall changes in wave size caused by the deeper channel are expected to be negligible.

In addition to the deeper channel not causing increased wave sizes, the project also is not expected to cause more frequent waves. While the project would increase the efficiency of

river commerce, it is not anticipated to increase the volume of river traffic. The 1999 Final IFR/EIS found that, “channel deepening in itself will not induce additional ship traffic” or “contribute to development of additional ports or port facilities.” This is consistent with historical vessel traffic trends on the Columbia River, as well as the market forces that drive port facility development. Historical data for the existing 40-foot channel shows that the total tonnage carried by ocean-going vessels calling at the lower Columbia River ports has more than tripled since Congress authorized the deepening from 35-40 feet in 1962, while the number of vessel transits has actually decreased slightly. The same trend is expected if the channel is deepened to 43 feet. Regional and national commodity forecasts project cargo volumes transiting the lower Columbia River will double or triple over the next 20 years, but a deeper channel will likely reduce or moderate the volume of vessel traffic relative to a no channel deepening alternative. Therefore, there is no expectation of more frequent ship wakes occurring as a result of the project.

Bedload

Sand from upstream areas is one of the sources of material for habitat-forming processes (accretion) in the estuary. This sand is important to the formation of tidal marsh and swamps and shallow water and flats habitat. An issue arose during the ESA consultation process in 2001 concerning the potential to reduce the quantity of bedload moving downstream to the estuary. This was based on the concern that removing sand from the upstream channel would cause a concomitant reduction in the amount of sand (habitat-forming material) that would reach the estuary. The amount of sand that reaches the estuary is based on the river’s sediment transport potential and the available sediment supply. Sediment transport potential is a function of hydraulic parameters such as depth, velocity, slope, and discharge. The available sediment supply comes from upstream discharges, the riverbed and banks, and tributary inflows. Climate, dams, and flow controls have significantly changed flow and sediment transport.

The project will not affect transport potential because the amount of material to be removed from the system is not the limiting factor for bedload movement; flow available to move the material is the limiting factor, and the project will not affect flow. The project will not significantly reduce the sand supply. The project will result in some side-slope adjustment as a result of altered bedload transport direction within the action area. This process will not affect water column or tidal marsh and swamp habitats. The side-slope adjustment process will take 5-10 years, and over that time shallow water and flats habitat at six historic shoreline disposal sites will tend to migrate laterally. All of these shoreline sites have been used for disposal in the past due to their proximity to the dredging action. Two of the six shoreline disposal sites, at CRM 86.2 and CRM 23.5, will be used throughout the project life. The other four shoreline disposal sites are not used for project purposes.

Because the bedload transport rate during side-slope adjustment is the same rate at which normal bedload transport would occur without the project (just in a different direction), the quantity and quality of shallow water and flats habitat is expected to remain constant. The

Corps is proposing to verify these conclusions through a monitoring survey of habitat conditions before, during, and after completion of the project (see Section 6.7).

6.2.2.2. ^{revised} Water Surface Elevations

For the Final SEIS, updated information developed on bathymetry has been added to this subsection. Bathymetric changes (as related to bottom elevation contours and water surface) will result from the project. First, dredging will immediately lower the riverbed at the dredge site and lead to long-term changes to the adjacent side slopes. Second, in-water and shoreline disposal will raise bed elevations at the disposal site. The disposal material will then be incorporated into the riverbed, forming sand waves and gradually moving downstream, mainly as bedload transport. Third, the deeper channel will cause a slight effect on water surface elevations, which could result in a change in water depth.

Riverine Reach. Bathymetric changes will include up to 3 feet of deepening in areas of the navigation channel that are currently shallower than -48 feet CRD and some rise in the riverbed at shoreline and flowlane disposal sites. The exact amount of riverbed lowering and the final dredging locations will depend on river bathymetry just prior to construction. There will be no changes in bathymetry in the approximately 40% of the navigation channel in this reach that will not require dredging. In addition, there is a potential for up to 3 feet of deepening along the side slopes adjacent to the dredge cuts.

Shoreline disposal at Sand Island (O-86.2) will periodically alter the bathymetry of the site. Disposal will raise the riverbed of shallow water areas along the beach. Some areas could change from shallow water to beaches. The disposal will erode away in 3-4 years and then the areas will be filled again by disposal.

Flowlane disposal will raise the riverbed intermittently along the channel throughout the life of the project. Flowlane disposal will generally be in portions of the river in or near the navigation channel that are between elevations -50 and -65 feet CRD although some disposal will occur in limited areas as shallow as -35 feet or deeper than -65 feet CRD. The sand will be spread out during disposal by keeping hopper dredges moving as they dump and by frequently moving the discharge pipe from a pipeline dredge. The disposal material will then be incorporated into the riverbed, forming sand waves and gradually moving downstream, mainly as bedload transport. Flowlane disposal is expected to be about 0.5 mcY during construction and 0.5 to 1.0 mcY per year over the first 20 years of maintenance.

There are no predicted changes in water surface elevations downstream of CRM 80 as a result of the project. Modeling predicts water surface reductions would begin near CRM 80 and become progressively larger in the upstream direction. The decreases would be in the range of 0.12-0.18 feet (approximately 2 inches) at CRM 106 (1999 Final IFR/EIS). These reductions would be caused by removal of sediments in the riverine reach of the navigation channel. This change is not expected to have a discernible impact in this area.

Estuary. Bathymetric changes will include up to 3 feet of deepening in areas of the navigation channel that are currently shallower than -48 feet CRD and some rise in the

riverbed at shoreline and flowlane disposal sites. The exact amount of riverbed lowering and the final dredging locations will depend on river bathymetry just prior to construction. There will be no changes in bathymetry in the approximately 55% of the navigation channel in this reach that will not require dredging. In addition, there is a potential for 0-3 feet of deepening along the side-slopes adjacent to the dredge cuts.

Shoreline disposal at Skamokawa (W-33.4) and Miller Sands (O-23.5) will cause bathymetric changes similar to those described for Sand Island. Disposal is expected to occur periodically at Skamokawa and annually on at least part of Miller Sands. The bathymetric changes caused by flowlane disposal in the estuary will be similar to those described for the riverine reach.

Two models were applied to the system to assess the impact of the channel deepening on surface water elevation: the Corps of Engineers, Waterways Experiment Station (WES) applied the RMA-10 model and the Oregon Health Sciences University/Oregon Graduate Institute (OHSU/OGI) applied the ELCIRC (Eulerian-Lagrangian CIRCulation) model as part of their CORIE system. The WES RMA-10 model indicates that the impact of channel deepening on surface water elevation is minimal. Differences between the baseline and with-project condition are estimated to be between -0.02 to 0.02 foot for all locations between the mouth and the upper estuary (Puget Island). Modeling conducted by OHSU/OGI supports the results of the WES model.

River Mouth. No changes to bathymetry in the Deep Water Site (Figures S1-1 and S4-1) as the result of disposal of sediment from the channel improvement project are expected for the first 20 years after construction, as described in the proposed action. Should ocean disposal become necessary for the proposed project, it will create mounding in the Deep Water site that is expected to be permanent. No changes to water surface elevation are anticipated in this reach.

The Corps is proposing to verify all of these conclusions through a monitoring survey of habitat conditions before, during, and after completion of the project (see Section 6.7).

6.2.2.3. ^{revised} Salinity

For the Final SEIS, updated information on salinity has been added to this subsection. Salinity is an important indicator in assessing the successful adaptation and outmigration of juvenile salmonids in the lower Columbia River. The concentration of salinity in important habitat and rearing areas of the system and the longitudinal gradient of salinity between the freshwater and ocean environments that bound the estuary portion of the system are particularly important. The location of the ETM, which is an important location of nutrients in the system, is driven by tidal forcing processes that influence salinity intrusion. Salinity also is an important indicator for non-listed species. For these reasons, it is important to determine the extent to which channel deepening actions might change the salinity profile in the action area.

The estuary is the location where saltwater and freshwater are mixed. In the Columbia, as in most river-dominated estuaries, tidal processes and river flow results in a zone of increased turbidity, the ETM. The turbidity in the ETM is the combination of both the concentration of suspended organic matter and the resuspension of organic and inorganic matter from the bottom. The length of the ETM is typically 0.6-3.0 miles. The position of the ETM ranges between CRM 9-18 from Youngs Bay to Tongue Point (Simenstad 1994).

Two models, the WES RMA-10 and the OHSU/OGI model, were applied to the system to assess the impact of channel deepening actions on salinity in the system. Based on modeling results, the channel deepening actions will have little to no impact on salinity intrusion. The Corps is proposing to verify this conclusion through a monitoring survey of habitat conditions before, during and after completion of the project (see Section 6.7).

Riverine Reach. Salinity intrusion does not extend upstream to CRM 40, which is the division between the riverine reach and the estuarine reach. Consequently, salinity is not a parameter that applies in the riverine reach.

Estuary. Based on modeling results presented in the 2001 BA, the channel deepening actions will have little to no impact on salinity intrusion:

- Based on the salinity modeling in the 2001 BA, salinity increases of less than 0.5 ppt would occur in the shallow embayments of the estuary (e.g., Cathlamet Bay, Grays Bay). Salinity increases up to 5 ppt would occur in areas not used by juvenile salmonids (bottom of the navigation channel).
- No measurable difference in habitat opportunity is anticipated.

The computed differences between baseline and with-project conditions for salinity in shallow areas are much smaller than natural temporal variations due to normal variations in freshwater flow and tidal dynamics. Also, the potential upstream shift of the ETM of less than a mile will have an insignificant effect on the distribution of nutrients in the estuary. The new modeling results support the conclusion in the 1999 Final IFR/EIS that no significant biological impact to ESA-listed or non-listed species would result from salinity changes predicted for the proposed channel deepening.

River Mouth. Salinity changes caused by the channel deepening actions in this reach are predicted by both models to be near zero.

6.2.2.4.^{new} Accretion/Erosion

For the Final SEIS, this new subsection on accretion and erosion has been added to provide new information (see Exhibit J, *Columbia River Sediment Impacts Analysis*). Some anticipated changes in accretion/erosion due to the project include shoal formation (accretion) and shoreline erosion. Following deepening of the channel, accretion will occur in the navigation channel for some time as the riverbed adjusts (stabilizes) to the new depth via side-slope adjustment. Gradual bank erosion in sandy beach nourishment sites may also

occur for some time, in response to the side-slope adjustment. These effects are addressed in the *Bedload* and *Water Surface Elevation* discussions (Sections 6.2.2.1 and 6.2.2.2).

Riverine Reach. Riverbed side-slope adjustments and some shoreline erosion will alter the accretion and erosion patterns within this reach. Side-slope adjustments that would affect shallow water and flats habitat might occur in the riverine reach at five locations—CRMs 99, 86, 75, 72, and 46 through 42. These are all past shoreline disposal sites and only the CRM 86.2 site is proposed for use in this reach due to the proximity of the dredging needed in this section of the river. These sites do not include tidal marsh and swamp habitat. Side-slope adjustment could cause 10-50 feet of lateral shoreline erosion of sandy beaches in each of those areas; however, this is not expected to reduce shallow water habitat. The alteration of the accretion and erosion patterns will not affect suspended sediment or bedload transport rates. The slight increase in suspended fine sediments during dredging and disposal operations will not increase accretion in the riverine reach because the river will transport those sediments to the estuary.

Estuary. The changes in river hydraulics are very small and are not likely to change accretion or erosion in the estuary. Accretion in the estuary is influenced by the amount and type of sediment being delivered from upstream. This is reflected in the estimated reduction in the amount of flow and estuary accretion of sediments from 2-5 millimeters (mm) per year before flow regulation to about 1 mm per year after flow regulation. The project will cause small increases in fine-grained suspended sediment delivered to the estuary during dredging and disposal operations. Based on the resuspension of less than 200,000 cubic yards (fine material makes up less than 1% of the total volume to be dredged), a fine material deposition rate of 30% (Hubbell and Glenn 1973), and a uniform distribution of deposition throughout the 95,500 acres of open water in the estuary, there would be an average of about 0.1 mm per year of additional accretion during construction. The natural background deposition during that 2-year period would be around 2 mm per year.

Over the long term, the project will have little effect on accretion in the estuary. There will be slightly more suspended fine sediment as a result of maintenance dredging and disposal. Over 20 years, this could result in less than 0.1 mm of estuary deposition above what would be caused by maintaining the existing channel. Although an upstream shift in the ETM may cause a minor change in accretion patterns, the long-term effects are not expected to be detectable.

Sandy sediment within the channel is one potential source of material for habitat-forming accretion in the estuary. During the consultation process, discussion and analysis focused on the potential long-term effects on accretion of removing sand from the upstream channel. The concern was that removing sediment would reduce the source of the estuary's sediment supply. However, the removal of sand from the river will not alter sediment transport to the estuary (Exhibit J). The volume to be dredged over the life of the project is only a tiny fraction of the total volume of sand in the riverbed. In addition, transport potential, rather than sand supply, is the limiting factor in sediment supply to the estuary. Also, sediment

inflow to the dredging area upstream of Vancouver is essentially the same as the sediment transport at CRM 54, indicating the main material source is upstream of the project.

The above changes in accretion are all the result of very slight project-related changes in suspended sediment concentrations. The effects are dispersed throughout the estuary by the distribution of flows. The naturally occurring local accretion and/or erosion rates are influenced by site-specific hydraulics and can be much greater than regional rates caused by the deposition of suspended sediment. As an example, Eriksen (SEI Presentation 2001) found the north channel between CRM 5-7 had in-filled up to 20 feet from 1982 to 2000. Natural accretion and erosion will continue on this scale in the estuary and will likely dwarf any project-related changes.

River Mouth. No changes to accretion/erosion are expected in this reach (see Exhibit J).

6.2.3. ^{revised} Proposed Disposal Alternative

As previously discussed in 4.4.3.10, *Disposal Plan Modifications Following Consultation*, two options have been identified for disposal of dredged material originating from CRM 3-29 for the channel improvement project. The first option is similar to Table 4-18, *Proposed Disposal Plan*, in the 1999 Final IFR/EIS.

Under the second option (also described in 4.4.3.10), the Corps would dispose of the material using a combination of ecosystem restoration, flowlane disposal and existing upland and shoreline sites. The Lois Island embayment and Miller-Pillar habitat restoration features are described in Section 4.8.6 and in the BA and Biological Opinions. The description of these features in Section 4.8.6 represents the modified approach to these restoration features from discussions with ODFW and Oregon Department of Land Conservation and Development, and subsequently coordinated with NOAA Fisheries and USFWS. As part of the ESA consultation process, the three federal agencies (NOAA Fisheries, USFWS and Corps) identified these two restoration features as being beneficial to listed salmonid stocks. Should either of these restoration features be substantially modified or discontinued through the public review process for this NEPA document, the Corps' intent would be to use the Deep Water Site for ocean disposal of the balance of the dredged material. Actual disposal would require coordination and concurrence by USEPA.

6.2.3.1. ^{revised} Upland Disposal

For the Final SEIS, this subsection has been updated. There was a reduction in the acreage of upland sites impacted by disposal actions during the consultation process (see Exhibit K-5, *Wildlife and Wetland Mitigation*; also Table S4-1). The proposed plan would impact about 1,630 acres of uplands versus 1,681 acres identified in the 1999 Final IFR/EIS. The principal acreage reduction occurred at disposal site O-63.5 where the site was reduced by 20 acres to a total of approximately 25 acres. About 17 acres of riparian forest were protected from loss at O-63.5 and agricultural land impacts at Gateway (W-101) were reduced from 69 to 40 acres. The Gateway site acreage has dropped as a result of applying local permitting standards, which resulted in a portion of the site becoming too narrow to

efficiently use as a disposal site. Disposal site O-42.9 was listed at 59 acres in the 1999 Final IFR/EIS but was reduced to 53 acres in the 2001 BA. Finally, wetland impacts of the project have been reduced from 20 to 16 acres (approximately 20% reduction).

6.2.3.2. ^{revised} In-Water Disposal

As stated on page 4-36 of the 1999 Final IFR/EIS, flowlane disposal was estimated at 3 mcy for construction and 24 mcy of maintenance for the first 20 years. The revised disposal plan estimates these quantities to be 2 mcy for construction and 26 mcy for maintenance for the first 20 years.

6.2.3.3. ^{new} Ocean Disposal

For the Final SEIS, updated information on ocean disposal has been added to this subsection. Additional baseline studies are reported in Exhibit N. As discussed in Subsection 4.4.3.10, five additional ecosystem restoration actions were developed for implementation as part of the channel improvement project to benefit the recovery of listed salmonids. Approximately 12 mcy of the dredged material proposed for ocean disposal in the 1999 Final IFR/EIS will be used to construct two of the restoration features (Lois Island embayment and Miller-Pillar). Construction of the Lois Island ecosystem restoration features would take all dredged material from the channel improvement project from CRM 3-29 generated during initial construction. The Miller-Pillar ecosystem restoration feature would beneficially use maintenance material for approximately 15 years. The remaining disposal in the estuary will be similar to the maintenance locations (Rice Island, Miller Sand Spit, Pillar Rock and flowlane) used for the 40-foot channel along with Miller-Pillar.

It is anticipated that other beneficial use opportunities will become available during the maintenance period. The Corps intends to not utilize ocean disposal for the channel improvement project. However, if the restoration features in the estuary are not fully implemented and if future opportunities do not arise, then the alternative would be to dispose of material in the ocean as described in the 1999 Final IFR/EIS. In the event dredged material from the channel did go to the ocean, it would be discharged into a site designated under Section 102 of the Ocean Dumping Act. The USEPA concurs with the Corps' proposed action. Such disposal would be in accordance with the then-current Site Management and Monitoring Plan as required by the Act, and would require coordination with, and concurrence by, the USEPA. At this point in time, USEPA anticipates proposing designation of the Deep Water and Shallow Water Sites under Section 102 of the Act.

Restoration of the Lois Island embayment would require approximately 6 mcy of material. Placement of the material at the Lois Island embayment would be during the 2-year construction period. This material would originate from the navigation channel between CRM 3-29. The Miller-Pillar ecosystem restoration feature would utilize approximately 5.5 mcy of material originating from operation and maintenance dredging of Miller Sands Channel (CRM 21.4 to 25.2) and Pillar Rock Range (CRM 25.2 to 28.8) over a 15-year period. These two ecosystem restoration features would utilize all of the initial construction and most of the operation and maintenance material that otherwise would have been

transported to the ocean for disposal. The balance of the O&M material would be disposed of at traditional disposal locations in the estuary.

6.2.4. ^{new} Ecosystem Restoration Features

For the Final SEIS, this new section on ecosystem restoration has been added to provide new information. Participants at the 2001 Lower Columbia River and Estuary Habitat Conservation and Restoration Workshop established general “Criteria for Identifying and Prioritizing Habitat Protection and Restoration Projects on the Lower Columbia River and Estuary, 2001.” Habitat themes expressed by the workshop participants were: a) habitat connectivity; b) areas of historic habitat loss; c) linkages to reference site(s); d) passive habitat restoration over habitat creation; e) monitoring and evaluation; and an additional theme of community support and participation.

Habitat connectivity emphasizes the linkages between habitat areas that provide a variety of functions for species at various points of their life. Areas of historic habitat loss pertains to the results of land use activities such as diking, filling and shoreline development that have removed many of the shallow, peripheral wetlands and isolated the lower Columbia River from its floodplain. Linkages to reference site(s) represents a means of evaluating restoration sites on the basis of relatively unaltered reference habitats in close proximity that can serve as a “control” for evaluating habitat change. The participants indicated that passive habitat restoration over habitat creation should receive first priority and when possible, returning the site to historic hydrologic conditions, using or mimicking natural processes, should be prioritized over large-scale earth moving and further engineered solutions. Monitoring and evaluation metrics were to be developed that enhance an understanding of the connection between habitat variables and species. Community support and participation reflected the desire to develop partnerships among communities, organizations, individuals and agencies.

Ecosystem restoration features proposed at Lois Island embayment and Miller-Pillar fit some of these themes. The original construction of Lois Island embayment resulted in the excavation and filling of intertidal marsh and shallow subtidal habitat. The ecosystem feature at Lois Island addresses historic habitat loss through restoration of tidal marsh habitat. Similarly, the restoration effort at Miller-Pillar would restore tidal marsh and intertidal flats habitat in an erosive area. There is linkage to reference sites at both restoration locations. The tidal marsh and intertidal flats habitats immediately east of Lois Island that have been historically unaltered provide an excellent reference site as does the tidal marsh and intertidal flats habitat that abuts Miller-Pillar. Neither Lois Island embayment nor Miller-Pillar represents a passive restoration action, although the intent is to mimic historical tidal marsh and intertidal flats elevations of adjacent habitats. Few readily implementable (defined as public and/or private lands available for restoration use) large-scale restoration projects have been identified in the lower Columbia River estuary.

At these restoration locations, there is a reduction in fishing area due to physical changes to the water depths. There would be a 19% reduction in the select area fishery at Tongue Point and a 14% reduction in fishing area for the commercial gill net drift at Miller-Pillar. See Subsection 6.8.1.

Monitoring and evaluation metrics have been identified for implementation for these ecosystem restoration features based upon criteria presented in the 2001 BA and 2002 Biological Opinions. These large-scale restoration features contribute to the recovery of the ESA-listed species and are a beneficial use of dredged material. They will restore tidal marsh habitat, which is one of the habitat types in the Columbia River estuary that has incurred the greatest historical loss in acreage. They further reduce the impacts at the Deep Water Site from use by the inner channel material. For these reasons, these options are being proposed.

6.3. ^{revised} Water Quality Impacts

For the Final SEIS, updated information on water quality has been added to this subsection. Navigation channel dredging, in-water and ocean disposal and ecosystem restoration would not result in significant water quality impacts. Dredging of fine-grained organic rich sediments could result in limited short-term elevations of chemicals and possible decrease in dissolved oxygen in the immediate area of the dredging and disposal sites. However, Columbia River navigation channel sediments are predominately medium to coarse grain sand with less than 1% silt or clay and thus differ significantly from the discussion in this paragraph regarding fine-grained, organic rich sediments. Short-term turbidity increases (cloudiness of the water caused by suspended particles) would also be expected from in-water disposal actions. Turbidity measurements were conducted at a beach nourishment site and at an in-water (flowlane) disposal site in the Columbia River. Additional monitoring was conducted at Morgan's Bar during placement of material dredged from the Willamette River. Most material was found to settle rapidly to the bottom with minimum suspension of sediment. This also was true for the fine-grained material from the Willamette River placed at Morgan's Bar.

Background turbidity levels upstream of the disposal site prior to disposal were measured at 3.55, 3.28 and 3.10 NTUs (nephelometric turbidity unit, a unit of measure for turbidity levels in water). Many readings were subsequently measured below this level during disposal site turbidity monitoring. A minimum turbidity reading of 1.82 NTU was recorded while a maximum of 14.38 NTU was recorded. A reading of 12.38 NTU was recorded from water noted to be discolored washing around the front of the open scow while the disposal scow turned to return after disposal. The scow had not yet closed the hopper. This was the only station where water was visibly discolored on the surface. The area affected was minimal and the effect transitory. No other significant discoloration was noted on the surface during or after discharge of the dredged material.

Turbidity induced by dredging and dredged material discharge in the Columbia River appears to be limited and transitory in nature. This is attributable to the coarseness of the dredged material and the lack of fines present. Compared to natural fluctuations in suspended sediment levels, dredging-induced turbidity would be a minor constituent to the Columbia River system.

Although the Columbia River is water quality limited for temperature, bacteria, dissolved oxygen, total dissolved gas, toxics, arsenic, and pH, the proposed project is not expected to cause or contribute to exceeding criteria for temperature, bacteria, pH, or total dissolved gas. Dredging has the potential to cause short-term localized decreases in dissolved oxygen in confined areas of fine-grained organic rich sediments. The potential for such impacts from the proposed project is negligible due to the location and nature of the material to be dredged. Specifically, dredging will predominantly occur in the open channel where the sediments are low in organic material. Water quality effects for the channel improvement project would be similar to what is encountered during maintenance of the current 40-foot channel. It is not anticipated that construction or maintenance of the project would contribute to dissolved oxygen concentration reductions that exceed the applicable water quality criterion. Dredging and disposal activities should not exceed criteria for toxics, and arsenic because sediment screening and testing in the navigation channel indicates that chemicals are well below threshold limits in the sediment. Sediments from the Columbia River channel were found to be suitable for unconfined, open-water and ocean disposal. See Appendix B to the Biological Assessment, and the Corps' April 22, 2002 Amendment Letter to the Biological Assessment (see Exhibit H on the Corps' website).

As discussed in the 1999 Final IFR/EIS, ocean disposal impacts would not be expected to have any impact on water quality outside the immediate area of discharge. Construction of the ecosystem restoration features could be considered a minor reduction of water quality perturbations to the ocean.

The surfactant R-11[®] is initially proposed for use with Rodeo[®] herbicide, consistent with the label, to improve efficacy of herbicide uptake by purple loosestrife. The USFWS currently uses R-11[®] in conjunction with their Rodeo[®] application to spartina in the Willapa Bay National Wildlife Refuge. Prior to implementation of this ecosystem restoration feature, the Corps will coordinate further with the AMT to ensure that an appropriate surfactant and application protocol is followed. The Corps, in compliance with Term and Condition 5e of the 2002 NOAA Fisheries Biological Opinion, "...shall coordinate with NMFS on the development and implementation of the Purple Loosestrife Integrated Pest Management Plan, including prior NMFS review and approval for all over-water use of Rodeo[®]." This use will be consistent with the state of Washington's general NPDES permit.

A revised Section 404(b)(1) Evaluation prepared for this Final SEIS is included in Exhibit E.

6.4. Sediment Quality Impacts

6.4.1. ^{revised} Navigation Channel

For the Final SEIS, the following updated information has been added to this subsection. As discussed in Chapter 1, *Willamette River Construction*, dredging in the Willamette River has been deferred at this time and is not part of the project covered by this Final SEIS.

Additional analysis of available sediment quality data relating to Columbia River dredging was conducted as part of the SEI and reconsultation process, and is presented in Appendix B

of the BA (Exhibit H on the Corps' website). Additional information was also provided to the NOAA Fisheries and the USFWS on sediment quality in the Corps April 22, 2002 amendment letter to the BA. This information is provided in Exhibit H (Exhibit H on the Corps' website). The NOAA Fisheries and the USFWS concluded that estimated risk of exposure of ESA-listed salmonids and bull trout from contaminated sediments from project activities is limited (see NOAA Fisheries and USFWS Biological Opinions in Exhibit H). Further, they support implementation of the Corps' contaminant monitoring and evaluation activities proposed in the 2001 BA and have included these activities in the mandatory terms and conditions of the Biological Opinions.

6.4.2. Ocean Disposal

No updating of the existing information in this subsection was necessary for the Final SEIS (see the Final IFR/EIS, August 1999).

6.4.3. ^{new} Ecosystem Restoration Features

For the Final SEIS, this new section on ecosystem restoration features has been added to provide new information. For the reasons discussed in Section 6.4.1, implementation of the ecosystem restoration features now associated with the project would not have a significant impact on sediment quality in the river, estuary or ocean. For the Bachelor Slough restoration feature, sediment sampling will be conducted prior to project implementation to ensure material to be dredged meets sediment quality criteria. Any necessary refinements to the Bachelor Slough restoration feature will be made during the preconstruction engineering and design phase of the project.

6.5. Hazardous, Toxic, and Radiological Waste Impacts

6.5.1. No Action Alternative

No updating of the existing information in this subsection was necessary for the Final SEIS (see the Final IFR/EIS, August 1999).

6.5.2. ^{revised} 43-foot Channel Deepening Alternative

For the Final SEIS, the following updated information was added to this subsection. As discussed in Chapter 1, *Willamette River Construction*, the Willamette River deepening has been deferred because parts of the lower Willamette River have been included on the National Priority List under CERCLA. The effects of this remediation will be evaluated in a Remedial Investigation/Feasibility Study prepared for that program.

There has been some infill into the Astoria turning basin since the release of the 1999 Final IFR/EIS. It is estimated that about 90,000 cubic yards of fine-grained material in this turning basin will be sampled and tested in accordance with the *Dredged Material Evaluation Framework* to determine whether the fine-grained material is suitable for in-water disposal.

6.5.3. ^{revised} Least Cost and Proposed (Sponsors') Alternatives

For the Final SEIS, the following updated information was added to this subsection.

6.5.3.1. ^{new} Ecosystem Restoration Features

For the Final SEIS, this new section on ecosystem restoration features has been added to provide new information. The ecosystem restoration features are not located near or anticipated to have any effect on known hazardous, toxic or radiological waste sites. Implementation of the Bachelor Slough restoration feature is contingent on the Corps' evaluation of sediment chemistry to determine suitability for upland disposal and approval by the WDNR and/or USFWS to dispose of dredged material on their property. Backwater channels are more likely to contain fine-grained sediments (silts) with a high organic content and therefore, a greater likelihood of contaminants (e.g., PCBs, DDT, DDE) than coarser-grained sands with low organic content found in the main navigation channel. Sediment sampling to determine contaminant levels is planned prior to initiating dredging of the slough. If sediment samples fail to meet the established thresholds or an upland dredge material disposal site on Bachelor Island is unavailable, this feature would not be constructed.

6.6. Biological Impacts

6.6.1. ^{revised} Aquatic Resources

6.6.1.1. ^{revised} No Action Alternative

Since completion of the 1999 Final IFR/EIS, additional information was obtained for Dungeness crab *Cancer magister* (Exhibit K-4); smelt (eulachon) *Thaleichthys pacificus* (Exhibit K-2); and white sturgeon *Acipenser transmontanus* and green sturgeon *A. medirostris* (Exhibit K-1). Also, additional information on non-indigenous species (ballast water) is provided.

Dungeness Crab

For detailed information, see Exhibit K-4, *Evaluation Report Dungeness Crabs* (revised). A modified Dredge Impact Model (DIM) used the observed summer 2002 dredge entrainment rates for crab (number of crab entrained per cubic yard dredged), to calculate adult equivalent loss to the crab population and loss to the fishery by entrainment for maintenance of the existing channel. Entrained crabs were counted by age class and sex, and this information was used in the DIM to calculate adult equivalent losses and loss to the fishery.

These losses are based on numbers of crabs of various age classes and sex that were entrained and how many of those crabs would have been expected to survive to a given age class based on known natural survival rates or to the legal harvest size for the fishery (Pearson et al. 2003).

Crab adult equivalent loss at age 2+ for the “no action” maintenance increment associated with the 40-foot project ranges from a worst case of 114,640 crabs to a best case of 20,772 crabs. This translates to a loss to the fishery of between 18,057 crabs and 3,905 crabs. Projected adult equivalent loss in “no action” maintenance years 1 and 20 are 44,643 and 25,503 crabs, respectively. Projected loss to the fishery in “no action” maintenance years 1 and 20 are 7,031 and 4,017 crabs, respectively. Year 1 was selected because it was anticipated to have the largest dredging volume. Year 20 was selected because it represents a reasonable planning horizon for dredged material management planning. Additionally, 20 years represents a point in time beyond which dredging volumes will be considered constant. Dredged volumes decrease over this period due to declining volumes expected at Flavel Bar (CRM 11-14).

Some impacts to crabs likely occur due to in-water disposal between CRM 3-18. Impacts below CRM 18 are likely not substantial because the area where disposal occurs is small compared to available habitat. Upriver of CRM 18, in-water disposal is not expected to have any significant impact on crab because of lack of available habitat due to low salinity.

Based on the earlier analysis in the 1999 Final IFR/EIS and the evaluation report in Exhibit K-4, the Corps concludes the No Action Alternative will have minimal impact on crab and their habitat and the fishery. It is anticipated that this impact will not have any significant effect on population structure or dynamics. Other factors, such as ocean climate conditions and natural population cycles, have a far greater effect on the crab population levels.

Smelt (eulachon)

As noted in Section 6.1.1.2, the ODFW and WDFW have conducted additional studies regarding smelt. The studies found that:

- The navigation channel was not observed to be the primary outmigration corridor for smelt larvae.
- Larvae were distributed throughout the water column at all sampling locations. At sampling locations situated within the navigation channel, larvae were generally more abundant at the bottom and middle of the water column than at the surface.

The following assessments of the potential impacts of dredging activities under the No Action Alternative on eulachon were based on the results documented in Exhibit K-2, *Evaluation Report Smelt* (revised).

- Given the large numbers of larvae and their distribution across the river channel and through the water column, and the relatively small area where dredging will occur as a percentage of this total, it is unlikely that dredging would have a significant impact (through entrainment) on the outmigrating larval population.

- Dredging is unlikely to directly impact eulachon spawning areas because the dynamic nature of the bottom within the reaches to be dredged would not provide a stable enough substrate that would allow an adhesive smelt egg to incubate for 30 days.
- Eulachon eggs incubating in near-shore areas in the proximity of dredging activities may be affected if these activities alter flow patterns or increase sedimentation. However, hydraulic models indicate dredging will not significantly alter the river's flow patterns. The average annual bedload transport in the main river channel is expected to remain within the existing range.

Dredging activities associated with the No Action Alternative are not expected to have a significant impact on the eulachon larval population, on eulachon spawning areas, or on eulachon eggs incubating in near-shore areas in the proximity of dredging activities. Larval smelt are not entrained in most cases because they are in the water column and outside the effect of the dredging action. Disposal is generally not a concern because most in-water disposal sites are further downstream than the major smelt spawning areas, which are at CRM 56-61 and CRM 67-69. While the current maintenance has some in-water disposal in these areas, this disposal is unlikely to directly impact eulachon spawning areas because the dynamic nature of substrates within the flowlane disposal sites (which are in or adjacent to the main channel) do not provide stable surfaces that would allow an adhesive egg to incubate for 30 days. The typical timing for the maintenance program is from July through October, which is after the typical spawning season for smelt.

White and Green Sturgeon

Green sturgeon are present in the project area. They are an anadromous member of the sturgeon family and range from Alaska to Mexico primarily in marine waters. They feed in estuaries and bays from San Francisco to British Columbia and spawn in fresh water in the mainstem of large rivers. Spawning currently only occurs in a few rivers—the Sacramento and Klamath Rivers in California and possibly the Rogue River in Oregon. No known spawning occurs in the Columbia River. Green sturgeon occur only in the lower 37 miles of the Columbia River (WaterKeepers 2001). They are demersal and occur from inshore water to deeper holes but commonly move to intertidal areas to feed at high tide. Most occur primarily in the lower estuarine portions of the Columbia though occasionally they may move up into freshwater. Green sturgeon are not fished commercially but are a bycatch in other fisheries along the south Washington coast and the Columbia River estuary. Based on recent catch data, it is believed that the population levels are declining (WaterKeepers 2001). Green sturgeon occupy similar habitat as white sturgeon in the estuary and are thought to behave similarly. Therefore, the conclusions of these studies regarding the behavior and potential impacts on white sturgeon should apply equally to green sturgeon.

Exhibit K-1, *Evaluation Report White and Green Sturgeon* (revised), includes a report conducted by ODFW/WDFW that provides information on the effects of dredging and in-water disposal of dredge materials on white sturgeon in the lower Columbia River. Because green sturgeon occupy similar habitat to white sturgeon, and because they are thought to behave similarly, the conclusions of the studies regarding behavior of and potential effects

on white sturgeon should apply equally to green sturgeon. Although no green sturgeon were caught during the studies, green sturgeon have been observed in the study area.

Exhibit K-1 concludes that sturgeon are present in three potential dredge disposal areas in the lower Columbia River. The response of these fish to disposal activities is not known. The study demonstrated some seasonal variability in catch rates that is strong evidence of variable season use. The short-term response of sturgeon to dredge disposal activities will be clarified by telemetry work underway by the U.S. Geological Survey. This added information will provide a more complete assessment of the effects potential loss of habitat (due to dredge-disposal activities) may have on sturgeon. Table S6-3 addresses the potential impacts being studied by the U.S. Geological Survey along with the recommended responses to the impacts, should they occur.

Table S6-3. Study Results on Potential Sturgeon Impacts and Recommended Responses

Potential Impacts	Responses
Direct Mortality (1) Immediate mortality of significant numbers of fish due to burial. (2) Delayed mortality of significant numbers of fish due to burial. (3) Fish survive disposal action.	(1) Do not dispose in area or modify/schedule disposal practices to minimize impact. (2) Do not dispose in area or modify/schedule disposal practices to minimize impact. (3) No mitigation action.
Disturbance (1) Significant numbers of fish leave area permanently. (2) Significant numbers of fish leave area temporarily. (3) Fish do not leave area.	(1) Do not use additional sites in the future or modify/schedule disposal to minimize impact. (2) Schedule use of site to periods of low abundance. (3) No mitigation action.
Feeding Sturgeon feed in site: (1) Significant, long-term effects. (2) Minor, short-term effects. (3) Sturgeon not feeding in site.	(1) Do not use additional sites in the future. (2) No mitigation action. (3) No mitigation action.
Loss of Habitat (1) Do not use habitat after disposal. (2) Return to area a short time after disposal. (3) Return to area a long time after disposal.	(1) Do not use additional sites in the future or modify/schedule disposal to minimize impact. (2) No mitigation action. (3) No mitigation action.

Pacific and River Lamprey

Both species of lamprey use the lower Columbia River in the project area principally as a migratory corridor. They move upstream from the ocean in the spring to spawn in upper reaches of tributary streams in gravel riffles. They build nests or redds similar to salmon. The eggs hatch in a few weeks and the young (referred to as ammocoetes) burrow into the mud near the banks of the tributary streams where they remain for 1-2 years. After this they change into the adult form and migrate downstream to the ocean where they begin a

parasitic/predacious life that lasts for an unknown period of time. Impacts to the lamprey species from dredging and disposal operations are expected to be minimal since during their upstream and downstream migration, they occur primarily in the water column above where dredging would occur.

Non-indigenous Species

Hundreds of non-native species arrive in waters of the U.S. from foreign seas each day by way of ships' ballast water, hull fouling and fishing activities. Many of these species establish themselves in U.S. waters, and millions of dollars have been spent in attempt to extinguish their invasion through research, control, and management efforts. The invasion of such species can cause reduction in native species numbers and through destruction of habitats and competition with native species for food. The biodiversity and balance of an ecosystem can also be threatened by changes in species interaction and transformations in nutrient rotation and energy flow. As trade patterns change, the number of donor regions increase, and new species become available to be established in non-indigenous regions, making the battle against non-indigenous species difficult to contain. The origin and history of many invasive species remains unknown and researchers can easily overlook the introduction of microscopic species and groups of species that are hard to recognize.

Ballast water is used by shipping vessels for stability and weight throughout a voyage, and to increase their manageability under harsh weather conditions (NRC 1996). Water is pumped into the ballast tanks at the original port where cargo is unloaded and typically discharged at the port-of-call when a vessel receives new cargo. Because ballast water is pumped in along shallow coastal zones, sediment is taken on board with a range of organisms from small viruses to fish living in surrounding waters. With the transfer of ballast water from one coastal zone to another, there is a possibility for the introduction of non-native species entering the port where the ballast water is discharged. Fortunately, it is difficult for many of these organisms to subsist in a new environment due to changes in salinity, food source and temperature, yet those few that do survive have potential to establish populations and cause economic and ecological harm.

Preventing ballast water organisms from establishing themselves begins with the elimination of species released by discharge. Accomplishing this task can be done by not taking on ballast water, killing the organisms during the voyage, or making sure that these organisms are not let go when ballast water is released. However, while limited research has been done to determine the best options of ballast water management, no single method has been proven to remove all unwanted organisms from ballast tanks. Without the presence of natural predators, some of these non-indigenous species have the ability to multiply very quickly, thereby displacing native organisms by preying on them or competing with them for food and space. When a bioinvader disrupts any species that is harvested commercially, or when such non-native species cause damage to structures it causes economic harm. The goal of ballast water management is to minimize the risk of invasion by species that have the potential of causing either economic and/or ecological destruction.

Mid-ocean ballast exchange has been shown to decrease aquatic nuisance species introductions, but also has disadvantages. Since not all ballast water is released during the exchange, removal of 100% of organisms is not guaranteed (Systma and Draheim 2002, personal communication). Exchanging water during rough weather can involve great risks, it cannot be practically applied to U.S. ship traffic, and also is very difficult to enforce. However, marine organisms from coastal zones, estuaries, and rivers are not likely to survive when released into the open ocean; the same is true for ocean organisms when released into coastal or river areas. Beyond the Great Lakes and Hudson River, the U.S. has no mandatory regulations concerning ballast water management. The International Maritime Organization, a United Nations association, recommends all vessels carrying ballast water undergo exchange in the open ocean to minimize risk of releasing non-indigenous organisms to coastal waters. A voluntary reporting system has been a low priority for most ship pilots (Ward 2002).

The Oregon Senate Bill 895 (2001) prohibits discharge of ballast water into waters of the state by vessels that have traveled outside the state waters except when: (1) the vessels have undergone open-sea or coastal exchange, (2) the ballast water originated from the coastal waters between parallel 40 degrees north latitude and the parallel 50 degrees north latitude, or (3) an exchange was not implemented because the vessel operator believed there to be a danger in doing so (ODEQ 2002). In Washington, ballast water management regulations are similar to those in Oregon.

All ballast water management reports must be turned in to the Oregon Department of Environmental Quality or the Merchants Marine 24 hours prior to entry into the state. From January 1 to March 8, 2002, 192 vessels were recorded entering into the waters of Oregon with 100% state compliance. Thirty-nine of those 192 vessels reported their ballast exchange inside the 24-hour window. The total water discharged into Oregon waters during that time was 475,664 metric tons. Of the 192 vessels, 85 were coastal, 10 of which discharged 25,878 metric tons of ballast into Oregon waters (4 discharged illegally). The average distance from shore for coastal discharge was 86.4 miles (Vinograd 2002, personal communication).

A majority of ships that come to port in the Columbia River never travel outside of the coastal zone, traveling north from California or south from the Puget Sound area. It is important to note that these coastal traveling vessels are unable to exchange ballast water, and arrive in the Columbia River as their second or third port-of-call. Therefore, almost 30% of the water currently being discharged into the Columbia River is not exchanged (Smith, personal communication). The short voyages that are taken may permit high survival of ballast water species. While it is difficult to determine the origin of many exotic species that could invade the Columbia River, the Chinese mitten crab, zebra mussel and Eurasian milfoil are known species that have invaded other inland U.S. waters.

The Chinese mitten crab is a native species of the Yellow Sea of Korea and China. Since its discovery in the San Francisco Bay in the early 1990s, this burrowing crab has established itself in the bay and Delta watershed, causing a threat to native invertebrates and various

fisheries. The potential of predation by mitten crabs on salmonid and sturgeon eggs and juveniles is of great concern. Since the mitten crab is a burrowing crab, there is also a concern of increased erosion activity of riverbanks and levees (Systma and Draheim 2002, personal communication). Mitten crabs have clogged pumps, screens and intakes and have caused damage and killed fish at salvage facilities associated with water diversions throughout the San Francisco Bay area (Carlton 2001). While only a handful of mitten crabs have been discovered in the Columbia River (both Chinese and Japanese), these numbers may greatly increase through larval dispersal and intentional release unless some method is found for their control.

Transferred to the U.S. in ballast water and on the hulls of vessels, zebra mussels have caused great environmental and economic harm in the Great Lakes and other inland waters. Zebra mussels attach to intake pipes and large colonies can disturb supplies of drinking, cooling, processing and irrigating water. They can attach to boat hulls, docks, navigation aids, fish ladders and lock structures causing permanent damage (Pennington 2002). Large colonies can alter aquatic ecosystems by filtering out and consuming food meant for native species. This increased filtration encourages unwelcome growth of rooted aquatic vegetation, benthic algae, and insect-like benthic organisms. Due to the large amount of water filtered by zebra mussels and their high body-fat content, they accumulate about 10 times more PCBs and other toxic contaminants than native mussel species. These contaminants can be transferred up the food chain to birds and fish that feed on zebra mussels (Sea Grant Great Lakes Network 2002).

Eurasian milfoil is a freshwater aquatic perennial plant with very fine, feather-like leaves that can adapt to a variety of environments. Watermilfoil negatively impacts aquatic ecosystems by forming dense canopies that completely shade out resident vegetation. Under the mats, temperature and pH levels increase altering water quality. The presence of Eurasian milfoil can interfere with fishing, boating, swimming, and water skiing activities, and dense clumps can clog intake pipes used for irrigation projects and power generation (WDOE 2002). Eurasian milfoil has invaded many of Washington's lakes and rivers and is found in the Columbia River as well. Because of its fast-growth, high reproduction rate, widespread distribution, and difficulty to control, Eurasian milfoil is considered one of the most problematic plants in the northwest region. While Eurasian milfoil appears to be spread from water to water mainly through boating activity, it is also easily picked up in the ballast water of large vessels.

Because of the buoyancy of grain carriers and container ships traveling across the ocean and along the Pacific Coast, the need for ballast is essential to maintain safety and stability. Of the approximately 2,000 commercial deep-draft vessels that travel the Columbia River every year, bulk grain carriers make up almost 25% of the total transits and take on a greater amount of ballast water due to their light weight prior to loading. With increased ballast water regulations in both Washington and Oregon, ballast water exchange is required for those ships entering the Columbia River, unless otherwise specified.

Under the No Action Alternative, there will be no change in vessel practice.

6.6.1.2. ^{revised} 43-foot Channel Deepening Alternative

For the Final SEIS, the following information has been added to this subsection for Dungeness crab, smelt, sturgeon, non-indigenous species, and essential fish habitat (EFH).

Dungeness Crab

For detailed information, see Exhibit K-4, *Evaluation Report Dungeness Crabs* (revised). A modified Dredge Impact Model (DIM) used the observed summer 2002 entrainment rates to project crab entrainment and adult equivalent loss and loss to the fishery. Crab adult equivalent loss at age 2+ for project dredging prism (construction and 40-foot channel maintenance) ranges from a worst case of 281,528 crabs to a best case of 38,811 crabs (of these amounts, the increment associated with channel improvement is 166,888 crabs and 18,039 crabs). This translates to a loss to the fishery of between 44,342 and 7,252 crabs (the increment associated with channel improvement project is 26,285 crabs and 3,347 crabs). This loss to the fishery compares to annual landings of 5.3 million crabs in the Washington and Oregon region around the Columbia River.

Transition with volumes over the first 20 years. Maintenance dredging for the 43-foot channel consists of materials that would have been dredged to maintain the 40-foot channel plus additional materials to maintain the additional depth. Project maintenance dredging quantities for the 43-foot channel are somewhat higher than projected quantities for the 40-foot channel in the early years of the project. However, in later years of the project the quantities become nearly equivalent. Projected adult equivalent loss for maintenance of the 43-foot project (including quantities from the 40-foot as well as additional increment due to the 43-foot project) in years 1 and 20 are 56,840 and 25,612 crabs, respectively (the increment associated with channel improvement project is 12,197 crabs and 109 crabs). Projected loss to the fishery for maintenance of the project in years 1 and 20 are 8,953 and 4,035 crabs, respectively (the increment associated with channel improvement project is 1,922 crabs and 18 crabs). In other words, by maintenance year 20 or sooner, entrainment associated with the channel improvement project is effectively equal to that of the No Action Alternative.

As with the No Action Alternative, some impacts to crabs are likely to occur due to in-water disposal between CRM 3-18. The proposed disposal plan may result in a marginally higher impact due to increased flowlane disposal relative to the no-action alternative. Impacts below CRM 18 are likely not substantial because the area where disposal occurs is still small compared to available habitat. Upriver of CRM 18, in-water disposal is not expected to have any significant impact on crab because of lack of habitat due to low salinity. In addition, the Corps through use of the salinity/crab abundance model will attempt to avoid and minimize impacts from in-water disposal.

Based on the Corps' and USEPA's earlier analysis in the 1999 Final IFR/EIS and the evaluation report in Exhibit K-4, while there is a marginal increase in entrainment and indirect effects (habitat disruption) compared to the No Action Alternative, the Corps

concludes the project still has minimal impact on crab, their habitat, and the fishery, and still does not have any significant effect on population structure or dynamics. As with the No Action Alternative, other factors such as ocean climate conditions and natural population cycles have a far greater affect on the crab population levels than would the project. Further, the Corps will use the salinity/crab distribution model to schedule dredging and disposal to avoid and minimize impacts to crab.

Exhibit N, *Physical and Biological Studies of the Deep Water and Shallow Water Sites*, includes information on additional data collection for the near ocean. The Corps and USEPA conducted physical characterization of the ocean sites including side-scan sonar, geophysical information, sediment profiling, sediment trend analysis, and sediment sampling with chemical evaluation. Also, biological data collection began in summer 2002 to include sediment profiling, benthic sampling, crab pot data collection, and trawling to characterize the biological baseline of the Deep Water Site. Crab pot data collection and trawling occurred at the Shallow Water Site. This data serves as the basis for considering measures to minimize impacts to crabs in the event that the ocean sites are used for this project.

Smelt (eulachon)

In general, the findings and recommendations from the state agency research (see Exhibit K-2, *Evaluation Report Smelt*) were that dredging activities associated with channel deepening are not expected to have a significant impact on migrating eulachon larvae (through entrainment), on eulachon spawning areas, or on eulachon eggs incubating in nearshore areas in the proximity of dredging activities. Disposal is generally not a concern because most in-water disposal sites are downstream of the lowest major smelt spawning areas, which are at CRM 56-61 and CRM 67-69. While the current construction plan has some limited in-water (flowlane) disposal at CRM 51-56 and CRM 59-62, this disposal is unlikely to directly impact eulachon spawning areas because the dynamic nature of substrates within the flowlane disposal sites (which are in or adjacent to the main channel) do not provide stable surfaces that would allow an adhesive egg to incubate for 30 days. Impacts to migrating larval smelt from disposal are a concern to the agencies and though they are unsure of the level of impact, they have indicated in the letter in Exhibit K-2 that disposal not occur during the peak of the larval movement downstream. The peak out migration in 2001 was from April 2-18, but can vary. The period of peak larval outmigration will be determined by the agencies prior to construction, but will likely fall within or near this period. The Corps has agreed to schedule construction dredging and disposal to avoid this period. No additional specific actions (e.g., timing restrictions) are recommended because it is unlikely that dredging associated with channel improvement would have a significant impact on eulachon. As discussed in the No Action Alternative, maintenance dredging occurs outside this window.

White and Green Sturgeon

Impacts to sturgeon from the 43-foot channel would be similar to those discussed under the No Action Alternative, although the volumes during the construction period would be greater (see Subsection 6.6.1.1).

Pacific and River Lamprey

Impacts to the lamprey species from dredging and disposal operations are expected to be minimal since during their upstream and downstream migration, they occur primarily in the water column higher than where dredging would occur. It is unlikely that the change in physical parameters predicted with the project will have an effect on their migration or ocean entry.

Non-indigenous Species

While the channel improvement project would provide greater navigation reliability and efficiency with existing vessels, it is not anticipated to increase the volume of river traffic. Therefore, the project would have no effect on the amounts of ballast water brought into the Columbia River.

Essential Fish Habitat

Exhibit I, *Essential Fish Habitat Assessment*, evaluates impacts to ground fish and coastal pelagic habitat. The NOAA Fisheries will review and comment on the EFH assessment for ground fish and pelagic species. The NOAA Fisheries reviewed the EFH for salmonids in the May 20, 2002 Biological Opinion and concluded that there may be adverse effects to a variety of habitat parameters for ESA-listed salmonids. However, NOAA Fisheries concluded that the ESA conservation measures, the reasonable and prudent measures, and terms and conditions, all of which are outlined in the Biological Opinion, address these adverse effects.

6.6.1.3.^{new} Ecosystem Restoration Features

This new subsection has been added for the Final SEIS to discuss impacts of the ecosystem restoration features on Dungeness crab, smelt, sturgeon, non-indigenous species and EFH. Impacts of these features on listed salmonids are discussed in the BA (Exhibit H, *ESA Consultation*, available on the Corps website). Also see Section 6.7.1.2.

Dungeness Crab

The ecosystem restoration features, including the new features developed during the ESA consultation, are all located above CRM 18 in areas where the salinity is not expected to support significant Dungeness crab populations. Therefore, creating the restoration features would not be expected to significantly impact crabs.

Smelt (eulachon)

The two ecosystem restoration features that use dredge material in a beneficial manner are downstream of the major smelt spawning areas. The ecosystem restoration features should not have an adverse impact on smelt.

White and Green Sturgeon

Sturgeon are known to use the Lois Island embayment. It is assumed they use the Millar Pillar area but the extent is unknown. Construction of the ecosystem restoration features at these two locations will impact any sturgeon that do use the areas due to the loss of habitat by filling operations. However, sufficient habitat for sturgeon exists in the estuary so this displacement is not expected to have significant impact on sturgeon populations. After completion, benthic productivity in the tidal marsh habitat that will develop is expected to be greater than base condition. Further, detrital export from the tidal marsh component of these features is likely to benefit sturgeon by increasing forage resources for benthic invertebrates in the estuary. A net gain in overall estuarine productivity, including that for sturgeon, would be anticipated from these two ecosystem restoration features. None of the other ecosystem restoration features are anticipated to have any effect on the deep-water areas used by sturgeon.

Pacific and River Lamprey

No impacts are anticipated to the lamprey species from dredging at the temporary sump and disposal operations at Lois Island, and disposal actions at Miller-Pillar. Lamprey occur primarily in the water column higher than where dredging would occur during their upstream and downstream migration. It is unlikely that the change in physical parameters associated with any of the ecosystem restoration features will have an adverse effect on their migration or ocean entry.

Non-indigenous Species

The ecosystem restoration features have no effect on the volume of river traffic. Therefore, these features would have no effect on the amounts of ballast water brought into the Columbia River.

Essential Fish Habitat

See Subsection 6.6.1.2.

6.6.2. ^{revised} Wildlife Resources

6.6.2.1. ^{revised} No Action Alternative

For the Final SEIS, the following updated information is being added to this subsection. Additional information regarding impacts to wildlife resources from Washington upland disposal sites is provided in Exhibit K-8, *Consistency with Critical Areas Ordinances Including Wetland Mitigation* (revised). Some of these upland disposal sites are used for the No Action Alternative and the proposed project. The discussion as it applies to those disposal sites indicates what the impacts would be under the No Action Alternative. This

exhibit also discusses measures considered and being used to avoid, reduce, minimize or mitigate such impacts. As discussed in Section 6.2.3.1, the size of some of the disposal sites has been reduced, and this reduction has decreased the impact to riparian and wetland habitat. Therefore, a corresponding reduction of impacts to wildlife species that rely on such habitat also would be anticipated.

6.6.2.2. ^{revised} 43-foot Channel Deepening Alternative

For the Final SEIS, the following updated information is being added to this subsection. Exhibit K-5, *Wildlife and Wetland Mitigation*, identifies potential impacts of the project from the use of existing and new Washington upland disposal sites for the proposed plan. This exhibit also discusses measures considered and being used to avoid, reduce and minimize impacts and includes a wetland mitigation plan to provide further detail on how wetland impacts will be mitigated.

Since issuance of the 1999 Final IFR/EIS, potential wildlife impacts have been reduced in several ways. Seventeen acres of riparian forest at Lord Island (O-63.5) were afforded protection in the 2001 BA reducing the overall riparian forest impact associated with the project from approximately 67 acres to approximately 50 acres (approximately 25% reduction). In addition, corrections to mapping inconsistencies at the Mount Solo disposal site (W-62.0) have resulted in a reduction of impacts to wetlands from approximately 20 acres to approximately 16 acres (approximately 20% reduction). As noted in Exhibit K-5, the mitigation plan currently calls for restoring or developing 194 acres of wetlands, which represents about a 12:1 ratio of mitigation to wetland impact. Exhibit K-8, *Consistency with Critical Areas Ordinances Including Wetland Mitigation*, contains a more detailed draft wetland mitigation plan for proposed Washington wetland mitigation effort at Woodland Bottoms and Martin Island.

6.6.2.3. ^{revised} Least Cost Disposal Alternative

For the Final SEIS, the following updated information is being added to this subsection. The review of disposal sites conducted during preparation of the 2001 BA resulted in a reduction in riparian forest impacts (see Exhibit K-5, *Wildlife and Wetlands Mitigation*). Seventeen acres of riparian forest at Lord Island (O-63.5) were afforded protection in the BA reducing the overall riparian forest impact associated with the project from 67 to 50 acres (approximately 25% impact reduction). As discussed above, correcting mapping inconsistencies at the Mount Solo site (W-62.0) also resulted in reducing wetland impacts associated with the least cost disposal plan from 28 to 24 acres.

6.6.2.4. ^{revised} Proposed (Sponsors' Preferred) Disposal Alternative

The Sponsor's preferred disposal alternative incorporates the same changes in Subsection 6.6.2.3, but with a further reduction in impact to agricultural lands from 200 to 172 acres (about 14%) due to reduced disposal acreage requirements at Gateway (W-101) and Mt. Solo (W-62). Under the current plan, the Gateway disposal site is reduced from 69 to 40 acres (approximately 40% reduction) and Mt. Solo has been reduced from 50 to 46 acres.

6.6.2.5. ^{new} Ecosystem Restoration Features

This new subsection is being added for the Final SEIS to discuss impacts of the ecosystem restoration features on wildlife resources. Five new restoration features were added to the project during the ESA consultation process. These features are in addition to the three discussed in the 1999 Final IFR/EIS. Impacts to ESA wildlife are discussed in the 2001 BA.

The Lois Island embayment habitat restoration will restore 191 acres of tidal marsh habitat for fish and wildlife resources. Waterfowl, shorebirds, raptors, including bald eagles, various songbirds and herons will ultimately benefit from the restoration of tidal marsh habitat as this habitat provides foraging resources for these species. There will be a time delay of 1 to 5 years for wildlife benefits to accrue as vegetation and benthic invertebrate communities pioneer into the restored area and become established. Detrital export from the tidal marsh habitat will provide forage resources for estuarine benthic invertebrates, and ultimately juvenile salmonids. The tidal marsh with associated mudflats and shallow subtidal channels that borders the upstream shoreline of Lois Island provides an excellent example of the restoration objective sought as regards to habitat complexity and wildlife use targeted by the restoration action. Bald eagles will be disturbed from portions of their foraging territory during project construction (2001 BA). Use by ducks, grebes, loons, cormorants, gulls and terns would be lessened during the construction years until the feature is completed and plant and benthic invertebrate communities colonize the area and become established.

The purple loosestrife control program is aimed at addressing the spread of this invasive plant species in the estuary between CRM 18-52. Where the plant has become densely established (Wallace Island), native plant diversity and density in the intertidal marsh habitat has been reduced. A reduction in the productivity of the native intertidal marsh vegetation in the estuary would have a substantial impact on the wildlife resources that use the estuary. A reduction in wintering waterfowl usage would impact raptors also, which make use of waterfowl as a forage resource. A monoculture of purple loosestrife could affect insect production and diversity, which would thus impact wildlife species dependent upon this resource (e.g., various songbirds and shorebirds). Implementation of the proposed feature over a 5-year period would result in minor site-specific disturbance to various wildlife species as control and monitoring activities are conducted. Such disturbance would be temporary in nature and only typically entail small, localized areas.

The Miller-Pillar restoration feature would restore 235 acres of tidal marsh/intertidal flats habitat in a currently erosive area where depths increased from -6 feet CRD to about -30 feet CRD. Shallow subtidal habitat is more productive for benthic invertebrates than deeper subtidal areas. Increased benthic invertebrate productivity is important for fish production, which has a bearing on the level of use by grebes, loons, cormorants, gulls, and terns. Use by these species is expected to increase post-construction. The benefits associated with this feature are comparable to Lois Island embayment. Construction disturbance would lessen wildlife use in the immediate area, but is considered relatively minor because the area is not currently frequented by wildlife concentrations. To lessen the presence of cormorants, bird excluders will be placed on top of the pile dikes. King piles at each pile dike would provide perching for bald eagles.

Restoration efforts at Tenasillahe Island would occur in three phases. The interim feature (Phase 1) includes provisions to increase flow and circulation in the 92 acres of interior slough channels (blocked by flood control levees encompassing the island). Improvements to flow and circulation will allow for juvenile salmonids access and egress and allow rearing and foraging activities by juvenile salmonids to occur in these channels. Construction of inlet channels and control structures and improvements to the existing tidegates would be accomplished. Construction of the inlets and outlet improvements would pose a minor disturbance to wildlife, including Columbian white-tailed deer. It is expected that the minor disturbance will simply cause wildlife to avoid the immediate area. Post-construction benefits for wildlife are relatively minor and would accrue from better water quality conditions and associated improvements in benthic invertebrate and aquatic vegetation production. Waterfowl broods rearing in the channels and aquatic furbearers represent species that may benefit from the interim action.

The Cottonwood-Howard Island Columbian white-tailed deer introduction (Phase 2 of the Tenasillahe Island restoration feature) is intended to reintroduce this species to a portion of their historic range on secure habitat. The sponsor ports will purchase the islands, except for portions owned by WDNR. That acreage (approximately 650 acres), outside the project needs for dredged material disposal, will be used for Columbian white-tailed deer range. Other wildlife species present on these islands are not likely to incur any adverse affects from this action.

Implementation of the long-term feature (Phase 3) poses substantial benefits for waterfowl, shorebirds, raptors, gulls and other species that forage in intertidal marsh/mudflat and shallow subtidal habitats. Breaching of the flood control dikes would restore 1,778 acres of intertidal marsh/mudflat and shallow subtidal habitat thus benefiting these species. Fisheries resources would benefit from unimpeded access to the area rearing and foraging activities. The significant increase in primary productivity from tidal marsh vegetation exported to the estuary as detritus would benefit production of benthic invertebrates and thus juvenile salmonids and other fish species that forage on them. The wildlife species incurring the most impact would be the Columbian white-tailed deer, which would lose substantial acreage of artificially maintained habitat (e.g., upland habitat provided through operation of flood control dikes and water control structures).

However, implementation of this long-term feature is predicated upon the delisting of Columbian white-tailed deer, which is dependent upon establishment of three secure and viable deer populations. Given the current condition, e.g., secure and viable populations at the mainland deer refuge and Tenasillahe Island, two additional secure and viable deer populations would have to be established prior to implementation of this feature. A 10-year period has been estimated for accomplishment of this task.

The Bachelor Slough restoration feature entails dredging of the slough to approximately 0 feet NGVD. This action encompasses approximately 85 acres of slough channel along the 2.75-mile length of the slough. Dredging of the slough is contingent upon slough sediments meeting established agency criteria for contaminants and availability of disposal sites on

adjacent lands owned by the USFWS or WDNR. Riparian forest development on the 46 acres of these disposal sites post-deposition represents a key element of this feature. Riparian forest development along 6 acres of the Bachelor Slough shoreline also is included.

Dredging of Bachelor Slough would be conducted between July 1-September 15 to minimize impacts to wildlife, which make greatest use of the Ridgefield National Wildlife Refuge during fall, winter, and spring when wintering waterfowl are present. Anadromous fisheries use is expected to be low in this timeframe due to low, warm waters. The riparian development along the shoreline of Bachelor Slough would benefit resident and Neotropical migrant songbirds, reptiles and amphibians, small mammals and aquatic furbearers. These species would incur some adverse impacts initially as the habitat is converted from an invasive plant (e.g., false indigo and reed canarygrass) to a native riparian forest habitat. With establishment of riparian forest, these species would attain better habitat conditions than at present. This improvement would be associated with a more diverse plant species composition and structural component (e.g., height, varying canopy layers, and ultimately large wood debris on the ground) that would develop as the riparian forest matures.

The upland disposal site on WDNR land is a sandy, previously used dredged material disposal site that has few plant species comprising minor ground cover present. Placement of dredged material, estimated to be relatively silty material, and subsequent development of riparian forest habitat would substantially improve wildlife use at this location for the aforementioned species groups while having a negligible impact on the few species that currently use the location. The other two potential riparian forest development locations are located at upland, presently grassland locations on the Ridgefield National Wildlife Refuge. Species such as savannah sparrows and garter snakes, which make use of this grassland habitat, would be adversely impacted by conversion to riparian forest habitat, which represents the historical habitat that would have occurred on these sites. Riparian forest habitat would support a more diverse array of wildlife species than grassland habitat. Loss of habitat, principally grasslands used for grazing by wintering waterfowl would be minimal.

6.7. Threatened and Endangered Species

6.7.1. ^{revised} Aquatic Species

For the Final SEIS, Subsections 6.7.1.1 and 6.7.1.2 have been added to provide information and analyses developed during the ESA consultation concerning impacts to listed salmonids from the project and the ecosystem restoration features. Also, Subsection 6.7.1.3 was added for the Final SEIS to discuss the Biological Opinions.

6.7.1.1. ^{new} ESA Consultation Results for the 43-foot Channel Deepening Alternative

Seven salmonid species have population segments that are federally listed under the ESA (endangered, threatened, or proposed for listing) and spend a portion of their lives in the action area of the Columbia River (see Sections 1.3.1 and 2.1 for a definition of the action

area). These species include 12 federally listed salmonid ESUs, one listed DPS, one DPS proposed for listing, and one candidate ESU. The 2001 BA prepared for the ESA consultation and the 2002 Biological Opinions are included as Exhibit H (Corps website) to the Final SEIS. The ESUs and DPSs addressed in the 2001/2002 ESA consultations are listed in Table S6-4. The 2001 BA and 2002 Biological Opinions include extensive information regarding the environmental conditions pertaining to these listed species and formerly designated critical habitat.²

Table S6-4. Federally Listed Salmonid ESUs/DPSs in the Action Area

Evolutionarily Significant Unit (ESU)	Status	Life History Type	Juvenile Life Stage in Lower Columbia River	Date Listed
Chinook salmon (<i>Oncorhynchus tshawytscha</i>)				
Snake River spring/summer	Threatened	Stream	Yearling +	4/22/92
Snake River fall	Threatened	Ocean	Subyearling	4/22/92
Lower Columbia River	Threatened	Ocean	Subyearling	3/24/99
Upper Columbia River spring	Endangered	Stream	Yearling +	3/24/99
Upper Willamette River	Threatened	Ocean	Subyearling +	3/24/99
Chum salmon (<i>Oncorhynchus keta</i>)				
Columbia River	Threatened	Ocean	Subyearling	3/25/99
Sockeye salmon (<i>Oncorhynchus nerka</i>)				
Snake River	Endangered	Stream	Yearling +	11/2/91
Steelhead trout (<i>Oncorhynchus mykiss</i>)				
Snake River	Threatened	Stream	Yearling +	8/18/97
Lower Columbia River	Threatened	Stream	Yearling +	3/19/98
Middle Columbia River	Threatened	Stream	Yearling +	3/25/99
Upper Columbia River	Endangered	Stream	Yearling +	8/18/97
Upper Willamette River	Threatened	Stream	Yearling +	3/25/99
Coho salmon (<i>Oncorhynchus kisutch</i>)				
Lower Columbia River/Southwest Washington	Candidate	Stream	Yearling +	7/25/95
Distinct Population Segments (DPS)				
Bull trout (<i>Salvelinus confluentus</i>)				
Columbia River	Threatened	Trout	Yearling +	6/10/98
Cutthroat trout (<i>Oncorhynchus clarki clarki</i>)				
Southwest Washington/Columbia River	Proposed Threatened*	Trout	Yearling +	10/25/99

*On July 5, 2002, USFWS withdrew its proposal to list cutthroat trout as threatened. 65 *Federal Register* 44934.

² Although NOAA Fisheries had formally designated critical habitat for salmonid species under its jurisdiction, the designations have since been withdrawn by the agency. Nevertheless, potential impacts of the project on the formerly designated critical habitat were analyzed in the 2001 Biological Assessment and 2002 NOAA Fisheries Biological Opinion. USFWS has not yet formally designated critical habitat for bull trout.

The 2001 BA (Exhibit H on the Corps' website) provides detailed information and environmental analyses for a number of topics relevant to the conservation of threatened and endangered salmonids. NOAA Fisheries and USFWS adopted much of this analysis in their 2002 no-jeopardy Biological Opinions. Summary information and analyses are provided in the following sections at the ecosystem pathway level as described in the conceptual model (habitat-forming processes, habitat types, habitat primary productivity, food web, growth, and survival). The effects discussed in the BA and Biological Opinions for individual ecosystem indicators are linked to this larger ecosystem scale by addressing how these effects might change the ecosystem pathways.

Effects on Pathways

This section addresses the specific effects of the project on the respective indicators at a broader ecological level of analysis (ecosystem pathways).

Habitat Forming Process Pathway

Potential changes to the seven individual ecosystem indicators (suspended sediment, bedload, woody debris, turbidity, salinity, accretion/erosion, and bathymetry) that are important to forming the three primary habitats (tidal marsh and swamp, shallow water and flats, water column) for juvenile salmonids in the lower Columbia River were identified and analyzed as follows.

- There will be short-term, localized increases in suspended sediment concentrations in the immediate vicinity of dredging and disposal operations. There may be as much as a 4.5% increase in the total suspended sediment load in the lower Columbia River as a result of dredging and disposal from the project. Increased suspended sediment levels would tend to improve habitat-forming processes in the estuary by providing additional materials to form tidal marsh and swamp habitat. However, the increased suspended sediment load is likely too small to have a measurable effect on habitat-forming processes.
- The project may temporarily shift the direction of bedload movement along the sides of the navigation channel as a result of side-slope adjustments, which may cause erosion at some previous beach nourishment sites. This process will take 5-10 years and would not affect water column or tidal marsh/swamp habitats. Over that time, shallow water and flats habitat at six historical shoreline disposal sites will tend to move shorewards into former areas of artificial beach that have slowly eroded. All of the shoreline sites have been used in the past for dredge disposal. Two of the six historical disposal sites, Sand Island (CRM 86.2) and Miller Sands Spit (CRM 22.5), would be used throughout the life of the project. Because the bedload transport rate during maintenance sideslope adjustment would occur at the same rate at which normal bedload transport would occur without the project (just in a different direction), the quantity and quality of shallow water and flats habitat is expected to remain constant in the river and estuary reaches.

- There will be short-term, localized increases in turbidity levels in the immediate vicinity of dredging and disposal operations. Short-term localized turbidity levels of 5-26 NTUs that could be caused by the project are not likely to produce detectable effects on plant growth in the lower river. Not only is the amount of increase too low, but it also will be localized to the immediate areas where dredging and disposal occurs. The highest levels of turbidity would occur in deep water and sandy beach areas that are not suitable salmonid habitat.
- Salinity increases of less than 0.5 ppt in the shallow embayments of the estuary (Cathlamet and Grays Bays) would occur. Salinity increases up to 5 ppt would occur in the bottom of the navigation channel. The computed differences in modeling between base and with project conditions for salinity in shallow areas are much smaller than natural temporal variations due to normal variations in freshwater flow and tidal dynamics. Differences computed for the channel bottom are increases up to 5 ppt. This will not affect habitat-forming processes in any of the three primary habitat types.
- The salinity wedge could potentially be shifted upstream (up to 1 mile), resulting in a possible shift in the ETM location. The potential ETM shift would occur in a relatively small part of the south channel. It would generally remain within the current range or path of the ETM, with up to a 1-mile shift in the upstream boundary. This change is smaller than the existing daily fluctuations caused by flow conditions. The ETM suspends nutrients in the estuary, which are then distributed by tides and currents in the river system. Any fluctuation in the location of the ETM that may result from the project is not expected to affect the tidal influences and currents that distribute nutrients throughout the estuary. The effect of the potential ETM shift on distribution of nutrients in the estuary is expected to be so small that it cannot be measured.
- Bathymetric changes will include up to 3 feet of deepening in areas of the navigation channel that are currently shallower than -48 feet CRD and some rise in the riverbed at shoreline and flowlane disposal sites. Also, there is a potential for 0-3 feet of deepening along the side slopes adjacent to the dredge cuts. Water surface elevation could be affected between CRM 80-146. The decrease could be as much as 0.18 foot (approximately 2 inches) at the upstream end of the project, which is not anticipated to affect habitat-forming processes. The 3-foot lowering of the channel bathymetry will occur in 56% of the navigation channel, which is not expected to directly impair habitat-forming processes because the water depth increase is limited to the channel and will add 3 feet to water column type habitat. Flowlane disposal occurs in water column habitat and will not have an effect on habitat-forming processes for any of the habitat types. Habitat opportunity, as defined by Bottom et al. (2001), considers water depth and velocity conditions that provide favorable habitat for juvenile salmonids. Using this definition, physical modeling results are nearly identical for the base and with-project conditions, which indicates that the project will not have an impact on habitat opportunity as it relates to water depth in the estuary. Shoreline disposal will occur in areas where salmonid habitat is not present and will not affect habitat-forming processes.

Therefore, modeling performed for the project, as well as the analysis provided during the ESA consultation process, indicates that there will not be a significant effect on habitat-forming processes as a result of the project. The Corps will implement compliance measures to ensure effects are minimized and will monitor to confirm this conclusion (see the *Monitoring and Compliance Actions* sections below).

Habitat Types Pathway

Potential changes to the three primary habitat types for juvenile salmonids in the lower Columbia River (tidal marsh and swamp, shallow water and flats, water column habitat) were identified and analyzed as follows.

- Side-slope adjustments may cause a shift in the location of shallow water habitat-forming processes in areas where the navigation channel is adjacent to previous shoreline disposal sites. Shoreline disposal could potentially disturb and shift the location of shallow water habitat at the three proposed disposal sites: Sand Island, Miller Sands Spit, and Skamokawa Beach. While the three sites have the potential to affect salmonid habitat areas, an assessment of the sites concluded that they do not contain many of the important habitat features used by salmonids for rearing, such as low velocity, vegetation, and food sources. These areas likely provide a corridor for migrating salmonids and, consequently, there is some potential effect from the project.
- Water column habitat will be directly affected by the increased depth (about 3 feet) of the water column within a portion of the navigation channel in the action area.
- Drilling and blasting actions (blasting is needed to remove about 50,500 cubic yards of rock (see Table S1-1) at Warrior Rock near St. Helens may affect water column habitat. Blasting will be done during the preferred in-water work window when salmonid abundance is lowest and will minimize impacts to listed stocks. The blasting plan will be designed to further minimize any impacts by keeping over pressures above the blast zone to less than 10 pounds per square inch. This level is generally believed by NOAA Fisheries to be below the level at which salmonids would be adversely affected. A state approved plan for blasting will be developed to further minimize impacts. Based on the above, the potential impacts to water column habitat would be minimized.
- Water clarity may be reduced temporarily in very localized areas by the action of the dredge head on the bottom of the navigation channel and by flowlane disposal of dredged material.
- Proposed dredging timelines are consistent with the Biological Opinion for maintenance dredging because dredging occurs in areas where salmon are not present at depths greater than 20 feet. Dredging and disposal during construction will be conducted over a 2-year period in selected areas of the channel. Although this is outside of the normal November 1 through February 28 in-water work period, it is not anticipated to have significant effects on listed salmonids. Salmonids normally do not occur to any extent in

the areas being dredged or the disposal sites (except the three shoreline sites). Juvenile salmonids normally migrate along the channel margins using the side slopes as structure. They occur primarily at depths less than 20 feet and should not be affected by dredging and disposal operations. Although they can occur near the three shoreline disposal sites, these sites are highly erosive and do not provide much, if any, habitat. Therefore, potential impacts associated with project timing would be minimized.

Therefore, the analysis provided during the ESA consultation indicates that there will be no measurable effects on the primary habitat types as a result of the project. The Corps will implement compliance measures to ensure effects are minimized and will monitor to confirm this conclusion (see the *Monitoring* and *Compliance Actions* sections below).

Habitat Primary Productivity Pathway

Potential changes to the six factors (light, nutrients, imported and resident phytoplankton production, benthic algae production, and tidal marsh/swamp production) that are important to primary productivity within salmonid habitat were identified and analyzed as follows.

- Short-term reductions in light may result in localized, short-term reductions in photosynthesis by benthic plants and phytoplankton. However, these changes likely will not be of sufficient duration to result in a loss of vegetation or measurable biomass production. The ephemeral and transient nature of the project activities suggests that a reduction in light penetration would occur for only very short periods of time. In addition, the reductions will occur primarily in deep-water areas that do not support large amounts of vegetation other than phytoplankton.
- Change in salinity intrusion may affect the location of resident phytoplankton productivity, the location where imported freshwater phytoplankton contact intolerable salinity extremes, and the location of benthic algae productivity. These productivity changes are anticipated to be undetectable. No change in type or quantity of imported phytoplankton within the system is anticipated. In addition, while resident phytoplankton will expand its range in correlation with any upstream expansion of salinity, this effect on phytoplankton will not be measurable because the upstream expansion of salinity is not anticipated to be measurable. There may be a small upstream expansion of benthic algae production, but this is difficult to determine because a myriad of diatom species that make up the flora are euryhaline. None of these slight changes would have a measurable effect on primary productivity within the system.

Therefore, the analysis provided during the ESA consultation indicates that there will be no measurable effects on habitat primary productivity as a result of the project. The Corps will implement compliance measures to ensure effects are minimized and will monitor to confirm this conclusion (see the *Monitoring* and *Compliance Actions* sections below).

Food Web Pathway

Potential changes in eight relevant components (deposit feeders, mobile macroinvertebrates, insects, suspension/deposit feeders, suspension feeders, tidal marsh macrodetritus, and resident/imported microdetritus) of the food web in the lower Columbia River were identified and analyzed as follows.

- Limited removal and burying of deposit feeders, suspension/deposit feeders, and suspension feeders will occur in portions of the navigation channel and deep water areas. Removal and burial effects on these organisms are expected to be relatively short-lived, with dredge and disposal areas being recolonized post-construction. These organisms occur in low densities in the navigation channel because the sand waves create unstable habitat conditions. In these and other areas of the river, densities fluctuate as a result of constantly changing environmental conditions. No changes to these organisms are anticipated in shallow water areas, side channels, or embayments, which are the important locations for salmonid feeding opportunities. The Corps' monitoring program includes a post-project survey of ecosystem conditions that addresses these organisms in shallow water areas.
- Dredging and disposal actions will result in loss of adult and juvenile mobile macroinvertebrates. Although some mortality of mobile macroinvertebrates by dredging and disposal operations will occur, this mortality is expected to have an insignificant effect on overall populations in either the estuary or the river mouth. Mobile macroinvertebrates are adapted to respond rapidly to disturbances and to recolonize areas following these disturbances. Mobile macroinvertebrates can be an important food item for salmonids in estuaries. Changes in mobile macroinvertebrate populations resulting from project actions are not anticipated to affect the salmonid food web.
- There may be a slight upstream shift in the ETM, which would be accompanied by a slight shift in the focus of resident and imported microdetritus food web input.

Therefore, the analysis provided during the ESA consultation indicates that there will be no significant effects on the food web as a result of the project. The Corps will implement compliance measures to ensure effects are minimized and will monitor to confirm this conclusion (see the *Monitoring* and *Compliance Actions* sections below).

Growth Pathway

No potential changes were identified to the six factors (habitat complexity, connectivity and conveyance; velocity field; bathymetry and turbidity; feeding habitat opportunity; refugia; and habitat-specific food availability) that can influence the growth of salmonids.

Survival Pathway

Eight factors were identified that can influence the survival of salmonids (contaminants, disease, suspended solids, stranding, temperature and salinity extremes, turbidity, predation, and entrainment). The following potential change to these factors was identified and analyzed as follows:

- A turbidity plume associated with dredging and disposal activities could increase salmonid predation. Increases in suspended sediments are likely to be very localized in deeper water and sandy shoreline areas and will be of short duration. For juvenile salmonids, the turbidity increase is unlikely to affect survival because juveniles do not use these areas.

Additional analysis of available sediment quality data relating to Columbia River dredging was conducted as part of the SEI and reconsultation process, and is presented in Appendix B of the Biological Assessment (Exhibit H on the Corps' website). Further information was also provided to the NOAA Fisheries and the USFWS on sediment quality in the Corps April 22, 2002 BA amendment letter. This information is provided in Exhibit H (on Corps website). The NOAA Fisheries and USFWS concluded that the estimated risk of exposure of ESA-listed salmonids and bull trout from contaminated sediments from project activities was limited (see NOAA Fisheries and USFWS Biological Opinions in Exhibit H). Further, they support implementation of the Corps' contaminant monitoring and evaluation activities proposed in the 2001 BA and have these included activities in the mandatory terms and conditions of the Biological Opinions.

Also, the Corps analyzed whether the increase in channel depth would result in larger vessel sizes and/or load capacity, which could result in increased vessel speed, larger wake, and increase juvenile salmon stranding (Exhibit K-3, *Evaluation Report Fish Stranding*). A 2001 analysis of whether the deeper draft ships will produce larger waves in a deeper channel indicates that little, if any, change in wave size is expected (Hermans, SEI Presentation, 2001). Hermans analyzed several mechanisms by which ships generate waves. The analysis found that for deep-draft vessels the most important wave mechanism in the Columbia River would be the primary or "suction" wave generation. This mechanism depends on the "blockage" ratio, which is the ratio of the cross-sectional area of the ship to that of the channel. Given the proposed increase in channel depth and the expected increase in vessel draft, the ratio changes very little. The blockage ratio of a 43-foot draft vessel in a 43-foot channel is only 1% to 5% higher than that of a 40-foot draft vessel in a 40-foot channel. However, for the much more numerous smaller ships that would not increase their draft, there would be a slight decrease (in the range of 1% to 5%) in the blockage ratio with the deeper channel. Therefore, while 43-foot draft ships may generate slightly larger wakes than occur now, this would be offset by most ships producing slightly smaller wakes. As a result, the overall changes in wave size caused by the deeper channel are negligible.

In addition to the deeper channel not causing increased wave sizes, the project is also not expected to cause more frequent waves. While the proposed channel improvements would increase the efficiency of river commerce, it is not anticipated to increase the volume of river traffic. Accordingly, there is no expectation of more frequent ship wake instances occurring as a result of the channel improvements and the channel improvement project is not expected to have a significant change in the stranding of juvenile salmonids.

Therefore, the analysis indicates that there will be no measurable effects on survival of salmonids as a result of the project. The Corps will implement compliance measures to ensure effects are minimized and will monitor to confirm this conclusion (see the *Monitoring and Compliance Actions* sections below).

Potential Short-term Effects

The conceptual model was used to evaluate how identified effects to the ecosystem (as determined from the pathways analysis) may affect the listed and candidate salmonid species (short-term effects). It also addressed potential effects on the Columbia River ecosystem over the 50-year life of the project (long-term effects). The following are the potential short-term effects that have been identified through application of the model.

- There may be a temporary loss of shallow water habitat associated with dredge material disposal at three shoreline disposal sites. One shoreline disposal site is located in the riverine reach at Sand Island (O-86.2). The site is a beach nourishment site intended for disposal during both construction and maintenance dredging. Two shoreline disposal sites are located in the estuarine portion of the action area, Miller Sands Spit in the estuary at O-23.5 and Skamokawa Beach at W-33.4. A narrow band of shallow water will be affected by disposal at these shoreline disposal sites. However, because there is so little actual habitat within the potential disturbance areas for the three disposal sites, there is very little potential for actual effects on salmonids. The proposed compliance actions are anticipated to be adequate to prevent effects on listed species. Monitoring will be performed to ensure that this conclusion is accurate.
- Drilling and blasting activities may affect water column habitat. The compliance actions associated with drilling and blasting activities are anticipated to be adequate to prevent effects on listed species. Monitoring will be performed to ensure that this conclusion is accurate. If monitoring identifies impacts to listed species, then appropriate compensation will be negotiated with NOAA Fisheries and USFWS.
- Proposed dredging timelines are consistent with the Biological Opinion for maintenance dredging. In addition, dredging will occur in areas that salmonids do not use at depths greater than 20 feet. The compliance actions associated with project timing are anticipated to be adequate to prevent effects on listed species. Monitoring will be performed to ensure that this conclusion is accurate. If monitoring identifies impacts, then appropriate compensation will be negotiated with NOAA Fisheries and USFWS.

Potential Long-term Effects

During the ESA consultation process, concerns were identified regarding potential long-term effects of the project. These have centered on minor changes that may be caused by project actions that are not detectable in the short term, but may affect listed salmonid habitat over the next 50 years. This also could include ecosystem effects that are not identifiable, given the current understanding of the ecosystem. Areas for which concern has been expressed during the ESA consultation include those related to the ETM, formation and preservation of tidal marsh and swamp habitats, habitat opportunity changes in isolated geographic areas, and elimination of connectivity between habitats for juvenile salmonids.

None of the identified potential effects are anticipated to measurably affect salmonids; however, there is uncertainty associated with ecosystem processes that warrant implementing specific impact minimization, monitoring, and evaluation actions. Table S6-5 presents a summary of the risks and uncertainties associated with the assessment of effects for the project identified by the SEI panel of independent scientists and the BRT, which is made up of federal agency representatives (NOAA Fisheries, USFWS and Corps).

Ecosystem evaluation also is being proposed that is aimed at advancing the knowledge base for the recovery of the listed salmonids. Table S4-7 outlines the proposed ecosystem evaluation activities. This evaluation may result in identification of effects that are not currently understood, given the current knowledge of the ecosystem. The proposed monitoring actions and compliance actions for the channel improvement project are discussed in the following sections.

Monitoring Actions

The monitoring actions proposed for the project will help to ensure that the conclusions of the project analysis regarding minor effects on habitat and individuals are correct. The monitoring actions are for indicators where the levels of uncertainty and risk from project effects warrant gathering additional information. It should be noted that these levels of risk were not high enough to alter the conclusions concerning the effects on the listed and candidate salmonid species, but are still of a level to warrant verification through monitoring. This includes potential effects on indicators related to potential for take of individuals of the listed and candidate salmonid species, as well as their habitat. Monitoring actions are summarized in Table S6-6. The contents of Table S6-6 include conceptual model indicator(s) addressed by each monitoring action; description of the monitoring task to be implemented; technical justification for each of the monitoring tasks; relative uncertainty and risk from project effects identified by the Corps, NOAA Fisheries, and USFWS and the analysis for each of the indicator(s); duration of the monitoring proposed for each task; and analysis of monitoring data for each monitoring task.

Compliance Actions

Compliance actions are those actions that will be taken during the implementation of project actions to avoid or minimize potential effects on listed and candidate salmonid species.

These compliance measures prescribe safeguards, techniques, and guidelines that will be followed to avoid or minimize take. Tables S6-7 and S6-8 address BMPs for project disposal and dredging actions, as well as timing restrictions associated with these actions. Further, the Corps proposes to use compliance actions identified in these tables to ensure the project minimizes or avoids take of individual listed or candidate salmonid species or their habitat.

These compliance actions have been developed over time through the Corps' dredging program, and they are considered to represent the best management practices for dredging and disposal to minimize any adverse effect to listed species or their habitat. These actions will be monitored by onsite inspection under established quality assurance processes. If the inspection identifies new information that potentially warrants a change, it will be reported to the AMT for consideration of changes to the compliance measures.

Table S6-5. Risk and Uncertainty Conceptual Framework

Pathway	Indicator	Uncertainty	Risk
Habitat-Forming Processes	Suspended sediment	L Lots of available data Empirical method	L Sensitivity very low No to small change
	Bedload (main channel)	M Limited data Empirical equation	L Sensitivity low Change none
	Woody Debris	H No data Professional judgment	L+ Sensitivity low to medium No change
	Turbidity	M+ Limited data Judgment, conceptual model	L Sensitivity low Small change
	Salinity	L Limited to abundant data Strong scientific methods	L+ Sensitivity moderate Small change
	Accretion/erosion (shallows)	M Limited data Empirical	L Sensitivity low No to small change
	Bathymetry (channel)	L Abundant data Models strong scientific method	M- Sensitivity low Measurable change
Habitat Type	Tidal marsh and swamp habitat	M Limited data Conceptual model	L+ Sensitivity moderate No to small change
	Shallow water and flats habitat	M Limited data Empirical	M-L+ Sensitivity moderate to high Small change
	Water column habitat	M Limited data Judgment and empirical	L Sensitivity low None to small change
Habitat Primary Productivity	Light	M Limited data Conceptual model	L Sensitivity low No change
	Nutrients	M+ Limited data Professional judgment	L Sensitivity low No to small change
	Imported phytoplankton production	M Limited data Professional judgment	L Sensitivity low Small change
	Resident phytoplankton production	M Limited data Professional judgment	L Sensitivity low Small change
	Benthic algae production	H Limited data Professional judgment	L+ Sensitivity low No to small change
	Tidal marsh and swamp production	M Limited data Conceptual model	L+ Medium sensitivity No to small change

Pathway	Indicator	Uncertainty	Risk
Food Web	Deposit feeders (channel bottom)	M Limited data Conceptual model	L Sensitivity low Small change
	Deposit feeders (side channels)	M Limited information Judgment-empirical Conceptual model	M Sensitivity medium No to measurable change
	Mobile macro-invertebrates	M Limited data Judgment-empirical	L Sensitivity low No change
	Insects (side channel, tidal marsh)	H None to limited data Judgment	M Sensitivity medium Small change
	Suspension/deposit feeders	M Limited information Judgment - empirical Conceptual model	M Sensitivity medium Measurable change
	Suspension feeders (side channel)	M Limited information Judgment - empirical Conceptual model	M Sensitivity medium No to measurable change
	Tidal marsh macrodetritus	H No available data Professional judgment	L+ Sensitivity medium Small change
	Resident microdetritus	H No available data Professional judgment	L+ Sensitivity low Small change
	Imported microdetritus	M Limited data Empirical	L+ Sensitivity medium No change
Growth	Habitat complexity, connectivity, and conveyance	L+ Limited data Strong scientific methods	M Sensitivity high No to small change
	Velocity field	L Limited data Modeled data 2x	L Sensitivity low No to measurable change
	Bathymetry and turbidity	H Limited data to no data Professional judgment	M Sensitivity medium to high No to little change
	Feeding habitat opportunity	L Limited data Some modeling	L+ Sensitivity medium to high No to little change
	Refugia	L Limited data Conceptual model	L+ Sensitivity High No change
	Habitat-specific food availability	M No to little data Conceptual model	M Sensitivity high Small change

Pathway	Indicator	Uncertainty	Risk
Survival	Contaminants	M Lots of data/limited Empirical methods/professional judgment	M Medium sensitivity Change measurable
	Disease	L Much data Some empirical	M- Sensitivity high No change
	Suspended solids	L Lots of data Empirical method	L Sensitivity very low No to small change
	Stranding	L Much data Empirical method	M Sensitivity high Small change
	Temperature and salinity extremes	L+ Some data Modeling temp. data literature	M Sensitivity high No to small change
	Turbidity	M+ Limited data Judgment Conceptual Model	L Sensitivity low Small change
	Predation	M Limited data Some studies	M Sensitivity high No to low change
	Entrainment	L Abundant data Empirical method	M Sensitivity high No change

Key: H = high; M = medium; L = low.

Table S6-6. ESA Section 7(a)(2) Monitoring Actions for Dredging and Disposal

Monitor Action No.	Indicator	Monitoring Task	Justification	Uncertainty and Risk ¹	Duration	Data Analysis	Trigger for Management Changes
MA-1	Salinity, velocity, water surface, habitat complexity, connectivity, and conveyance, and habitat opportunity.	The Corps will maintain 3 hydraulic monitoring stations, 1 downstream of Astoria, 1 in Grays Bay, and 1 in Cathlamet Bay. Parameters measured include salinity, water surface, and water temperature.	Physical changes related to channel deepening are expected to be small and concentrated near the navigation channel.	Salinity L, L+; velocity L, L; bathymetry L, M-; habitat complexity, connectivity, and conveyance L+, M	7 years: 2 years before, 2 years during, and 3 years after construction	An analysis conducted to determine pre- and post-project relationships among flow, tide, salinity, water surface, and temperature.	Post-project data exceeds defined threshold values. Determine if task should continue and appropriate funding source.
MA-2	Dredging volume, bedload.	Annual dredging volumes, construction and O&M.	To ensure scale of the project does not change.	Bedload M, L	Life of the project.	Actual volumes will be compared to predicted.	Dredging volumes exceed capacity of the disposal plan.
MA-3	Accretion-erosion, bathymetry (main channel).	Main channel bathymetric surveys throughout project area.	Side-slope adjustments expected to occur intermittently adjacent to the navigation channel.	Accretion/erosion M, L; bathymetry L, M-	7 years: 2 years before, 2 years during, and 3 years after construction	Bathymetric changes will be tracked to determine if habitat is altered.	Habitat alteration in main channel due to side-slope adjustment.
MA-4	Tidal marsh, swamp, flats, refugia, habitat complexity, connectivity & conveyance, suspension-deposit feeders, insects, macrodetritus and habitat specific food availability, juvenile salmonids in peripheral habitats/habitat opportunity.	Repeat estuary habitat surveys being conducted by NOAA Fisheries (Bottom and Gore 2001 proposal).	Identify if there is a change to habitat due to deepening.	Tidal marsh and swamp habitat M, L+; flats habitat M, M-L+; suspension-deposit feeders M, M; deposit feeders M, M; suspension feeders M, M; insects H, M; macrodetritus H, L+; habitat-specific food availability M, M; feeding habitat opportunity L, L+	One time survey conducted 3 years after completion of the deepening.	Habitat mapping from aerial photos and ground surveys.	Changes to individual habitat types that are based on defined threshold values. Determine need for other surveys.

Monitor Action No.	Indicator	Monitoring Task	Justification	Uncertainty and Risk¹	Duration	Data Analysis	Trigger for Management Changes
MA-5	Contaminants	The Corps, USFWS and NOAA Fisheries will annually review any new sediment chemistry from the lower Columbia River and estuary from sources such as SEDQUAL database and known permit applicants and determine if there are any changes in the "Management Area Ranking" as defined in the DMEF manual.	Ensure that channel construction and maintenance do not disturb undetected deposits of fine-grained material, potentially causing redistribution of contaminants that pose a risk to salmonids and trout.	Contaminants M, M	2 years before construction, 2 years during construction, and annually during maintenance.	New sediment samples will be obtained in accordance with the DMEF manual and will be compared to the NOAA Fisheries guideline for the protection of salmon.	Any exceedance reported to the AMT to determine if consultation should be reinitiated. Corps, NOAA Fisheries, and USFWS will meet annually or as new circumstances arise to review new data showing changed condition that would trigger the need for additional sediment testing. Changed conditions include spills, new listing of chemicals, changes in guidelines or threshold values, or other indicators that suggest there is a reason that further testing may be required.
MA-6	Stranding	Monthly field surveys at selected beaches (upper, mid, and lower river) during April-August outmigration to measure if fish are being stranded.	Identify if there is a change in stranding due to deepening.	Stranding L, M.	One year before deepening and 1 year after deepening.	Compare pre- and post-project stranding counts.	If there is an increase in fish stranded, proposals would be developed and presented to decision makers.

¹ In this column L = low, M = medium, and H = high. A + sign means that the L, M, or H is of higher concern; a - sign means that the L, M, or H is of lower concern. The first L, M, or H after the indicator is the factor identified for uncertainty; the second L, M, or H after each indicator is the factor identified for risk. These factors were identified by the Corps, Sponsor Ports, NOAA Fisheries, and USFWS.

Table S6-7. Minimization Practices and Best Management Practices for Dredging

Monitor Action No.	Indicator	Measure	Justification	Duration	Management Decision
Hopper Dredging					
CA-1	Entrainment (survival) Benthic Invertebrates Deposit Feeders	Maintain dragheads in the substrate or no more than 3 feet off of the bottom with the dredge pumps running.	This restriction minimizes or eliminates entrainment of juvenile salmonids during normal dredging operations.	Continuous during dredging operations.	Maintain until new information becomes available that would warrant change.
CA-2	Habitat Complexity Bathymetry & Turbidity Feeding Habitat Opportunity Suspension-Deposit Feeders Deposit Feeders Mobile Macroinvertebrates	Dredge in shallow water areas (less than 20 feet) only during the recommended ESA in-water work period for the Columbia River of November 1 until February 28.	Areas < 20 feet deep are considered salmonid migratory habitat. Dredging or disposal in these areas could delay migration or reduce/eliminate food sources.	Continuous during dredging operations.	Maintain until new information becomes available that would warrant change.
Pipeline Dredging					
CA-3	Entrainment (survival) Benthic Invertebrates Deposit Feeders	Maintain cutterheads in the substrate or no more than 3 feet off of the bottom with dredge pumps running.	This restriction minimizes or eliminates entrainment of juvenile salmonids during normal dredging operations.	Continuous during dredging operations.	Maintain until new information becomes available that would warrant change.
CA-4	Habitat Complexity Bathymetry & Turbidity Feeding Habitat Opportunity Suspension-Deposit Feeders Deposit Feeders Mobile Macroinvertebrates	Dredge in shallow water areas (less than 20 feet) only during the recommended ESA in-water work period for the Columbia River of November 1 until February 28 and July 1 to Sept 15 for certain restoration features.	Areas less than 20 feet deep are considered salmonid migratory habitat. Dredging or disposal in these areas could delay migration or reduce or eliminate food sources.	Continuous during dredging operations.	Maintain until new information becomes available that would warrant change.

Monitor Action No.	Indicator	Measure	Justification	Duration	Management Decision
General Provisions for All Dredging					
CA-5	Contaminants Water Column Habitat	The contractor will not release any trash, garbage, oil, grease, chemicals, or other contaminants into the waterway.	Protect water resources.	Life of contract or action.	If material is released, it will immediately be removed and the area restored to a condition approximating the adjacent undisturbed area. Contaminated ground will be excavated and removed, and the area restored as directed. Any in-water release will be immediately reported to the nearest Coast Guard Unit for appropriate response.
CA-6	NA	The contractor, where possible, will use or propose for use materials considered environmentally friendly in that waste from such materials is not regulated as a hazardous waste or is not considered harmful to the environment. If hazardous wastes are generated, disposal will be done in accordance with 40 CFR parts 260-272 and 49 CFR parts 100-177.	Dispose of hazardous waste.	Life of contract or action.	If material is released, it will immediately be removed and the area restored to a condition approximating the adjacent undisturbed area. Contaminated ground will be excavated and removed, and the area restored as directed. Any in-water release will be immediately reported to the nearest U.S. Coast Guard Unit for appropriate response.

Table S6-8. Best Management Practices for Disposal

Monitor Action No.	Indicator	Measure	Justification	Duration	Management Decision
Flow Lane Disposal					
CA-7	Accretion/Erosion	Dispose of material in a manner that prevents mounding of the disposal material.	Spreading the material out will reduce the depth of the material on the bottom, which will reduce the impacts to fish and invertebrate populations.	Life of contract or action.	Maintain until new information becomes available that would warrant change.
CA-8	Bathymetry & Turbidity (Survival) Suspended Solids	Maintain discharge pipe of pipeline dredge at or below 20 feet of water depth during disposal. Exceptions are Miller-Pillar and Lois Island restoration features.	Reduces the impact of disposal and increased suspended sediment/turbidity to migrating juvenile salmonids; are believed to migrate in upper 20 feet of the water column.	Continuous during disposal operations.	Maintain until new information becomes available that would warrant change.
Upland Disposal					
CA-9	Suspended Solids Turbidity (Survival) Bathymetry & Turbidity	Berm upland disposal sites to maximize the settling of fines in the runoff water.	This action reduces the potential for increasing suspended sediments and turbidity in the runoff water	Continuous during disposal operations.	Maintain until new information becomes available that would warrant change.
CA-10	Habitat Complexity, Connectivity & Conveyance, Insects, Resident Macrodetritus, Microdetritus, Large Woody Debris	Maintain 300-foot habitat buffer for new upland disposal sites - Gateway 3 (W-101), Fazio B (W-96.9, interior ½) Mt. Solo (W-62) and Puget Island (W-44). Otherwise use existing dredged material disposal locations to avoid loss of non-impacted lands within ESA salmonid critical habitat zone.	Maintains important habitat functions.	Life of contract or action.	Maintain until new information becomes available that would warrant a change.
Shoreline Disposal					
CA-11	Habitat Complexity, Bathymetry & Turbidity, Feeding Habitat Opportunity, Suspension-Deposit Feeders, Deposit Feeders, Mobile Macroinvertebrates	Disposal of material in shoreline areas will be done concurrently with the dredging operation. Timing restrictions will be based on the dredging operation not the shoreline disposal operation. Only three erosive shoreline disposal areas are proposed - Sand Island (O-86.2), Skamokawa (W-33.4) and Miller Sands Spit (O-23.5).	Shoreline disposal sites are highly erosive and do not provide much, if any, juvenile salmonid habitat. Thus, it is not necessary to limit disposal actions to the in-water work period even though it is a shallow water area.	Continuous during disposal operations.	Maintain until new information becomes available that would warrant change.

Monitor Action No.	Indicator	Measure	Justification	Duration	Management Decision
CA-12	Stranding	Grade disposal site to a slope of 10% to 15%, with no swales, to reduce the possibility of stranding juvenile salmonids.	Ungraded slopes can provide conditions on the beach that creates small pools or flat slopes that strand juvenile salmonids when washed up by wave action.	Continuous during disposal operations.	Maintain until new information becomes available that would warrant change.
Ocean Disposal					
CA-13	N A	Dispose of in accordance with the site management and monitoring plan, which calls for a point dump placement of any material from the project during construction. The plan is to place any construction material in the SW corner of the Deep Water Site.	This action minimizes conflicts with users and impacts to ocean resources.	Continuous during dredging operations.	Maintain until new information becomes available that would warrant change.
General Provisions for All Disposal					
CA-14	N A	Dispose of hazardous waste.	The contractor, where possible, will use/propose materials that are environmentally friendly in that their waste is not regulated as a hazardous waste or is not considered harmful to the environment. If hazardous wastes are generated, material disposal will be done in accordance with 40 CFR parts 260-272 and 49 CFR parts 100-177.	Life of contract or action.	If material is released, it will immediately be removed and the area restored to a condition approximating the adjacent undisturbed area. Contaminated ground will be excavated and removed, and the area restored as directed. Any in-water discharge will be immediately reported the nearest U.S. Coast Guard Unit for appropriate response.

Adaptive Management

The AMT was established to provide input to evaluation and monitoring results and then render management decisions on adapting project implementation actions to counter or negate adverse effects. The AMT and proposed monitoring actions are intended to validate the conclusions of the 2001 BA, help minimize take of listed species, and ensure that proposed activities will not jeopardize listed species or adversely modify designated critical habitat [ESA Section 7(a)(2)]. The proposed monitoring plan, on which the AMT will rely for appropriate data, will monitor to address uncertainty and risk related to potential project effects over the long term and to validate assumptions used in analyzing project effects. The Biological Opinions specified that the adaptive management process would conform with NOAA Fisheries guidance found in *Federal Register* July 1, 2000. The draft implementation plan was transmitted to the Services on December 18, 2002. When finalized, the plan will be posted to the Corps' website.

The adaptive management process will include input from the tribes, state resource agencies and interested stakeholder groups. The meetings will be semi-annual and open to the public; evaluation proposals, results and decisions will be posted to the Corps' website. The input provided by the Columbia River Inter-Tribal Fish Commission, the tribes and the states will be considered in making recommendations to the adaptive management workgroup. The AMT is prepared to meet with the Columbia River Inter-Tribal Fish Commission, member tribes, and the states to discuss areas of concern before making decisions.

The Corps intends to have a process separate from the ESA adaptive management process for state issues related to water quality and coastal zone authorities because these issues are much broader. This process has been proposed and recently discussed with WDOE, ODEQ, Oregon Department of Land Conservation and Development, and USEPA as an adaptive management process to deal with 401 and CZMA concerns with both states, and to discuss both the channel improvement project and the MCR project from a regulatory perspective.

6.7.1.2.^{new} ESA Consultation Process Results for the Ecosystem Restoration Features

The 2001 BA determined that the new ecosystem restoration features might have a short term adverse effect on salmonids but that over the long term would benefit these species by: (1) providing shallow water and intertidal marsh habitat, (2) increasing connectivity and complexity, (3) provide rearing habitat for ocean-type salmonids, (4) increase detrital export, (5) maintain native tidal marsh plant communities, (6) increase benthic invertebrate productivity, (7) increase access/egress for ocean-type salmonids, and (8) improve access for adult salmonids to headwaters for spawning (for a more detailed discussion, see Exhibit H on the Corps' website).

6.7.1.3.^{new} Biological Opinions for the Final SEIS

On May 20, 2002, the NOAA Fisheries and USFWS transmitted their final Biological Opinions to the Corps (see Exhibit H on Corps' website). These opinions determined that the channel improvement project, including dredging, disposal, operation and maintenance, monitoring, adaptive management, evaluation, and ecosystem restoration, is not likely to jeopardize the continued existence of 12 federally listed salmonid ESUs, one listed DPS, one DPS proposed for listing, one candidate ESU, bald eagles, or Columbian white-tailed deer. Also, NOAA Fisheries concurred that the project is not likely to adversely affect northern (Steller) sea lions. The main findings of the Biological Opinions are summarized below.

- Direct impacts to listed fish could occur during dredging, disposal, and blasting activities. Fish could be pumped into dredges, thereby causing injury or death. Fish could be harmed by dumping of dredged sediments, as these materials could smother food items, create turbidity in the water, or release contaminants into the ecosystem. Removal of a single, deep-water rock formation would require underwater blasting, which could injure or kill fish.
- Indirect impacts to fish habitat, especially shallow water marshes and swamps, could occur during dredging and disposal. Changes to river and estuary currents (velocity), changes in water depth, and changes in ocean saltwater flow into the estuary could impact fish habitats.
- Protective measures that will minimize and avoid direct impacts to listed fish will be implemented. Monitoring and dredging restrictions, including keeping the dredge "cutterhead" in the river bottom where fish don't occur, will ensure fish are not pumped into dredges. Blasting restrictions, including timing restrictions and minimizing the "blast zone" will avoid impacts to fish. Disposing of dredged materials may create adverse turbidity effects for fish, but turbidity "plumes" will be minimized by disposal of materials into deeper water areas that have fewer fish. Some fish prey will be harmed by disposal of materials.
- Computer models indicate that the project's indirect impacts to Columbia River and estuary water depth and velocity will mainly occur in the navigation channel, not in important marsh and swamp habitats. These predicted habitat changes in the navigation channel are small, and will have limited impacts to listed fish. Limited shallow water and shoreline habitat will be eroded; however, these habitats do not currently provide important listed fish habitat. The models do indicate that ocean salt water will extend farther into the estuary than currently. Salt water extension will occur in the deep-water navigation channel, and the regulatory agencies believe this salt water extension will not impact listed fish, fish prey, or important marsh and swamp habitats.
- Contaminants samples collected in the navigation channel, where project dredging will occur, have not exceeded current USEPA or NOAA Fisheries contaminant thresholds. The science panel carefully reviewed all available information on contaminants and

project impacts to fish from these chemicals. As a result of these contaminants analyses, the two regulatory agencies have determined it unlikely that the project will risk the health and survival of listed species.

- Careful monitoring of long-term changes to shallow water beaches, marshes, and other important fish habitat features will occur. The monitoring actions will track project impacts and ensure that unanticipated effects can be rapidly addressed. An adaptive management team will be charged with altering or stopping the project, should any unforeseen impacts be discovered.
- These limited impacts, and the long-term monitoring and adaptive management programs, indicate the project will not jeopardize listed fish species. The project will not adversely modify or destroy critical habitat for salmonids.³
- Restoration and evaluation actions are integral components of the project. The ecosystem restoration features will restore 2,204 acres of tidal marsh habitat (Lois Island embayment, Miller-Pillar and Tenasillahe long-term, Phase 3); 177 acres of side-channel habitat (Bachelor Slough and Tenasillahe interim, Phase 1); 335 acres of embayment habitat (Lord-Walker/Hump-Fisher); 52 acres of riparian forest habitat (Bachelor Slough); 650 acres (Cottonwood/Howard Islands, Phase 2) for Columbian white-tailed deer reintroduction; provide for 470-839 acres (Shillapoo Lake) wetland management; purple loosestrife control in tidal marsh habitat between CRM 18-52; and will make available 38 miles of currently inaccessible salmonid habitat (tidegate retrofits).

Both Biological Opinions also contain Incidental Take Statements, which include mandatory terms and conditions. The terms and conditions implement and make enforceable the monitoring and compliance actions discussed above. They also provide additional detail regarding the adaptive management process, reporting, and other reasonable and prudent measures to minimize take of listed species.

On November 14, 2002, the USFWS proposed to designate critical habitat for threatened bull trout in the Columbia River Basin. Critical habitat is proposed for the Mainstem Columbia River Critical Habitat Unit, from the MCR (CRM 0) to Chief Joseph Dam (CRM 545). This proposed critical habitat unit includes the Columbia River within the channel improvement project action area. Section 7(a)(4) of the ESA requires, when critical habitat is proposed, that federal agencies to confer with the Service on any action which is likely to adversely modify or destroy proposed critical habitat.

The proposed Mainstem Columbia River Critical Habitat Unit serves as a migration corridor, provides foraging habitat, and is an overwintering area for bull trout. Three primary constituent elements are provided by the Columbia River to bull trout in the project

³ As noted previously, although NOAA Fisheries had formally designated critical habitat for salmonid species under its jurisdiction, the designations have since been withdrawn by the agency. Nevertheless, potential impacts of the project on the formerly designated critical habitat were analyzed in the 2001 BA and 2002 Biological Opinion. The USFWS has not yet formally designated critical habitat for bull trout.

area: water quality, migratory corridor, and an abundant food supply. The Corps believes that, based on the extensive analysis found in the Corps' 2001 BA and the USFWS's 2002 Biological Opinion, the project will not adversely modify or destroy proposed critical habitat in the action area. Therefore, no additional conferencing is necessary. Upon finalization of the bull trout critical habitat rule, and if the Columbia River within the project's action area is formally designated as critical habitat, the Corps will reinitiate ESA consultation with the USFWS. The AMT will remain updated on the USFWS's progress in finalizing the critical habitat rule, and ensure that coordination between the Corps and the USFWS continues.

6.7.2. ^{revised} Wildlife Species

The following updated information is being added to this subsection for the Final SEIS. Impacts to terrestrial species under USFWS jurisdiction for dredging, disposal, operation and maintenance and the three original ecosystem restoration features (Shillapoo Lake, tidegate retrofits and enhanced embayment circulation) and Miller-Pillar were addressed in the 1999 BA to the USFWS for the channel improvement project (1999 Final IFR/EIS, Exhibit G) and in the Final SEIS. Those determinations are incorporated by reference. New and updated information in this section relates to the potential effects of the new ecosystem restoration features on threatened and endangered wildlife species.

Project impacts to marine mammals and sea turtles were addressed in the BA for the DMMP (Corps 1998) and in the 1999 Final IFR/EIS. The conclusion of "no effect" from that BA also applies to the new ecosystem restoration features and evaluation actions, and is incorporated by reference.

Ten USFWS listed terrestrial species (Columbian white-tailed deer, bald eagle, marbled murrelet, western snowy plover, brown pelican, Oregon silverspot butterfly, *Howellia*, golden paintbrush, Bradshaw's lomatium, and Nelson's checkermallow) occur in the general project area for the new ecosystem restoration features. For detailed information on these species, see the BAs and Biological Opinions previously published for the DMMP (Corps 1998) and the 1999 Final IFR/EIS. Two species, the peregrine falcon and the Aleutian Canada goose, have been delisted since the 1999 Final IFR/EIS was completed and are not addressed in this Final SEIS.

Seven of the 10 species listed above and under USFWS purview (marbled murrelet, western snowy plover, Oregon silverspot butterfly, *Howellia*, golden paintbrush, Bradshaw's lomatium, and Nelson's checkermallow) do not occur in the areas identified for the new ecosystem restoration features and evaluation actions or were addressed in the previous BA (Exhibit G of the 1999 Final IFR/EIS). Therefore, it is the Corps' determination that there will be "no effect" to these seven species from the five new proposed ecosystem restoration features and the evaluation actions set forth in the 2001 BA. The new ecosystem restoration features and evaluation actions would have no effect on hump-backed, right, fin, sei, blue, or sperm whales, or on Pacific leatherback, loggerhead, green, or Pacific Ridley sea turtles. These species do not occur in the area for these restoration features or evaluation actions.

Potential impacts for Columbian white-tailed deer, brown pelicans, and bald eagles associated with the new ecosystem restoration features and evaluation actions are addressed in Chapter 8 of the 2001 BA for the channel improvement project (also see Exhibit H and the USFWS Biological Opinion on the Corps' website).

Implementation of the Tenasillahe Island interim ecosystem restoration feature may affect, but is not likely to adversely affect, Columbian white-tailed deer. The long-term restoration feature at Tenasillahe Island was determined to have no effect on Columbia white-tailed deer as implementation of the feature is contingent upon the species being delisted. The Lois Island embayment, purple loosestrife control, Cottonwood-Howard Island Columbian white-tailed deer reintroduction, and Bachelor Slough ecosystem restoration features may affect but are not likely to adversely affect bald eagles. Long term, the ecosystem restoration features are generally expected to be beneficial to bald eagles. Implementation of the Lois Island embayment, purple loosestrife control, Miller-Pillar, Tenasillahe Island interim and long-term actions, Lord-Walker and Hump-Fisher embayments, and Bachelor Slough ecosystem restoration features may affect, but are not likely to adversely affect Northern sea lions. Other ESA-listed species that may occur in the project area were determined not to be affected by implementation of the ecosystem restoration features.

As noted above, on May 20, 2002, the USFWS transmitted its final Biological Opinion to the Corps. This opinion, together with the 1999 USFWS Biological Opinion, determined that the channel improvement project, including dredging, disposal, monitoring, adaptive management evaluation, and all ecosystem restoration features, is not likely to jeopardize the continued existence of bald eagles or Columbian white-tailed deer.

The 2002 USFWS Biological Opinion also contains updated Incidental Take Statements for bald eagles and Columbian white-tailed deer. The updated Incidental Take Statements include mandatory terms and conditions to minimize take of listed species. Some of the benefits afforded to wildlife species associated with ecosystem restoration features include establishing secure viable sub-populations of Columbian white-tailed deer, and providing increased waterfowl, shore bird, wading bird, and raptor habitat.

The Corps will implement four terms and conditions outlined in the USFWS's Biological Opinion to monitor contaminants and bald eagle productivity. These terms and conditions represent an extremely conservative approach to assess the situation. Isaacs and Anthony (2002) provide detailed information on the breeding bald eagle population and their reproductive success for Recovery Zone 10, the lower Columbia River, from 1973 to present. Total breeding territories surveyed in 1973 was one; for 2002, that number increased to 95 of which 89 (94%) were occupied. Young/occupied territory in 2002 was 1.02. The 5-year average for young/occupied territory in Recovery Zone 10 has increased from 0.77 in 1998 to 0.92 in 2002. The habitat management goal for Recovery Zone 10 is 47 bald eagle territories, and the recovery population goal is 31 territories (USFWS 1986, *Pacific Bald Eagle Recovery Plan*). Present data demonstrates these goals have been substantially surpassed. As discussed elsewhere in the Final SEIS, the channel improvement project will not increase contaminant loading in the lower Columbia River; therefore, no impact to these species would be expected.

The following information on state-listed threatened or endangered species (sandhill cranes and lower Columbia River coho) has been added in response to comments on the Draft SEIS.

Sandhill crane use occurs in the Vancouver Lowlands and the species does occur in the vicinity of disposal site W-101.0 during fall and spring migration. They would be expected to utilize waste grain at these locations, provided tillage operations post-harvest of cereal grain or silage corn, the predominant crops grown there, has not eliminated the waste grain. Their use of the location is generally dependent upon crop grown and tillage operations implemented. Foraging for invertebrates such as earthworms may occur on tilled lands.

The Corps has reviewed the Final Washington State *Sandhill Crane Recovery Plan* and determined that the channel improvement project, including the proposed wildlife mitigation, is consistent with the final plan. The Corps will only use a 40-acre disposal site in the Columbia Gateway property. The wildlife habitat value of the property has been determined and wildlife mitigation efforts will be implemented at the Woodland Bottoms mitigation site. Mitigation at Woodland Bottoms will include 132 acres in long-term pasture and 97 acres in wetland habitat that will benefit sandhill cranes. As discussed above, the mitigation plan for the project assessed the habitat value of the W-101 disposal site and more than compensates for any impact to it. The wildlife mitigation plan provides for securing lands and habitat development in Woodland Bottoms which is documented by WDFW in their final sandhill crane recovery plan as lands used by this crane population. Given the extensive array and acreage of State Wildlife Management Areas (Sauvie Island, Oregon, approximately 12,000 acres; Shillapoo Lake, Washington, 2,371 acres; and Ridgefield National Wildlife Refuge, 5,150 acres) in the area, plus private agricultural lands, and the full mitigation effort for this project, it is not anticipated that the project would adversely affect sandhill cranes. Further, should the Port of Vancouver's independent Columbia Gateway development be implemented, the Port of Vancouver will develop mitigation measures for their project-related impacts.

Lower Columbia River native coho salmon listed as endangered under the State's ESA spawn in small, relatively low gradient tributaries in the lower Columbia River. Juveniles rear in these tributaries for two years before migrating to the ocean. Adult coho return to spawn as three year olds. Lower Columbia River coho are predominately of hatchery origin, with only the Clackamas and Sandy Rivers still having wild runs. Most of the coho juveniles in the channel improvement project area are of hatchery origin and are released from mainstream and tributary hatcheries as smolts. Coho juveniles are considered stream type since most of their rearing occurs in the tributary areas. Consequently, the analysis of the impacts to federally listed stocks with stream type juveniles by the channel improvement project consultation would apply for coho as well. In addition, all the monitoring and restoration actions proposed for the federally listed stocks would be beneficial for juvenile coho as well. Adult coho return in the same time frame as federally listed stocks of adult fall chinook and would use the same habitat. Consequently, the assessment done for adult fall chinook would be applicable for coho. As a result, the BA and Biological Opinions prepared

for the channel improvement project for the federally listed stocks in the Columbia River is considered adequate for the assessment of impacts to lower Columbia River coho.

In that assessment, the Corps and Services developed a conceptual model of the lower Columbia River ecosystem relationships that are significant for salmonids. This model also applies to lower Columbia River coho. Because the habitat requirements of adult salmonids are limited in the lower Columbia River, the model focuses on juvenile salmonids. The conceptual model incorporates the best available science for adult and juvenile salmonids. The basic habitat-forming processes-physical forces of the ocean and river-create the conditions that define habitats. The habitat types, in turn, provide an opportunity for the primary plant production that gives rise to complicated food webs. All of these pathways combine to influence the growth and survival and, ultimately, the production and ocean entry of juvenile salmonids moving through the lower Columbia River.

The conceptual model also demonstrates that the project complies with the Survival Guidelines in ORC 635-100-135. Specifically, the analysis demonstrates that the project should not degrade water quality, reduce stream flows, affect gravel in spawning areas, or adversely affect riparian habitat. The ESA analysis, including the conceptual model, demonstrates that the project and any incidental take associated with it will not adversely impact the long term conservation of lower Columbia River coho or its habitat, or significantly decrease the likelihood that the fish will recover. The ESA analysis also demonstrates that the project complies with the Survival Guidelines in ORC 635-100-135. Specifically, the analysis demonstrates that the project should not degrade water quality, reduce stream flows, effect gravel in spawning areas, adversely affect riparian habitat, or impair fish migration.

Although none of the changes identified in the conceptual model from the channel improvement project are believed to have a measurable effect on existing habitat types, the Corps is proposing to implement compliance measures to ensure effects will be minimized and will also monitor to confirm this conclusion. In addition, proposed ecosystem restoration and evaluation actions will benefit lower Columbia River coho. Based on the above, the project will not have a significant effect on native lower Columbia River coho.

The following information on mink and river otter has been added in response to comments on the Draft SEIS

Henny et al. (1996) evaluated mink and river otter populations on the lower Columbia River (CRM 11-119.5) and the influence of environmental contaminants. They conducted a population estimate for river otter and estimated 286 individuals comprised the population along the lower Columbia River. No population estimates were derived for mink, although Henny et al. (1996) states that the population is extremely low. Conversely, a habitat suitability evaluation they conducted for the lower Columbia River indicated that habitat was excellent in many segments. They determined that a number of organochlorine and polychlorinated biphenyls were significantly higher in river otter from the lower Columbia River than a Coast Range reference population. Henny et al. (1996) noted that these

contaminants were rarely correlated with CRM for age class 0 otters, never correlated for age class 1 otters, and almost always correlated with age 2+ otters. Low residue concentrations may explain the result for age 0 otters. Age 1 otters are dispersing from their natal areas and thus may confuse the issue. Adults (age 2+) are relatively sedentary in their home range. Their spatial information showed that river otter collected at CRM 119.5 typically contained the highest concentration of contaminants. The author's considered this to be the Portland-Vancouver area when in actuality it corresponds to Camas-Washougal, Washington. As discussed elsewhere in the Final SEIS, the channel improvement project will not increase contaminant loading in the lower Columbia River; therefore, no impact to these species would be expected.

6.8. Socio-Economic Resources

6.8.1. ^{revised} Economic Impacts

For the Final SEIS, the following information is added to this subsection. As discussed in Section 4.5.1.3, the ecosystem restoration features at Lois Island embayment and Miller-Pillar will impact commercial fishermen. A net-pen program and associated select area fishery have been established at Tongue Point. Restoration at Lois Island embayment would reduce the available acreage for commercial fishing by 191 acres or roughly 19% of the select area fishery acreage base at Tongue Point. The restoration feature would create intertidal marsh and intertidal flats habitat, which is not conducive to commercial fishing as compared to the uniform depth, open water area that currently exists.

Implementation of the Miller-Pillar restoration feature would eliminate 14% of the Miller Sands drift acreage base for drift net (gill and/or tangle net) fishing. The construction of the pile dike field plus development of tidal marsh habitat at Miller-Pillar would preclude commercial fishing activity at this location. Long term, the proposed restoration features are intended to aid the recovery, and ultimately assist in the delisting of Columbia River ESA-listed ESUs.

The reintroduction of Columbian white-tailed deer to Cottonwood-Howard Island is intended to assist development of another secure and viable population of this species. The feature would assist attainment of the Columbian white-tailed deer recovery plan goals and objectives, and aid efforts to delist this species. The Tenasillahe Island long-term feature, which is dependent on delisting of Columbian white-tailed deer, would provide a substantial acreage base for habitat restoration for ESA salmonids and many wildlife species. This would contribute to the delisting of ESA listed salmonids and aid in the reduction of socio-economic constraints associated with listed species.

Two identified project actions could affect the Dungeness crab population, dredging and disposal. As discussed in Section 6.6.1.2, dredging impacts to crab are anticipated to be small. The crab population in the estuary is only part of the total crab population in the area. Current entrainment evaluation indicates that the loss to the fishery during construction would be between 44,342 and 7,252 crabs (the increment associated with channel

improvement project is 26,285 crabs and 3,347 crabs) and between 8,953 and 4,035 crabs annually from maintenance. These losses compare to the average annual commercial harvest of 5.3 million adult crabs in the Washington and Oregon region around the Columbia River. Therefore, the project is not anticipated to adversely affect the crab fishery.

Under the preferred option, construction material from CRM 3-29 would be used for creation of tidal marsh habitat at the Lois Island embayment restoration feature. Dredged material would be placed in a temporary sump between CRM 18-20 in and adjacent to the southern boundary of the navigation channel. Crab populations at the temporary sump are expected to be low because water conditions do not meet the crabs' required salinity range. Additionally, with implementation of the preferred option, no dredged material would be placed in the ocean. Post-construction of the Lois Island ecosystem restoration feature, maintenance material would be used to create the Miller-Pillar ecosystem restoration feature and also be disposed at locations currently used for 40-foot channel maintenance (Rice Island, Miller Sands Spit, Pillar Rock Island, flowlane).

6.8.2. ^{revised} Land Use

The following updated information is being added to this subsection for the Final SEIS. However, no updating of the existing information in subsections 6.8.2.1 to 6.8.2.4, and subsections 6.8.3 through 6.8.5 and 6.8.7 is necessary because the new ecosystem restoration features and the revised disposal plan (with reduced dredging volumes, reduced rock removal volumes, reduced ocean disposal, reduced upland disposal site acreage, and reduced impacts on agricultural land, riparian habitat and wetland habitat) would have less impact on land use, air quality, noise, aesthetics, and cultural resources than would the alternatives analyzed in the 1999 Final IFR/EIS.

The ecosystem restoration features outlined in the 2001 BA will not result in any significant land use changes. Restoration features at Lois Island embayment and Miller-Pillar will result in the restoration of tidal marsh and intertidal flats habitat in areas presently 18-30 feet deep. No land use change is associated with the purple loosestrife control program. The interim and long-term features at Tenasillahe Island, Bachelor Slough, and Shillapoo Lake will occur on USFWS refuge lands or on a WDFW wildlife management area (Shillapoo) and will result in changes in management prescriptions. However, land use will still be directed toward fish and wildlife management. Tidegate retrofits for salmon passage and the improved embayment circulation at Walker-Lord and Hump-Fisher Island complexes would not impact land use practices at these locations. Reintroduction of Columbian white-tailed deer to Cottonwood and Howard Islands, given purchase of these islands by the Sponsor Ports, would not alter land use at these locations.

Additional information regarding consistency with land use requirements is provided in Exhibit K-8, *Consistency with Critical Areas Ordinances including Wetland Mitigation* and Exhibit K-9, *Consistency with Washington Local Shoreline Master Programs*.

6.9. ^{revised} Secondary Impacts

For the Final SEIS, the following updated information is being added to this subsection. Section 4.6.3 of the 1999 Final IFR/EIS and this Final SEIS identify the berthing areas that will require deepening to benefit from the project.

Deepening the federal navigation channel could result in future modification to other berthing areas and non-Corps side channels that are not part of the authorized federal project. The effects of this type of future activity are covered in the 1999 Final IFR/EIS. Further, development of any non-Corps side channels would be subject to regulatory review and approval under the Clean Water Act, Section 10 of the Rivers and Harbors Act of 1899, ESA, and NEPA.

In the 1999 Final IFR/EIS, there was an inconsistency that showed berths at the Ports of Astoria and Longview had dredged volumes of 46,500 cubic yards and 28,000 cubic yards, respectively. These berths are not expected to be deepened as a result of the project.

Current information indicates that the U.S. Gypsum sheetrock facility (formerly Port of St. Helens) near Rainier, Oregon will require berth deepening to benefit from channel deepening. Impacts from deepening at this site are anticipated to be similar to those expected for deepening other berths, as analyzed in the 1999 Final IFR/EIS. Any such deepening will be subject to additional environmental review and permitting, including additional sediment sampling, under NEPA, the Clean Water Act, and ESA prior to implementation.

6.10. ^{revised} Mitigation

The following information is being added to this section for the Final SEIS. However, no updating of the existing information in subsections 6.10.1, 6.10.2, or 6.10.2.1 is necessary (see the Final IFR/EIS, August 1999).

The Corps and the resource agencies have met and further coordinated since the issuance of the Draft SEIS. As a result, the Corps has modified the final mitigation plan. Exhibit K-5, *Wildlife and Wetland Mitigation*, includes a mitigation plan that provides further information regarding the creation of the mitigation sites. The plan concludes that the mitigation ratio for wetland impacts (approximately 12:1) significantly exceeds the ratio required under local and state requirements. Exhibit K-8, *Consistency with Critical Areas Ordinances Including Wetland Mitigation*, also contains a more detailed draft wetland mitigation plan for proposed Washington wetland mitigation projects (Woodland Bottoms and Martin Island).

The following changes to the project are likely to affect the conclusions in the habitat evaluation procedure (HEP) analysis used to develop the mitigation plan:

- Reduction in impact to riparian forest from 67 acres to 50 acres (approximately 25%) due to reduced disposal at Lord Island (O-63.5).

- Reduction in impact to agricultural lands from 200 acres to 172 acres (approximately 14%) primarily due to the reduced disposal acreage required at the Gateway site (W-101) and Mt. Solo (W-62).
- Reduction in impact to wetlands from 20 acres to 16 acres (approximately 20%) due to a reduction at the Mt. Solo site resulting from correcting a mapping inconsistency.
- Reduction of the Martin Island embayment mitigation action from 32 acres to approximately 16 acres to address the comments received from the State of Washington and Cowlitz County.
- Modification to Woodland Bottoms wetland mitigation unit is planned via removal of levees along Burris Creek to affect a more natural hydrologic regime.

The Port of Portland has purchased 190 acres at the Webb location near Westport, Oregon. Seventy-four acres will be used for wildlife mitigation purposes. In the event Martin Island is acquired in its entirety, the Corps would be agreeable to discussing additional actions on the 80-acre parcel currently not included in the HEP analysis. If the entire balance of the island is not available and additional mitigation is required, then the Corps intends to develop additional mitigation acreage on the Webb Site.

6.10.2.2. ^{revised} Proposed (Sponsor's Preferred) Disposal Alternative

See the discussion in Section 6.10 and Exhibit K-5, *Wildlife and Wetland Mitigation*, concerning updated information for this alternative for the Final SEIS.

6.11. ^{revised} Unavoidable Adverse Impacts

The following updated information has been added for the Final SEIS. Deepening the navigation channel would impact benthic and fisheries habitats not previously disturbed by dredging. Additional impacts could occur because these volumes are higher than maintenance dredging, however, the overall volume of dredged materials has been reduced by 21% and rock removal has been reduced by 17% (dredged sand reduced from 18.4 mcy to 14.5 mcy; rock removal reduced from 590,000 cubic yards to 490,500 cubic yards). Disposal of dredged material would adversely affect additional in-water and upland areas, including 172 acres of agricultural land, 50 acres of riparian forest habitat, and 16 acres of wetlands. As described in the preceding section, these habitat losses would be replaced through mitigation actions. Additional tidal marsh and intertidal flats habitat, wetlands, and riparian habitat would be restored through the proposed ecosystem restoration actions.

6.12. ^{revised} Cumulative Impacts

The following updated information has been added to this section for the Final SEIS. Cumulative impact is the impact on the environment that results from the incremental impact of the action when added to other past, present, and reasonably foreseeable future actions regardless of what agency or person undertakes such other actions. Cumulative impacts can result from individually minor but collectively significant actions taking place over a period of time (40 CFR 1508.7).

In accordance with the Council on Environmental Quality's guidance on cumulative effects, this analysis focuses primarily on effects that are truly meaningful, i.e., important issues of national, regional, or local significance. It is also focused on actions that potentially affect the same environmental resources as the channel improvement project, and on resources that have been historically affected by cumulative actions in the project area. A number of these important issues (e.g., impacts to wetlands) were identified in scoping undertaken for the 1999 Final IFR/EIS and in comments received by stakeholders and agencies on that document. This set of issues was refined as a result of the ESA consultation process, Washington's and Oregon's initial denial of Section 401 certification in 1999, and additional comments received on the Draft SEIS. Based on this iterative process of refinement, the cumulative impact analysis focuses on:

- water quality;
- sedimentation and sediment transport;
- sediment quality (in particular, toxic contamination);
- aquatic and wildlife resources (in particular, crab (including effects of ocean disposal), and wetland issues); and,
- threatened and endangered species (in particular, salmonids)

Certain past, present, and reasonably foreseeable future actions impact, or have the potential to impact, these environmental resources within the geographical area at issue for the project (see Chapter 2, *Study Area Description*). The identified actions are:

- operation and maintenance of the Mouth of the Columbia River Federal Navigation project (MCR);
- operation and maintenance, and potential deepening of the Willamette River navigation channel;
- operation and maintenance of the Upper Columbia-Snake River navigation channel project;
- operation and maintenance of the Federal Columbia River Power System (FCRPS);
- port, industrial, urban and agricultural development; and,
- large-scale restoration, recovery and remediation efforts.

Most of these actions are in the project's study area. The Upper Columbia-Snake River navigation channel is not in the study area, but is being reviewed specifically to respond to comments on the Draft SEIS.

This section is organized as follows. First, Subsection 6.12.1 summarizes the channel improvement project's impacts on each of the specified environmental elements. Next, Subsection 6.12.2 discusses past, present, and reasonably foreseeable actions, again with a focus on the selected environmental elements. A number of significant restoration, remediation, and recovery actions also are underway, or are reasonably foreseeable. They also are taken into account in the cumulative impact analysis. Finally, Subsection 6.12.3 evaluates the project's impacts, together with past, present, and future actions.

6.12.1^{new} Channel Improvement Project

The starting point in a cumulative impact analysis is a review of the potential impact of the proposed project. It is this impact that must be added to the impacts of other past, present, and reasonably foreseeable future actions. The potential impacts of the channel improvement project have now been well studied and documented. They are discussed in detail in the Corps' 1999 Final IFR/EIS, 2001 BA, and this Final SEIS, as well as in the NOAA Fisheries and USFWS Biological and Conference Opinions. They are briefly summarized below. References to the appropriate sections of the 1999 Final IFR/EIS and Final SEIS are provided.

Water Quality

Section 6.3 of this Final SEIS concludes that navigation channel dredging and in-water and ocean disposal would not result in significant water quality impacts.

Sedimentation and Sediment Transport

The potential impacts of the channel improvement project on sedimentation and sediment transport in the lower Columbia River, estuary and littoral cell have been updated in this Final SEIS. In general, they are expected to be indiscernibly small. Specifically, Exhibit J concludes that the project will not alter sand discharge to the Pacific Ocean. Accordingly, the project is not anticipated to affect coastal accretion or erosion (1999 Final IFR/EIS and Final SEIS at Section 6.2; Final SEIS, Exhibit J).

Sediment Quality

The channel improvement project will have no significant impact on sediment quality in the ocean, river or in the upland disposal sites. Review of thousands of samples indicates that sediments in the Columbia River portion of the navigation channel are primarily sand with a low percent organic content. They are suitable for unconfined in-water and upland disposal. Where contaminants have been detected, they are far below established levels of concern (i.e., DMEF, NOAA Fisheries). Accordingly, the dredging, disposal, and beneficial reuse of these sediments associated with the project (including ecosystem restoration features) is not anticipated to adversely affect sediment or water quality (1999 Final IFR/EIS and Final SEIS at Section 6.4).

Aquatic and Wildlife Resources

There is expected to be some crab entrainment caused by dredging as well as some impact associated with flowlane disposal in the lower estuary. Estimates of crab losses by direct measurement of entrainment are shown to be minimal [e.g., worst case total loss to the fishery from construction is 44,342 crabs (the increment associated with channel improvement project is 26,285 crabs), as compared with an annual harvest of 5.3 million crabs in the Washington and Oregon region around the Columbia River, the highest

projected annual loss to the fishery from maintenance dredging of 8,953 crabs]. Disposal impacts in the estuary and indirect effects are also expected to be minimal. Neither of these impacts from the channel improvement project is anticipated to have any significant effect on population structure or dynamics. Further, the Corps will use the salinity/crab distribution model to schedule dredging and disposal to avoid and minimize impacts to crab.

The preferred alternative for the channel improvement project shifts away from ocean disposal of dredged material for construction and the first 20 years of maintenance, as the dredged material previously planned for ocean disposal is currently planned to be beneficially used for two restoration features and placed in existing disposal sites (flowlane, Rice Island, Miller Sands Spit, Pillar Rock Island) in the estuary. Even if it should become necessary to dispose of material from the project in the ocean, the limited amount of material to be disposed as part of this project is not anticipated to have significant effects on crab populations in the Washington and Oregon region around the Columbia River (1999 Final IFR/EIS and Final SEIS at Section 6.6.1).

Dredging is not expected to have a significant impact on smelt spawning or distribution of smelt larvae in the main navigation channel. Disposal of dredged material in flowlane sites has the potential to bury juvenile sturgeon; however, in most normal disposal operations, sturgeon would likely escape burial. Disposal will cover the benthic invertebrates that sturgeon may use as a food supply. Loss of this food supply may reduce the value of these areas as rearing areas for sturgeon. Effects on sturgeon in deeper water areas are currently the subject of ongoing studies, which will be used, as necessary, to develop measures in consultation with state resource agencies to further avoid and minimize impacts to sturgeon (1999 Final IFR/EIS and Final SEIS at Section 6.6.1).

The ecosystem restoration features are neither expected to significantly impact crabs, nor to have any adverse impact on smelt due to their location relative to these resources. Construction of restoration features at Miller-Pillar and Lois Island embayment may initially impact sturgeon due to filling of the embayment and loss of benthic invertebrates. However, a net gain in overall estuarine productivity, including that for sturgeon, is anticipated (1999 Final IFR/EIS and Final SEIS at Section 6.6.1).

The project's potential wildlife impacts have been reduced since the 1999 Final IFR/EIS. The amount of habitat loss has been reduced (28 fewer acres of agricultural land affected, 17 fewer acres of riparian habitat affected, and 4 fewer acres of wetlands affected). There also has been a reduction in the total acreage of 29 upland disposal sites (i.e., exclusive of shoreline disposal sites and the Lonestar gravel pit), impacted by disposal actions (1,630 acres versus 1,681 acres; Final SEIS Section 6.2.3.1). Finally, under the preferred alternative, with beneficial reuse of dredged materials for construction of ecosystem restoration features at Lois Island embayment, Miller-Pillar, and other changes to the disposal plan, it is projected that ocean disposal should not be necessary for construction and the first 20 years of maintenance (1999 Final IFR/EIS and Final SEIS at Section 6.6.2).

Threatened and Endangered Species

After extensive analysis of the potential impacts of the channel improvement project, NOAA Fisheries and USFWS concluded that the project is not likely to jeopardize the continued existence of 12 federally listed salmonid ESUs, one listed DPS, one DPS proposed for listing, and one candidate ESU, or likely to destroy or adversely modify their designated critical habitat (2002 Biological Opinions). NOAA Fisheries and USFWS concluded that any expected impacts to key physical processes potentially affecting listed fish species would be limited and short-term in nature. They further concluded that there is some low level of risk and uncertainty surrounding the long-term biological response to physical change, but that monitoring and adaptive management will address the limited risk and uncertainties (Final SEIS Section 6.7.1). The project also is not likely to jeopardize the continued existence of bald eagles or Columbian white-tailed deer, and is not likely to adversely affect Steller sea lions (2002 Biological Opinions; 1999 Final IFR/EIS and Final SEIS at Section 6.7.2).

Sandhill cranes (state endangered) are present in the project area. The proposed 40-acre disposal site W-101.0 is within a larger area used by cranes during part of the year. The Corps' wildlife mitigation plan addresses the potential lost habitat value associated with use of this disposal site and more than compensates for the loss through the Woodland Bottoms mitigation site. The Corps has reviewed the Final Washington State *Sandhill Crane Recovery Plan* and determined that the channel improvement project, including the proposed mitigation, is consistent with the final plan. Mitigation at Woodland Bottoms will include 132 acres in long-term pasture and 97 acres in wetland habitat that will benefit sandhill cranes. Given the extensive array and acreage of State Wildlife Management Areas (Sauvie Island, Oregon, approximately 12,000 acres; Shillapoo Lake, Washington, 2,371 acres) and Ridgefield National Wildlife Refuge (5,150 acres) in the area, plus private agricultural lands, and the full mitigation effort for this project, it is not anticipated that the project would adversely affect sandhill cranes (1999 Final IFR/EIS and Final SEIS at Section 6.7.2).

Restoration and Mitigation Features

To accurately assess the impacts of the channel improvement project, it is necessary also to consider its positive effects, including the proposed ecosystem restoration component. The primary purpose of the proposed ecosystem restoration features is to restore habitats lost due to historic activities and to restore habitat conditions that would contribute to the recovery and long-term viability of listed fish species. These features also would provide benefit to many other species of fish and wildlife. In addition to the original ecosystem restoration features evaluated in the 1999 Final IFR/EIS, additional restoration features are proposed. Table S4-1 of the Final SEIS identifies acreage and stream miles provided by each restoration feature plus their type, function and value for fish and wildlife resources. The ecosystem restoration features added during ESA consultation represent an increment in the overall effort to address historic cumulative impacts to fish and wildlife habitat and resources in the study area (1999 Final IFR/EIS and Final SEIS at Section 6 generally).

Further, to the extent there are projected adverse effects to wildlife and wetlands, the channel improvement project includes a detailed mitigation plan to more than compensate for these effects. The mitigation plan was developed through a cooperative interagency process that included both state and federal resource managers. The mitigation plan involves development or substantial improvement to 194 acres of wetland habitat and 202 acres of riparian forest habitat, plus 132 acres of permanent pastureland. The wetland mitigation acreage represents about a 12-fold increase over projected losses, would result in a net gain of wetland habitat, and significantly exceeds the ratio typically required under local and state requirements. Riparian mitigation plans represent nearly a four-fold increase over projected losses and would also increase the riparian habitat acreage from existing levels (1999 Final IFR/EIS and Final SEIS at Section 6.10; 1999 Final IFR/EIS at Exhibit G; Final SEIS at Exhibit K-5).

6.12.2 ^{new} Past, Present, and Reasonably Foreseeable Future Actions

6.12.2.1 ^{new} Mouth of the Columbia River Federal Navigation Project

The Corps began dredging at the mouth of the Columbia River (MCR) in 1904. The MCR navigation project consists of a 0.5-mile wide navigation channel extending for about 6 miles through a jettied entrance between the Columbia River and the Pacific Ocean. The northerly 2,000 feet of the MCR channel is maintained at 55 feet (+5 feet for over-depth dredging), and the southerly 640 feet is maintained at 48 feet (+5 feet for over-depth dredging). The current MCR project refers to the Corps' ongoing dredging to maintain the Congressionally authorized MCR navigation channel, which has not changed substantially since 1984. The Corps removes 4-5 mcy of sand and sediment from the channel each year. There is no plan to deepen or otherwise change the Congressionally authorized MCR project at this time.

Historic MCR ocean disposal sites A, B, E and F have been used in their original USEPA-designated site dimensions since 1977 and in their expanded site dimensions since 1993 (sites A, B, F) and 1997 (site E). These sites were determined by USEPA (1991) to be inadequate to provide future capacity for the MCR project as well as the potentially deepened river navigation channel under study at the time. Site designation studies were conducted by USEPA and Corps, and two new ocean disposal sites selected for designation by USEPA (1999 Final IFR/EIS). A new in-water disposal site at the North Jetty was approved in 1999 for disposal of dredged material and to reduce erosion at the base of the jetty. In 2002, a proposal for placement of MCR maintenance material at Benson Beach was assessed. This site is within the surf zone of Benson Beach in Fort Canby State Park, north of the north jetty. The Corps Portland District provided dredged material to the "test project" that is sponsored by Pacific County under permit PN 200-2-001174 issued by the Seattle District, in order to determine the feasibility for addressing beach erosion. Approximately 44,000 cubic yards of MCR maintenance material was successfully placed at Benson Beach during the 2002 dredging season. The USEPA is currently initiating the designation for the Shallow Water Site (formerly expanded Site E) and a new Deep Water Site.

The baseline of the ongoing MCR project and its relationship to the channel improvement project study area is reflected in the assessment of existing conditions in the 1999 Final IFR/EIS (Section 5), Final SEIS (same) and 2001 BA (Chapter 2). A 1983 EIS (Corps 1983) addressed the MCR navigation channel and its maintenance. Information in the 1983 EIS has been updated through several environmental assessments. However, dredging practices have essentially remained the same since 1983.

The area off the MCR is a productive biological environment that is influenced by a variety of complex physical processes. The major short-term processes that affect the area are tides and local winds and currents. River flow also has a major seasonal impact on the area. The nearshore areas are subjected to high current and wave energy and populated by biological organisms adapted to this high-energy environment. The offshore area is less active and populated by organisms adapted to more stable environments (Corps 1999).

Bottom sediments at the proposed nearshore sites are primarily sand containing little or no silt or organic material. No rock or other unusual bottom features exist within the sites (Corps 1999). Baseline studies conducted at the Deep Water Site confirm that bottom sediments are primarily fine-grained sands, particularly within the smaller placement area. The percent fines increase with the increased distance from shore and with depth (Corps 1999; 1999 BA). Side scan sonar data from this site show that the surface is uniform and nearly featureless with little detectable differentiation in material type. The only apparent geomorphic feature within the surveyed area is a band of low relief seafloor undulations in the eastern portion of the site (Corps 1999; 1999 BA).

Previous studies have demonstrated that offshore biological communities exhibit considerable seasonal and yearly variation in structure and species composition. Species assemblages would likely vary between the proposed sites. Based on offshore area studies, the Deep Water Site would likely contain higher numbers and diversity of benthic species than nearshore areas (Corps 1999).

A variety of anadromous and resident fish occur within the Columbia River offshore area. Occurrence of adult migratory species in the offshore area is correlated primarily with their period of upstream migration. Juvenile migratory species are present following their migration out of the estuary. Resident species occur throughout the year with many using the estuary and nearshore area for rearing and as a nursery area. Species present include various flatfish, rockfish, and other demersal species (Corps 1999). Field reconnaissance at Benson Beach found evidence of clam populations, including razor clams. Dungeness crabs were also present within the area to be affected by disposal. The WDFW has stated that the Benson Beach area is too unstable to be a productive razor clam bed, juvenile rockfish, flatfish, or lingcod settling or rearing area, or baitfish spawning area. For the same reason, Dungeness crabs are rarely, if ever, found in the surf zone on this beach (Burkle 2000, personal communication).

Almost all of the Columbia River offshore area experiences some type of commercial fishing activity. The major fisheries are for bottom fish, salmon, crab, and other species of

shellfish. Crab fishing occurs from December to September with the majority of the catch occurring early in the season. Most crab fishing occurs north of the Columbia River mouth at depths ranging from 25 to 250 feet MSL. Dungeness crab population numbers are subject to large cyclic fluctuations in abundance. Catch records for the fishery are generally believed to represent actual population fluctuations. Modeling studies by Higgins et al. (1997) has shown that small scale environmental changes such as delay in the inshore currents in the Spring by a short period of time can dramatically impact survival of young of the year crab, but have no effect on adults and older juveniles inshore. Bottom fishing by trawl for flatfish, rockfish and pink shrimp occurs year-round throughout the entire offshore area, primarily at depths offshore from disposal sites. Commercial and recreational salmon fishing occurs over much of the offshore area. Fishing seasons and quotas are set by the Pacific Fisheries Management Council and state agencies (Corps 1999).

Federally listed threatened and endangered species which may occur in the offshore area include 15 wildlife species and 12 federally listed salmonid ESUs, one listed DPS, one DPS proposed for listing, and one candidate ESU. Wildlife species potentially affected by the disposal actions include blue, fin, sei, right, hump-backed and sperm whales, northern (Steller) sea lion, Columbian white-tailed deer, loggerhead and Pacific leatherback sea turtles, brown pelican, marbled murrelet, western snowy plover, bald eagle, and Oregon silverspot butterfly. Adults and juveniles of the listed salmonid stocks are present in the lower river year-round. Biological Assessments have been prepared to address the likely presence of these species within the Columbia River estuary and offshore area and potential effects of the proposed disposal actions (Corps 1999; 1999 BA).

Environmental Impact Studies

A number of studies provide information about the evolution of the MCR project and its environmental impacts. Relevant studies are identified in this section. The next section contains a discussion of the results of these studies.

Physical and biological resources of the Columbia River offshore area have been investigated since the mid 1970s, including recent site monitoring and evaluation studies conducted by the Portland District Corps for ocean disposal sites. Information from these studies is included in the 1999 Final EIS/IFR, in subsequent baseline studies for the Deep Water Site (Corps 1999; 1999 BA), and in this Final SEIS (Exhibit N, *Physical and Biological Studies of the Deep Water and Shallow Water Sites*). Although the Congress has authorized the channel improvement project and the MCR project as two separate projects, the Corps and USEPA have, where appropriate, coordinated the review of relevant impacts. For example, the 1999 IFR/EIS reviews the long-term disposal plan and its impacts for both the channel improvement and MCR. Similarly, crab entrainment studies conducted in 2002 reviewed impacts from both projects.

Concerns over possible entrainment of Dungeness crabs, salmon and other fish have been addressed by separate studies, such as *Entrainment of Dungeness Crabs by Hopper Dredge at the Mouth of the Columbia River, Oregon and Washington* (Larson 1993) and *Entrainment of Outmigrating Fish by Hopper Dredge at the Columbia River and Oregon*

Coastal Sites (R2 Resource Consultants, Inc. 1999). Recent studies of the impacts of dredging and disposal to Dungeness crabs include: initial estimates of crab entrainment during dredging (Pacific International Engineering, 2002 using the Dredge Impact Model of Armstrong et al. 1987 and Wainwright et al. 1992); statistical analysis of historic data to develop a rigorous sampling design for determining entrainment rates in the Columbia River; assessment of population level entrainment impacts (Pearson et al. 2003); and salinity-crab distribution model to estimate the portion of the estuarine crab population vulnerable to dredging (Pearson et al. 2003).

Findings of No Significant Impact (based on Environmental Assessments) were made in relation to the expansion of existing sites (1993 and 1997) and the development of new disposal sites (North Jetty Site, 1999; Benson Beach in May 2002). The Benson Beach Finding of No Significant Impact noted that Benson Beach could be used in conjunction with existing ocean disposal sites A, F, expanded Site E and the North Jetty disposal site. Although these existing sites were not the subject of the Benson Beach Environmental Assessment, use of the existing sites and the channel dredging was addressed by reference.

In early 2002, the Corps issued a *Statement of Findings* regarding maintenance dredging of the MCR (*Statement of Findings Maintenance Dredging at Mouth of the Columbia River*, May 2002). The proposed action was the maintenance dredging of approximately 4-5 mcy of material annually and the disposal of it in nearby designated offshore sites, and potentially at the Benson Beach demonstration site. The *Statement of Findings* is effective for five concurrent dredging years. The *Statement of Findings* referred to the *Environmental Assessment Maintenance Dredging at the Mouth of the Columbia River New Disposal Site Oregon-Washington*, May 2002 (Benson Beach Environmental Assessment); *Section 404(b)(1) Evaluation Columbia River at the Mouth Channel Maintenance New Disposal Site*, May 2002; and *Finding of No Significant Impact, Maintenance Dredging at the Mouth of the Columbia River New Disposal Site Oregon-Washington*, May 2002. The MCR project's specific effects on coastal erosion were considered in a 2002 study annexed to this channel improvement Final SEIS (Exhibit J).

Environmental Impact Findings

Water Quality

Dredging in the Mouth of the Columbia River will disturb bottom sediments. The States of Washington and Oregon most recently certified that this activity complied with state water quality standards on April 22, 2002. This certification documents that the MCR maintenance dredging does not have significant adverse impacts to water quality.

Sedimentation and Sediment Transport

Exhibit J, a 2002 study on sedimentation, found that the reduction in the Columbia River's net sand discharge to the MCR since the early 1900s is related to lower Columbia River flood discharges and not the navigation channel or the MCR jetties (Final SEIS, Exhibit J).

Declines in the Columbia River's average annual sand transport are related to global climate variations and upstream flow regulation. The reduced sand flow from the river has contributed to the reduction in sand accretion in the estuary, and the MCR jetties (constructed in the early 1900s) have reduced sand transport from the MCR into Baker Bay and across Clatsop Spit into the south channel caused by ocean waves. However, the jetties caused a large discharge of sand from the MCR and vicinity, to the ocean. The sand which was eroded from the inlet and south flank of the inlet following jetty construction has deposited in the outer delta, on Peacock Spit, and the shorelines along Long Beach, Washington, and Clatsop Plains, Oregon. Excluding the historic effect of the MCR jetties, navigation channel development and maintenance, including maintenance of the MCR project, has not altered the estuary's overall accretion/erosion or bedload transport patterns.

The 1983 MCR assessment concluded that material placed in disposal sites A, B and F was not expected to leave the general vicinity, and material from site E was expected to move mostly north and northwest with a smaller volume moving to the south and southeast depending upon waves and tidal conditions (Corps 1983). The area of shoaling was expected to move farther into the estuary. *Id.* Greater stratification and increased salinity intrusion was predicted to occur in the estuary, a slightly larger introduction of ocean water during flood tides was expected, but no problems with ship generated waves were anticipated. *Id.*

Placement of dredged material at Benson Beach is a demonstration project to determine its feasibility as a long-term disposal alternative that contributes sand to the littoral system. If effective, placement of dredged material at Benson Beach could help reduce the need for ocean disposal in the future (Benson Beach Environmental Assessment).

Sediment Quality

The material dredged for MCR maintenance is similar to that to be dredged for the channel improvement project, and similarly, does not raise significant concerns regarding contaminants. Material to be dredged from the MCR was evaluated in conjunction with the 1983 EIS (evaluation under Section 103, Marine Protection, Research and Sanctuaries Act, Appendix D, 1983 EIS) and has been reassessed periodically by the Corps and EPA. Periodic reassessment and characterization as needed would occur pursuant to the DMEF. Pollution levels of MCR sediments were generally low, and disposal of dredged material was predicted to have no adverse effect on the biota in the immediate vicinity. The sediments are in an area of high current and wave action, large bedload movement and shifting bars and are distant from significant sources of pollution. They also generally contain very low levels of organic materials and fine sediments.

Aquatic and Wildlife Resources

Preliminary data (Pearson et al. 2003) resulting from entrainment studies conducted aboard the *Essayons* hopper dredge from July 9 through October 13, 2002 showed that dredging of the MCR in 2002 (consisting of approximately 2.7 mcy) resulted in entrainment rates of 0.06 crab per cubic yard and were separated by age class: 0⁺ (0.003), 1⁺ (0.014), 2⁺ (0.032),

and 3⁺ (0.010). Entrained crabs were counted by age class and sex, and predicted adult equivalent losses were calculated. These calculations employed a modified version of Wainwright et al. 1992 (see Pearson et al. 2003). The data predicts how many crabs at a given age class would be lost to the fishery in the future based on numbers of crabs of various age classes entrained and how many of those crabs would have been expected to survive to a given age class based on known natural survival rates. Pearson et al. (2003) estimated adult equivalent losses at age 2⁺ of approximately 108,000 crabs and at age 3⁺ of approximately 49,000 crabs. The number of male recruits lost to the fishery was estimated at approximately 6,000 crabs. These calculations were based on sampling within an approximately 3 month period during the dredging season of one year, but abundance by age class can vary by year and by season (McCabe et al. 1986) and may explain differences in observed entrainment rates among studies.

Regarding macroinvertebrates and fishes, benthic communities disturbed by dredging are expected to recolonize the area (Corps 1983). Increased estuary salinities predicted from the 1984 deepening of the MCR project were expected to cause an upstream shift of marine habitat and marine species but the extent of change could not be predicted at that time. *Id.* However, now that the project had been deepened, future maintenance dredging of the existing MCR project is not anticipated to result in any further change in the salinity regime of the estuary. A loss of benthic organisms and a reduction of overall productivity are also expected as a result of material being placed in disposal areas. *Id.* Temporary turbidity is anticipated but is not expected to have a significant adverse effect on fish and other aquatic life forms (*Statement of Findings* 2002).

Fisheries (from Disposal at the Deep Water and Shallow Water Sites)

Fine sand (0.25 mm diameter) falls at about 6 feet per minute through water, which approximates the descent rate of the disposal material (Corps 1983). Therefore, dredged material would completely reach the bottom of the Shallow Water Site in about 10 minutes and the Deep Water Site in about 35 minutes. The natural sediment transport rate at the Shallow Water Site is high, moving mostly to the north and northwest (Corps 1983). Resuspension of disposed material is unlikely at the Deep Water Site once the material has settled to the bottom. Material placed in the Deep Water Site would likely remain in place or move very slowly. Sediment transport analysis conducted in the offshore area indicate that sediment movement through the Deep Water Site location is in dynamic equilibrium, i.e., rates of erosion and accretion are essentially equal (Corps 1999). Dredged material placed at the Deep Water Site would be coarser than sediments existing at the site but would contain similar chemical constituents (Corps 1999; 1999 BA). Previous studies at offshore sites demonstrate that ambient sediment covers the dredged material within about 1 year (Corps 1999). Little turbidity is expected from disposal of these sediments.

Benthic organisms within the disposal sites would be subjected to burial. Most benthic organisms would not likely survive burial from the disposal action. Recolonization of the site would be expected after disposal stopped. Demersal fish and shellfish would either avoid the disposal activity or be buried. Studies conducted by Chang and Levings (1978)

and the Corps (1999) on crab and flatfish burial from dredged material disposal concluded that test dumps had no apparent adverse effects on flatfish but resulted in some mortality to crabs. The tests resulted in no obvious physical damage such as cracked carapaces or detached legs. Most crabs remained on the surface following the test dumps. All but a few crabs that were buried during the test disposal were found dead after 72 to 96 hours. The cause of death was not apparent from the tests. These studies were conducted under limited conditions, i.e., small buckets or tanks, and are not conclusive relative to burial response under actual disposal conditions in the open sea. Portland District Corps biologists believe that survival rates of crabs from disposal in the open sea would be high (Corps 1999).

Preliminary data (MEC Analytical Systems 2002, unpublished progress report) show that in late spring/early summer of 2002, trappable crabs (trapped using crab pots) were more abundant, smaller, and had softer carapaces in the Shallow Water Site than in the Deep Water Site. The majority of crabs trapped at both sites were female. In fall of 2002, trappable crabs were more abundant and had harder carapaces in the Shallow Water Site than in the Deep Water Site, but were similar in size. The majority of crabs trapped at the Shallow Water Site were females and at the Deep Water Site were males. Crabs, in general, were more abundant and larger in fall than in late spring/early summer. Preliminary numerical data is presented below:

Site	Season	# Crabs	Crab Density ¹	% Female	Size ²
Shallow	sp/su	451	~25	~75	~5.1
Deep	sp/su	82	<2	~80	~5.5
Shallow	fall	852	~39	~69	~5.9
Deep	fall	1,313	~27	~10	~5.9

¹ Crab density measured in crabs per pot per 24-hour soak

² Crab size (carapace length) measured in inches

Two crab pot-sampling locations were located in what is now the 103 portion of the Deep Water Site in fall of 2002 (48 hour deployment of traps). A total of 124 crabs were trapped in these two sites and about 79% were males. These numbers do not appear aberrant compared to other sampling locations within the Deep Water Site, but data has not been analyzed yet.

The most abundant commercially important fish caught (via otter trawl) during both late spring/early summer and fall of 2002 at the Shallow Water Site included tom cod (228 caught in late spring/early summer and 45 caught in late summer) and eulachon (356 caught in late spring/early summer and 788 caught in late summer) and at the Deep Water Site included Pacific sanddab (1,072 caught in late spring/early summer and 249 caught in late summer) and rex sole (168 caught in late spring/early summer and 228 caught in late summer).

On wildlife, adverse impacts are minimal for pelagic birds and nonexistent for waterfowl, shorebirds, and terrestrial birds and mammals (Corps 1983). Also, the maintenance dredging planned for the next 5 years will not impact any wetland areas (Statement of Findings 2002).

The dredging and disposal activities associated with MCR maintenance are nearly identical to the activities proposed for the channel improvement project. Accordingly, conclusions regarding the project's limited short-term effects on listed fish suggest similar limited effects from MCR maintenance. A 1990 salmon study concluded that migrating juvenile and adult salmon are not entrained during MCR dredging since the dragheads are at or slightly below the bottom surface (Larson and Moehl 1990). A further study in 1999 also suggests that dredging activities as currently practiced are not likely to entrain juvenile salmonids, including those listed under the ESA (*Entrainment of Outmigrating Fish by Hopper Dredge at the Columbia River and Oregon Coastal Sites* 1999). The MCR maintenance complies with the ESA (NOAA Fisheries, 1999 Biological Opinion). In the 1999 Biological Opinion, NOAA Fisheries concluded that operation and maintenance program for the Columbia River navigation channel, which includes the portion of the channel at the MCR, was not likely to jeopardize the continued existence of listed species.

Restoration and Mitigation

A current *Site Management/Monitoring Plan*, as required by the Marine Protection, Research, and Sanctuaries Act and jointly prepared by USEPA and the Corps, will govern use of the ocean disposal sites in the future. The *Site Management/Monitoring Plan* covers issues such as: the times, quantities, and physical/chemical characteristics of dredged material dumped at the sites; disposal controls, conditions, and requirements to avoid and minimize potential impacts to the marine environment; and monitoring site environs to verify that unanticipated or significant adverse effects are not occurring from past or continued use of the disposal sites, and that permit terms are met (for non-Corps disposals). A new *Site Management/Monitoring Plan* will be included in USEPA's designation package and will need to be reevaluated and updated periodically.

6.12.2.2^{new} Willamette River Navigation Channel

Deepening

Deepening of the Willamette River federal navigation channel is part of the Congressionally authorized project for channel improvement. Specifically, the existing 600-foot-wide navigation channel is authorized to be deepened from -40 feet to -43 feet CRD, from river mile 0 to river mile 11.6 on the Willamette River. The three turning basins located at river miles 4, 10, and 11.7 on the Willamette River also are authorized to be deepened. Accordingly, the 1999 Final IFR/EIS includes an assessment of the environmental impacts of the Willamette deepening project.

However, as indicated earlier in this Final SEIS, the Willamette River portion of the project has been deferred because large parts of the Willamette channel have been listed by USEPA on the National Priorities List under CERCLA on December 1, 2000. A site investigation performed by the USEPA found a pattern of contaminated sediments in Portland Harbor (from approximately river miles 3.5 to 9.2). As a result of that site investigation and subsequent to the issuance of the 1999 Final IFR/EIS and Chief's Report to Congress, this

stretch of the river was listed. Subsequently in March 2002, a memorandum of understanding was signed by USEPA Region 10, the Corps Portland District, and the Oregon Department of Environmental Quality to facilitate and encourage a more streamlined and effective means of carrying out the agencies' statutory and regulatory responsibilities.

Although the USEPA and Corps are coordinating closely on all sediment and permitting related activities in the Willamette River, the Corps has made it clear that any deepening of the Willamette River will be deferred until the completion of the remediation investigation and remediation decisions related to contaminated sediments in Portland Harbor. The Superfund listing creates uncertainty surrounding the timing and details of any channel improvements in the Willamette River.

Cleanup under the Superfund program will involve extensive study of the area, evaluation of alternatives, and public involvement in the selection of a final remedy that is protective of human health and the environment. The final remedy selected by USEPA may result in changes to the previously proposed channel improvements for the Willamette River—changes that cannot be anticipated at this time. Any improvements to the channel in the Willamette River will therefore take place under conditions different from those found today, i.e., conditions reflecting the Superfund cleanup. Accordingly, the sponsor ports and the Corps will not move forward on deepening in the Willamette River channel until plans are fully in place for any necessary remediation. At such time as the sponsor ports and the Corps may proceed with channel improvement activities for the Willamette River, the Corps will conduct appropriate additional NEPA review.

As noted above, the potential environmental effects of the authorized Willamette River channel deepening were reviewed in the 1999 Final IFR/EIS. Effects unrelated to sediment contamination (e.g., potential effects of dredging activities on migrating salmonids) are not qualitatively different from the effects of the channel improvement project generally and therefore, are anticipated to be limited. Further, for the reasons discussed for the channel improvement project generally, Willamette deepening would not be anticipated to have any effect on sediment transport and sedimentation in the estuary or mouth of the river. Similarly, because the project is located well above the reach of the river inhabited by Dungeness crab, Willamette deepening would have no effect on this resource.

However, attempting to further specify impacts of Willamette deepening at this time would be largely speculative because the details of the cleanup (e.g., quantities and locations of material to be removed) are not yet known. Accordingly, the details of deepening activities required after cleanup (e.g., the quantity, location and nature of channel material remaining after cleanup that needs to be dredged for deepening) also are not yet known.

Again, at such time as the sponsor ports and Corps may proceed with channel improvement activities for the Willamette River, appropriate additional NEPA and ESA review will be conducted. Detailed analysis of issues related to Willamette River contaminants will be available as part of USEPA's *Remedial Investigation and Feasibility Study*.

Maintenance

Maintenance dredging for the deep draft navigation channel in the Willamette River is conducted, on average, every 3-4 years. The last maintenance dredging operation was in 1997. Up to 0.5 mcy of material is removed each time the 40-foot authorized channel is dredged, and up to 2 feet of advance maintenance dredging is performed. The dredged material ranges from medium silt to medium sand. In recent history, this material has been placed in the flowlane in the Columbia River near river mile 100. Since the lower Willamette River was placed on the National Priority List for contaminated sediments, no maintenance dredging has been performed. Most of these contaminated sediments occur outside the navigation channel. Any future maintenance dredging of the Willamette River navigation channel will be conducted pursuant to the March 2002 Letter of Agreement between USEPA Region 10, Oregon Department of Environmental Quality, and the Corps concerning the lower Willamette River.

With the exception of dredging potential contaminated sediments, the impacts of which will be minimized through the letter of agreement, effects of dredging the deep-draft navigation channel are expected to be similar to that described for the channel in the Columbia. The dredging and disposal locations are below the photic zone and the migratory corridor for fish. Consequently, these areas do not provide much, if any, productive habitat for aquatic species.

6.12.2.3^{new} Upper Columbia/Snake River Navigation Channel

The Columbia and Snake River navigation projects include the entire inland navigation system that provides navigation from the mouth of the Columbia River near Astoria, Oregon, to port facilities on the Snake and Clearwater Rivers in Lewiston, Idaho, and Clarkston, Washington. This section discusses the portions of the navigation projects that are above the Bonneville Dam, the Upper Columbia-Snake River navigation waterway. This waterway has historically required dredging to, among other things, maintain shoal areas that impede navigation, and remove sediment that impedes hydraulic flow.

The navigation channel between Vancouver, Washington and The Dalles, Oregon, is maintained annually through hopper dredging in various reaches, mostly below Bonneville Dam. The channel is dredged to provide 17 feet of depth for users, with 2 feet of advance maintenance performed to ensure adequate depth between dredging operations. An average of 150,000 cubic yards of medium grain sand is removed from shoals that occur in the navigation channel each year. This material is placed in the flowlane within or adjacent to the navigation channel downstream of the dredging areas.

Impacts from dredging this reach are expected to be minimal. The areas to be dredged are disturbed annually and are at or below the photic zone in the Columbia. Consequently, these areas are not likely very productive and do not provide much highly productive habitat for aquatic resources including listed species. Dredging occurs during the recommended in-water work period of 1 November to 28 February; consequently, the impacts to migrating salmon are expected to be small.

The navigation channel above The Dalles Dam is authorized to 14 feet of depth. It rarely requires maintenance dredging. The last time it was dredged, a total of about 25,000 cubic yards were removed. Any dredging that would be done in this reach would take place between mid-December and mid-March. It is unlikely that the minimal dredging that occurs in this reach would have any major effect on aquatic resources or listed species. Though there would be some alteration of habitat during dredging and disposal, the sites would be expected to recover to the previous level of production and remain at that level until it was disturbed again in the future.

In 2002, the Final DMMP/EIS presented the Corps programmatic plan for the five locks and dams on the *upper* portion of the Columbia and Snake Rivers navigation project: McNary, Ice Harbor, Lower Monumental, Little Goose, and Lower Granite. The plan provides for maintenance of the navigation channel for 20 years, for management of dredged material from these reservoirs; and for maintenance of flow conveyance capacity at the upstream extent of the Lower Granite reservoir for the remaining economic life of the dam and reservoir project (to year 2074). The DMMP defined an operations and regulatory preference for beneficial use of all dredged sediments where practicable and established a Local Sediment Management Group to review sediment issues and help implement the DMMP. The USEPA, Region 10, was a cooperating agency on the DMMP/EIS and will co-chair the management group with the Corps. The DMMP anticipated formation of the Regional Dredging Team.

The DMMP/EIS contains four alternatives to maintain the existing, authorized federal projects. Alternative 1 continues historic maintenance of the authorized navigation channel in the study area. It would involve maintenance dredging with in-water disposal. Alternative 2 involves the same dredging activities as alternative 1, but with changes in dredging methods, work window, and disposal location for silt. Dredged materials would be placed in water to create shallow-water fish habitat beneficial to salmonid species. This alternative also includes raising the levee at Lewiston up to 3 feet at critical locations to maintain flow conveyance. Alternative 3 uses the same dredging activities as Alternatives 1 and 2, but with upland disposal of dredged material. The 3- foot levee raise is included. Alternative 4 (the selected plan) also considers the same dredging activities and the 3-foot levee raise. In addition, Alternative 4 includes a management strategy for dredged material that focuses on beneficial uses: for each dredging activity, the Corps would identify potential beneficial uses and coordinate the uses with a Local Sediment Management Group.

Although the DMMP/EIS is currently the subject of a preliminary injunction, the injunction is based on the alleged failure to adequately consider alternatives, not the accuracy or adequacy of information regarding potential impacts contained in the document.

Relevant Impacts

The DMMP/EIS reviews the environmental impacts of Alternatives 1 through 4. Since Alternative 1 represents historic maintenance, its effects as outlined in the DMMP/EIS indicate the past and present environmental impacts of the Upper Columbia/Snake

navigation project. The impacts of the Upper Columbia/Snake navigation project apply only to the extent that they affect the environment or resources of the channel improvement project area.

Water Quality

All alternatives considered in the DMMP/EIS for the Upper Columbia/Snake River navigation project are expected to have a temporary, direct adverse effect on water quality, mostly because of turbidity plumes caused by the dredging and, where proposed, in- water disposal. However, it is anticipated that elevated turbidity levels would be confined and will stay within the “mixing zones” (established under Clean Water Act Section 401 water quality certification) allowed for this activity, and allowable turbidity downstream of the mixing zone would not be exceeded.

To date, sediment contaminant levels have been at low levels that allow in- water disposal, and this is not expected to change. However, the Corps will continue its sediment sampling protocols.

Construction of levees proposed under Alternatives 2, 3, and 4 could result in short-term, minor water quality impacts due to runoff and erosion. These concerns would be minimized with the implementation of a site-specific Erosion/Sedimentation Control Plan and construction best management practices. The levees would also be stabilized by hydroseeding immediately after construction.

Direct, temporary, minor impacts due to erosion may occur as a result of construction and disposal operations at the Joso upland site as proposed in Alternative 3. Mitigation measures would be implemented to offset any impacts, including use of a containment berm, implementation of an Erosion/Sedimentation Control Plan and best management practices, and regular stabilization during disposal.

Impacts from beneficial use of the dredged material proposed in Alternative 4 could vary depending on the use but would be subject to Erosion/Sedimentation Control Plan measures and best management practices.

Sedimentation and Sediment Transport

Most of the sediment to be dredged in the Upper Columbia/Snake navigation project is sands and gravel that have deposited in the reservoirs. The only sediment impacts downstream of the dredging and disposal sites are expected to be localized, short-term increases in turbidity, caused by the release of small amounts of fine-grained sediments. Therefore, maintenance activities in the Upper Columbia/Snake navigation project would not be anticipated to have any effect on sediment transport and sedimentation in the estuary or mouth of the Columbia River.

Sediment Quality

Comments on the channel improvement project Draft SEIS raised concerns about whether dredging upriver contaminated materials may redistribute contaminants and represent a risk for salmon that utilize these habitats. The DMMP for the Snake/Upper Columbia Navigation project concludes that fine sediment is the only dredged material that is potentially contaminated, and sampling data indicates little if any contamination in fine river sediments in the areas proposed to be dredged. Thus, there is a low risk of changes to water quality because of release of chemicals of concern from the sediments. Dredged sediments will be evaluated pursuant to the revised regional *Dredged Material Evaluation Framework* and guidance of the Regional Dredging Team to check for any change over time.

Aquatic and Wildlife Resources

The Upper Columbia/Snake navigation project has no impacts on aquatic and wildlife resources (e.g., Dungeness crab and wetlands) in the study area of the channel improvement project.

Threatened and Endangered Species

Anadromous salmon and steelhead stock from several ESUs listed as threatened or endangered under the ESA that are found in the channel improvement project area also pass through the McNary reservoir and lower Snake River. The dredging activity associated with all four alternatives would have the same indirect, minor, short-term effects on aquatic ecosystems by disturbing sediments and removing macroinvertebrate species (which are prey species for resident and migratory fish). However, recolonization of macroinvertebrates would occur relatively rapidly. Because dredging and disposal activities would only occur during authorized in-water work windows, impacts to salmonids would be minimized. NOAA Fisheries has determined that the proposed actions would not cause jeopardy to anadromous fish species listed under the ESA.

The creation of in-water fish habitats under the DMMP selected alternative 4 works to mitigate the environmental impacts on salmonids. Some of the beneficial uses proposed in alternative 4 create salmonid habitat directly. Other potential beneficial uses may reduce risks to listed species (e.g., capping of contaminated sediments).

Moreover, the Corps has recently selected the action it will take as a result of the Lower Snake River Juvenile Salmon Migration Feasibility Study. The study examined ways of improving salmon passage through the four lower Snake River dams and reservoirs: Ice Harbor, Lower Monumental, Little Goose, and Lower Granite. Structural changes in the selected action include spillway improvements, upgrading adult fish passage systems, upgrading juvenile fish facilities, additional fish transportation barges, turbine upgrades, removable spillway weirs and surface bypass structures. Operational changes include improving the coordination and implementation of spill, flow augmentation and juvenile fish transportation.

6.12.2.4^{new} Federal Columbia River Power System

Another ongoing project that directly affects the Channel Improvement Project study area is the Federal Columbia River Power System (FCRPS). The Bureau of Reclamation and Corps own and operate the system of hydropower projects on the Columbia and lower Snake Rivers, which collectively provide about 75% of the electricity used by Pacific Northwest residents and industries. The Bonneville Power Administration (BPA) markets and distributes the power generated from these dams.

The FCRPS project facilities include Bonneville, The Dalles, John Day, and McNary Dams (Lower Columbia River facilities); Ice Harbor, Lower Monumental, Little Goose, Lower Granite, and Dworshak Dams (Lower Snake River/Clearwater River facilities); Grand Coulee, Albeni Falls, Libby, Hungry Horse and Chief Joseph Dams, and Banks Lake Pump Storage (Upper Columbia River facilities). The FCRPS is relevant to the cumulative impacts analysis only to the extent to which it interrelates with the environment or resources of the channel improvement project area.

Water Quality

The operation and configuration of the FCRPS has two primary effects on water-quality-related salmon survival: dissolved gas supersaturation and water temperature. Total dissolved gas is generated when water is spilled at dams. Falling water entrains volumes of air and carries the air into the stilling basin. Hydrostatic pressure at depth in the basin forces the entrained gases into solution, causing supersaturation. Spilling waters is the most benign way to move non-transported juvenile downstream migrants past the dams, while avoiding passage through the turbines. But, the total dissolved gas generated by the spilling strategy can exceed current water quality standards (110% total dissolved gas). To address this problem, nearly all Columbia/Snake River projects now have spill deflectors, which reduce the impacts of dissolved gas supersaturation. In addition, monitoring programs now appear to accurately detect total dissolved gas levels, and spill adjustments can be made to restrict gas below the level considered safe for salmonids.

Hydroelectric dams also modify natural water temperature regimes in the mainstream Columbia River. Snake River basin storage reservoirs are known to affect temperatures by extending water residence times and by changing the heat exchange characteristics of affected river reaches. As with dissolved gas supersaturation, dam operation is manipulated to address the problem. To minimize water temperature related effects on juvenile fall chinook, Dworshak Dam is routinely operated to release large amounts of cool water during the months of July and August when elevated temperatures are a concern.

Wide-scale mitigation measures for water quality are also proposed. The 2000 FCRPS Biological Opinion recommended that the action agencies, coordinating through the Water Quality Team, should annually develop a 1- and 5-year water quality plan for operation and configuration measures at FCRPS projects. Appendix B of the Biological Opinion accordingly contains a federal agency proposal for development of a water quality plan for the Columbia River mainstem.

Sedimentation and Sediment Transport

The FCRPS reservoirs alter river flows via flow regulation and this, in turn, has permanently altered river and sediment discharges in the channel improvement project area. The reservoirs store water during the spring snowmelt, reducing the freshet discharges. The reduced discharges have caused large reductions in sediment transport during the spring freshet. The stored water is released during the fall and winter to increase hydroelectric power generation. Those releases cause little increase in sediment transport because the river discharges remain below critical levels to initiate large-scale sediment transport. Hydroelectric power releases also cause relatively minor hourly river discharge fluctuations that do not alter sedimentation (this Final SEIS, Exhibit J).

Sediment Quality

While the FCRPS may decrease the potential downriver transport of any contaminated sediments by trapping them behind the dams, the operation of the FCRPS is not anticipated to have any significant adverse effect on sediment quality within the channel improvement project study area.

Aquatic and Wildlife Resources

The FCRPS has altered flow patterns in the Columbia River, contributing to reductions in flood levels and frequencies, and altered seasonal salinity intrusion in the estuary. The reduced flooding has subsequently reduced the input of detritus (nutrients) into the river. This reduction in nutrient supply and the altered salinity pattern has likely had some impact on the river's aquatic resources. The reduced flooding also has impacted riparian habitat and wildlife along the river (see next section regarding threatened and endangered species).

Threatened and Endangered Species

Construction and operation of the FCRPS have affected anadromous salmonids in several ways. These include inundation of spawning habitat, changes in migration rates and conditions of juvenile fish through the reservoirs and at the dams, changes in adult migration conditions, and improved habitat for predators of juvenile salmonids. Hydrosystem effects include both direct (e.g., turbine mortality) and indirect effects (e.g. delayed mortality, due to such mechanisms as changes in estuary arrival times; FCRPS Biological Opinion 2000).

In 2000, a FCRPS Biological Opinion considered whether the effects of FCRPS configuration, operations, and maintenance are likely to jeopardize the continued existence of 12 listed species of salmonids and cause the destruction or adverse modification of their designated critical habitat (at the same time, the Bureau of Reclamation also consulted on 19 of its projects in the area. The Biological Opinion does not apportion the relative impacts of the FCRPS and Bureau projects).

The 2000 FCRPS Biological Opinion concludes that the proposed operation and configuration of the FCRPS and Bureau of Reclamation projects are likely to jeopardize the continued existence of Upper Columbia River spring chinook salmon, Snake River fall chinook salmon, Snake River spring/summer Chinook salmon, Snake River steelhead, Upper Columbia River steelhead, Middle Columbia River steelhead, Columbia River chum salmon, Snake River sockeye salmon, and to adversely modify their designated critical habitat. However, the Biological Opinion proposes Reasonable and Prudent Alternatives in relation to these fish and concludes that, with their implementation, the projects are *not* likely to jeopardize the continued existence of these ESUs or to destroy or adversely modify their designated critical habitat. These conclusions are based on elements of the Reasonable and Prudent Alternatives that remedy shortcomings of the projects. The Biological Opinion also includes an incidental take statement containing various terms and conditions to avoid and minimize take to the maximum extent practicable. For example: ESA-listed fish must be handled with extreme care and kept in water to the maximum extent possible during sampling and processing; adequate circulation and replenishment of water in holding units is required; when using gear that captures a mix of species, ESA-listed fish must be processed first to minimize the duration of handling stress.

The Biological Opinion also concludes that the projects are not likely to jeopardize the continued existence of the Upper Willamette River chinook salmon, Lower Columbia River chinook salmon, Upper Willamette River steelhead, Lower Columbia River steelhead, or to destroy or adversely modify their designated critical habitat.

Further relevant information is contained in a series of White Papers produced in 2000 by NOAA Fisheries. One White Paper considers the effects of river flow through the hydropower system on anadromous salmonids. Other White Papers address the effects of dam passage on salmonids, and the effects of transporting juvenile salmonids around dams.

The continued operation of the FCRPS also is not likely to jeopardize the continued existence of bull trout in areas downstream of Hells Canyon Dam and in the Upper Columbia River Basin (USFWS 2000 Biological Opinion).

Comments on the channel improvement project SEIS suggest the possibility of oil spills or leaks from the dams, and impacts on salmonids and water quality. The impact of oil spills, leaks, and discharges from the Columbia River dams is addressed in existing documents. The Corps provides a single consolidated document (Spill Response Plan) to meet multiple spill response planning requirements as identified under OSHA's HAZWOPER Standard, RCRA's Contingency Plan, SARA Title III's Emergency Planning and Community Right To Know Act, the Oil Pollution Act, the Clean Water Act, and the State, Area, Regional, and National Contingency Plans for spill response.

In the 1980s, the Corps Portland District recognized the potential impacts of having polychlorinated biphenyls (PCBs) in and around its operating projects. The Corps has taken prudent and proactive steps to eliminate the use of PCBs in following areas: main unit transformer oil; bushings and associated electrical equipment (sealed and oil-filled type); light ballasts.

The impacts of historic leaks and spills from Columbia River dams within the Portland District over the last 10-15 years are a matter of public record. The National Response Center (<http://www.nrc.uscg.mil>) provides detailed information on the type and size of spills from Northwest power projects. In all cases, following relevant federal and state guidance, the Corps has worked cooperatively with state and federal agencies to remediate spills and confine them within the structure (powerhouse, spillway, etc.).

The 2000 FCRPS Biological Opinion does not consider the possibility of oil spills or leaks from the dams as a potential significant impact.

Restoration and Mitigation Projects

The continued operation and maintenance of the FCRPS, as analyzed in the 2000 Biological Opinions, includes a number of mitigation measures. For example, it augments water volume to improve juvenile salmonid migration.

Moreover in November 2002 the BPA, the Bureau of Reclamation and Corps released the *Final 2003/2003-2007 Implementation Plan* for the FCRPS (incorporated by reference). The plan identifies and describes the specific measures that the three agencies plan to implement in fiscal years 2003-2007 and addresses the actions called for in the 2000 Biological Opinions. The goals of the plan are: to avoid jeopardy and assist in meeting recovery standards for Columbia Basin salmon, steelhead, bull trout, sturgeon, and other ESA-listed aquatic species that are affected by the FCRPS; to conserve critical habitats upon which salmon, steelhead, bull trout, sturgeon, and other listed aquatic species depend, including watershed health; and to assure tribal fishing rights and provide non-tribal fishing opportunities; and balance other needs (e.g. other native fish and wildlife, human needs; tribal culture resources).

Mitigation efforts by the agencies are already underway pursuant to the “Endangered Species Act 2002 Annual Implementation Plan for the Federal Columbia River Power System” (2002 1-Year Plan).

6.12.2.5^{new} Port, Industrial, Urban and Agricultural Development

While not caused by or connected to the channel improvement project, some urban, industrial and port development is reasonably foreseeable within the project study area. Of these potential projects, the Port of Vancouver’s proposed Columbia Gateway development is analyzed in detail here because is perhaps the largest and also was the subject of significant comments on the Draft SEIS. When the 1999 Final IFR/EIS was prepared, the Port of Portland’s West Hayden Island Development project had been proposed and was in the process of being permitted. However, since that time the Port has withdrawn its development plans, withdrawn its permit applications, and is holding the property in long-term strategic reserve. Therefore, the project is not considered reasonably foreseeable for the purposes of a cumulative impact analysis.

Columbia Gateway Project

The Gateway project refers to the Port of Vancouver's proposal for development at Columbia Gateway in Vancouver, Washington. The property is located in the Vancouver Lake lowlands area and spans river miles 100-102 along the Columbia River. The project involves planned development of water, heavy, and light industrial uses. The proposal involves 1,094 acres of property, designated by the Port as parcel 2 (35 acres), parcel 3 (517 acres), parcel 4 (112 acres), and parcel 5 (430 acres).

A Draft EIS for the Gateway project was released on August 27, 2002. The Gateway DEIS analyzes four alternatives. Alternative 1 is No Action. Alternative 2 proposes water development of parcel 3, and no development on parcels 4 and 5. Alternative 3 involves heavy industrial and water development in parcel 3 and light industrial development in parcel 5. Alternative 4 involves water development in parcel 3, and light industrial development in parcel 5. The Gateway FEIS is scheduled to be completed in early 2003.

The Gateway DEIS reviews the potential significant adverse impacts of Alternatives 1 through 4, as well as the mitigation measures. Some of the impacts are relevant to the cumulative impact analysis of the channel improvement project and some are not. Those of key relevance are discussed in more detail.

Water Quality

No significant adverse impacts on water quality are expected under Alternative 1. Under Alternatives 2, 3, and 4, development operations are expected to generate industrial wastewater, sanitary sewage, and stormwater. Pollutants will accumulate on paved surfaces and be washed into the storm drain system. Placement of dredged material could potentially affect water quality. Construction will cause the soil surface to be exposed and erosion could occur. Eroded sediment could be washed into surface water bodies. The Gateway DEIS provides for the following potential mitigation measures: discharging industrial wastewater and sanitary sewage to the City's treatment systems; implementing storm water treatment measures; undertaking construction and discharging water in accordance with new or revised National Pollutant Discharge Elimination System permits, and employing best management practices for construction activities in or near wetlands and buffers.

Sedimentation and Sediment Transport

The Port's proposed development activities at Gateway are not anticipated to have any effect on sediment transport and sedimentation in the estuary or mouth of the river. The Gateway DEIS addresses localized sedimentation issues in its discussion of earth and geotechnical impacts. There are no expected earth and geotechnical impacts under Alternative 1. Under Alternatives 2, 3, and 4, construction of marine structures would require initial and maintenance dredging. Upland disposal of dredged material could raise the water table. Site preparation would generate strippings and require extensive areas of cuts and fills. Site grading would result in large exposed areas susceptible to erosion. Boat basin construction

under Alternatives 3 and 4 would require dredging and/or excavation and may generate turbid water. Periodic maintenance dredging may be needed.

To mitigate earth and geotechnical impacts, the Port proposes a range of mitigation measures. For example, Alternative 2 mitigation includes: performing in-water construction work during time windows prescribed by natural resource agencies; revegetating and restoring disturbed ground surfaces; protecting exposed surfaces from erosion through engineered erosion control and water quality plans; establishing final floor grades above anticipated flood levels; providing subdrainage for subsurface structures; and, stripping ground surface prior to excavation or placement of structural fill and stockpile strippings for use in landscape or filling in mitigation areas. For Alternatives 3 and 4, additional mitigation measures include using material excavated from boat basin to construct fills in other areas.

Sediment Quality

Under Alternatives 2, 3 and 4, it is possible that dredge spoils or other materials deposited on site as fill could contain contaminants. To address this issue, dredged materials will be tested prior to placement. Further, dredging activities will be subject to review, including sediment sampling and ESA evaluation, as part of the permitting process for in-water work. Such review will likely avoid and minimize the effects of dredging any contaminated materials that may be discovered.

Aquatic and Wildlife Resources

The Gateway DEIS addresses aquatic and wildlife resources (particularly habitat) issues in its discussion of wetlands, hydrology and water quality. There are no expected significant and adverse impacts under Alternative 1. Alternative 2 is predicted to impact 111 acres of wetlands. Under Alternatives 3 and 4, development will fill about 84 acres of wetlands.

Under Alternative 2, there are no expected adverse impacts on hydrology. Regarding water quality, development operations will generate industrial wastewater, sanitary sewage, and stormwater. Pollutants will accumulate on paved surfaces and be washed into storm drain system. Placement of dredged material could potentially affect water quality. Construction will cause soil surface to be exposed and erosion could occur. Eroded sediment could be washed into surface water bodies. Some hydrologic change will occur in wetlands under Alternative 3. Water quality impacts are expected to be the same as for Alternative 2.

To mitigate impacts on wetlands, hydrology and water quality under Alternative 2, 103 acres of wetlands would be created or restored and 8 acres of existing wetland sloughs would be enhanced. Under Alternatives 3 and 4, 60 acres of wetlands would be created and 38 acres enhanced. To compensate for water quality impacts under all alternatives, industrial wastewater and sanitary wastewater will be discharged into the City's wastewater, collection, treatment and disposal system, and a stormwater treatment plan and treatment ponds will be constructed. Best management practices will be used for all construction activities in or near wetlands and associated buffers. There also are mitigation measures to apply during construction.

The Gateway DEIS also specifically reviews impacts to vegetation and wildlife. There are no expected impacts under Alternative 1. Alternative 2 is predicted to result in the loss of 857.4 habitat units. Alternative 2 is predicted to impact potential foraging and loafing habitat for sandhill cranes. Alternative 3 would result in loss of 1,151.9 habitat units. Alternative 3 is also predicted to impact some potential foraging and loafing habitat for sandhill cranes.

To mitigate the potential adverse impacts on vegetation and wildlife under Alternative 2, 240 acres of wetland and upland habitat will be created and enhanced resulting in a net gain of 51 habitat units for eight evaluation species. Under Alternatives 3 and 4, 324 acres of habitat will be created and enhanced, resulting in a net gain of about 99 habitat units. To compensate for loss of low quality sandhill crane habitat, the proposed habitat mitigation plan under Alternative 2 will provide 70 acres of high quality grains, 34 acres of improved grassland, and 50 acres of enhanced emergent wetland. For Alternatives 3 and 4, 130 acres of high quality grains, 58 acres of improved grassland, and 50 acres of enhanced emergent wetland will be provided.

Threatened and Endangered Species

Alternatives 2 and 3 would eliminate a current bald eagle nesting site and potential foraging habitat. Other impacts include loss of perching habitat and a former nest site, although some perch trees and potential nest trees would remain.

A Biological Assessment and Management Plan for the bald eagle will likely be required, and the Gateway DEIS anticipates mitigation measures such as establishing black cottonwood and other native trees to provide perching and future nesting trees. A former nest site will be enhanced under Alternatives 2, 3 and 4 and, in addition, under Alternatives 3 and 4, additional trees will be established around a former nest site.

Impacts on salmon are covered in the Gateway DEIS discussion on habitat and fisheries. There are no expected impacts to habitat and fisheries under Alternative 1. Under Alternatives 2 and 3, nearshore habitat losses of between 15.8-25.4 acres could result depending on flow events (2-, 5-, and 10-year). Under Alternative 4, the equivalent predictions range between 8.6-15.9 acres. Under Alternatives 3 and 4, the boat basin dredging also will alter topographic landscape including shallow water habitat and creation of predator habitat. Boat basin traffic is also predicted to impact habitat quality and fish use. Some disruption of nearshore habitat ecology is also possible under Alternatives 3 and 4. Again, the permitting process for in-water work will include appropriate review of potential effects on listed fish species through the ESA consultation process.

To mitigate the potential adverse impacts on habitat and fisheries, specific mitigation measures will be developed depending on actual development that occurs. However, general conservation and mitigation measures have been developed to address potential impacts. For example: preserving natural shoreline/bankline and nearshore habitat where possible; using bioengineered bank treatments along shoreline to reduce erosion and promote riparian

growth; where possible, removing areas of shoreline hardening and implement restoration; if possible, avoiding placement of fill waterward of ordinary high water mark.

Other Historic and Reasonably Foreseeable Development in the Study Area

Past development in the channel improvement project study area includes diking for agricultural development, filling for urban developments, port developments, and related infrastructure development such as roads and railroads. The baseline impact of past development on the study area is reflected in the assessment of *Affected Environment* (see 1999 Final IFR/EIS and Final SEIS at Section 5).

As described in Section 3.4 of the Final SEIS, while not caused by or connected to channel improvement, some future development of port facilities is reasonably foreseeable within the study area. Industrial growth could result in additional dredging around dock facilities and additional dredging for deeper access channels to enable ports to compete with other west coast port facilities. Continued urban and industrial development in the study area is also reasonably foreseeable in response to regional and national economic trends.

As noted above, when the 1999 Final IFR/EIS was prepared, the Port of Portland's West Hayden Island Development project had been proposed. However, since that time the Port has withdrawn its development plans and is holding the property in long-term strategic reserve. Therefore, the project is not considered reasonably foreseeable for the purposes of a cumulative impact analysis.

Sedimentation and Sediment Transport

Historic dredging, pile dike fields and shoreline disposal have combined to increase the depth and reduce the width of the riverbed; however, navigation development has not measurably altered Columbia River sand transport (Exhibit J, Final SEIS). Future dredging in the project area that is unrelated to the project would be expected to have minimal impacts on sedimentation and sediment transport for the same reasons as the channel improvement project.

Sediment Quality

Future dredging, other remedial techniques, and aquatic ecosystem restoration in the project area that is unrelated to the channel improvement project may encounter areas with contaminated sediments, particularly in the Willamette River. A discussion of future CERCLA activities on the Willamette is contained elsewhere in the Final SEIS. However, all these activities will be subject to appropriate review, including sediment sampling and analysis pursuant to the *Dredged Material Evaluation Framework* and coordination through the Regional Dredging Team structure and ESA evaluation, as part of the permitting process for in-water work. Such review will likely avoid and minimize the effects of dredging and disposal of any sediment, contaminated or clean.

Aquatic and Wildlife Resources, Including Endangered Species

Much of the significant wetland loss in the study area can be attributed to diking and/or a 20,000-acre increase in urban development that has occurred since the 1880s. Agricultural lands along the lower Columbia River continue to incur losses from urban and industrial development plus mining for gravel resources. Agricultural and urban/industrial land development is also principally responsible for an estimated 13,800 acres of riparian forest loss since the 1880s.

Future development in the project area would likely result in localized increases in environmental impacts to habitat including wetland, riparian and shallow water habitat and agricultural lands. It also is likely that there will be impacts on water quality, and potentially on other environmental resources. More specifically, urban growth will increase demand for electricity, water and buildable land in and near the study area, will affect water quality, and increase the need for transportation, communication, and other infrastructure. These impacts will probably affect habitat features such as water quality and quantity important for ESA-listed species. There will likely be both positive and negative effects on listed species and their habitats due to inconsistency among local governments (NOAA Fisheries Biological Opinion, Ch. 8; USFWS 2002 Biological Opinion, Ch. 6). Industrial growth could potentially result in alteration and loss of riparian areas, increased pollution, and alteration and loss of shallow water habitat. *Id.*

Restoration and Mitigation

Initiatives by state, Tribal and local governments will seek to mitigate or restore the environmental impacts of historic and future development. For example, natural resource protections are a central feature in Oregon's statewide land use planning program, which will govern future development in Oregon. Similar protections exist in Washington's Growth Management Act, which will govern future development in that state. State and federal requirements under the Clean Water Act and ESA are also expected to reduce future wetland/riparian habitat losses and provide appropriate mitigation for unavoidable losses. Habitat restoration programs by the States of Oregon and Washington, the National Estuary Program, and the Corps' Ecosystem Restoration Program also have the potential to restore large areas. Most local governments in Oregon and Washington are considering ordinances to address effects on aquatic and fish habitat from different land uses. While effective implementation of these programs is difficult to predict because of uncertainties in policy and funding, the overall effect is to address some historic losses while limiting and mitigating for future losses (NOAA Fisheries Biological Opinion, Chapter 8; USFWS 2002 Biological Opinion, Chapter 6).

Portland Harbor/Willamette River Cleanup

Historic activities and development around the Willamette River have resulted in contaminated sediments in some areas of Portland Harbor, and the Portland Harbor has been named by USEPA to the National Priority List. A *Remedial Investigation/Feasibility Study*

has been initiated. Therefore, cleanup of the lower Willamette River is reasonably foreseeable. However, the *Remedial Investigation/Feasibility Study* has not yet been completed and a remedy has not been selected.

Therefore, it is not possible at this time to determine the nature or magnitude of any short-term or long-term impacts of the cleanup action on the project area or whether such impacts would be cumulative to any impact of the channel improvement project. However, given the statutory purpose of the CERCLA, it is very likely that the cleanup actions will be designed to minimize both the short term and long-term effects of contaminated sediments in the Willamette River and their cleanup, including the possibility that the sediments are a source of contaminants to the Columbia River. The cleanup also will likely minimize contaminant concerns associated with future deepening of the Willamette River. Again, at such time as the sponsor ports and the Corps may proceed with channel improvement activities for the Willamette River, the Corps will conduct appropriate additional review under NEPA and ESA.

6.12.2.6^{new} Large-scale Restoration and Recovery Efforts

In addition to the ecosystem restoration features of the channel improvement project, there are a number of other restoration and recovery activities underway or proposed in the project area. These activities reflect incremental efforts to address historical environmental damage and are part of the total picture necessary for evaluating the potential cumulative impacts of the channel improvement project. Significant efforts and examples include:

The Lower Columbia River Estuary Partnership (LCREP) works with private environmental groups, federal, state and local governments on ecosystem protection of the lower Columbia River. The LCREP develops a Comprehensive Conservation and Management Plan to address land use, water quality, and species protection. The LCREP works with the USFWS on recovery planning for salmonids (USFWS 2002 Biological Opinion, 6.3).

In December 2000 a team of nine federal agencies (the Federal Caucus) released a long-term strategy to recover threatened and endangered fish in the Columbia Basin. The Basin-wide Salmon Recovery Strategy is the core of the federal recovery initiative under the ESA. It contains strategies related to habitat, hydropower, hatcheries, and harvest.

In July 2000 Idaho, Montana, Oregon, and Washington released recommendations for the “Protection and Restoration of Fish in the Columbia River Basin.”

Oregon’s Plan for Salmon and Watershed measures includes numerous programs designed to benefit salmon and watershed health in the lower Columbia River.

Washington has adopted legislative and administrative programs that either directly or indirectly work to restore and mitigate effects on the habitat of listed species. Legislative initiatives include the 1998 Salmon Recovery Planning Act, the Watershed Planning Act 1998, the Salmon Recovery Funding Act, and the Wild Stock Recovery Initiative Act

1992. Washington States' Forest and Fish Plan is a set of administrative rules designed to establish criteria for forest activities that will improve conditions for listed species. Estuary restoration projects, including acquisition of diked lands and reconnecting them with the Columbia River estuary, are being investigated by various entities. The Lower Columbia Fish Recovery Board is drafting recovery plans for the lower Columbia region. Washington is developing TMDL management plans on each of its 303(d) water-quality-listed streams. Washington also has programs in place to restrict water rights appropriations due to endangered species concerns.

Tribal governments are also engaged in watershed and basin planning designed to improve aquatic and fish habitat. For example, the "Spirit of the Salmon" plan is a joint restoration plan for anadromous fish in the Columbia River Basin prepared by the Nez Perce, Umatilla, Warm Springs and Yakama Tribes. Future implementation of the plan should have positive cumulative impacts on listed species and their habitat (USFWS 2002 Biological Opinion, 6.4).

In addition, there are a number of private environmental groups working in the lower Columbia River on conserving and restoring ecosystem functions that benefit salmonids. They are coordinating their work through LCREP's science working group. Overall, their actions should have positive cumulative impacts on listed species and their habitats. (USFWS 2002 Biological Opinion, 6.5).

Washington also has published a final recovery plan for sandhill cranes. The plan should guide state and local efforts to both control adverse effects of proposed projects and engage in affirmative recovery activities. The plan identifies target population objectives and strategies to increase the breeding population of greater sandhill cranes to the point that it can be delisted, and to conserve essential habitat for the nonbreeding flocks of sandhill cranes. The strategies and tasks include: monitoring populations; protecting habitat; managing breeding territories; and, coordinating and encouraging cooperation with agencies, landowners, nongovernmental organizations, and funding sources.

Large-scale restoration and recovery efforts are intended to restore historic functions to different parts of the Columbia River ecosystem. These improvements are expected to improve certain aspects of water quality, although it is not possible to specifically quantify all of these benefits.

All these activities entail the evaluation of any cumulative impact of the channel improvement project, which must be considered not only in combination with projects such as the MCR and FCRPS, but also with these restoration and recovery efforts. In addition, all significant future development and restoration projects will be subject to additional independent environmental reviews by state and federal agencies under NEPA, the Clean Water Act, the ESA, and similar state programs, which will serve to avoid and minimize adverse effects wherever possible, and provide appropriate mitigation for unavoidable resource or habitat losses.

6.12.3^{new} Cumulative Impact of the Channel Improvement Project When Added to All Past, Present, and Reasonably Foreseeable Future Actions

The sections above have outlined other past, present, and reasonably foreseeable future actions that may impact significant environmental resources in the channel improvement study area. This section assesses the incremental impact of the channel improvement project when added to these other actions. The project's absence of significant impacts, and the benefits to be provided by the ecosystem restoration features, provides the starting point; the question is whether that conclusion must be altered at all when the project's impacts are added to the impacts of the other actions.

Because the cumulative effects analysis requires consideration of historic actions as well as reasonably foreseeable future ones, it is apparent that, for most of the environmental resources covered by this analysis, historic actions have resulted in significant impacts. For example, construction of the FCRPS has modified river flows in a way that affects sedimentation and sediment transport in the lower river; historic industrial activities have resulted in sediment contamination in portions of the Willamette River; historic development has resulted in significant wetland and other habitat losses in the project area; and many human activities and other factors have resulted in depleted populations of fish species requiring their protection under the ESA.

However, to evaluate this project's cumulative impacts, it also is necessary to look forward in time. Future actions, including this project, are taking place in a dramatically different regulatory and political climate than did the most damaging historic actions. Specifically, future actions are subject to detailed review at the federal, state or local level, or some combination thereof. As appropriate, this review includes NEPA or SEPA, ESA, Clean Water Act, CZMA, state wetlands and growth management regulations, and local protections for critical resources. Accordingly, unlike historic actions, future projects will avoid and minimize effects to key resources, and provide appropriate mitigation for unavoidable losses.

As discussed above, future actions include many efforts at restoration and recovery of resources and habitats impacted by historic actions. Inherent in these projects is the expectation that they will provide benefits over time to numerous environmental resources in the project area. It is against this entire background of historic and anticipated future actions that the potential impacts of the project, both adverse and beneficial, must be evaluated.

Water Quality

As noted in Section 6.3, the Columbia River is water quality limited for temperature, bacteria, dissolved oxygen, total dissolved gas, toxics, arsenic, and pH. These water quality limitations reflect historic as well as modern activities. While future activities will include discharges of these parameters, such discharges will occur in a regulatory landscape that is far more restrictive and which will include specific plans to address these pollutants.

With regard to the actions discussed in this section, the cumulative impacts of the project when taken together with other actions are not likely to be significant.

Sedimentation and Sediment Transport

Exhibit J to the Final SEIS contains a comprehensive analysis of the past, present, and reasonably foreseeable sedimentation impacts to the Columbia River estuary and littoral cell. In essence, it contains a cumulative impact analysis in relation to sedimentation. Specifically, Exhibit J discusses the impacts of flow regulation associated with the FCRPS, the upper river navigation projects, the MCR project, and the channel improvement project.

In sum, the channel improvement project will not alter sand discharge to the Pacific Ocean. This would only occur if the amount of available sand, or the capacity of the sand transport system, were reduced; the project will do neither.

The Columbia River's average annual sand transport has declined considerably from the late 1800s to present. However, past navigation channel development is not responsible for the decline. The MCR jetties (constructed in the early 1900s) have reduced sand transport from the MCR into Baker Bay and across Clatsop Spit into the south channel. However, they caused a large discharge of sand from the MCR and vicinity, to the ocean. Following jetty construction, the sand that was eroded from the inlet and south flank of the inlet deposited in the outer delta and on shorelines. Past dredging and channel modifications upstream of CRM 40 have not measurably altered the available sand supply or sand transport in the river.

Flow regulation has reduced sand transport in the river. The FCRPS reservoirs alter flow patterns and this, in turn, has altered river and sediment discharges in the project area. The reservoirs store water during the spring snowmelt, reducing the freshet discharges. The reduced discharges have caused large reductions in sediment transport during the spring freshet.

While other actions, including primarily flow regulation and MCR jetty construction early in the 20th century, have affected sedimentation and sand transport in the estuary and lower river, the channel improvement project is not expected to have any measurable positive or negative effect on this resource because it does not alter the available sand supply or sand transport in the river.

Sediment Quality

As noted above, historic actions have resulted in sediment contamination in some parts of the project area, including parts of the lower Willamette River. However, with the protections provided by the Clean Water Act and other relatively new regulatory tools for source control, sediment conditions in the project area should not be subject to significant future degradation. Further, through active sediment cleanup and natural processes, existing

sediment conditions, particularly in the lower Willamette, should improve significantly over the long term.

In theory, there is some potential for incremental impacts because of the proximity of the Willamette River, the proposed clean up of that river, and deferred plans to deepen it. The remedial investigation and feasibility study for the Willamette have not yet been completed and a cleanup plan has not been selected. Therefore, it is not possible at this time to determine the precise nature or magnitude of any short-term or long-term impacts of the cleanup action on the project area. However, the driving purpose of the CERCLA remedial investigation, feasibility study, and remedy selection process is to devise methods for managing the contaminated material during clean up and over the long-term to reduce exposure to humans and the environment. Therefore, the Willamette cleanup is very likely to result in a significant long-term incremental improvement in sediment conditions in the project area. Any future deepening will occur in an environment that has undergone the rigorous Superfund remediation and will have to be consistent with that remediation.

Other development projects in the study area that involve dredging may encounter contaminated sediments. If they do, review through the permitting process for in-water work will determine how to avoid disturbing contaminated materials or handle them in such a way as to minimize exposure to humans and the environment.

Again, the channel improvement project does not, of itself, create sediment quality concerns because the Columbia River channel sediment to be dredged is primarily sand with a low percentage of organic content and, where detected, very low levels of contaminants. Therefore, dredging and disposal of this material, much of which is already naturally suspended and resuspended as it is transported along the bottom, does not add to any existing contamination issues or pose a risk to human health or the environment.

Accordingly, while historic actions have resulted in localized sediment contamination in some parts of the larger project area (i.e., outside of the areas to be dredged), the channel improvement project is not expected to make an incremental contribution to sediment quality degradation. Further, over the long-term, sediment cleanups and other processes should actually result in improved conditions in the project area.

Aquatic and Wildlife Resources

Crab

According to the Pacific Fisheries Management Council, the crab resource is currently healthy (October 22, 1999 letter from Pacific Fisheries Management Council to Corps). Pacific Northwest National Laboratories (Pearson et al. 2003) estimated total maximum loss to the fishery from the project of 44,342 crabs during construction (the increment associated with channel improvement project is 26,285 crabs), and up to 8,953 crabs annually during maintenance. In addition, entrainment data from 2002 annual maintenance dredging for the MCR indicates a loss to the fishery of approximately 6,000 crabs. Based upon comparison

of the study results with the average annual harvest in the Columbia River area (5.3 million crabs), the cumulative impacts of the channel improvement project and the MCR project to the crab resource and crab fishery are minimal, and are not anticipated to have any significant effect on crab population structure or dynamics.

Wetlands

While historic development in the project area has caused significant wetland loss, these actions occurred in a regulatory landscape that is very different from that which exists today. While future development will likely have localized impacts on wetlands, under the current regulatory regime, wetlands are unlikely to suffer significant losses. Moreover, initiatives by state, Tribal and local governments will operate to mitigate the unavoidable environmental impacts of development.

The channel improvement project is itself an example of the reduced impacts and significant mitigation involved in present day development. As outlined above, the potential wetland impacts of the project have been reduced from 20 to 16 acres since the 1999 Final IFR/EIS, and a detailed wetland mitigation plan will operate to offset wetland impacts. The mitigation plan involves development or substantial improvement to 194 acres of wetland habitat, representing about a 12-fold increase over projected losses. Also, the channel improvement project will result in the implementation of ecosystem restoration features, which are intended to restore a substantial acreage of wetland habitat.

The Columbia Gateway project illustrates the same trend. Some of the Gateway project alternatives are predicted to have wetland impacts in the project area. There are no expected impacts under Alternative 1, but impacts of the other alternatives range from 84 to 111 acres. However, like the channel improvement project, the Gateway plans include significant mitigation. Depending on the alternative, between 60 and 103 acres of wetlands would be created or restored, and between 8 and 38 acres would be enhanced. Including upland habitat as well as wetland habitat, between 240 acres (Alternative 2) and 324 acres (Alternative 4) of habitat will be created or enhanced resulting in a net gain of between 51 and 99 habitat units.

Other actions considered in this cumulative impact analysis have no predicted impact on wetlands in the channel improvement project study area. The MCR maintenance dredging planned for the next 5 years is not expected to impact any wetland areas. Neither the Upper Columbia-Snake River navigation channel project nor the FCRPS has impacts on wetlands in the channel improvement project area. Due to the uncertainty surrounding the Willamette River clean up, it is not possible at this point in time to evaluate potential impacts of the clean up on wetlands, although given USEPA Region 10 policies and practices at other CERCLA sites in the Pacific Northwest, it is potentially positive. Any future deepening project will, like the channel improvement project, include appropriate mitigation.

In sum, while historic actions have had adverse effects on wetlands in the study area, the channel improvement project is not expected to make an incremental contribution to those

negative effects. By contrast, the project's mitigation plans and ecosystem restoration features will improve the overall wetland acreage. And, future development in the area (including Gateway) is expected to follow the same trend: significant mitigation that will counterbalance or even outweigh any adverse effects on wetlands. Other restoration actions in the lower Columbia River, particularly for wetland habitat, also are being pursued by numerous entities.

Threatened and Endangered Species

Salmonids

Similar to other resources, salmonids have been detrimentally impacted by historical actions, but present and future actions (including the channel improvement project) are not, in the aggregate, expected to have significant overall impacts. Specifically, the dams and reservoirs that comprise the FCRPS have impacted spawning habitat, migration rates, and migration conditions; increased predator risks; and, caused turbine mortality. However, in the modern regulatory and political environment, potentially adverse effects of future actions are not expected to be significant, or are expected to be offset by mitigation actions and restoration initiatives.

The channel improvement project itself has no significant impacts on salmonids. It is not likely to jeopardize the continued existence of 12 federally listed salmonid ESUs, one listed DPS, one DPS proposed for listing, and one candidate ESU. The project's impacts on physical processes that affect salmonids will be limited and short-term. While there is a low level of risk and uncertainty surrounding long-term biological responses, these will be addressed through monitoring and adaptive management.

In addition, the new ecosystem restoration features of the project will restore substantial habitat for salmonids. For example, the restoration projects at Lois Island embayment (191 acres), Miller/Pillar (235 acres), Tenasillahe Island Long-term Restoration (1,778 acres), Bachelor Slough (85 acres), and Walker-Lord and Hump-Fisher Islands (335 acres) will provide detrital export to the estuary and rearing habitat for juvenile salmonids. The tidegate retrofits (38 stream miles), and the Tenasillahe Island Interim Restoration (92 acres of side channel habitat) features will increase access and egress for juvenile salmonids. The tidegate retrofits will also improve access for adult salmonids to headwaters for spawning.

The present and reasonably foreseeable future actions discussed in this section do not materially change the cumulative impact. The MCR and the proposed actions in the upper Columbia/Snake River navigation channel have been found not to jeopardize listed anadromous fish species. Likewise, the *future* operation of the FCRPS is not likely to jeopardize the continued existence of four of the listed salmonids in that area, or to destroy or adversely modify their designated critical habitat. The FCRPS's most significant adverse impacts on eight other listed salmonids can be avoided by the reasonable and prudent alternatives proposed by NOAA Fisheries and the USFWS. While the Gateway project is expected to have impacts, for example on salmonid habitat, the Gateway DEIS recognizes

that the ESA consultation process will ensure the impacts are properly managed. When the Services conduct that consultation, they will establish the baseline condition, which will reflect the impacts that have occurred since the Biological Opinions discussed in this section. The baseline condition will incorporate past activities in a manner consistent with the cumulative impact requirement under NEPA. The potential impacts of any future Willamette channel deepening or unspecified future development cannot be determined at this time.

Moreover, to the extent that there are any adverse impacts on salmonids by present and future actions, they must be considered with the mitigation efforts included to offset them. For example, in-water fish habitats will be created as part of the Columbia/Snake navigation channel, and a number of significant changes will be made pursuant to the *Lower Snake River Juvenile Salmon Migration Feasibility Study*. Practices implemented under the MCR's management/monitoring plan will minimize its impacts. Pursuant to the FCRPS implementation plans, a wide range of measures are being implemented to avoid jeopardy, assist in meeting recovery standards, and to conserve critical habitats. Specific mitigation measures will be developed in relation to the Gateway project depending on actual development; however, general mitigation measures include preserving natural shoreline/bankline and nearshore habitat where possible. A number of general mitigation and remediation activities, such as the *Basin-Wide Salmon Recovery Strategy*, also operate to offset past, present, and future impacts on salmonids.

Accordingly, while historic actions have resulted in adverse impacts on salmonid populations that pass through the study area, the channel improvement project is not expected to have negative incremental impacts on salmonid populations. This conclusion is consistent with analysis in the 2002 Biological Opinions. For example, NOAA Fisheries concluded that, *taking into account cumulative effects*, in addition to other factors, the channel improvement project was not likely to jeopardize the continued existence of ESA-listed salmonids or result in the destruction or adverse modification of their designated critical habitat. (NOAA Fisheries, 2002 Biological Opinion, Section 9.6). Over the long term, recovery work should result in improved salmonid populations.

Sandhill Crane

The sandhill crane is a Washington state-listed endangered species, listed at least partly due to historical actions within the study area of the Columbia River Channel Improvement Project. However, that situation is being addressed by the recently completed *Sandhill Crane Recovery Plan*, and the channel improvement project is consistent with that plan. Sandhill cranes are present in an area that contains a proposed disposal site under the channel improvement project. However, the Corps' wildlife mitigation plan addresses the potential lost habitat value associated with the disposal site. Mitigation at Woodland Bottoms will include 132 acres in long-term pasture and 97 acres in wetland habitat that will benefit sandhill cranes. Ratios of land recovered through mitigation to land adversely affected by the project are 12:1, 4:1 and approximately 1:1, respectively, for wetlands, riparian habitat, and agricultural lands. Due to these mitigation plans, together with the

extensive acreage of State Wildlife Management Areas, National Wildlife Refuges, plus private agricultural lands in the area, it is not anticipated that the project would adversely affect sandhill cranes.

The other actions considered in this cumulative impact analysis either have no impact on sandhill cranes, or the mitigation plans are expected to similarly outweigh the adverse effects. Specifically, the MCR project, the upper Columbia/Snake River navigation channel, and the FCRPS are not expected to have any impacts on sandhill crane populations in the study area. Due to the uncertainty surrounding the Willamette River clean up, it is not possible at this point in time to evaluate potential impacts of the clean up on sandhill cranes. If necessary, any future deepening of the Willamette River will include appropriate mitigation. Alternatives 2 and 3 of the Gateway project are predicted to impact potential foraging and loafing habitat for sandhill cranes. However, to compensate for loss of low quality sandhill crane habitat, the proposed habitat mitigation plans for Gateway increase acreages of high quality grains, improved grassland, and enhanced emergent wetlands.

In conclusion, while historic actions have resulted in adverse impacts to sandhill cranes, the channel improvement project is not expected to result in incremental adverse impacts on the populations or their habitat. Mitigation efforts associated with the channel improvement project, the Gateway project, and other future actions in the study area should actually result in increased crane habitat.

Conclusion

There are inherent uncertainties in any cumulative impact analysis. However, based on available information, the incremental impact of the channel improvement project, when added to the impacts of other projects and developments described in this section, is not anticipated to be significant. One of the fundamental reasons is the minimal adverse impact of the project itself.

Moreover, the mitigation features of the channel improvement project, and the other projects, operate to offset impacts that do exist. In addition, the ecosystem restoration and evaluation actions that are part of the project are intended to provide net environmental *benefits* for several key environmental resources. Finally, as discussed above, several federal, state, Tribal, and non-governmental efforts are being developed or are underway to provide similar environmental benefits for resources in the project area.

6.13.^{revised} Relationship Between Short-term Uses of the Environment and Maintenance and Enhancement of Long-term Productivity

The NOAA Fisheries and USFWS May 20, 2002 Biological Opinions concluded the ecosystem restoration features will provide benefits to the habitat types identified in the Conceptual Model (see Chapter 5 of the 2001 BA). When implemented in coordination with NOAA Fisheries and other entities conducting habitat conservation/restoration activities, these features should complement those activities currently occurring in the lower Columbia River and estuary. For these reasons, the NOAA Fisheries and USFWS concluded that the proposed ecosystem restoration features would benefit ESA-listed salmonids and their habitats. In addition, the ecosystem restoration features will enhance the long-term productivity of the Columbia River ecosystem for many other species that are not listed under the ESA.

6.14. Irreversible and Irretrievable Commitments of Resources

No updating of the existing information in this section is necessary for the Final SEIS (see the Final IFR/EIS, August 1999).

CHAPTER SEVEN

COORDINATION AND

PUBLIC INVOLVEMENT

***7. COORDINATION AND PUBLIC INVOLVEMENT**

7.1. Required Coordination

No updating of the existing information in this section was necessary for the Final SEIS (see the Final IFR/EIS, August 1999).

7.2. ^{revised} Public Workshops

The Corps and sponsor ports held a series of public meetings and hearings leading up to this Final SEIS. The meetings provided an opportunity for study personnel, as well as personnel from USEPA, NOAA Fisheries, USFWS and state agencies, to share data, information, and study progress with the public. The public hearings allowed the public to provide comments on the project directly to Corps and sponsor port personnel. The public was notified of the workshops and hearings through news releases, web postings, and local media announcements. Public meetings were held on July 29 in Warrenton, OR, July 31 in Vancouver, WA, September 5 in Longview, WA, and September 10 in Astoria, OR. The public provided testimony at the Vancouver, Longview and Astoria meetings.

Comments received during the public hearings are provided in Volumes 5 to the Final SEIS; Volume 4 includes all written comments submitted on the project and responses to those comments.

In August 2002, the Corps also convened two technical review panels to evaluate the reasonableness of the Corps' economic analysis. One technical review panel evaluated the benefit analysis and the other panel evaluated the cost analysis. The technical review process was transparent, facilitated by a neutral, non-profit organization and included two sessions that were open to the public; an all day session on August 5, which included the Corps' and sponsor ports' presentations to the panels, and a half-day session on August 9, which included the panels' preliminary reports and responses to questions from the Corps, sponsor ports, and the public. The panels' reports are accessible on the Corps' website.

7.3. ^{revised} Specialized Coordination Activities

No updating of the existing information in subsections 7.3.1 to 7.3.7 was necessary for the Final SEIS (see the Final IFR/EIS, August 1999). However, subsections 7.3.8 and 7.3.9 have been added to address ESA consultation coordination activities.

7.3.8. ^{new} ESA Consultation and SEI Workshops

In August 2000, NOAA Fisheries withdrew their previous Biological Opinion for the channel improvement project, citing the availability of new information regarding impacts to bathymetry (water depths) and flow on estuarine habitat, and resuspension of contaminants. Because a Biological Opinion that meets ESA requirements for listed salmonids must be in

place before the project can proceed, the Corps and NOAA Fisheries reinitiated the ESA consultation process to resolve issues connected with the project. The USFWS joined the reconsultation process to address new information regarding potential impacts of the project on two USFWS purview listed species, coastal cutthroat trout and bull trout.

For the ESA consultation, in February 2001 the Sustainable Ecosystems Institute (SEI) was hired to facilitate a series of workshops to provide an independent, scientific peer-review process to evaluate the potential environmental issues using best available scientific knowledge. The Corps, NOAA Fisheries, and USFWS jointly agreed to use SEI's experience to help resolve the issues. The SEI process included formal and informal review of scientific materials by an independent panel of seven scientific experts. The process included five workshops held from March to August 2001, which were open to the public, to review the science underlying the channel improvement project. Outcomes of the SEI workshops and informal discussions among the agencies provided input for a new BA. In January 2002, the BA was sent by the Corps to NOAA Fisheries and USFWS for use in preparing the May 2002 Biological Opinions.

The SEI Workshops addressed the following topics.

- Process, expectations and prior analysis and issues (March 17-18, 2001).
- Modeling (April 28-29, 2001).
- Fish and estuarine ecology (May 15-16, 2001).
- Sediments and sediment quality (June 7-8, 2001).
- Monitoring and adaptive management (July 14-15, 2001).
- Final workshop (August 28-29, 2001).

Information from all workshops, including copies of the presentations made and summaries of workshop discussions, are available at SEI's website (<http://www.sei.org/columbia/home.html>).

7.3.9. ^{new} State and Local Coordination

The Corps and Sponsor Ports have continued to meet frequently with state and local jurisdictions since September 2000. Coordination with Oregon State agencies included the Oregon Department of Environmental Quality, Department of Land Conservation and Development, ODFW, Department of Geology and Mineral Industries, Division of State Lands, and the Governor's office. Coordination with Washington State agencies included the Department of Ecology, WDFW, WDNr, State Parks, and the Governor's offices. Coordination with local jurisdictions included the Columbia River Estuary Taskforce, Clatsop County, Pacific County, Wahkiakum County, Cowlitz County, Clark County, the City of Longview and the City of Vancouver.

Provided below is a list of all the coordination meetings the Corps has held with these state agencies and local jurisdictions.

September 14, 2001	Interagency Coordination (general)
October 24, 2001	Pacific County
October 24, 2001	Interagency Coordination (general)
October 25, 2001	Wahkiakum County
October 25, 2001	Crab
November 2, 2001	Interagency Coordination (general)
November 13, 2001	SEPA Compliance
November 20, 2001	Cowlitz County/City of Longview
November 20, 2001	Wetlands
December 2, 2001	Sediment Supply
January 11, 2002	Interagency Coordination (general)
January 23, 2002	Clark County/City of Vancouver
January 23, 2002	Crab
January 30, 2002	Sediment Supply
February 6, 2002	Fish Stranding
February 7, 2002	Sturgeon/Smelt
February 8, 2002	Crab
February 8, 2002	Interagency Coordination (general)
February 15, 2002	Habitat Evaluation Procedure (HEP)
February 25, 2002	Sediment Supply
March 14, 2002	Interagency Coordination (general)
June 10, 2002	Crab
August 30, 2002	Habitat Evaluation Procedure (HEP)
September 5, 2002	Crab
November 6, 2002	Sediment Supply
December 2, 2002	Habitat Evaluation Procedure (HEP)

7.4. ^{revised} Compliance with Environmental Laws and Executive Orders

No updating of the existing information in Subsections 7.4.1, 7.4.6, 7.4.7, 7.4.9, 7.4.11 to 7.4.13, 7.4.15, 7.4.16, and 7.4.18 was necessary for the Final SEIS (see the Final IFR/EIS, August 1999). Subsections 7.4.2, 7.4.3, 7.4.4, 7.4.5, 7.4.8, 7.4.10, 7.4.14, and 7.4.17 have been updated. Also, Subsections 7.4.19 and 7.4.20 were added for the Final SEIS.

7.4.2. ^{revised} Clean Water Act of 1977, as Amended

The Corps has requested the States of Washington and Oregon to issue certification of compliance under the Clean Water Act. A revised Section 404(b)(1) Evaluation has been prepared and is included as Exhibit E to this Final SEIS. The water quality applications to the States of Washington and Oregon are available on the Corps website.

7.4.3. ^{revised} Coastal Zone Management Act of 1972, as Amended

A revised “Determination of Consistency” for the project has been prepared for actions in or affecting the coastal zone of Oregon and Washington, and is included in Exhibit F. The states have been requested to concur with the determination regarding compliance with their respective state coastal management programs and local land use plans. The Coastal Zone Consistency Determinations are available on the Corps website.

7.4.4. ^{revised} Comprehensive Environmental Response, Compensation and Liability Act

As discussed in Chapter 1, since issuance of the 1999 Final IFR/EIS, a portion of the lower Willamette River has been placed on the CERCLA National Priorities List. Therefore, channel improvement in the lower Willamette River has been deferred until after resolution of the sediment cleanup issues associated with the national priorities listing. Any Willamette River channel improvement will be reevaluated in a separate NEPA document to be prepared at that time and is not covered in this Final SEIS.

7.4.5. ^{revised} Endangered Species Act of 1973, as Amended

ESA consultation was reinitiated for the project at the request of NOAA Fisheries regarding the fish species listed and proposed to be listed under the ESA. A new BA for listed salmonids was prepared by the Corps and provided to NOAA Fisheries and USFWS on January 2002 (see Exhibit H on the Corps' website). On May 20, 2002, NOAA Fisheries and USFWS transmitted their final Biological Opinions to the Corps. The opinions determined that the channel improvement project, including dredging, disposal, ecosystem monitoring and evaluation, adaptive management, and ecosystem restoration, is not likely to jeopardize the continued existence of, or to destroy or adversely modify designated critical habitat for, the 13 listed, one proposed, and one candidate fish species, bald eagles, or Columbian white-tailed deer. In addition, the NOAA Fisheries concurred that the project is not likely to adversely affect Steller sea lions.

7.4.8. ^{revised} Fish and Wildlife Coordination Act

The updated information and analyses in the Final SEIS have been developed with the assistance of the federal and state resource agencies, and complies with the act as required. The original USFWS *Fish and Wildlife Coordination Act Report*, and Corps responses to the recommendations, are located in Exhibit C of the Final IFR/EIS (August 1999).

7.4.10. ^{revised} Marine Protection Research and Sanctuaries Act of 1972, as Amended

The need for designating new Ocean Dredged Material Disposal Sites off of the mouth of the Columbia River remains fundamentally unchanged by the Final SEIS and will proceed as discussed in the 1999 Final IFR/EIS to formal rulemaking by the USEPA. The USEPA expects to initiate formal rulemaking on the Shallow Water and Deep Water Sites in February 2003, with the designations becoming effective by June 2003.

7.4.14. ^{revised} Cultural Resources Acts

In 1999, cultural resource evaluations, studies, and comments on potential impacts for the channel improvement project were submitted to the Washington and Oregon State Historic Preservation Offices per Section 106 of the National Historic Preservation Act, for review and comment. The Corps acknowledged in our transmittal letter that additional construction sites, wildlife mitigation areas, and general project contingencies would occur that may

affect cultural resources. To deal with subsequent project developments following State Historic Preservation Office review, the Corps recommended development of a Memorandum of Agreement per 36 CFR 800 implementing regulations for the National Historic Preservation Act. Both the Washington and Oregon State Historic Preservation Offices concurred with the project as described in 1999 and agreed in their concurrence letter with an use of a Memorandum of Agreement. This memorandum is under preparation.

Coordination with Native American tribes was conducted throughout the study phase of the project. Presentations and briefings have been provided to the tribal councils and executive committees of the Confederated Tribes of the Warm Springs Reservation of Oregon, Confederated Tribes and Bands of the Yakama Nation, and Confederated Tribes of the Umatilla Indian Reservation. The Corps Portland District and Division also met with the subcommittee for Natural Resources of the Executive Committee for the Nez Perce Indian Tribe. The Corps continues to be open to consult nation to nation with any of the tribes in the project area. To date, the aforementioned nations have not responded to our offer for additional consultations or briefings on the channel improvement project. Discussions on technical issues have been held with the Columbia River InterTribal Fish Commission.

7.4.17. ^{revised} Executive Order 11988, Floodplain Management

Revised information on floodplain effects for the proposed plan and the least cost plan is found in Exhibit K-7 (*Evaluation Report Floodplains*). Review of the disposal site selection process shows that there are no practicable alternatives to the selected sites. The project, including disposal, is anticipated to have minimal effect on the floodplain or flood levels, and conforms to the requirements of this executive order.

7.4.19. ^{new} State Environmental Policy Act

As discussed in Chapter 1, this Final SEIS is issued as a joint document by the sponsor ports and the Corps to comply with the Washington State Environmental Policy Act (SEPA), as well as with NEPA.

7.4.20. ^{new} Magnuson-Stevens Fisheries Conservation and Management Act

As discussed in Chapter 6, the Corps and USEPA have analyzed the potential effect of the project on Essential Fish Habitat (EFH) under the Magnuson-Stevens Act for salmon, coastal pelagic and groundfish species. The managed salmon stocks were evaluated during the ESA consultation with NOAA Fisheries. In their 2002 Biological Opinion (see Exhibit H on Corps' website), NOAA Fisheries concluded that the project may result in adverse effects to EFH for listed salmonids, but noted that the Biological Opinion's conservation measures, reasonable and prudent measures, and terms and conditions address these potential adverse effects. The Corps and USEPA are in the process of evaluating NOAA Fisheries EFH conservation recommendations. The NOAA Fisheries is currently in the process of reviewing EFH information for groundfish and coastal pelagic species (see Exhibit I).

7.5. ^{revised} Other Related Programs

No updating of the existing information in Subsections 7.5.1 and 7.5.2 was necessary for the Final SEIS (see the Final IFR/EIS, August 1999). However, Subsections 7.5.3 to 7.5.5 have been added for the Final SEIS.

7.5.3. ^{new} Columbia River Fish Mitigation

The purpose of the Columbia River Fish Mitigation (CRFM) project is to investigate and develop improvements to anadromous fish passage facilities and operations at the eight lower Columbia and Snake River projects (Lower Granite, Little Goose, Lower Monumental and Ice Harbor on the Snake River; and McNary, John Day, The Dalles, and Bonneville on the Columbia River). The CRFM project has two major components: (1) a mitigation analysis, prepared in cooperation with regional federal, state, and tribal interests, to conduct research and evaluate measures to improve passage survival through the projects; and (2) the design and construction of recommended improvements. The CRFM project serves as one of the principle vehicles for the Corps to implement the requirements in the NOAA Fisheries Biological Opinions of 1995, 1998 and 2000 for listed salmon and steelhead species in the Columbia River Basin. Through Fiscal Year 2002, CRFM expenditures will be about \$800 million. The total cost to complete the CRFM is currently estimated at \$1.5 billion. The Anadromous Fish Evaluation Program involves research, monitoring, and evaluation in the estuary, and is funded under the CRFM project. Some current proposed studies include: (1) estuarine habitat and juvenile salmon - current and historic linkages in the lower Columbia River and estuary; (2) evaluation of the relationship among time of ocean entry, physical, and biological characteristics of the estuary and plume environment, and adult return rates; and (3) a study to estimate salmonid survival through the Columbia River estuary using acoustic tags.

7.5.4. ^{new} Section 536

Section 536 of the Water Resources Development Act of 2000 authorized the Lower Columbia River Ecosystem Restoration Study to bring together and implement current efforts by a number of governmental and private organizations to identify and cost share restoration projects. These organizations include the National Estuary Program, six state agencies from Oregon and Washington, four federal agencies, recreation, ports, industry, agriculture, labor, commercial fishing, environmental interests and private citizens.

In the President's Budget for Fiscal Year 2003, this action was funded as a new start for \$2,000,000. The primary purpose of the proposed study is to carry out ecosystem restoration projects necessary to protect, monitor and restore fish and wildlife habitat based on recommendations made by the Lower Columbia River Estuary Program (LCREP). Furthermore, Section 536 is principally focused on fish and wildlife habitat as outlined by LCREP, and allows for immediate identification and construction of restoration projects. Also, the Corps conducted site visits to the proposed restoration sites with the LCREP Scientific Committee. The LCREP provided written comments, which are included in Volume 4 of the Final SEIS.

7.5.5.^{new} Federal Columbia River Power System

In December 2000, NOAA Fisheries and USFWS issued a multi-species Biological Opinion on the operation of the Federal Columbia River Hydropower System (FCRPS), which recognized that estuarine protection and restoration must play vital roles in rebuilding the productivity of listed salmon and steelhead throughout the Columbia River Basin. Reasonable and prudent action items, numbers 158-163 and 194-197 (summarized below), are included in the FCRPS Biological Opinion, and specifically address estuary research, conservation, and restoration actions that support the survival and recovery of ESA-listed salmonids. These action items are referred to in the Incidental Take Statement of the 2002 Biological Opinion for the channel improvement project, in order to better integrate ESA compliance measures for these two projects.

- Action 158. During 2001, the Corps and Bonneville Power Administration (BPA) shall seek funding and develop an action plan to rapidly inventory estuarine habitat, model physical and biological features of the historical lower river and estuary, identify limiting biological and physical factors in the estuary, identify impacts of the FCRPS system on habitat and listed salmon in the estuary relative to other factors, and develop criteria for estuarine habitat restoration.
- Action 159. BPA and the Corps, working with LCREP and NOAA Fisheries, shall develop a plan addressing the habitat needs of salmon and steelhead in the estuary.
- Action 160. The Corps and BPA, working with LCREP, shall develop and implement an estuary restoration program with a goal of protecting and enhancing 10,000 acres of tidal wetlands and other key habitats over 10 years, beginning in 2001, to rebuild productivity for listed populations in the lower 46 river miles of the Columbia River.
- Action 161. Between 2001 and 2010, the Corps and BPA shall fund a monitoring and research program acceptable to NOAA Fisheries and closely coordinated with the LCREP monitoring and research efforts to address the estuary objectives of this Biological Opinion.
- Action 162: During 2000, BPA, working with NOAA Fisheries, shall continue to develop a conceptual model of the relationship between estuarine conditions and salmon population structure and resilience. The model will highlight the relationship among hydropower, water management, estuarine conditions, and fish response.
- Action 163. The Action Agencies and NOAA Fisheries, in conjunction with the Habitat Coordination Team, will develop a compliance monitoring program for inclusion in the 1- and 5-year plans.
- Action 194. The Action Agencies and NOAA Fisheries shall work within the annual planning and congressional appropriation processes to establish and provide the appropriate level of FCRPS funding for studies to develop a physical model of the lower Columbia River and plume.
- Action 195. The Action Agencies shall investigate and partition the causes of mortality below Bonneville Dam after juvenile salmonid passage through the FCRPS.
- Action 196. The Action Agencies and NOAA Fisheries shall work within the annual planning and congressional appropriation processes to establish and provide the appropriate level of FCRPS funding for studies to develop an understanding of juvenile and adult salmon use of the Columbia River estuary.
- Action 197. The Action Agencies and NOAA Fisheries shall work within the annual planning and congressional appropriation processes to establish and provide the appropriate level of FCRPS funding for studies to develop an understanding of juvenile and adult salmon use of the Columbia River plume.

CHAPTER EIGHT

PROJECT

IMPLEMENTATION

8. PROJECT IMPLEMENTATION

8.1. Identification of Sponsors

No updating of the existing information in this section was necessary for the Final SEIS (see the Final IFR/EIS, August 1999).

8.2. ^{revised} Cost Allocation and Apportionment

For the Final SEIS, Table S8-1 was updated for the 43-foot Columbia River Channel Improvement Project.

Table S8-1. Executive Fully Funded Cost Summary

Least Cost Disposal Plan (in \$1,000s)	
General Navigation Features (GNF) - Cost Shared	Total
Channel and Turning Basins	\$55,438
Rock	\$19,195
Mitigation Construction	\$477
Contingency	\$12,486
Engineering and Design	\$1,758
Supervision and Administration	\$8,262
Monitoring	\$11,550
Total GNF	\$109,166
Non-Federal	
Local Service Facilities (LSF)	\$942
LERRD*	\$18,542
Utilities (to be paid by the permit applicant)	\$0
Total Non-Federal	\$19,484
10% GNF = \$10,917 < LERRD = \$18,542 No Extra 10%	
Navigation	
Federal Share (75% GNF = \$109,166 x 0.75)	\$81,874
Non-Federal Share (25% GNF + LERRD + LSF = \$25,955+\$19,484)	\$46,775
Ecosystem Restoration	\$16,448
Federal Share (65%)	\$10,691
Non-Federal Share (35%)	\$5,757
<i>Per Section 210 of WRDA 1996, the non-federal cost for ecosystem restoration projects is 35 percent of all construction costs, including LERRD, and 100 percent of OMRR&R**</i>	
Total Federal Cost (\$81,874+\$10,691)	\$92,565
Total Non-Federal (\$46,775+\$5,757)	\$52,532
TOTAL	\$145,097

*LERRD =lands, easements, rights-of-way, relocation, and disposal sites.

**OMRR&R = operation, maintenance, repair, replacement, and rehabilitation.

Table S8-1 (continued). Executive Fully Funded Cost Summary

Locally Preferred Disposal Plan (LPP) (Proposed Action, in \$1,000 - Effective Pricing Level, October 2002)		
LPP Cost	\$147,414	
Federal	\$92,565	\$NED Cap on Federal Investment
Non-Federal	\$54,849	
	Non-Federal	\$54,849
	Berths	\$942
	Real Estate Already Owned	\$9,649*
	Cash	\$44,259
	State of Washington	\$22,129
	State of Oregon	\$22,129

* Value from 1999 Final IFR/EIS

In addition, the non-federal sponsor would be responsible for \$15,569 per year to be provided to the Federal Government to cover incremental O&M costs for the Locally Preferred Disposal Plan.

8.3. Non-Federal Cost Sharing

No updating of the existing information in this section was necessary for the Final SEIS (see the Final IFR/EIS, August 1999).

8.4. Division of Responsibilities

No updating of the existing information in this section was necessary for the Final SEIS (see the Final IFR/EIS, August 1999).

8.5. Sponsor's Support

No updating of the existing information in this section was necessary for the Final FEIS (see the Final IFR/EIS, August 1999).

8.6. ^{revised} Implementation Process

The following updated information has been added to this section for the Final SEIS. Figure S8-1 has been replaced by Table S8-2 and shows the major milestones and assumptions for project implementation. The Draft SEIS was circulated for a 60-day public review and comment period. Three public meetings and one information meeting took place during this period. A technical panel review of the costs and benefits also occurred during the 60-day comment period. This Final SEIS is being circulated for a 30-day comment period. It is anticipated that a *Record of Decision* for the Final SEIS would be issued in spring 2003.

Table S8-2. Proposed Project Implementation Schedule

Milestones	Start	End
60-day Public Review	15 July 2002	16 September 2002
Astoria Information Meeting	29 July 2002	29 July 2002
Vancouver Public Meeting	31 July 2002	31 July 2002
Panel Technical Review	4 August 2002	9 August 2002
Longview Public Meeting	5 September 2002	5 September 2002
Astoria Public Meeting	10 September 2002	10 September 2002
Revise Report	16 September 2002	20 January 2003
Final Public Review	31 January 2003	2 March 2003
Record of Decision	April 2003	April 2003

The construction phase is anticipated to begin in federal Fiscal Year 2004 and completion in federal Fiscal Year 2006. It is anticipated that the construction phase will consist of the following contracts.

1. Pipeline Dredging Contract
2. Hopper Dredging Contract
3. Rock Removal Contract
4. Mitigation Sites Construction Contract
5. Numerous contracts to construct the restoration features; the exact grouping of these contracts has not been decided.

Construction is anticipated to begin in February 2004 with some of the ecosystem restoration features, followed by the construction of the mitigation sites. Shillapoo Lake, Tenasillahe interim actions, translocation of Columbian white-tailed deer, tide gate retrofits, improved embayment circulation at Walker-Lord and Hump-Fisher Islands, and Bachelor Slough would be constructed in 2004. The purple loosestrife control program is a 5-year effort beginning in 2004. Dredging could start as early as July 2004 and last for 24 months. The Lois Island embayment ecosystem restoration feature requires the use of dredged material to accomplish the restoration and will be constructed during the months of November to February due to ESA concerns. Lois Island embayment would be constructed beginning in November 2004 and be completed with construction material in February 2006. Miller-Pillar requires the placement of five pile dikes, and it is anticipated that three of these pile dikes, per agency coordination, would be driven from October 2005 through June 2006. The remaining two pile dikes would be constructed following the results of the monitoring actions. Maintenance material from the deepened channel would be placed at Miller-Pillar for approximately 15 years following construction.

8.7.^{new} Changes to the Real Estate Plan

This new section has been added for the Final SEIS. Some adjustments/additions to the real estate requirements for the project were identified during the ESA consultation process and following the analysis of updated 2001 and 2002 hydrographic survey data. Minor changes have been identified for the dredged material disposal plans contained in the 1999 Final

IFR/EIS. Significant changes to real estate requirements have been identified, due in large part to additional ecosystem restoration features being added to the channel improvement project, together with ecosystem evaluation actions and monitoring actions associated with dredging and disposal. These changes to real estate requirements are grouped for discussion purposes in accordance with the anticipated nature of the project's use.

8.7.1^{new} Disposal Plan Modifications

Based on reduced dredging volumes predicated on updated hydrologic survey data, and the new ecosystem restoration features that require dredged material for their construction, modification is required for five upland disposal sites cited in Appendix D, Real Estate Plan, 1999 Final IFR/EIS. Disposal site O-63.5, Lord Island Upstream, requires modification to reflect a reduced acreage requirement change from 46 acres to 25 acres. This change is required for both the Corps least cost disposal plan and Sponsors' preferred disposal plan; the cited 13-year easement remains the appropriate real property interest for both plans.

Disposal site O-57.0 (Crims Island) requires modification to reflect acreage increases to 46 acres from 40 acres.

Disposal site O-42.9, James River, requires modification so as to reflect a reduced acreage requirement change from 59 acres to 53 acres. This change is required for both the Corps least cost disposal plan and sponsors' preferred disposal plan; the cited 20-year easement remains the appropriate real property interest for both plans.

Disposal Site W-101.0, Gateway Parcel 3, requires modification so as to reflect a reduced acreage requirement change from 69 acres to 40 acres. This change applies to only the sponsors' preferred disposal plan and the cited "fee title" interest remains the appropriate real property interest.

Disposal Site W-70.1, Cottonwood Island, will require no acreage change; however, a change in the project required real property interest is required from cited 20-year easement to full "fee title" interest. Due to restrictions placed on the sale of "fee title" interest in Washington State-owned lands, the WDNR-owned component of disposal site W-70.1 shall continue to reflect a project required 20-year use agreement or easement interest in sponsors' preferred disposal plan. The more extensive real property interest is appropriate, predicated on the newly identified Cottonwood-Howard Island Columbian white-tailed deer restoration feature requiring "fee title" interest acquisition for all the remaining non-disposal site acreage, portion, of the affected private ownership. This change in project required real property interest is appropriate for both the Corps least cost disposal plan and sponsors' preferred disposal plan.

Disposal Site W-68.7, Howard Island, requires modification to reflect a reduced acreage requirement that requires a change from 362 acres to 200 acres. This change is required for both the Corps least cost disposal plan and sponsors' preferred disposal plan and is predicated on the newly identified Cottonwood-Howard Island restoration feature's use allocation of all the island's non-disposal site acreage for deer habitat. The sponsors'

preferred disposal plan also requires a change from cited 20-year easement interest to full “fee title” interest requirement for the 156.5 acre privately-owned component of disposal site W-68.7. Due to restrictions placed on the sale of “fee title” interest in Washington State owned lands, the WDNR-owned component of disposal site W-68.7 shall continue to reflect a project required 20-year use agreement or easement interest in sponsors’ preferred disposal plan. All the above identified disposal plan modifications have been taken into account in the updated real estate cost estimate contained in the Final SEIS.

8.7.2^{new} Modifications to the Original Ecosystem Restoration Features

Two of the three separate and distinct ecosystem restoration features identified in Appendix D, *Real Estate Plan*, 1999 Final IFR/EIS require some modification as part of the Final SEIS. The Shillapoo Lake restoration feature requires modification to reflect a reduced acreage due to a change in development plans involving two of the original eight diked cells envisioned for construction to restore wetland and riparian habitat at Shillapoo Lake. The two cells that are withdrawn from the restoration project (Cells 1 and 8) constitute 409 acres of the originally anticipated 1,252 acres of restored wetland and riparian habitat and are part of the WDFW ownership. Two cells, encompassing approximately 369 acres remain in private ownership and may or may not be included in the restoration feature depending upon acquisition actions underway between WDFW and the landowners. Based on these factors, the acreage requirement for Shillapoo Lake will change from the original 1,252 acres to approximately 470 to 839 acres of project right-of-way. The WDFW ownership, together with one private owner, constitutes the identified 470 to 839 acres of project right-of-way. The WDFW still plans on purchasing the remaining ownership using funding provided in large part from the Bonneville Power Administration’s Wildlife Mitigation Program. The Shillapoo Lake restoration feature is still predicated on WDFW’s acquisition of all identified rights-of-way acreage. The restoration feature involves construction of hydraulic control structures desired by WDFW, together with all operation and maintenance being a WDFW responsibility, a no cost “Cooperative Agreement” is identified as the appropriate instrument by which the local sponsors secure all needed real property interests. Therefore, no estimated LERRD credit is allocated for this ecosystem restoration feature.

The second ecosystem restoration feature identified in Appendix D, *Real Estate Plan*, 1999 Final IFR/EIS that requires modification, is the action to improve embayment circulation at two island complexes by constructing connecting channels at the upstream end of Walker-Lord and Hump-Fisher Islands. It was initially thought all project right-of-way required for these actions was below the ordinary high water line of the Columbia River and as such, construction would be accomplished by exercising the rights of Navigation Servitude. Based on updated information, it appears that 1.3 acres (Walker-Lord) and 3.6 acres (Hump-Fisher) of required project right-of-way is above the ordinary high water line. The identified upland acreages are owned by the State of Oregon (Division of State Lands) and WDNR; the local sponsors will need to secure a perpetual “Channel Improvement Easement” for project use of these upland acres.

No updating is necessary for the ecosystem restoration feature for retrofitting existing levee tide gates with fish slides.

8.7.3^{new} Modifications for the Additional Ecosystem Restoration Features

During the ESA consultation process, additional ecosystem restoration features were identified for inclusion in the channel improvement project. These features are discussed in detail in Chapter 4 of the Final SEIS. Because they are varied with regard to the parties' task responsibilities and future operation and management requirements, their real estate requirements are discussed individually. All restoration features will be cost shared by the sponsor ports.

8.7.3.1.^{new} Lois Island Embayment Habitat Restoration

This restoration feature restores 191 acres of tidal marsh habitat between Lois and Mott Islands. Construction of a 600-foot wide by 2-mile long (145 acres), temporary in-water sump would occur immediately adjacent to the south side of the designated navigation channel. A pipeline dredge will extend for about 11,000 feet across the estuary waters from the temporary construction sump to the embayment area. Hopper dredges will be used to deposit dredged material in the sump as required. All project right-of-way required for this restoration feature is below the ordinary high water line of the Columbia River and as such, will be accomplished by exercising the rights of Navigation Servitude. Pipeline dredging to take material from the temporary sump to the Lois Island Embayment would occur during the November to February in-water work window.

8.7.3.2.^{new} Purple Loosestrife Control Program

This restoration feature is a 5-year effort to assist multiple entities ongoing efforts to establish bio-control of purple loosestrife, an invasive species in the Columbia River estuary. This action will be confined to CRM 18-52. Helicopter surveys will be used to help identify the actual targeted stands and to monitor progress during the 5-year effort. Boats and/or Hovercraft will provide access to the targeted stands for herbicide and/or mechanical treatments. All project right-of-way required for this restoration feature lie below the ordinary high water line of the Columbia River and as such, will be accomplished by exercising the rights of Navigation Servitude.

8.7.3.3.^{new} Miller-Pillar Habitat Restoration

This restoration feature will create 235 acres of tidal marsh and intertidal flats habitat between Miller Sands and Pillar Rock Islands in the Columbia River estuary. This area is currently an erosive area of the river just south of the authorized navigation channel. This feature includes construction of three pile dikes during the initial construction phase and two additional pile dikes pending the results of monitoring results to evaluate this feature. The placement of dredged material within the constructed Miller-Pillar pile dike field will complete this feature. The pile dike field, including associated bird excluders, is to be maintained by the Corps as a navigation feature. All project right-of-way required for this restoration feature lies below the ordinary high water line of the Columbia River and as such, will be accomplished by exercising the rights of Navigation Servitude.

8.7.3.4.^{new} Tenasillahe Island Phased Restoration

This restoration feature is planned as a three-phase effort, clearly with the final “long-term” phase being predicated on achieved environmental results separate from the success and/or failure of the interim restoration action. The purpose of this phased approach is to provide valuable habitat to ESA listed stocks.

Phase one, the interim feature, involves conducting hydraulic engineering analysis for fish of inlet channel and control structures, and tidegate structures that would allow ingress and egress of Columbia River waters to sloughs/backwater channels interior to the existing levee currently protecting an approximately 1,778 acre portion of Tenasillahe Island. Tenasillahe Island is a large natural island in the Columbia River estuary and its levee-protected acreage is owned in entirety by USFWS and is part of Julia Butler Hansen Columbian White-tailed Deer National Wildlife Refuge. Predicated on engineering feasibility, as determined by the engineering analysis, construction of two controlled inlets would occur at separate levee locations at the upstream end of the island so as to allow Columbia River flows into the headwaters of two interior sloughs. This, coupled with retrofitting improvement features for two downstream tidegates, comprises the construction features of the interim restoration action. Each one of these construction features would require the use of about 0.5-acre construction sites. Pre- and post-construction monitoring of the Tenasillahe phased restoration would cover a 12-year time period. The interim action requires the use of varied USFWS owned lands, and as post-construction operation and maintenance of the four constructed features will be accomplished by USFWS as part of their ongoing day-to-day operations, a no cost “Special Use Permit” is identified as the appropriate instrument by which the local sponsors would secure needed real property interests for all interim restoration actions. Therefore, no estimated LERRD credit is allocated for the interim action.

Phase two of this action is intended to provide secure habitat for Columbian white-tailed deer on Cottonwood-Howard Islands, with the expectation of achieving a secure and viable subpopulation as defined in USFWS’s recovery plan. Cottonwood-Howard Islands comprise about 920 acres above the ordinary high water line of the Columbia River and in effect constitute a single island mass. Historically, they were separate islands but due to their use as dredged material disposal sites they were, in effect, connected. The upstream and downstream portions of the islands were designated for dredged material disposal and access of dredging-related equipment in the 1999 Final IFR/EIS. The restoration feature calls for use of all the islands acreage, outside of the two actual designated disposal sites, to be used for Columbian white-tailed deer restoration. The use allocation of the 920 upland acres is as follows: 262 acres designated for disposal site use (Howard and Cottonwood Islands), 8 acres for equipment access, and 650 acres for restoration feature use. The restoration acreage includes the designated 300-foot wide riparian buffer between the river’s shore and the actual designated disposal sites, together with all the remaining island acreage. The ownership of Cottonwood-Howard Islands is comprised of two private holdings and WDNR ownership. As previously stated, due to the dual subject project requirements for Cottonwood-Howard Islands, “fee title” acquisition is now identified as the appropriate real property interest for the local sponsors to acquire from the two private ownerships. Due to restrictions placed on

the sale of “fee title” interest in Washington State lands, the approximately 158.5-acre WDNR ownership will continue to reflect a 20-year use agreement or easement interest requirement for dredge material disposal.

It also is important to note that one of the private owners also owns 60 acres of adjacent tidelands to Howard Island and good real estate practice will require purchase of “fee title” interest to those tidelands in conjunction with the acquisition of the upland acreage. The real estate costs associated with acquisition of the tidelands is reflected as a restoration feature component in the Final SEIS. Translocation of the white-tailed deer will be accomplished with the help of the USFWS. A no cost “Special Use Permit” with the USFWS is identified as the appropriate instrument by which the local sponsors would secure needed real property interests necessary for implementation of this part of the restoration feature. The USFWS also is identified for involvement with the feature’s habitat operation and maintenance and monitoring efforts.

The final phase is the long-term restoration action involving restoring the 1,778-acre levee protected portion of Tenasillahe Island to full tidal circulation. This would be accomplished by removal of downstream plugs (tidegates) on the internal drainage channels and removal of upstream levee sections to open historic upstream connections to these interior channels. These construction actions clearly have a significant effect on USFWS’s use of the affected 1,778-acre parcel. Post-construction monitoring of the acreage to verify environmental outcomes is also a component of this long-term feature. Again, this long-term restoration action is only proposed for implementation based on the achievement of off-site environmental actions (delisting of Columbian white-tailed deer) and as the long-term action clearly requires the full committed use of USFWS’s ownership as inter-tidal acreage, a no cost “Special Use Permit” is identified as the appropriate instrument by which the local sponsors secure needed real property interests necessary for the implementation of this action. Also, there are no identified operational and management actions required for the long-term action.

8.7.3.5. ^{new} Bachelor Slough Restoration

This restoration feature is intended to improve in-stream salmonid habitat and create riparian habitat along Bachelor Slough, a 2.75 mile-long side channel to the Columbia River. The restoration feature calls for dredging the entire slough (85 acres) and all project right-of-way required for this portion of the restoration feature which lies below the ordinary high water line of Bachelor Slough will be accomplished by exercising the rights of Navigation Servitude. Three upland sites have been identified for dredge material placement; one site owned by WDNR and two sites owned by USFWS. The WDNR owned 17-acre disposal site is located outside the flood protection dike on the Columbia River side of Bachelor Island. Both USFWS sites are located within Bachelor Island’s flood protection dike and when combined total 29 acres.

It should be noted that the Bachelor Slough restoration feature is only proposed for implementation based on suitability of the sediment chemistry for upland disposal and availability of adjacent targeted disposal sites. Sediment sampling in Bachelor Slough is the

first task to be accomplished and as stated previously, access to Bachelor Slough will be accomplished by exercising the rights of Navigation Servitude.

For the WDNR-owned lands, a short term use agreement or “dredge material disposal easement” is identified as the appropriate real property interest to allow for project use. The restoration feature’s use of USFWS lands includes not only the temporary use of the 29 acres contained within the two designated disposal sites, but the corresponding temporary use of lands between Bachelor Slough and the three disposal sites for dredging-related transport equipment. Upon completion of dredging action, the three disposal sites afford the bare mineral soil necessary for natural reestablishment of riparian forest habitat. The USFWS also is identified for involvement with post-construction riparian forest operation and maintenance and monitoring efforts. Based on USFWS level of involvement with this restoration feature, a no cost “Special Use Permit” with USFWS is identified as the appropriate instrument by which the local sponsors would secure the needed real property interests necessary for implementation of this portion of the restoration feature.

A second component to this restoration feature involves restoration of riparian forest along a narrow 6-acre strip of land located immediately adjacent to the left bank of Bachelor Slough. The scarification and sloping of this strip of land will create the bare mineral soil necessary for natural reestablishment of riparian forest habitat. The 6-acre strip of land is in WDNR ownership and its use will also be required during the dredging operation to allow for dredge material transport. Based on varied restoration actions required use for the 6-acre parcel, a no cost “Cooperative Agreement” with WDNR is identified as the appropriate instrument by which the local sponsors secure the needed real property interests necessary for implementation of this portion of the restoration feature.

8.7.4^{new} Ecosystem Evaluation Actions

During the ESA consultation process, the need for additional studies designed to provide useful information to aid in the recovery of salmon was highlighted and ecosystem evaluation actions were identified that, when accomplished, will contribute to the knowledge base of indicators for salmonids. The evaluation actions are to begin prior to project construction and continue up to 3 years after construction. All project right-of-way required for the accomplishment of these ecosystem evaluation actions is located on lands below the ordinary high water line of the Columbia River and as such, will be accomplished by exercising the rights of Navigation Servitude.

8.7.5^{new} Monitoring Actions Associated with Dredging and Disposal

During the ESA consultation process, the need for additional monitoring actions for analyzing the affects of project dredging and disposal actions was identified. Four specific monitoring tasks are proposed. Two of these tasks are to occur within a 7-year time period (2 years before, 2 years during and 3 years after construction), one of the monitoring tasks occurs 3 years after construction, and one task will occur for the entire life of the project. It appears all project right-of-way required for accomplishment of these monitoring actions is either located on lands below the ordinary high water line of the Columbia River, and as

such, will be accomplished by exercising the rights of Navigation Servitude, or achievable utilizing disposal site lands, mitigation site lands and/or ecosystem restoration feature lands upon which the local sponsors have secured appropriate real property interests necessary for project use.

8.8. ^{new} Royalty Fees for State-owned Dredged Material

This new section has been added for the Final SEIS. More information also is located in Exhibit K-6, *Royalty Fees for State Owned Dredged Material* (revised). Washington and Oregon laws require that royalties be paid to the respective state for dredged material (sand) removed from the Columbia River navigation channel and subsequently used for commercial purposes. The Oregon Division of State Lands and the Washington Department of Natural Resources, who administer the sand and gravel program for their respective states, have indicated a need to be able to track the location and volume of dredging, dredged material placement at upland disposal sites, and the sale of the dredged material from the channel improvement project. These materials, such as sand taken from the Columbia River channel, are at a premium and are being used for fill material related to construction, roads, filters for city water systems, golf courses, and sand for concrete and all of its many uses.

If the location and volume of dredging, as well as the placement of dredged material at upland disposal sites, are not adequately tracked during dredging and disposal operations for the channel improvement project, Oregon and Washington revenues from royalty fees generated from the sale of dredged material could be reduced.

The Corps will add a requirement to the channel improvement project construction contract that the contractor report directly to the Oregon Division of State Lands and the Washington Department of Natural Resources with the information needed to track dredging locations, volume, and dredged material placement. Therefore, the ability to track the royalty fees paid to Washington and Oregon from the sale of dredged material should be improved.

CHAPTER NINE

CONCLUSIONS AND

RECOMMENDATIONS

9. CONCLUSIONS AND RECOMMENDATIONS

9.1. ^{revised} Conclusions

Section 101(b)(13) of the Water Resource Development Act of 1999 authorized the deepening of the Columbia and Lower Willamette Rivers Federal Navigation Channel to 43 feet. The authorized project, which is the locally preferred plan, consisted of the following.

- The existing 600-foot-wide and 40-foot-deep navigation channel would be deepened from -40 feet to -43 feet Columbia River datum (CRD), from Columbia River mile (CRM) 3 to CRM 106.5, including advanced maintenance dredging for overwidth and overdepth (authorized and approved actions) in the reaches where this practice is currently performed in the maintenance program.
- The existing 600-foot-wide, 40-foot-deep navigation project channel would be deepened from -40 feet to -43 feet CRD, from Willamette River mile (WRM) 0 to WRM 11.6 (the construction of the Willamette River portion of the authorized project has been deferred).
- Three of the existing five turning basins on the Columbia River (located at CRM 13, 73.5, and 101.5, respectively) would be deepened to -43 feet CRD.
- The three turning basins located at WRM 4, 10, and 11.7 on the Willamette River would be deepened to -43 feet CRD (the construction of the Willamette River portion of the authorized project has been deferred).
- A total of 29 upland (with a total land area of 1,681 acres), three shoreline, and two ocean *and one gravel pit* disposal sites would be required for the disposal of construction materials and subsequent channel maintenance dredged material.
- Ecosystem restoration features include the use of a combined pump/gravity water supply for restoring wetland and riparian habitat at Shillapoo Lake. Tidegate retrofits with fish slides for salmonid passage would be installed at selected locations along the lower Columbia River. Connecting channels would be constructed at the upstream end of Walker-Lord and Hump-Fisher Islands to improve juvenile salmonid access to their embayment-rearing habitats.
- Environmental mitigation features on a total of 740 acres of land located at the Woodland Bottoms, Martin Island, and Webb mitigation sites.

The non-federal sponsors for the proposed project requested that the Willamette River deepening be delayed to allow coordination with the USEPA and Oregon Department of Environmental Quality investigation and remediation planning for the Portland Harbor. Because of the evolving Portland Harbor Superfund remedial investigations/feasibility studies by USEPA, further work to complete these investigations, complete the Willamette River disposal site alternative analysis, and deepen the Willamette River would be deferred until the completion of the remediation investigation and remediation decisions related to contaminated sediments in the Portland Harbor. Any Willamette River deepening will be re-evaluated in a separate NEPA document and is not covered in this Final SEIS.

The reporting officers recommended several provisions for plan implementation, as shown below:

a. Where confined disposal facilities are located on port property, the disposal facility operations, maintenance and management should be authorized to be accomplished at full non-federal cost without reimbursement. Specifically, the sponsor would operate, maintain, and manage the disposal facilities in exchange for the opportunity to beneficially use the dredged material. Where private property owners propose to use dredged material deposited on their property, the potential value obtained for use of the material would be reflected in the payment for the real estate interest for use of the property.

b. Subject to the availability of funds, the Federal Government should be authorized to reimburse the non-federal sponsors an amount equal to the federal share of the actual costs of the operation and maintenance of disposal facilities performed that fiscal year or the actual fiscal year appropriation identified for operation and maintenance of disposal facilities, whichever is less. When the non-federal sponsors sell material from a disposal facility, the proceeds from the sale, less any State royalties, be deducted from the federal payment for operation, maintenance and management of the disposal facilities.

c. The Federal Government be authorized to allow the non-federal sponsor to assist in the work of maintaining the main ship channel in the Columbia and Willamette Rivers by making available to the United States a suitable pipeline dredge in good operating condition, with full crew and equipment, without charge other than reimbursement for the full operating cost of the dredge on a basis approved by the Chief of Engineers. The reimbursement to be afforded, subject to Government audit, would be based on the full operating cost of the Port of Portland's dredge while performing maintenance dredging of the project. This would include the proportionate cost of maintenance of the dredge based on the period of time the dredge is performing work for the United States that fiscal year or the actual fiscal year appropriations identified for that portion of maintenance dredging that are made available, whichever is less.

d. The non-federal sponsors be authorized to be given a pro-rated share of the value of LERR for disposal sites needed for operation and maintenance of the existing 40-foot project against the additional 10% cost share for the 43-foot project if the sites will also be needed for disposal facilities for construction and subsequent operation and maintenance of the 43-foot project. The pro-rated value would be based on the actual proportionate use of disposal site capacity for the maintenance of the existing project versus the projected capacity that would be used for the construction, maintenance and operation of the 43-foot project.

e. The non-federal sponsor be authorized to construct, and be granted credit for construction of that portion of the project from CRM 95 to the upstream end of the project at CRM 106.5 and improvement of the embayment circulation portion of the ecosystem restoration features of the project. The proposed credit to be afforded, subject to Federal

Government audit, would be applied toward the non-federal sponsor's cash contribution required for construction.

f. The Federal Government be authorized to make lump sum payment to the Oregon Department of Fish and Wildlife and the Washington Department of Fish and Wildlife to fulfill the Federal Government's responsibility to operate and maintain mitigation areas, subject to agreement by these agencies to accomplish the operation and maintenance of the mitigation areas without further cost to the Federal Government.

9.1.1^{new} Additional Conclusions

For the Final SEIS, the following updated information has been added to this section. This Final SEIS incorporates the revisions identified in this report into the authorized project. These include reduced dredging volumes and reduced rock blasting. In addition, five new ecosystem restoration features, monitoring actions, ecosystem evaluation actions and adaptive management were added to the project (see Chapters 1 and 4 for further information). Two of the five new ecosystem restoration features, Lois Island embayment and Miller-Pillar ecosystem restoration features, beneficially use dredge material. If fully implemented, the Lois Island and Miller-Pillar ecosystem restoration features and traditional estuarine disposal sites and practices should eliminate the need for ocean disposal for construction and the first 20-years of maintenance. The three remaining ecosystem restoration features (Tenasillahe Island Phased Restoration, Bachelor Slough and Purple Loosestrife Control) were added to benefit ESA stocks through the ESA consultation. The revised plan reduces impacts to wetland, riparian and agricultural lands. As a result of these revisions and modifications, the project costs and benefits also were revised. The following list details the specific revision to the authorized plan.

Disposal Sites (construction and 20-year maintenance plan). A total of 29 upland disposal sites, for a total land area of 1,630 acres (excludes three shoreline disposal, one gravel pit, one disposal site for wildlife mitigation purposes (Martin Island embayment), and in-water are proposed for the disposal of construction and subsequent channel maintenance dredged material. Four upland disposal sites are new; all other upland disposal sites are located at previously used disposal sites. It is acknowledged that USEPA is designating two ocean disposal sites.

Wildlife Mitigation. Wildlife mitigation features would be implemented on a total of 528 acres of the 740 acres of land purchased at the Woodland Bottoms, Martin Island and Webb mitigation sites. The Martin Island embayment has been reduced from 32 acres to 16 acres.

Monitoring Actions. The six monitoring actions are intended to obtain data on physical changes and their effect on ESA salmonid habitat in the project area. The monitoring actions, coupled with review by the adaptive management team, are intended to address the risk and uncertainties associated with key salmonid pathways and indicators identified in the 2002 Biological Opinion. The intent of these actions is

to verify that the project's long-term adverse effects to ESA-listed salmonids and their habitats are likely to be limited.

Adaptive Management. The Adaptive Management Team (AMT), composed of the Corps, Sponsor Ports, NOAA Fisheries and USFWS, was established to consider information obtained during project implementation and operation regarding project actions, compliance measures, monitoring programs, evaluation actions and ecosystem restoration features. The AMT would be the decision-making body regarding modifications to these elements of the project, if warranted by the data obtained. The AMT and proposed monitoring actions are intended to validate the conclusions of the 2001 BA, help minimize take of listed species, and ensure that proposed project activities will not jeopardize listed species or adversely modify designated critical habitat [ESA Section 7(a)(2)].

Ecosystem Evaluation Actions. Ecosystem evaluation actions are measures take by the Corps as part of the project to assist the efforts of the Corps, NOAA Fisheries, USFWS, and others in the broader issues of understanding the lower Columbia River ecosystem. The evaluation actions address indicators of the salmonid conceptual model and will advance the knowledge base for the conservation and recovery of salmonid species.

This plan has been reviewed and endorsed by the local sponsors (see attached letter). This report satisfies Corps Engineering Regulation 1105-2-100, the Planning Guidance Notebook, and is intended to serve as a limited reevaluation. This reevaluation specifically evaluated the 43-foot channel improvement project under current policies, criteria and guidelines.

9.2. ^{revised} Recommendations

I have given careful consideration to all significant aspects of this study in the overall public interest, including engineering and economic feasibility as well as social and environmental effects. The selected plan described in this Final SEIS provides the optimum solution for improvements to the authorized Columbia and Lower Willamette Rivers Federal Navigation Channel in Oregon and Washington. This recommendation pertains exclusively to the Columbia River portion of the authorized project (as noted above, the Willamette River portion of the project has been deferred). The Columbia River portion of the fully funded cost estimate for this selected plan, including the environmental restoration components, is \$145,097,000.

This Final SEIS continues to support the need for the Columbia River portion to be modified to provide a 43-foot deep navigation channel. The proposed disposal plan continues to be the locally preferred plan. Disposal actions would occur in-water, at three beach nourishment locations, at new and previously used upland locations. The selected plan includes an environmental restoration component to restore for fish and wildlife habitats along the lower Columbia River, especially for anadromous fish species and two restoration features which beneficially use dredge material.

In addition, the authorizing document allows for the Port of Portland to be reimbursed for maintenance dredging of the project, performed by the Port of Portland's pipeline dredge. The reimbursement to be afforded, subject to Government audit, will be based on the full operating cost of the Port of Portland's dredge while performing maintenance dredging of the project, including proportionate cost of maintenance of the dredge based on the period of time the dredge is performing maintenance of the project.

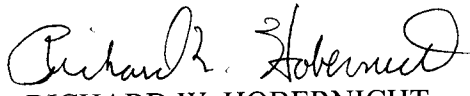
The non-federal sponsor is authorized credit for participation in the construction of the project from Columbia River mile 95 to the upstream end of the project and improvement of embayment circulation portions of the ecosystem restoration features of the project. The credit to be afforded, subject to Federal Government audit, will be applied toward the non-federal sponsor cash contribution required for construction.

The new ecosystem restoration features were not included in the 1999 Report of the Chief of Engineers. These features are recommended to be part of the overall project, and would be constructed under either the Chief of Engineer's discretionary authority or the Continuing Authorities Program.

Lastly, the Corps is authorized to make lump sum payment to the Oregon Department of Fish and Wildlife and the Washington Department of Fish and Wildlife in fulfillment of the Federal Government's responsibility to operate and maintain these mitigation areas, subject to agreement by these agencies to accomplish the operation and maintenance of the mitigation areas without further cost to the Federal Government.

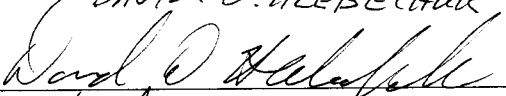
The recommendations contained herein reflect the information available at this time and current Departmental policies governing formulation of individual projects. They do not reflect program and budgeting priorities inherent in the formulation of national Civil Works Construction program nor the perspective of higher review levels within the Executive Branch.

Date: 19 January 2003


RICHARD W. HOBERNIGHT
Colonel, EN
Commanding

CERTIFICATION OF LEGAL REVIEW

The report for the Final SEIS including all associated documents required by the National Environmental Policy Act have been fully reviewed by the Office of Counsel, Portland District, and is approved as legally sufficient.

DAVID D. HLEBETCHUK

Assistant District Counsel

19 JANUARY 2003
Date

INTERSTATE COLUMBIA RIVER IMPROVEMENT PROJECT (ICRIP)

P.O. Box 3529

Portland, OR 97208

Port of Kalama

Port of Longview

Port of Portland

Port of St. Helens

Port of Vancouver

Port of Woodland

January 10, 2003

Mr. Robert E. Willis
Chief, Environmental Resources Branch
CENWP-PM-E
Post Office Box 2946
Portland District
U.S. Army Corps of Engineers
Portland, Oregon 97208-2946

Dear Mr. Willis:

We are writing on behalf of the Interstate Columbia River Improvement Project (ICRIP), which consists of the following ports: the Ports of Kalama, Longview, Vancouver, and Woodland in Washington and the Ports of Portland and St. Helens in Oregon. We are pleased to serve as the non-federal co-sponsors for the Columbia River Channel Improvement Project and stand ready to fulfill our obligations as required for a federal navigation project.

We would like to reconfirm our support for the modified Columbia River Channel Improvement Project, as described in the Final Supplemental Integrated Feasibility Report and Environmental Impact Statement (IFR/EIS).

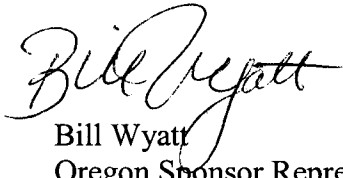
We support the proposed project including modifications made as a part of the Endangered Species Act consultation and subsequent Supplemental EIS, which will provide improved habitat for Lower Columbia River endangered fish and wildlife. The preferred project alternative beneficially uses dredged material for ecosystem restoration features that enhance the estuary. The ecosystem restoration features, adaptive management, monitoring and evaluation actions added to the channel project ensure that the project meets the high expectations of the citizens of this region for an environmentally sound and economically viable project.

All six sponsors continue to support the recommendation to delay the construction of the Willamette River channel improvements until resolution of sediment cleanup issues associated with its designation as a federal National Priorities List site under the Comprehensive Environmental Response, Compensation, and Liability Act. We understand that at that time additional engineering and environmental review would have to be pursued for the Willamette channel improvements to be constructed.

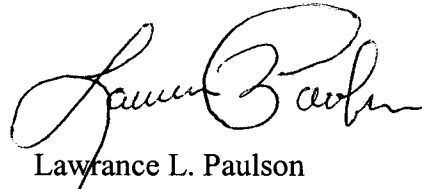
The sponsor ports look forward to entering into a Project Cooperation Agreement (PCA) with the Corps of Engineers prior to construction of the project. The sponsor ports are capable of funding our obligations for cost sharing the proposed project. The states of Oregon and Washington have both appropriated the necessary non-federal cost share for the Columbia River navigation project. Specific details will be provided in the sponsors' financing plan to be submitted with the PCA.

We urge the Corps to complete the steps necessary to bring the project to construction as expeditiously as possible. We stand ready to carry out our obligations as non-federal sponsors.

Sincerely,



Bill Wyatt
Oregon Sponsor Representative
Executive Director
Port of Portland



Lawrence L. Paulson
Washington Sponsor Representative
Executive Director
Port of Vancouver USA

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GLOSSARY FOR THE SUPPLEMENTAL IFR/EIS

This glossary defines terms that are specific to the *Supplemental Integrated Feasibility Report for Channel Improvements and Environmental Impact Statement*.

Alevin: The first post-hatch life stage of salmon. Alevins will have some portion of their yolk sac showing on their abdomen. A life stage commonly found only within spawning gravel or hatcheries.

Anadromous: Fish that hatch in fresh water, migrate to seawater as juveniles, and return to spawn in fresh water as adults.

Bathymetry: Topographical (surface) configuration of the riverbed.

Beach nourishment disposal sites: Shoreline fills that replace eroded material. See also shoreline disposal.

Benthic: An environment or habitat related to the bottom of a stream or body of water.

Biological Assessment: Information prepared by, or under the direction of, a Federal agency to determine whether a proposed action is likely to: (1) adversely affect listed species or designated critical habitat; (2) jeopardize the continued existence of species that are proposed for listing; or (3) adversely modify proposed critical habitat.

Biological Opinion: A document which includes: (1) the opinion of the U.S. Fish and Wildlife Service or the NOAA Fisheries (National Marine Fisheries Service) as to whether or not a federal action is likely to jeopardize the continued existence of listed species, or result in the destruction or adverse modification of designated critical habitat; (2) a summary of the information on which the opinion is based; and (3) a detailed discussion of the effects of the action on listed species or designated critical habitat.

Candidate species: Plant and animal taxa considered for possible addition to the list of endangered and threatened species. These are taxa for which the Fish and Wildlife Service has on file sufficient information on biological vulnerability and threat(s) to support issuance of a proposal to list, but issuance of a proposed rule is currently precluded by higher priority listing actions.

Columbia River Datum (CRD): The Columbia River navigation channel elevations are referenced to the Columbia River datum established in the 1930s. The CRD is a local datum based on observed water surface elevations during low discharge-low tide conditions.

Conceptual Model. A graphic diagram designed to visually represent the holistic, complex relationships with a functioning system.

Critical habitat: Under the Endangered Species Act, critical habitat is defined as (1) the specific areas within the geographical area occupied by a federally listed species on which are found physical and biological features essential to the conservation of the species, and that may require special management considerations or protection; and (2) specific areas outside the geographical area occupied by a listed species, when it is determined that such areas are essential for the conservation of the species.

Cubic feet per second (cfs): A unit of measurement pertaining to flow or discharge of water. One cfs is equal to 449 gallons per minute.

Delist: To remove from the federal list of endangered and threatened species because such species no longer meets any of the five listing factors provided under section 4(a)(1) of the ESA and under which the species was originally listed (because the species has become extinct or has recovered).

Endangered species: Any species that is in danger of extinction throughout all or a significant portion of its range, and published in the Federal Register.

Entrainment: The mechanical process by which fish are trapped. During dredging activities, fish may be entrained by the suction of hopper or pipeline dredges.

Epibenthic: Pertaining to the habitat that includes the sediment surface and the overlying one meter of water, or to the organisms that live in this habitat.

Estuary: The transition zone at the mouth of the lower reach of a river where freshwater and seawater mix, and is characterized by a layer of reduced salinity near the surface and a higher salinity layer below. It is the part of the course of a river where its current is met and influenced by the tides.

Estuary turbidity maximum (ETM): An area in the water with very high concentrations of suspended matter. In many estuaries, a turbidity maximum occurs near the leading bottom tidal flow.

Euryhaline organisms: Organisms that tolerate and can live in waters with wide ranges of salinity.

Eutrophic: A stage of aquatic ecosystems characterized by an accumulation of nutrients that support a dense growth of algae and other organisms, the decay of which depletes shallow waters of oxygen, especially in summer.

Evolutionarily Significant Unit (ESU): A distinct population segment of a species that interbreeds when mature, generally genetically distinct from other groups, and representing a significant portion of the evolutionary lineage of the species.

Fingerling: An early freshwater life stage of salmon that are several months old and are about finger size, usually about 40-50 mm (1.5 to 2 inches) in length. Follows fry life stage.

Flowlane disposal: The deposition of dredged material in deep areas of the riverbed in and adjacent to the navigation channel. See also In-water disposal.

Fry: An early life stage of salmon that have emerged from gravel, but still within its first few months of life. Fry are generally about 30-50 mm in length. Follows alevin life stage.

Habitat complexity: The existence of a variety of habitats.

Habitat connectivity and conveyance: The ability to access a habitat.

Habitat forming process: Those physical agents that form landscape features (hydrology, erosion, sediment, temperature, salinity, wind, waves, currents, nutrients, and others).

Habitat opportunity: The ability of salmonids to access habitats.

Intertidal: Characterizing the shoreline zone exposed at low tides and inundated at high tides; also, characterizing the area ecosystem and organisms between extreme low tide and extreme high tide.

In-water disposal: The placement of dredged material along the riverbed in or adjacent to the navigation channel, or in designated sites below low water. Also commonly referred to as flowlane disposal, this practice has been used through out the lower river system for many years. In-water disposal sites vary from year-to-year, depending on the dredging location and river depths available in the vicinity of the dredging action.

Juvenile salmon: Young salmon that have not reached sexual maturity, and generally referring to young salmon that have not yet migrated to the sea or have just entered the sea.

Larva (plural larvae): An immature form of an animal which is unlike the adult body form and that requires fundamental morphological changes before reaching maturity.

Listed species: Any species, including subspecies and distinct vertebrate populations, of fish, wildlife or plant that has been determined to be endangered or threatened under Section 4 of the Endangered Species Act.

Macrodetritus: The decaying remains of multi-celled plants, such as tidal marsh and swamp plants.

Microdetritus: Decaying remains of single-celled plants and organisms, such as phytoplankton and benthic diatoms. Imported microdetritus are the remains of phytoplankton produced upstream that are carried downstream. Resident microdetritus are primarily the remains of phytoplankton produced in the estuary (see phytoplankton).

Nephelometric turbidity unit (NTU): Measurement of turbidity using a nephelometer that measures the size and concentration of particles in a liquid by analysis of light scattered by the liquid.

Ocean type: A life history designation for salmon that spend only a brief period (weeks to several months) rearing in freshwater and the estuary before they migrate to sea, as contrasted to stream-type salmon that spend at least one winter in freshwater before migrating directly to the ocean.

Phytoplankton: Single-celled plants suspended in the water column. Phytoplankton serve a vital role as the base of the food web on which zooplankton, benthic fauna and epibenthic organisms feed. Phytoplankton are termed imported if they have been produced behind the mainstream dams, or resident if they are produced within the lower river.

Pile dike: A structure consisting of two parallel rows of piling that are tied together and extend into the river.

Plankton: The collection of small or microscopic organisms, including algae and protozoans, that float or drift in great numbers in fresh or salt water, especially at or near the surface, and serve as food for fish and other larger organisms.

Salinity: The relative proportion of salt in a solution, such as water.

Salinity gradient: The variable rate of increase or decrease of the ratio of salinity to freshwater.

Salinity intrusion: The movement of saltwater into freshwater.

Salmonid: Fish belonging to the family salmonidae, including salmon, trout, char and allied freshwater and anadromous fish.

Section 7 consultation: The various Section 7 processes of the Endangered Species Act, including both consultation and conference if proposed species are involved.

Sediment deposition or erosion: The adding (deposition) or removal (erosion) of sediments to an area by some transporting agent, such as wind or water.

Sediments: The organic and inorganic particulate materials, including gravel, sand, silt and clay, that cover the bottom of water bodies, including river and tributaries bottoms, estuary bottoms, and intertidal areas.

Shoreline disposal: Material that is dredged and pumped into shallow water and beach areas along the river. Shoreline disposal is done primarily with pipeline dredges.

Side-slope adjustment: The bedload movement is generally directed down stream, but there can be a small displacement towards deeper water caused by the side-slopes of the riverbed. This displacement is larger on steeper side-slopes.

Smolt: A life stage of salmon that is undergoing or has completed the physiological transition that allows it to live in seawater. Commonly involves changes in body form to a slightly more streamlined shape and silvery body coloration.

Smoltification: Physiological transformation process young anadromous fish undergo that allows them to move from freshwater to seawater.

Suspended sediments: Soil particles that remain suspended in water due to the upward forces of turbulence and currents, and/or colloidal suspension.

Take: To harass, harm, pursue, hunt, shoot, wound, kill, trap, capture, or collect or attempt to engage in any such conduct. Harm is defined by the U.S. Fish and Wildlife Service to include significant habitat modification or degradation that results in death or injury to listed species by significantly impairing behavioral patterns such as breeding, feeding, or sheltering. Harass is defined as actions that create the likelihood of injury to listed species to such an extent as to significantly disrupt normal behavior patterns which include, but are not limited to, breeding, feeding or sheltering.

Threatened species: Any species that is likely to become an endangered species within the foreseeable future throughout all or a significant portion of its range.

Turbidity: Reduced water clarity resulting from the presence of suspended matter; also, the amount of particulate matter suspended in water.

Upland disposal: Depositing dredged material on a site that is elevated, dry land. Upland disposal sites are designed as holding ponds, with earthen dikes to contain the dredged material and hold the sand while allowing sand and suspended material to settle. Weirs are used to regulate the return of water from the piped slurry to the river.

Zooplankton: The group of small (usually microscopic) passively suspended or weakly swimming animals in the water column.

INDEX FOR THE SUPPLEMENTAL IFR/EIS

INDEX

Topics are referenced to section numbers or chapters in the Final SEIS.

Adverse Effects	6.11
Affected Environment	Chapter 5
Alternatives	Chapter 4
Aquatic Resources	6.6.1
Authorization	Chapter 1
Bank Erosion	6.2
Bedload	6.2
Benefit/Cost	4.5, 4.6
Biological Impacts	6.6
Coastal Zone	7.4.3
Comparison of Alternatives	4.5
Conclusions	Chapter 9
Coordination	Chapter 7
Cost Sharing	Chapter 8
Cover Sheet	Front page
Cumulative Impacts	6.12
Disposal Sites	4.3, 4.4.3, 6.2.3
Dredging	4.4.3, 6.2
Dungeness Crab	6.1.1.2, 6.6.1.1, 6.6.1.2
Economic Comparison	4.5.2
Ecosystem Restoration	4.8, 6.4.3, 6.5.3.1, 6.6.1.3, 6.6.2.5
Endangered Species Act Consultation	Chapter 1, 6.7.1
Endangered Species	6.7
Essential Fish Habitat	6.6.1.2
Irreversible & Irretrievable Commitments	6.14
Land Use	6.8.2
List of Preparers	after Chapter 9
LoadMax	4.3

Mitigation	6.10
Monitoring	6.7.1.1
Non-indigenous Species	6.6.1.1
Non-structural Alternative	4.3
Ocean Disposal	4.4.3, 6.2.3.3
Physical Impacts	4.5.1.1, 6.2
Plan Selection	4.6
Purpose and Need	1.1
Salinity	6.2.2.3
Schedule for Design and Construction	8.2
Secondary Impacts	6.9
Sediment Quality	6.4
Smelt	6.1.1.2, 6.6.1.1, 6.6.1.2
Socio-Economic	4.5.1.3, 6.8
Study Area	1.3
Study Scope	1.4
Sturgeon	6.1.1.2, 6.6.1.1, 6.6.1.2
Unavoidable Adverse Impacts	6.11
Upland Disposal	6.2.3.1
Water Quality	6.3
Water Surface Elevation	6.2.2.2
Wave Conditions	6.2.2.1
Wetlands	4.4.3.10
Wildlife Resources	4.5.1.2, 6.6.2

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