



U.S. Army Corps
of Engineers
Seattle District

Centralia Flood Damage Reduction Project Chehalis River, Washington General Reevaluation Study

**Final Environmental Impact Statement
Part 1, Chapters 1-4
June 2003**

This page was intentionally left blank.

FINAL ENVIRONMENTAL IMPACT STATEMENT

**Centralia Flood Damage Reduction Project
Chehalis River, Washington
General Reevaluation Study**

**U.S. Army Corps of Engineers
Seattle District**

June 2003

FINAL
ENVIRONMENTAL IMPACT STATEMENT

for
CENTRALIA FLOOD DAMAGE REDUCTION PROJECT

Proposed Action: Seven alternatives were proposed to provide 100-year flood protection to the cities of Centralia and Chehalis, Washington, while providing potential restoration opportunities within the project area.

Responsible Agencies: U.S. Army Corps of Engineers

Lead Agency: U.S. Army Corps of Engineers

Abstract

The cities of Centralia and Chehalis, Washington, have been subject to flooding for many years. This flooding has caused extensive damage to private and public property and caused periodic closure of critical transportation routes resulting in significant economic losses. The closure of critical transportation routes also disrupts emergency response teams and adversely impacts public safety. In addition, stream habitat functions of the Chehalis River and its tributaries have been damaged in the past due to development throughout much of the Chehalis Basin. This has resulted in the diminishment of the remaining habitat to adequately support sustainable fish and wildlife resources. The loss of wetlands, riparian areas, and back channels has also contributed to increased flooding in the area. The proposed preferred alternative will provide the cities 100-year flood protection and provide habitat enhancement opportunities for fish and wildlife. With set back levees, there will be opportunities for the river to overflow its banks and potentially restore riparian habitat along its banks while providing flood reduction. The Skookumchuck Dam modifications will allow floodwater storage up to 492 feet or 20,000 acre-feet of water behind the dam for a period not to exceed five days. This will provide some flood reduction along the Skookumchuck River. After modifications are completed to the dam, a re-operation plan will call for a maximum flow at Pear Street not to exceed 5,000 cubic feet per second. This can only occur on events under the normal two-year event because, with events two years and over, the tributaries will augment the river flow resulting in a loss of flow controls at Pear Street. The greatest protection from dam modifications will occur between the 50- and 100-year events. There is expected to be an adverse impact on 34 acres of wetlands resulting from levee construction and no major wetland impacts from dam modifications. The Corps has committed to further studies to investigate stream bed-load and sediment movement on the Skookumchuck River.

This report is also available on the web site at: <http://www.nws.usace.army.mil>

For Further Information Contact: Mr. George Hart, U.S. Army Corps of Engineers, Seattle District, P.O. Box 3755, Seattle, Washington 98124-3755, Tel: 206/764-3641.

EXECUTIVE SUMMARY

The Seattle District, U.S. Army Corps of Engineers (the Corps) and Lewis County, Washington, have collaborated to re-evaluate a previously authorized flood reduction project in the Chehalis River Basin and prepare an Environmental Impact Statement. The previously authorized project was not found to be economically justified under its narrow scope, and flooding continues to be a problem in the basin, especially in the cities of Centralia and Chehalis. The purpose of this Final Environmental Impact Statement (FEIS) is to provide the public and all parties concerned, a list of all reasonable alternatives considered and an in depth discussion of the benefits and adverse impacts of the alternatives including the environmentally preferred and national economic development preferred alternatives. This project is authorized under Section 401(a) of 1986 Flood Control Act (PL 99-662), which authorized construction of "works of improvement" substantially in accordance with the Report of the Chief of Engineers, dated 20 June 1984. On 9 October 1998, the U.S. House of Representatives Committee on Transportation and Infrastructure adopted Resolution 2581, requesting a review of past Corps report recommendations with a view to determining if the recommendations should be modified "with particular reference to flood control and environmental restoration and protection, including non-structural floodplain modification." This resolution provided the authority and directive for the Corps to conduct a Flood Hazard Reduction and Ecosystem Restoration Study for the Chehalis River Basin.

Habitat conditions for fish and wildlife in the Chehalis Basin are limited by several factors, including altered hydrologic regime, loss of floodplain connectivity, changes to sediment supply and transport, loss of riparian zone, presence of fish barriers and poor water quality. This FEIS describes seven different alternatives that were investigated to address those limiting factors while reducing flood damage to the basin.

ALTERNATIVE 1 - NO ACTION

Under this alternative, no project features are implemented. The studies conducted in the General Reevaluation Report (GRR) indicate this alternative would result in continued flooding in the project area.

ALTERNATIVE 2 - SKOOKUMCHUCK DAM MODIFICATIONS

This alternative is intended to provide reductions in flooding along the Skookumchuck River. This is needed to address flooding problems in the Town of Bucoda and the City of Centralia. This alternative may also provide some reduction in discharge in the Chehalis River downstream of the confluence with the Skookumchuck River.

ALTERNATIVE 3 - OVERBANK EXCAVATION AND FLOWWAY BYPASS

This alternative was developed in an effort to reduce flooding in the City of Chehalis, to prevent State Route 6 (SR-6) from overtopping in large floods through floodplain modification, and to reduce flooding of Interstate Highway 5 (I-5). By overbank excavation, it would increase channel capacity in the vicinity of Centralia. It was anticipated that a combination of these two features would provide significant flood damage reduction in these areas.

ALTERNATIVE 4 - LEVEE SYSTEM

This project design was to reduce flood damages associated with the Chehalis and Skookumchuck rivers. It also addresses flooding along Salzer Creek, Dillenbaugh Creek, and the Newaukum River. This alternative reduces damages to structures and allows I-5 to stay open for transportation.

ALTERNATIVE 5 - UPSTREAM FLOW RESTRICTION STRUCTURES, AND UPSTREAM STORAGE

Flow restrictors are intended to increase water surface elevation upstream of the flow restrictor at low flows providing potential benefits to wetlands and fisheries. Currently there is lack of off-channel habitat for salmon along the mainstem of the Chehalis River. If spring and summer flows could be backed up into adjoining low areas or disconnected oxbows, without also resulting in a stage increase during the 100-year flood event, then additional off-channel habitat could be created. The increased upstream inundation could also have a potential benefit in regards to increasing groundwater recharge.

ALTERNATIVE 6 - NON-STRUCTURAL ALTERNATIVE

The intent of the non-structural alternative was to formulate a viable non-structural solution to reduce flood damages throughout the study area. This would be accomplished by watershed management, flood proofing structures, evacuation plans, and removal of structures from the floodplain.

ALTERNATIVE 7 - INTERAGENCY COMMITTEE ALTERNATIVE

The purpose of this alternative is to provide short and long-term actions that will reduce flooding hazards to the Centralia and Chehalis area residents, while at the same time, restore and enhance river hydrology and floodplain functions to support the basin's salmonoid habitat base. This would be accomplished by focusing first on regulatory and voluntary measures. The connectivity of the Chehalis River to its floodplain would be maintained and enhanced by using land use and development regulations before implementation of any costly structural solutions. This would include the use of floodplain easements, acquisition of frequently flooded areas and structures, relocation or elevation of structures, and improved upland water storage.

The Levee Alternative and the Skookumchuck Dam Modifications (low dam) combined are the National Economic Development Plan, and are economically feasible to construct. The Levee Alternative and the Skookumchuck Dam Modifications (high dam) are the environmentally preferred and locally preferred alternative based on the following restrictions: The Skookumchuck Dam can only be used for flood reduction events. Water can be stored no longer than a 5-day period for the 50- to 100-year flood event. During the 2- to 50-year period of frequency, retention greater than elevation 477 feet (NGVD 1929) should not occur more than every other year; storage should be no longer than 5 days for these events. The environmental impacts between the low and high dam are basically the same. Differences occur mainly with the frequency of events and the time of retention of floodwaters above 477 feet, with no known environmental impacts if water is stored no longer than 5 days. The levee alignment and Skookumchuck Dam operations were combined based on the 100-year flood event.

For levee alignments, the peak flood stage would be decreased below River Mile (RM) 70 along the Chehalis River. The peak flood stage would be increased between RM 70 and RM 78 with the maximum increase of 0.65 feet at RM 72.8. At the Galvin Road Bridge, peak flood stage would decrease 0.15 feet, and at Grand Mound the peak flood stage would decrease 0.2 feet.

Between Grand Mound and Porter, the peak flood stage decrease would vary from as much as 0.39 feet to as little as 0.06 feet.

Along the Skookumchuck River, peak flood stages would decrease in a range of 2.22 feet to 0.38 feet from RM 10 to the mouth for the dam modifications and levee alignment. Chapter 2 of the FEIS gives a full description of all the alternatives and the preferred alternative. The preferred alternative was chosen after a series of studies were conducted in many technical areas including:

- Survey and mapping
- Hydrology and hydraulics
- Engineering design
- Geotechnical Studies
- Economic Studies
- Cultural Resource Studies
- Environmental Studies

The scopes of these studies and their findings are discussed in detail in Chapter 2, but the overall purpose of these studies was to assist in identification and selection of the preferred alternative.

The purpose of the chosen preferred alternative is to provide flood protection during a 100-year event, with an indirect result in damage reduction caused by the flooding. Another benefit of the preferred alternative is to provide the opportunity to establish restoration areas to enhance fish and wildlife habitat. Setting the levees back from the Chehalis River will give the river an opportunity to overbank during certain flood events and possibly re-establish riparian zones along the river's banks while protecting the main infrastructure of the cities of Centralia and Chehalis. The project will have no effect on farmlands.

Major Conclusions

The levee system will provide 100-year flood protection for the cities of Centralia and Chehalis that are within the boundaries of the levees while minimizing environmental impacts. Modifications to Skookumchuck Dam and levees along a portion of the Skookumchuck River will also provide 100-year flood protection to Centralia.

With an impact of approximately 34 acres of wetlands for construction of the levee system, all mitigation efforts will be concentrated along the Scheuber ditch, SR-6 oxbow, and associated potential wetland sites. Total wetland loss is estimated to be 34 acres of wetlands over approximately 15 miles of levees and floodwalls. Approximately 14 miles of the preferred alternative consists of levees and 1 mile of floodwall. This will result in 68 acres required for mitigation of the wetland loss based on a 2:1 ratio for the emergent type wetlands impacted. Farmland will not be impacted by the project.

Skookumchuck Dam modifications will not have a major impact on wetlands or stream geomorphology downstream of the dam as earlier expected. Skookumchuck Dam controls only approximately a quarter of the total watershed in the study area. A number of tributaries along the Skookumchuck have an extremely large influence on the environment associated with, in and along the mainstem of the Skookumchuck River. The re-operation plan for the modified dam will ensure that a fishery and/or fishery habitat flow will be maintained during all events. Since this is a flood control dam, all flows will be allowed to flow through the dam as they do now unless flows approach major flooding. At that time the flow from the dam will be reduced to offset the input of the tributaries (but not below the required fish and/or fishery habitat flow) until the tributaries recede and the dam can resume a higher flow of water downstream. Therefore, there are no expected impacts to wetlands or the mainstem channel of the Skookumchuck from the dam modification.

Issues to be Resolved

The winter steelhead population is depressed. Information about how well the existing dam functions with respect to fish passage is lacking. There is uncertainty as to whether the trap and haul operation has been successful in producing smolts, or that any smolts produced actually reach the dam, given the assumed level of predation in the reservoir.

This page intentionally left blank

TABLE OF CONTENTS

Abstract	ii
EXECUTIVE SUMMARY	iii
Alternative 1 - No Action	iii
Alternative 2 - Skookumchuck Dam Modifications	iv
Alternative 3 - Overbank Excavation and Flowway Bypass	iv
Alternative 4 - Levee System	iv
Alternative 5 - Upstream Flow Restriction Structures, and Upstream Storage	iv
Alternative 6 - Non-Structural Alternative	v
Alternative 7 - Interagency Committee Alternative	v
Major Conclusions	vi
Issues to be Resolved	vii
TABLE OF CONTENTS	viii
LIST OF TABLES	xiv
APPENDICES	xv
LIST OF FIGURES	xvi
1. INTRODUCTION	1
1.1 Need for the Proposed Action	1
1.2 Project Purpose	1
1.3 Background	2
1.3.1 Authorizations	2
1.3.2 Status of Authorized Project	5
1.3.3 Chehalis River Basin Study	6
1.4 Study Area	6
1.5 National Environmental Policy Act	8
1.5.1 Public Scoping Process	8
1.5.2 Supplemental Studies	10
2. ALTERNATIVES & THEIR DESCRIPTION	16
2.0 National Environmental Policy Act (NEPA)	16
2.1 Alternatives Analysis	16
2.1.1 Alternatives Development	17
2.1.2 Range of Alternatives	17
2.1.3 Actions Common to All Alternatives with the Exception of the No Action Alternative	18
2.2 Major Project Criteria	18
2.3 Evaluation of Alternatives	24
Alternative 1 - No Action	25
Alternative 2 - Skookumchuck Dam Modifications	25
Alternative 3 - Overbank Excavation and Flowway Bypass	27
Alternative 4 - Setback Levees	32
Alternative 5 - Flow Restrictors	34
Alternative 6 - Non-Structural Alternative	37
Alternative 7 - Interagency Committee Alternative	38

2.4 Evaluation of Remaining Alternatives	44
2.5 Preferred Alternative.....	53
2.5.1 Setback Levees.....	53
2.5.2. Skookumchuck Dam Modifications.....	57
2.5.3 Non-Structural Features	58
2.6 Potential Restoration Sites	63
3. AFFECTED ENVIRONMENT.....	74
3.1 Hydrology and Hydraulics.....	74
3.1.1 Introduction.....	74
3.1.2 Upper Chehalis River Basin.....	74
3.1.3 Climate.....	77
3.1.4 Stream Flow Characteristics.....	78
3.2 River Geomorphology	82
3.2.1 Physiography.....	82
3.2.2 Geomorphology	82
3.3 Water Quality.....	89
3.3.1 Regulatory Background	89
3.3.2 Existing Conditions.....	90
3.3.3 Pollutant Loading Sources	93
3.3.4 Chehalis River Basin TMDLs	94
3.3.5 Tributaries	96
3.3.6 Groundwater.....	100
3.4 Biological Resources – Vegetation, Wetlands and Riparian Areas	101
3.4.1 Vegetation	101
3.4.2 Wetlands and Riparian Areas.....	103
3.5 Biological Resources – Wildlife	108
3.5.1 Existing Wildlife Habitat Conditions.....	108
3.5.2 Priority Habitats	110
3.6 Biological Resources - Threatened and Endangered Species	112
3.6.1 Aquatic Species.....	113
3.6.2 Terrestrial Species.....	114
3.7 Biological Resources – Fish.....	117
3.7.1 Community Structure.....	117
3.7.2 General Life History and Habitat Requirements	118
3.7.3 Distribution and Habitat Utilization	120
3.7.4 Stock Status and Population Trends of Salmonids in the Chehalis River Basin	126
3.8 Land Use and Planning.....	129
3.8.1 Lewis County	129
3.8.2 Thurston County	139
3.9 Recreation and Aesthetic Resources.....	142
3.9.1 Developed and Undeveloped Parks.....	143
3.9.2 Golf Courses	144
3.9.3 Historic Steam Train	145

3.9.4 Rivers, Creeks, Lakes, and Ponds	145
3.9.5 Chehalis to Raymond Riverfront Trail	146
3.9.6 Aesthetics	148
3.10 Transportation and Traffic	148
3.10.1 Major Transportation Routes in the Study Area.....	149
3.10.2 Scheduled Road Improvement Projects and Ongoing Studies	151
3.10.3 Pedestrian and Bicycle Facilities.....	152
3.10.4 Public Transit	153
3.10.5 Airports	153
3.10.6 Rail Transportation.....	154
3.10.7 Flooding	154
3.11 Air Quality	155
3.11.1 Regulatory Background	155
3.11.2 Existing Conditions.....	156
3.12 Noise.....	158
3.12.1 Regulatory Background	159
3.12.2 Existing Conditions.....	159
3.13 Hazards and Hazardous Materials.....	161
3.13.1 Regulatory Background	161
3.13.2 Criteria for Determining Baseline Conditions.....	162
3.13.3 Potential HTRW Concerns.....	163
3.14 Cultural Resources	164
3.14.1 Archaeology and History	164
3.14.2 Previous Cultural Resources Investigations and Known Cultural Resources	165
3.15 Environmental Justice.....	166
3.16 Socioeconomics	171
4. ENVIRONMENTAL EFFECTS	173
4.1 Hydrology and Hydraulics	175
4.1.1 No Action Alternative.....	175
4.1.2 Criteria for Determining Significance of Effects	176
4.1.3 Preferred Alternative.....	176
4.1.4 Summary	179
4.1.5 Mitigation.....	180
4.2 River Geomorphology	180
4.2.1 No Action Alternative.....	181
4.2.2 Criteria for Determining Significance of Effects	181
4.2.3 Preferred Alternative.....	181
4.2.4 Summary	183
4.2.5 Mitigation.....	183
4.3 Water Quality.....	183
4.3.1 No Action Alternative.....	183
4.3.2 Criteria for Determining the Significance of Effects.....	184
4.3.3 Preferred Alternative.....	184

4.3.4 Skookumchuck Dam Modifications	185
4.3.5 Summary	185
4.3.6 Mitigation	186
4.4 Biological Resources – Vegetation and Wetlands and Riparian Areas	187
4.4.1 No Action Alternative	187
4.4.2 Criteria for Determining the Significance of Effects	188
4.4.3 Preferred Alternative	188
4.4.5 Summary	195
4.4.6 Mitigation	196
4.5 Biological Resources - Wildlife	201
4.5.1 No Action Alternative	201
4.5.2 Criteria for Determining Significance of Effects	202
4.5.3 Preferred Alternative	202
4.5.4 Dam Modifications	203
4.5.5 Summary	203
4.5.6 Mitigation	204
4.6 Biological Resources- Threatened and Endangered Species	204
4.6.1 No Action Alternative	204
4.6.2 Criteria for Determining Significance of Effects	204
4.6.3 Preferred Alternative	205
4.6.4 Summary	208
4.6.5 Mitigation	208
4.7 Biological Resources - Fish	208
4.7.1 No Action Alternative	208
4.7.2 Criteria for Determining Significance of Effects	211
4.7.3 Preferred Alternative	212
4.7.4 Summary	227
4.7.5 Mitigation	228
4.8 Land Use and Planning	229
4.8.1 No Action Alternative	229
4.8.2 Criteria for Determining Significance of Effects	229
4.8.3 Preferred Alternative	229
4.8.4 Summary	233
4.8.5 Mitigation	233
4.9 Recreation and Aesthetic Resources	234
4.9.1 No Action Alternative	234
4.9.2 Criteria for Determining Significance of Effects	234
4.9.3 Preferred Alternative	234
4.9.4 Summary	235
4.9.5 Mitigation	235
4.10 Transportation and Traffic	235
4.10.1 No Action Alternative	235
4.10.2 Criteria for Determining Significance of Effects	235

4.10.3 Preferred Alternative	236
4.10.4 Summary	237
4.10.5 Mitigation	238
4.11 Air Quality	238
4.11.1 No Action Alternative	238
4.11.2 Criteria for Determining Significance of Effects	238
4.11.3 Preferred Alternative	239
4.11.4 Summary	240
4.11.5 Mitigation	240
4.12 Noise	241
4.12.1 No Action Alternative	241
4.12.2 Criteria for Determining Significance of Effects	241
4.12.3 Preferred Alternative	241
4.12.4 Summary	243
4.12.5 Mitigation	243
4.13 Hazards and Hazardous Materials	244
4.13.1 No Action Alternative	244
4.13.2 Criteria for Determining Significance of Effects	244
4.13.3 Preferred Alternative	244
4.13.4 Summary	245
4.13.5 Mitigation	245
4.14 Cultural Resources	246
4.14.1 No Action Alternative	246
4.14.2 Criteria for Determining Significance of Effects	247
4.14.3 Preferred Alternative	247
4.14.4 Summary	249
4.14.5 Mitigation	250
4.15 Environmental Justice	250
4.15.1 No Action	250
4.15.2 Preferred Alternative	250
4.15.3 Finding of Significance	251
4.15.2 Mitigation	251
4.16 Socioeconomics	252
4.16.1 No Action Alternative	252
4.16.2 Criteria for Determining Significance of Effects	252
4.16.3 Preferred Alternative	252
4.16.4 Summary	253
4.16.5 Mitigation	253

LIST OF TABLES

Table 2.1.3-1: Summary of Alternatives Evaluated.....	18
Table 2.3-1: Summary of Screening-level Alternatives Evaluation	44
Table 2.4-1: With-project Economic Analysis	47
Table 2.4-2: Total Annual Cost and Net Benefits.....	51
Table 2.5.3-1: Costs of Elevating Structures with Induced Flooding.....	59
Table 3.1-1: Precipitation Totals Ranked for 10 Largest Storms at Centralia	78
Table 3.1-2: USGS Stream Gages	79
Table 3.1-3: Ten Largest Floods on the Chehalis, Skookumchuck, and Newaukum Rivers since 1971	80
Table 3.2-1: Comparison of Key Geomorphic Indicators.....	86
Table 3.3-1: Class A Freshwater Quality Criteria	90
Table 3.3-2: Water Bodies on the Final 1998 303(d) List	91
Table 3.3-3: Ambient Monitoring Water Quality Data (from Michaud <i>et al.</i> 2000)	92
Table 3.4-1: Chehalis River Wetlands and Riparian Areas (in Acres) within the Study Area	106
Table 3.4-2: Skookumchuck River Wetlands and Riparian Areas (in Acres) within the Study Area.....	108
Table 3.7-1: Matrix of Migration, Spawning, Emergence and Rearing.....	123
Table 3.9-1: Public Parks and Recreation Areas within the Study Area.....	147
Table 3.11-1: National, State, and Local Ambient Air Quality Standards.....	156
Table 3.11-2: Ecology Facility List of Air Pollutant Emitters.....	157
Table 3.11-3: 2000 Lewis County Emissions (in Tons per Year).....	158
Table 3.12-1: Maximum Permissible Sound Levels L_{eq}	159
Table 3.12-2: Noise Monitoring Summary (FHWA and WSDOT 1998).....	160
Table 3.15-1: Census Data Summary for the Study Area.....	167
Table 4.4-1: Project Features, Linear Feet, Total Acreage of Project Footprint, and Total Impact Areas for Riparian Areas and Wetlands.....	191
Table 4.12-1: Typical Construction Equipment Noise Levels.....	242
Table 4.12-2: Construction Noise in the Vicinity of an Active Construction Site.....	242
Table 4.16-1: Table of Quantification	254

APPENDICES

Appendices are available on the enclosed CD-ROM

APPENDIX A – FISH, RIPARIAN, AND HABITAT STUDY

APPENDIX B – SKOOKUMCHUCK DAM RE-OPERATION REPORT

APPENDIX C – WETLAND AND RIPARIAN SURVEY

APPENDIX D – HAZARDOUS, TOXIC, AND RADIOACTIVE WASTE

APPENDIX E – BIOLOGICAL ASSESSMENT

APPENDIX F – DRAFT FISH AND WILDLIFE COORDINATION ACT REPORT

APPENDIX G – 404(b)(1) ANALYSIS

LIST OF FIGURES

Figure 1.1. Extent of inundation, 100- and 500-year floods.	3
Figure 1.2. Vicinity map.....	7
Figure 2.1. Study area for authorized project.	21
Figure 2.2. Preferred Alternative, 100-year flood.....	54
Figure 2.6. Mitigation area and some restoration areas.	73
Figure 4.4.6-1. Mitigation for unavoidable impacts, preferred alternative.	199
Figure 4.7.3. Levee and floodwall alignment.	215

1. INTRODUCTION

1.1 NEED FOR THE PROPOSED ACTION

The cities of Centralia and Chehalis and surrounding communities in Lewis and Thurston counties, Washington, have a long history of flooding and flood damage. Episodic flooding has caused extensive damage to private and public property and intermittent closure of critical transportation routes resulting in significant economic losses. The January 1990 flood, the second highest flood of record observed since 1929, alone caused an estimated \$19,189,000 in damages (PIE 1996). In closing transportation routes, the flooding also significantly disrupts emergency response by local governments, adversely affecting public safety. Without implementation of flood hazard reduction measures, actions, or projects, the area will continue to suffer from damaging floods. The local economy will continue to experience depressing economic effects due to the damages and uncertainty associated with future floods. Figure 1.1 shows the extent of inundation within the project area during a 100-year flood.

In addition, stream habitat functions of the Chehalis River and its tributaries have been damaged in the past by development throughout much of the Chehalis River basin. This has diminished the ability of the remaining habitat resources to adequately support sustainable fish and wildlife resources. Loss of wetlands, riparian areas, and back channels has also contributed to increased flooding in the area. The improvement of degraded areas along the Chehalis River or its tributaries can be a significant factor in sustaining and improving existing fish and wildlife resources in the Chehalis Basin. The restoring of floodplain functions will help in the restoration of stream habitat functions.

1.2 PROJECT PURPOSE

The purpose of the actions proposed by this study are to reduce flood hazards to the study area, which includes Centralia and Chehalis, as well as surrounding areas in Lewis and Thurston counties, and to incorporate appropriate fish and wildlife habitat improvements. Flood hazards are defined as significant damage to existing structures, including private and public property, high risk to life, and extended closures of transportation corridors.

The proposed project would provide reductions in flooding along the Chehalis, Skookumchuck, and Newaukum rivers, and smaller tributaries, protecting the flood-prone areas near the cities of Chehalis and Centralia and the Town of Bucoda. The project aims to reduce damage costs in the project area and decrease the transportation closures during flooding on Interstate Highway 5 (I-5) and other critical transportation corridors. Additional objectives include avoiding increasing flood risks downstream of the project area and adverse impacts to the environment.

1.3 BACKGROUND

1.3.1 Authorizations

Authority for the Centralia Flood Hazard Reduction General Reevaluation Study and any subsequent construction is provided by the following Congressional actions:

1.3.1.1 Skookumchuck Dam Modification Project

Section 401(a) of 1986 Flood Control Act (PL 99-662) authorized construction of “works of improvement” substantially in accordance with the Report of the Chief of Engineers, dated 20 June 1984. The report was an interim report submitted (third in a series) under the Chehalis River and Tributaries Feasibility Study authority, originally authorized by a 19 April 1946 House of Representatives Flood Control Committee Resolution. The project recommended in that report envisioned modification of the existing private water supply dam on the Skookumchuck River to provide a maximum of 28,500 acre-feet (ac-ft) of flood storage, reducing flood damages in the Skookumchuck valley, the Town of Bucoda, and the City of Centralia.

The recommended project was authorized in 1986 with an estimated cost of \$30.2 million (converted to 2001 price level). It proposed to add a 12-foot-diameter, 1,200-foot-long, low-level, gated discharge tunnel through the dam’s north abutment and a bascule gate, 15 feet high by 136 feet wide, on the existing spillway crest. That project would provide up to 28,500 ac-ft of flood storage and reduce the Skookumchuck River 200-year flood flow (1985 analysis) from 13,300 cubic feet per second (cfs) to 6,700 cfs (a flood depth reduction of 2 to 5 feet along the Skookumchuck River in Centralia). With average annual benefits estimated at \$4.3 million (2001 price level), the project had a benefit-to-cost ratio of 1.4 to 1.0.

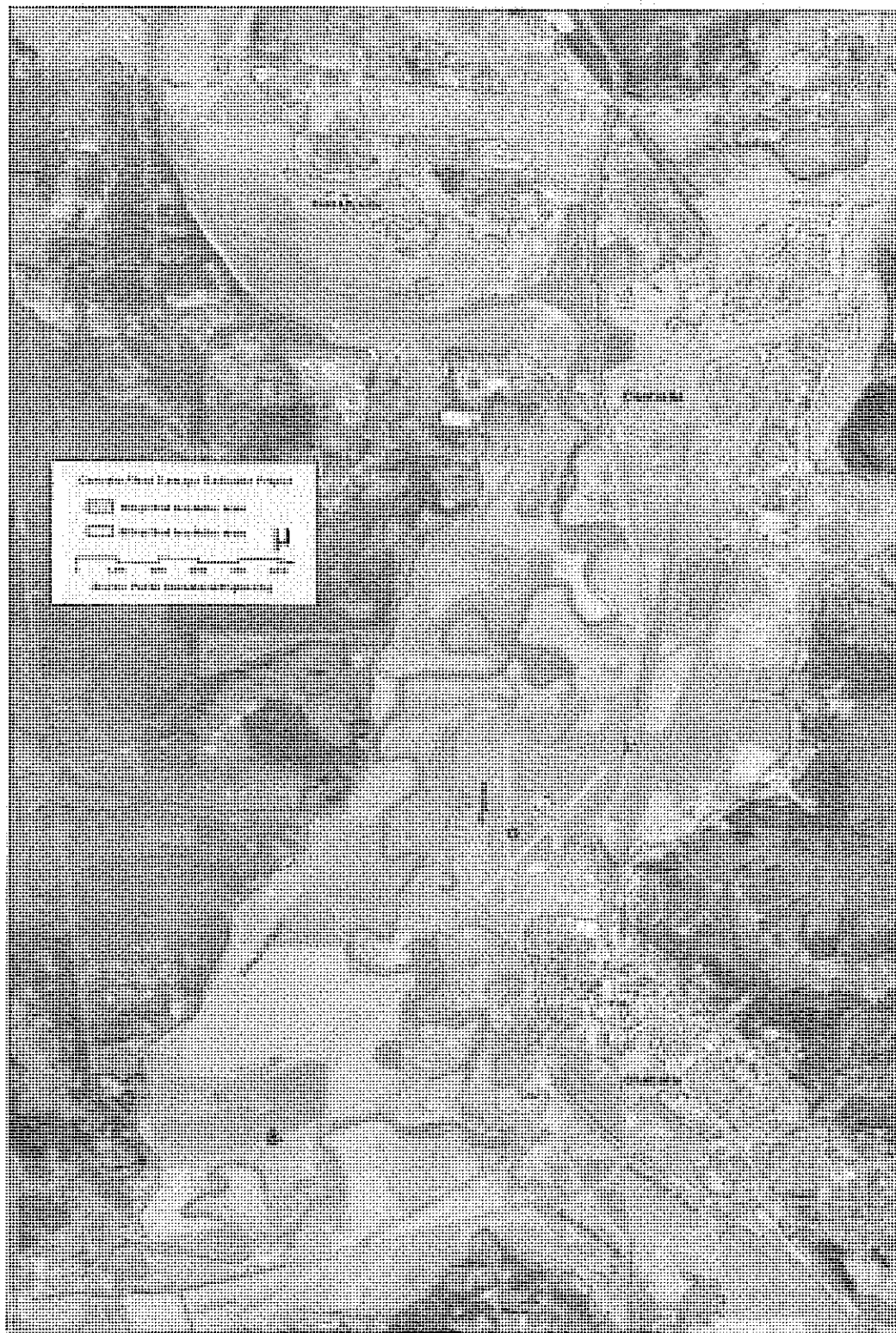


Figure 1.1. Extent of inundation, 100- and 500-year floods.

1.3.1.2 Chehalis River and Tributaries General Reevaluation Study

On 9 October 1998, the U.S. House of Representatives Committee on Transportation and Infrastructure adopted Resolution 2581, requesting a review of past Corps report recommendations with a view to determining if the recommendations should be modified “with particular reference to flood control and environmental restoration and protection, including non-structural floodplain modification.” This resolution provided the authority and directive for the Corps to conduct a Flood Hazard Reduction and Ecosystem Restoration Study for the Chehalis River basin.

1.3.2 Status of Authorized Project

Prior to this study, the Corps had conducted Preconstruction Engineering and Design (PED) work on the 1984 Authorized Project (Skookumchuck Dam) from February 1988 through August 1990. Negotiations were undertaken with the dam operator, PacifiCorp, to identify the maximum amount of flood storage they would agree to provide at Skookumchuck Dam, about 12,000 ac-ft. The Corps prepared basic hydrologic, hydraulic, and economic studies that were updated from the previous reports and preliminary spillway design layouts and cost estimates. The Corps suspended design work after studies indicated that the recommended plan lacked economic justification. The most promising design at that time involved replacing the gated tunnel and spillway gate with gated sluices in the existing spillway (or a short gated tunnel) to control reservoir elevations and provide 11,900 ac-ft of flood storage.

Following the disastrous 1996 flood event, a group of interested citizens formed the Flood Action Council (FAC) to work on options to reduce or eliminate severe flooding of the Centralia-Chehalis area. The FAC developed a preliminary plan that combined modifying Skookumchuck Dam and providing additional upstream flood storage with overbank excavation of the Chehalis River near the City of Centralia. The proposal to form a Chehalis Basin (Lewis County) Flood Control District to implement that plan was rejected by the Lewis County Commissioners because it did not meet legal criteria for creation. However, the Commissioners decided that Lewis County would take the lead in identifying flood reduction measures and set up by ordinance a countywide Flood Control Zone District (FCZD).

Subsequently, Lewis County used local and state funding to conduct studies that identified possible modifications to the 1984 Authorized Project (Skookumchuck Dam) that could result in a potentially economically justified project. These studies were developed to provide a

community-based alternative to the Washington State Department of Transportation's (WSDOT) plan to upgrade and possibly raise I-5 grade near Centralia and Chehalis. The local governments wanted a plan for a comprehensive flood hazard management project that would provide flood relief as well as avoid raising I-5.

On 7 July 1998, Lewis County requested that the Corps resume PED work with the idea of combining additional measures with the authorized dam modification element to form a more complete flood hazard reduction plan for the Centralia-Chehalis urban area. Although the City of Centralia had been the project sponsor through the feasibility phase and initial work, Lewis County has agreed to serve as local sponsor for project construction and to provide the appropriate cost sharing when necessary. Using available funds, the Corps resumed work in July 1998. Initial effort involved reviewing the documents and technical reports produced by Lewis County.

1.3.3 Chehalis River Basin Study

In a separate but complementary effort, the Corps has partnered with Grays Harbor County on the Ecosystem Restoration General Investigation (GI) study for the entire Chehalis River basin. The study will assess historic and existing conditions of the Chehalis River basin in order to identify project alternatives, which both recover the degraded ecosystem, primarily for salmonoid recovery, and provide ancillary flood damage reduction benefits to the basin. The study encompasses the study area for the authorized project (described below).

1.4 STUDY AREA

The study area for the authorized project includes the mainstem Chehalis River, its floodplain and tributaries from the South Fork Chehalis River confluence to Grand Mound, and includes the cities of Centralia and Chehalis, and surrounding areas in Lewis and Thurston counties in southwest Washington (Figure 2.1).

Tributaries entering the study area include the Skookumchuck and Newaukum rivers and numerous smaller creeks. The study area extends along the Skookumchuck River to a point upriver of Skookumchuck Dam and includes the Town of Bucoda in Thurston County. Figure 1.2 shows the location of the study area within the Chehalis River Basin.

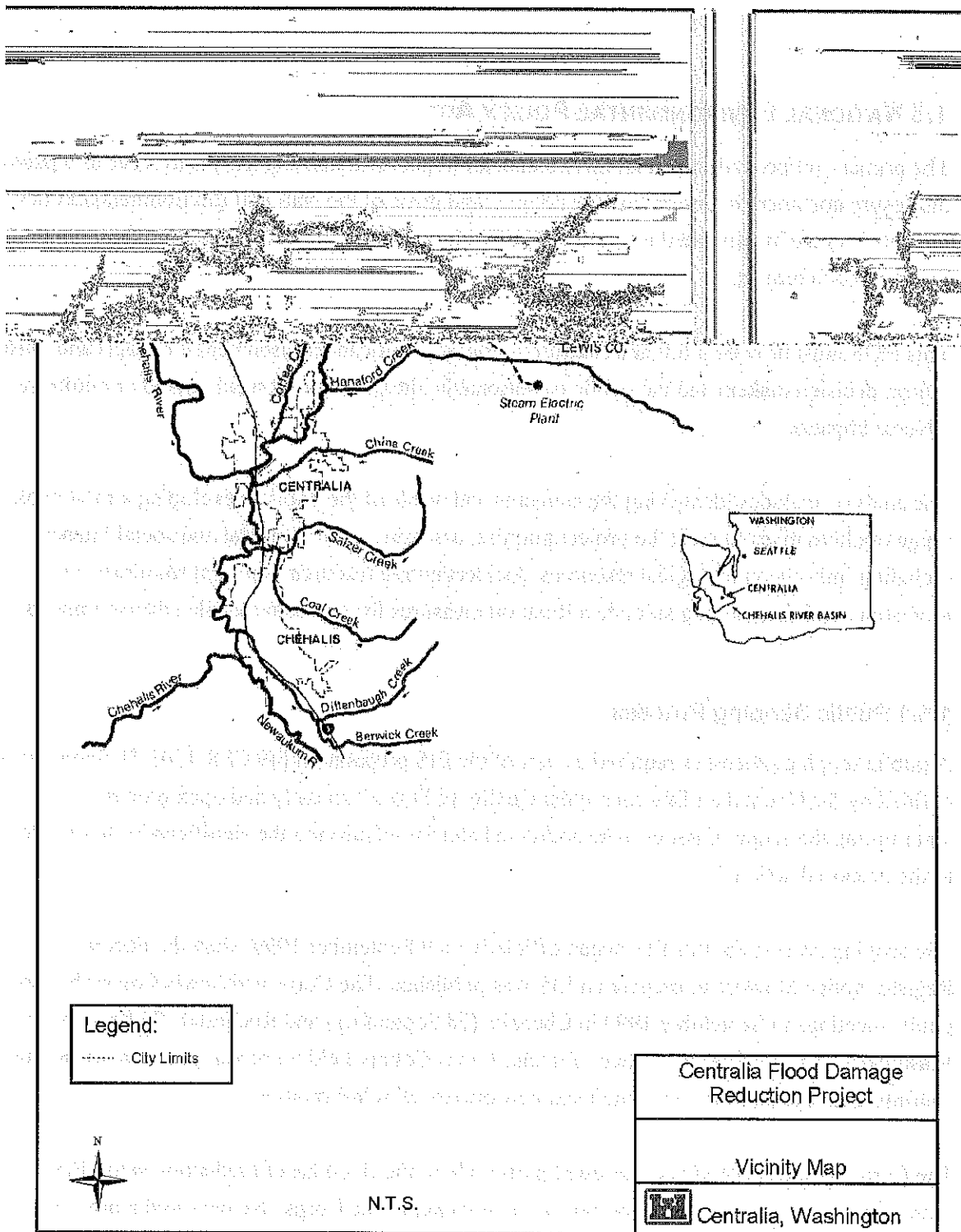


Figure 1.2. Vicinity map.

1.5 NATIONAL ENVIRONMENTAL POLICY ACT

The primary purpose of this Final Environmental Impact Statement (FEIS) is to serve as a public disclosure document to ensure that the policies and goals of the National Environmental Policy Act (NEPA) are incorporated into and duly considered during the development of the recommended project.

This FEIS must provide a full and fair discussion of significant environmental impacts and must inform decision makers and the public of reasonable alternatives that would avoid or minimize adverse impacts.

The analysis includes identifying the concerns and needs of the public, developing a reasonable range of alternatives to meet the project purpose, assessing environmental and social impacts, including impacts on biological resources, socioeconomic resources, cultural resources, and recreation, and determining suitable mitigation measures for any unavoidable adverse impacts.

1.5.1 Public Scoping Process

A public scoping process is required as part of the EIS preparation [49 CFR 1501.7]. Scoping, as defined by the Council on Environmental Quality (CEQ) is “an early and open process for determining the scope of issues to be addressed and for identifying the significant issues related to the proposed action.”

The scoping process for this EIS began officially on 9 September 1999 when the Federal Register notice of intent to prepare an EIS was published. The Corps and Lewis County held two public meetings in September 1999 in Chehalis (28 September) and Rochester (29 September), Washington. Even before the notice of intent, Lewis County held numerous public meetings and hearings and regularly provided the local newspapers with information.

The Corps notified potentially interested parties about the flood hazard reduction study EIS scoping process and provided opportunities to comment. The Corps also provided a press release about the scoping meetings to area media and placed notices in the local newspapers.

The key issues identified during public scoping are discussed below. The Corps and Lewis County had also identified many of these issues as potential areas of concern during internal scoping evaluations.

1.5.1.1 Alternatives

Public comments urged the Corps and Lewis County to evaluate a full range of alternatives that include non-structural alternatives such as flood proofing, buy-outs, and land use planning.

1.5.1.2 Skookumchuck Dam

Public comments expressed concern regarding the stability of Skookumchuck Dam. In addition, comments provided information regarding potential benefits and detriments of the future operation of the dam for flood storage purposes.

1.5.1.3 Increased Downstream Flooding

Public comments expressed concern regarding the potential of any project to increase flooding downstream during high water events.

1.5.1.4 Increased Low Flow Impacts

Public comments expressed concern regarding the potential of any project to diminish summer flows, which are identified as an existing limiting factor to fishery health.

1.5.1.5 Water Quality

Public comments expressed concern regarding the potential of any project to degrade existing water quality conditions, some of which are already severely degraded (high summer water temperatures, bacterial contamination, high levels of dissolved oxygen).

1.5.1.6 Tribal Coordination

The Confederated Tribes of the Chehalis requested full coordination on this project because of potential impacts to tribal resources. The Chehalis Reservation is also located downstream of the study area.

1.5.1.7 Cultural Resource Impact

The Chehalis Basin is rich in both historical and archeological resources. Public comments expressed concern regarding potential impacts to these resources.

1.5.1.8 Hazardous Wastes

The study area has multiple sites of known hazardous waste contamination, including sites listed on the National Priorities List under the Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA also known as "Superfund"). Public comments expressed concern regarding the interface between any proposed project and these sites.

1.5.1.9 Sediment Transport

Public comments expressed concern regarding the potential of any proposed project to change the sediment transport characteristics of both the Chehalis River and the Skookumchuck River. Concerns include increased erosion or sedimentation within the study area and downstream, decreased inundation of riparian forests and wetlands through channel incision, and increased scouring or sedimentation of critical fish habitat.

1.5.1.10 Habitat Impacts

Public comments expressed concern regarding the potential of any proposed project to result in the loss and/or degradation of critical habitat types within the study area. These include wetlands and riparian areas.

1.5.1.11 Fisheries Impacts

Public comments expressed concern regarding the potential of any proposed project to result in the loss and/or degradation of critical fisheries within the Chehalis River basin.

1.5.2 Supplemental Studies

Seattle District and Lewis and Thurston counties completed the following supplemental studies to address concerns raised during the scoping process and the project development process. The scopes of these technical studies are summarized in the following sections. The results of these studies are presented in detail in the respective technical appendices of this FEIS and the General Reevaluation Report (GRR), as appropriate. Results that were key to the formulation and

selection of the recommended plan are summarized throughout the following chapters in this document.

The Chehalis River General Reevaluation Study is a Post Authorization Study being conducted by the Corps of Engineers Seattle District and Lewis County. A general reevaluation study is a reanalysis of a previously completed and authorized study, using current planning criteria and policies, which is required due to changed conditions and/or assumptions. The results may affirm the previous plan; reformulate and modify it, as appropriate; or find that no plan is currently justified. The results of the study are documented in the GRR.

1.5.2.1 Hydrologic and Hydraulic Studies

Hydrologic and hydraulic study tasks were completed to update, calibrate, and operate a hydraulic model of the Chehalis River valley. Previous Corps archived databases and models were activated and updated as appropriate. The deregulated natural and existing condition flows on mainstem Skookumchuck and Chehalis rivers and tributaries associated with winter and spring floods of record were updated for use in hypothetical flood and dam regulation analyses. The Chehalis Basin frequency curves were reviewed and, particularly the low flow curves, revised, and hypothetical floods developed for the 2-, 10-, 25-, 50-, 100-, 200-, 500-year, and larger events. Work developed the magnitude of flow versus timing relationships and updated observed and hypothetical flood routings for use in hydraulic model.

Information was developed on the expected interior runoff for any areas protected by the potential alternatives. Risk and uncertainty associated with hydrologic data were also identified.

Reservoir release options were investigated regarding fishery impacts, river sedimentation, and water supply. The former reservoir temperature analyses were updated. The former "Probable Maximum Flood" and "Standard Project Flood" analyses were reviewed and updated for site-specific dam safety analysis and spillway discharge adequacy. Reservoir storage rule curves and gate operating schedules were revised and updated. A preliminary data-collection plan and preliminary reservoir-operating plan were developed.

An existing hydraulic model (UNET1D) was updated to reflect revised hydrologic and topographic data. The model covers the river floodplain from the mouth at Aberdeen through Pe Ell (RM 107) with particular emphasis in the upper basin above Grand Mound (RM 60). The model includes 10 miles on the Black River, 22 miles on the Skookumchuck River, 9 miles on

the Newaukum River, about 5 miles in the Lincoln Creek valley, 9 miles in the Hanaford Valley, and 8 miles in the South Fork Chehalis River valley. An assessment of sediment transport in the river was prepared. After the models were calibrated to replicate past flood conditions accurately, the existing “without-project” flooding conditions were determined for the selected range of floods. In addition, an analysis was conducted to update the flood insurance floodplain and floodway maps for the Federal Emergency Management Agency (FEMA) to publish on an interim basis until a project(s) is/are constructed. If there were a construction project that would affect the floodplain, a revised version of the maps would be prepared before actual construction.

The model was used to develop the “with-project” conditions for reviewing potential alternatives. Sediment sampling and analysis was performed to evaluate the impact of alternatives on the sediment regime and to develop potential project operation and maintenance costs. A probabilistic risk and uncertainty analysis was performed for the selected project to help determine the levels of damage reduction.

1.5.2.2 Geotechnical Studies

Geotechnical studies for this study include the investigation, exploration, and analysis of foundations and materials conditions related to the selection and design of the alternative flood damage reduction measures. Geotechnical effort was divided into two distinct elements: Skookumchuck Dam investigations and analyses and floodplain investigations and analyses.

Skookumchuck Dam: The geotechnical studies for Skookumchuck Dam included a site-specific ground motion study due to increased estimations of the seismic risk in the Pacific Northwest. Past seismic studies were evaluated using present state-of-the-art practice and existing literature. A seismic analysis of the dam embankment stability based on dynamic loading methods followed the ground motion study. A soil exploration program was conducted beneath portions of the downstream dam embankment berm to determine liquefaction susceptibility of dam foundation silt and alluvium. An exploratory core-drilling program was conducted to support rock cut slope stability and dewatering.

Floodplain Investigations: The geotechnical studies included review of available geotechnical information from previous studies and intrusive field investigations to physically characterize the subsurface materials. The exploration program involved auger drill borings, backhoe test pits, and the installation of piezometers.

1.5.2.3 Environmental Studies

Environmental studies included environmental data collection and the determination of environmental impacts of alternative plans. Activities included literature searches and review of existing reports and field surveys to establish environmental baseline conditions; identification of future "without-project" conditions; determination of impacts of the alternatives; coordination with the U.S. Fish and Wildlife Service (USFWS) and National Marine Fisheries Service (NMFS); analysis of mitigation needs; and the development of potential habitat restoration opportunities.

A literature search and compilation of existing data were accomplished to collect all pertinent information for use in assessing project impacts. Some of the information is in the Geographical Information System (GIS) format and was entered on the Seattle District GIS for overlaying on study and/or report maps. Resource specific studies are described in the following:

Riparian Habitat Survey and Inventory: Existing information was reviewed on riparian habitat, vegetation type and structure, and floodplains. A field survey was completed to evaluate the quality and extent of riparian areas along the Chehalis River and tributaries in the study area. Riparian areas were also inventoried and mapped, using a classification system developed by the USFWS.

Wetland Inventory: Existing information on wetlands in the study area was reviewed and evaluated. Wetlands were inventoried and mapped, using a classification system developed by the USFWS.

Fishery Survey: Existing information on fish distribution and use of the Chehalis River and tributaries was reviewed. Additional field investigations were conducted, including field surveys of instream habitats and fish use on the Skookumchuck River and fish use of portions of the Chehalis River during spawning. Specific information included the following:

- spawner surveys (Skookumchuck River and the mainstem Chehalis River);
- habitat survey (above Skookumchuck Dam);
- off-channel habitat surveys (Skookumchuck River and the mainstem Chehalis River) that assess functional connections with streams, access, temperature, and changes in off-channel habitat resulting from potential water level changes;
- fish passage at dam;
- instream habitat effects of water level changes; and

- investigation of potential habitat restoration opportunities.

1.5.2.4 Hazardous Waste Studies

Guidance for the consideration of issues associated with hazardous materials or waste which may be located within project boundaries or may affect or be affected by Corps Civil Works projects is found in the Army Corps of Engineers Regulation 1165-2-132, Hazardous, Toxic and Radioactive Waste (HTRW) Guidance for Civil Works Projects. This regulation outlines procedures to facilitate early identification and appropriate consideration of HTRW concerns in the various phases of a project. Specific goals include:

- identification of level of detail for HTRW investigations and reporting for each phase of project;
- promotion of early detection and response by the appropriate responsible parties;
- determination of viable options to avoid HTRW problems; and
- the establishment of a procedure for resolution of HTRW concerns, issues or problems.

HTRW studies were conducted to determine the presence and character of contamination, if any, on lands within the study area. Lands potentially needed for alternatives were reviewed, and sites with possible contamination identified in an initial screening. Further review of available information concerning those sites was conducted to estimate the volume and level of any contamination.

A preliminary assessment was conducted for occurrence of HTRW on lands in the study area. The assessment included a project review, review of site literature and project features, database search, review of available records, site inspections and interviews. The assessment included a review of historical documentation; a review of regulatory listings and, when required, review of site files; site visits; and interviews with regulators, site owners and tenants where available or necessary. The assessment covered the general vicinity of the proposed project or existing features proposed for significant modification. The project conditions assume that any HTRW found during any phase of the project would be remediated in accordance with local, state, and federal laws or avoided.

1.5.2.5 Cultural Resource Studies

Cultural resource studies were conducted to locate, identify, and evaluate historic and prehistoric cultural resources (CR) possibly impacted by alternative measures. Previous CR studies identified numerous sites within the study area. A preliminary evaluation of the effects of flood damage reduction alternatives upon historic properties was conducted. These tasks were accomplished in consultation with the Washington State Historic Preservation Office (SHPO). If required, site data recovery would occur during the project construction phase. The CR data recovery strategy will be developed in accordance with a Memorandum of Agreement between the Seattle District, the SHPO, the Advisory Council on Historic Preservation, and the Confederated Tribes of the Chehalis.

1.5.2.6 Economic Studies

Economic studies involved studies pertinent to an economic cost/benefit analysis of the alternatives. Expected annual flood damages were estimated under the existing (without-project) and the alternative with-project conditions.

The economic analysis was conducted in several phases. First project mapping was reviewed and all structures within the 500-year floodplain were provided a unique identifier number and entered into a database. This was followed by a field survey to obtain relevant data on the structures for entry into the database. A risk-based economic analysis was performed to develop the stage-damage function for each category of structures. The stage-damage functions and structures database were combined with water surface profiles from hydraulic analysis into a model (HEC-FDA) to calculate expected annual damages under existing conditions. The damages reduced by each alternative were then computed and compared to the cost of each alternative to identify the plan that maximizes net benefits.

2. ALTERNATIVES & THEIR DESCRIPTION

2.0 NATIONAL ENVIRONMENTAL POLICY ACT (NEPA)

The NEPA process is intended "...to help public officials make decisions that are based on (an) understanding of environmental consequences and (to) take actions that protect, restore and enhance the environment" (40 CFR 1500.1). NEPA applies to federal agencies and any public or private project that either requires a federal permit or is funded from federal sources. In this case, the Centralia Flood Damage Reduction General Reevaluation Study is federally funded and therefore subject to the requirements of NEPA.

2.1 ALTERNATIVES ANALYSIS

Pursuant to NEPA, an Environmental Impact Statement (EIS) is required to analyze alternatives to ensure that they meet the purpose of the project, evaluate the potential for environmental impacts, and examine ways to avoid and minimize impacts. In the Corps' Procedures for Implementing NEPA; Final Rule, "reasonable alternatives" are those that are feasible and such feasibility must focus on the underlying purpose and need of the project (33CFR 325, Appendix B).

Potential alternatives were developed from several sources, including substantial public input and involvement. The alternatives analyzed in this Final EIS include those the Corps determined to represent a range of reasonable alternatives. The determination of whether an alternative was reasonable and feasible was based on project-defining criteria that are discussed in Section 2.2. The project criteria were developed in conjunction with Lewis County, tribal representatives, and federal, state, and local agencies. In addition, the Corps requested comment on the project criteria within the public scoping process.

The alternatives analyzed here include those developed during the General Reevaluation process that examined previously studied alternatives, an alternative developed by Lewis County and others, an alternative proposed by the Chehalis Tribe, and an alternative developed by federal, state, and local agency representatives. Consistent with NEPA requirements, a no action alternative was also analyzed. Alternatives are presented in detail in Section 2.3.

For all potential alternatives that were eliminated from detailed study, the reason or reasons for eliminating the alternative are discussed in this chapter. The alternative analysis resulted in the identification of a preferred alternative, which is described in Section 2.5. Potential mitigation measures were also identified and are described in Chapter 4.

2.1.1 Alternatives Development

Previously Studied Alternatives. These alternatives were derived from previous studies conducted in the Lewis County area and consist of (1) modifications to Skookumchuck Dam (part of the original Authorized Project); (2) setback levees (from a 1970 study that did not receive local funding); and (3) non-structural measures such as flood proofing, relocation out of the floodplain, and watershed planning (ongoing studies sponsored by FEMA).

Alternative Proposed by Lewis County. The alternative developed by Lewis County in conjunction with the WSDOT and other interested parties consists of overbank excavations and a flowway bypass.

Alternative Proposed by the Confederated Tribes of the Chehalis. The alternative proposed by the Confederated Tribes of the Chehalis and developed in conjunction with other federal, state, and local resource agencies consists of a series of check dams and flow restrictors.

Alternative Proposed by Interagency Committee. The alternative developed by an interagency committee consists of several structural and non-structural measures.

2.1.2 Range of Alternatives

The Corps considered the alternatives above, in addition to a no action alternative, to represent a reasonable range of alternatives under NEPA. These include both structural and non-structural alternatives and reflect information gathered and compiled during the public scoping process. The Corps considered each alternative to have the potential to evolve or be modified during the evaluation process. For example, features of various alternatives could be combined to form an additional alternative, if applicable. Table 2.1.3-1 summarizes the alternatives evaluated.

Table 2.1.3-1: Summary of Alternatives Evaluated

Alternative Number	Name of Alternative in FEIS	Also Known As
Alternative 1	No Action	NA
Alternative 2	Skookumchuck Dam Modifications	Authorized Project
Alternative 3	Overbank Excavation and Flowway Bypass	Lewis County Alternative
Alternative 4	Setback Levees	Levee Alternative, Levees, Levee System
Alternative 5	Flow Restrictors	Confederated Tribes of the Chehalis Alternative
Alternative 6	Non-structural Alternative	NA
Alternative 7	Interagency Committee Alternative	NA

2.1.3 Actions Common to All Alternatives with the Exception of the No Action Alternative

The Corps requires a local sponsor to develop a new floodplain management plan in order to be compliant with Executive Order 11988 (Flood Plains Management)¹, prior to the implementation of any alternative that includes construction for flood damage reduction. Therefore, development of a new floodplain management plan was considered a part of each action alternative. The action alternatives also included potential environmental restoration measures that could be incorporated into the project. Environmental restoration is an integral part of the project purpose and will be included to the maximum extent practicable for any alternative that includes construction for flood damage reduction. Potential restoration measures are presented in Section 2.6.

2.2 MAJOR PROJECT CRITERIA

The following are project criteria that were established by the Corps and Lewis County and included in the scoping and early study phase. The purpose of the criteria was to provide a rationale for equitably assessing each alternative relative to its ability to achieve the project

¹ The intent of EO 11988 is to avoid floodplain development, reduce hazards and risk associated with floods, and restore and preserve natural floodplain values.

purpose. For the purposes of the evaluation, an alternative must meet all the criteria in order to achieve the project purpose. The criteria are in no order of priority; each was considered equally important for meeting the project purpose.

The purpose of the actions proposed as a result of this study are to reduce flood hazards to the study area, which includes Centralia and Chehalis, as well as surrounding areas in Lewis and Thurston counties, and to incorporate appropriate fish and wildlife habitat improvements. Flood hazards are defined as significant damage to existing structures, including private and public property, high risk to life, and extended closures of transportation corridors. Figure 2.1 shows the location of the study area within the Chehalis River Basin.

Following is a summary of each criterion.

1. Reduce flood hazards in the project area to the maximum extent practicable.

This criterion was included because flood hazard reduction is the subject of the General Reevaluation Report (GRR) and the area of federal interest. No particular flood (i.e., 50-year event or 100-year event) was selected early in the study process because the relationship between flood damage and flood magnitudes needed to be determined. Initially, however, a qualitative analysis of alternatives was done to determine whether they could reduce flood stages significantly in a 100-year event. Subsequent quantitative analysis of the 1-year to 500-year events demonstrated that the damage reduction for the 100-year event provided the most benefit for costs expended. Accordingly, reducing damages caused by the 100-year event became the quantitative measurement for this criterion.

2. Decrease the transportation closures during flooding on I-5 and other critical transportation corridors to the maximum extent practicable.

The reduction of flooding on the major transportation corridors is another major interest of this project. The recent severe floods in the area have closed I-5 for several days. This resulted in diverting traffic approximately 100 miles, costing millions of dollars. In addition, the stretch of I-5 between Chehalis and Centralia also requires widening to increase safety, efficiency and convenience, and to increase capacity. Widening of the highway cannot be undertaken unless WSDOT and the Federal Highway Administration (FHA) 50-year flood clearance requirements are met. Because major floods disrupt transportation to the regional hospital and other essential

facilities, a project must provide, to the extent practicable, improved access on local critical transportation corridors during floods.

3. Avoid increasing flood risks downstream from the project area.

To meet the project purpose, a proposed project must not increase downstream flood risks. This includes increases in flood stage, timing, and/or duration of flooding. Each alternative was first analyzed to determine whether it could increase downstream flood risks. If an alternative did not appear to increase downstream flood risks, additional analysis was done to determine if the alternative would cause other downstream effects such as hydraulic or geomorphic changes.

4. Avoid decreasing any existing low flow benefits provided by Skookumchuck Dam.

The current operation of the dam provides a maximum flow of 95 cfs (or natural flow plus 50 cfs) between April and August, and minimum flows of 140 cfs between 1 September and 31 October and 95 cfs between 1 November and 31 March for fisheries benefits. A selected alternative must ensure that this low flow benefit continues to be met, and if practicable, be enhanced. Any project that includes modification of the Skookumchuck Dam to provide flood storage would need to meet this criterion.

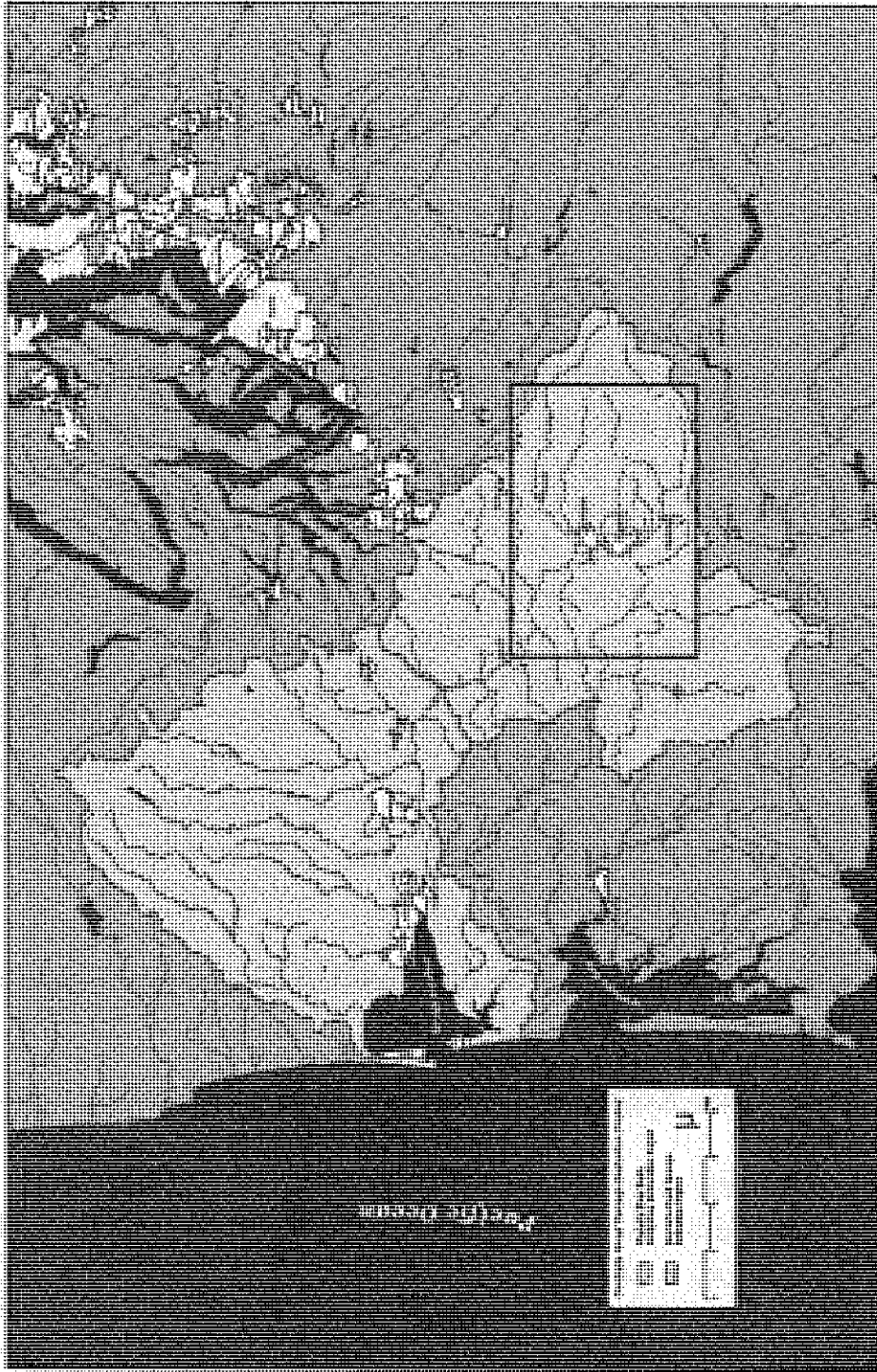
5. Reduce flood damage costs in the project area to the maximum extent practicable.

This criterion covers the same damage reduction requirements as Criterion 1; however, it is a measurement of cost rather than function. Criterion 1 originally contained both statements. Through the evaluation, it became apparent that there is an engineering feasibility element (Criterion 1) and an economic feasibility element (Criterion 5). Criterion 5 evaluates the benefits of a project feature relative to the costs of including the feature in a project. In order for an alternative to meet this criterion, the costs of constructing the project cannot exceed the costs of the benefits derived from the project. This assessment is based on the guidance and procedures discussed below.

The quantitative analysis included economic studies pertinent to a cost/benefit analysis of alternatives. Expected annual flood damages were estimated under the existing (without-project) conditions and under alternative with-project conditions. A narrative economic report is included as an appendix to the GRR and summary information is included in the main GRR.

June 2003

Figure 2.1. Study area for authorized project



The economic analysis was conducted in several phases. First, maps of the project area were reviewed and all structures within the 500-year floodplain were provided a unique identifier number and entered into a database. A field survey was then done to obtain information on the structures (e.g., first floor elevation and type of structure) for entry into the database. A risk-based economic analysis was performed to develop the stage-damage functions for each category of structures. The stage-damage functions and structures database were combined with water surface profiles from hydraulic analysis into the HEC-FDA (Hydrologic Engineering Center – Flood Damage Analysis) model to calculate expected annual damages under each alternative. The damages reduced by each alternative were then compared to the cost of each alternative to identify the alternative that maximized net benefits. In the final phase of analysis, the alternative identified as the preferred alternative was evaluated again at various sizes and with various combinations of features to identify the optimal scale of the preferred alternative.

The principal controlling guidance of the economic analysis comes from the Corps' "Planning Guidance Notebook", ER 1105-2-100, with specific guidance from Appendix D - Economic and Social Considerations. Additional guidance on the risk-based analysis was obtained from the "Engineering and Design - Risk-based Analysis for Flood Damage Reduction Studies" (U.S. Army Corps of Engineers (USACE) EM 1110-2-1619, dated 1 August 1996). Guidance on assessing agricultural damages was derived from the Corps Water Resources Support Center's "National Economic Development Procedures Manual - Agricultural Flood Damage," IWR Report 87-R-10, dated October 1987.

In summary, for an alternative to meet this criterion, it must provide benefits that exceed the costs of the project.

6. Reduce transportation delay costs in the study area to the maximum extent practicable.

This criterion covers the same transportation features as Criterion 2; however, it is a measurement of cost rather than function. Criterion 2 originally contained both statements. Through the evaluation, it became apparent that there is an engineering feasibility element (Criterion 2) and an economic feasibility element (Criterion 6). Criterion 6 evaluates the benefits of a project feature relative to the costs of including the feature in a project. This economic analysis is similar to what was done under Criterion 5.

7. Be cost-effective for both construction and maintenance.

Using procedures similar to those used to determine if an alternative met the purpose of reducing flood hazards and flood damage costs, each alternative was evaluated on maximizing flood damage reduction relative to the costs of constructing, operating, and maintaining the project. For example, if an alternative would provide only minimal reduction in flooding, yet the costs for constructing, operating and maintaining it were high, then that alternative would not be carried forward in the evaluation process.

8. Avoid adverse impacts to the aquatic environment to the maximum extent practicable. Minimize and compensate for unavoidable adverse impacts to the aquatic environment.

Any project that is constructed must avoid and minimize impacts to the aquatic environment to the maximum extent practicable. The Chehalis River basin has been affected by a variety of development activities and a project to reduce flooding should not adversely impact the basin's environment. Once the impacts of an alternative are minimized, mitigation must be sufficient to offset the remaining impacts.

9. Incorporate appropriate fish and wildlife habitat creation, enhancement, and restoration measures to the extent practicable.

Each alternative was evaluated on the feasibility of incorporating appropriate fish and wildlife habitat measures. As mentioned earlier, this is a requirement of each alternative.

10. Comply with all federal, state, and local regulations, including environmental regulations.

Alternatives were evaluated for compliance with applicable regulations; any alternative that could not meet a regulatory requirement would not be carried further in the evaluation.

2.3 EVALUATION OF ALTERNATIVES

Each of the alternatives was evaluated based on the 10 criteria described above.

The initial evaluation of the seven alternatives screened out four of the alternatives from further evaluation. Those screened out were Alternatives 1, 2, 5 and 6. The evaluation indicated that

these four alternatives would not meet one or more of the project criteria. The three alternatives that were carried on for further evaluation were Alternative 3 (overbank excavations and flowway bypass), Alternative 4 (levees) and Alternative 7 (Interagency Committee alternative).

For all alternatives, design, cost, and modeling information was used in the initial evaluation, and a screening-level environmental analysis of the impacts of the various alternatives was conducted. The environmental analysis included identification of the known hazardous and toxic waste sites in the area. It also included working with the tribal governments and a panel of state and federal agencies to identify the potential impacts of each alternative. For some of the structural alternatives, a limited investigation of the effect on the geomorphology of the Chehalis River was conducted.

Alternative 1 - No Action

Alternative Description. Under the no action alternative, no project would be implemented. Technical studies conducted as part of the GRR indicate that this alternative would result in continued flooding in the study area.

Discussion and Summary. The no action alternative would not reduce flood hazards in the project area, and would not meet Criterion 1; it would also do nothing to reduce flood-related transportation closures (Criterion 2). It would not reduce flood damage costs (Criterion 5), or transportation delay costs (Criterion 6). Under the no action alternative, flood damage would continue to cost the local economy an estimated \$9,122,060 annually, and flood damage costs would increase. This annual cost estimate does not include the costs of raising I-5 to meet flood clearance requirements. The no action alternative clearly could not reasonably meet the project criteria; however, it was carried forward for comparative purposes per NEPA guidelines.

Alternative 2 – Skookumchuck Dam Modifications

Alternative Description. This alternative is intended to provide reductions in flooding problems in the Town of Bucoda and the City of Centralia along the Skookumchuck River. This alternative may also provide some reduction in discharge in the Chehalis River downstream of the confluence with the Skookumchuck River.

In 1986, Congress authorized a project modifying Skookumchuck Dam. The project recommended in the 1984 feasibility report envisioned modification of the existing, private,

water supply dam on the Skookumchuck River to provide a maximum of 28,500 acre-feet of flood storage, reducing flood damages in the Skookumchuck valley, the Town of Bucoda, and the City of Centralia. Most of the alternative configurations of dam modifications evaluated in the current study (and described below) are improvements on the originally authorized project.

Skookumchuck Dam is located on the Skookumchuck River at approximately RM 22. The dam was constructed in 1970 to supply water for the Centralia steam generating plant. The dam is an earth-fill structure approximately 190 feet high with the top of the dam at elevation 497 feet. The dam has a 130-foot-wide uncontrolled spillway, on the left abutment, with a crest at elevation 477 feet. The dam has a limited capacity to release water from the reservoir when the pool is lower than elevation 477 feet. Outlet works consist of two 24-inch Howell-Bunger valves with a combined discharge capacity of 220 cfs.

Alternative 2 consists of modifications to the existing Skookumchuck Dam for providing flood control. Modifications to the dam for flood control purposes could include modification of the outlet works to allow a flood storage pool at an elevation of either 477 or 492 feet. Modifications would also likely include additional low-level outlet works to allow the rapid evacuation of stored water above an elevation of approximately 455 feet. Storage of water to a pool elevation of 477 feet would provide flood storage from 455 to 477 feet, such that the total storage would be about 11,000 ac-ft. A maximum pool elevation of 492 feet would add an additional 9,000 ac-ft of flood storage to the reservoir such that the total storage between elevations 455 and 492 feet would be approximately 20,000 ac-ft. Although originally authorized to provide 28,500 ac-ft of storage, the previous study of the dam found that no additional flood protection would be provided above 20,000 ac-ft of storage, or a pool elevation of 492 feet.

The Skookumchuck Dam modifications would change the function of the dam from primarily a water supply facility to a facility with flood control features. The Corps evaluated four different designs to achieve the desired flood control results. Each design would create an outlet structure, modify the spillway, and provide a maximum pool elevation of 492 feet. Flood storage to the 477-foot elevation was also evaluated to optimize the benefits of the dam modifications. Each design dealt only with modification of the dam and had a similar potential for environmental effects.

The four designs were as follows:

- Alternative 2B1 – Spillway Sluices with Gates and Rubber Crest Weir

- Alternative 2B2 – Short Tunnel with Gates and Rubber Crest Weir
- Alternative 2B3 – Tainter Gates in Rock Cut with Rubber Crest Weir
- Alternative 2B4 – Tainter Gates in Rock Cut with Emergency Spillway

Specific engineering design details on these designs can be found in the GRR.

Discussion and Summary. This alternative was subjected to detailed economic and feasibility review, although it was evident early in the study process that it could not reasonably meet the project criteria as a “stand-alone” alternative. Modifications to Skookumchuck Dam would provide some flood damage reduction to Bucoda and parts of Centralia, but not to other parts of the study area (specifically, the City of Chehalis) and therefore could not fully meet Criterion 1 and 5 (maximum reduction of damage and damage costs). This alternative would have no effect on flooding of I-5 and other transportation routes and therefore could not meet Criteria 2 and 6 (maximum reduction of transportation delay and delay costs). However, the Skookumchuck Dam modifications could provide flood damage reduction for portions of the study area. This alternative could also provide protection from some potential downstream flooding impacts by delaying flood flows on the Skookumchuck River until Chehalis River peak flows have passed. Therefore, the Corps rejected Alternative 2 as a stand-alone alternative, but evaluated the benefit of incorporating it into Alternatives 4 and 7. Lewis County also included Skookumchuck Dam modifications as a feature of its proposed alternative (Alternative 3). Skookumchuck Dam modifications were carried further into the evaluation as a component of those three alternatives. As part of this process, the four design variations were evaluated. The short tunnel with gates and rubber crest weir was further modified by replacing the rubber crest weir with slide gates and was the only design that proved to be feasible from an engineering standpoint.

Alternative 3 – Overbank Excavation and Flowway Bypass

Alternative Description. The flowway bypass and overbank excavation alternative was developed by Lewis County to 1) reduce flooding in the City of Chehalis and to prevent State Route 6 (SR-6) from overtopping in large floods through floodplain modification and 2) to reduce flooding of I-5 and the City of Centralia by overbank excavation in the Chehalis River to increase channel capacity in the vicinity of Centralia. These two features would provide significant flood damage reduction in these areas. In order to provide flood damage reduction along the Skookumchuck River and reduce downstream effects, modifications to Skookumchuck Dam (described in Alternative 2 above) would be combined with these features.

Components of the Alternative. This alternative would have three primary components. The first component, common to all variations of Alternative 3, is modification of Skookumchuck Dam to provide flood control storage. The second component is floodway modifications near Mellen Street bridge between RM 65.90 and RM 68.25. A variation of this component would include modifications to the existing Mellen Street bridge abutment. The third component is floodplain modifications near Chehalis/SR-6 to provide flood flow bypass and storage. The components and final design of Alternative 3 are discussed below; a more detailed description can be found in the GRR.

Centralia Overbank Excavation. This would involve excavation of approximately 2.4 million cubic yards of material from the banks of the Chehalis River to create a floodway bench. The floodway bench elevation would be set to an elevation above the summer normal flow stage so that construction activities would occur in the dry, above the water level. At the upper end of the excavation near RM 68.05, the bench elevation would be approximately at elevation 158 feet. At the lower end of the excavation near RM 65.90, the bench elevation would be approximately at elevation 148 feet. The floodway would have an average excavation width of about 600 feet. Floodway side slopes were assumed to be two horizontal to one vertical (2:1). Flow velocities in the excavation reach would be reduced from a high of almost 8 feet per second (fps) to less than 4 fps.

The Mellen Street bridge section of the Chehalis River is one of the most restrictive for flood flows. In order to alleviate this bottleneck, modifications to the bridge would be necessary. The modifications to the bridge would include excavation of the right (east) bank and extending the bridge on piers to elevate it above the excavated floodway.

Several variations of this were modeled to achieve a cost-effective and efficient design. The most cost-effective and efficient design included floodway excavation between RM 65.90 and RM 68.05.

Skookumchuck Bypass. This component would involve diverting a portion of the flow in the Skookumchuck River during flood events to a secondary overflow channel. This secondary overflow channel would start at approximately RM 1.5 on the Skookumchuck River. The channel would be routed under I-5 at Blakeslee Junction, connect with some existing small lakes, and ultimately connect with a remnant channel of the Chehalis River. The channel would empty back into the Chehalis River at approximately RM 60.5, 6.5 miles downstream of the

Skookumchuck confluence with the Chehalis River. It was assumed that the channel would be designed to divert up to 5,000 cfs of flood flow.

Construction of a secondary channel in this location would negatively affect fish habitat in the lower river, including potential spawning habitat for fall and spring chinook salmon. Because of the length of the bypass, scoured areas would form and stranding of fish following floods would be a concern. The hydrologic regime of wetlands and riparian areas in the lower 1.5 miles of the Skookumchuck River would likely be affected by the reduction or elimination of overland flows. In the absence of periodic recharge, wetland and riparian plant communities would change to upland vegetation types, and impacts to wildlife dependent on wetland and riparian habitat would occur.

Construction of the secondary channel would have a significant impact on the built environment, including dislocation of residents as well as industrial, commercial, and agricultural operations. Roads and other public facilities within the bypass footprint would also need to be relocated, which would likely make the component not cost-effective and not meet Criterion 7. This component was not carried forward for further evaluation.

Centralia Hospital Bypass. This bypass channel would start at about RM 68.0 and would end at the mouth of Scammon Creek at RM 65.9. The alignment would run roughly northwest following localized low ground and would pass immediately south of the hospital. This channel alignment would require the construction of three bridges and would require excavating out lower Scammon Creek. The entrance to the bypass channel would be set at approximately elevation 165 feet. This is approximately the water surface elevation for the annual flood event. The channel would likely be grass-lined and have a rock-armored entrance to prevent scour.

Construction of this bypass would involve excavation through wetlands, and adjacent wetland areas could be affected by reductions in recharge from overbank flows. Channel and substrate conditions near RM 65.9 would be altered, and could affect potential fish spawning habitat at this location.

Like the Skookumchuck bypass, construction of the Centralia Hospital bypass would cause significant impacts to the built environment, and would require relocation of regional medical facilities. It would also require construction of three bridges. These requirements would make the component cost-prohibitive, and it would not meet Criterion 7. This component was not carried forward for further evaluation.

Hump Excavation. The “hump” is located in the Chehalis River at approximately RM 67.1 to RM 65.9. The channel bottom at this location is approximately at elevation 148 feet. This is approximately 10 feet higher than much of the channel bottom further upstream. This high bottom elevation appears to restrict flow during the 100-year flood. There have been numerous suggestions from the public and some agencies that excavation of this “hump” would significantly increase hydraulic capacity of the channel during flood flows, and thus reduce upstream flooding.

To evaluate the effects of the “hump” on hydraulic capacity during flood flows, two excavation variations were analyzed. The maximum velocity reductions resulting from either variation would be insignificant in the excavation reach. This is because during a flood, a significant portion of the flow is in the overbank area. Thus, the slight increase in channel capacity would have only a marginal effect on the total flow area. As a component of an alternative, hump excavation would not contribute to meeting Criteria 1, 2, 5, or 6. Therefore, this component was not carried forward for further examination.

SR-6 Bypass. This component would include a 400-foot-wide excavation under SR-6. The portion of SR-6 between the Scheuber Road intersection and the bridge crossing at RM 74.6 acts as a weir to limit overbank flows from the Chehalis River between RM 75.8 and RM 77.4, but the roadway is frequently overtopped by flood flows. The invert elevation of the excavation would be 179 feet. This would involve excavating and grading approximately 65,000 cubic yards of material, and elevating the roadway. The bypass would reconnect a portion of the historic Chehalis River floodplain north of SR-6 with the river by providing clearance for overbank flows to the floodplain. This component would include a bridge or culvert crossing at SR-6 and a year-round connection for flows from the Chehalis River to the oxbow south of SR-6. The floodplain along Scheuber Road would store floodwater when flows on the Chehalis River at RM 77 exceed the annual flood magnitude. Flows bypassing through the SR-6 excavation to the floodplain would return to the river at the north end of the floodplain bypass and storage area. Returning flows would discharge first through the existing Scheuber drainage ditch and then over the low-lying overbank area between RM 71.6 and RM 72.4 on the Chehalis River. Modifications to the banks in the area where the bypass flows re-enter the river channel may be required. These modifications could include armoring of the banks on both sides of the river to protect from possible head cutting or erosion. Reshaping of the Scheuber ditch side of the river to allow for smooth transition flow back into the river is another possible modification.

Discussion and Summary. As a result of the initial analysis, the Skookumchuck bypass, the Centralia Hospital bypass, and hump excavation components were dropped from this alternative. The Centralia overbank excavation and the SR-6 bypass were retained as components of Alternative 3. As noted earlier, modifications to Skookumchuck Dam (described in Alternative 2, above) would be included to provide flood damage reduction along the Skookumchuck River and reduce downstream effects.

Alternative 3 was then further evaluated based on the project criteria. The first stages of analysis indicated that this alternative met all of the project criteria. Hydraulic modeling demonstrated that Alternative 3 would reduce flood stages significantly within the study area; therefore, it met Criterion 1. Alternative 3 would provide 100-year flood protection for I-5 and significantly decrease the flooding of other transportation corridors (Criterion 2). With the inclusion of Skookumchuck Dam modifications, Alternative 3 would not result in any additional downstream flood risks (Criterion 3). Low flow benefits at Skookumchuck Dam would be maintained (Criterion 4). The screening indicated that the flood stage reductions would significantly reduce the flood damage costs (Criterion 5). Because flooding would be decreased on transportation corridors, transportation delay costs would be reduced (Criterion 6). Construction, operation, and maintenance appeared to be cost-effective (Criterion 7).

With regard to Criterion 8, a number of environmental concerns and issues were raised about Alternative 3. For example, concerns raised by resource agencies included potential changes in sediment transport on the Chehalis River, changes in river geomorphology, effects on groundwater recharge, potential reduction in summer low flows, impacts on water quality, and loss of wetlands and riparian areas. This alternative appeared to have the potential for more than minimal environmental impacts. Additional studies would be needed to evaluate the alternative's impact on environmental resources. The SR-6 bypass would reconnect a portion of the historic floodplain to the Chehalis River and could be designed to maximize the environmental benefits of this reconnection (Criterion 9). Additional review would be necessary to determine compliance with all applicable rules and regulations (Criterion 10).

The screening indicated that this alternative was consistent with the project criteria, although there were issues that needed further investigation. Specifically, the economic benefits and environmental impacts warranted further review. This alternative was carried forward for further evaluation.

Alternative 4 – Setback Levees

Alternative Description. This alternative was designed to reduce damages associated with flooding on the Chehalis and Skookumchuck rivers. It would also address flooding along Salzer Creek, Dillenbaugh Creek, and the Newaukum River. This alternative would reduce damages to structures and allow I-5 to remain open for transportation during flood events up to and including the 100-year flood.

This alternative would consist of a system of setback levees and floodwalls to protect flood-prone areas near Chehalis and Centralia. Levees and floodwalls would be constructed at selected locations along the Chehalis and Skookumchuck rivers as well as along several tributaries (e.g., Salzer Creek, Coffee Creek). The alternative was considered both with and without the benefit of flood control operations at Skookumchuck Dam. Options for 11,000 and 20,000 ac-ft of flood control storage in the Skookumchuck reservoir were evaluated as part of the alternative.

This alternative was initially based on the levee alignment developed in the 1970s. Refinements were made based on flood observations done in 1990 and 1996. The levee alignment was tied into existing levees where possible and adjusted to protect existing infrastructure while allowing inundation of the floodplain. The alignment was further adjusted to minimize impacts to residential areas, community infrastructure including roadways, and the natural environment.

The alignment was reevaluated following initial hydraulic modeling. Some levee segments were deleted either because flood protection was not required or improved alignments were identified. Modifications were also incorporated based upon coordination with WSDOT to ensure consistency with the proposed widening of I-5. The levees were designed using the standard Corps levee design with 12-foot top width and 2:1 horizontal to vertical slopes as the primary levee design. Vertical floodwalls were incorporated in areas where it was important to minimize the impact footprint (i.e., areas close to the Chehalis River or areas with limited space available for a levee).

The levee system would protect residential and commercial structures, local roadways, state highways, and other infrastructure from flooding. Flood protection would extend along the Chehalis River from approximately RM 75 to RM 64, along the Skookumchuck River from approximately RM 5 to near the mouth, as well as along most of the lower 2 miles of both Dillenbaugh Creek and Salzer Creek. Figure 2.2 shows the currently planned levee alignment and 100-year flood inundation area with the levee system and dam modifications in place.

Discussion and Summary. The initial screening indicated that Alternative 4 would reduce flooding from the Chehalis River, Salzer Creek, Skookumchuck River and Dillenbaugh Creek and would significantly reduce the flood hazards in Chehalis and Centralia (Criterion 1). Alternative 4 would meet Criterion 2 by protecting I-5 from flooding and providing protection to other critical transportation corridors in and around Chehalis and Centralia. This alternative would slightly increase flood stages downstream of the project area, potentially not meeting Criterion 3. However, further evaluation determined that these downstream risks would not be significant. Analysis indicates that construction of the Chehalis River levees without the addition of the Skookumchuck Dam modifications would cause the 100-year flood peak stage to increase by a maximum of 0.1 foot downstream of Centralia. By incorporating modifications to Skookumchuck Dam into the alternative, the risk would be alleviated and no increase in downstream flood impacts would be experienced. Low flow benefits of the Skookumchuck Dam would be maintained (Criterion 4). Alternative 4 would protect a significant portion of the existing residential and commercial infrastructure in Centralia and Chehalis area from flooding and protect I-5, thereby reducing flood damage costs and transportation delay costs (Criteria 5 and 6, respectively). The initial analysis indicated that Alternative 4 was cost-effective (Criterion 7).

With regard to Criterion 8, Alternative 4 could result in impacts to wetlands and riparian areas. The Skookumchuck Dam modifications could also result in adverse impacts to fish habitat and riparian areas along the Skookumchuck River, mainly between the dam and the first tributary downstream of the dam. Those impacts will be based on the dam re-operation process. Strict adherence to the proposed rule of not allowing additional water to be held behind the dam for a period not longer than five consecutive days and release control based on fishery guidelines will minimize any potential adverse impacts. The resource agencies raised questions about reductions in groundwater recharge, changes in sediment transport, channel self-maintenance, and channel stability. Additional evaluation of the alternative's impact on environmental resources would be needed. Although the levee alignment incorporated avoidance of environmental impacts within the design, additional adjustments to the levee alignment may further reduce adverse impacts to wetlands and riparian areas. Setting the alignment away from the river's edge may also allow opportunities for environmental restoration (Criterion 9). Finally, additional review would be necessary to determine compliance with all applicable rules and regulations (Criterion 10).

This alternative appeared to be consistent with the criteria, although there were issues that needed further investigation. Specifically, the economic benefits and environmental impacts warranted further review. This alternative was carried forward for further evaluation.

Alternative 5 – Flow Restrictors

Alternative Description. Flow restrictors are any kind of structure that intentionally restricts and holds back flow in order to help reduce downstream flooding or to increase upstream inundation. Flow restrictors are much simpler structures and smaller in scale than flood control dams.

Flow restrictors would increase the water surface elevation upstream of the flow restrictor at low flows. Increased upstream inundation can help to create or enhance wetlands and riparian areas upstream of the restrictor and can benefit fisheries by providing off-channel habitat. This would help to offset the lack of off-channel habitat for salmonids along the mainstem Chehalis River. If flow restrictors could be located to back up spring and summer flows into adjoining low areas or disconnected oxbows, then additional off-channel habitat could be created. The increased upstream inundation could also have a potential benefit by increasing groundwater recharge. However, in order to meet project criteria, the flow restrictors could not cause an upstream stage increase during the 100-year flood.

Therefore, for all flow restrictors, it was assumed that upstream inundation levels would not be allowed to exceed the current 100-year flood level. Known high water marks from the February 1996 flood were used as the measure during hydraulic modeling. Three different structure types were analyzed: a slot structure, a fixed weir structure, and a control type structure. The control type was found to be most effective of the three. Restrictor sites evaluated included:

- Mainstem Chehalis River at RM 87.56
- Mainstem Chehalis River at RM 89.61
- Mainstem Chehalis River at RM 104.09
- South Fork Chehalis River at RM 0.3
- Lincoln Creek
- Stearns Creek
- Salzer Creek

Hydraulic modeling indicated that the flow restrictors discussed above would cause no significant water surface reduction for the 100-year flood in the Centralia-Chehalis area due to the limited volume of flood storage they would provide. In order to create the volume of flood control storage necessary to effect significant water surface level reductions downstream, other design options for this alternative were considered early in the evaluation process. The other

design options were: upstream flood control dams, multiple smaller headwater dams, and flood storage dikes on the floodplain.

Upstream Flood Control Dams. The Corps investigated five potential locations for large multi-purpose storage dams in the upper Chehalis River Basin in the course of its earlier flood control studies (USACE 1982). The five locations consisted of two sites on the Newaukum River, one site on the South Fork Chehalis River, and two sites on the mainstem of the Chehalis River, upstream of the Newaukum River. Dams at all five locations were determined to be economically infeasible at the time of the earlier investigations. The flood stage reduction provided by the Newaukum River or South Fork Chehalis dams would be small, and construction costs would be high. For these two dams, 100-year flood stage reductions on the Chehalis River near the Mellen Street bridge were estimated to range from 0.3 to 0.7 foot, at a cost of \$90 million to \$125 million (1998 dollars). The mainstem Chehalis dams would provide greater stage reduction (2.3 to 3.4 feet at the Mellen Street bridge). However, costs would be very high (\$230 million and \$433 million in 1998 dollars), and would equate to \$100 million to \$127 million per foot of stage reduction. Review for this study indicated that these dam options remain economically infeasible. In addition, there would be significant environmental issues associated with their construction and operation, including blockage of fish passage, inundation and loss of fish and wildlife habitat, and inundation of structures, agricultural lands, roads, and other public and private facilities. The miles of instream habitat lost would vary, depending on the reservoir location. Spawning habitat for spring and fall chinook salmon, coho salmon, and winter steelhead could be particularly affected. Potential downstream effects could include changes in the quality of water flowing out of the reservoir behind a dam and changes in downstream water temperatures. Downstream wetland and riparian areas that are dependent on overbank flows for recharge would probably experience reductions in size.

This design option of Alternative 5 could not reasonably meet Criterion 7 and was therefore dropped from further investigation.

Small Headwater Dams. In earlier studies, the Corps also investigated the feasibility of building several small headwater dams (USACE 1982). The Corps evaluated twelve sites in the drainage above Centralia and Chehalis. The combined flood storage capacity of all 12 dams would be only 14,500 ac-ft, with an estimated reduction in flow on the Chehalis River at Grand Mound of 3,000 cfs for a 100-year flood. The 3,000-cfs flow reduction would result in a flood stage reduction of approximately 3 inches. In 2001 dollars, the Corps estimated cost to construct the 12 dams would be approximately \$118 million, which would equate to approximately \$472 million dollars per

foot of flood stage reduction. Because of the poor benefit-to-cost ratio, this design option of Alternative 5 could not reasonably meet Criterion 7 and was dropped from further investigation.

Flood Storage Dikes. The Corps also investigated the feasibility of creating flood storage areas in the floodplain. This would be accomplished by enclosing a large area with a dike. During floods, the floodwaters would overflow into the dike-enclosed storage area. Stored floodwaters would then be released slowly through a downstream outlet. The investigation determined that placing flood control storage areas in the floodplain would require a much larger storage volume for equivalent stage reduction compared to other alternatives. An estimated 40,000 acre-feet of storage volume would be needed in the floodplain to achieve a 1-foot stage reduction at the Mellen Street bridge. Assuming a 10-foot storage depth, this would require approximately 4,000 acres of land. Because of the large land area required, environmental impacts of this option could be substantial. The specific impacts could not be defined until potential storage locations were identified. This design option of Alternative 5 could not reasonably meet Criteria 1, 2, 5, 6 and 7. Therefore, it was dropped from further investigation.

Discussion and Summary. Preliminary hydraulic modeling of flow restrictors showed that they would not significantly reduce flooding in the project area and that they could cause a relatively significant increase in the areal extent and depth of flooding upstream of the structures. Therefore, Alternative 5 could not reasonably meet Criterion 1. Because flow restrictors would not decrease the flooding to I-5 or other critical transportation corridors in or around Chehalis or Centralia, the alternative would not meet Criterion 2. Any of the design options of Alternative 5 would avoid increased flooding downstream as the purpose would be to store water during a flood (Criterion 3). Alternative 5 does not include any modifications to Skookumchuck Dam, so low flow benefits would not be affected (Criterion 4). The flow restrictors would not reduce flood stages and flood damages in the study area and would not meet Criterion 5. Alternative 5 would not decrease flooding to I-5 and the costs of transportation delay and would not meet Criterion 6. All design options of Alternative 5 had very high operational and maintenance costs because of the multiple structures and extensive area of coverage, and Criterion 7 would not be met. Although there may be short-term changes in sediment transport associated with installation of flow restrictors, this alternative would likely not have significant environmental impacts (Criterion 8). The flow restrictors have potential to create or enhance wetlands and create off-channel fish habitat, and would meet Criterion 9. Further investigation would be necessary to determine if this alternative would comply with all federal, state, and local regulations (Criterion 10).

Although Alternative 5 met some of the project criteria, none of the design options could reasonably meet all of the criteria. Alternative 5 was therefore dropped from further evaluation.

Alternative 6 – Non-Structural Alternative

Alternative Description. The intent of Alternative 6 was to formulate a viable non-structural solution to reduce flood damages throughout the study area. Non-structural measures include watershed management, flood proofing structures, evacuation plans, and removal of structures from the floodplain. Watershed management includes such actions as reforestation, timber harvest control, and restrictions on floodplain development. These measures do not directly address flood stage elevations, but reduce economic damages and safety hazards. Flood proofing structures would require elevation of residential buildings to the 100-year flood level, and making the first floor of commercial buildings watertight. In addition, no new construction would be allowed in the floodplain. Evacuation plans would be developed to assist floodplain dwellers in avoiding flooding impacts. A selected number of structures, or even all of the structures in the floodplain, may have to be removed.

Discussion and Summary. Alternative 6 would reduce some of the flood hazards in the study area by removing structures from the floodplain (Criterion 1) although it would not have any effect on closures of the existing transportation corridors (Criterion 2). Alternative 6 would not result in flooding impacts downstream of the study area (Criterion 3) or affect the low flow benefits of Skookumchuck Dam (Criterion 4). Alternative 6 would reduce flood damages (Criterion 5) but would not have any effect on reducing the costs of transportation delays (Criterion 6). The cost-effectiveness of Alternative 6 was not fully evaluated because the initial screening showed that large-scale and relocation of residents and businesses would be cost prohibitive. For example, based on information provided by the City of Centralia (City of Centralia 1998) it has been estimated that as many as 3,000 structures could need to be removed from Centralia alone. Therefore, this alternative would not meet Criterion 7. With regard to Criterion 8, there would be at least temporary air quality, soil disturbance, hazardous waste, and water quality issues associated with the demolition and removal of structures, and substantial adverse impacts on the social fabric and economy of the area if large numbers of residents and businesses were required to relocate. These impacts would need further evaluation if the alternative were carried forward. Alternative 6 would have high potential for environmental restoration, including reforestation and reestablishment of wildlife corridor connectivity, and would meet Criterion 9. Further investigation would be necessary to determine if this alternative would comply with all federal, state, and local regulations (Criterion 10).

Because Alternative 6 could not reasonably meet Criteria 2, 6, and 7, it was dropped from further investigation. However, many of the non-structural measures contained in this alternative would be incorporated into any recommended plan. Section 2.5.3 provides additional detail on non-structural measures that would be a part of the preferred alternative.

Alternative 7 – Interagency Committee Alternative

Alternative Description. In the fall of 1996, the Washington Department of Ecology Chehalis Basin Local Action Team began work with local governments to build partnerships to solve water problems in the Chehalis Basin. In 1998, the Action Team formed a technical committee, which included representatives of tribal, federal, state, and local agencies. The technical committee formed an alternatives subcommittee to identify and evaluate potential flood hazard reduction measures and to develop alternatives for meeting specific flood hazard reduction goals. Alternative 7 is the product of the subcommittee's work.

The purpose of Alternative 7 was to provide short-term and long-term actions that would reduce flooding hazards to Centralia and Chehalis area residents, while restoring and enhancing river hydrology and floodplain functions to support the basin's salmonid habitat base.

Alternative 7 focused first on reducing flood hazards and increasing floodwater storage through regulatory and voluntary measures. The connectivity of the Chehalis River to its floodplain would be maintained and enhanced using land use and development regulations before implementation of any costly structural solutions. In addition, Alternative 7 sought to maintain vital I-5 and SR-6 access by constructing a traffic bypass and by reducing flood frequency and duration. Alternative 7 also included the uses of floodplain easements, acquisition of frequently flooded areas and structures, relocation or elevation of structures, and improved upland water storage. Finally, Alternative 7 included a sequence of actions that required analysis before additional actions would be proposed.

The alternatives subcommittee reviewed a variety of different flood hazard reduction measures and used a format of facilitated workshops to analyze potential combinations of measures by describing the major elements (these could be individual measures or measures in combination) that make up the combination alternative. These measures included:

Measure 1 – Moratorium on Floodplain Development. In the interim, a moratorium on floodplain development would be implemented until the new flood insurance rate maps are adopted. Lewis County and possibly Grays Harbor and Thurston counties along with area cities would enact interim regulations that restrict new fills until the new FEMA floodplain and floodway maps are prepared and adopted.

Measure 2 - Adopt New FEMA Floodplain and Floodway Maps. This included defining a new floodway based on a 0.2-foot rise in the water surface profile and using the new topographic information for this analysis. The 0.2-foot rise and the new 100-year floodplain would be used to develop or update floodplain management plans and regulations governing future floodplain development.

Measure 3 – Develop Flood Warning System. Measure 3 would include the development and implementation of a basin-wide flood warning system. This would require that the system be well coordinated and interconnected among the various jurisdictions and agencies that provide emergency services.

Measure 4 - Restrict Floodway Development. Measure 4 would restrict development (residential, commercial, industrial) in the newly defined floodway and require currently approved filling/floodplain development activities to provide a hydraulic analysis to show a 0.2-foot rise or less in the floodwater surface elevation. Jurisdictions would review pending permits to ensure that the proposed development does not increase flood damage risk to adjacent, upstream, and downstream properties. Jurisdictions should also consider establishing a time limit on development permits.

Measure 5 – Restrict Development in Flow Path. In addition to defining the 0.2-foot floodway as described in Measure 2 above, development would also be restricted within additional critical portions of the floodplain, specifically in areas considered to be significant flow paths. Flow paths are naturally occurring swales, which are normally dry, but which have historically conveyed significant amounts of flowing water during flood stage. These flow paths would be established by identifying split flow conditions as part of the flood analysis, or by identifying flow paths from photos and observations. If blockage of a flow path produced more than 0.2-foot backwater, then it would be considered a flow path and would be protected from future development.

Measure 6 – Restrict Floodplain Filling. This measure would restrict new filling in the floodplain by requiring that fill be mitigated through the removal of an equal volume of fill elsewhere in the floodplain or floodway. Cut and fill balances should be retained within the project site whenever possible.

Measure 7 – Preserve/Enhance Floodplain Flood Storage. This measure would implement an analysis to quantify the potential amount of floodplain storage provided by existing, expanded, and enhanced floodwater storage areas. Potential areas are south of SR-6 in the Newaukum Basin, South Fork of the Chehalis River, and the area bordered by Ceres Hill and White Road, a site near Stan Hedwall Park, existing wetlands, connections to oxbows and historic flow paths, SR-6 floodplain storage, and upland storage. The analysis would provide an assessment of the storage capacity that could be gained by removing barriers that are no longer used or can be redesigned, such as railroad grades, roadways, and bridges. The analysis would generate hydrographs demonstrating the role of storage, and could be used to implement measures such as voluntary buy-outs, purchase of flow easements, etc.

Measure 8 – Restrict Upland Land Uses. This measure would utilize other land use measures that lower and slow the hydrologic response of the basin. For example, this measure would preserve upland vegetation coverage, reduce development densities, and reduce the area of impervious surfaces. This measure would also require avoidance of impacts to wetlands, and preserve and maintain wetlands, critical areas, and farmlands that supply floodplain storage capacity.

Measure 9 – Flood Audits. This measure would conduct a flood audit for the cities of Chehalis and Centralia and surrounding communities in order to determine which structures would benefit from raising, flood proofing, or acquisition.

Measure 10 – Upgrade Stormwater Management Systems. This measure would require an analysis to determine the detention effects of a 25-year design storm versus a 100-year design storm throughout the basin. Stormwater management is an integral element of the National Flood Insurance Program (NFIP). It regulates new development throughout the watershed to ensure that post-development runoff is no worse than pre-development runoff, and it regulates new construction to minimize soil erosion and protect water quality. Stormwater management is also mitigation for development. This measure is based on judicious planned development to reduce flood reduction risks. However, mitigation for development is inadequate when communities do not have a local stormwater management program or use less than the 100-year design storm for

their local programs. With this in mind, it is imperative that stormwater management programs be implemented consistently throughout the basin to mitigate for development. It is also equally vital that the design criteria used for these programs are high enough to be effective. Detention for design storms would be based on the 100-year event. Use of a 100-year, 24-hour design storm is a standard national and state design criteria for stormwater management. This design storm should not be confused with a 100-year flood, which is based on physical characteristics, geology, climatologic antecedent conditions, land use, river morphology, size, and development density of the watershed.

Measure 11 – Improve Alternative Transportation and Emergency Access Routes. This measure would identify alternative transportation and emergency access routes. The proposed priority would be to lower flood levels so that I-5 and the State Routes are not closed during a 50-year event and to maintain emergency access routes on local roads up to a 25-year event. The local medical facility is on Cooks Hill in Centralia, and the two routes via Scheuber Road and Mellen Street are linked to SR-6 and I-5. Improvements would be needed on portions of Scheuber Road along with modifications on the SR-6 Bridge, Mellen Street bridge, and I-5. This local access road could be used as an I-5 alternate route. Depending on the severity of the flood, the local route may be closed during severe flooding conditions. Depending on the need to keep local roads open, there may be additional modifications to SR-6.

Measure 12 – Expand Capacity of Centralia-Chehalis Airport Dike Culverts. This measure proposes modifications to culverts and levees affecting the duration of flooding on northbound lanes of I-5 (modifications would reduce duration only - not the incidence or frequency of flooding). The recommended measures are to install flap gates and expand culverts to direct water to drain northerly. Flap gated culverts would be necessary on the west side of the highway to drain the airport and the southbound lanes of I-5. An additional flap gate would be needed on the east side in order to drain the northbound lanes of I-5.

Measure 13 – Off-channel Storage and Upstream Flow Restriction Structures. This measure would investigate the flood reduction achieved by installing flow restrictors (such as artificial logjams or agricultural stormwater ponds) at strategic locations that would allow for water to be temporarily stored during normal and large flood events. In all areas above flow restrictors and where buy-outs or flood easements take place, the following restoration activities are recommended: 1) restore floodplain and riparian areas via revegetation and livestock exclusion, 2) maximize stormwater mitigation opportunities from urban areas, 3) mitigate agricultural ditch runoff (agricultural stormwater ponds), 4) restore wetland complexes (enhancement of

summertime flows), and 5) re-establish oxbow/side channel habitat functions as they relate to over winter/summer habitat for salmon.

Measure 14 – Chehalis Flowway Bypass. This measure would include the floodwater bypass measure at SR-6 (included in Alternative 3) in combination with voluntary buy-outs and flood easements to attain enhanced floodwater storage capacities in areas identified in Measure 7. This measure would then be re-assessed and, if still necessary to reach flood hazard reduction goals, include Measure 15.

Measure 15 – Excavate Overbank Downstream of “Hump.” This measure would add a carefully designed overbank excavation downstream of the “hump” on the Chehalis River. Any excavation should be strategically designed to align with old side channels, and to remove invasive species such as reed canary grass and restore native vegetation. Excavation should not be located where the banks are functioning well and mature riparian forest is established.

Measure 16 – Elevate Segments of I-5. This measure would add elevation to specific segments of I-5 to avoid flood closures.

Measure 17 – Modify Skookumchuck Dam. This measure would add modifications of Skookumchuck Dam to improve flow control, but would not increase the storage.

Other Measures if Required. Following a detailed analysis of the flood hazard reduction achieved by the above listed measures, this alternative would consider a sequence of structural measures.

Discussion and Summary. Alternative 7 combines several aspects of Alternatives 2 through 6 and therefore is a multiple-action alternative. Through discussion with the alternatives subcommittee, the subcommittee concurred with the Corps’ findings regarding the use of flow restrictors (see discussion of Alternative 5) and excavation of the hump (see discussion of Alternative 3) and therefore dropped those measures from Alternative 7. However, the other actions remained as part of Alternative 7.

When structural measures are included, Alternative 7 would reduce flood hazards (Criterion 1) and decrease transportation closures (Criterion 2). Again, when structural measures are included, Alternative 7 would not result in downstream impacts (Criterion 3) or changes in the low flow operation of Skookumchuck Dam (Criterion 4). Because flood hazards would be reduced, costs

of flood damages would also be reduced (Criterion 5) as would the costs of transportation delay (Criterion 6). Costs of operation and maintenance would need to be further evaluated to determine if Criterion 7 could be met. With regard to Criterion 8, adverse environmental impacts such as loss of existing wetlands and riparian areas, corridor connectivity, and impacts to potential fish habitat would likely be similar to Alternatives 4 and 6 if all measures were implemented. Additional analysis would need to be done to evaluate the socioeconomic effects of development restrictions. Restoration opportunities would be similar to Alternatives 4 and 6 and inclusion of the SR-6 bypass would provide restoration opportunities described earlier for that component of Alternative 3 (Criterion 9). Further investigation would be necessary to determine if this alternative would comply with all federal, state, and local regulations (Criterion 10).

This alternative appeared to be consistent with the criteria, although there were issues that needed further investigation. Specifically, the operation and maintenance costs and environmental impacts warranted further review. This alternative was carried forward for further evaluation.

Table 2.3-1 summarizes the results of the screening-level evaluation.

Table 2.3-1: Summary of Screening-level Alternatives Evaluation

Alternative	Screening Results	Carry Forward for Further Evaluation?
Alternative 1 – No Action	Could not reasonably meet Criteria 1, 2, 5, and 6.	YES, per NEPA requirements
Alternative 2 – Skookumchuck Dan Modifications	Could not reasonably meet Criteria 1, 2, 5, and 6 as a stand-alone alternative.	YES, as a component of other action alternatives
Alternative 3 – Overbank Excavations and Flowway Bypass	Meets all criteria; additional analysis of economic benefits, environmental impacts, and compliance with laws and regulations needed.	YES
Alternative 4 – Setback Levees	Meets all criteria; additional study of economic benefits, environmental impacts, and compliance with laws and regulations needed.	YES
Alternative 5 – Flow Restrictors	Could not reasonably meet Criteria 1, 2, 5, 6, and 7.	NO
Alternative 6 – Non-structural Alternative	Could not reasonably meet Criteria 2, 6, and 7.	NO, but non-structural measures would be included in all action alternatives
Alternative 7 – Interagency Committee Alternative	Meets all criteria; additional study of operation and maintenance costs, environmental impacts, and compliance with laws and regulations needed.	YES

2.4 EVALUATION OF REMAINING ALTERNATIVES

The initial screening process identified three alternatives that tentatively met the project criteria (Alternatives 3, 4, and 7). It also identified one alternative (Alternative 2) that merited incorporation into the other three alternatives. As described earlier, any of the action alternatives identified as the preferred alternative would include non-structural flood damage reduction measures. Consistent with NEPA requirements, the no action alternative (Alternative 1) was also carried forward for further evaluation.

A risk-based analysis was performed for each of these alternatives to further evaluate the ability of the alternatives to meet the criteria of reducing of flood hazards and damage costs to the

maximum extent possible (Criteria 1, 2, 5, and 6). This included an analysis of engineering performance, costs, damage reduction, residual damages after project implementation, and net benefits. This analysis is fully described in the GRR and is summarized here.

The analysis of alternatives was based on a common water surface profile from the hydraulic model. All alternatives used the 100-year frequency flow and the associated water surface profile to define project components such as levee heights and bypass size. The 100-year flood frequency was selected as the common event for economic screening and allowed an alternative-by-alternative comparison of engineering performance.

To ensure that the analysis was complete, a number of modifications or variations of the alternatives were evaluated. Table 2.4-1 summarizes the results of the evaluation. The alternatives and modifications or variations that were evaluated are indicated on Table 2.4-1 as follows:

No Action: This is the no action alternative.

CheLev2-Ex SkDam: This configuration of Alternative 4 includes the levees on the Chehalis River elevated to the FEMA 100-year performance height and the Skookumchuck Dam with no flood-controlled reservoir.

CheLev2-SkDam1: This configuration of Alternative 4 includes levees on the Chehalis River elevated to the FEMA 100-year performance height combined with the Skookumchuck Dam modifications with 11,000 ac-ft of flood storage.

CheLev2-SkDam2: This configuration of Alternative 4 includes levees on the Chehalis River elevated to the FEMA 100-year performance height combined with the Skookumchuck Dam modifications with 20,000 ac-ft of flood storage.

CheLev2-Ex SkDam/SkLev: This configuration includes levees on the Chehalis River elevated to the FEMA 100-year performance height combined with Skookumchuck River levees and the Skookumchuck Dam with no flood-controlled reservoir.

CheLev2-SkDam 1/SkLev: This configuration of Alternative 4 includes levees on the Chehalis River elevated to the FEMA 100-year performance height combined with Skookumchuck River levees and the Skookumchuck Dam modifications with 11,000 ac-ft of flood storage.

CheLev2-SkDam 2/SkLev: This configuration of Alternative 4 includes levees on the Chehalis River elevated to the FEMA 100-year performance height combined with Skookumchuck River levees and the Skookumchuck Dam modifications with 20,000 ac-ft of flood storage.

Bypass/SkDam1: This configuration of Alternative 3 includes the overbank excavation and flowway bypass plus the Skookumchuck Dam modifications with 11,000 ac-ft of flood storage.

Bypass/SkDam2: This configuration of Alternative 3 includes the overbank excavation and flowway bypass plus the Skookumchuck Dam modifications with 20,000 ac-ft of flood storage.

Hybrid Plan – Existing Dam: This configuration of Alternative 3 includes a modification to the bypass at Mellen Street and the SR-6 bypass. Both overbank excavations would be reduced in size from the original Alternative 3 configuration, and the berm in the floodplain would be removed. The Chehalis levee system was added to this configuration. The levee heights were adjusted for the decrease in flood stages due to the influence of the overbank excavation areas. This also includes the Skookumchuck Dam with no flood-controlled reservoir.

Hybrid Plan - SkDam1: This configuration of Alternative 3 includes the hybrid plan plus the Skookumchuck Dam modifications with 11,000 ac-ft of flood storage.

Hybrid Plan - SkDam2: This configuration of Alternative 3 includes the hybrid plan plus the Skookumchuck Dam modifications with 20,000 ac-ft of storage.

Alternative 7- Existing Dam: This configuration includes all of the structural features described in Alternative 7, but elevation of I-5 is not included, since it was clear early in the evaluation that this element would make the alternative not cost-effective. For this configuration, elevation of I-5 is replaced by construction of levees along I-5. This configuration includes the existing Skookumchuck Dam with no flood-controlled reservoir. The non-structural features of Alternative 7 could not be modeled or assigned costs for the study.

Table 2.4-1: With-project Economic Analysis

Alternative	Expected Annual Damages (\$1,000)*					Flood Damages Reduced	Other Damages	Other Damages Reduced	Total Damages Reduced	Cost	Net Benefit	B/C
	Chehalis		Skookumchuck		Total							
	Res/Comm	Public	Res/Comm	Public								
No Action	6147.81	442.93	2211.84	42.36	8844.94	0.00	2239.10	0.00	0.00	0.00	0.00	0.00
CheLev2 - Exsting SkDam	2347.19	82.95	2392.52	46.94	4869.60	3975.34	2239.10	2239.10	6214.44	4537.06	1677.38	1.37
CheLev2 - SkDam 1	2081.67	70.05	595.59	15.34	2762.65	6082.29	2239.10	2239.10	8321.39	5622.75	2698.64	1.48
CheLev2 - SkDam 2	2057.19	68.37	504.68	10.57	2640.81	6204.13	2239.10	2239.10	8443.23	5839.89	2603.34	1.45
CheLev2SR-6 - Ex SkDam	2186.09	58.63	2290.11	42.72	4577.55	4267.39	2239.10	2239.10	6506.49	4863.89	1642.60	1.34
CheLev2SR-6 - SkDam 1	1893.35	45.85	694.59	14.09	2647.88	6197.06	2239.10	2239.10	8436.16	5949.58	2486.58	1.42
CheLev2SR-6 - SkDam 2	1876.98	43.86	498.56	10.30	2429.70	6415.24	2239.10	2239.10	8654.34	6166.72	2487.62	1.40
Hybrid Plan - Existing Dam	2231.15	61.06	1363.55	38.16	3693.92	5151.02	2239.10	2239.10	7390.12	5098.44	2291.68	1.45
Hybrid Plan - SkDam 1	1901.64	47.66	562.03	14.14	2525.47	6319.47	2239.10	2239.10	8558.57	6184.14	2374.43	1.38
Hybrid Plan - SkDam 2	1900.60	45.02	464.71	8.85	2419.18	6425.76	2239.10	2239.10	8664.86	6401.28	2263.58	1.35
CheLev2 - Ex SkDam/SKLev	2217.91	60.56	1677.61	42.06	3998.14	4846.80	2239.10	2239.10	7085.90	4865.90	2220.00	1.46
CheLev2 - SkDam 1/SKLev	1932.99	50.86	453.78	11.19	2448.82	6396.12	2239.10	2239.10	8635.22	5951.60	2683.62	1.45
CheLev2 - SkDam 2/SKLev	1924.27	48.05	337.42	9.32	2319.06	6525.88	2239.10	2239.10	8764.98	6168.73	2596.25	1.42
Bypass - Existing Dam	3404.44	30.56	2225.90	38.25	5699.15	3145.79	2239.10	0.00	3145.79	6070.04	2924.25	0.52
Bypass - SkDam 1	2996.60	98.17	542.00	9.28	3646.05	5198.89	2239.10	0.00	5198.89	6882.46	1683.57	0.76
Bypass - SkDam 2	2977.01	94.28	458.70	6.60	3536.59	5308.35	2239.10	0.00	5308.35	7526.87	2218.52	0.71
Alternative 7 - Existing Dam	3382.07	97.10	2288.89	41.94	5810.00	3034.94	2239.10	0.00	3034.94	5081.55	2046.61	0.60
Alternative 7 - SkDam 1	2899.76	74.89	601.44	18.63	3594.72	5250.22	2239.10	0.00	5250.22	5718.95	-468.73	0.92
Alternative 7 - SkDam 2	2869.41	70.80	526.26	7.69	3474.16	5370.78	2239.10	0.00	5370.78	5869.87	-499.09	0.91

Alternative 7- SkDam1: This configuration is the same as Alternative 7 above, but includes Skookumchuck Dam modifications with 11,000 ac-ft of flood storage.

Alternative 7- SkDam2: This configuration is the same as Alternative 7 above, but includes Skookumchuck Dam modifications with 20,000 ac-ft of flood storage.

The evaluation indicated that the benefit/cost (B/C) ratio for Alternative 3 with various dam configurations (shown as the "bypass" alternative on Table 2.4-1) was less than 1; that is, the costs would exceed the damage reduction benefits. The Corps cannot undertake a project unless the benefits can be shown to exceed the project costs. Therefore, this alternative was eliminated from further evaluation. The modified version of this alternative that included a portion of the levee system and altered bypass configurations (the "hybrid plan") was also evaluated. The analysis showed that the modified Alternative 3 reduced flood damages and achieved a B/C ratio greater than 1. However, flood damage reduction was not maximized; in other words, the modified Alternative 3 was not the most efficient alternative for meeting Criteria 1, 5, and 7. This alternative did not have the highest net benefit or B/C ratio. In addition, there were environmental concerns that would still need to be addressed. These concerns include changes in sediment transport and the potential upstream and downstream effects of these changes.

Early hydraulic model runs showed that all of the structural measures of Alternative 7 would need to be implemented in order to meet project criteria related to engineering effectiveness. This resulted in excessive costs that were not economically justified. In order to determine if this alternative could still be viable, it was modified to include levees. The flow restrictors and raising I-5 were eliminated because they were too costly and did not provide substantial flood reduction benefits. Other modifications included construction of levees along I-5 and various Skookumchuck Dam configurations. The non-structural features of the alternative could not be modeled or assigned costs for the study, and so were not analyzed quantitatively.

The evaluation showed that the B/C ratio for the various configurations of the modified Alternative 7 was less than 1; that is, the costs would exceed the flood reduction benefits. However, many of the non-structural features of Alternative 7 would be incorporated in any alternative identified as the preferred alternative. Non-structural measures that would not be specifically included in the preferred alternative but which could be undertaken by local jurisdictions include placing a moratorium on floodplain development until new FEMA maps are adopted (Measure 1) and restricting upland land uses (Measure 8). The local jurisdictions would

adopt the new FEMA 100-year floodplain maps. Restricting upland uses would likely have a minimal effect on reducing flood stages. However, federal, state, and local regulatory programs already require protection of wetlands and critical areas included as part of Measure 8. Based on the analysis of floodplain, storage conducted for Alternative 5, removing barriers such as railroad grades, roadways, and bridges to increase floodplain storage (Measure 7) likely would not have a significant effect on flood stages. Improving alternate transportation routes (Measure 11) would not be necessary if a flood reduction project were implemented. The non-structural measures that would be specifically included in the preferred alternative are discussed in Section 2.5.3.

The non-structural features from Alternative 7 are incorporated as part of the preferred alternative. These include (1) elevation of structures, (2) definition of a new 100-year FEMA floodplain, (3) appropriate improvements in the flood warning system, (4) restriction of development in floodways and other critical floodplain areas, (5) restriction of filling in the floodplain, and (6) appropriate improvements to local stormwater management plans. As stated in Section 2.5.3, the local sponsor will implement the listed actions to the maximum extent possible; the actions will be included in the revised floodplain management plan required by E.O. 11988 for the project to be constructed. The Corps will review and approve the revised plan to insure that the non-structural project components are appropriately incorporated into the plan and will provide technical support to assist in developing non-structural features to assure the integrity of the project structural components. The elevation of structures is included as part of the cost-shared project. Eight homes showed to be economically justified for flood protection through elevating the structures.

Alternative 4 was identified as the most effective alternative for reducing flood damages. In the final phase of the evaluation, analyzing combinations of several different sizes of the structural features optimized the alternative. This included combinations of various levee heights and the 11,000 ac-ft or 20,000 ac-ft flood storage pool behind Skookumchuck Dam. Table 2.4-2 summarizes the costs and benefits of these combinations. This included combinations of various levee heights and the 11,000 ac-ft or 20,000 ac-ft flood storage pool behind Skookumchuck Dam. The table is broken out by dam size: 11 equals 11,000 ac-ft, the protection size of the levees; 100 equals approximately 100-year flood protection (this is 3 feet above 100-year water surface); BW equals backwater from the Chehalis River into the Skookumchuck River; 0 equals the levee profile at the 100-year water surface; and -1 equals 1 foot below 100-year water surface. The table also shows the residual damages, which are annual flood damages that will remain after the project is constructed, the construction costs, total flood reduction benefits, and net benefits of the project.

Table 2.4-2: Total Annual Cost and Net Benefits

Dam Size	Chehalis Levee*	Skookumchuck Levee*	Residual Damages**	Damage Reduction	I-5 Avoided Costs	I-5 Delay Benefits	Total Benefits	Skook Dam Cost	Chehalis Levee Cost	Skook Levee Cost	Total Cost	Net Benefits
11	100	-2	\$2,556.28	\$6,288.65	\$2,110.00	\$129.10	\$8,527.75	\$1,085.70	\$4,272.00	\$642.03	\$5,999.73	\$2,528.00
11	100	-1	\$2,533.37	\$6,311.55	\$2,110.00	\$129.10	\$8,550.65	\$1,085.70	\$4,272.00	\$688.03	\$6,045.73	\$2,504.92
11	100	BW	\$2,647.88	\$6,197.04	\$2,110.00	\$129.10	\$8,436.14	\$1,085.70	\$4,272.00	\$755.03	\$5,932.73	\$2,503.41
11	100	-3	\$2,591.48	\$6,253.44	\$2,110.00	\$129.10	\$8,492.54	\$1,085.70	\$4,272.00	\$636.03	\$5,993.73	\$2,498.81
11	100	0	\$2,513.16	\$6,331.76	\$2,110.00	\$129.10	\$8,570.86	\$1,085.70	\$4,272.00	\$732.03	\$6,089.73	\$2,481.13
11	100	75	\$2,498.06	\$6,346.86	\$2,110.00	\$129.10	\$8,585.96	\$1,085.70	\$4,272.00	\$769.32	\$6,127.02	\$2,458.94
11	200	-1	\$2,337.05	\$6,507.87	\$2,110.00	\$129.10	\$8,746.97	\$1,085.70	\$4,550.83	\$663.14	\$6,299.66	\$2,447.31
20	100	-1	\$2,409.98	\$6,434.94	\$2,110.00	\$129.10	\$8,674.04	\$1,302.83	\$4,272.00	\$663.14	\$6,237.97	\$2,436.07
11	200	0	\$2,316.83	\$6,528.09	\$2,110.00	\$129.10	\$8,767.19	\$1,085.70	\$4,550.83	\$711.09	\$6,347.62	\$2,419.57
20	100	0	\$2,388.65	\$6,456.27	\$2,110.00	\$129.10	\$8,695.37	\$1,302.83	\$4,272.00	\$711.09	\$6,285.92	\$2,409.45
11	200	75	\$2,301.74	\$6,543.18	\$2,110.00	\$129.10	\$8,782.28	\$1,085.70	\$4,550.83	\$769.32	\$6,405.85	\$2,376.43
20	100	75	\$2,373.82	\$6,471.10	\$2,110.00	\$129.10	\$8,710.20	\$1,302.83	\$4,272.00	\$769.32	\$6,344.16	\$2,366.04
11	100	100	\$2,448.83	\$6,396.09	\$2,110.00	\$129.10	\$8,635.19	\$1,085.70	\$4,272.00	\$920.73	\$6,278.42	\$2,356.77
20	200	-1	\$2,223.00	\$6,621.92	\$2,110.00	\$129.10	\$8,861.02	\$1,302.83	\$4,550.83	\$663.14	\$6,516.80	\$2,344.22
20	200	0	\$2,200.67	\$6,644.25	\$2,110.00	\$129.10	\$8,883.35	\$1,302.83	\$4,550.83	\$711.09	\$6,364.75	\$2,318.60
11	100	200	\$2,406.04	\$6,438.88	\$2,110.00	\$129.10	\$8,677.98	\$1,085.70	\$4,272.00	\$1,011.16	\$6,368.85	\$2,309.13
20	200	75	\$2,185.85	\$6,659.07	\$2,110.00	\$129.10	\$8,898.17	\$1,302.83	\$4,550.83	\$769.32	\$6,622.98	\$2,275.19
11	200	100	\$2,252.50	\$6,592.42	\$2,110.00	\$129.10	\$8,831.52	\$1,085.70	\$4,550.83	\$920.73	\$6,557.25	\$2,274.27
20	100	100	\$2,319.05	\$6,525.87	\$2,110.00	\$129.10	\$8,764.97	\$1,302.83	\$4,272.00	\$920.73	\$6,495.56	\$2,269.41
11	200	200	\$2,209.71	\$6,635.21	\$2,110.00	\$129.10	\$8,874.31	\$1,085.70	\$4,550.83	\$1,011.16	\$6,647.68	\$2,226.63
20	100	200	\$2,291.50	\$6,553.42	\$2,110.00	\$129.10	\$8,792.52	\$1,302.83	\$4,272.00	\$1,011.16	\$6,585.99	\$2,206.53
20	200	100	\$2,131.07	\$6,713.85	\$2,110.00	\$129.10	\$8,952.95	\$1,302.83	\$4,550.83	\$920.73	\$6,774.38	\$2,178.57
20	200	200	\$2,103.52	\$6,741.40	\$2,110.00	\$129.10	\$8,980.50	\$1,302.83	\$4,550.83	\$1,011.16	\$6,864.82	\$2,115.68
Ext	100	BW	\$4,577.55	\$4,267.37	\$2,110.00	\$129.10	\$6,506.47	\$0.00	\$4,272.00	\$591.89	\$4,863.89	\$1,642.58
11	75	-1	\$2,983.30	\$5,861.62	\$0.00	\$0.00	\$5,861.62	\$1,085.70	\$3,776.69	\$663.14	\$5,525.52	\$336.10
11	75	0	\$2,963.10	\$5,881.82	\$0.00	\$0.00	\$5,881.82	\$1,085.70	\$3,776.69	\$711.09	\$5,573.48	\$308.34
11	75	75	\$2,948.00	\$5,896.92	\$0.00	\$0.00	\$5,896.92	\$1,085.70	\$3,776.69	\$769.32	\$5,631.71	\$265.21
20	75	-1	\$2,846.42	\$5,998.50	\$0.00	\$0.00	\$5,998.50	\$1,302.83	\$3,776.69	\$663.14	\$5,742.66	\$255.84
20	75	0	\$2,824.10	\$6,020.82	\$0.00	\$0.00	\$6,020.82	\$1,302.83	\$3,776.69	\$711.09	\$5,790.61	\$230.21
20	75	75	\$2,809.27	\$6,035.65	\$0.00	\$0.00	\$6,035.65	\$1,302.83	\$3,776.69	\$769.32	\$5,848.84	\$186.81
11	75	100	\$2,898.76	\$5,946.16	\$0.00	\$0.00	\$5,946.16	\$1,085.70	\$3,776.69	\$920.73	\$5,783.11	\$165.05
11	75	200	\$2,855.97	\$5,988.95	\$0.00	\$0.00	\$5,988.95	\$1,085.70	\$3,776.69	\$1,011.16	\$5,873.54	\$115.41

Dam Size	Chehalis Levee*	Skookumchuck Levee*	Residual Damages**	Damage Reduction	I-5 Avoided Costs	I-5 Delay Benefits	Total Benefits	Skook Dam Cost	Chehalis Levee Cost	Skook Levee Cost	Total Cost	Net Benefits
20	75	100	\$2,754.50	\$6,090.42	\$0.00	\$0.00	\$6,090.42	\$1,302.83	\$3,776.69	\$920.73	\$6,000.25	\$90.17
20	75	200	\$2,726.94	\$6,117.98	\$0.00	\$0.00	\$6,117.98	\$1,302.83	\$3,776.69	\$1,011.16	\$6,090.68	\$27.30
11	0	-1	\$3,695.48	\$5,149.44	\$0.00	\$0.00	\$5,149.44	\$1,085.70	\$3,573.22	\$663.14	\$5,322.05	-\$172.61
11	0	0	\$3,675.26	\$5,169.66	\$0.00	\$0.00	\$5,169.66	\$1,085.70	\$3,573.22	\$711.09	\$5,370.01	-\$200.35
20	0	-1	\$3,540.11	\$5,304.81	\$0.00	\$0.00	\$5,304.81	\$1,302.83	\$3,573.22	\$663.14	\$5,539.19	-\$234.38
11	0	75	\$3,660.17	\$5,184.75	\$0.00	\$0.00	\$5,184.75	\$1,085.70	\$3,573.22	\$769.32	\$5,428.24	-\$243.49
20	0	0	\$3,517.77	\$5,327.15	\$0.00	\$0.00	\$5,327.15	\$1,302.83	\$3,573.22	\$711.09	\$5,587.14	-\$259.99
20	0	75	\$3,502.94	\$5,341.98	\$0.00	\$0.00	\$5,341.98	\$1,302.83	\$3,573.22	\$769.32	\$5,645.37	-\$303.39
11	0	100	\$3,610.93	\$5,233.99	\$0.00	\$0.00	\$5,233.99	\$1,085.70	\$3,573.22	\$920.73	\$5,579.64	-\$345.65
11	0	200	\$3,568.13	\$5,276.79	\$0.00	\$0.00	\$5,276.79	\$1,085.70	\$3,573.22	\$1,011.16	\$5,670.07	-\$393.28
20	0	100	\$3,448.18	\$5,396.74	\$0.00	\$0.00	\$5,396.74	\$1,302.83	\$3,573.22	\$920.73	\$5,796.78	-\$400.04
20	0	200	\$3,420.63	\$5,424.29	\$0.00	\$0.00	\$5,424.29	\$1,302.83	\$3,573.22	\$1,011.16	\$5,887.21	-\$462.92
11	-1	-1	\$4,340.59	\$4,504.33	\$0.00	\$0.00	\$4,504.33	\$1,085.70	\$3,398.52	\$663.14	\$5,147.36	-\$643.03
11	-1	0	\$4,320.37	\$4,524.55	\$0.00	\$0.00	\$4,524.55	\$1,085.70	\$3,398.52	\$711.09	\$5,195.31	-\$670.76
20	-1	-1	\$4,179.64	\$4,665.28	\$0.00	\$0.00	\$4,665.28	\$1,302.83	\$3,398.52	\$663.14	\$5,364.49	-\$699.21
11	-1	75	\$4,305.28	\$4,539.64	\$0.00	\$0.00	\$4,539.64	\$1,085.70	\$3,398.52	\$769.32	\$5,253.54	-\$713.90
20	-1	0	\$4,157.31	\$4,687.61	\$0.00	\$0.00	\$4,687.61	\$1,302.83	\$3,398.52	\$711.09	\$5,412.45	-\$724.84
20	-1	75	\$4,142.48	\$4,702.44	\$0.00	\$0.00	\$4,702.44	\$1,302.83	\$3,398.52	\$769.32	\$5,470.68	-\$768.24
11	-1	100	\$4,256.03	\$4,588.89	\$0.00	\$0.00	\$4,588.89	\$1,085.70	\$3,398.52	\$920.73	\$5,404.95	-\$816.06
11	-1	200	\$4,213.24	\$4,631.68	\$0.00	\$0.00	\$4,631.68	\$1,085.70	\$3,398.52	\$1,011.16	\$5,495.38	-\$863.70
20	-1	100	\$4,087.72	\$4,757.20	\$0.00	\$0.00	\$4,757.20	\$1,302.83	\$3,398.52	\$920.73	\$5,622.08	-\$864.88
20	-1	200	\$4,060.17	\$4,784.75	\$0.00	\$0.00	\$4,784.75	\$1,302.83	\$3,398.52	\$1,011.16	\$5,712.51	-\$927.76

In addition, concerns expressed by local officials (e.g., FEMA certification for the 100-year flood in Centralia and the added protection provided by the 20,000 ac-ft flood storage pool) were considered in determining which of the alternative configurations would be carried forward as the preferred alternative. This included the features that have the highest net benefit in combination with addressing local concerns regarding the dam. The configuration finally identified as the preferred alternative includes the following:

- modifications to the Skookumchuck Dam including 20,000 ac-ft of flood storage;
- construction of set back levees providing 100-year flood protection on the Chehalis River;
- construction of set back levees providing 100-year flood protection on a portion of the Skookumchuck River; and
- non-structural components.

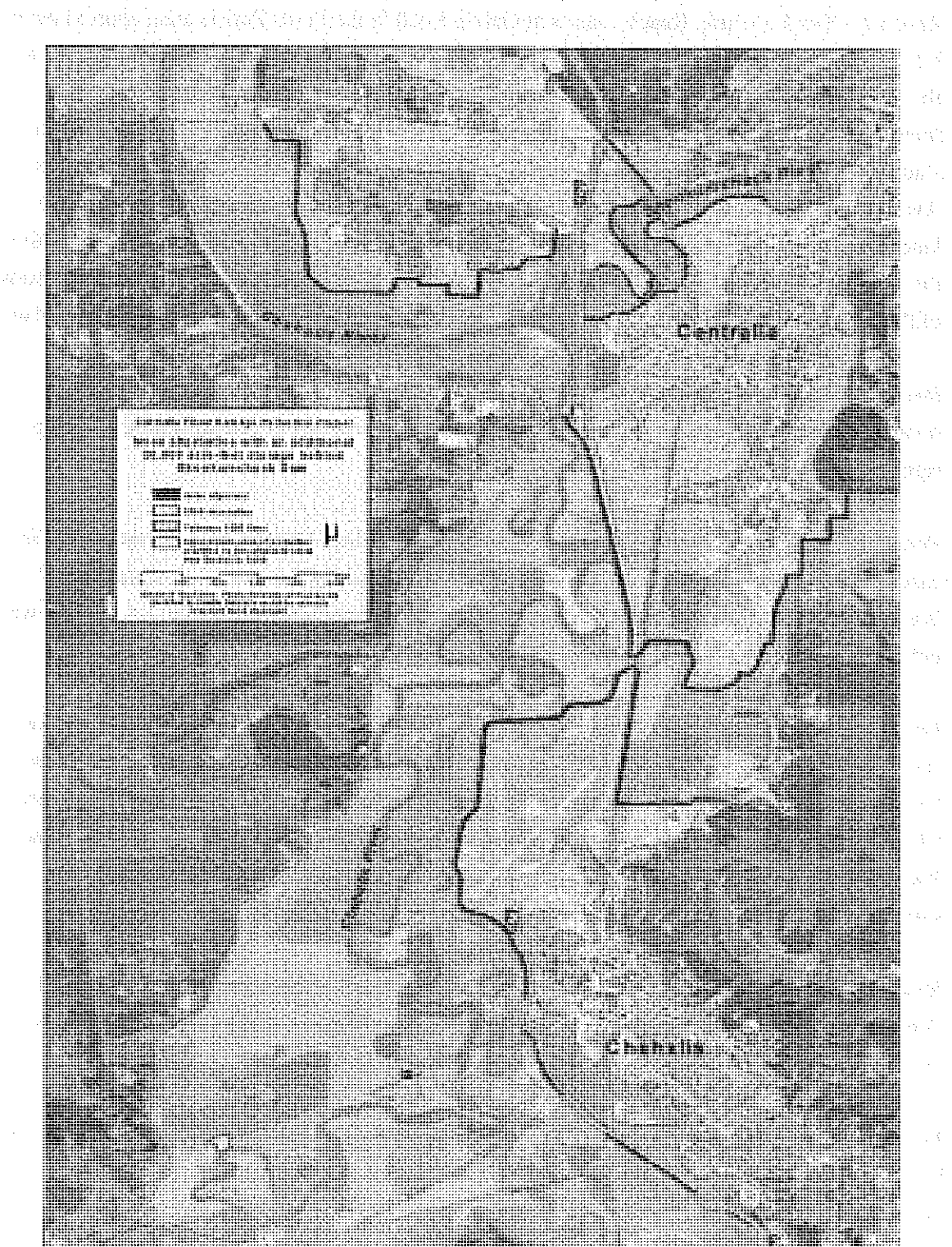
The preferred alternative is described more fully in the following section; the levee alignment is illustrated on Figure 2.2.

2.5 PREFERRED ALTERNATIVE

2.5.1 Setback Levees

The levee system is intended to provide 100-year protection from the Chehalis River flooding. The setback levees would protect existing residential and commercial structures, I-5, and other transportation infrastructure from flooding. Large areas of the floodplain that are not developed would not be protected, so construction of the levee system would not encourage new floodplain development. Flood protection would extend along the Chehalis River from approximately RM 75 to RM 64, as well as along most of the lower 2 miles of both Dillenbaugh Creek and Salzer Creek. In addition, levee protection will be provided on the Skookumchuck River for backwater effects of the Chehalis River. The affected reach extends approximately 2 miles upstream on the Skookumchuck to the confluence with Coffee Creek.

A description of the levee alignment by reach is provided below. Additional detail on the levee alignment and design features is provided in the GRR.



Reach 1 – Fords Prairie. Reach 1 starts at Galvin Road in the Fords Prairie area, approximately 0.5 mile east of the Galvin Bridge near RM 64. The levee alignment travels generally south to the WDFW Bird Farm, where it is approximately 1,800 feet from the Chehalis River. From there, the alignment travels east to Bryden Avenue and then north to the high school track and stadium. The alignment heads east behind the stadium and then north to the east end of Borst Avenue near the Harrison Avenue/I-5 interchange. The embankment for the I-5 southbound lanes would be incorporated as part of the levee system. The levee alignment continues south to the right bank of the Skookumchuck River and ties into the bridge abutment. From the left bank of the Skookumchuck River, the levee alignment continues south to the sewage treatment plant.

Reach 2 – Sewage Treatment Plant. Reach 2 travels around and behind the existing sewage treatment plant and connects with high ground about 200 feet east of the Mellen Street bridge right bank abutment.

Reach 3 – Mellen Street Bridge to Salzer Creek Bridge. Reach 3 begins approximately 200 feet east of the Mellen Street bridge abutment and heads south along the river side of the Airport Way right-of-way. The alignment crosses Airport Way and continues along the I-5 right-of-way until it intersects with the Salzer Creek Bridge abutment.

Reach 4 – Salzer Creek Right Bank. Reach 4 starts at the I-5/Salzer Creek Bridge intersection and follows the right bank of Salzer Creek. The alignment then crosses the railroad tracks and ties into an existing levee at the fairgrounds. The alignment crosses National Avenue and then follows Salzer Creek north to Kresky Avenue, where it travels along the west side of the road. The alignment travels northward generally along the alignment of Pacific Avenue and then switches east and north until it ties into high ground at Summa Street.

Reach 5 – Salzer Creek Left Bank. Reach 5 starts at the south Salzer Creek Bridge abutment. The alignment parallels the railroad tracks until it turns eastward across Coal Creek where a culvert will be installed. It then ties in with an existing levee and crosses National Avenue.

Reach 6 – Coal Creek. Reach 6 starts at National Avenue and heads east to Kresky Avenue. The levee in this reach would consist of raising an existing floodwall around the perimeter of a parking lot.

Reach 7 – Salzer Creek to Airport. Reach 7 starts at the Salzer Creek Bridge abutment on the west side of I-5. The alignment parallels Airport Way until it connects with an existing airport levee, which would be widened and raised. This portion of the alignment parallels Airport Way to the south until it reaches the intersection of Airport Way and Arizona Avenue. An existing levee on the south side of Airport Way will be removed out of consideration for an environmentally sensitive area located on the south side of the road. The alignment continues from Arizona Avenue to Louisiana Avenue and continues along the southbound lanes of Louisiana Avenue.

Reach 8 – SR-6 to Railroad Underpass. Reach 8 starts at the I-5/SR-6 interchange southbound on-ramp and travels along the right side of the road until it reaches Dillenbaugh Creek Bridge and crosses the creek. A flood control box with a flap gate would be installed at this crossing. During major floods, the control box would prevent Dillenbaugh Creek flows from flowing east to west and entering the Chehalis River. The levee alignment continues south until it reaches the railroad underpass.

Reach 9 – Dillenbaugh Creek. Reach 9 starts on the north side of the I-5 bridge abutment at RM 0.5 on Dillenbaugh Creek. The alignment crosses the railroad tracks and Dillenbaugh Creek. A flood control box would isolate Dillenbaugh Creek flows to the west side of I-5 during major floods. The levee alignment in this reach is offset from I-5 to allow for future widening of the I-5 interchange.

Reach 10 – Dillenbaugh South. Reach 10 runs along the southbound on-ramp and interchange area. Construction in this reach would not be necessary if the Rice Road interchange is improved prior to implementation of the preferred alternative.

Reach 11 – West Reynolds Avenue to BNSF. Reach 11 starts at West Reynolds Avenue near the intersection of the BNSF tracks, the Chehalis Western tracks, and I-5 underpass. The levee alignment runs south, parallel to the BNSF tracks to a point approximately 200 feet from the Skookumchuck River.

Reach 12 – Chehalis Western Railroad to Harrison Street Bridge. Reach 12 starts on the west side of the Chehalis Western tracks and follows the left bank of the Skookumchuck River until it reaches existing high ground. None of the construction would be immediately adjacent to the riverbank. The alignment follows high ground and then travels over the existing road through

Fort Borst Park, until it reaches the I-5 embankment approximately 100 feet north of the Skookumchuck River.

Reach 13 – Harrison Street Bridge to I-5 Right Bank. Reach 13 starts on the right bank just downstream of the Harrison Street bridge and follows the perimeter of Hayes Lake, continuing along the edge of an existing access road that ties into I-5.

Reach 14 – Left Bank I-5 to Harrison Street Bridge. Reach 14 starts approximately 100 yards south of the I-5 bridge abutment on the left bank of the Skookumchuck River. The alignment heads east following high ground and then ties into an existing berm behind a nursing home. From this point, the alignment continues northeast and ties into Denny Way. The alignment continues to Latona Street and the Harrison Street bridge. From the upstream side of the bridge, the alignment travels on the left bank along First Street, continuing one block west of M Street, where it ties into existing high ground.

Reach 15 – Harrison Street Bridge to Chehalis Western Railroad. Reach 15 begins at the Harrison Street bridge along First Street and turns north on M Street to an existing raised driveway. A levee segment would surround a residential area and tie into an existing Chehalis Western rail embankment approximately 200 feet from the Skookumchuck River.

Reach 16 – Chehalis Western Railroad to Existing Left Bank Levee. Reach 16 connects high ground near the Chehalis Western embankment to the BNSF embankment. A portion of this reach follows an existing ridgeline along the Skookumchuck River floodway, where it ties into an existing levee near the intersection of West 7th Street and G Street.

2.5.2. Skookumchuck Dam Modifications

The short tunnel with gates and rubber crest weir was the only dam modification design that proved to be feasible from an engineering standpoint. Replacing the rubber crest weir with slide gates further modified this design. Storage of water to a pool elevation of 492 feet would provide flood storage from 455 to 492 feet, such that the total flood storage would be about 20,000 ac-ft.

The Corps determined that the preferred alternative would be the least environmentally damaging alternative based on the following restrictions on flood storage at Skookumchuck Dam. Water storage in the Skookumchuck reservoir above pool elevation 477 feet could only be used for flood damage reduction. Water would be stored above this elevation no longer than 5

days for the 50-year to 100-year flood. For the 2- to 50-year flood, water storage above elevation 477 should not occur more than every other year, and storage above elevation 477 would be no longer than 5 days for these events.

2.5.3 Non-Structural Features

The following outlines the non-structural features that are a part of the preferred alternative. The local sponsor will implement these actions to the maximum extent practicable. These actions will be included in the revised floodplain management plan for the project. This plan will be completed prior to the signing of the cooperative agreement for project implementation. The Corps will provide technical support to assist in development of sound actions within the project area to assure the integrity of any project structural components.

The Corps considered non-structural measures during the alternative evaluation process. Many of these measures are already being implemented at the county and city level. This includes ordinances on construction in the floodways, emergency warning systems, and other non-structural solutions such as building of homes and businesses and property buy-outs. Land use management plans are also in the process of being revised by Lewis County to have requirements that are more restrictive.

The following describes the non-structural component for the preferred alternative. Further effort on non-structural options will be evaluated during the development of a new floodplain management plan for the project area to be compliant with Executive Order 11988. This will occur during the project design process.

Elevation of Structures. Implementation of the preferred alternative will result in slightly increased flood elevations over existing conditions (average of 4 inches for the 100-year event) for eight residential structures in the study area. To address this issue, the Corps conducted a reconnaissance level analysis of raising the affected structures so that first floor elevations would be 1 foot above the with-project 100-year water surface elevation (WSE). The estimated cost for elevating structures is based on cost data obtained for previous Corps studies, which indicates an average cost of \$25,000 per residence. Most of the costs of raising a structure are incurred in separating the structure from its foundation and installing a raised foundation. The height of this raised foundation is not generally a significant factor in the total cost and was not used in this estimate. However, the average number of feet these structures are below the 100-year WSE was recorded.

The affected structures are located in two sub-areas. The eight structures would be raised an average of 1.85 feet at a total cost of \$200,000. The flood damage reduction benefits of raising these structures were based on data taken from the HEC-FDA model results. These data indicated average annual flood damages would be reduced by \$1,730 per structure, or \$13,840 for all eight structures. The average annual benefits of \$13,840 compared to average annual costs of \$12,910 results in a B/C ratio of 1.1 to 1.0 for this non-structural project component.

The two sub-areas, the number of affected residences, their average elevation below the 100-year without- and with-project WSE, and the first cost and average annual cost to elevate to 1 foot above the 100-year with-project WSE are presented below.

Table 2.5.3-1: Costs of Elevating Structures with Induced Flooding

Sub-Area	Number of Affected Residences	Avg. Elevation Below 100-yr WSE Without Project (ft)	Ave. Elevation Below 100-yr WSE With Project (ft)	Average Change in 100-yr WSE due to project (ft)	First Cost Estimate (\$)	Average Annual Costs @ 6.125% over 50 Years (\$)
BELOW AIRPORT	6	0.66	1.2	0.51	150,000	9,682
NORTH OF SR-6	2	0.29	0.5	0.18	50,000	3,228
Totals/Averages	8	0.475	0.85	0.345	200,000	12,910

Define a New 100-Year FEMA Floodplain. A new 100-year FEMA floodplain map will be generated after the recommended plan has been approved and FEMA has accepted that project will be completed. The communities will adopt this map.

Flood Warning System. Currently the cities and the county utilize the Emergency Broadcast System (EBS) and other forms of public information such as radio and television to transmit emergency and warning transmissions for the area. Also, three local emergency/information phone numbers have been established to answer the public's questions or receive important flood information from residents. There are also neighborhood notification networks. Lewis County Emergency Management division is responsible for carrying out the emergency response program. The City of Chehalis has warning sirens to notify the community of flood hazards, as well as a telephone network through the Chamber of Commerce. They also utilize a website to show where flooding is occurring. The community is also working with the National Weather

Service to post bulletins of flood hazards. The flood warning system will be further addressed in the flood management plan.

Additional initiatives that are being considered by Lewis County include:

- 1) Installing additional river gauging stations to help in flood warning and emergency response activities. Potential additional gauges may include the following:
 - a. updating the Newaukum gauge near Chehalis with telephone-linked capabilities;
 - b. adding a telephone-linked gauge at South Fork Chehalis; and
 - c. installing gauges on other major tributaries within the Centralia/Chehalis area.
- 2) The cities of Chehalis and Centralia and the County Engineer will coordinate the flood forecasting efforts.
- 3) Formalizing and updating the road closure database, creating a predictive tool by coordinating related flood stages to road closures.
- 4) Increasing distribution of flood information materials by making them available at the Emergency Management Office and at libraries throughout the county.
- 5) Updating Federal Insurance Rate Maps based on historical flood records to provide more accurate flood hazard information.
- 6) Enacting a public disclosure ordinance to provide a property's floodplain status at the time of purchase.
- 7) Documenting flood warning and emergency response activities for submittal to Community Rating System. These will count as credits to reduce flood insurance premiums.

Restriction of Development. The Corps will determine in the design phase the new floodway and flow paths within the project area after the implementation of the structural features. The local community will utilize this information to ensure local ordinances are being followed. This would include utilizing the newly developed 100-year floodplain and hydraulic modeling. The local jurisdictions can either amend their own Flood Hazard and SEPA ordinances and their own Shoreline Master Programs (as directed under the state Shoreline Management Act) or utilize the

state's guidelines. In addition to defining the 0.2-foot floodway, development is also discouraged within other critical portions of the floodplain, specifically in areas considered to be significant flow paths. Flow paths are naturally occurring swales, which are normally dry, but which historically conveyed significant amounts of flowing water during floods. The following is a brief description of the current ordinances for floodway construction for Lewis County, the City of Chehalis and the City of Centralia. These ordinances generally support having an approved filling/floodplain development plan, and provide for a hydraulic analysis to show a 0.2-foot rise or less in the floodwater surface elevation.

Lewis County – Development within the FEMA floodway is highly discouraged. Landfills, substantial improvements, and new residential structures are entirely prohibited. Commercial development is allowed, but only if accompanied by an engineer's certification that the proposed development will not result in any increase in flood levels during the 100-year flood. Variances are possible for development within the floodway but Lewis County does not encourage them.

City of Centralia – Development is not allowed in the FEMA floodway. Centralia ordinances state that no impact or 0-foot rise is required of any development. Request for variances are few and are seldom granted. Applicants for projects that lie in both the Flood Plain Ordinance and the Shoreline Master Program areas are required to apply for, and obtain, both permits. In addition, any development within the FEMA flood fringe must be elevated to at least 1 foot above the elevation of the 100-year flood (these elevations are based on the FIRM).

City of Chehalis – Development within the FEMA floodway is highly discouraged. New residential structures are entirely prohibited in special flood hazard areas. Commercial development is allowed, but only if accompanied by an engineer's certification that the proposed development would not raise flood levels at all during the 100-year flood. In addition, all new development and substantial improvements must comply with all applicable flood hazard reduction provisions of the city, state and federal regulations.

Restriction of Fill in the Floodplain. This measure ensures that there are restrictions to new filling of the floodplain by requiring that fill be mitigated by removal of equal volume of fill at the site or elsewhere in the floodplain or floodway. Cut and fill balances should be retained within the project site whenever possible. In the Comprehensive Flood Hazard Management Plan for Lewis County, details adding the requirement for compensatory storage to the Flood Damage Prevention Ordinance is a method for reducing the effects of filling in the flood fringe. Whenever fill material is added to the flood fringe, the area that the fill occupies is removed from

the potential flood storage area. Under compensatory storage requirements, and individual placing fill in the flood fringe must excavate an area of equivalent volume to eliminate the effects of the fill material on the flood storage.

Lewis County – The standard is that fill materials must be obtained from the site to the extent practicable. If the fill cannot be so obtained from the same site, it must be obtained as practical from the flood hazard area. In addition, the fill must have a beneficial use and be deemed necessary.

City of Centralia – Filling in the flood fringe landward of the floodway is allowed. All construction must be consistent with the model National Flood Insurance Regulations.

City of Chehalis – As a part of the Shoreline Management Plan, there is a restriction of a one-to-one fill and cut within the floodplain area.

Stormwater Management. This measure relates to increasing the detention from a 25-year design storm to meet the Washington State Department of Ecology (WDOE) stormwater management criteria. The local communities are evaluating these new criteria and determining whether they can meet the new WDOE regulation. Better management of stormwater will assist in reduction of flooding in the project area. The Corps will continue to evaluate the timing of stormwater versus the watershed runoff, to determine an optimum management of stormwater release during a flood event. The Corps will continue to assess the development of local stormwater plans.

Best Management Practices. The Corps will ensure that all BMP will be implemented to ensure protection to the environment during construction. For example, fueling of equipment will be conducted at a minimum of 100 feet from any body of water. Oil spills will be cleaned up immediately and the material properly disposed of. There will be many more BMPs that will be part of the specifications package as the project develops through the various stages.

The preferred alternative also follows Criteria 9 and 10 respectively, incorporating fish and wildlife habitat creation, enhancement, and restoration while complying with all federal, state, and local regulations. Numerous restoration sites have been identified by the Centralia-Chehalis environmental working group to comply with Criterion 9. All Corps projects must insure that all federal, state and local regulations that apply will be met. This meets Criterion 10 mentioned above.

2.6 POTENTIAL RESTORATION SITES

Incorporating appropriate fish and wildlife habitat restoration measures to the maximum extent practicable is one of the defining criteria of the project and consistent with the Corps mission for environmental sustainability. Habitat restoration would provide benefits over and above the benefits of any mitigation actions undertaken to offset the potential environmental impacts of a project. Mitigation actions proposed to offset the environmental impacts of the preferred alternative are described in Chapter 4.

Potential habitat restoration sites were identified during the reevaluation study. The restoration measures will be evaluated further during the design phase to be incorporated into the preferred alternative for the purpose of achieving an environmentally sustainable project.

Each of the potential restoration measures is conceptual at this point and may be altered, eliminated, or combined with others as more detailed design studies are conducted. In addition, consultation with local tribes and resource agencies will also be conducted prior to implementation of any of the potential restoration measures. The descriptions below are intended to provide a conceptual idea of what each restoration measure would involve, the target habitat conditions expected to be achieved, and the actions required to achieve those targets.

The locations for proposed restoration measures were selected based on habitat needs as reported in existing literature and studies, and opportunity for implementation. The following list is not intended to include all potential restoration measures that could be undertaken in the upper Chehalis Basin.

As discussed above, additional analyses and consultation with resource agencies would need to be completed prior to implementing any of the potential restoration measures.

MF Newaukum Revegetation, Tauscher Road. This site is located at approximately RM 1 on the Middle Fork Newaukum River. The land is in timber production, and a riparian buffer comprising numerous 30-year old conifers has been left along the stream. The buffer width is 50 to 100 feet in most areas and canopy closure over the stream is 80 to 100 percent. This riparian zone appears to extend for most of the length of the Middle Fork. Downstream of Tauscher Road, there is a riparian corridor approximately 500 feet wide. The water was turbid when observed in March 2001, likely from road runoff or timber harvested areas upstream.

This site should be protected to prevent future degradation. Restoration measures at this site would be minimal but would provide further enhancement to an existing area of good riparian habitat and protection from adjacent and upstream timber harvest. Measures would include under plantings of conifers and native shrubs to ensure succession to coniferous forest, as well as placement of large woody debris in the channel to provide more aquatic habitat diversity and trap sediments. Some removal of blackberries may be necessary. Geomorphically, there are no major issues with this site. Additional vegetation and large woody debris would further stabilize the stream channel and banks.

NF Newaukum Revegetation, Tauscher Road. The North Fork at Tauscher Road has a long pool with riffles upstream and downstream. The riparian zone is 25 to 50 feet wide, but sparse, with an understory of reed canary grass. Alder, cottonwood, and some sparse Douglas fir are the dominant trees, and most are less than 50 years in age. The water was visibly turbid when the site was visited in 2001, even though precipitation had not occurred recently. The pool had accumulations of silt, while the riffles were of medium gravel, with 10 to 15 percent fines. No large woody debris was observed in this reach. The property on the right bank downstream of the bridge has a steelhead pond. Riprap is along the banks adjacent to the bridge and downstream at the next bend. The site is approximately 5 acres.

Restoration measures at this site would include under planting of riparian species for a 50-foot-wide buffer including conifers and shrubs, removal of invasive vegetation, and placement of large woody debris in the channel. The banks are low, so no bank sloping would be necessary. Geomorphically, this should stabilize the channel and banks.

Mainstem Oxbow Reconnections. This site includes four separate oxbows in the mainstem floodplain between RM 68 and RM 73 along the Chehalis River. Each oxbow is isolated from the river except during flows greater than a 5-year event. Two of the oxbows are located within the Riverside Golf Course, one is designated as Horseshoe Lake, and the fourth is an unnamed large oxbow northwest of Airport Road. Currently, the riparian zone around the oxbows ranges from 0 to less than 100 feet wide, although the typical width is less than 25 feet, particularly on the golf course oxbows. Riparian vegetation consists of young cottonwood, alder, Oregon ash, and some willows. Reed canary grass and blackberries are also common. Yellow pond lilies and *Polygonum* species are common aquatic plants in the oxbows. Waterfowl such as geese and ducks utilize these oxbows at least seasonally. The total combined site area is approximately 38 acres.

Restoration measures would include excavation of channels to connect the upstream and downstream ends of the oxbows to the river for most winter and spring flows (November-June). In addition, riparian zones would be restored or increased in size around the perimeters and inlet/outlet channel banks. Within the golf course, riparian zones could likely be only 50 feet in width or less. A minimum 100-foot-wide riparian zone is proposed, however, for both Horseshoe Lake and the airport oxbow. Detailed design would require additional hydraulic and sediment transport analyses to confirm sediment transport issues and develop channel geometries and profiles.

Mainstem Riparian Revegetation, RM 66-80. This large-scale restoration project addresses the Centralia reach of the Chehalis River. In this reach, the riparian vegetation is the most denuded and land uses are of the highest impact. The riparian zone ranges from nonexistent to extremely narrow. In some areas, no buffer separates livestock and agricultural runoff from the river. The riverbanks are severely eroding in many locations. This reach also has a very low gradient and the channel has incised. Little to no large woody debris is present. This reach is on the 303(d) list of impaired water bodies for high temperatures, low dissolved oxygen, high levels of fecal coliform, and increased nutrients.

This restoration measure comprises a large-scale riparian revegetation effort. Banks would be sloped back to a 2:1 or flatter ratios in areas on the inside of meander bends or wherever feasible. A minimum 100-foot-wide zone would be revegetated with native riparian species. In areas where native trees already occur, they would be left in place to the maximum extent practicable and supplemented with under plantings of conifers and shrubs. Invasive vegetation would be removed, including blackberries and reed canary grass. Large woody debris would be keyed into the banks where bank sloping is proposed to add increased stability and improve aquatic habitat. The total riparian restoration area is approximately 321 acres.

Skookumchuck Revegetation, Chehalis Confluence. This site is at the confluence of the Skookumchuck River with the Chehalis River. The right bank of both rivers is within Fort Borst Park. The left bank of the Skookumchuck is also publicly owned. The left bank of the Chehalis is a privately owned agricultural area.

Currently, the Chehalis River is very incised through this reach and the left bank overtops at approximately a 5-year event. In the park and other public land, there is an extensive riparian zone (more than 100 feet wide) dominated by cottonwoods of about 50 years in age as well as alder, ash, and willows. There is significant coverage of reed canary grass in the understory. On

the left bank of the Chehalis, there are only sparse, young (less than 20 years old) trees on the bank, which are limited to the top of the slope. The south bank of the mainstem Chehalis, both upstream and downstream of the confluence, has minimal riparian vegetation and high eroding banks. Riprap is present in some locations. The Skookumchuck enters the Chehalis at an angle of approximately 90° over a gravel delta and is a popular fishing area. The site is approximately 15 acres.

Restoration measures at this site would include sloping the south bank of the Chehalis back to a 2:1 or lower ratio and planting a 200-foot-wide riparian zone for a distance of approximately 3,500 feet.

Skookumchuck Revegetation, RM 12. This site extends from approximately RM 12 to RM 13 on the Skookumchuck River, upstream of Bucoda. The river runs through a moderately wide valley in this reach and is confined to the south side of the valley. The left bank has moderate shading of second-growth deciduous trees. The right bank (north side) is bordered entirely by agricultural and pasture lands. The riparian vegetation present on the right bank is composed almost entirely of reed canary grass and is extremely narrow. There are no fish passage barriers, but habitat and cover are very limited. The site is approximately 23 acres.

Restoration measures at this site would include placement of large woody debris in the channel and planting a 100-foot-wide riparian buffer along the right bank. Under planting of conifers may be beneficial on the left bank. Removal of invasive plant species would also be conducted.

SF Chehalis Revegetation and Wetland Creation, RM 0-5. The lower miles of the South Fork Chehalis River lack suitable quantity and quality of riparian vegetation. The typical width varies between 10 and 25 feet and it comprises mostly young deciduous trees with only a few conifers. The surrounding lands are agricultural and rural residential with timber harvest on the uplands. Although this reach is not listed on the 303(d) list, it is known to experience high water temperatures and elevated levels of fecal coliform due to uncontrolled runoff of agricultural wastes. Channel migration has been reduced and large woody debris is infrequent and recruitment is very low. Glide habitat dominates the aquatic habitat, but pools and riffles are present in moderate rates and a limited number of side channels exist.

Restoration measures include a large-scale riparian revegetation effort along with moderate wetland creation. Banks would be sloped back to a 2:1 or flatter ratio in areas on the inside of meander bends or wherever feasible and the floodplain would be excavated down to allow

seasonal inundation in some areas. A 50- to 100-foot-wide corridor would be revegetated with native riparian species and exotic species would be removed from that area. In areas where native trees already occur, they would be supplemented with under plantings of conifers and shrubs. Clumps of large woody debris would be keyed into the banks where sloping actions are proposed to enhance stability and increase aquatic habitat diversity. Livestock fencing would be implemented as needed. The bank sloping aspect should be evaluated to ensure it does not cause channel migration in areas of development. It appears that minimal channel migration is occurring in this reach, but more detailed hydraulic and geotechnical analysis would need to be conducted to evaluate the stability of the sloped banks and wetlands.

SF Chehalis Reconnections and Wetland Creation, SF and Mainstem Chehalis Confluence. This site is located at the confluence of the South Fork and the mainstem Chehalis rivers. Between these rivers, a large fallow pasture exists, which is bisected by SR-6 and the railroad tracks. This area floods currently at about a 2- to 5-year event and would benefit from a significantly improved floodplain plant community. The mainstem left bank is in early successional stages of reforestation with young willows and alders and is frequently flooded. Coarse gravel bars are present in large amounts in this area and some channel migration is occurring. A moderate amount of large woody debris is present in the channel.

Restoration actions at this site would include revegetation of the riparian areas on the left bank of the mainstem and between the mainstem and South Fork. Additionally, two 2-acre wetland areas would be excavated, the first on the inside of the meander bend of the mainstem, and the second between the railroad and SR-6 on the left bank of the South Fork. Wetlands would increase channel diversity and off-channel habitat, and would be designed to prevent fish stranding. Riparian zone widths would be a minimum of 100 feet. In addition, non-native plant species would be removed and large woody debris placement would occur throughout the connection channels and wetlands.

Restoration measures at this site would also include excavation of a meandering low flow channel through the wet meadow, excavation of wetland areas adjacent to the channel as needed for annual inundation, removal of reed canary grass and other invasive species, placement of large woody debris in the channel, and replanting approximately 28 acres with riparian and wetland species. Additional livestock fencing would be constructed where needed.

Newaukum Revegetation and Wetland Creation, at Chehalis Confluence. At this site, the left bank of the Chehalis mainstem is vegetated with mature cottonwoods at the top of bank. Banks

along the lower Newaukum and right bank of Chehalis have minimal riparian vegetation and are experiencing some significant erosion, particularly just downstream of the railroad bridge on the Newaukum. A fallow pasture area is located at the confluence on the left bank of the Newaukum and right bank of Chehalis. The Newaukum carries a moderate amount of small/medium gravel into the Chehalis. The lower reach is incised, probably to meet the highly incised Chehalis River channel. No large woody debris was observed. The total site area is 8 acres.

Restoration measures at this site would include creation of a 2-acre forested wetland and revegetation of both the mainstem and Newaukum banks both upstream and downstream of the confluence. The forested wetland would be created by a 3- to 4-foot depth excavation of the fallow pasture area to receive inundation from approximately the 2-year event. Revegetating the right bank of the Chehalis downstream of the confluence would be assisted by sloping the bank to a 2:1 or lower ratio. Riparian buffers or under plantings in all areas would be a minimum of 100 feet wide. Clumps of large woody debris would be placed along the outside bend to prevent erosion and increase aquatic habitat.

Geomorphically, the floodplain excavation should not be lower than the elevation of the 1.5-year flow in order to keep the mainstem from migrating into the Newaukum and bridges. Sloping the banks may provide more stability in an erosional area, but some protection other than vegetation, such as fabric or large woody debris, may be required.

Realignment of the Newaukum channel to reduce erosion specifically under the railroad and Newaukum Avenue bridges would not be advised because it would shorten the channel and increase velocities.

Newaukum Reconnection and Wetland Creation, Stan Hedwall Park. At this site, the Newaukum River flows along the south side of Stan Hedwall Park, which has a low-lying, grassy area. A park road elevated on a berm isolates this low-lying area from the river except during flood events. A culvert is present under the road that appears to receive water during high flows (probably greater than the 5-year event). The riparian zone varies from 50 to 100 feet wide with sparse mature cottonwoods and some sparse, younger alders. Reed canary grass dominates both riverbanks. The Newaukum is moderately incised in this reach, but the substrate is medium gravel with approximately 10 percent fines. An island occurs in the river at the upstream end of the park, dominated by willows and reed canary grass. The lesser channel around the island is very silty. Soils on banks are clays and silts. Existing culverts in this area appear to be used to drain the low-lying areas after flooding.

Restoration measures at this site would include the conversion of the low-lying zone into a seasonally inundated wetland and revegetation of the upstream and downstream banks of the Newaukum. The park road would both be notched and bridged to allow flow-through or be removed and reconstructed farther north to allow wetland creation. Under either scenario, the existing berm would be partly left in place, but open channels would be excavated through the berm to connect the wetland to the river. A riparian buffer 100 feet in width would be established on both banks for approximately 1,200 linear feet. Clumps of large woody debris would be placed within the wetlands and Newaukum River to stabilize banks and increase aquatic and terrestrial habitat diversity. The existing old meander immediately upstream of the road would be excavated as needed to allow continuous connections during winter and spring flows (November-June) and additional riparian restoration would be done along both banks of the old channel, including the removal of non-native species.

Newaukum Revegetation, RM 0-10. The lower Newaukum River downstream of the North Fork and South Fork confluence is completely surrounded by agricultural lands and rural residential development. Numerous roads and bridges cross the river and the riparian zone is typically very narrow to non-existent. The lower portion of the river is listed on the 303(d) list for high temperature and elevated levels of fecal coliform bacteria. Livestock have access to the river in many locations. The upper watershed is mixed between agricultural uses and timber harvest. Erosion of fine sediments from the banks and from upstream roads and landslides are also a problem. Large woody debris is present in moderate amounts, but there is a lack of recruitment, and amounts will probably decline over time in the absence of riparian revegetation. The aquatic habitat is dominated by glides, although riffles and pools are present in moderate amounts. The riparian revegetation area is 114 acres.

Restoration measures in this reach would include a large-scale riparian revegetation effort. Banks would be sloped back to a 2:1 or lower ratio on the inside of meander bends or wherever feasible. A minimum 50- to 100-foot-wide buffer would be revegetated with native riparian species. In areas where native trees already occur, the area would be supplemented with underplantings of conifers and shrubs. Invasive vegetation would be removed. Large woody debris would be keyed into the banks where sloping actions are proposed. Fencing to prevent livestock access would occur as needed.

NF/SF Newaukum Confluence Connections and Wetland Creation. This site is located adjacent to the North Fork/South Fork Newaukum River confluence. The North Fork from the North Fork

Road down to the confluence has only a sparse riparian zone (young alder and willows), but is primarily dominated by reed canary grass. The floodplain area on the right bank appears to be fallow, although it may be used for pasture later in the season. The South Fork has a moderately good riparian zone as does the mainstem left bank downstream of the confluence. The water in the North Fork was turbid during the site visit in 2001 and the channel is incising to some extent. Substrate is small/medium gravel, but highly embedded. No large woody debris was observed. The site is approximately 31 acres.

Restoration measures at this site would include some minor excavation of the floodplain to ensure annual inundation, placement of large woody debris in the channel of the North Fork, South Fork and mainstem, and replanting riparian vegetation in the floodplain area and a 50 to 100-foot-wide buffer along the North Fork. Geomorphically, there are no issues with this project. Vegetation and large woody debris would stabilize the stream channel and banks.

Salzer Creek Revegetation and Wetland Creation, Chehalis Confluence. Salzer Creek runs through a narrow ditch lined primarily with reed canary grass with only a few sparse, immature willows, young alders and ash. The lower end is in the process of incising to meet the highly incised Chehalis River. Salzer Creek has severely degraded water quality and is on the 303(d) list for high temperatures and elevated levels of fecal coliform. Agriculture is the dominant land use and livestock access to the creek occurs frequently. An oxbow of the Chehalis River is located approximately 300 feet to the south of Salzer Creek at this site and has year-round water. The oxbow is currently connected to the mainstem during 2-year events via a lower-lying swale (observed to be connected in winter 2001). The restoration area is 8 acres.

Restoration measures at this site would include excavating an upstream and downstream channel at both ends of the oxbow, which would provide a connection to Salzer Creek during normal winter/spring flows (November-June). Invasive vegetation would be removed, a 100-foot-wide riparian buffer would be established around the new channels and wetlands, and large woody debris would be placed in Salzer Creek, the mainstem, and the oxbow. The buffer would extend from the mainstem, around the wetlands and oxbow to Airport Road, and up Salzer Creek to Airport Road. Small upland areas could be incorporated into the wetland to increase terrestrial habitat diversity.

Salzer Creek Reconnection and Wetland Creation, Frozen Foods Site. At RM 0.25 on Salzer Creek, just upstream of the railroad mainline crossing, the creek has been realigned in a series of

90° bends to run between two agricultural fields. The north side property (right bank) is used for disposal of frozen food liquid waste. The riparian zone on the upstream half of the property is approximately 50 feet wide, but the downstream half of the property has very sparse vegetation, primarily a few willows. Salzer Creek has been realigned to the property boundary and is essentially in a ditch. The creek approaches the railroad bridge at a sharp angle and may be causing erosion at the bridge. The water quality is very poor; high temperatures, turbidity, and fecal coliform are concerns.

Restoration measures at this site would include realignment of the creek through what appears to be the old meandering channel swale, excavation of the site to create a wetland and upland mosaic, placement of large woody debris in the channel and floodplain, removal of invasive vegetation, and revegetation of approximately 4 acres with wetland and riparian species. Although these measures result in a slight shortening of the creek length, the proposed location is more geomorphically stable and is likely the historic alignment. It will also eliminate a severe 90° turn occurring immediately upstream of the railroad bridge and reduce the need for future placement of riprap or other bank protection.

Salzer Creek Revegetation and Wetland Creation, RM 3.1. This site is located on Salzer Creek at approximately RM 3.1, upstream of and immediately adjacent to Centralia-Alpha Road, which crosses the creek and floodplain. Salzer Creek flows through pasture both upstream and downstream of Centralia-Alpha Road and has a very narrow or non-existent riparian zone for some distance (more than 1 mile in both directions). A mobile home park with about 50 to 100 homes is located immediately downstream of the road in the floodplain. The dominant streamside vegetation is reed canary grass with a few sparse alders and Oregon ash. The creek is contained within an apparent ditch and the water was turbid and foamy, which typically indicate the presence of fine sediment runoff, nutrients and bacteria. Salzer Creek is listed on the 303(d) list for bacteria and high temperatures. There is a fallow field adjacent to the creek on its left bank upstream of the road. No cattle were observed in the creek at the site, but they were present in the creek approximately 1.5 miles upstream. Approximately 600 to 800 feet upstream of the road crossing, Salzer Creek enters some seasonal wetlands and no defined channel exists within the wetland. It is assumed that fish passage is not possible above this point. The floodplain currently receives overbank flows at a 2- to 5-year event. The site is approximately 28 acres.

Restoration measures at this site would include excavating a meandering low flow channel through the wet meadow, excavation of wetland areas adjacent to the channel as needed for annual inundation, removal of reed canary grass and other invasive species, placement of large

woody debris in the channel, and replanting approximately 28 acres with riparian and wetland species. The area would be fenced off from livestock as needed.

Salzer Creek Revegetation and Wetland Creation, RM 4.5. This site is located between the Proffitt Road crossings on Salzer Creek at approximately RM 4.5. The creek flow is ditched and runs through pastures with essentially no riparian buffer. Reed canary grass dominates the creek banks along the entire reach. Livestock were observed adjacent to and in the creek in the vicinity. Water quality was very poor based on visual observations. The site is approximately 17 acres.

Restoration measures at this site would include excavation of a meandering channel, excavation of a wetland complex adjacent to the channel, removal of reed canary grass and other invasive species, placement of large woody debris in the channel, and replanting of a 100-foot-wide riparian zone on each bank. The area would be fenced off from livestock as needed. Figure 2.6 shows the area of proposed mitigation and some of the restoration sites.

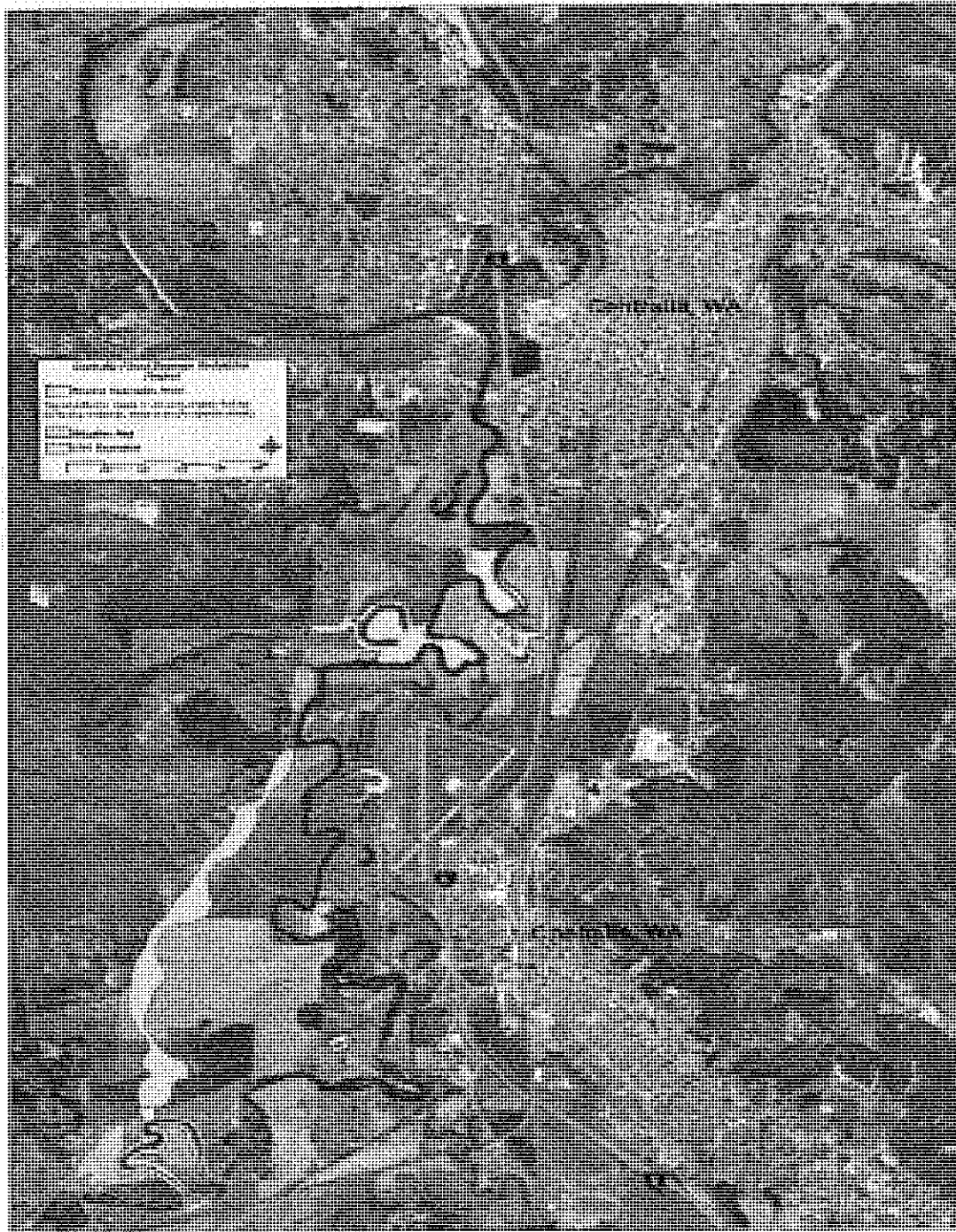


Figure 2.6. Mitigation area and some restoration areas.

3. AFFECTED ENVIRONMENT

3.1 HYDROLOGY AND HYDRAULICS

3.1.1 Introduction

The Chehalis River is approximately 125 miles long, originating in the Willapa and Doty hills southeast of Aberdeen and flowing northeast and then northwest before emptying into Grays Harbor. In addition to the Willapa and Doty hills, the basin uplands include the western flank of the Cascade Mountains and the southern Olympic Mountains. The entire Chehalis drainage basin has an area of approximately 2,114 square miles, with 1,294 square miles draining above the Chehalis River at Porter gage and 895 square miles draining above the Chehalis River at Grand Mound gage.

From its headwaters in the extreme southwestern corner of the basin, the Chehalis River flows east for about 25 miles to its confluence with the Newaukum River at Chehalis. From Chehalis, the river flows north to its confluence with the Skookumchuck River at Centralia. The Chehalis then flows generally north and west for about 50 miles to its mouth at Grays Harbor on the Washington coast.

The Chehalis River valley is characterized by a broad, well-developed floodplain and low terraces surrounded by highly dissected uplands of low to moderate relief. The valley bottom lies at an elevation of approximately 150 feet, and upland elevations average 300 to 600 feet. The higher elevations in the basin range from about 1,000 feet in the lowland hills to 2,658 feet at Capital Peak in the southern Olympic Mountains, to 3,110 feet in the Boistfort Hills in the southern portion of the basin, and 3,800 feet in the foothills of the Cascade Mountains east of Chehalis and Centralia.

3.1.2 Upper Chehalis River Basin

The slope of the upper Chehalis River is steep from its source to Chehalis, falling an average of 16 feet per mile. The slope flattens to about 3 feet per mile in the valley surrounding Chehalis

and Centralia, where the river occupies a meandering channel. Downstream from Chehalis, the average width of the floodplain is 1.5 to 2 miles. The floodplain in this region shows little relief, which has resulted in a sinuous river course with numerous oxbow lakes and abandoned channels.

The upper Chehalis River has three main tributaries: the Skookumchuck River, Newaukum River, and South Fork Chehalis River.

3.1.2.1 Skookumchuck River

The Skookumchuck River originates in the Gifford Pinchot National Forest northeast of Centralia. It drains an area of approximately 181 square miles and flows into the Chehalis River at RM 67. The Skookumchuck River basin ranges in elevation from 160 feet at the mouth to 3,800 feet at the headwaters, with approximately two-thirds of the basin located below elevation 1,000 feet.

The basin has three distinctly different hydrologic regions, all of which are of approximately equal size. The region above Bloody Run Creek has a drainage area of 66 square miles, and is a steep, forested, mountainous area with elevations generally above 1,000 feet. In this region, the river flows through a steep-sided, narrow floodplain and drains into the reservoir behind Skookumchuck Dam. The region from Bloody Run Creek to the mouth of the Skookumchuck (excluding the Hanaford Creek drainage) has a drainage area of 56 square miles and contains a relatively broad floodplain bordered by steep-sided ridges. The slope of the river to the Town of Bucoda is steep, falling an average of 19 feet per mile; below Bucoda, the slope flattens to about 5 feet per mile. Hanaford Creek, the largest tributary, has a drainage area of 59 square miles and enters the Skookumchuck River at RM 3.8.

The Skookumchuck River is regulated by the Skookumchuck Dam, which is owned and operated by Scottish Power (PacifiCorp). The dam is located at RM 22, just upstream from Bloody Run Creek. The dam, which was completed in 1971, is an earth-fill structure approximately 190 feet high with a crest elevation of 497 feet. The primary purpose of the dam currently is to supply water for the Centralia coal-fired power plant, which has authority to divert up to 54 cfs of water from the Skookumchuck River. A portion of the water supplies a Washington Department of Fish and Wildlife (WDFW) fish rearing facility located approximately 0.5 mile below the dam.

Outflow from the reservoir is either over the spillway crest at elevation 477 feet or through the outlet works with intake gates at elevations 449, 420, and 378 feet. The discharge capacity is approximately 220 cfs when the pool elevation is at the spillway invert. Because of the limited outlet capacity, the reservoir typically fills early in the flood season and subsequent flood flows are passed over the spillway, which has a capacity of 28,000 cfs. The normal active storage capacity of the reservoir is 38,700 ac-ft between elevations 400 feet (normal minimum operating pool) and 492 feet (maximum operating pool). Additional usable storage of 3,170 acre-feet is available between elevations 378 feet (invert of the lowest intake) and 400 feet. Dead storage is approximately 1,420 ac-ft between elevations 340 and 378 feet. At the normal minimum operating pool elevation, the reservoir extends approximately 3 miles up the valley and covers an area of approximately 640 acres.

3.1.2.2 Newaukum River

The Newaukum River drains 175 square miles of lowland and foothills southeast of Chehalis and enters the Chehalis River at RM 75. Elevations in the Newaukum River basin range from 180 feet at the confluence to a little over 3,000 feet in the upper basin.

The Newaukum River is composed of the North, Middle, and South forks. Upstream portions of the North and Middle forks have slopes of 83 feet per mile; the South Fork has a slope of 188 feet per mile above the town of Onalaska. The average channel slope for the entire Newaukum River basin is 35 feet per mile. The Newaukum River has no dams and is free flowing from its head to the confluence with the Chehalis River.

3.1.2.3 South Fork Chehalis River

The South Fork Chehalis drains 130 square miles and joins the mainstem Chehalis River at RM 86. The lower South Fork Chehalis Basin (up to RM 9) consists of a broad, flat valley with small streams draining the hills on either side. From RM 9 to RM 15, the valley narrows from 1.5 miles to 0.75 mile in width.

3.1.2.4 Other Tributaries

China Creek is a relatively small, short stream that flows through Centralia to the Chehalis River. Its watershed encompasses approximately 6 square miles, draining an area that ranges in elevation from 180 feet to 570 feet. Much of the watershed is moderately steep. Most of the channel consists of pipes and culverts where the stream runs through Centralia.

Salzer Creek flows into the Chehalis River from the east, just south of the Centralia city limits. Salzer Creek originates in the low-lying hills east of Centralia and Chehalis and drains an area of 24.5 square miles. The watershed has a maximum elevation of approximately 800 feet.

Dillenbaugh Creek also enters the Chehalis River from the east, at Centralia. It originates in the steep foothills southeast of Chehalis, and drains an area of approximately 15 square miles. The gradient of Dillenbaugh Creek in its upper reaches is steep, falling at about 70 feet per mile. After the stream flows out onto the Newaukum River floodplain, the gradient drops as Dillenbaugh Creek parallels the Newaukum and Chehalis rivers for nearly 3 miles before entering the Chehalis River. The lower reaches of Dillenbaugh Creek collect much of the storm drainage from the City of Chehalis.

3.1.3 Climate

The study area has a predominantly marine climate characterized by mild temperatures both summer and winter. Extreme temperatures are unusual for the area because prevailing westerly winds bring maritime air over the basin and provide a moderating influence throughout the year.

During the spring and summer, high-pressure centers predominate over the northeastern Pacific, sending a northwesterly flow of dry, warm air over the basin. The dry season extends from late spring to midsummer, with precipitation generally limited to a few light showers during this period. Average summer temperatures are in the 50s and 60s (°F), although hot, dry easterly winds that occasionally cross the Cascade Mountains can raise daytime temperatures into the 90s.

In fall and winter, strong winds and heavy precipitation occur throughout the basin. Storms are frequent and may continue for several days. Successive secondary fronts with variable rainfall may move onshore daily or more often. Heavy rainfall frequently is produced by these storms when warm, saturated air rises over the coastal range and west slopes of the Cascades.

The Centralia-Chehalis area receives moderate to heavy rainfall when storms move onshore and through the basin. Normal annual precipitation at Centralia is 41.6 inches, with 77 percent falling during the period October through March.

Snowfall in the region is generally low. The average annual snowfall is approximately 9 inches, with a recorded extreme maximum of 45 inches. Most of the snowfall occurs in January, with an average of about 4.5 inches.

Precipitation totals at Centralia for the ten largest one-day, two-day, and three-day storms of record are shown in Table 3.1-1.

Table 3.1-1: Precipitation Totals Ranked for 10 Largest Storms at Centralia

One-Day Storm		Two-Day Storm		Three-Day Storm	
Month & Year	Total Precip. (in.)	Month & Year	Total Precip. (in.)	Month & Year	Total Precip. (in.)
Jan. 1990	4.13	Nov. 1986	6.09	Nov. 1986	6.49
Nov. 1990	3.96	Dec. 1933	5.10	Feb. 1996	6.40
Dec. 1933	3.95	Feb. 1996	5.02	Jan. 1990	5.87
Nov. 1986	3.22	Jan. 1990	4.96	Dec. 1933	5.49
Oct. 1942	3.22	Nov. 1990	4.82	Dec. 1937	5.41
Feb. 1996	3.34	Nov. 1932	4.02	Nov. 1990	5.25
Feb. 1951	3.15	Feb. 1951	3.84	Nov. 1932	4.47
Nov. 1932	3.07	Oct. 1942	3.59	Feb. 1951	4.22
Dec. 1937	2.10	Dec. 1937	3.58	Oct. 1942	4.20
Jan. 1972	1.95	Jan. 1972	3.13	Jan. 1972	3.64

Source: USACE, 1997

3.1.4 Stream Flow Characteristics

3.1.4.1 Stream Gage Stations

Table 3.1-2 summarizes information for stream gages maintained by the U.S. Geological Survey (USGS) in the upper Chehalis River basin. In addition to the USGS stream gage stations, the National Weather Service (NWS) maintains wire weight stage gages at the Mellen Street and Pearl Street bridges. These gages are used by NWS for flood forecasting and warning.

Table 3.1-2: USGS Stream Gages

Station Name	Station ID	Drainage Area (Sq. Mi.)	River Mile	Record Period
Chehalis River near Doty	12020000	113	101.8	1939-Present
Elk Creek near Doty	12020500	46.7	2.5	1942-1970
S.F. Chehalis River near Boistfort	12020900	44.9	8.0	1965-1980
S.F. Chehalis River at Boistfort	12021000	48	6.0	1942-1965
Chehalis River near Chehalis	12023500	434	77.5	1929-1931
M.F. Newaukum River near Onalaska	12024000	42.4	8.0	1944-1971
N.F. Newaukum River near Forest	12024500	31.5	6.5	1960-1966
Newaukum River near Chehalis	12025000	155	4.1	1929-1931 1942-Present
Salzer Creek near Centralia	12025300	12.6	3.9	1968-1971
Skookumchuck River near Vail	12025700	40	28.8	1967-Present
Skookumchuck River near Centralia	12026000	61.7	21.0	1929-1969
Skookumchuck River below Bloody Run Creek	12026150	65.9	20.7	1969-Present
Skookumchuck River near Bucoda	12026400	112	6.4	1967-Present
Lincoln Creek near Rochester	12027000	19.3	9.0	1942-1950
Chehalis River near Grand Mound	12027500	895	59.9	1928-Present

Source: U.S. Geological Survey

3.1.4.2 Runoff

Stream flow generated within the Chehalis River basin originates primarily from rainfall, although snowmelt occasionally augments runoff in the highest elevation reaches. Stream flows in the basin show seasonal variation characterized by sharp rises of short duration from October through March, corresponding to the period of heaviest rainfall. After March, flows tend to decline gradually to a relatively stable base flow, which is maintained from July into October. The average annual discharge of the Chehalis River at its mouth and at the USGS stream gage near Grand Mound is estimated to be 6.4 million ac-ft and 2.0 million ac-ft, respectively.

3.1.4.3 Historical Floods

Major flooding occurs during the wet season, usually from November through February. Storms that cover the entire basin can cause widespread flooding. Flooding may also be localized; for

example, storms centered over the Willapa Hills can cause flooding in the upper Chehalis River, whereas those centered over the Black Hills and Cascade foothills may result in flooding in the Skookumchuck and Newaukum River Basins.

The largest flood discharge on the Chehalis River in the Centralia-Chehalis area recorded in the last 70 years occurred in February 1996. Table 3.1-3 summarizes the largest floods of record in the basin since 1971.

Table 3.1-3: Ten Largest Floods on the Chehalis, Skookumchuck, and Newaukum Rivers since 1971

Gage	Chehalis River near Grand Mound			Skookumchuck River near Bucoda			Newaukum River near Chehalis		
Date	Stage (ft.)	Disch. (cfs)	Rank	Stage (ft.)	Disch. (cfs)	Rank	Stage (ft.)	Disch. (cfs)	Rank
Feb. '96	20.04	74,900	1	17.87	9,370	1	13.34	13,800	1
Apr. '91	17.66	42,800	7	16.82	7,860	5	12.07	9,210	7
Nov. '90	18.12	48,00	5	17.23	8,400	3	12.73	10,300	4
Jan. '90	19.34	68,700	2	17.33	8,540	2	12.75	10,400	3
Nov. '86	18.41	51,600	3	15.01	5,770	10	12.76	10,700	2
Dec. '77	16.79	36,500	10	16.18	7,170	6	12.49	10,300	5
Dec. '75	17.73	44,800	6	15.42	6,110	8	10.85	8,020	10
Jan. '74	16.88	37,400	9	15.30	5,950	9	11.17	8,440	8
Jan. '72	18.21	49,200	4	16.82	8,190	4	12.12	9,770	6
Jan. '71	17.29	40,800	8	15.82	6,630	7	11.99	8,390	9

Source: USACE, 1997

Brief descriptions of the three most recent, largest floods in the Centralia-Chehalis area (the January 1990, November 1990, and February 1996 floods) are provided below.

January 1990 Flood

The January 1990 flood was primarily the result of a series of back-to-back storms accompanied by heavy rainfall over the 8-day period 3-10 January (Hubbard 1991). The storm system was quite complex and included high winds and strong surges of precipitation. During the 8-day period, 8 inches of rain were recorded at the Centralia climatological station maintained by NWS. This represents 19 percent of the average total yearly precipitation recorded at that station. The most intense precipitation in the basin occurred near the headwaters of the Skookumchuck and Newaukum rivers.

The surges in precipitation resulted in more than one flood peak in many of the basin's streams, and streams did not return to base flow between storm surges. The early precipitation saturated soils in the basin and significantly increased the flooding potential when the heaviest rains arrived on 9 January. Peaks of record, up to this event, were recorded at the Chehalis River gaging stations near Doty, near Grand Mound, and at Porter. These flood peaks were estimated at the time as the 100-year flood.

November 1990 Flood

Above average precipitation in October and early November resulted in saturated soils that contributed to the flooding potential when a major storm arrived during the period 21-25 November (Hubbard 1994). Wet weather accompanied by cool temperatures in the first part of November lowered snow levels to approximately the 1,000-foot elevation. The Cascade foothills received 6 inches of snow at elevations of 1,000 to 2,000 feet, 12 inches at 2,000 to 3,000 feet, and 12 to 18 inches at 3,000 to 4,000 feet. As a warm front moved through western Washington on 21 November, the snow changed to rain, and rising temperatures caused melting of snow up to elevations of 5,500 feet. Over the next three days, intense rain fell on drainages where streams were beginning to swell from snowmelt, and severe flooding followed. Floodwaters receded when a cold front that moved into the area on 26 November lowered freezing levels and diminished precipitation. These flood peaks were estimated at the time as the 75- to 100-year event.

February 1996 Flood

To date, the February 1996 flood is the flood of record on all the major drainages in the Chehalis River basin. By 5 February, soils throughout the basin were at or near saturation from above average precipitation that had fallen in the preceding weeks (USACE 1996). A recent cold snap had caused snow to fall as low as the 500-foot elevation. Warm, moist subtropical air being transported from the Pacific Ocean caused freezing levels to rise above 8,000 feet and resulted in warm, moist rains on the snow pack in the foothills.

A strong, polar jet stream extending into the central and western Pacific Ocean sustained and strengthened storms as they moved into the area off the eastern Pacific. An atmospheric blocking pattern caused stationary major troughs and ridges around the Northern Hemisphere. The Pacific Northwest was situated between a trough to the west and a ridge to the east, creating a condition

for weather systems to be at maximum strength when they reached the area. The atmosphere remained in this general pattern for at least 96 hours, during which large amounts of rain fell and quantities of water were released from the snow pack as stream flow. These flood peaks were estimated at the time as another 100-year flood.

3.2 RIVER GEOMORPHOLOGY

3.2.1 Physiography

The Chehalis River Basin is unique in western Washington. It has the largest drainage area of all rivers on the west slopes of the Cascade Range. In addition, it does not adjoin the crest of the range, and contains very little high elevation terrain. Hence, normal snowmelt plays only a small role in its runoff patterns. Rather, the basin responds directly and relatively quickly to rainfall events, the largest of which occur typically in the fall and early winter months.

The core of the study area (RM 67 to 75) is also unique in that several streams (the Newaukum River, Dillenbaugh and Salzer creeks, and the Skookumchuck River) converge within a 10-mile reach of the mainstem. Several smaller tributaries also join the mainstem in the core study reach.

3.2.2 Geomorphology

3.2.2.1 Floodplain Characteristics

The Chehalis River has a gradient of about 3 feet per mile in the valley surrounding Centralia and Chehalis, where the mainstem has a meandering channel that occupies a fairly uniform floodplain averaging over 1 mile wide. Most of the valley becomes inundated during large flood events (PIE 1998).

From Chehalis to Montesano, the average width of the floodplain is about 1.5 to 2.0 miles. Surficial sediments within the floodplain attain a maximum depth of 100 feet.

Glancy (1971) estimated the mean annual suspended sediment of the Chehalis River mainstem near Grand Mound at about 150 tons per square mile, and 98 tons per square mile for the mainstem near Porter. The Black River is the main tributary between Grand Mound and Porter,

and joins the Chehalis River upstream from Oakville; however, Glancy affirms that the Black River contributes little runoff and sediment to the mainstem. The suspended sediment load passing Grand Mound appears to generally exceed that at Porter during periods of high runoff. Glancy also observed a general decrease in average particle size from Doty to Porter, which may indicate that (1) the proportionate suspension of fine sediment increases in a downstream direction, (2) more of the coarser material moves as bedload past the stations near Grand Mound and at Porter, or (3) individual particle abrasion in a downstream direction effectively decreases average particle size.

Geologic evidence indicates that the Chehalis River has reworked its valley since the deposition of sand and gravel outwash derived from alpine glaciers. This sand and gravel forms the older river terraces that line the valley margins. This timeline would make the recent river deposits less than 7,000 to 10,000 years old. Conditions of the canyon wall imply a mature topographic landscape prior to river sedimentation. This type of landscape would contribute to the long-term, slow aggradation by the river system with deposition of fine sand and some fine gravel, but a predominance of silt, clay, and organic mud. Mapping of the Centralia-Chehalis area by the Natural Resources Conservation Service (formerly Soil Conservation Service) confirms that at least 50 percent of the deposits in the upper 5 feet of the valley sediments are organic mud, silt, and plastic clay.

The Secretary of War (1890) describes the navigability of the Chehalis River from Claquato (upstream from Centralia at RM 82) to its mouth. The mainstem is described as a river that becomes progressively shallower and increasingly blocked by snags and fallen trees in the upstream direction. From Elma to Claquato, "the river is practically blockaded during the summer and fall by snags, shoals, and a general lack of water; at this time the river is a succession of shoals and pools" (Secretary of War 1890, p. 2,984), many of which were recorded as shallow as 6 to 12 inches in depth. The GLO Survey Plat records provide additional accounts of numerous side channels, sloughs, and ponds hydrologically connected to the Chehalis mainstem, the Newaukum, and the Skookumchuck rivers (GLO 1833-1860).

3.2.2.2 Natural Influences

Most of the major physiographic features of the Chehalis River basin were likely in existence before Quaternary time (i.e., 1.6 million years before present) (Glancy 1971). The basin is underlain by a variety of lithologic units that reflect the area's complex geologic history. The principal units are igneous and sedimentary rocks of Tertiary age (the Tertiary period ranges

from 66 million years to 1.6 million years before present) and unconsolidated deposits of Quaternary age; in most places bedrock is deeply weathered, with a soil mantle of varying thickness. The dense natural vegetation of the region generally protects the soil from sheet and rill erosion; however, mass-wasting processes supply large quantities of material to the stream channels for subsequent removal (Glancy 1971).

During Quaternary time, alpine and continental glaciation and eustatic changes in sea level exerted major influences on rivers located north of the basin, such as the upper reaches of the Wynoochee River, Satsop River, and Cloquallum Creek basins (Glancy 1971). However, the basin was mostly unaffected by glaciation except for areas in the upper South Fork Newaukum River and in the Skookumchuck basin downstream from the Skookumchuck Dam (Hunting *et al.* 1961). The Puget Lobe of the Cordilleran Ice Sheet reached its maximum southerly extent at Centralia. Glacial outwash terraces can be observed in and around Centralia, and some are exposed along the banks of the Skookumchuck and Chehalis rivers, particularly downstream from RM 67 on the Chehalis.

Soils of the area are fine-grained and deep, primarily due to the extensive weathering when developed on bedrock, and due to deposit thickness when developed on alluvium (Evans and Fibich 1987). Soils in the uplands are typically well drained, whereas those in the low-lying areas such as floodplains are poorly drained.

The climate in the basin is characterized by warm, wet winters and cool, dry summers. Partly due to topographic controls, a variable weather pattern within the basin results in precipitation that ranges from an average of less than 45 inches per year near Chehalis to an average of more than 120 inches per year in the upper reaches of the Chehalis River. The hydrology of the basin is described in detail in Section 3.1.

3.2.2.3 Human Influences

The basin has experienced various forms of development since the mid-19th century. These include extensive logging, diking, road building, damming, grazing and other agriculture, and construction in general.

The Secretary of War's (1890) plan to improve the navigability of the Chehalis River included the removal of snags, overhanging trees, logjams, drift heaps, shoals, and other obstructions to navigability. In one year (1887), 293 large snags were removed from the main channel,

beginning at Claquato and ending near Oakville (approximately 16 miles), and masses of log drifts and logjams were loosened or burned (Secretary of War 1887). The practice of removing woody obstructions continued for decades through this reach for purposes of floating logs generated by timber operations (Secretary of War 1892; Wendler and Deschamps 1955).

The earliest logging dams were built in the 1880s and construction of these dams continued through the 1920s. Splash dams were built on Elk Creek, Hope Creek, Chehalis River, South Fork Chehalis, Deep Creek, and the Skookumchuck River. The length of time that the dams remained in the streams ranged from less than one to more than 50 years, with an average of about 20 years. All splash dams were removed, washed out, or burned prior to 1944 except for one splash dam that remained intact on Elk Creek at least through 1955 (Wendler and Deschamps 1955). Splash dams were intentionally destroyed to carry logs downstream, a process termed "splashing." This process significantly affected channel dynamics. The floods of logs and water scoured or moved gravel bars, leaving only barren bedrock or heavy boulders (Wendler and Deschamps 1955). New channels were created in some areas and the geometry (width, depth, cross-section shape) of existing channels was modified. Splashing generally occurred on the average of once each week, but could occur as often as once a day.

If the sudden influx of logs into a stream below the splash dam caused a logjam, dynamite or black powder was used to clear the obstruction (Wendler and Deschamps 1955). Natural logjams were removed in the process as well. Extensive logjams on the mainstem were also removed in the mid-1800s to aid navigation. The lack of logjams and the scour from splash dams has resulted in a simplified stream system in which water and sediment are routed downstream much faster than before logging occurred.

Although much of the study area retains a rural character, the core of the study area has been extensively developed. The cities of Centralia and Chehalis occupy portions of the floodplain, and supporting infrastructure crosses the river and portions of the floodplain, as well as tributaries, and portions of their floodplains. Most of the floodplain is currently used for pasture and growing crops. There is a small amount of impervious surface in the low-lying portions of the floodplain.

3.2.2.4 Channel Pattern and Behavior

Between the confluences with the Newaukum and Skookumchuck rivers, the Chehalis River is meandering, with a sinuous, single-thread channel and a wide floodplain. As measured from

USGS 7.5' topographic maps, the sinuosity of the core reach is 1.95 (river length/valley length), whereas the reach immediately downstream from the Skookumchuck mouth has a sinuosity of 1.70. The lower 4 miles of the Newaukum have a sinuosity of 1.39, and the lower 4 miles of the Skookumchuck have a sinuosity of 1.51. Logjams provide an important mechanism in creating and maintaining multi-thread channels. In the absence of a large sediment load, the removal or loss of large woody debris (LWD) jams eliminate this mechanism for forming new side channels and can lead to the abandonment of existing side channels as the main channel incises and flattens over time.

Channel sinuosity is not so much a driver of channel processes as it is a result of those processes. Sinuosity is most closely related to channel gradient and sediment characteristics. Flatter channels that transport predominantly sand or fine-grained material tend to be more sinuous than steeper channels that transport gravel-dominated sediment. Oxbows are remnants of multi-thread channels or portions of the main channel abandoned as the river avulses to new locations. Primary mechanisms that can drive the formation of multi-thread channels and oxbows include high sediment loads that divert out of the channel through aggressive deposition and large accumulations of LWD that can divert flow onto the floodplain and form new channels.

Numerous oxbows are present in the core reach, although they are less common in the reaches above, below, and in tributaries. No recent meander cutoffs are present. In fact, a particularly narrow meander bend showed virtually no change during the last 50 or so years based on a comparison of aerial photographs taken over that time. The gradient of the core reach is 0.027 percent, meaning that it is gentler than reaches above, below, or in the tributaries (Table 3.2-1). The floodplain is wide, flat, and very gently slopes down valley. In contrast, the floodplain upstream on the Chehalis is narrower and steeper. Downstream from the confluence with the Skookumchuck, the gradient is somewhat steeper, and the bed material is much coarser, including cobbles and gravel.

Table 3.2-1: Comparison of Key Geomorphic Indicators

Reach	Sinuosity (dimensionless)	Gradient (%)	Mean particle size of grab samples (mm)
Chehalis, RM 67-75	1.94	0.027	0.22
Chehalis, RM 62.5-67	1.70	0.067	30.5
Newaukum, RM 0-4	1.39	0.106	No data
Skookumchuck, RM 0-4	1.57	0.145	33.0

The spatial patterns of the channels in the study area may be a result of a change in substrate related to the Pleistocene glaciation of the area. The change in sinuosity and gradient coincides with the edge of glacial outwash deposits from the Puget Lobe. The transition from fine (sand and smaller) bed and bank material to coarse material (sand, gravel, and cobble) is abrupt. The river may not be able to transport the larger clasts, and this may be responsible for the inflection in the channel profile just downstream from the Skookumchuck confluence.

Based on aerial photograph analysis, the plan form pattern of the Chehalis River has been remarkably stable during the last 50 years, with maximum observed lateral migration of approximately 10 meters in one location, and smaller amounts of localized migration in a few other areas. Oxbows and other abandoned channel features visible in 1949 photos remain visible in 1999 photos, although these features have grown slightly smaller and more disconnected from the main channel, apparently through sediment deposition. The river formed no new abandoned channel features within the core area over the 50-year period of record. There are only four significant sediment bars within the core study area. Sediment bars were visible throughout the period of record in the same locations and showed no discernible change in size. These features were generally narrow and limited in extent. Sediment composition on these bars was predominantly sand and silt with small amounts of gravel (less than 1 inch diameter). The sediment characterization includes sediment samples from these bars that provide quantitative size distribution data (see Section 3.2.2.5).

Although the Chehalis River has changed little in 50 years, the Newaukum and Skookumchuck rivers have experienced changes that are more obvious. A portion of the Skookumchuck River was relocated at the time I-5 was constructed, and the location of the Skookumchuck River confluence has changed as a result. Channel migration on the Newaukum River has occurred within the first 5 miles above the confluence with the Chehalis River.

Channel cross-sections of the Chehalis appear to be relatively stable as well. However, throughout the study area, there are continuous sections of riverbank hundreds of meters in length with bare soils, or with slight vegetation cover, indicating active erosion. This is in apparent contradiction to the aerial photograph observations, and suggests recent erosional events. The recent series of peak flows during the 1990s (see Section 3.1) may be partly responsible for the raw banks. The channel has a low width to depth ratio (less than 10), and is incised into the floodplain. The removal of woody debris appears to be the cause of the incision. However, if incision has occurred, the gradient has likely increased within the core reach. The gradient of the pre-settlement Chehalis River would have been even gentler than it is now.

The height of the riverbank above the water surface decreases progressively downstream between the Newaukum River confluence and the Skookumchuck River confluence. Field investigations conducted by the Corps in 2001 showed that the bank height above water surface decreased from about 26 feet (typical) to 16 feet (typical) in this reach. Reported river stage at USGS gaging station 12027500 "Chehalis River at WWTP at Chehalis, WA," at the time of observation indicates that short-term changes in river stage do not account for this observation.

At approximately RM 72.3, floodwaters have recently flowed out of the channel and scoured vegetation and soil from the riverbank and floodplain.

3.2.2.5 Sediment Characteristics

In 2001, the Corps conducted sediment sampling to collect information on the sediment load carried by the Chehalis. A grain size analysis indicates that within the core reach, sand and silt dominate the bed material. However, at the lower end of the study area (approximately RM 62-67), the riverbed is dominated by gravel and cobbles. The average particle size of grab samples taken from sediment bars in this reach was 1.2 inches, which is two orders of magnitude greater than within the core reach.

Sediment samples collected along the Skookumchuck River at Rotary Riverside Park in Centralia contained mostly gravel and some small cobbles. The average particle size of all samples on the Skookumchuck was 1.3 inches, similar to the lower reach of the Chehalis.

Bank material within the core reach of the Chehalis is composed predominantly of fine sand and silt. One sample taken from an actively eroding bank was composed almost entirely of fines (97 percent), whereas another bank sample had an average particle size of 0.9 inch.

3.2.2.6 Large Woody Debris

Evidence from the Queets River provided by Abbe (2000) indicates that woody debris jams historically formed an integral element in large alluvial channels flowing through forested lands in western Washington. In particular, Abbe found that LWD jam formation is a principal mechanism that controls reach-level habitat diversity through the formation of scour pools, bars, in-channel islands, and riparian forest refugia. LWD jams may act as local hydraulic controls over several decades and possibly centuries.

The accounts provided by the Secretary of War and the GLO support the premise that LWD strongly influenced the geomorphic processes in the floodplain areas of the basin. The systematic removal of LWD and the removal of riparian vegetation have very likely changed the channel processes in these systems.

Although it almost certainly played an important role in channel form prior to settlement, there is a noticeable absence of LWD in the channel today. No debris jams or significant accumulations of LWD were observed in any of the study area reaches. This suggests that the supply of LWD is extremely limited. In the core reach, there are a few places with LWD that may be recruited into the channel. Additionally, the tributaries appear to lack the transport capacity to supply significant amounts of LWD to downstream reaches.

As described previously, analysis of aerial photographs indicates that channel migration has proceeded slowly over the past 50 years, and no new oxbows or other channel cut-off features have been formed during that period. Based on estimated sediment accumulation rates and the observed shrinking of the oxbows observed on the floodplain within the core reach, these cut-off features can be interpreted as young features that probably formed within the past few hundred years. These observations, combined with the documented removal and reduction of LWD within the study area, support the hypothesis that logjams drove the process of channel avulsion and oxbow formation, and this process has now been interrupted and discontinued due to the lack of LWD to support this process. The lack of LWD jams in recent years has reduced the length and area of side channels, decreased overall channel length, and allowed the channel to incise.

3.3 WATER QUALITY

3.3.1 Regulatory Background

Water quality in the upper Chehalis River basin is governed by the Water Quality Standards for Surface Waters of the State of Washington (WAC 173-201A) (WDOE 1997). State water quality standards designate most of the upper basin as Class A (excellent). Class A waters must meet or exceed the requirements for all or substantially all uses as defined by the water quality standards. Characteristics of Class A uses include water supply (domestic, industrial, and agricultural); fish and fish rearing, spawning, and harvesting; wildlife habitat; recreation; and commerce and navigation. Water quality criteria for Class A waters are presented in Table 3.3-1. The water

quality standards also identify special conditions, which relax certain criteria for the mainstem Chehalis River near Centralia and Chehalis for the period of 1 June to 15 September.

Table 3.3-1: Class A Freshwater Quality Criteria

Parameter	Criteria
Fecal Coliform	Shall not exceed a geometric mean value of 100 colonies/100 mL and no more than 10% of all samples with a geometric mean value exceeding 200 colonies/100 mL
Dissolved Oxygen	Shall exceed 8.0 mg/L ^a
Dissolved Gas	Shall not exceed 110% of saturation
Temperature	Shall not exceed 18.0°C due to human activities. When natural conditions exceed 18.0°C, no temperature increases will be allowed which will raise the receiving water temperature by greater than 0.3°C.
pH	Within the range of 6.5 to 8.5 with a human-caused variation of less than 0.5 units
Turbidity	Shall not exceed 5 NTU over background turbidity when the background turbidity is 50 NTU or less, or have more than a 10% increase in turbidity when the background turbidity is more than 50 NTU.
Toxic, Radioactive, or Deleterious Material	Concentrations shall be below those, which have the potential to adversely affect characteristic water uses.
Aesthetic Values	Shall not be impaired by the presence of materials or their effects, which offend the senses of sight, smell, touch, or taste.

3.3.2 Existing Conditions

The primary water quality problems in the upper Chehalis River basin are high temperature, fecal coliform, high pH, and low dissolved oxygen (DO). Water body segments that do not meet state surface water quality standards and are included in the final 1998 Section 303(d) Impaired Water Body List are presented in Table 3.3-2. The Washington Department of Ecology (WDOE) maintains ambient monitoring stations on the mainstem Chehalis (RM 101.7 to RM 59.9) and

near the mouths of a number of tributaries, including the South Fork Chehalis, the Newaukum, and the Skookumchuck rivers. Recent water quality data are presented in Table 3.3-3.

Upstream from Centralia, the Chehalis River is a relatively shallow and swift-moving stream. However, in the Centralia reach (RM 65.8 to RM 75.2), the river channel deepens, and stream velocities decrease substantially. The Centralia reach is caused by a natural sill in the river more similar to a reservoir or lake than to a river. Temperature stratification is established during summer months, which leads to higher surface temperatures and prohibits mixing between stratified layers (Pickett 1994). Additionally, oxygen depletion occurs with depth. This naturally slow-moving reach has merited separate criteria for DO and temperature for part of the year. The criteria for this reach include a special condition stipulating that DO shall exceed 5.0 milligrams per liter (mg/L) from 1 June to 15 September and temperature shall be between 18° and 20.4° Celsius.

Table 3.3-2: Water Bodies on the Final 1998 303(d) List

Water Body Segment	Segment Name	Segment Boundary Description	Parameters
WA-23-1010	Chehalis River	Porter Creek (RM 33.3) to Scammon Creek (RM 65.8)	Fecal Coliform, Temperature
WA-23-1020	Chehalis River	Scammon Creek (RM 65.8) to Newaukum River (RM 75.2)	Fecal Coliform, Temperature, PCB-1254, PCB-1260
WA-23-1023	Salzer Creek	Mouth at Chehalis RM 69.4 to headwaters	Fecal Coliform, Temperature
WA-23-1027	Dillenbaugh Creek	Mouth at Chehalis RM 74.5 to headwaters	Fecal Coliform, Temperature
WA-23-1030	Skookumchuck River	Mouth at Chehalis RM 66.9 to headwaters	Fecal Coliform, pH, Temperature
WA-23-1070	Newaukum River	Mouth at Chehalis RM 75.2 to headwaters	Fecal Coliform, Temperature
WA-23-1100	Chehalis River	Newaukum River (RM 75.2) to Rock Creek (RM 106.7)	Fecal Coliform, Temperature
WA-23-1102	Stearns Creek	Mouth at Chehalis RM 78.1 to headwaters	Not listed
WA-23-1104	Bunker Creek	Mouth at Chehalis RM 84.8 to headwaters	Not listed
WA-23-1106	South Fork Chehalis River	Mouth at Chehalis RM 88.3 to headwaters	Temperature
WA-23-1108	Elk Creek	Mouth at Chehalis RM 100.2 to headwaters	Fecal Coliform
WA-23-1019	Lincoln Creek	Mouth at Chehalis RM 61.9 to headwaters	Fecal Coliform, Temperature

Table 3.3-3: Ambient Monitoring Water Quality Data (from Michaud *et al.* 2000)

River Mile	Location	Temp (°C)		DO (mg/L)		TP (mg/L)		NH ₃ (mg/L)		NO ₂₊₃ (mg/L)		TSS (mg/L)		FC ² (cfu/100 mL)	
		Avg	max	avg	min	avg	max	avg	max	avg	max	avg	max	avg	max
Mainstem															
101.7	@ Dryad	10.3	24.5	11.1	8.0	.03	.36	.01	.08	.30	.96	26	782	33	2800
77.7	@ Claquato ¹	10.2	20.1	10.2	7.5	.09	.41	.02	.04	.46	.87	20	102	61	730
67.5	@ Centralia	12.1	21.3	9.7	5.4	.08	.38	.06	.58	.48	1.1	16	109	47	1000
59.9	@ Prather Road	11.2	22.1	10.0	7.2	.06	.14	.03	.12	.59	.86	15	118	37	1500
Tributaries															
3.0	@ South Fork Chehalis	9.5	17.5	10.5	8.0	.05	.08	.02	.05	.56	.77	14	80	117	540
0.1	@ Newaukum	10.8	17.2	10.6	8.7	.03	.05	.02	.03	.61	1.60	27	90	78	760
2.3	@ Skookum-chuck	10.6	16.9	10.3	9.1	.04	.14	.02	.07	.54	1.48	8	43	41	960

¹ Sampled only in 1970s

² Fecal coliform is calculated as a geometric mean value.

A Total Maximum Daily Load (TMDL) study conducted by WDOE in 1991 and 1992 found that the upper Chehalis River had problems with low DO from RM 90.0 downstream, elevated temperature from RM 100.5 downstream, and high fecal coliform over the entire stretch with most of tributaries sharing these problems (Pickett 1994). The highest temperatures measured in the upper Chehalis River basin were in the slow-flowing Centralia reach (Pickett 1994).

Furthermore, the Class A criterion of 8.0 mg/L was met in less than half of the measurements made from the surface to 2 meters deep. During the summer months (when the special criterion of 5.0 mg/L was in effect) all measurements were above this criterion level; however, in waters 2 meters and deeper, the criterion was met only 70 percent of the time for regular conditions and 40 percent for special condition periods. Downstream from the Centralia reach, from the confluence with Scammon Creek (RM 65.8) to RM 59.9, water quality problems are mainly high temperatures and low DO.

Because of the low elevation, warm summer water temperatures may have been historically present in much of the Chehalis watershed; however, human activities have led to widespread riparian vegetation loss, reduced shading levels, and floodplain isolation contributing to

increased water temperatures (Wampler *et al.* 1993). Floodplain isolation results in the loss of wetland and groundwater discharge, hindering the creation of localized areas of cool water habitat available to aquatic organisms. Additionally, the lack of LWD results in a homogeneous riverbed that reduces water penetration into the riverbed. This results in a reduction in intersubstrate flow that creates cooler, oxygenated water in deep pools. Livestock impacts (livestock access and poor livestock waste handling practices) are the primary suspected non-point source of fecal coliform bacteria and pollutants that cause low DO, although commercial and residential sources such as urban stormwater and failing septic systems are also possible contributors (Pickett 1994).

3.3.3 Pollutant Loading Sources

Pollutant loading sources to the Chehalis River system include both point and non-point sources. Point sources are discharges regulated under the federal and state National Pollutant Discharge Elimination System (NPDES). The NPDES permit program is designed to protect the quality of receiving waters from various pollutant sources. The program includes permits for municipal wastewater discharge, industrial wastewater discharge, and stormwater discharge during construction and operation of development projects.

A number of facilities in the study area discharge as point sources under the NPDES program. These facilities include municipal wastewater treatment plants (WWTP) at Pe Ell, Chehalis, and Centralia, and one industrial WWTP, WestFarm Foods, which discharge treated wastewater directly to the mainstem Chehalis River. National Frozen Foods and Midway Meats are facilities regulated under State Waste Discharge Permits for land application of wastewater. These operations apply wastewater on fields that border the Chehalis River and Salzer Creek (Pickett 1994).

The WestFarm Foods and Chehalis WWTPs have a significant influence on the water quality of the Chehalis River due to their location at the head of the Centralia reach (Pickett 1994). The National Frozen Foods spray irrigation system was the source of a major wastewater spill to Salzer Creek in 1979 that caused an extreme DO drop in the Chehalis River. A low-DO event in October 1991 was attributed to an upset at a permitted wastewater treatment facility at the head of the Centralia reach, and to non-point sources, most likely in the Stearns Creek basin or on the mainstem Chehalis River upstream from the Newaukum River and below Adna (Pickett 1994). Additionally, the Chehalis WWTP raises the level of nitrogen in the river by two to six times the level upstream of the plant.

Currently, the Centralia WWTP discharges effluent into the Chehalis River at the Centralia reach, where natural conditions cause low, slow-moving flows, and high water temperatures in the summer (City of Centralia 1999). The Centralia WWTP has experienced a number of minor permit violations since August 1995 related to effluent concentrations of total suspended solids (TSS), biochemical oxygen demand (BOD), and fecal coliform (Pickett 1994). Centralia is currently constructing a new WWTP with a discharge point downstream from the existing WWTP.

Recognized non-point sources of pollution in the upper basin include agricultural and forest practices; commercial, industrial, and residential development; urban stormwater runoff; land disposal of industrial waste, solid waste and residential sanitary waste; failing septic systems; and groundwater discharge (Pickett 1994). Land use within the upper basin is dominated by forestlands (82.7 percent) and logging activities in these areas can contribute suspended solids to the streams. Although agriculture represents only about 10 percent of the land use in the watershed, agricultural activities (primarily field crop production and animal pasturage) typically occur adjacent to the river corridor and contribute fecal coliform, dissolved oxygen demand (DOD) and nutrients, such as phosphorus and nitrogen, to the mainstem Chehalis River and many of the tributaries (Michaud *et al.* 2000).

3.3.4 Chehalis River Basin TMDLs

Federal law requires states to identify sources of pollution in waters that fail to meet state water quality standards, and to develop TMDLs for addressing those pollutants. The TMDL process is established by Section 303(d) of the Clean Water Act (CWA), and TMDLs are based on the total amounts of a pollutant a water body can receive from all sources and continue to meet water quality standards. Once the TMDLs for a specific water body are determined, the allowable pollutant quantities (calculated on a per-day or a per-liter basis) are divided among the existing dischargers.

As noted earlier, WDOE conducted a TMDL study to evaluate water quality in the upper Chehalis River (Pickett 1994). Over the 1991-1992 period, several surveys in the study area were conducted during the dry season (May to November). Past studies have documented areas of low DO during the summer in the Centralia reach. The Chehalis River and tributaries were evaluated for loading sources and other physical, chemical, and biological river conditions that contribute to the oxygen deficit.

The results of these surveys indicated that widespread thermal stratification occurs in the Centralia reach during the summer months. In deeper waters, hypoxia and anoxia were associated with the thermal stratification. DO was repeatedly below water quality criteria in the surface waters and the tributaries of the Chehalis River. Additionally, violations of both the temperature criterion of 18.0°C and the fecal coliform bacteria criterion were also found in the mainstem Chehalis River and its tributaries. Furthermore, fecal coliform loading in the upper Chehalis Basin accounts for approximately 40 percent of the bacterial load in the lower Chehalis Basin and Grays Harbor, which are currently listed under Section 303(d) as not meeting water quality standards for fecal coliform bacteria and currently is the focus for a WDOE TMDL (Rountry and Pelletier 2002). The study found that almost two-thirds of the measurements in the Centralia reach exceeded the temperature criterion for Class A water quality standards during the dry season.

The TMDL for DO approved by Environmental Protection Agency on 21 October 1996 restricts the discharge of BOD material to the upper Chehalis River from 1 May to 31 October each year. In the case of Chehalis and WestFarm Foods, the waste load allocation for the Centralia reach during the 1 May to 31 October period was reduced to zero pounds BOD and ammonia. This TMDL was revised in response to a settlement of legal action initiated by the City of Centralia, the City of Chehalis, and WestFarm Foods (Jennings and Pickett 2000). The revised TMDL modifies the seasonal restrictions on the pollutant discharge for each plant based on river flows, and requires that each plant discontinue direct discharge to the Centralia reach at low flows. Three sets of final limits were developed based on the flow rate of the river: "dry-weather" flows, "very low" flows and "wet-weather conditions." During periods when the river flow drops below the specific thresholds, the waste load allocations for Chehalis and WestFarm Foods remain the same as in the TMDL previously approved by the EPA. However, when river flows are above those low flow thresholds, Chehalis and WestFarm Foods are allowed to discharge to the river within the Centralia reach at levels that protect water quality standards for DO.

As part of a 1997 agreement with WDOE, the City of Centralia proposes to move and expand the Centralia WWTP. The proposal involves moving the discharge point downstream from the Skookumchuck River confluence and upgrading treatment technology to improve the quality of the discharge (City of Centralia 1999).

A temperature TMDL for heat caused by solar radiation was approved by EPA in December of 2001 for the upper Chehalis River basin (Butkus and Jennings 1999). Under Section 502(6) of

the CWA, heat is considered a pollutant. The TMDL study indicates that heat generated by solar radiation from sunlight reaching streams provides enough energy to raise water temperatures. Very low-elevation streams are known to be the most dependent on shade to limit temperatures, and the Chehalis River basin has been affected by reduced tree canopy on over 90 percent of the mainstem. Anthropogenic activities, which have contributed to degraded riparian vegetation conditions, include agricultural and silvicultural activities, as well as residential and urban development. Instream flow and channel morphology are additional factors that influence heat distribution. Low flows may contribute to high temperatures by reducing the volume of water that can absorb incoming heat and channel morphology may influence heat distribution. With increased sediment loads, stream channels may become wider and shallower, allowing more thermal radiation to be absorbed by the water surface.

3.3.5 Tributaries

3.3.5.1 Bunker and Stearns Creeks

Although neither Bunker nor Stearns Creek was included in the final 1998 Section 303(d) list for impaired water bodies, water quality problems have been observed in these streams. Exceedances of temperature, DO, and fecal coliform criteria have been observed in Stearns Creek and observed DO levels have been consistently depressed below the 8.0 mg/L criterion during summer months in Bunker Creek (Pickett 1994).

Land use in the subbasin is primarily forestland (81 percent) with 17 percent agricultural and less than 1 percent residential and urban development. Sources of nutrient loading (primarily phosphorus, as Bunker and Stearns Creeks are nitrogen limited) are primarily agricultural (Michaud *et al.* 2000). A survey by the U.S. Fish and Wildlife Service (USFWS) found an estimated 26 percent of stream miles on these streams that were degraded by livestock access and impact and other pollutant inputs (Wampler *et al.* 1993).

3.3.5.2 Dillenbaugh Creek

Dillenbaugh Creek was included in the final 1998 Section 303(d) impaired water body list for fecal coliform and temperature. Two reaches were listed for fecal coliform and two reaches were listed for both fecal coliform and temperature. Previous surveys of the creek reveal a wide variety of point and non-point sources of pollution that contribute to water quality degradation (Crawford 1987; Pickett 1992 and 1994). High fecal coliform levels are most probably due to

farming activities, such as livestock impacts and a dairy feedlot, although failing or inadequate septic systems adjacent to the creek may also contribute to the problem. Industries in the Chehalis Industrial Park may contribute to temperature violations. Additionally, an urban storm sewer was found to be the source of several contaminated discharges (Pickett 1992).

This creek also has relatively high turbidity, (TSS), BOD, total organic carbon (TOC), total phosphorus (TP), and total nitrogen (TN) (Pickett 1994). Urban stormwater discharges to Dillenbaugh Creek have been identified as a potential contributor to the high pollutant levels. Another possible source of pollution is the American Crossarm and Conduit (ACC) Superfund site adjacent to the creek. ACC was formerly a wood-treating facility that is now heavily contaminated with pentachlorophenol (PCP). The Remedial Investigation (RI) for the site (Weston 1991) found PCP levels in Dillenbaugh Creek as high as 19 ug/L during the spring of 1991. Additional site improvements have been made at ACC since 1991 as part of an emergency remediation, and levels of PCP have dropped to below established water quality criteria with acute toxicity not appearing to be present (Pickett 1994; Marti 2001).

3.3.5.3 Elk Creek

Previous studies indicate good water quality in Elk Creek with temperature, pH, and DO all within water quality criteria. The exception to this is fecal coliform bacteria (Pickett 1994). One reach of Elk Creek was included in the final 1998 Section 303(d) impaired water body list for fecal coliform concentrations. Livestock access and potentially inadequate septic systems may be sources of elevated fecal coliform, TP, and BOD concentrations (Pickett 1994; Wampler *et al.* 1993). The Elk Creek subbasin is dominated by forestland (98.4 percent) with some logging and agricultural activities (0.6 percent of land use) (Michaud *et al.* 2000).

3.3.5.4 Lincoln Creek

The 1991-1992 WDOE survey observed DO consistently below 6.0 mg/L, temperatures above 18.0° C, turbidity and TOC relatively high; the two fecal coliform analyses both well above water quality criteria (Pickett 1994). Lincoln Creek is included in the final 1998 Section 303(d) list for fecal coliform concentrations and temperature. A USFWS degradation survey identified livestock access, livestock waste inputs, and other pollutant sources at numerous locations (Wampler *et al.* 1993).

3.3.5.5 Newaukum River

Although previous surveys indicated mostly good water quality (Pickett 1994), water quality in the Newaukum River basin is degraded and the Newaukum is included in the final 1998 Section 303(d) list for temperature and fecal coliform concentrations. Elevated coliform bacteria levels were associated with the wet season and were not observed during the TMDL study, which was conducted during the dry season (Pickett 1994; Michaud *et al.* 2000).

Ambient water quality data for temperature, DO, pH, TP, inorganic nitrogen, TSS, and fecal coliform for the 1992-1993 water years are presented in Table 3.3-3. While the average TP concentrations were at the lower end of the range for tributaries, inorganic nitrogen concentrations averaged highest in the Newaukum at 0.61 mg/L, although still less than background concentrations of 0.8 mg/L (Michaud *et al.* 2000).

Agricultural activities (17 percent of land use) are likely sources of high inorganic nitrogen yields. Extensive stretches of reduced stream canopy observed between the confluence of the North and South Forks and the mouth of the Newaukum contributes to high temperatures (Michaud *et al.* 2000; Wampler *et al.* 1993).

3.3.5.6 Salzer Creek

Salzer Creek has been the focus of several water quality investigations. In 1979, low DO was observed in the Chehalis River. The source of the problem was identified as the failure of a food processing wastewater pipe leading to a spill in Salzer Creek. The wastewater was to have been land-applied on fields adjacent to Salzer Creek by the National Fruit Canning Company (now owned by National Frozen Foods and currently holding a Washington State Discharge Permit to land-apply food processing wastewater). In 1986, WDOE conducted a survey of the creek to identify point and non-point sources in the drainage and impacts on water quality (Crawford 1987). Low DO and high fecal coliform levels were observed as the main water quality problems. The causes cited were poor farm management practices and leachate infiltration from the Centralia Municipal landfill (currently undergoing corrective action as a federal Superfund site).

Subsequent surveys have found Salzer Creek to be heavily affected by several sources, including stormwater runoff from a drainage sump at the Southwest Washington Fairgrounds (suspected as a contributing source of high nutrients, fecal coliform and low DO), urban and residential sources, livestock activities, and possibly other unidentified sources (Pickett 1994). Salzer Creek

was included in the final 1998 Section 303(d) impaired water body list for fecal coliform and temperature. Approximately 3 percent of the Salzer Creek basin has been developed for urban, commercial and industrial uses; agricultural uses comprise 12.9 percent; and forestlands dominate the subbasin at 83.9 percent.

3.3.5.7 Skookumchuck River

The Skookumchuck River is the only tributary in the study area for which flows are largely regulated by reservoir releases. Hanaford Creek, a major tributary of the Skookumchuck River, is the site of an open-pit coal mine and power plant. The Skookumchuck River is included in the final 1998 Section 303(d) list for fecal coliform concentrations, pH, and temperature. Land use in this subbasin is dominated by forestlands (86.5 percent), with agricultural activities representing 7.5 percent, commercial and industrial representing 2.4 percent, and urban development representing only 1.4 percent of land use.

During the 1991 survey, temperatures were above 18° C on several occasions and DO was always above the criterion of 8.0 mg/L. Hanaford Creek water temperatures were above 18° C on one of three sampling dates, and DO fell below 6.5 mg/L on one of three sampling dates. Conditions in the Skookumchuck River above Hanaford Creek were similar to conditions at the mouth of the river, with temperature elevated on one of three dates and DO consistently high; however, pH was much higher at the mouth and Pickett (1994) suggests a source in this stretch of the river. Overall, the data indicated that water quality was generally quite good, with turbidity, BOD, TOC, nutrients and chloride all detected at relatively low levels. Hanaford Creek has slightly higher levels than the Skookumchuck for all parameters except inorganic nitrogen.

The Skookumchuck Dam and reservoir, located about 12 miles northeast of Centralia at Skookumchuck RM 22, were constructed in 1969-1970 to supply cooling water to the coal-fired Centralia steam electric power plant. An instream flow agreement between PacifiCorp and Washington Department of Fish and Wildlife requires that instream water temperatures be maintained at 10° to 13° C. The dam has a multi-level intake system located at elevations 449, 420 and 378 feet (between 28 and 100 feet below the water surface) that allows water temperature below the dam to be maintained at less than 16° C. When the reservoir drops below full pool and ceases spill, the water is then drawn from lower outlet gates, which lowers water temperatures in the stream below the dam. Currently, dam operations result in summer water temperatures at or below 13° C.

3.3.5.8 South Fork Chehalis River

The South Fork Chehalis River is included in the final 1998 Section 303(d) list for exceeding the state water quality criterion for temperature. This subbasin is predominantly forestland (89 percent) with some agricultural activities (9.5 percent).

Previous studies have identified widespread water quality impacts. The USFWS survey identified pollutant inputs in over 15 separate locations, and documented riparian canopy loss over approximately one-third of the river miles and cattle access in over 21 percent of the river miles in this subbasin (Wampler *et al.* 1993). The WDOE TMDL study indicated temperature and fecal coliform as water quality problems (Pickett 1994). There are numerous dairies in the South Fork basin and agricultural practices may be a source of fecal coliform, high TP, inorganic nitrogen, and TSS yields (Pickett 1994).

3.3.6 Groundwater

The Centralia area contains one large aquifer (the Fords Prairie aquifer), created by glacial outwash from the north along Waunch and Fords prairies. The aquifer supplies all domestic water use for Centralia and is classified as a critical aquifer. Domestic water supply comes from several wells throughout the city service area. The total source capacity for the wells is 7,178 gallons per minute (gpm). If a shortage of water occurred due to an extensive drought, the city could draw up to 3,125 gpm from the Newaukum River.

In 1990, the Lewis County Environmental Health Department completed a groundwater study along Fords and Waunch prairies and found that the underlying aquifer contained elevated levels of nitrates caused by an unknown number of failing septic tanks. In addition, a contaminant plume of tetrachloroethylene (PCE) approximately 1.5 miles long was discovered through routine, required testing for volatile organic compounds. A dry cleaning operation near the Trailer Village Mobile Home Park located near Harrison Avenue and Russell Road was closed approximately 12 years ago and since then, several wells within the trailer park and nearby homes were found to have elevated levels of PCE, ranging from 60 parts per billion (ppb) to 125 ppb. The Safe Drinking Water Act allows a level of 5 ppb. The PCE plume also contaminated a city well referred to as Eshom well located near Galvin Road and Eshom Road. The Eshom well is now closed and the trailer park is currently serviced with municipal water and sewer.

Dangerous levels of toxic chemicals contaminate two separate aquifers in the Chehalis area. Near the City of Chehalis, at the intersection of Hamilton and LaBree Roads, PCE is present in a

shallow aquifer and affects two small public water systems and at least one private well. PCE concentrations are as high as 3,000 ppb in the drinking water supply and 36,000 ppb in the groundwater. This area of contamination is now a federal Superfund site.

Another shallow aquifer south of the Chehalis area is contaminated with several industrial chemicals. Contamination by halogenated organics and non-halogenated solvents has been confirmed in groundwater under the Lewis County Central Shop at Forest, at the intersection of Jackson Highway and Forest-Napavine Road. Contamination of drinking water by petroleum is suspected at this location. Elevated levels of solvents have also been detected in off-site domestic wells.

Leaking underground storage tanks (LUST) are an additional source of groundwater contamination. Appendix D and the attached map provide additional information regarding LUST sites.

3.4 BIOLOGICAL RESOURCES – VEGETATION, WETLANDS AND RIPARIAN AREAS

3.4.1 Vegetation

The study area is located in the Puget Trough physiographic province described by Franklin and Dyrness (1973). This consists of lowland areas within a moderate climate. Pre-European settlement vegetation consisted of evergreen forests dominated by western hemlock (*Tsuga heterophylla*), western red cedar (*Thuja plicata*) and Douglas fir (*Pseudotsuga menziesii*). The river valleys likely supported riparian gallery forests dominated by black cottonwood (*Populus balsamifera*), big-leaf maple (*Acer macrophyllum*), western red cedar, Oregon ash (*Fraxinus latifolia*) and red alder (*Alnus rubra*). Parts of the study area also support native prairies on the glacial outwash plains (e.g., Fords Prairie and Grand Mound). Typical native prairie vegetation consisted of Idaho fescue (*Festuca idahoensis*) and white aster (*Aster curtus*). Wetlands were also common, including peat systems around the northern boundaries of the study area. Typical wetland vegetation likely consisted of multiple species of rushes (*Juncus spp.*), sedges (*Carex spp.*) and willows (*Salix spp.*). Other typical wetland plants would have likely included hardhack (*Spiraea douglasii*), red-osier dogwood (*Cornus stolonifera*), and salmonberry (*Rubus spectabilis*). Typical vegetation communities found are described below.

3.4.1.1 Forested Deciduous Community

This community is generally found near or adjacent to the major rivers and streams and is typical of riparian communities in the Puget Trough physiographic province. These can be either wetland or upland forests. The predominant canopy species are generally black cottonwood with patches of red alder, big leaf maple and Oregon ash or Oregon white oak (*Quercus garryana*). The understory can include snowberry (*Symphoricarpos albus*), red-osier dogwood, and Indian plum (*Oemleria cerasiformis*).

3.4.1.2 Coniferous Forested Community

Coniferous forests are found in the highland and/or well-drained portions of the study area. Many of these have been in forest production and rotation and are either second- or third-growth forests. Typical community dominants include Douglas fir, western hemlock, and western red cedar. Common understory species include salmonberry, vine maple (*A. circinatum*), and salal (*Gaultheria shallon*).

3.4.1.3 Mixed Forested/Scrub-Shrub – Forest Dominant Community

This community is characterized by approximately 60 percent forest and can either be wetland or upland forests. The forest includes the deciduous and coniferous trees listed above. The understory species are highly variable and can include willows, Oregon ash, Pacific ninebark (*Physocarpus capitatus*), red elderberry (*Sambucus racemosa*), Indian plum, and Nootka rose (*Rosa nutkana*). Invasions of blackberry (*R. procera* and *R. lacinatus*) may also occur in the understory and in disturbed areas of the other community types as well.

3.4.1.4 Mixed Forested/Scrub-Shrub – Scrub Dominant Community

This community can either be wetland or upland scrub-shrub communities. Common shrubs of this community include red-osier dogwood, willows, snowberry, and bald-hip rose (*Rosa gymnocarpa*). Black cottonwood usually predominates but other tree species found in this unit may include bitter cherry (*Prunus emarginata*), black hawthorn (*Crataegus douglasii*) and Scot's broom (*Cytisus scoparius*).

3.4.1.5 Emergent Community

This community is most common in the study area and consists of wetland and upland pasture, upland prairie, and emergent wetlands. Emergent vegetation includes typical pasture grasses

such as reed canarygrass (*Phalaris arundinacea*), bluejoint (*Calamagrostis canadensis*), red fescue (*F. rubra*), tall fescue (*F. arundinacea*), velvet grass (*Holcus lanatus*) and bentgrass (*Agrostis spp.*). Cattail (*Typha latifolia*), sedges, rushes are occasionally found in the emergent wetlands as well as the grass species listed above.

Priority plant communities within the study area are wetlands and riparian areas, as described below.

3.4.2 Wetlands and Riparian Areas

Wetlands (along with other waters of the United States) are those areas specifically administered by the Corps and the (EPA) under the Clean Water Act. The following wetland definition was used for determining and mapping the wetlands within the study area:

"...those areas that are inundated or saturated by surface or groundwater at a frequency and duration sufficient to support, and that under normal circumstances do support, a prevalence of vegetation typically adapted for life in saturated soil conditions. Wetlands generally include swamps, marshes, bogs, and similar areas." [33 CFR 328.3(b) and 40 CFR 230.3(u)]

The USFWS developed the following definition for a riparian classification system in the western United States. This definition was used for determining and mapping riparian areas within the study area:

"Riparian areas are plant communities contiguous to and affected by surface and subsurface hydrologic features of perennial or intermittent lotic and lentic water bodies (rivers, streams, lakes, or drainage ways). Riparian areas have one or both of the following characteristics: 1) distinctly different vegetation species than adjacent areas and 2) species similar to adjacent areas but exhibiting more vigorous or robust growth forms. Riparian areas are usually transitional between wetlands and uplands." (USFWS 1998)

The following discussion on wetlands and riparian areas is separated by those systems associated with the Chehalis (which includes the Newaukum River, Black River, Scatter Creek, Scammon Creek, Dillenbaugh Creek, Salzer Creek, Coal Creek, China Creek, Lincoln Creek, and numerous small drainages within the Chehalis River valley) and the Skookumchuck River (which includes Hanaford Creek and Coffee Creek). The reason for this distinction is the different hydrological and geomorphological characteristics of each river that have influenced the extent and characteristics of wetlands and riparian areas associated with them.

3.4.2.1 Chehalis River Wetlands and Riparian Areas

Chehalis River ecosystems are a remnant of a once extensive system of braided channels, wetlands, and riparian areas across a broad floodplain. The river was an extremely dynamic system that carried a high load of organic materials (wood and other debris) with shifting channels. The wetland and riparian plant communities probably supported many of the same species found in the remnant systems today: shrub-shrub and emergent wetlands with evergreen and deciduous wetland and riparian areas along the higher flood terraces. These communities would be typical of a braided river system with frequently shifting stream channels. Functions associated with the historic wetlands would have included habitat for aquatic invertebrates, anadromous and resident fish habitat, wildlife habitat, export of organic matter, and biodiversity. Because of the dynamic nature of the riverbed (rapid erosion and sedimentation), plants found in this environment were likely to be highly adaptable and highly productive as primary producers. This would result in a rich food web supporting invertebrates and vertebrates. The Chehalis River system was likely a rich source of food for a vast variety of both fish and wildlife species. The richness of cultural resource sites around the study area (see Section 3.14) indicates the river was also an important source of food and materials for Native Americans.

Euroamerican settlement brought dramatic changes to the system. Agricultural development resulted in the clearing and draining of all but the most difficult to access or drain wetland systems. Large areas of riparian forests were also cleared. As described in Section 3.2, LWD jams historically were the principal mechanism that controlled river habitat diversity through the formation of scour pools, bars, in-channel islands, and riparian forests in the Pacific Northwest (Abbe 2000).

The historic records support the premise that LWD strongly influenced the hydrologic characteristics of the Chehalis floodplain areas of the basin. The removal of wood and the clearing of riparian vegetation have very likely changed the channel dynamics in this system. The mainstem appears to be undergoing a long-term trend of channel entrenchment since pre-settlement conditions, which likely began with the regular removal of woody debris. Woody debris removal resulted in concentrating river flow into one main channel. River transport of logs from logging operations also created conditions that further favored processes of entrenchment. Lastly, bank protection measures prevented (and continue to prevent) the mainstem from adjusting to flow events through channel changes.

Historic actions changed the Chehalis River wetland characteristics by reducing both the frequency and duration of low intensity flood events and by decreasing the ability of wetlands to

store water. Draining wetlands and channelizing the river system decreased the ability of the entire system to store water (flood retention, groundwater discharge), to augment low flows and reduce summer temperatures (discharge cooler groundwater during the summer drought months) and to reduce the peak of flooding events. The Chehalis River system also lost biodiversity due to the loss and/or degradation of habitat and the loss and/or degradation of connectivity between habitats.

The impacts of the historic actions include loss of population and/or population isolation of many species (both plant and animal), loss of primary and secondary productivity, loss and/or degradation of fisheries habitat, loss of flood storage and low flow augmentation, and loss of biodiversity. Today, however, the Chehalis River ecosystem is still a relatively extensive complex of emergent, scrub-shrub and forested wetlands and riparian areas, as well as large area of agricultural wetlands that are actively cultivated during the spring and summer months. Much of the agricultural area of the floodplain has subsurface tiles and ditches to facilitate drainage. Some of the ditches and drains were successful in converting wetland areas into uplands, whereas other systems have failed, resulting in maintenance of wetland hydrology. The extent of either situation is difficult to determine without supporting field observations, although the Soil Survey for Lewis County (USDA 1987) has mapped large units of hydric soils throughout the study area, including the areas currently under cultivation.

Interspersed with the wetland complexes are equally large areas of well-drained soils. This complex variety of soils is a result of the glacial-fluvial history of the area, which was historically part of a broad glacial outwash plain and is currently part of an active floodplain.

The Chehalis River wetlands are supported by a combination of high seasonal water tables, periodic flooding, and seasonal ponding. Those areas directly adjacent to the river probably experience both high seasonal water tables and periodic flooding. The areas away from the river likely are a result of high seasonal water tables and ponding.

The Chehalis River riparian areas are located in parts of the floodplain that are regularly inundated by floodwaters. Some of the riparian areas may also be wetlands, whereas others, located on the well-drained soils, are not inundated long enough to support wetland vegetation.

Functions likely provided by these wetlands include sediment and nutrient removal, peak flow reduction, base flow support, shoreline stabilization, primary production and organic export, fish and wildlife habitat, and native plant richness. Functions associated with the riparian systems

include habitat for passerine birds, small mammals, amphibians, LWD supply, and native plant richness.

Table 3.4-1 provides a summary of the acreage and type of wetlands and riparian areas found within the study area of the Chehalis River valley.

Table 3.4-1: Chehalis River Wetlands and Riparian Areas (in Acres) within the Study Area

Forested Wetlands	Scrub-Shrub Wetlands	Emergent Wetlands	Riparian Areas
6,385	2,683	1,447	2,693

3.4.2.2 Skookumchuck River Wetlands and Riparian Areas

The historic impacts to the Skookumchuck River are less well documented than those to the Chehalis River. However, the position of the Skookumchuck River in the landscape and the Lewis County Soil Survey (including information on soil forming processes) indicate that historically the Skookumchuck River wetlands were not as extensive as those associated with the floodplain of the Chehalis River.

The confluence with Chehalis River, where the floodplain is the widest, likely supported the largest area of wetlands and riparian habitat along the historic Skookumchuck River. The existing river meanders suggest that this was an area of lower energy, which probably looked and functioned much like the historic Chehalis River in the same reach. Almost all of these wetlands and riparian areas were lost with the development of Centralia.

The Skookumchuck River probably also provided a source of LWD to the system, some of which was trapped with the construction of the Skookumchuck Dam. Although there are no specific records, it is also likely that historically this river system contained much more LWD and logjams than it currently does. These were probably removed to facilitate log transfer downstream, much like the work done on the Chehalis River.

Functions lost or degraded due to historic impacts of the Skookumchuck River include food chain support for invertebrates and vertebrates, sediment removal, shoreline stabilization, high biodiversity for both plants and animals, and high organic export.

The existing wetland systems associated with Skookumchuck River are not as large or diverse as those of the Chehalis River. The river floodplain is narrow and somewhat incised until it reaches the vicinity of Bucoda, where it broadens into its widest area at the confluence with Hanaford Creek and Centralia. Most of the area is in agricultural production, with the exception of the area within Centralia. Wetlands associated with this system are directly adjacent to the river or in the floodplain. This area does not contain extensive areas of hydric soils, which suggests that there may not have been extensive wetlands associated with the river above the confluence with Hanaford Creek. Hanaford Creek, in contrast, supports extensive emergent wetlands with extensive areas of mapped hydric soils (USDA 1987). Areas around the reservoir behind the dam are predominately vertical rock faced walls. There is a small area that could contain riparian habitat but would not be impacted if the water is stored during a flood event no longer than 5 continuous days.

The Skookumchuck River wetlands are supported by a combination of high seasonal water tables, periodic flooding, and seasonal ponding. Those areas directly adjacent to the river probably experience both high seasonal water tables and periodic flooding. The areas away from the river likely are a result of high seasonal water tables and ponding.

Like the Chehalis River systems, some of the riparian areas are also wetlands, whereas those found on well-drained soils are not. The riparian areas are found in parts of the floodplain that are regularly inundated.

Agriculture, logging, urban development, and the construction of Skookumchuck Dam have affected conditions in this reach of the Skookumchuck River. Agricultural development has changed the complexity and extent of wetlands as well as adjacent riparian forests. Urban development (mostly in Centralia) has resulted in the direct loss of wetlands and riparian areas and well as indirect impacts to the remaining habitats.

Functions likely provided by these wetlands include sediment and nutrient removal, peak flow reduction, base flow support, shoreline stabilization, primary production and organic export, fish and wildlife habitat, and native plant richness. Functions likely provided by the riparian areas include habitat for passerine birds, small mammals, amphibians, LWD supply, and native plant richness.

Table 3.4-2 provides a summary of wetland and riparian acreage and type associated with the Skookumchuck River within the study area.

Table 3.4-2: Skookumchuck River Wetlands and Riparian Areas (in Acres) within the Study Area

Forested Wetlands	Scrub-Shrub Wetlands	Emergent Wetlands	Riparian Areas
1188	612	90	81

3.5 BIOLOGICAL RESOURCES – WILDLIFE

Wildlife populations in the study area consist primarily of species associated with open forest canopies and young vegetation. The climax deciduous forests associated with the pre-settlement era were removed in the 19th century, converting the hardwood wetland floodplain and lowland habitat of the study area into agriculture and timber production. As development of the area has increased, forested habitat in the riparian zone along the mainstem Chehalis and tributaries has been reduced to narrow strips. Near Centralia and Chehalis, wildlife populations are characterized by species associated with urban development. Species not tolerant of human activity no longer use those areas. This section describes the species and habitats known to be present, as well as the existing conditions of riparian habitat along the mainstem Chehalis River within the study area. Black tailed deer, elk and various birds are considered resident or local to the area. The deer and elk visit the study area that falls outside the levy boundary and would not be directly affected by construction of the levy. A more comprehensive catalog of faunal groups within the study area is presented in Appendix A.

3.5.1 Existing Wildlife Habitat Conditions

Field studies were conducted in 2000-2001 for Lewis County to identify wildlife habitats in the study area (PIE 2001). Detailed discussion of the results of these studies is presented in Appendix A.

Wildlife habitat associated with the Chehalis River riparian and riverine areas was evaluated by examining the width of the existing riparian zone, the riparian vegetation species and their value to wildlife habitat, and wetlands associated with the riparian corridor.

The majority of the Chehalis River within the study area lacks riparian cover, and the riparian zones that are present average only 45 feet in width. Consequently, there has been a loss of habitat connectivity and instream temperature protection due to reduced riparian function throughout the study area. The dominant tree species within the riparian zones along the Chehalis River are black cottonwood and big-leaf maple, with an understory shrub layer of vine maple and willow. The majority of wetlands in the study area are emergent wetlands dominated by reed canary grass and other pasture-type grasses. The following overview of the existing riparian habitat conditions along the Chehalis River is based on observations made during the 2000-2001 field surveys.

From the confluence of the Chehalis River and Lincoln Creek upstream to the mouth of the Skookumchuck River, the habitat is dominated by hardwood riparian woodland with a secondary or shrub layer beneath. This hardwood riparian area averages 51 feet wide throughout this segment, largely because of the wetland areas located along the right bank. The dominant canopy species are black cottonwood and big-leaf maple, with vine maple and willow dominating the understory. Some areas along the left bank have reed canary grass beneath a narrow margin of cottonwoods. Cottonwood snags are prevalent throughout this reach. Beyond the riparian buffers, the area is developed into either pasture lands or residential and commercial properties.

From the mouth of the Skookumchuck upstream to the mouth of the Newaukum River, 30 percent of the riparian habitat has no vegetative cover. Big-leaf maple is the dominant canopy species on the remaining riparian habitat. Where a shrub layer exists, red-osier dogwood is dominant. Ground cover is dominated by reed canary grass and Himalayan blackberry. The average width of the riparian buffer, where present, is 35 feet in this reach. The adjacent oxbows are bordered by western red cedar with an understory of big leaf maple, red-osier dogwood, and Pacific willow (*S. lasiandra*), with reed canary grass beneath. LWD and snags are scarce; only one snag was observed in this entire section. Beaver, raccoon, and deer were observed throughout this section, and waterfowl utilize the oxbow ponds.

The section from the mouth of the Newaukum to approximately 5 miles upstream from the South Fork Chehalis River confluence contains dense stands of Himalayan blackberry and reed canary grass dominating the understory. Red alder and big-leaf maple are co-dominant in the overstory, and black cottonwood is sporadically present. The average riparian width is 42 feet in this section. There are emergent wetlands within the riparian buffer immediately adjacent to the river, with forested wetlands set back from the river. There are also areas devoted to agricultural use

adjacent to the river. During the field surveys, waterfowl, otter, deer, songbirds, beaver and bald eagles were observed using these wetlands.

The remaining upstream portion of the Chehalis River within the study area has fewer riparian wetlands, yet the average width of the riparian buffer is 46 feet. Red alder and big-leaf maple with a red-osier dogwood and vine maple understory dominate the hardwood overstory. The valley bottom in this reach is narrower, with channel erosion evident along both banks and overhanging vegetation present. Snags and burrows were observed within this reach, with songbirds, deer, beaver, otter, coyote, and small mammals also evident. Significant portions of this valley are wetlands, but these areas are generally farmed and do not provide typical wetland functions.

Wildlife habitat has been reduced throughout much of the study area through depletion of riparian buffers and the loss of hardwood wetlands and off-channel areas as a result of agricultural, residential, and commercial development. This loss of quality riparian, wetland, and off-channel habitat and function limits the quantity and diversity of wildlife species present within the study area.

3.5.2 Priority Habitats

Priority habitat is defined by WDFW as those habitat types or elements with unique or significant value to a diverse assemblage of species. Priority habitat that was identified within the study area is described below.

3.5.2.1 Freshwater Wetlands

This habitat supports (at least periodically) hydrophytic plants, has a substrate that is predominantly undrained hydric soils that are saturated or covered with shallow water at some time during the growing season. Freshwater wetlands are located throughout the study area, with higher concentrations along the Chehalis and Skookumchuck rivers (PIE 2001).

3.5.2.2 Fresh Deepwater

These are habitats where hydrophytes are the dominant plants; however, the water in these areas is too deep to support emergent vegetation. This environment also includes all underwater structures and features such as caverns, woody debris, and rock piles. Fresh deepwater habitat is

found in the Skookumchuck reservoir, as well as in several large ponds along the Skookumchuck and Chehalis rivers.

3.2.2.3 Cliffs

Cliffs are considered priority habitat if they are greater than 25 feet high and occur below elevation 5,000 feet. They must also contain high densities of wildlife breeding and nesting area to be classified priority habitat. Cliffs were observed along the banks of the Skookumchuck reservoir during the 2000-2001 field surveys (PIE 2001).

3.5.2.3 Instream

This habitat comprises the physical, biological, and chemical processes and conditions that interact to provide life history requirements for fish, wildlife, and invertebrate resources in a lotic environment. Instream habitat is found throughout the study area, and includes all the major rivers and their tributaries.

3.5.2.4 Mature Forest

This habitat type includes tree stands with average diameters exceeding 21 inches at breast height (dbh). The density of trees, number of snags and quantity of large downed logs is generally less than that of old-growth forest. Stands of mature forest are found throughout the upper Newaukum, Skookumchuck, and Chehalis River Basins (PIE 2001).

3.5.2.5 Riparian Habitat

This habitat includes the area adjacent to streams and other water bodies, beginning at the ordinary high water mark and extending to the terrestrial areas that are influenced by, or directly influence, the aquatic ecosystem. These areas include the entire floodplain and riparian areas of wetlands that are directly connected to stream courses. Riparian habitat has been reduced throughout the study area and is now present only in narrow strips along the lower portions of the Skookumchuck, Newaukum, and Chehalis rivers (PIE 2001).

3.5.2.6 Rural Natural Open Space

This habitat includes open space that (1) functions as a corridor connecting other priority habitats (especially areas that would otherwise be isolated), (2) is an isolated remnant of natural habitat

larger than 10 acres surrounded by agricultural or urban developments, or (3) provides habitat for a priority species. This habitat must also contain unique species assemblages in agricultural or urban areas to be classified as a priority habitat. Most areas of open space habitat within the study area have been affected by agriculture or urban development and very few of these areas provide migratory corridors.

3.5.2.7 Talus Slopes

Talus slopes are a priority habitat if the rock rubble is homogenous, averages 0.5 to 6.5 feet in size, and is composed of basalt, andesite, and/or sedimentary rock. Mine tailings and riprap may also be included. One talus slope in the northeast corner of the Skookumchuck reservoir was identified during field surveys (PIE 2001).

3.5.2.8 Snags and Logs

Areas with abundant and well-distributed snags and logs are considered priority snag and log habitat. This habitat may consist of single snags or logs, or groups of snags or logs of exceptional value to wildlife due to their scarcity or location within the landscape. Snags must be greater than 20 inches dbh and 6.5 feet tall and logs must be greater than 12 inches in diameter at the largest end and at least 20 feet long in order to be classified as a priority habitat. Snags and logs are present in many locations throughout the study area, but in limited quantity. Reduced riparian buffers and the clearing of snags have depleted the sources of this habitat type within the study area.

3.6 BIOLOGICAL RESOURCES - THREATENED AND ENDANGERED SPECIES

The following species appear on the List of Endangered and Threatened Wildlife and Plants, as authorized by the Endangered Species Act of 1973. These species have been identified as potentially occurring in the study area:

- Bald eagle (*Haliaeetus leucocephalus*) (threatened)
- Marbled murrelet (*Brachyramphus marmoratus*) (threatened) and designated critical habitat
- Northern spotted owl (*Strix occidentalis caurina*) (threatened) and designated critical habitat
- Coastal/Puget Sound population segment bull trout (*Salvelinus confluentus*) (threatened)

- Canada lynx (*Lynx canadensis*) (threatened)
- Gray wolf (*Canis lupus*) (endangered)
- Grizzly bear (*Ursus arctos*) (threatened)
- Kincaid's lupine (*Lupinus sulphureus kincaidii*) (threatened)
- Golden paintbrush (*Castilleja levisecta*) (threatened)

Candidate species:

- Oregon Spotted Frog (*Rana pretiosa*)
- Whulge's Checkerspot (*Euphydryas editha taylori*)
- Mardon Skipper (*Polites mardon*)

Federal species of concern include California wolverine (*Gulo gulo luteus*), Pacific fisher (*Martes pennanti pacifica*), western pocket gopher (*Thomomys mazama*), Pacific Townsend's big-eared bat (*Corynorhinus townsendii townsendii*), long-eared myotis (*Myotis evotis*), long-legged myotis (*M. volans*), western gray squirrel (*Sciurus griseus*), Northern goshawk (*Accipiter gentilis*), peregrine falcon (*Falco peregrinus*), olive-sided flycatcher (*Contopus cooperi*), Pacific lamprey (*Lampetra tridentata*), river lamprey (*L. ayresi*), Columbia torrent salamander (*Rhyacotriton kezeri*), Van Dyke's salamander (*Plethodon vandykei*), Larch Mountain salamander (*Plethodon larselli*), Cascades frog (*Rana cascadae*), tailed frog (*Ascaphus truei*), western toad (*Bufo boreas*), valley silverspot (*Speyeria zerene bremeri*), tall bugbane (*Cimicifuga elata*), white-top aster (*Aster curtus*), and pale larkspur (*Delphinium leucophaeum*).

Finally, several state-listed species of concern include the great blue heron (*Ardea herodias*), bufflehead (*Bucephala albeola*), wood duck (*Aix sponsa*), osprey (*Pandion haliaetus*), band-tailed pigeon (*Columba fasciata*), and western pond turtle (*Clemmys marmorata*). The Olympic mud minnow (*Novumbra hubbsi*) is a state candidate species.

A letter of concurrence with the Corps findings of may effect not likely to adversely affect was received on 23 October 2002 from the U.S. Fish and Wildlife Service.

3.6.1 Aquatic Species

Several of the species of concern are especially adapted for slack-water, muddy bottom conditions. These species include the Olympic mudminnow, Pacific and river lampreys, and

western pond turtle. According to the WDFW Priority Habitats and Species (PHS) database, these species are found in ponds associated with low gradient streams (or along side channels or heavily vegetated banks of such streams), such as Hanaford Creek, Lincoln Creek, Bunker Creek, and Deep Creek. Western toad and Oregon spotted frog are found in shallow marshes, generally with stable water levels. The PHS database lists no western toads in the study area, and the Oregon spotted frog is known only from one location in the south Puget Sound region, in Thurston County, several miles from the study area. Western pond turtles are currently only known to occur in two locations in Washington, both near the Columbia River in Skamania and Klickitat counties. A small population has been introduced to a pond complex in Pierce County (WDFW 2002).

A few of the sensitive species listed for the study area are found almost exclusively in fast-moving, clear, cold-water streams. These species are the Columbia torrent salamander, Van Dyke's salamander, Cascades and tailed frog. These habitats do not occur along the mainstem Chehalis or lower reaches of the tributaries. Tailed frogs and Van Dyke's salamanders have been found in the Skookumchuck River and tributaries beginning about 5 miles upstream from the reservoir. Columbia torrent salamanders have been found about 10 miles southwest of the study area.

Amphibian and reptilian populations and distributions within the study area are poorly documented. The Washington State Gap Analysis Project (Dvornich *et al.* 1997) identified suitable habitat for amphibians and reptiles, then cross referenced these habitats with museum records and documented sightings. The results of the gap analysis, indicating habitat and recorded presence of amphibians and reptiles within the study area are included in Appendix A.

3.6.2 Terrestrial Species

3.6.2.1 Prairie Species

The Whulge's checkerspot, Mardon skipper, western pocket gopher, western gray squirrel, valley silverspot, white-top aster, and pale larkspur are all restricted to prairie habitats. Nearly all of the extant prairie habitats in the vicinity of the study area occur at Grand Mound Prairie. The Boistfort Prairie also supports the checkerspot and skipper, Kincaid's lupine and pale larkspur. The golden paintbrush is known to occur in only 5 sites as of 1981 (WDNR 1981). One of these sites was in Thurston County, presumably on Grand Mound Prairie. In the current Natural

Heritage Database, the only extant population listed occurs in the Deception Pass area of Skagit County (WDNR 2002).

3.6.2.2 *Species of Forested Habitats*

Over 20 bald eagle territories are known to be in the study area (WDFW 2002), and individuals are often observed throughout the area during the winter. The primary prey base of these bald eagles is not known, but very likely includes anadromous fish returning to spawn, and waterfowl. It is possible that bald eagles in the study area supplement their diet with resident fish, carrion, rabbits, and other small mammals, as these are known food items in places where anadromous fish spawn and waterfowl are scarce (especially during the eagle nesting season). No communal night roosts are known to occur in the study area (WDFW 2002).

Bald eagle nest sites have been identified along the mainstem Chehalis River. Nest sites also occur along the upper Skookumchuck River, and along the Newaukum River. Most of these nests are in large cottonwood trees, although some are in spruce trees. Bald eagle nesting was observed in the vicinity of the Skookumchuck reservoir during field surveys conducted in 2000-2001 (PIE 2001).

The PHS database lists four observations of marbled murrelet flights within the study area. These do not necessarily reflect a nest location, but probably do indicate nesting activity somewhere nearby. All of these observations occurred west of the study area, and several miles south of the Chehalis River. There are no marbled murrelet observations within the Skookumchuck River Basin.

Suitable spotted owl habitat within the study area is limited due to extensive recent logging activities. The presence of mature forest is requisite to attract nesting pairs to the area. Only two spotted owl observations are known near the study area; both of these occurred several miles to the south and west.

The ranges of Canada lynx, gray wolf, and grizzly bear do not generally include the study area, although on occasion it may be possible for individuals to wander into the area. However, all three species are largely restricted to high elevations in the north Cascade Mountains in Washington, and are not expected to be found in the study area.

Other species restricted to forested landscapes include California wolverine, Pacific fisher, Pacific Townsend's big-eared bat, long-eared myotis, long-legged myotis, northern goshawk, olive-sided flycatcher, tall bugbane, and band-tailed pigeon. Only tall bugbane is cited in the PHS database as occurring within the study area. Three discrete populations are noted in the area. Although observations of other species are not noted in the database, it is likely that the two species of myotis, the northern goshawk, the olive-sided flycatcher, and band-tailed pigeon are all found in areas that still support mature or successional-stage forests. According to the PHS database, a California wolverine was sighted in the area several years ago. However, this occurrence is regarded as highly unusual, since the normal habitat for wolverine is high elevation forests.

3.6.2.3 Species of Riparian Habitats

Four state-listed candidate species, the great blue heron, bufflehead, wood duck, and osprey, are found in riparian habitats within the study area. The bufflehead and wood duck are cavity nesters. The heron builds nests in colonies in living trees and the osprey selects large, dead snags for nesting. All of these require mature riparian forests to develop trees and snags large enough to support large nests and cavities. A few areas of mature riparian forest occur along the mainstem Chehalis and Skookumchuck rivers. During the 2000-2001 field surveys, great blue herons were frequently observed in and along the Chehalis, Skookumchuck, and Newaukum rivers. No great blue heron nesting was observed within the study area (PIE 2001). During the field surveys, osprey were observed in the Chehalis and Newaukum River basins and one pair of wood ducks was sighted in the Newaukum basin (PIE 2001).

3.6.2.4 Species of Other Habitats

The peregrine falcon nests on cliffs, or tall man-made structures, including high bridges, and typically forages over open spaces. No peregrine falcon nests are known in the study area (WDFW 2002). The Larch Mountain salamander is found almost exclusively on steep talus slopes, where the rocks range in size from 0.5 to 2.5 inches in diameter (WDFW 1993). One talus slope in the northeast corner of the Skookumchuck reservoir was identified during field surveys (PIE 2001), but no records of the Larch Mountain salamander in the study area were found in the PHS database.

3.7 BIOLOGICAL RESOURCES – FISH

The study area provides a variety of aquatic habitat types, each inhabited by a discrete community of cold and warm water fishes. Although the study area remains relatively rural, agricultural activities, industrial development, and urban growth have resulted in stream segments with high sediment oxygen demand (resulting in low DO), high summer water temperatures, and suspended sediment and contaminants from upland runoff. Existing side channels, wetlands, and riparian habitats have also been affected by development. Flood control measures, including construction of levees, have also affected streams in the study area by removal of riparian vegetation and, in some cases, triggering channel incision. The mouths of some tributaries have been altered as a result. Although some historic environmental concerns (e.g., point-source pollution, floodplain construction) affecting stream habitats have been reduced markedly, mainstem habitats are still in limited supply and runoff from some upland areas still contains high levels of fecal coliform bacteria and other common contaminants. High water temperatures in the mainstem and some tributaries remain a concern.

The following section provides a description of the community structure and habitat utilization of fishes within the study area habitats.

3.7.1 Community Structure

The Chehalis River and its tributaries support many species of salmonids, including spring and fall chinook (*Oncorhynchus tshawytscha*), coho (*O. kisutch*), and chum (*O. keta*) salmon. Summer and winter steelhead (*O. mykiss*), rainbow (*O. mykiss*), and both sea-run and resident cutthroat trout (*O. clarki clarki*) are also present (WDFW 1975). Although sockeye salmon (*O. nerka*) and pink salmon (*O. gorbuscha*) have been observed in streams in the lower Chehalis Basin, it is thought that these fish are strays from other river systems and are not indigenous to the Chehalis River Basin (WDFW 1975; WSCC 2001). Brook trout (*Salvelinus fontinalis*) have been introduced into some lakes and streams within the Chehalis watershed (Envirovision 2000). Little is known about the distribution and status of brook trout, but populations appear to be small.

The Chehalis River watershed probably represents the southern end of the range of anadromous bull trout/Dolly Varden trout (*Salvelinus confluentus*/*S. malmo*) on the west coast. In its final rule for determination of bull trout as a threatened species, USFWS noted that a subpopulation of native char was reported to occur in the Chehalis River/Grays Harbor basin (USFWS 1999).

However, data confirming the presence of such a subpopulation are limited; very few native char have been collected during monitoring studies over the past 30 years. A single fish was captured in the Chehalis River at RM 50 in 1997 and another was captured near Oakville in 1973 (USACE 2001). During the 11-year period that WDFW has operated a smolt trap in the Chehalis River, only one char has been observed (in 1997) (WDFW 1998b). The Corps conducted a literature review of bull trout in the lower Chehalis River, which revealed few instances of bull trout in the study area (USACE 2001). Char do appear to utilize the tidally influenced lower reaches of the Chehalis River, as evidenced by the capture of seven sub-adult char in Grays Harbor in the winter of 2001 by R2 Resources, Inc. The origin of these fish is unknown. There are no confirmed genetic data to determine whether the captured char are bull trout or Dolly Varden trout.

The Chehalis River system also supports white sturgeon (*Acipenser transmontanus*), green sturgeon (*A. medirostris*) and the non-native American shad (*Alosa sapidissima*) (Hiss and Knudsen 1993). Several exotic warm water species, including largemouth bass, perch, catfish, sunfish (*Lepomis cyanellus*), and many other resident fishes are present.

3.7.2 General Life History and Habitat Requirements

3.7.2.1 Anadromous Salmonids

Anadromous salmonids, including Chehalis River salmon and bull trout, use the ocean for a major portion of their growth, but depend on freshwater for reproduction. All species of anadromous salmonids require a freshwater environment for spawning and development of embryos, but the various species differ in the timing of seasonal migration and spawning, and the extent to which they rear in freshwater after emerging from the spawning gravel as fry (British Columbia Ministry of Energy and Mines 2002).

Pacific salmon (e.g., spring and fall chinook, coho, and chum) die after spawning, but trout and char may survive to spawn more than once. All anadromous salmonids use the gravel bottom of stream for spawning areas. Fertilized eggs are deposited and buried in redds, which consist of pockets in the gravel. The period from spawning to fry emergence may range from as little as two months in the case of spring-spawning trout, to as much as nine months for salmonids spawning in colder months.

Although sea-run cutthroat trout and anadromous char make extensive use of nearshore, intertidal and estuarine areas for feeding, many anadromous salmonid species migrate widely for feeding in the Pacific Ocean. They range between northern California and the Gulf of Alaska, and can be found up to 1,000 miles offshore.

In freshwater, anadromous salmonids generally require fairly cool, well-oxygenated water. Stream water must be clear enough to permit sunlight to reach the stream bottom where most primary production occurs; since salmonids feed by sight, they also depend on clear water to find food items. Good salmon and trout stream habitat is characterized by relative stable flows, without extreme floods or low flows. Gravels used for spawning must be clean and stable, and are typically located in riffles. Fry and juveniles move to different habitats as they grow, and therefore require access up and down the stream and into smaller tributaries. Habitats used by juvenile salmonids for rearing may include wetlands, small stream and side channels, or intermittently wetted areas. Cover in the form of undercut banks, logs, deep pools, and overhanging streamside vegetation is used by juveniles as feeding areas and as refuge for escaping predators. Adult salmonids require adequate stream flow and access to spawning areas to complete their life cycle. During their spawning migrations, adult salmonids use deep pools as cover for resting and to escape predators.

3.7.2.2 Other Fishes

The white sturgeon and green sturgeon are primitive, bottom-dwelling fishes. Both species are slow growing, anadromous, and reach maturity at an age of 5 to 11 years (PSMFC 2002). White and green sturgeon rely on streams, rivers, and estuarine habitat as well as marine waters during their life cycle. Both white and green sturgeon prefer to spawn in the lower reaches of large rivers that have swift currents and large cobbles.

White sturgeon can spawn several times during their life, and are believed to spawn every 4 to 11 years as they grow and mature. Anadromous white sturgeon move into rivers in early spring, and spawn May through June. Older white sturgeon produce more eggs, but do not spawn as frequently as younger fish. Unlike salmon and trout, white sturgeon do not build nests; instead, the adult fish broadcast spawn into the water column and the fertilized eggs sink and attach to the bottom to hatch. After hatching, the young fish remain in freshwater for a period to rear, feeding on algae and small invertebrates. Older juveniles and adults can also be found in rivers, as well as in estuaries and marine waters, where they feed on bottom organisms such as worms, mollusks, crustaceans and other fish such as lamprey and sculpins. In North America, white

sturgeon are found from Ensenada, Mexico to Cook Inlet, Alaska. They are found in most estuaries of large rivers along the Pacific coast.

Green sturgeon are highly migratory in the ocean; fish tagged in the Sacramento/San Joaquin estuary were found in the Columbia River and Grays Harbor one year later (PCMFC 2002). They are the most broadly distributed, wide-ranging, and marine-oriented species of the sturgeon family (NOAA Fisheries 2002). They are believed to spend most of their lives in nearshore oceanic waters, bays, and estuaries.

Like white sturgeon, green sturgeon can spawn several times during their life. They move into freshwater and spawn during the spring and summer months. As with white sturgeon, green sturgeon do not build nests, but spawn into the water column. Young fish remain in freshwater until they are two to four years old. Adults spend limited time in freshwater, using rivers only for spawning. Green sturgeon are found from Mexico to southeast Alaska. They are not abundant in any estuary along the Pacific coast, although they are caught incidentally in estuaries by the white sturgeon fishery.

Research indicates that water flow is one of the key determinants of larval survival for both white and green sturgeon (PSMFC 2002). Water diversions for municipal or irrigation use, power generation facilities, and other diversions that reduce the amount of water in rivers can negatively affect white and green sturgeon.

Olympic mudminnows are endemic to the upper Chehalis River drainage, as well as streams on the Olympic Peninsula and Ozette Lake. They have also been found in the Queets River drainage, where they may be an introduced species. Olympic mudminnows inhabit slow-moving, marshy stream, bogs, and ponds. They require habitats with deep mud bottoms, little water flow, and dense vegetation.

3.7.3 Distribution and Habitat Utilization

3.7.3.1 Chehalis River

The mainstem Chehalis River provides spawning and rearing habitat for salmonids as well as access to upriver habitat. In the Centralia reach, the mainstem generally lacks suitable riffles for spawning, while low flows coupled with high water temperatures during the summer and early

fall limit the availability of rearing habitat. High sediment loads in this reach of the Chehalis River also decrease the area and quality of spawning and rearing habitat. No pools of sufficient depth or cover to provide holding or rearing habitat are present (PIE 2001). In the upper portion of the study area (upstream from the confluence with the South Fork Chehalis), the mainstem provides spawning and rearing habitat for spring and fall chinook, coho, and steelhead. Several quality pools are present in this area, along with LWD, which offers holding habitat for migrating salmonids (PIE 2001).

The timing of the Chehalis River spring chinook run is not known with precision. The Washington Department of Fisheries (1975) stated that fish enter the river in March through mid-August, but chinook catches in the Confederated Tribes of the Chehalis reservation fishery have been reported as early as February. Chinook spawn in the mainstem and in the tributaries in late August through September, with spawning in the upper basin occurring slightly later. Fry emerge late the following winter. Juvenile spring chinook generally remains in the river for over a year, with seaward migration taking place the second spring after emergence.

Adult fall chinook begin entering the Chehalis River in August, with the run peaking in September and tapering off through November (WDF 1975). Spawning generally occurs during October through mid-December. Within the study area, fall chinook salmon spawn in suitable riffles in the reach between the mouth of the Skookumchuck River and the mouth of the Black River, as well as in areas upstream from Centralia and Chehalis. Fall chinook fry emerge in late winter through early spring, and remain in freshwater for 3 to 5 months before beginning their seaward migration.

The Chehalis and nearby drainages produce more coho smolts than any other system along the Washington coast, and in 1999 was the third largest producer in Washington state (WSCC 2001). Coho salmon begin entering the Chehalis in September and continue through November, with spawning occurring over the period from October through January (WDFW 1975). "Late-run" coho, which enter the river in mid-November through February, are not found in significant numbers within the study area and upper portions of the basin. Coho tend to seek out smaller tributary streams, and the mainstem Chehalis River within the study area provides little suitable coho spawning habitat. Coho fry emerge from the gravel in late spring. They typically migrate seaward during April, May, and June of their second year, although some fry and fingerlings migrate downstream in their first year during periods of flooding and heavy runoff.

Chum salmon enter the Chehalis system in early October through mid-December and spawning peaks in mid-November. Within the study area, chum salmon spawn in suitable riffles in the reach between the mouth of the Skookumchuck River and the mouth of the Black River. Chum fry begin their seaward migration shortly after emergence in early spring.

Wild summer steelhead in the Chehalis River system is a distinct stock based on the geographical isolation of the spawning population. Specific spawning locations are unknown, but it is thought that wild summer steelhead may spawn in the upper reaches of the Chehalis River. Run timing is generally from May through October, and spawning is believed to occur from February through April. Wild winter steelhead are distinct from wild summer steelhead based on run timing. Run timing for winter steelhead in the mainstem Chehalis is December through May, with spawning occurring from mid-February through early June.

American shad have been observed in the Chehalis River as far upstream as Rainbow Falls (RM 97), but the largest concentration of shad spawning is thought to be near Rochester (Hiss and Knudsen 1993). Within the study area reach there is likely little shad spawning, as there are few areas of suitably sized gravels.

Sturgeon are known to be present in the Chehalis River as far upstream as the mouth of the Newaukum River. A few juveniles, apparently months old, were seined from the mainstem Chehalis during summer in the early 1970s (Hiss and Knudsen 1993). Within the study area, there are a few locations in the mainstem Chehalis River that contain larger cobble substrates that could be used for spawning. However, use of these areas by sturgeon is considered unlikely.

The Olympic mudminnow, which is listed by Washington State as a sensitive species, is not known to occur in the mainstem Chehalis River, although suitable habitat occurs in some off-channel ponds. This species is known to be present in China Creek, which enters the Chehalis near Mellen Street (City of Centralia 1999).

There are currently no dams or other man-made structures that block the upstream or downstream movement of anadromous fish in the mainstem Chehalis. As described in Section 3.3, water quality in the Centralia reach frequently fails to meet Class A water quality criteria for temperature and DO during the dry season. The combination of low flows, high water temperatures, and low DO levels in late summer and early fall may form a block to fish migration in the Centralia reach. Upstream from the South Fork confluence, there are numerous culverts on tributaries that are known to block passage of cutthroat trout, and several culverts that

block passage for both cutthroat and steelhead (WSCC 2001). In addition, one culvert on a tributary to the East Fork Chehalis is known to block migrating coho. A natural barrier to salmon migration occurs at RM 97, where Rainbow Falls occasionally hinders passage of adult fish at low flows.

The matrix below summarizes the timing of migration, spawning, emergence, and rearing of various species in the Chehalis system.

Table 3.7-1: Matrix of Migration, Spawning, Emergence and Rearing

	Jan	Feb	Mar	Apr	May	June	July	Aug	Sept	Oct	Nov	Dec
Spring chinook												
Fall chinook												
Coho												
Chum												
Summer steelhead												
Winter steelhead												
Anadromous cutthroat												
Resident cutthroat												

-----	Juvenile Seaward Migration	-----	Adult Migration
-----	Fry Emergence	-----	Spawning
-----	Juvenile Rearing		

3.7.3.2 South Fork Chehalis

The South Fork Chehalis River supports runs of spring and fall chinook and coho salmon, as well as steelhead trout. Coho are the most abundant salmonid in this stream (WSCC 2001). The coho stock in the South Fork Chehalis River basin is classified as part of the much larger population of coho found throughout the Chehalis River system upstream from the Satsop River

confluence. Similarly, spring chinook and fall chinook salmon in the South Fork Chehalis are components of the Chehalis River chinook stocks. Winter steelhead in the South Fork Chehalis River are part of a larger population found throughout the Chehalis River basin upstream from the Satsop River (WSCC 2001). This stock does not include spawners in the Skookumchuck and Newaukum basins.

Although the South Fork Chehalis is used primarily for upstream access and rearing, there are some suitable riffles that provide limited spawning for chinook. Coho and steelhead spawning is confined primarily to tributary streams containing suitable spawning gravels. Low flows, high water temperatures, high silt loads, and concentrations of predatory fish are factors that limit successful salmon spawning in the South Fork Chehalis.

There are limited opportunities for salmonid rearing and holding in the South Fork Chehalis River. One reach was identified as having side channel habitat that could be utilized by juvenile salmonids for rearing (PIE 2001). LWD functioning as holding habitat for fish was observed in two reaches; however, no pools of sufficient depth or cover that could provide rearing or holding habitat were identified. High silt loads from extensive bank cutting limit the availability of holding and rearing pools throughout the South Fork.

There are several culverts on South Fork tributaries that are known to be barriers to migrating salmon, steelhead, or both (WSCC 2001). The length of stream habitats blocked by these culverts has not been determined.

3.7.3.3 Skookumchuck River

The Skookumchuck River provides spawning and rearing habitat for spring and fall chinook and coho salmon, and supports winter steelhead and resident cutthroat trout. Chum salmon used this stream historically, but have not been found in the Skookumchuck for many years (WDFW 1975). The Olympic mudminnow is reported to occur in Hanaford Creek (WDFW 1999).

The spring chinook and fall chinook stocks in the Skookumchuck River are considered components of the larger Chehalis River chinook stocks. Chinook use the mainstem Skookumchuck River for spawning and rearing from the mouth up to the Skookumchuck Dam at RM 22.

The coho stock in the Skookumchuck River is classified as part of the much larger population of coho found throughout the Chehalis system upstream from the Satsop River confluence. Coho use the mainstem Skookumchuck up to the dam for spawning and rearing, and spawn in the accessible reaches of tributaries. Wild winter steelhead in the Skookumchuck River basin are considered to be part of a larger population that includes Newaukum River winter steelhead.

Prior to construction of the Skookumchuck Dam, coho and steelhead utilized the Skookumchuck River up to an impassible falls near RM 28.9. The dam, which was built in 1970, blocks natural passage to all anadromous fish. It is estimated that 3.6 miles of spring and fall chinook mainstem habitat and 7 miles of coho mainstem habitat were lost when the dam was constructed (WSCC 2001). WDFW traps returning steelhead at a collection facility at the base of the dam, and transports them to stream reaches upstream from the dam for spawning. Steelhead smolts are transported downstream by allowing water over the spillway from 15 March to 1 June (USFWS 1982). Following dam construction, cutthroat were planted above the reservoir by the Washington Department of Game, but this practice was discontinued in 1980.

Several reaches of the Skookumchuck River below the dam contain pools of sufficient depth and cover to provide quality rearing and holding habitat for salmonids, particularly in the upper and lower reaches (PIE 2001). Several side channels that provide rearing habitat for juvenile salmonids are present in the upper and middle reaches.

There are two culverts on Skookumchuck River tributaries in the upper basin that are known to be barriers to steelhead (WSCC 2001).

3.7.3.4 Newaukum River

The Newaukum River, including its North and South forks, supports runs of spring and fall chinook and coho salmon as well as steelhead. American shad use the lower Newaukum River for spawning (WDFW 1975).

The spring and fall chinook stocks in the Newaukum are considered components of the Chehalis River chinook stocks; this drainage contributes an estimated 34 percent of the spawning population of Chehalis River spring chinook and an estimated 6 percent of the total spawning population of Chehalis River fall chinook (WSCC 2001). Spring and fall chinook spawn up to RM 12.5 on the North Fork and up to RM 31 on the South Fork Newaukum River.

The coho spawning in the Newaukum River are considered part of the Chehalis River population found upstream from the Satsop River. Coho salmon use the mainstem Newaukum River for rearing and transportation, and use tributary streams for spawning and rearing. Winter steelhead in the Newaukum River basin are considered to be part of a larger population that includes Skookumchuck River winter steelhead. Steelhead use the mainstem Newaukum River for rearing and transportation, and use tributary streams for spawning and rearing. Coho and steelhead have been documented as far upstream as RM 18.5 on the North Fork and up to RM 32.2 on the South Fork Newaukum River. Tributaries producing coho and steelhead include Allen and Taylor creeks (mainstem tributaries), Lucas, Bear, Mitchell, and Johns Fork creeks (North Fork tributaries), and Bearnier, Beaver, Frase, Gheer, Kearney, and Lost creeks (South Fork tributaries).

The South Fork Newaukum River contains a number of deep pools with cool water temperatures, which provide excellent rearing habitat for juvenile salmonids, as well as adult resting and maturation habitat. The area and quality of rearing and maturation habitat on the North Fork is limited by low flows, high water temperatures, high silt loads, and large concentrations of predatory fish (WDFW 1975).

A diversion dam was built in 1918 at RM 12.5 on the North Fork Newaukum to provide water for the cities of Centralia and Chehalis. This dam blocked access for anadromous fish until 1970, when a fish ladder was constructed. On the South Fork, a series of falls upstream from RM 31 apparently block salmon from utilizing some potential upstream production areas (WDFW 1975).

3.7.4 Stock Status and Population Trends of Salmonids in the Chehalis River Basin

Many Chehalis River basin wild salmon and steelhead populations have been extensively influenced by hatchery releases of non-native stocks (Hiss and Knudsen 1993; WSCC 2001). Many hatcheries developed brood stocks from outside strains, and most Chehalis Basin salmonid populations have had considerable non-native influence. Stocks occurring in the Study Area that are considered to be of mixed origin include Chehalis River fall chinook, Chehalis River coho, and Skookumchuck/Newaukum River winter steelhead (Envirovision 2000).

Reports developed by WDFW and Western Washington Treaty Indian Tribes summarize the most recent information available on the status of salmonid stocks in the Chehalis Basin and study area (WDFW and WWTIT 1994; WDFW 1998b and 2000).

Escapement estimates for years 1986-1996 for coho and fall and spring chinook within the study area are presented in Appendix A. Steelhead red count summaries for years 1989-1996 are also presented in Appendix A.

3.7.4.1 Spring Chinook

There is one stock of spring chinook found in the Chehalis River basin and the study area. The Chehalis River stock of spring chinook is considered a native stock and is maintained by wild production. The stock is considered healthy. From 1982 through 1991, escapement ranged from 610 to 3,488. With the exception of 1988 and 1989 (two strong return years), average escapement during the 1982-1991 period was approximately 1,400 (WDFW and WWTIT 1994). Since 1991, the average escapement has increased to 2,379 (WSSC 2001). The population trend is considered stable or possibly positive (Envirovision 2000).

3.7.4.2 Fall Chinook

There are seven stocks of fall chinook in the Chehalis River basin, one of which (the Chehalis River stock) is found in the study area. The Chehalis River stock of fall chinook salmon is of mixed origin, and is maintained by wild production. The stock is considered healthy. From 1985 through 1990, escapement ranged from 2,971 to 7,837 (WDFW and WWTIT 1994). Estimates indicate that recent escapement levels have been stable (WSSC 2001). There is no recent population trend reported for Chehalis River fall chinook (Envirovision 2000).

3.7.4.3 Coho

Of the seven stocks of coho in the Chehalis Basin, one (the Chehalis River stock) occurs in the study area. The Chehalis River coho stock is of mixed origin, with composite production of hatchery and wild fish. The stock is considered healthy. Between 1984 and 1991, escapement averaged 18,510, and then declined to an average of 14,625 between 1992 and 1998. However, a portion of the population has recently increased its level of returns, resulting in numbers similar to the 1984-1991 period (WSSC 2001). No recent population trend has been reported for this stock (Envirovision 2000).

3.7.4.4 Fall Chum

There are two stocks of fall chum in the Chehalis River basin, one of which (the Chehalis River stock) is found in the study area. The Chehalis River fall chum stock is considered native, and is maintained by wild production. The stock is considered healthy. Escapement levels and population trend for this stock are unknown (WDFW and WWTIT 1994).

3.7.4.5 Summer Steelhead

There are two stocks of summer steelhead in the Chehalis River basin. One, the Chehalis River stock, occurs in the study area. The origin of the stock is unknown; a native stock originally returned to the Wynoochee River and possibly other rivers, but there is uncertainty about the contribution by hatchery summer steelhead spawning in the wild (WDFW and WWTIT 1994). The stock is maintained by wild production. The status of the stock and population trends are unknown. Escapement is not monitored for this stock, nor has an escapement goal been identified.

3.7.4.6 Winter Steelhead

Of the eight stocks of winter steelhead in the Chehalis River basin, two (the Chehalis River and the Skookumchuck/Newaukum River stocks) occur in the study area. The Chehalis River stock is native and is maintained by wild production. This stock is considered healthy. From 1984 through 1992, escapement ranged from 2,540 to 4,156. The Skookumchuck/Newaukum River winter steelhead stock is of mixed origin and is maintained by composite production. Production is partially sustained by hatchery production at the Skookumchuck Dam. The stock is considered depressed, with a negative population trend. From 1984 through 1992, escapement ranged from 644 to 1,202 (WDFW and WWTIT 1994). From 1996 to 1999, wild escapement ranged from only 193 to 473, below the wild escapement goal of 766 (WSCC 2001).

3.7.4.7 Coastal Cutthroat

The Chehalis River stock complex of coastal cutthroat trout includes fish in the Skookumchuck and Newaukum rivers, the smaller tributaries and headwaters of the Chehalis River, and tributaries downstream from the study area. The stock complex is considered native and is maintained by wild production. The status of the stock complex and population trend is unknown. Some researchers believe that that stock complex may be depressed (Envirovision 2000). However, WDFW (2000) indicates that cutthroat are relatively abundant and widely

distributed in the basin, based on juvenile density sampling at over 80 sites in the upper basin and returns to a trap operated by the Quinault Indian Nation on the West Branch Hoquiam River.

3.7.4.8 Bull Trout/Dolly Varden Trout

As described in Section 3.6, the Coastal/Puget Sound population segment bull trout is listed as threatened under the Endangered Species Act. A native, wild-producing stock of bull trout/Dolly Varden trout has been identified in the Chehalis River/Grays Harbor system. However, most information on this stock consists of anecdotal accounts by sport fishers, and the stock status and population trend are unknown (WDFW 1998b).

3.8 LAND USE AND PLANNING

Political jurisdictions in the study area include Lewis and Thurston counties, the cities of Chehalis and Centralia, and the towns of Pe Ell and Bucoda. Unincorporated communities include Adna, Doty, Dryad, Fords Prairie, and Galvin.

The study area is generally devoted to rural residences, commercial agriculture, and timber production; small areas of commercial business and light industry are typically located near freeway interchanges. Large tracts of undeveloped land occur along the South Fork Chehalis River, to the east of Centralia along Hanaford Creek, and in the Skookumchuck River basin upstream from Bucoda. In the population centers of Centralia and Chehalis, land uses include a full range of residential, commercial, service, industrial, and public uses.

3.8.1 Lewis County

The majority of the study area lies within the unincorporated portions of Lewis County. The overall character of the study area in Lewis County is rural residential and agricultural, with large areas of undeveloped forestland. Industrial developments include the Centralia Steam Plant located in the Hanaford Valley, and light industrial establishments near I-5 from Rush Road to the Labree Road overpass. Concentrated retail and commercial development has occurred near the intersection of I-5 at the Harrison Avenue overpass in Centralia. Agricultural fields and pastureland predominate along the west side of I-5 and along SR-6 downstream from the confluence of the South Fork and mainstem Chehalis.

3.8.1.1 Comprehensive Plan

The Lewis County Comprehensive Plan and Environmental Impact Statement was adopted 10 May 1999. According to the Plan, over 98 percent of land in Lewis County is open space or remote rural areas with less than 2 percent available for urban development. Currently, only 1 percent of land lies within urban areas, with much of that devoted to right-of-ways and public uses. An additional 1 percent is classified as "Rural Areas of More Intense Development" which includes small communities in unincorporated areas as well as small commercial and industrial enclaves.

As mentioned above, the majority of the study area lies within unincorporated portions of Lewis County near the cities of Centralia and Chehalis. Most of the study area occupies land which is developed as rural residential and agricultural, however several areas along the Chehalis, Skookumchuck, and Newaukum rivers contain low-density residential and commercial development. Class A farmland is presently adjacent to the Chehalis and South Fork Chehalis rivers west of Chehalis. The majority of lands surrounding the study area west of Chehalis consist of forest resource lands. Residential land use areas not inside city limits include several areas of medium-density development southwest of Adna, west of Chehalis across the Scheuber floodplain, and south of Chehalis, with commercial and industrial development concentrated within the designated Urban Growth Areas of Centralia and Chehalis.

Mineral resource lands present in Lewis County include coal, clay, cinnabar ore, gold, silver, copper, iron, graphite, shale, and arsenic. Mineral resource lands include:

- existing permitted surface mining operations;
- areas containing mineral deposits the significance of which cannot be evaluated from available data;
- mines of local importance.

There are several mineral resource lands throughout the study area. These include coal, clay, shale, and gravel mining operations, most of which are less than 25 acres in size. The Centralia Mining Company coal mine, located northeast of Centralia, is the largest tract of mineral resource land (greater than 1,000 acres) in the study area. There are several small mines located north of Centralia; two near Schaefer Park, and three adjacent to I-5 north of Reynolds Avenue. Two small mines are located northeast of Chehalis, and several small mines are located along

SR-6 west of Adna. At present, no mineral resource lands are located within the footprint of the current levee alignment proposal for the proposed project.

Specific goals and corresponding policies that relate to land use in Lewis County are stated in the Plan. An overall goal for urban growth within the county is to encourage development in urban areas where adequate public facilities and services already exist. One policy to achieve this goal is the development of planned communities, which insures development of adequate services and facilities. To reduce urban sprawl, a goal is to reduce the conversion of undeveloped land into low-density development. A policy to achieve this goal is to identify short-term and long-term planning areas to help consolidate development around existing utilities and services. Additional land use goals include building efficient transportation systems based on regional priorities and coordinated with county and city comprehensive plans and promoting economic development and opportunities for all citizens.

3.8.1.2 Shoreline Management

The Revised Shoreline Master Program for Lewis County, adopted in June 1980, sets forth policies, rules, and regulations for the development of shorelines located within the county. The Program sets guidelines for development of shoreline areas with several goals in mind. These goals include:

- encouraging full and complete utilization of resources in a manner consistent with minimizing adverse effects to the shoreline environment;
- maintaining and developing shoreline public access and recreational opportunities; and
- encouraging sound management of renewable shoreline resources and preservation of non-renewable, historic, and/or cultural shoreline resources.

The program separates shoreline environments into four designations: Natural, Conservancy, Rural, and Urban. These designations are an indicator of the amount of development pressure each shoreline area can be expected to withstand. Designations are determined using various criteria including soil classifications, slopes, ownership data, and existing and projected land uses, and reflect the condition of the shoreline and its relation to surrounding environments and land uses. There are several rivers and streams located in the study area that fall under the jurisdiction of the Shoreline Management Act, and are addressed in the program.

In addition to Lewis County's shoreline environment designations, the Shoreline Management Act of 1971 designates shorelines of statewide significance. Shorelines of statewide significance comprise the main bodies of water within the county that are important to people of the state and the county. These shorelines are managed in the same manner as all other shorelines of the county; however development along these shorelines also requires thorough review by affected state agencies before permits can be issued.

Based on stream flow (mean annual flow of 1,000 cfs or more), one shoreline within the study area has been designated as a shoreline of statewide significance under the Shoreline Management Act. This shoreline is located on the Chehalis River from the mouth of the South Fork Chehalis River downstream to the Lewis County and Thurston County line.

3.8.1.3 Floodplain Management

Much of the study area within Lewis County occurs within the floodplains of the Chehalis, Skookumchuck, and Newaukum rivers. The majority of developed lands within these floodplain areas are currently devoted to rural agricultural and low-density rural residential development; however some areas of higher-density residential, commercial, and industrial development do occur. Most, if not all, of these current floodplain uses were developed prior to the adoption of the current floodplain development restrictions.

Title 15, Chapter 15.35 "Flood Damage Prevention" of the Lewis County Code states methods and policies for promoting public health and safety, as well as minimizing public and private loss due to flood conditions in specified areas. Specified areas, or "designated floodways", are defined as the floodways that have been delineated on the Flood Insurance Rate Map or the flood boundary/floodway map of the "Flood Insurance Study for Lewis County," dated November 1981. These include any areas subject to a base or 100-year flood event. As a result of work completed as part of this project, new projections of the 100-year floodway have been calculated. However, maps based on these projections have yet to be submitted to, or adopted by, the Federal Emergency Management Agency or local governments.

Specific methods for reducing potential floodwater damage, as stated in Chapter 15.35, include:

- restricting or prohibiting uses that could result in damages to persons or property due to water or erosion, or that could result in increases in erosion or flood height or velocity;
- requiring that uses vulnerable to floods be protected against flood damage at time of initial construction; and

- controlling filling, grading, dredging, and other development that may increase flood damage, unnaturally divert floodwaters, or result in increased flood hazards in other areas.

3.8.1.4 Stormwater Management

Recent population growth into rural portions of the study area within Lewis County has increased development pressures in those areas. Construction of roads, buildings, and other impervious surfaces has led to increasing amounts of stormwater runoff, which can be detrimental to surface water quality. Stormwater management policies for Lewis County are outlined under Title 15, Chapter 15.45 “Stormwater Management” of the Lewis County Code. The purpose of this Chapter is to provide for adequate stormwater quality and quantity controls in order to protect property rights, preserve fish and wildlife habitat, and preserve water quality.

The minimum stormwater management requirements for new development and redevelopment under Chapter 15.45 are adopted from the Stormwater Management Manual for Western Washington. The manual identifies minimum requirements for stormwater management for developments, including: preparation of stormwater site plans, source control of pollution, onsite stormwater management, runoff treatment, wetlands protection, and basin/watershed planning. Depending on the size and type of the planned development, different combinations of these minimum requirements may be needed. Also, some sites may require additional controls depending on special water quality and/or basin concerns.

3.8.1.5 Public Services

Fire protection services are provided by several jurisdictions within the Lewis County portion of the study area. The Centralia and Chehalis Fire Departments provide fire protection within their respective city limits. Outside of Centralia and Chehalis, fire protection services within the study area are provided by Lewis County Fire Protection Districts Numbers 1, 5, 6, 11, 12, 13, and 16. Small towns within the study area are also served by their own fire departments. Many of the firehouses in the area are relatively small and are staffed by mostly volunteer firefighters.

Police services within the study area are provided by the Lewis County Sheriff’s Department Patrol Areas 1, 2, 3, and 5, the Washington State Patrol District 5, and several municipal police departments. Centralia and Chehalis, as well as small towns such as Pe Ell, are served by municipal police departments. The Lewis County Sheriff’s Department supplements service within incorporated areas of Lewis County, as well as providing primary service to

unincorporated areas. The Washington State Patrol provides service along the I-5 corridor and along several state highways in the area.

Emergency medical services are provided by primary response ambulance units and one area hospital. Ambulance service is mainly provided by local fire departments, although private ambulatory services do operate in some portions of the study area. There is one full service hospital in the study area, located on Cooks Hill Road west of the Mellen Street bridge in Centralia. Currently, access to the hospital is hindered during flood conditions on the Chehalis River.

Utilities within the study area in Lewis County include water and sewer, electricity, natural gas, telephone, and television cable. Water service in the study area is supplied by four major providers. The City of Chehalis provides water service to the majority of Chehalis, and extends service approximately 17 miles south of the city limits along Jackson Highway and the North Fork Road. The City of Centralia Water System serves Centralia and some of the immediately surrounding areas. Boistfort Valley Water serves approximately 20 square miles from the Boistfort Prairie area to north of Claquato. American Water Resources manages several small water supply systems throughout Lewis County, including along Middle Fork Road, State Route 508, Jackson Highway, and Hanaford Road within the study area. The Town of Pe Ell also has a small water supply system managed by the town.

There are currently three main sewer service providers within the Lewis County portion of the Study Area: City of Chehalis, City of Centralia, and Lewis County Sewer District 1. The City of Chehalis provides sewer service within the city boundaries as well as several miles south, incorporating much of the city's Interim Urban Growth Area (IUGA). The city operates one sewage treatment facility located immediately northwest of the SR-6/I-5 interchange. In addition to Chehalis, the facility also treats sewage from both the City of Napavine and Lewis County Sewer District 1 through a shared interceptor sewer system. The facility has an average daily treatment of 1.45 million gallons per day (gpd). Currently, access and operation of the facility are hindered when flood conditions occur on the Chehalis River.

The City of Centralia provides sewer service to the incorporated areas of the city as well as the Fords Prairie and Salzer Creek areas. The city maintains one sewage treatment facility located immediately northwest of the Mellen Street/I-5 interchange, with an average daily treatment of 1.45 million gpd. Currently, access and operation of the treatment facility are negatively impacted during flood conditions.

The third major sewer services provider located in the Lewis County portion of the study area is Lewis County Sewer District 1. It provides service to the Jackson Highway/Bishop Road area southeast of Chehalis. As mentioned earlier, the Sewer District pipes sewage from its collection area to the Chehalis treatment facility.

The Town of Pe Ell also operates a small sewage treatment facility located at the northwest corner of the town limits along the Chehalis River. The facility serves 320 customers inside the town limits, and 3 customers outside the town limits, with a peak discharge of 114 gallons per minute.

With the exception of Centralia, all areas of Lewis County within the study area are provided electricity by Lewis County Public Utilities District (PUD). Lewis County PUD serves approximately 27,000 customers with a system capacity of 180 megawatts. The City of Centralia and some adjacent areas are served by Centralia City Light. The city generates approximately 30 percent of its power needs at the Centralia Steam Plant, with the remaining 70 percent being purchased from Bonneville Power Administration.

Natural gas service is provided to the study area by Puget Sound Energy (PSE). PSE purchases the gas from several regional suppliers, such as Northwest Pipeline Corporation, which operate pipelines in the area.

The major carrier of telephone service within the study area is Qwest Communications, which maintains both aerial and buried copper and fiber lines. These telephone lines may be used for voice or data transmission. Qwest also supplies cellular communications to portions of the study area.

Cable television service in the Centralia/Chehalis area is provided by TCI Cablevision. Most outlying areas receive cable through use of personal satellite dishes.

3.8.1.6 City of Centralia

The Centralia Comprehensive Plan was adopted on 8 December 1998. According to the plan, the predominant land use is residential development, which accounts for 35 percent of the total land base. Commercial and industrial development accounts for 6 percent and 5 percent, respectively. The remaining land uses, including parks/open space, public/right-of-ways, vacant, and

undeveloped critical areas, account for 54 percent of the current land uses. The majority of commercial uses occur near the Harrison Avenue overpass and in the downtown area, while industrial uses are mainly adjacent to the rail lines.

Existing zoning regulations within Centralia city limits allocate approximately 73 percent of the city's land for residential development. The remaining 26 percent is allocated to commercial and industrial development, with commercial development accounting for 15 percent and industrial development accounting for 11 percent.

There are several goals related to land use, and policies designed to achieve them, that are outlined in the Comprehensive Plan. One goal for residential development is to protect, preserve, and enhance existing residential neighborhoods. Policies designed to achieve this goal include providing guidelines for development of transitional land uses which buffer residential areas from intensive commercial and industrial uses, protecting existing residential areas from encroachment by incompatible land uses, and encouraging beautification and upgrading of residential structures and landscaping.

Goals for commercial development within Centralia include orderly growth and continued vitality of existing commercial areas. Policies designed to achieve these goals include providing adequate and safe vehicular and pedestrian circulation throughout commercial areas, supporting programs that preserve and enhance existing commercial areas, and coordinating with other jurisdictions to ensure that adjacent commercial areas are compatible with development in Centralia. Goals for industrial development include encouraging the expansion of existing industries and the siting of new industries, and ensuring that industrial uses develop as efficient and attractive working environments. Policies designed to achieve these goals include ensuring that industrial areas are adequately served by roads and utilities, and requiring mitigation of off-site impacts.

3.8.1.7 City of Chehalis

The City of Chehalis Comprehensive Plan and Environmental Impact Statement was adopted 12 July 1999. According to the Comprehensive Plan, the current distribution of land use within Chehalis city limits favors residential development, which accounts for 38 percent of the total land use allocation. Included in residential land use are single family (24 percent), multifamily - medium density (4 percent), multifamily - high-density (9 percent), and transitional (1 percent) housing. Commercial development, including the Central Business District, comprises 23

percent of land allocation, while industrial development also comprises 23 percent. Planned Unit Development (PUD) accounts for 16 percent of allocated land use.

Currently, there are relatively few large, vacant parcels of land within the city limits that are available for development. Constraints such as floodplains, shoreline areas, steep slopes, and wetlands further limit development in more than one-third of the city's total land area. The remaining opportunities for development include infilling on smaller parcels, development of parcels with natural constraints, and redevelopment of vacant or underused parcels.

Due, in part, to the limited capacity for development within the city limits, the IUGA adopted for the City of Chehalis is located primarily south of the existing city limits. The bulk of the land within the IUGA (53 percent) is intended for industrial use. Land intended for residential use comprises 15 percent, and 32 percent is set aside for commercial use.

The overall goals related to land use in the City of Chehalis as stated in the plan are as follows:

- manage growth in such a way as to ensure that suitable land is available to support residential, commercial, and industrial uses, while also preserving open space and recreational opportunities;
- encourage growth in urban areas where sufficient public facilities and services exist or can be provided; and
- ensure that land uses are related in ways that are compatible with projected growth in the area to provide maximum efficiency.

Specific goals for residential development include maintaining the low-density character of the community while also providing affordable housing to all segments of the population. This includes ensuring that residential areas are sufficiently supported by public facilities and services as well as commercial and retail activities, while minimizing impacts to surrounding residences.

Goals for commercial and retail land use are to encourage redevelopment of existing commercial areas, such as the Central Business District, and to provide a wide range of services and opportunities to residents. Commercial zones offer job opportunities to residents, as well as providing an important economic base for the community.

Recent trends indicate that much of the industrial growth within Lewis County is likely to occur in the City of Chehalis. Therefore, goals for industrial land use are to facilitate this growth by

providing easy access to industrial transportation corridors such as I-5 and existing rail lines. The goals also seek to ensure compatibility between industrial and residential zones to better take advantage of an expanding labor force.

3.8.1.8 Pe Ell

The Comprehensive Plan for the Town of Pe Ell was adopted in June 1997. According to the Plan, 47 percent of land use within Pe Ell city limits (not including right-of-ways) is currently classified as residential development. Within the residential classification, low-density residential (one or more acre per dwelling unit) comprises approximately 36 percent of residential development, while single family residential (less than 1 acre per dwelling unit) comprises approximately 64 percent. Commercial and industrial land use accounts for approximately 2 percent of the total non-right-of-way land use; however, existing land in this category is exclusively commercial. Open space (agriculture, pasture, forest, natural area) comprises 27 percent of non-right-of-way land use, while public/community and vacant parcels comprise 11 percent. The estimated area in right-of-ways is approximately 29 percent of the total land in Pe Ell.

The overall land use goals as stated in the plan are to ensure the following:

- continuance of the existing town design by adopting policies for future residential development;
- development of vacant, buildable lots and agricultural lands into low-density residential uses;
- conformity and compatibility of commercial activities within the central business core, while also promoting downtown economic revitalization to provide new job opportunities for local residents; and
- limited highway commercial and industrial development, with carefully designed access points, compatible with surrounding residential uses.

In addition to these overall goals, specific goals of the plan include discouraging or prohibiting development within floodplains, wetlands and other critical areas, creating and maintaining buffer areas in and around developments, and providing suitable space to accommodate future institutional and public land uses.

3.8.2 Thurston County

The northern portions of the study area lie in southern Thurston County and are predominately rural residential/agricultural and undeveloped areas of wooded land and open fields. Agricultural fields and small rural residential enclaves are sparsely distributed along the Chehalis River, and along the Skookumchuck River below the Skookumchuck Dam. Timber production is prevalent in the areas surrounding the Skookumchuck reservoir. The Town of Bucoda is the only area of significant commercial or industrial activity located within the study area in southern Thurston County.

3.8.2.1 Comprehensive Plan

The Thurston County Comprehensive Plan was revised in 1998. According to the plan, land use in southern Thurston County is primarily low-density (one unit per 5 acres [1/5]) rural residential development and long-term agriculture land. Long-term forestry lands and open space are also prevalent throughout the area. Within the study area, long-term agriculture and rural 1/5 residential are the dominant land uses adjacent to the Chehalis River south of Grand Mound. The land within Waunch Prairie south of Bucoda is primarily rural 1/5 residential, becoming interspersed with long-term agriculture and long-term forestry land east of Bucoda to the Skookumchuck Dam. The land east of the dam, surrounding the Skookumchuck reservoir, is exclusively devoted to long-term forestry.

There are several mineral extraction sites present within the Thurston County portion of the study area. A portion of the Centralia Mining Company coal mine is located southeast of Bucoda, and smaller rock quarries are located at the upstream end of the Skookumchuck reservoir, south of Skookumchuck Road near RM 16, and adjacent to the Skookumchuck River at RM 17.4.

Land use goals for residential development in southern Thurston County include maintaining the rural aspects of the county, while also providing buffering and transitions between environmentally sensitive areas and existing rural development, and areas of higher density development. Goals for commercial development include providing commercial services to rural and urban residences in an efficient manner, redeveloping and infilling existing rural commercial areas, and providing limited expansion of commercial centers to serve the growth of surrounding communities.

Land use goals for industrial development include siting industrial developments in close proximity to agriculture, forest, and mineral resource lands in order to make accessibility to these and other resources efficient.

3.8.2.2 Shoreline Management

Shoreline development in Thurston County is regulated by policies set forth in the Shoreline Master Program for the Thurston Region, the Shoreline Management Act of 1971, and Title 19 of the Thurston County Code. These policies are designed to encourage proper development of shoreline areas, while minimizing harmful impacts to the shoreline environment. Within the Thurston County portion of the study area, the Chehalis River and Skookumchuck River fall under the jurisdiction of the Shoreline Management Act.

3.8.2.3 Floodplain Management

The portion of the study area that occurs within Thurston County is prone to flooding by the Skookumchuck River. The land in this area is primarily used for agriculture, with some areas of rural residential development also present. A portion of the Town of Bucoda, consisting primarily of low-density, single-family residential developments, is located in the Skookumchuck floodplain.

Title 14, Chapter 14.38 "Flood Hazards" of the Thurston County Code sets forth provisions to promote public safety and general welfare, and to minimize damage due to flood conditions in specified areas. These areas of special flood hazard are identified on the Flood Insurance Rate Maps prepared by the Federal Insurance Administration, and supplemented by "The Flood Insurance Study for Thurston County", dated November 1980.

3.8.2.4 Stormwater Management

Stormwater management policy in Thurston County is set forth in Title 15, Chapter 15.05 "Thurston County Stormwater Standards" of the Thurston County Code. Regulations pertaining to the control of new development and redevelopment construction stormwater outflow and/or treatment are stated in the Drainage Design and Erosion Control Manual for Thurston County. Currently, the county is reviewing WDOE's Stormwater Management Manual for Western Washington for future incorporation into county policy.

3.8.2.5 Public Services

Police protection for the Town of Bucoda, as well as areas of Thurston County within the study area, are provided by the Thurston County Sheriff's Department. Fire protection and emergency medical assistance within the city limits of Bucoda are provided by the Bucoda Volunteer Fire Department. Fire protection and emergency medical assistance in all other unincorporated areas are provided by Thurston County Fire District 12 (Tenino) and Medic One of Thurston County.

Utilities provided in the area of Bucoda include electricity, telecommunications, and cable television. Electricity service is provided to Bucoda by PSE. Bucoda is served by a 115 kV line that originates from a PSE distribution station in Tenino.

Telecommunication services are provided to Bucoda and the surrounding areas by the Tenino Telephone Company. Cable television service is provided by TCI Cablevision, which operates a cable that runs adjacent to SR-507.

3.8.2.6 Bucoda

The Bucoda Comprehensive Plan was adopted in 1994. According to the plan, approximately 83 percent of the total land area within Bucoda is currently zoned for residential use. Commercial land use accounts for approximately 8 percent, while industrial use accounts for approximately 9 percent of the total land zoned in Bucoda. While industrial and commercial zoning accounts for approximately 17 percent of the total land in Bucoda, actual land use in these areas is dominated by residential development and vacant space.

The Bucoda Comprehensive Plan was created with several goals relating to land use. These goals include:

- promotion of contiguous, non-sprawling residential development using existing undeveloped lands within Bucoda city limits;
- preservation of the small, clean, and rural town character as well as the protection of the town's many historical landmarks and areas; and
- protection of the aquifer and aquifer recharge areas from which the town obtains its water supply.

With the population of Bucoda not expected to experience significant growth in the next 20 years, there is sufficient developable land within city limits to allow for compatible residential,

commercial, and industrial development without increasing the areal extent of the town. However, there are several constraints to development in many areas within the city limits, which include:

- proximity of the Skookumchuck River and its adjacent floodplain which occurs within the eastern and southern portions of the city limits;
- locations of wetlands, steep slopes, and sensitive aquifer recharge areas; and
- current extent of the town's water supply and sewage treatment capabilities.

Specific goals for residential development, as stated in the plan, include maintaining the rural, small town character by developing residential areas in contiguous patterns in order to protect and enhance neighborhood development while reducing low-density sprawl. This emphasis on neighborhood enhancement must also be compatible with adjoining commercial and industrial land uses to avoid residential disturbances. Future commercial development in Bucoda will occur near the entry to the town adjacent to SR-507. Goals for commercial development are to provide easy access for pedestrians and adequate parking for professional, service, and retail-oriented activities. Commercial development will also serve as an aesthetic benefit as well as improve business access to residents and visitors to the town.

Goals for industrial development include ensuring the compatibility of industrial usage with surrounding land uses. Another goal is to use the existing rail line to attract clean industrial activity that would provide more employment opportunities to local residents. Such industrial activities could include warehousing, storage, light industrial activities, and machine and repair shops.

3.9 RECREATION AND AESTHETIC RESOURCES

Diverse outdoor recreational opportunities exist within the study area. These include both public and private recreational areas and facilities. Recreational areas range from developed urban parks to open space that provides recreation such as nature study. Table 3.8-1 lists recreational lands and facilities within the study area.

Most of the developed recreation areas are within Centralia and Chehalis. The most intensively developed areas are Fort Borst Park in Centralia and Stan Hedwall Park in Chehalis. Generally, there are four types of parks: mini, neighborhood, community and regional parks. Neighborhood and community parks predominate, as they provide the widest range of active and passive

recreation opportunities. Mini parks supplement the neighborhood parks and meet casual recreational needs. Regional parks offer unique recreation opportunities not commonly offered at other parks.

3.9.1 Developed and Undeveloped Parks

Schaefer County Park. Located along the Skookumchuck River approximately 2 miles north of Centralia on SR-507, Schaefer Park covers approximately 14 acres. It provides picnicking, designated swim areas, covered shelter, hiking, a volleyball court, a playground, fishing, horseshoe pits, and group picnic area. The park contains riparian wetlands associated with the Skookumchuck River. Half the park has trails, which pass through alder and vine maple forests near the river and its backwaters. River-associated wildlife includes muskrat and beaver.

Fort Borst Park. Fort Borst Park is one of the most developed parks in the region. Centered on the Historic Borst Family Homestead, the park has a variety of recreation opportunities, including fishing, swimming, picnicking, nature study, bird watching, boating, and hiking. Facilities include fields for soccer, softball, and baseball, tennis courts, horseshoe pits, volleyball courts, picnicking areas, an arboretum, a boat launch, historical Borst Home and Fort Borst Blockhouse, community kitchens, playground, and the Centralia Parks and Recreation Office.

Rotary-Riverside Park. Situated off Harrison Avenue along the Skookumchuck River, this park offers a campground, picnicking areas, fishing, horseshoes, outdoor shelter, a playground, soccer and baseball fields, a fitness trail, and natural area.

Stan Hedwall Park. This regional park totals 202 acres in size. The developed portion of the park is 111 acres and includes a little league complex with four fields, a playground, two full-sized baseball fields, four softball fields, soccer fields, a 29-unit campground with hook-ups, a nature study area, picnicking areas, and a community kitchen. The City of Chehalis has capital improvement projects slated for Stan Hedwall Park over the next 20 years (City of Chehalis 1999).

Westside Park. This 0.9-acre park in Chehalis provides a children's play area, basketball courts, and picnic shelters.

Duffy Park. There is a demonstration forest that was logged and replanted in 1993 and 1994 and a trail system in this 4.5-acre park.

Millett Field. There are 3.3 acres at Millett Field, which include an open play field, a tennis court, basketball court, and a small natural area.

Recreation Park. There are 12 developed acres at this park. There is a playground, a community kitchen, a softball complex, outdoor swimming pool, and several picnic shelters. Sixteen improvement projects are planned for the next 20 years.

McFadden Park. McFadden Park covers 28 acres and offers open space for hiking, bird watching, and nature study.

Dobson Park. Dobson Park covers 26 acres located along the Chehalis River across from and adjacent to the confluence of the Newaukum River. The park has trails and a scout lodge, which is currently not used.

Other parks in the Centralia and Chehalis area include:

- Cedar Street Park
- Alexander Park
- Wilbur Parkins Park
- Seminary Hill Natural Area
- Central Park
- Ed S. Mayes Park
- Logan Community Park
- Plummer Lake Boat Launch

3.9.2 Golf Courses

There are three golf courses in the study area: Centralia Public Golf, Riverside Country Club, and Newaukum Valley Golf. The Rainbow Miniature Golf and Driving Range is also located within the study area.

3.9.3 Historic Steam Train

The Chehalis-Centralia Railroad is a restored 1916 logging train that operates over a 9-mile section of track that extends southwest from Chehalis. The line winds through scenic rolling hills, through farmland, and over several wooden bridges. An especially scenic portion of the line follows the Chehalis River in the study area.

3.9.4 Rivers, Creeks, Lakes, and Ponds

The major watercourses traversing the study area are considered important open space and recreational assets. These include portions of the mainstem Chehalis River, the Skookumchuck River, and the Newaukum River.

Mainstem Chehalis. Within the study area, the Chehalis River provides boating, angling, and swimming, although the river flows through mostly private land with limited public access. Fort Borst Park offers access and a boat launch to the Chehalis River. Dobson Park, across from the Newaukum River confluence, has some lightly used trails for access to the Chehalis River. Rainbow Falls State Park, which is located at the upstream end of the study area, offers fishing and swimming. There is also unofficial, dispersed recreational use along the river throughout the study area.

Skookumchuck River. There is significant recreational use of the Skookumchuck River from its confluence with the Chehalis River to just below Skookumchuck Dam. There is easy river access at Fort Borst Park, Riverside-Rotary Park, and Wilber Parkins Park in Centralia. Schaefer Park near Bucoda offers river access as well, and has a boat launch. Dispersed recreation along undeveloped reaches of the river also occurs throughout the study area, although much of the river passes through private property. Below Skookumchuck Dam, there is good angler access, as well as swimming, bird watching, and nature study opportunities.

Salzer Creek. Recreational use of Salzer Creek is dispersed and there are no developed recreational sites. Exploration of the creek corridor is likely the extent of most recreational use.

Newaukum River. Stan Hedwall Park along the Newaukum River is the primary location of recreation use on the Newaukum River. Other dispersed recreation, largely from private property, occurs also.

Hayes and Plummer Lakes. Hayes Lake is a historical river meander that was created when I-5 was constructed. Administered by WDFW, this 20-acre lake is undeveloped, but is used by anglers and hikers. Plummer Lake is approximately 10 acres and is administered by the City of Centralia. There is a car-top boat launch at the lake.

3.9.5 Chehalis to Raymond Riverfront Trail

The former railroad grade from Chehalis to Raymond was acquired and converted to a multi-use trail under the Rails-to-Trails program. The Chehalis to Raymond Trail has not been developed through the study area.

Table 3.9-1: Public Parks and Recreation Areas within the Study Area

Name	Size (acres)	Location	Facilities
Schaefer County Park	14	One mile north of Centralia on Bucoda Highway/SR-507	Picnicking, designated swim area, covered shelter, hiking, volleyball court, playground, fishing, horseshoes.
Cedar Street Park		Centralia	
Fort Borst Park		West of I-5 off Exit 82	Soccer and baseball fields, tennis courts, access to Chehalis and Skookumchuck rivers, wading pool, horseshoes, volleyball, picnicking areas, arboretum, rhododendron gardens, youngsters fishing lake, historical Borst Home, one room schoolhouse, Fort Borst Blockhouse, outdoor shelters, community kitchens, and playground.
George Washington Park		Between Pearl and Silver Streets	Memorial walk.
Stan Hedwall Park	202	Rice Rd., Chehalis	Playground, soccer/softball/baseball fields, volleyball courts, horseshoe pits, arboretum, campground.
Westside Park	0.9	Chehalis	Play area, picnicking.
Duffy Park	4.5	Chehalis	Nature study.
Millett Field	3.3	Chehalis	Tennis courts, natural area, play fields
Recreation Park	12	Chehalis	Swimming, open fields, playground
McFadden Park	28	Chehalis	
Dobson Park	26	Chehalis	
Alexander Park	6	Chehalis	
Wilbur Parkins Park		Meridian St. along the Skookumchuck River	Picnicking, fishing.
Seminary Hill Natural Area		East of downtown Centralia	Trails.
Central Park		Downtown Centralia	
Ed S. Mayes Park		Centralia	Flower gardens
Rotary-Riverside Park		Off Harrison Avenue (exit 82) along the Skookumchuck River	Campgrounds, picnicking, fishing, horseshoes, outdoor shelter, playground, soccer and baseball fields, fitness trail.
Logan Community Park		Intersection of Logan and Vienna Streets	Playground, tennis and basketball courts, horseshoes, picnic shelter, youth play court area.
Plummer Lake Boat Launch		West end of Lewis Street	Car top boat launch.
Rainbow Falls State Park	139	17 miles west of Chehalis on SR-6.	Camping, picnicking, hiking, biking, and equestrian trails, fishing, swimming, horseshoes, softball field, nature study, flower garden.

3.9.6 Aesthetics

Although most of the study area lies within unincorporated Lewis County, the most commonly accessed viewshed is from I-5 through the cities of Centralia and Chehalis. Other common views include those from SR-6 and SR-508. The quality and characteristics of these viewsheds are as follows:

I-5 enters the study area from the north immediately south of U.S. 12 and travels in a direct line through Centralia and Chehalis. Most of the urban development in both cities is east of the highway and remains low in the valley; views of the surrounding hills are unobstructed, and Mount Adams and Mount Saint Helens appear in the distance. Development along the highway is predominantly retail and associated signage. Because most of the interstate through the study area is at a higher elevation than surrounding area, the commercial and retail development falls into the foreground. The mid-view and background views are rural and natural. The relatively straight route of I-5 through the study area maintains a consistent scenic presentation of the view. Since the highway is not divided, the northbound views are similar in aesthetic quality, without views of Mount Adams or Mount Saint Helens.

SR-6 travels in an east-west alignment across the study area, traversing a broad floodplain with mostly agricultural, residential and scattered commercial use. The route is level and, although it follows the course of the Chehalis River, the river is only visible at crossings. Westbound travel affords unobstructed views of the hillsides above the floodplain and eastbound travel provides a view of Chehalis in the foreground with hillsides and mountains in the background.

SR-508 follows the South Fork Newaukum River from I-5 to Onalaska. SR-508 travels mostly through agricultural and forested areas with rural residential development adjacent to the road. Most long-range views are obstructed by roadside vegetation. Otherwise, there are unobstructed views of forested hills.

3.10 TRANSPORTATION AND TRAFFIC

This section describes existing transportation conditions within the study area. Information on major routes was gathered from the *2000 Annual Traffic Report* (WSDOT and FHWA 2001) and accident summaries compiled and prepared by WSDOT. Some of the major effects of flooding on transportation are also described in this section.

3.10.1 Major Transportation Routes in the Study Area

3.10.1.1 Interstate 5

Interstate 5, which is part of the federal interstate highway system, extends from the U.S./Canadian border in Blaine, Washington, south to the Mexican border. I-5 is the major north-south route in western Washington for travel between cities. Within the study area, the interstate crosses through the city centers of Centralia and Chehalis. Except for this 12-mile stretch of road, I-5 passes primarily through rural areas within the study area. U.S. Highway 12 intersects I-5 at milepost (MP) 68 and is jointly designated with I-5 for 20 miles, until Exit 88 where it continues east of the interstate.

Most of I-5 within the study area is a four-lane highway with 10-foot outside shoulders, and a median that ranges from 15 to 40 feet in width (FHWA and WSDOT 1998). The most recently published Average Daily Traffic (ADT) volumes cited an average of 54,800 vehicles from 5 milepost stations between MP 69 and 86 in the year 2000, ranging between 45,000 and 65,000 vehicles (WSDOT and FHWA 2001). For the area between MP 63 and 95 on I-5, there were 836 accidents between 1998 and 2000, averaging 279 a year. Roughly 60 percent of those accidents involved property damage, and approximately 40 percent were injury accidents.

3.10.1.2 U.S. Highway 12

U.S. Highway 12 (U.S. 12) shares the I-5 corridor between MP 68 and 88 (20 miles). U.S. 12 is a major route used for travel to and from the southeastern cities of Washington (Walla Walla, Yakima, Tri-Cities) and cities on the Olympic Peninsula (such as Aberdeen).

Because U.S. 12 is separated into three fairly distinct sections in the study area (corridor west of I-5, the section also designated as I-5, and the corridor east the I-5 intersection), the following traffic information is also split into three sections. The portion of U.S. 12 that enters the study area from the west extends from approximately MP 42 to 46. The average traffic volume of seven stations within this stretch was 10,543 in 2000. The lowest volume was 8,500 vehicles, while the highest recorded volume was 16,000 vehicles. The portion of the route shared by I-5 (approximately MP 47 to 67) had an ADT of 9,267 vehicles in 2000 (averaged over three station counts, ranging from 6,900 to 11,000 vehicles). The section of U.S. 12 extending east from I-5 within the study area between MP 67 and 80 had readings for ADT volumes at twelve stations

ranging from 5,900 and 7,600 vehicles; the average was 6,908 vehicles (WSDOT and FHWA 2001).

3.10.1.3 State Route 6

State Route 6 (SR-6) transects the southwestern quarter of the study area. It intersects I-5 at the Exit 77 interchange.

Although there are approximately 30 miles of SR-6 in the study area, there are only traffic data for the last few miles of the route as it ends in Chehalis. In 2000, the average traffic volume was 8,567 vehicles from six stations between MP 49 and 51. The lowest volume reading was 6,000 vehicles while the highest was 10,000 vehicles (WSDOT and FHWA 2001).

3.10.1.4 State Route 507

State Route 507 (SR-507) begins in the City of Centralia and intersects I-5 at MP 82. It continues north within the study area for approximately 15 miles.

Although SR-507 extends through approximately 15 miles of the study area, there are only traffic data for the first 5 miles of the route as it begins in Centralia. The average traffic volume was 8,057 vehicles between 14 stations between approximately MP 0 and 5. The lowest volume reading was 2,100 vehicles while the highest was 14,000 vehicles. Additionally, the SR-507 couplet running through Centralia did not differ much in the annual volume of traffic (7,950 vehicles) as compared to the other sections measured within the study area (WSDOT and FHWA 2001).

3.10.1.5 State Route 508

State Route 508 (SR-508) transects the southeastern corner of the study area. It begins just east of the community of Napavine, at the Exit 71 interchange of I-5.

SR-508 extends approximately 18 miles from I-5 to the east boundary of the study area. The traffic data from MP 0 to approximately 18 revealed an ADT volume of 3,754 vehicles, as averaged from thirteen locations in 2000; they ranged from 1,400 to 6,300 vehicles (WSDOT and FHWA 2001).

3.10.2 Scheduled Road Improvement Projects and Ongoing Studies

Washington State Department of Transportation is currently evaluating alternatives for improvements to I-5 between the Toutle Park interchange (Exit 52) and the Maytown interchange (Exit 95), including the portion of the highway that runs through the study area. Improvements are being proposed to accommodate the expected 2020 travel demand and to upgrade transportation facilities to meet current WSDOT and FHWA design standards. Alternatives are being evaluated for widening existing four-lane segments of I-5 to a six-lane divided highway and improving existing interchanges, including the U.S. 12 West interchange (Exit 88) within the study area. Improvements could also include widening or replacement of bridges and overcrossings, alignment improvements, drainage improvements, and frontage road relocations (FHWA and WSDOT 1998). As part of this process, raising the grade of the highway by up to 6 feet across portions of the Chehalis River floodplain is being evaluated in order to reduce flooding-related closures of the highway in the Centralia/Chehalis area. If the flood reduction project is built, then I-5 would potentially not have to be raised.

In addition, a number of projects are scheduled by local jurisdictions to improve current road conditions within the study area. The projects currently planned for each jurisdiction are identified in the following paragraphs.

3.10.2.1 Lewis County

The following projects are included in the Lewis County Draft 2002-2007 Six Year Transportation Improvement Program:

- 2002 – Centralia-Alpha Road – Resurfacing 2.3 miles
- 2002-2004 – Centralia-Alpha Road – Resurfacing 3.0 miles
- 2003-2004 – Jackson Highway – Road Improvements 2.6 miles
- 2003-2007 – Centralia-Alpha Road – Resurfacing 2.3 miles
- 2004-2007 – Centralia-Alpha Road – Resurfacing 2.1 miles
- 2004-2007 – Jackson Highway – Road Improvements 2.0 miles
- 2005-2007 – Jackson Highway – Resurfacing 2.9 miles

3.10.2.2 Thurston County

The following projects are included in the Thurston County Roads and Transportation Capital Projects, 2002-2007:

- 2002-2004 – Skookumchuck Road Upgrade, Coal to Whitefish
- 2003-2007 – Grand Mound Growth Area – road upgrades and a bridge replacement

3.10.2.3 City of Centralia

The City of Centralia Six Year Transportation Improvement Program from 2002-2007 includes the following projects:

- 2002 – Maple Street Bridge replacement
- 2003-2004 – Central Boulevard, Area Transportation Improvements – construction of new truck route
- 2003 – Harrison Avenue widening

3.10.2.4 City of Chehalis

Included in the City of Chehalis Six Year Transportation Improvement Program from 2002-2007 are the following projects:

- 2002-2003 – National Avenue Asphalt Overlay
- 2003 – Kresky Avenue Flood Mitigation Feasibility Study
- 2003-2004 – SW Newaukum Improvement
- 2004-2005 – SW Snively Avenue Improvement
- 2005-2006 – Downtown Market Boulevard. Improvement
- 2006-2007 – NW Front, NW Pacific, and NW Park Improvements

3.10.3 Pedestrian and Bicycle Facilities

Sidewalks serve a majority of the streets within the cities of Centralia and Chehalis, Bucoda, and other incorporated areas. In the unincorporated portions of Lewis County, sidewalks are found mostly in newer areas developed under the county's current development standards. Paved shoulders and shared roadways provide pedestrian transport in much of the rural county.

Hundreds of miles of pathways and trails traverse the forest and timberlands in Lewis County and in the Skookumchuck drainage in southern Thurston County.

Within the City of Chehalis, bicycle paths are designated on several streets throughout the city, including Market Street/National Avenue, Kresky Avenue, Chehalis Avenue, and Saint Helens Avenue/Lawrence Road. The Port of Chehalis Comprehensive Plan (May 1997) evaluated long-range plans for pathways that would connect sites on Maurin Road, Bishop Road, and Jackson Highway with recreational facilities in the city, potentially converting abandoned railroad beds for bicycle and pedestrian use. Most of these run through the urban growth area and into Lewis County. Bicycling in the Centralia/Chehalis and surrounding area is very popular, drawing cyclists regionally for organized rides and tours.

3.10.4 Public Transit

Transit service is provided by Twin Transit, serving the Lewis Public Transportation Benefit Area (LPTBA). The LPTBA has an estimated population of 20,305, with the cities of Chehalis and Centralia as the core of the service area (City of Chehalis 1999). In 2000, the system average 22,000 passenger trips per month, with a total of 264,952 riders in that year (Twin Transit, pers. com. 2001).

Twin Transit provides daily fixed route and para-transit service. The buses are wheelchair-accessible and fixed-route service runs seven days per week on three routes. The Lewis County Mall in Chehalis and the Centralia Train Depot serve as transfer points between routes. Connecting service to Thurston County's Intercity Transit is also available. Twin Transit serves two park-and-ride facilities.

3.10.5 Airports

The Chehalis-Centralia Airport is located in Chehalis, west of the I-5 interchange at Exit 79. Runway 15/33 is 5,000 feet long and serves approximately 36,000 operations annually (City of Chehalis 1999). Approximately 65 percent of the air traffic handled by the airport is local general aviation, and 35 percent is transient general aviation. A second runway, runway 1/19, was permanently closed several years ago when its usable length was reduced.

3.10.6 Rail Transportation

Passenger rail transportation is provided by Amtrak, which serves the Centralia/Chehalis area with six daily trains. The station is located in Centralia, just east of SR-507. This service operates on track owned by Burlington-Northern Santa Fe Railroad (BNSF).

Freight rail service is provided by BNSF and Union Pacific (The Chamber 2001). These rail lines serve several commercial and industrial operations in the area, and a spur line extends into the Port of Chehalis Industrial Park (City of Chehalis 1999).

The Port of Chehalis owns the CM&E rail line, which connects to the BNSF mainline via the City of Tacoma rail line near Main Street in Chehalis. The CM&E rail line extends approximately 10 miles west to the Curtis Industrial Site.

3.10.7 Flooding

Flooding has occurred along the I-5 corridor within the study area, and in some cases has resulted in the closing of the interstate and other transportation routes. I-5 was closed for several days during the flood events in 1990, and substantial portions of the interstate between the 13th Street interchange in Chehalis and the Mellen Street interchange in Centralia were under water in February 1996, closing the highway for four days (FHWA and WSDOT 1998). WSDOT and FHWA minimum flood criteria require that the mainline pavement not be flooded during the 50-year flood event. Sections of I-5 that do not meet this standard include portions between the Chamber of Commerce Way interchange in Chehalis and the Mellen Street interchange. A section of the interstate around the 13th Street interchange in Chehalis also does not meet the 50-year flood standard.

All primary arterials in the City of Centralia are inundated with floodwater during a 100-year flood event, which eliminates access to all major healthcare facilities (e.g., Centralia Providence Hospital) and severely hampers evacuation activities related to convalescent facilities, isolated residential areas and other public health and safety facilities, such as treatment plants, water wells, dikes and levees. Further, flooding significantly impacts the ability of police patrol cars and other civil service vehicles to reach people in need (Calkins, pers. com. 2001).

Within Centralia, SR-507 (named throughout the city as Mellen Street, Alder, Cherry Street, Pearl Street, Tower Avenue and Sixth Street) also becomes completely inundated in a large flood event. In addition to this major route, many of the smaller routes surrounding the city become

significantly inundated, resulting in other portions of Lewis County becoming isolated from needed services and facilities (Calkins, pers. com. 2001).

Interstate commerce can only reach the cities of Centralia and Chehalis from the north (Olympia) via I-5. During a flood event, the interchanges at I-5 Exits 81 and 82 are flooded and impassable, in addition to the section of I-5 flooded to the south of Centralia (Calkins, pers. com. 2001).

3.11 AIR QUALITY

3.11.1 Regulatory Background

The Federal Clean Air Act (CAA) was enacted in 1969 and established the National Ambient Air Quality Standards (NAAQS). The NAAQS includes both primary and secondary standards for various air pollutants. Unless a state has adopted more stringent standards, NAAQS apply (Table 3.11-1). The primary standards define maximum concentrations of specific pollutants, which are set to protect the public health. The secondary standards define maximum concentrations of certain pollutants that are known or suspected of causing damage to vegetation, visibility impairment or material soiling.

Air quality regulation in Washington is divided between the EPA (Region 10) and WDOE. EPA and WDOE establish regulations designed to limit emissions from air pollution sources and to minimize concentrations of pollutants in the outdoor air. Although their regulations are similar in stringency, each agency has established its own standards. Washington has established additional state ambient standards for total suspended particulates and sulfur dioxide standards more stringent than the federal requirements.

The EPA developed the General Conformity Rule to implement Section 176(c) of the CAA. The rule became effective on 31 January 1994. The underlying principle of the General Conformity Rule is that federal actions must not cause or contribute to any violation of a NAAQS. A conformity determination is required for each pollutant where the total of direct and indirect emissions caused by a federal action in a non-attainment area exceeds minimum threshold levels listed in the General Conformity Rule (40 C.F.R § 93.153.).

WDOE has established state local ambient air quality standards that are equivalent to the national standards with a few limited additional conditions. The Southwest Clean Air Agency (SWCAA),

the agency responsible for air quality regulation in the Centralia area, has adopted the EPA and WDOE's standards by reference.

3.11.2 Existing Conditions

Under federal regulations, areas that violate primary ambient air quality standards are designated as non-attainment areas, and State Implementation Plans must be developed to bring these areas into attainment. For the Centralia area, the SWCAA is the direct manager of air quality issues. Based on local air quality monitoring data and WDOE and SWCAA analysis, EPA has determined that the Lewis County area is either in attainment or unclassified for each of these standards. Because the area meets all ambient air quality standards, SWCAA's regulatory program has been developed to maintain air quality. This includes general regulations and project-specific programs.

Table 3.11-1: National, State, and Local Ambient Air Quality Standards

Pollutant	Averaging Time	National (Primary)	National (Secondary)	Washington State
Total Suspended Particulates	Annual Geometric Mean 24 – Hour Average	No Standard	No Standard No Standard	60 ug/m ³ 150 ug/m ³
Particulates PM ₁₀	Annual Arithmetic Mean 24 – Hour Average	50 ug/m ³ 150 ug/m ³	50 ug/m ³ 150 ug/m ³	50 ug/m ³ 150 ug/m ³
Particulates PM _{2.5}	Annual Arithmetic Mean 24 – Hour Average	15 ug/m ³ 65 ug/m ³	15 ug/m ³ 65 ug/m ³	No Standard No Standard
Sulfur Dioxide (SO ₂)	Annual Average 24-Hour Average 3-Hour Average 1-Hour Average	0.03 ppm No Standard 0.14 ppm No Standard	No Standard 0.50 ppm No Standard No Standard	0.02 ppm 0.10 ppm No Standard 0.40 ppm ^A
Lead (Pb)	Quarterly Average	1.5 ug/m ³	1.5 ug/m ³	No Standard
Carbon Monoxide (CO)	8-Hour Average 1-Hour Average	9 ppm 35 ppm	9 ppm 35 ppm	9 ppm 35 ppm
Ozone (O ₃)	1-Hour Average 8-Hour Average ^B	0.12 ppm 0.08 ppm	0.12 ppm 0.08 ppm	0.12 ppm No Standard
Nitrogen Dioxide (NO ₂)	Annual Arithmetic Average	0.053 ppm	0.053 ppm	0.05 ppm

Notes: ppm = parts per million, ug/m³ = micrograms per cubic meter

^A 0.25 not to be exceeded more than two times in any 7 consecutive days.

Primary standards are listed in this table as they appear in the federal regulations.

^B Eight-hour ozone standard went into effect on 16 September 1997, but implementation is limited.

Air quality at a given location is described by the concentration of air pollutants in the atmosphere. Units of concentration measurement are generally expressed in parts per million (ppm) for micrograms per cubic meter (ug/m³). The significance of a pollutant concentration is determined by comparing it with an appropriate federal and/or state standard. For the purpose of

this study, a significant air quality impact is defined as an exceedance to the standards that cannot be minimized to a level below the standards.

A list of facilities that are currently permitted by the state to emit air pollutants in the study area is presented in Table 3.11-2. The latest annual emissions inventory from SWCAA for Lewis County is shown in Table 3.11-3.

Table 3.11-2: Ecology Facility List of Air Pollutant Emitters

Facility Site Name	Ecology Identifier	Description
Cascade Hardwood	39118225	Small source governed only by local air authorities.
Columbia Harbor Lumber Co.	85236989	Small source governed only by local air authorities.
Darigold, Inc., Chehalis Db WestFarm Foods	28466988	Facility that would be regulated under operating permit program but has opted to keep its emission limits lower than the threshold for the program.
Northwest Hardwoods, Inc. Fill	1155	Small source governed only by local air authorities.
Northwest Pipeline Corp. Chehalis Meier	93825228	Facility that as a part of its process will emit air pollutants and is seeking construction permits for either a new source or changes to an existing facility.
Pacific Power	98913453	Facility that as a part of its process will emit air pollutants and is seeking construction permits for either a new source or changes to an existing facility.
TransAlta Centralia Mining LLC	55942474	Small source governed only by local air authorities.
Washington Natural Gas Chehalis	2298122	Facility that would be regulated under operating permit program but has opted to keep its emission limits lower than the threshold for the program.
West Coast Mills, Inc.	98535131	Small source governed only by local air authorities.
Wood Products Div. Wayne Dalton Corp.	78756294	Small source governed only by local air authorities.

Table 3.11-3: 2000 Lewis County Emissions (in Tons per Year)

SOURCE	CO	SO ₂	VOC	NO _x	PM	PM-10
Industry	2,537	83,620	465	20,331	4,145	2,615
On-road Vehicles	14,348	133	1,183	3,141	5,384	2,956
Non-road Mobile Sources ¹	4,541	48	762	579	71	71
Area Sources ²	6,758	10	2,269	154	1,019	911
TOTAL	28,184	83,811	4,679	24,205	10,618	6,553

Notes: ¹ Non-Road Mobile Sources include aircraft, vessels/ships, railroads, lawn and garden equipment, recreational vehicles, and light commercial, industrial, construction agricultural, and logging equipment.

² Area Sources include solvent utilization, gasoline storage and transport, stationary source fuel combustion, woodstoves/fireplaces, residential trash and yard burning, slash burning, structure and wildfires.

3.12 NOISE

Sound travels through the air as waves of minute air pressure fluctuations caused by vibrations. Several frequency-weighting schemes have been used to develop composite decibel scales that approximate the way the human ear responds to noise levels. The weighting of noise levels at different frequencies is due to the psychological perception of noise by humans. The A-weighted decibel scale (dBA) is the most widely used for this purpose.

The decibel (dB) scale used to describe sound is a logarithmic scale that accounts for the large range of audible sound intensities. People generally perceive a 10 dB increase in a noise source as a doubling of loudness. For example, an average person will perceive a 70 dB sound level as twice as loud as a 60 dB sound. Most people under normal listening conditions would probably perceive a 5 dB change.

Sound levels typically decrease by about 6 dB for every doubling of distance from the noise source, when distance is the only factor considered. Noise levels at different distances can also be affected by several factors other than the distance from the noise source. Topographic features and structural barriers that absorb, reflect, or scatter sound waves can increase or decrease noise levels. Atmospheric conditions (wind speed and direction, humidity levels, and temperature) can also affect the degree to which sound is attenuated over distance. As a result, the existing noise environment can be highly variable depending on local conditions.

3.12.1 Regulatory Background

The Federal Noise Control Act of 1972 (Public Law 92-574) requires that all federal agencies administer their programs in a manner that promotes an environment free from noises that may jeopardize public health or welfare.

Noise levels in the study area are regulated under the provisions of Chapter 173-60 WAC. Administered by WDOE, these regulations set maximum permissible noise levels for various types of land uses, based on three classes of Environmental Designation for Noise Abatement (EDNA): residential (Class A), commercial (Class B), and industrial (Class C). WAC 173-60 establishes maximum permissible noise levels for noise sources shown in Table 3.12-1. These maximum noise levels may be exceeded by 5, 10, and 15 dBA for limited durations (15-, 5-, and 1.5-minute periods in any 1 hour, respectively). Construction noise is regulated for rural and residential receiving properties during night hours (10 p.m. to 7 a.m.) only.

Table 3.12-1: Maximum Permissible Sound Levels L_{eq}

Noise Source	Receiving Property			
	Residential Day	Residential Night	Commercial 24 hours	Industrial 24 hours
Residential	55	45	57	60
Commercial	57	47	60	65
Industrial	60	50	65	70

In addition to state regulations, the City of Centralia has a noise ordinance (Ordinance No. 1754), which prohibits any person from causing a "public disturbance noise." This includes "creation of frequent, repetitive, or continuous sounds which emanate from any building, structure, [etc]...which unreasonably disturbs or interferes with the peace and comfort of owners or possessors of adjacent property....".

3.12.2 Existing Conditions

The study area includes a mixture of residential, commercial, industrial, and agricultural lands. A variety of noise sources are present in the area. Based on observations made in the vicinity, sources of noise include the following:

- traffic on I-5 and other roadways;
- trains passing through the rail corridor;
- agricultural machinery operated on agricultural land;

- various commercial and industrial activities;
- general aviation aircraft.

WSDOT conducted noise monitoring at near-highway locations, including the Chehalis-Centralia urban areas, order to characterize existing levels near I-5 (FHWA and WSDOT 1998). Highway noise, caused by passing vehicles, was considered to be the predominant noise near interstate highways. Other noise sources, which could affect the noise environment, include two rail lines and aircraft using the Chehalis-Centralia Airport. However, these noise sources are sporadic, and have little effect on the equivalent noise levels in the study area. Data collected during the WSDOT study are presented in Table 3.12-2.

Table 3.12-2: Noise Monitoring Summary (FHWA and WSDOT 1998)

Location	Monitored L_{eq} (dBA)	Approx. Distance to I-5 (meters)
1652 Bishop Road (Chehalis)	70	92
1034 Prindle Road (Chehalis)	62	84
1090 Prindle Road (Chehalis)	74	18
Corner NW Maryland St. & NW Folsom St. (Chehalis)	76	9
772 NW Maryland St. (Chehalis)	63	38
1213A Long Road (Centralia)	73	23
Lakeshore Motel at Plummer Lake (Centralia)	70	11
505 Lakeshore Drive (Centralia)	64	229
1317 Alexander (Centralia)	59	130
Borst Park (Centralia)	65	61
1112 Eckerson Road (Centralia)	66	92

Note: The noise descriptor, L_{eq} is the equivalent continuous sound level in decibels, measured in dBA.

3.13 HAZARDS AND HAZARDOUS MATERIALS

3.13.1 Regulatory Background

Federal, state, and local legislation regulates the proper use, disposal, and cleanup of hazardous materials.

The Comprehensive Environmental Response, Compensation and Liability Act (CERCLA, also known as the Superfund Act) of 1980 (Public Law 96-510) is intended to protect the public and the environment from the effects of prior hazardous waste disposal and hazardous materials spills. CERCLA provides funds to compensate victims and to decontaminate the environment. The Superfund Amendments and Reauthorization Act (SARA) of 1986 (Public Law 99-499) amends some provisions of CERCLA and includes a Community Right-to-Know program that provides for public access to information on the presence of hazardous chemicals in their communities and releases of these chemicals into the environment.

The EPA administers the Resource Conservation and Recovery Act (RCRA) of 1976 (Public Law 94-580), along with the Hazardous and Solid Waste Amendments of 1984. This legislation provides the principal regulations for the storage, transportation, and disposal of both solid and hazardous waste. RCRA imposes requirements for reporting and permitting activities involving hazardous waste, and exercises operational control over those who generate, treat, store, transport, or dispose of hazardous waste.

Various state laws also govern hazardous materials and hazardous waste management. State hazardous waste regulations, analogous to RCRA, are primarily contained in the Washington State Dangerous Waste Regulations Chapter 173-303 WAC and the Model Toxics Control Act Chapter 173-340 WAC. The Hazardous Waste Control Law lists hundreds of hazardous and potentially hazardous chemicals. In addition, this code establishes criteria for identifying hazardous materials; regulates the storage, transport, and disposal of hazardous wastes; and identifies hazardous wastes that cannot be disposed of on land. The Washington State Dangerous Waste Regulations (Chapter 173-303-145 WAC), provides response authority for releases of hazardous substances, including spills, and hazardous waste disposal sites that pose a threat to the public health or the environment. Similar to CERCLA, Washington's cleanup law, the Model Toxics Control Act (Chapter 173-340 WAC) sets the standards and requirements for the cleanup of hazardous waste sites in order to protect the state's citizens and environment. This code

establishes cleanup levels and points of compliance that are to be applied on a site-by-site basis. Cleanup levels determine the level a particular hazardous substance will not threaten human health or the environment, and points of compliance designate the location on the site where the cleanup levels must be met.

The Army Corps of Engineers Regulation 1165-2-132, Hazardous, Toxic and Radioactive Waste (HTRW) Guidance for Civil Works Projects, provides guidance for considering issues associated with HTRW, which may be located within project boundaries or may affect or be affected by Corps Civil Works projects. This regulation outlines procedures to facilitate early identification and appropriate consideration of HTRW concerns in the reconnaissance, feasibility, preconstruction engineering and maintenance, repair, replacement, and rehabilitation phases of a project. Specific goals include: (1) identification of level of detail for HTRW investigations and reporting for each phase of a project; (2) promotion of early detection and response by the appropriate responsible parties; (3) determination of viable options to avoid HTRW problems; and (4) the establishment of a procedure for resolution of HTRW concerns, issues or problems. The Corps is responsible for the characterization of any suspected HTRW sites discovered during construction; the Local Sponsor is responsible for any necessary remedial action. A contingency plan in the event of discovery of hazardous materials during the course of construction will be included in the Project Work Plan.

3.13.2 Criteria for Determining Baseline Conditions

The Corps conducted a preliminary HTRW evaluation via the Internet and through coordination with the Department of Ecology Toxics Cleanup Program, Southwest Regional Office, for occurrence of HTRW on lands, including structures and submerged land, in the study area. The evaluation included a project review, review of site literature and project features, database search, review of available records and aerial photography, site inspections, and interviews. The following potential indicators were searched for: landfills, sumps, disposal areas, above-ground and underground storage tanks, vats, containers of unidentified substances, spills, seepage, slicks, odors, dead or stressed vegetation, water treatment plants, wells, ditches, abandoned buildings, and transport areas (such as boat yards, harbors, rail yards, airports, truck terminals, and fueling stations).

The evaluation included a review of historical documentation; a review of regulatory listings and, if necessary, review of site files; site visits; and interviews with regulators, site owners and tenants where available or necessary. Regulatory lists reviewed included:

- EPA Lists: CERCLIS and the NPL
- Washington Lists: Confirmed and Suspected Contaminated Sites, State Cleanup Sites (MTCA), Voluntary Cleanup Sites, Hazardous Waste Generator Sites, Underground Storage Tanks, Leaking Underground Storage Tanks.

The assessment covered all study regions, within the general vicinity of the proposed project or existing features proposed for significant modifications. Several site visits were conducted over the past few years. A Preliminary Assessment/Site Investigation will be conducted to determine the presence of contamination within the main footprint of the preferred alternative.

3.13.3 Potential HTRW Concerns

Sites of potential concern within the study area (both identified and unidentified sites) include the following:

Old Centralia Landfill. Adjacent to and downstream from the City of Centralia Wastewater Treatment Plant at the Mellen Street bridge is the old Centralia Landfill (a separate site from the Municipal Landfill). WDOE does not have any available environmental data on the landfill, but considers this site potentially contaminated.

Fort Borst Park. This park is located south of Harrison Avenue and between Belmont Avenue and I-5. Stormwater runoff from I-5 is of concern in this area west of the highway. The Borst Park BP/Unocal No. 4722 is another concern in this area. Leaking underground storage tanks and product lines were removed from the site in 1991 (RZA AGRA 1992). New USTs were installed in 1994 with the construction of the present service station (GeoEngineers 1995).

Industrial Park in Northeast Chehalis. The industrial park is located downstream from the point where Coal Creek flows into the Chehalis River valley. Land use is primarily commercial and industrial, with LUSTs the primary concern. A site visit behind the building at 1685 North National Avenue indicated the possibility of a tank removal. Review of the UST and LUST lists indicates tanks were removed.

Salzer Creek Flats. This area is north of Salzer Creek and east of Centralia and Chehalis. Land use includes commercial, residential, and agriculture. A site visit revealed a previously

unidentified diesel UST and a small oil spill associated with farm equipment at this site. Additionally, a salvage yard is located in the area.

Jorgenson Mill on Central Avenue. WDOE is currently investigating this abandoned mill site.

Chehalis-Centralia Airport. The airport is located on the west side of I-5 between Chehalis and Centralia. Leaking USTs are of primary concern at this site. A Complaint Investigation Report was filed by WDOE in October 1991. The file states that aviation fuel was forced from one of the USTs during the January 1990 flood. This tank and two others were removed from the site in 1991 with 425 cubic yards of contaminated soil. The airport is currently operational and surfaces are paved or grass covered.

3.14 CULTURAL RESOURCES

3.14.1 Archaeology and History

Artifact forms found in this region suggest that the archaeological record may span roughly the past 8,000 to 10,000 years. The earlier part of this long interval (prior to about 4,000 B.P.) appears to represent highly mobile hunting and gathering economies that depended heavily on hunting of large game. After about 3,000 years B.P., a subsistence system involving heavier dependence on fishing and vegetal resource collecting emerged. This system involved a greater degree of sedentary occupation, especially during the winter months when stored foods provided a major part of the food supply. From spring through fall months, village groups split into smaller family foraging groups that moved between a series of resource collecting sites where roots, berries, salmon, various other fish, deer, elk, smaller mammals, and waterfowl were exploited. This semi-sedentary form of land use persisted through the first half of the 19th century.

The flood control project area lies within the traditional territory of the Upper Chehalis Tribe, a division of the Southwestern Coast Salish. This area contained habitats for many important food resources in the native economy: salmon, various other fish, camas, berries, acorns, bracken fern roots, deer, elk, and waterfowl. Most of these resources were available within the project area and archaeological sites associated with their harvest or capture are expected to exist there. Because of frequent winter flooding, most of the project area is not well suited to winter

residential sites or villages. Those settlement types most likely to be represented in the project area are the various warm season resource collecting camps and stations.

Euroamerican presence in the area was of a relatively low intensity in the early 1800s, and primarily associated with the fur trade and the travel route between the Hudson Bay Company's posts at Fort Nisqually and Cowlitz Farm. By the mid-1850s, Euroamerican settlement of the area began with settlement focusing initially on the prairies around the confluence of the Skookumchuck and Chehalis rivers. By the last decade of the 1800s, the greater Centralia area supported a population of about 5,000 people. The mainstays of the economy included harvesting and milling of timber, two large brick manufacturing yards, a furniture factory, coal mining, and diverse agricultural activities including hop growing. Most of these activities persisted as central elements of the local economy through the remainder of the historic period.

3.14.2 Previous Cultural Resources Investigations and Known Cultural Resources

Previous cultural resources investigations have been carried out for a variety of construction projects including natural gas pipelines, highway building, a sewage treatment plant, the Corps of Engineers Centralia-Chehalis urban levee alignments project, City of Centralia waterline routes, a fiber optic cable, a gas-fired combustion turbine generation plant. The peak of archaeological work in this area took place in the 1970s but some work has continued up to the surveys for the proposed flood control project during the past year. These projects have inventoried a total of 69 prehistoric archaeological sites, most of which are characterized as open campsites or lithic scatters comprised of flaked stone and fire-modified rock.

A cultural resources reconnaissance for a Corps of Engineers flood control project in the Centralia-Chehalis urban area was done in 1977. This survey covered 445 acres, recorded 20 new sites and 7 previously recorded sites. Most sites were located on the floodplain, but several were on higher ground such as on outwash terraces and upland forest locations. Stone tool forms represented suggest an 8,000-year history of usage.

A total of 16 historic sites have been previously recorded for the project area. Nine of these sites pertain to historic structures that are associated with the concentration of the region's populations. These six include: the Old Ferry Site (45LE176), the Claquato Church (45LE236), the Fort Borst Blockhouse (45LE239), the O. B. McFadden house (45LE240), Centralia College (45LE244), the Borst House (45LE245), the Olympic Club saloon (45LE246), the Starke

farmstead (45TN73), and a split cedar rail fence (45TN74) probably associated with the Starke residence. The site of the Centralia Massacre (45LE243) was the site of a unique incident.

A cultural resources reconnaissance of the Skookumchuck Reservoir that was carried out in the fall of 2000 recorded three previously unidentified prehistoric lithic scatters, one previously recorded lithic scatter, and elements of a historic period granite quarry site (Hercules Quarry 6). The prehistoric sites appear to represent occupations older than 3,000 to 4,000 years in age.

During the summer of 2001, a cultural resources reconnaissance was performed on approximately a 10 percent sample of the total acreage of properties in the flood control project area that had a Right of Entry contract in place. These properties are largely confined to the west side of I-5 and the Chehalis River, an area of notable information deficiency in the previous surveys. This reconnaissance covered 266 acres and employed systematic shovel probes for those tracts of land where ground surface was obscured by vegetation. A total of nine new sites and one isolate were recorded and boundaries of two previously recorded sites were extended. Cultural materials identified at these sites were predominately fire-modified rock with some formed tools and debris from stone tool manufacture.

The topography of the Chehalis River floodplain contains slight elevation differences that are expressed as linear ridges or as knolls. It is likely that these features represent geomorphic features formed during the terminal Pleistocene or during subsequent erosional and depositional episodes, but modern agricultural practices have probably modified the sharpness of these features. Previous cultural resource investigations indicate a tendency for sites to be concentrated on these slightly elevated landforms. These investigations also allow an estimation of the average density of prehistoric sites within the project area: 1 site/19 acres.

Substantial areas of the floodplain within the project area are cultivated and this activity causes some ongoing loss of integrity of archaeological deposits that are within the plow zone. Because most of the recorded archaeological sites in the project area have not been tested, depth characteristics, integrity, and status relative to the National Register of Historic Places are mostly unknown.

3.15 ENVIRONMENTAL JUSTICE

Executive Order 12898 requires the federal government to achieve environmental justice by identifying and addressing disproportionately high adverse effects of its activities on minority

and low-income populations. It also requires the analysis of information such as the race, national origin, and income level for areas that would be affected by environmental actions.

Environmental justice is the fair treatment and meaningful involvement of all people regardless of race, color, national origin, or income with respect to the development, implementation, and enforcement of environmental laws, regulations, and policies. Fair treatment means that no group of people, including a racial, ethnic, or socioeconomic group, should bear a disproportionate share of the negative environmental consequences resulting from industrial, municipal, and commercial operations or the execution of federal, state, local, and tribal programs and policies.

The demographics of the study area were examined to characterize the groups of people found within the study area. The data came from U.S. Census Bureau data from the State of Washington, Lewis County, Thurston County, the cities of Chehalis and Centralia, the towns of Bucoda, Rochester, Pe Ell, and Grand Mound, and the Chehalis Reservation. The town of Galvin is also within the study area, but no census data were available specifically for Galvin. Table 3.15-1 below provides a summary of the some of the census data used for this review.

Table 3.15-1: Census Data Summary for the Study Area

Entity	Total Population	Race	% of Total Population by Entity	% of Total State Population	% Families BPL ²	% Individuals BPL ¹
Washington State	5,894,121		100	100	7.3	10.6
		White	81.8			
		Black or African American	3.2			
		American Indian or Native American	1.6			
		Asian	5.5			
		Native Hawaiian or other Pacific Islander	0.4			
		Other	3.9			
		Two or More Races	3.6			
		Hispanic or Latino (of any race) ³	7.5			
Chehalis Reservation	691		100	0.01	19.7	24.4
		White	34			
		Black or African American	0.4			
		American Indian or Native American	56.2			
		Asian	0.0			

² BPL – Below the Poverty Level

³ Pursuant to the U.S. Census Bureau (Census 2000), the percent of the Hispanic or Latino population is in relation to the entire population, regardless of race. Using the state values as an example, 7.5% of the population is Hispanic or Latino, in relation to 92.5% of non-Hispanic or Latino.

Entity	Total Population	Race	% of Total Population by Entity	% of Total State Population	% Families BPL ²	% Individuals BPL ¹
		Native Hawaiian or other Pacific Islander	0.0			
		Other	1.7			
		Two or More Races	7.1			
		Hispanic or Latino (of any race) ²	7.5			
Lewis County	68,600		100	1.16	10.4	14.0
		White	93.0			
		Black or African American	0.4			
		American Indian or Native American	1.2			
		Asian	0.7			
		Native Hawaiian or other Pacific Islander	0.2			
		Other	2.6			
		Two or More Races	2.0			
		Hispanic or Latino (of any race) ²	5.4			
Thurston County	207,355		100	4.0	5.8	8.8
		White	85.7			
		Black or African American	2.4			
		American Indian or Native American	1.5			
		Asian	4.4			
		Native Hawaiian or other Pacific Islander	0.5			
		Other	1.7			
		Two or More Races	3.9			
		Hispanic or Latino (of any race) ²	4.5			
City of Chehalis	7,057		100	0.12	16	19.8
		White	89.6			
		Black or African American	1.3			
		American Indian or Native American	1.5			
		Asian	1.2			
		Native Hawaiian or other Pacific Islander	0.2			
		Other	4.0			
		Two or More Races	2.2			
		Hispanic or Latino (of any race) ²	7.9			
City of Centralia	14,742		100	0.25	13.6	18
		White	89.8			
		Black or African American	0.4			
		American Indian or Native American	1.2			
		Asian	0.9			
		Native Hawaiian or other	0.3			

Entity	Total Population	Race	% of Total Population by Entity	% of Total State Population	% Families BPL ²	% Individuals BPL ¹
Town of Bucoda	628	Pacific Islander				
		Other	4.9			
		Two or More Races	2.4			
		Hispanic or Latino (of any race) ²	10.2			
			100	0.01	18.5	25.1
		White	92			
		Black or African American	0.0			
		American Indian or Native American	0.8			
		Asian	2.2			
		Native Hawaiian or other Pacific Islander	0.3			
Town of Rochester	1,829	Other	1.3			
		Two or More Races	3.3			
		Hispanic or Latino (of any race) ²	2.1			
			100	0.03	6.2	7.7
		White	88.4			
		Black or African American	0.2			
		American Indian or Native American	1.7			
		Asian	0.9			
		Native Hawaiian or other Pacific Islander	0.1			
		Other	5.5			
Town of Grand Mound	1,948	Two or More Races	3.2			
		Hispanic or Latino (of any race) ²	10.4			
			100	0.03	13.5	14.8
		White	88.0			
		Black or African American	0.3			
		American Indian or Native American	1.2			
		Asian	0.3			
		Native Hawaiian or other Pacific Islander	0.1			
		Other	6.6			
		Two or More Races	3.4			
Town of Pe Ell	657	Hispanic or Latino (of any race) ²	10.2			
			100	0.01	20.0	22.4
		White	93.2			
		Black or African American	0.3			
		American Indian or Native American	2.3			
		Asian	0.9			
		Native Hawaiian or other Pacific Islander	0.6			

Entity	Total Population	Race	% of Total Population by Entity	% of Total State Population	% Families BPL ²	% Individuals BPL ¹
		Other	1.1			
		Two or More Races	1.7			
		Hispanic or Latino (of any race) ²	2.3			

¹ BPL – Below the Poverty Level

² Pursuant to the U.S. Census Bureau (Census 2000), the percent of the Hispanic or Latino population is in relation to the entire population, regardless of race. Using the state values as an example, 7.5% of the population is Hispanic or Latino, in relation to 92.5% of non-Hispanic or Latino.

Two distinct minority groups are evident in the study group: the American Indian and Native American population and the Hispanic or Latino population. Low-income populations are found throughout the study area, with no distinct pattern. Almost all of the communities, with the exception of Rochester, have a higher number of families and individuals below the poverty level than the state average.

Executive Order 12898 also requires federal agencies to identify the need to ensure the protection of populations relying on subsistence consumption of fish and wildlife, through the analysis of information on such consumption patterns and communications to the public of associated risks. Consumption records were not available; however, the Confederated Tribes of the Chehalis has an active interest in the maintenance of fishery resources for consumptive use as well as sources of income to tribal members.

Public involvement activities were related to developing public information on the study and reaching all groups within the study areas. The public involvement/outreach strategy consisted of (1) a series of workshops and public meetings, (2) workshop and meeting notices, news releases, and public information brochures, and (3) speaking engagements at community service clubs and local organizations by Corps and Lewis County personnel. The events were held in several locations throughout the study area. Local newspapers and local radio stations also provided extensive coverage of the study.

Lewis County also solicited the active involvement of Native American tribes, local land use planners, environmental groups, local governmental agencies, businesses, interested groups, and private citizens.

3.16 SOCIOECONOMICS

Lewis County's population increased moderately from 59,358 in 1990 to 68,600 in 2000, ranking 15th among the 37 counties in the state. During the period from 1969 to 1999, Lewis County's population increased by 52.6 percent, trailing the state increase of 72.2 percent and outpacing the national population increase of 35.5 percent. From 1988 through 1997, the average annual growth rate was 1.8 percent. The statewide average growth for the same period was 2.2 percent. Most recently, the growth rate in Lewis County has been stagnant, with an average annual increase of 0.3 percent from 1998 to 2000. There was essentially no population growth in 2000.

After several years of economic distress in the early 1980s associated with cutbacks in the timber industry, Lewis County has begun to show some positive growth. From 1986 to 1997, the civilian labor force increased annually by an average of 3.4 percent, and nonagricultural jobs increased by an average of 3.1 percent. The unemployment rate decreased from 11 percent in 1993 to 8.2 percent in 1999. However, with a three-year average unemployment rate (January 1999 – December 2001) of 8.8 percent, Lewis County is designated as a "distressed area" under state guidelines (Washington State ESD 2002). Lewis County's economy is currently in transition. Although much of the county's economic activity remains focused on agriculture and forestry, substantial gains have been made in light industry and retail trade. Overall, the county is moving from a resource-based, extractive economy to one seeking emphasis on light manufacturing, wholesale distribution, and commerce. In 2000, the largest employer was the service industry at 45 percent, followed by retail trade at 16 percent and construction at 8 percent.

In 1999, Lewis County had a per capita personal income (PCPI) of \$20,851, ranking 23rd in the state. This was 69 percent of the state average of \$30,380 and 73 percent of the national average of \$28,546. This reflects an increase of 4.8 percent from 1998. During the same period, the state increase in PCPI was 6.3 percent and the national increase was 4.5 percent.

The total personal income (TPI) for Lewis County in 1999 was \$1,430,803, ranking 16th in the state and accounting for 0.8 percent of the state total. The TPI for 1999 reflects an increase of 5.6 percent from 1998, compared with a state increase of 7.6 percent and a national increase of 5.4 percent.

The TPI includes the earnings (wages and salaries, other labor income, proprietors' income), dividends, interest, and rent; and transfer payments received by the residents of Lewis County. In

1999, earnings were 58.1 percent of TPI; dividends, interest, and rent were 19.5 percent; and transfer payments were 22.4 percent. From 1998 to 1999, earnings increased 6.1 percent; dividends, interest, and rent increased 4.5 percent, and transfer payments increased 5.6 percent.

Total earnings by persons employed in Lewis County increased from \$849,512 in 1998 to \$901,965 in 1999, a change of 6.2 percent. The largest earnings by industries in 1999 were services, accounting for 17.8 percent of earnings. State and local government accounted for 16.9 percent of earnings and retail trade accounted for 16.0 percent. Of the employers that accounted for at least 5 percent of earnings in 1999, the slowest growth in earnings from 1998 to 1999 occurred in state and local government, which increased 4.3 percent. The fastest growth in earnings during this period occurred in construction, which increased 15.2 percent. Construction accounted for 7.1 percent of total earnings in 1999.

The 1997 model-based median household income in the county was \$32,557. The percent of persons below the poverty level was 14.2 percent in Lewis County; the statewide poverty rate in 2000 was 10.2 percent

According to the 2000 census, there were 29,585 housing units in the county. Of these, 63.5 percent were owner occupied, 25.4 percent were renter occupied, and 11 percent were vacant.

4. ENVIRONMENTAL EFFECTS

This chapter provides a description of the environmental consequences of the preferred alternative relative to the no action alternative on all elements of the affected environment as described in Chapter 3.

In general, the discussion for each of these elements of the affected environment includes an analysis of individual short-term and long-term effects for both the no action and preferred alternatives, as described in Chapter 2. Additionally, planning for this project has identified a major mitigation feature located in the Scheuber ditch, SR-6 area (Figure 2.6). This feature is proposed to provide mitigation within the project area to address project impacts from several disciplines. Focusing on mitigation principally within the Scheuber ditch area is intended to consolidate multiple mitigation objectives to achieve added benefits through increased floodplain connectivity and improved interaction between wetland, fish and wildlife ecology. The following paragraphs give a brief overview of the components of this mitigation proposal.

Scheuber Ditch/SR-6 Mitigation

The Scheuber floodplain actions would involve the creation of a pond/wetland complex on the west side of the Chehalis/Centralia reach of the mainstem Chehalis River, north and south of SR-6. The purpose of the effort is to reconnect portions of the Chehalis River to the adjacent floodplain, providing functioning habitat for fish and wildlife as well as attenuation of flood flows. There are four elements of the project:

The oxbow immediately south of SR-6 would be reconnected to the Chehalis River by increasing to 400 feet the width of a low area between the oxbow and the river. This reconnection would provide surface flows to the oxbow at approximately the 1- or 2-year flood stage. Invasive plants would be removed and a 100-foot-wide riparian zone would be planted around the oxbow. The area would be fenced off from livestock as needed. A shallow channel would also be excavated from the northern edge of the oxbow to SR-6. A 400-foot section of the state highway will be elevated onto a causeway with the shallow channel continuing beneath approximately 1,000 feet to a new wetland area. The channel would carry flows at the 1- and 2-year flood stage. This would result in approximately 21 acres of new wetland habitat with 11 acres of riparian planting.

North of the highway, excavation and grading would allow distribution of flows through a series of interconnected ponds and wetlands. The existing topography and hydric soil distributions indicates that the wetlands are best located at the base of the slope on the west side of the floodplain near at the confluence of Bunker Creek and Scheuber ditch. The pond/wetland area would cover approximately 37 acres. The area would be configured as a high-interspersion habitat to increase productivity, refuge function, and hyporheic recharge. An existing unnamed creek would flow into the pond/wetland area and provide positive flow back through the shallow channel into the oxbow when Chehalis River flows are below approximately the 5-year flood stage. This would maintain water quality and increase function for salmonid rearing. Invasive plants would be removed from the area and shrubs and small trees such as alders, willows and dogwoods would be planted along the borders of the ponds and on the small islands within the complex to offer shading of aquatic habitat and foraging opportunities for terrestrial wildlife. An understory of shrubs and small trees as well as native grasses and forbs would be planted on the outer margins of the complex. LWD would be placed in the new channels and wetlands.

The connection between the pond/wetland complex and Scheuber ditch will include a sill so that flows below the 5-year flood stage will not flow north to the downstream end of the ditch, but rather would recede back through the pond/wetland complex. From the north end of the pond/wetland complex, a 400-foot-wide riparian area (200 feet on each side) will be planted along both banks of Scheuber ditch to its downstream end, providing approximately 75 acres of riparian habitat. The ditch would be reconfigured to add meanders. This would provide primarily an aesthetic benefit, giving the ditch a more natural appearance.

A second wetland complex would be created at the north (downstream) end of Scheuber ditch. This area would be excavated and graded with a configuration similar to the complex at the south end and designed to provide many of the same functions. The complex would receive inflow from Coal Creek and Scheuber ditch from the south. This would provide flow through the wetland into the Chehalis River. The wetland would also receive backwater from the Chehalis River at annual high flows, which would provide refuge from high velocities for coho, chum and chinook salmon. Vegetation planting and LWD placement would occur as described above for the south wetland complex. The north wetland complex would encompass approximately 10 acres.

As with other project features involving ground disturbance during construction, excavation and grading at the mitigation sites could cause short-term releases of dust and exhaust from

construction equipment. Soil disturbance could cause changes in water quality if sediments are introduced into surface waters and streams; however, as described in Section 4.13, erosion and pollution control plans would be implemented during construction to minimize potential impacts on water quality. Bank armoring at the oxbow reconnection may be necessary to prevent erosion in this area over the longer term. The need for and design of bank armoring in this area will be specifically determined during the project design phase.

Because the majority of the Scheuber floodplain area is farmed, little existing native vegetation would be disturbed by construction of the mitigation features. Some areas of emergent wetlands may be disturbed. As described in more detail in Section 4.4.3.2, the extent of emergent wetlands in the project area is not known with precision at this time. Much of the former wetlands in the Scheuber floodplain may have been tiled and drained. Remaining emergent wetlands that may be disturbed by mitigation construction provide little habitat value, and likely perform wetland hydrologic functions at a severely reduced level. Overall, impacts to any existing wetlands would be very minor as compared to the increase in wetland acreage and function that would result from the mitigation actions.

The mitigation project will provide wildlife and fisheries habitat, floodplain function and vegetative diversity in the mid-Chehalis Basin. The project will also provide hydraulic function. Discussion of the relevance of each discipline to the conceptual mitigation project described above is included in the pertinent sections of this chapter.

4.1 HYDROLOGY AND HYDRAULICS

4.1.1 No Action Alternative

Under the no action alternative, levees and other features of the preferred alternative would not be constructed. No structural changes would be made to the Skookumchuck Dam. Reservoir operations would not be modified for flood control, but would continue to be operated on a fill-and-spill basis with provision for a minimum 95 cfs outflow throughout the year. Minor and major flooding would continue to occur on the Chehalis River and tributaries, and the project area would continue to experience flood-related damages currently estimated at \$9,122,060 annually million annually. Although no major projects with significant effects on hydrology and hydraulics have been approved in the area, other agencies or jurisdictions would continue to undertake flood hazard reduction measures. These efforts could include measures such as

additional flood proofing or relocation of structures. Improvements to I-5 to accommodate future traffic demands would require raising portions of the roadway in the vicinity of Centralia-Chehalis or other measures to provide flood protection. Widening and elevating the roadway would entail additional fill that would incrementally add to the loss of floodplain storage in the area. Although WSDOT has not completed detailed hydraulic studies, initial analysis indicated that this loss would have minor effects on 50- and 100-year flood elevations (FHWA and WSDOT 1998). Widening of the freeway, construction of interchanges, and other improvements would increase the area of impervious surface and increase highway runoff. It is likely that bridges and culverts along I-5 would need to be modified to maintain adequate flow capacities.

4.1.2 Criteria for Determining Significance of Effects

The following criteria were used to evaluate the significance of effects on hydrology and hydraulics. A significant effect would occur if project construction and/or operation would:

- substantially alter stream flow characteristics within, downstream, or upstream of the project area;
- cause a substantial increase in flood stage within, downstream, or upstream of the project area such that there would be increases in flood hazards. This could include increased damage to existing structures, closure of transportation corridors, or risk to life;
- cause a substantial increase in flow velocity within, downstream, or upstream of the project area such that there would be significant increases in bank erosion, damage to existing structures, or risk to life;
- substantially reduce recharge of groundwater resources in the project area.

4.1.3 Preferred Alternative

4.1.3.1 Short-term Effects

In locations where roadways would be modified as part of levee construction, flows in culverts or under bridges would be redirected for short periods during construction. Removal of vegetation, soil disturbance, and construction of temporary haul roads would temporarily increase runoff from construction areas. During levee construction, stormwater runoff would be routed to catch basins or other detention structures and treated in accordance with applicable criteria contained in the *Stormwater Management Manual for Western Washington* (WDOE

2001). With proper runoff controls in place, substantial increases in stormwater flows to local drainages are not expected.

Structural modifications to Skookumchuck Dam would be constructed during the late summer when the pool elevation in the reservoir is low. Since the modifications likely could not be completed in a single season, construction would be scheduled over two summers. During the interim fall and winter seasons, the reservoir would be allowed to fill and flows would be passed over the spillway as they are under existing operations. Since changes in the reservoir outflow regime would not occur until after construction of the dam modifications is complete, no short-term effects on hydrology and hydraulics are expected.

4.1.3.2 Long-term Effects

The preferred alternative would alter flood hydrology and hydraulics in the project area. The levee system would result in some reduction of the floodplain area that is inundated and alter floodwater storage. However, because the levees would be set back a significant distance from the existing stream banks, there would be relatively little effect on the active floodplain. As a result, the active floodplain would generally function in a manner similar to existing conditions. The areal extent of flooding would be only slightly modified during small floods. Notable changes in the areal extent of flooding would occur only during floods larger than the 2-year event. The areas that would be protected from flooding during these events are mostly urban areas east of I-5. The protected areas are, in general, not within the active floodway, but rather are backwater or temporary storage areas where short-duration flooding occurs with little flow velocity.

There would be a change in peak flood stage at several locations in the project area. There would be a decrease in the 100-year peak flood stage below RM 70.74 on the Chehalis River. The peak flood stage would increase roughly between RM 70.9 and RM 74.1; the maximum increase in the 100-year peak stage would be about 0.5 foot near RM 72.8. The 100-year peak flood stage would decrease by about 0.2 foot at the Galvin Road bridge, and by about 0.25 foot at Grand Mound. Between Grand Mound and Porter, decreases in the peak 100-year flood stage would vary between about 0.1 to 0.5 foot.

Along the Skookumchuck River, the 100-year peak flood stage would decrease from 0.47 foot to 4.25 feet from RM 10 to the mouth. There would also be significant flood damage reduction to communities upstream; for example peak flood stages would be reduced by 3.22 feet at Bucoda.

During major floods, control boxes would isolate the flow of Dillenbaugh Creek and keep it from entering the Chehalis River to prevent backwater from flooding I-5 and Chehalis. Construction of the levee system may involve relocation of a channelized portion of Dillenbaugh Creek in the area between the Rice Road interchange and the BNSF tracks. Other reaches to the south may also need to be relocated. Detailed design of the channel relocation will be completed in future design phases.

The areas that would be protected from flooding do not represent significant sources of groundwater recharge to the Chehalis Basin. The vast majority of groundwater recharge in the basin occurs as a result of the infiltration of direct precipitation. The infiltration of floodwaters in floodplain areas represents only a minor contribution to groundwater recharge. This occurs because of the limited areal extent of the floodplain, the relatively short duration of flooding, and the predominantly fine-grained soils in the area. The areas that would be protected from flooding are mostly developed and have a high percentage of impervious surfaces (e.g., roads, parking lots, roofs) that further limits recharge of groundwater resources.

Recharge in floodplain areas often constitutes bank storage that provides base flow to the stream immediately following a flood, but provides little base flow thereafter. Since flooding in the Chehalis River basin generally occurs from late October through March, base flow contributions from bank storage to the river would be negligible during the low flow periods that typically occur in later July through early October. Overall, the levee system is predicted to have an undetectable and insignificant effect on groundwater recharge and base flow contribution to the Chehalis River.

Modification of the Skookumchuck Dam would provide up to 20,000 ac-ft of flood storage and alter the timing and duration of flood flows from the reservoir. During non-flood periods, flows from the dam would be similar to those under the existing operation. Although a rule curve for managing high flow events has not been finalized, it is assumed that reservoir operations would be modified to allow drawdown of the pool to elevation 455 feet in late fall. Any inflows less than 3,000 cfs would be allowed to discharge directly through the new spillway outlet gates. When inflows exceed 3,000 cfs, the flood control pool would be used to store most of the flood flow, except for a constant minimum outflow of 95 cfs. Because of the contributions of tributary streams below the dam, flows in the Skookumchuck River downstream from the dam would still be well above 95 cfs during floods. During a flood, outflows from the reservoir would be reduced to prevent Chehalis River flows at Pearl Street from exceeding 5,000 cfs. After the event

passes, water stored in the reservoir would continue to be released at volumes high enough to reach but not exceed 5,000 cfs at Pearl Street. Discharge of flood flows from the dam would likely be limited to 3,000 cfs, which is essentially bankfull flow in the upper reaches of the Skookumchuck below the dam. As a result of the modified operations, flood peaks would be reduced, the timing of peak flows would be delayed, and the duration of bankfull flows would be extended. Depending on the event, bankfull discharges could last from a few hours for smaller floods up to approximately 5 days for extreme floods.

The reduction in overbank flooding on the Skookumchuck is not expected to significantly affect groundwater recharge in the Skookumchuck subbasin. The large volume of tributary input, frequency of local flooding, and location of adjacent wetlands indicate that the Skookumchuck subbasin approaches or exceeds groundwater saturation without the addition of water from winter and early spring floods.

Changes in flow velocities within the Chehalis and Skookumchuck rivers are expected to have a negligible effect on bank erosion and would not increase damage to structures or risk to life.

Hydraulic modeling of the preferred alternative indicates that there would be little effect on flood stages downstream from Centralia. Because the levee system would cause relatively little change in the active floodplain, flood flows would be conveyed downstream in a manner similar to existing conditions. Improved flood storage at the Skookumchuck reservoir would result in flood stage reductions up to several tenths of a foot in areas downstream from the confluence with the Skookumchuck River. There would be negligible effect on the timing and duration of flooding downstream of Centralia.

4.1.4 Summary

In summary, over the long-term, implementation of the preferred alternative would change the hydrology and hydraulics of flood flows along the Chehalis and Skookumchuck rivers and tributaries, but not substantially. The levee system would reduce the floodplain area that is inundated and alter floodwater storage characteristics, but these changes would be minimized by the levee setbacks and therefore would cause no significant impacts. Significant reductions in groundwater recharge and base flow (flow velocity within, downstream, or upstream of the project) support are not expected. There would be a slight reduction (no substantial increase) in flood stages downstream of Centralia.

4.1.5 Mitigation

In developing the preferred alternative, a number of actions were taken to avoid and minimize impacts on the aquatic environment, which performs an important role in the hydrology of the area. The actions include:

- setting the levees back from the river as far as possible to reduce effects on the active floodplain;
- placing the alignment of the levees away from the river along the highest ground in the northern part of the project area along the east side of the Chehalis River. All wetlands were avoided in this area;
- proposing floodwalls in areas where river bends come close to the freeway;
- proposing floodwalls where Dillenaugh Creek flows under I-5;
- setting the levee alignment along the Skookumchuck River along high ground to coincide with the existing levee where possible;
- avoiding wetlands and mature trees within the riparian edge where the Skookumchuck levees connect with I-5.

During final design, additional modifications may be made to the levee alignment or footprint to further reduce potential impacts to wetlands, riparian areas, and floodplain area.

Mitigation actions in the SR-6/Scheuber floodplain area would reconnect portions of the Chehalis River to its floodplain. This would increase the frequency with which flood flows enter that area and allow distribution of flows through a series of interconnected ponds and wetlands. These actions would be expected to enhance local groundwater recharge associated with minor (1- to 2-year) floods and provide some attenuation of flood flows from larger events.

4.2 RIVER GEOMORPHOLOGY

The alternatives considered include project components that could directly modify geomorphic features and alter geomorphic processes that form and maintain the river channel and its floodplain. Geomorphic features and processes documented within the project area are described in detail within Section 3.2. The assessment of potential environmental effects on river geomorphology describes the potential changes in geomorphic features and processes related to specific project elements for the no action alternative and the preferred alternative.

4.2.1 No Action Alternative

Under the no action alternative, geomorphic processes would continue to operate under the current flow and sediment regime. Recent trends (last 50 years) indicate that channel change proceeds within the project area at a slow rate primarily through localized bank erosion, channel migration, and sediment accumulation within the channel and on the floodplain. The project area will continue to be a zone of sediment accumulation in which the rates of channel adjustment vary in response to temporal changes in sediment delivery.

4.2.2 Criteria for Determining Significance of Effects

The following criteria were used to evaluate the significance of effects on river geomorphology. A significant effect would occur if project construction and/or operation would:

- result in the loss of flushing flows such that sediment transport is significantly affected;
- increase flood duration such that significant erosion or depositional changes occur and negatively affect channel processes;
- increase erosion or degrade channel processes through excessively rapid ramping up of flow as flow management at the dam transitions from storage during the flood peak to release following the peak.

4.2.3 Preferred Alternative

The combined setback levee and Skookumchuck Dam modifications alternative will alter flood hydrology and hydraulics within the project area. Since hydraulics drive the sediment transport and erosion processes that modify channel form, the assessment of environmental effects on river geomorphology evaluates the magnitude and location of changes to sediment transport capacity within the project area. Specific potential changes considered within the geomorphic analysis include the following:

- Proposed modifications to the Skookumchuck Dam would alter the shape of flood hydrographs within the Skookumchuck River. Possible hydrograph changes include reduced peak flow, delayed timing of peak flow, rapid ramping of flow volume when stored water is quickly released, and extended duration of elevated flow as the reservoir is drained after the flood event. In localized areas that typically experience bank erosion or riverbed scour, these hydrologic changes could affect the rate and extent of erosion and scour.
- The proposed levee network would reduce the extent of active floodplain that receives

floodwaters. The proposed levee network would modify the locations and timing of temporary floodwater storage on the floodplain. This change in storage would alter the peak water surface elevation at several locations and modify the timing and duration of floodwater routing. Such changes could alter the locations and rates of sediment transport, deposition, bank erosion, and riverbed scour.

4.2.3.1 Short-term Effects

These potential effects were analyzed by evaluating changes in shear stress and velocity values at cross-sections within the Skookumchuck River and the Chehalis River. The details of the dam operation plan are not yet completed as part of the conceptual design. For the purpose of modeling flood hydraulics and dam operation, simplified hydrographs were developed to maximize the flood control benefits afforded by the reservoir by providing maximum flood storage and evacuating the reservoir as quickly as possible after the flood event. These dam management release hydrographs will need to be refined as the actual dam operation plan is developed. The evaluation of potential geomorphic effects is based on the flow hydraulics predicted by the current flood hydraulic model including the simplified dam management release hydrographs.

4.2.3.2 Long-term Effects

The evaluation of potential geomorphic changes showed that the anticipated hydrologic and hydraulic changes would have no effect on sediment transport capacity and potential for bank erosion within the Chehalis River except in a short (500 feet) reach of the river immediately upstream of the airport. Within this river reach floodwaters will be backwatered during extreme flood events reducing transport capacity locally and potentially encouraging additional sediment deposition within the channel in this area.

Within the Skookumchuck River, the potential for geomorphic change is greater than it is within the Chehalis River, but actual changes will depend strongly on the final dam operation plan for regulating flow releases. The simplified dam release hydrographs eliminated storm peaks, ramped from 95 cfs up to 3,000 cfs very quickly, and maintained continuous, steady release rates between 2,000 and 3,000 cfs for approximately 5 days. The potential geomorphic effects of this hydrograph diminish progressively downstream because the flood wave attenuates as it propagates down the river. The steady release rate of 3,000 cfs is high enough to transport sediment and modify channel form. Since this elevated flow extends the duration of erosion and channel adjustment in comparison to the pre-modification hydrograph, there will be some impact

on channel morphology. The specific locations and cumulative magnitude of potential channel changes have not been mapped out as part of the current analysis. This additional analysis should be performed in support of developing a refined plan for dam operation.

4.2.4 Summary

In summary there would be no net loss in flushing flows or an increase in flood duration. Erosion or degraded channel processes will not occur based on the ramping up of the flow as the requirement for fisheries habitat will dictate ramping procedures as discussed in Appendix B.

4.2.5 Mitigation

The current analysis determined that significant effects on channel morphology are possible if dam operation maximizes flood mitigation benefits without accounting for potential geomorphic impacts. Potential geomorphic effects can be reduced at the expense of diminished flood control. Mitigation needs will depend on the specific impacts associated with the refined operational guideline for Skookumchuck Dam and hydrologic reporting, both anticipated to be completed in Planning, Engineering and Design phase of the proposed project. The relations between flow releases and geomorphic processes conceptually described above will guide the development of the operational guidelines to optimize the balance of flood management benefits and geomorphic impacts associated with dam operation.

4.3 WATER QUALITY

4.3.1 No Action Alternative

Under this alternative, no action would be taken by the Corps to change the current status of water quality in the project area. Therefore, water quality within the project area would not be affected by construction activities and would be expected to remain similar to existing conditions. Impacts from industrial and residential sources under the no action alternative will be limited to existing impacts from development and industrial activities as well as runoff from developed areas, sewer and wastewater outfalls. Agricultural activities within the project area will continue to provide high summer levels of fecal coliform and turbidity from natural sources, existing livestock and farming practices, heavy vegetation management, irrigation and frequent disturbance of unprotected soils. Water quality impacts are primarily those of elevated fecal

coliform from upland runoff, pesticides, and elevated metals concentrations from industrial and residential activities as well as road runoff.

4.3.2 Criteria for Determining the Significance of Effects

The following criteria were used to evaluate the significance of effects on water quality. A significant effect would occur if project construction and/or operation would:

- violate any water quality standards or waste discharge requirements;
- substantially degrade surface water and/or groundwater quality;
- contaminate a public water supply;
- substantially increase suspended solids in and turbidity of the river;
- discharge contaminants into the river.

4.3.3 Preferred Alternative

4.3.3.1 Short-term Effects

Short-term impacts to water quality from the preferred alternative would be primarily construction related. Levee construction would involve disturbance of soil that could impact water quality if sediments are introduced into streams. This could result in temporary increases in turbidity, suspended solids, and biostimulatory nutrients within and downstream of the project area. Several water bodies within the project area are currently included in the current Section 303(d) list for water body segments that do not meet state surface water quality standards for fecal coliform and temperature (these water bodies are provided in Table 3.3-2 in Section 3.3.2). This designation requires that no activity shall occur that will cause an increased effect on the listed water body's impairment and includes activities that may have either temporary or long-term water quality impacts. While the preferred alternative should not increase fecal coliform loading, the levee design could result in impacts to riparian areas. Evidence indicates that significant removal of riparian shading contributes to elevated water temperatures. Existing information indicates that construction of several smaller sections of levees around the Skookumchuck River within the City of Centralia would result in the loss of 0.8 acre of riparian habitat where the levees would transverse two riparian areas adjacent to I-5 (refer to Section 4.4.3.2 for additional information). Functions associated with riparian areas, including shading for cooler water temperatures may be lost or adversely impacted. The Corps will continue to

evaluate measures during the design process, including further refinement of the project design, in order to avoid direct impacts to riparian areas.

4.3.3.2 Long-term Effects

Potential long-term consequences of the preferred alternative include increased levels of fine sediment and contaminants in stream corridor from non-point source runoff. However, long-term effects of the levee would also be minimized through the levee design; setting levees back away from river as far as possible, or a minimum 50-foot buffer zone from water edge to levee toe when setback is not possible will reduce levee-related adverse effects to non-significant levels.

4.3.4 Skookumchuck Dam Modifications

The construction and excavation of Skookumchuck Dam spillway sluices, intake structures, and other activities associated with this feature would be performed during summer months when water levels are low and water quality effects from short-term construction activities would, therefore, be minimized. Modifications to the Skookumchuck Dam have been designed to improve storage efficiency and should not result in changes to the seasonal water levels in the Skookumchuck River during the fall and winter months when flood storage would be required.

Since dam construction, sediments from the upper basin have likely been trapped by the reservoir. This sediment accumulation may provide a benefit by reducing the turbidity downstream during fill and spill operations. However, data are not available to further interpret the sediment supply and transport characteristics of the Skookumchuck River below the dam. Potential long-term effects such as increased moderate flows may result in greater scour of substrate and increased sedimentation; however, whether sediment movement impacts will continue in the long-term or become significant is difficult to predict. The geomorphic analysis of the proposed modifications to the Skookumchuck Dam suggests that the modifications would have a negligible effect on sediment transport capacity and potential for bank erosion (Section 4.2).

4.3.5 Summary

In review, construction related soil disturbances and potential effects from turbidity and suspended solids would likely be a temporary unavoidable impact. The introduction of sediments should be minimized through levee design and the implementation of an erosion plan. Potential

long-term unavoidable adverse effects of operation and maintenance of the preferred alternative may include increased runoff and increased sedimentation. However, these effects should also be minimized by the setback levee design. There would be no contamination to the public water supply nor would contaminants be discharged into the river. Furthermore, proposed ecological mitigation and restoration activities have the potential to improve long-term water quality.

4.3.6 Mitigation

Construction related disturbances and potential effects would be avoided or minimized through the levee design and implementation of pollution control plans. Levee design -- such as setting the levees away from the river as far as possible or providing a minimum 50-foot buffer zone between the water edge and levee toe when setback is not possible -- and incorporating areas of existing levees or tying into an existing levee system should minimize direct impacts. Additionally, floodwalls were incorporated into the design where levees would have encroached upon the river. The Corps will continually evaluate additional adjustments to the levee alignment to avoid or reduce potential direct and indirect impacts to the system. Implementing pollution control plans throughout construction will also minimize these potential impacts; for example, placing trench soils well above the stream bank and protecting them with silt fences, hay bales, or other means that would reduce sediment runoff into the stream. Also, staging areas would be located at least 50 to 100 feet from the waterway to reduce or avoid loss of riparian vegetation and limit potential damage from any accidental spills of construction materials. A site-specific stormwater pollution prevention plan will be available onsite and followed during construction. In order to protect important fisheries in the basin from construction related disturbances, construction would occur during biological windows. Design objectives include:

- setting back levees away from river as far as possible;
- providing a minimum 50-foot buffer zone where possible between water edge and levee toe when setback is not possible;
- minimizing in-water work;
- carrying out construction during biological window.

No other mitigation is anticipated.

There is potential for significant differences in the impacts associated with the 11,000 acre-foot and the 20,000 acre-foot modifications on the Skookumchuck dam. These significant differences will occur if the re-operation plan (5 days allowed to hold water) is not followed, and would be

associated with the habitat surrounding the reservoir that would be inundated for a period longer than 5 days. The differences are listed specifically in the cumulative impacts section of this EIS. The mitigation for these impacts would have to be calculated based on the event actually happening. Impacts would be tied directly to the number of days past 5 that water was retained behind the dam, making calculations for the event impossible at this time. Again, as long as they operate per the specified days detailed in this EIS and re-operation plan, there will be no additional impacts.

4.4 BIOLOGICAL RESOURCES – VEGETATION AND WETLANDS AND RIPARIAN AREAS

4.4.1 No Action Alternative

4.4.1.1 Vegetation Impacts

Short-term Effects

Existing practices for land use and development (including forestry and agriculture) will continue to be in place that can result in the modification, loss and/or adverse impacts to existing vegetation communities. These are not expected to change as a result of the no action alternative.

Long-term Effects

It is likely that changes to existing vegetation communities will continue to occur as the study area develops and population increases. Forestry and agricultural practices are likely to continue into the foreseeable future, although it is possible that more forest and agricultural land will be converted to residential and commercial uses.

4.4.1.2 Wetland and Riparian Area Impacts

Short-term Effects

The existing permitting process for wetland filling and alteration will continue to be in place as well as existing unregulated activities that adversely impact wetlands. These are not expected to change as a result of the no action alternative. There is very little regulatory authority covering

riparian areas that are not wetlands, so existing activities that adversely impact riparian areas are expected to continue.

Long-term Effects

While no major projects with significant impacts have been approved in the project area, flood damage reductions measures would continue to be explored. The WSDOT is still likely to pursue improvements to I-5 to accommodate traffic demands, which may include flood proofing measures such as raising the freeway or constructing levees. Given the extent of wetlands within the project area, loss and/or degradation of wetland resources would be expected with these projects. Riparian areas are much more limited within the project area. Future impacts would need to be assessed on a case-by-case basis, but the Corps expects that any major flood damage reduction measures would include impacts to riparian areas.

4.4.2 Criteria for Determining the Significance of Effects

The following criteria were used to evaluate the significance of effects on vegetation, wetlands and riparian areas. A significant effect would occur if project construction and/or operation would cause:

- substantial loss and/or degradation of vegetation, wetlands and/or riparian areas that provide habitat to threatened or endangered species;
- substantial loss and/or degradation of vegetation, wetlands and/or riparian areas that provide habitat to migratory birds;
- substantial loss and/or degradation of vegetation wetlands and/or riparian areas that support or provide habitat for species of federal or state interest;
- substantial loss and/or degradation of wetlands and/or riparian areas that provide low flow augmentation;
- substantial loss and/or degradation of wetland and or riparian area diversity and structure.

4.4.3 Preferred Alternative

4.4.3.1 Vegetation Impacts

The assessment of vegetation was based on the review of existing resources on the vegetation characteristics of the study area (Franklin and Dyrness 1973), in addition to the Washington State Department of Natural Resources databases on native plant communities. Other sources

include the Lewis County and Thurston County soil surveys (UDSA 1991 and 1987, respectively) and site inspections of the study area.

Short-term Effects

Construction of the levees would result in the clearing and grading of approximately 45 acres of terrestrial (excluding wetland and riparian habitats, in Section 4.4.2) habitat. The majority of this area currently consists of farmland that is either in pasture grass production or corn. Other areas in the footprint of the preferred alternative include freeway right-of-way, Lewis County roads and road right-of-way, and Lewis County parklands. Very little native terrestrial vegetation, if any, is located within the preferred alternative footprint. Short-term effects would include disturbance and loss of existing vegetation.

Long-term Effects

The terrestrial vegetation communities that would be affected by the preferred alternative are widespread throughout the study area and the preferred alternative would have negligible impact on vegetation biodiversity and abundance. Most of the plants within the communities are either planted pasture grasses or crops and/or invasive non-native species such as Scot's broom and blackberries. The levees will be seeded with similar grasses to those currently in the project footprint and kept maintained (mowed and clear of large woody vegetation) for structural integrity. Long-term effects to terrestrial vegetation would be minimal.

4.4.3.2 Wetland and Riparian Area Impacts

The inventories for wetlands and riparian areas were prepared by the U.S. Fish and Wildlife Service and were based on 1998 color-infrared aerial photography. This level of effort was adequate to determine the extent of resources within the project area with the exception of determining the extent of emergent wetlands. This is due to the fact that it is difficult to determine the extent of emergent wetlands with the late-season photography typically used for inventory level wetland determinations; by the time the aerial photographs are taken all evidence of hydrology has usually disappeared.⁴

To account for some of the limitations of the wetland inventory maps with regards to seasonal wetlands the extent of mapped hydric soils was evaluated to determine the potential extent of wetlands within the study area. This information was available from the soil surveys from Lewis and Thurston counties as well as web-based data from the U.S. Department of Agriculture

(USDA) web page (USDA 2002). A hydric soil is a soil that is saturated, ponded, or flooded long enough in the growing season to support anaerobic conditions in the upper part (NTCHS 2001). All wetlands have hydric soils. However, not all hydric soils support wetlands due to the fact that many hydric soils have been drained and/or converted for agriculture and no longer exhibit hydrologic characteristics typical of wetlands.

Between these two mapping and inventory conventions, forested wetlands, riparian areas, and scrub-shrub wetlands were reasonably well mapped and represent a reasonable estimate of extent. This is because the vegetation communities in these systems are persistent and distinct and therefore easy to interpret from aerial photography, regardless of the season. The emergent wetlands are likely *underrepresented* on the wetland maps and likely *over represented* on the hydric soils maps. As such, the wetland impact assessment for emergent wetlands is based on the soils maps because these maps represent the maximum possible extent of direct wetland impacts from the preferred alternative. The Corps also assumes that this maximum estimate can be reduced with further design modifications. Once a final design footprint is established, the Corps will complete a more precise wetland and riparian area delineation of the project area based on field data.

The preferred alternative would result in the direct loss of wetlands and riparian areas within the footprint of the levees. Table 4.4-1 provides a summary of the total of wetland and riparian impacts from the levee footprint by specific areas. The only wetland type within the project footprint is emergent wetlands. As such, the wetland impact acreage is based on extent of mapped hydric soils.

⁴ Early season (spring) aerial photography in the Pacific Northwest is difficult to obtain because of the persistent cloud cover. Most aerial photography is taken between late July and early September when clear conditions are more likely.

Table 4.4-1: Project Features, Linear Feet, Total Acreage of Project Footprint, and Total Impact Areas for Riparian Areas and Wetlands

Reach	Project Levee	Feature Wall	Linear Feet	Total Acreage	Riparian Areas ⁵ (Acres)	Wetlands ⁶ (Acres)
1	X		14,676	11.500	0.00	0.00
2	X		658	0.500	0.00	0.00
3a		X	700	0.010	0.00	0.00
3b	X existing		3,000	0.000	0.00	0.00
3c		X	700	0.010	0.00	0.00
3d	X		2,905	5.200	0.00	5.00
4	X		12,599	11.700	0.00	11.70
5	X		4,767	4.500	0.00	4.50
6a	X		1,445	1.400	0.00	1.30
6b		X	1,034	0.010	0.00	.01
7a	X		12,792	9.000	0.00	7.00
7b		X	1,305	0.800	0.00	0.00
8a		X	250	0.003	0.00	0.00
8b		X	150	0.002	0.00	0.00
8c	X		1,511	1.600	0.00	1.40
9a	X		185	0.200	0.00	0.00
9b	X		60	0.003	0.00	0.00
9c	X		2,581	3.100	0.00	3.10
10		X	1,750	0.020	0.00	0.00
11	X		2,331	1.600	0.00	0.00
12	X		3,834	3.400	0.00	0.00
13		X	3,050	0.040	0.00	0.00
14	X		2,082	2.200	0.60	0.00
15	X		3,869	2.700	0.00	0.00
16	X		3,419	2.700	0.20	0.00
Totals			81,653	62.198	0.8	34.01

Total wetland loss is estimated to be 34 acres of emergent wetlands over approximately 15 miles of levees and floodwalls. Approximately 14 miles of the preferred alternative consists of levees and 1 mile of floodwall.

Short-term Effects

The levee alignment is in segments and located in areas that can be grouped based on specific locations and site characteristics within project area. The following discussion focuses on 5 areas of levees and the wetland and riparian impacts associated with them.

⁵ Forested riparian areas were the only type within the impact area footprint

⁶ Farmed and/or emergent wetlands were the only type within the impact area footprint

Chehalis reaches 1 and 2 are the northern most end of the preferred alternative set back well away from the river and follow high ground. There are no wetlands or riparian area within the impact footprint.

Chehalis Reach 3 is immediately adjacent to the western edge of I-5 and to the east of the Chehalis River. The wetlands associated with this reach are emergent wetlands some with crops (pasture or grain crops). Functions associated with these wetlands include migratory waterfowl habitat, groundwater recharge and discharge, floodwater storage and low flow augmentation. Any wetlands and riparian areas directly adjacent to the river may also provide a source of organic detritus (food chain support) to the river. Reach 3 provides abundant small mammal habitat and therefore support a large raptor population. These functions would be lost or adversely impacted due to project construction. Wetland impact acreage for this reach is 5 acres of emergent wetlands. No riparian habitat was mapped or noted during field inspections for this reach.

Total impact area for reaches 1, 2 and 3 is 17 acres of area (including 5 acres of wetland), 21,239 linear feet of levees and 1,400 linear feet of floodwalls.

Salzer Creek reaches of the preferred alternative are on the east side of the Chehalis River and I-5, south of the City of Centralia and north of the City of Chehalis. Most of alignment surrounds areas of existing development, which resulted in crossing pastures and open fields. Most of the pastures and field have been mapped as either wetlands or as having hydric soils or both. Functions associated with wetlands include small mammal habitat, sediment and nutrient trapping, floodwater storage and low flow augmentation. These functions would be lost or adversely impacted under the preferred alternative. Total impact acreage is estimated to be 17.5 acres of wetlands. No riparian areas were mapped or noted during field inspections within the footprint of the preferred alternative.

Total impact area for these reaches is 17.6 acres of area (of which 17.5 are wetlands), 18,811 linear feet of levees and 1,034 linear feet of floodwalls.

The Dillenbaugh reach sections of the preferred alternative are immediately adjacent to the west side of Interstate-5, south of reaches 1, 2, and 3, east of the Chehalis River. The alignment is located within emergent wetlands. Functions associated with these wetlands include floodwater storage, sediment and nutrient trapping, low flow augmentation, small mammal habitat, and raptor habitat. These functions would be lost or adversely impacted to project construction. Total

impact is estimated to be 11.5 acres of wetlands. No riparian areas were mapped or noted during field inspections for these sections of levees.

Total impact area for these reaches is 15 acres of area (of which 11.5 acres are wetlands), 17,129 linear feet of levees and 3,455 linear feet of floodwalls.

There are several smaller sections of levees that provide flood protection around the Skookumchuck River within the City of Centralia. In the Skookumchuck reaches, levees are set back away from the river except for a narrow area where the floodplain is constricted upstream from the confluence with the Chehalis. The levees would transverse two riparian areas that are located adjacent to I-5 (reaches 14 and 16). Although the inventory information indicates a loss of riparian areas at these reaches, the impacts may be avoided through further refinement of project design. Functions associated with riparian areas include passerine bird habitat, source area of large woody debris to the Chehalis and Skookumchuck rivers, shading for cooler water temperatures, aesthetics (adjacent to residential lakes), and passive recreation (bird watching). These functions may be lost or adversely impacted due to project construction. Maximum total impacts would be the loss of 0.8 acre of riparian habitat.

Total impact area for these reaches is 12.6 acres of area (including 0.8 acre of riparian habitat), 15,534 linear feet of levees and 3,050 linear feet of floodwalls.

Long-Term Effects

The long-term impacts associated with the potential loss of wetlands within the project area could include loss of animal and plant biodiversity and abundance (due to loss of habitat), decreased ability for floodwater storage and low flow augmentation within the floodplain, and decreased connectivity between habitats. The levees may also result in additional ponding of water behind levees and/or a disruption of lateral surface and groundwater flow, which would change the hydrologic characteristics of existing wetlands. In the case of ponding, some areas of existing upland may develop into wetlands or existing areas of wetlands may be expanded. If there is substantial disruption of lateral surface and groundwater flows that cutoff or diminish sources of water, then existing wetlands may be lost or adversely affected.

The maximum total wetland loss from the preferred alternative is approximately .3 percent of the estimated total wetlands within the study area (12,335 acres of mapped wetlands). Localized impacts could have synergistic and/or cumulative impacts to the entire area.

Indirect Effects

In addition to the possible short- and long-term impacts of the preferred alternative within the study area, additional indirect impacts may also be associated with this alternative. The preferred alternative is located within the active floodplain of the Chehalis River. Floodplains are complex systems of ground and surface water flows that largely drive the characteristics of both wetlands and riparian areas. Changes in the floodplain that can change surface and groundwater interaction will likely have some effect on the existing wetland and riparian areas. The levee and floodwall feature can trap water, which may expand the boundaries of existing wetlands and possibly create or restore wetlands in areas that do not currently exhibit wetland hydrology. Conversely the levee and floodwall alignment may disrupt some of the surface and groundwater flow patterns, which may result in less water for existing wetlands. However, the complexity of the sources of water for the Chehalis floodplain wetlands and riparian areas (flooding, groundwater saturation, surface water ponding, and high precipitation) makes cause and effects relationships difficult to predict. The proposed location of the preferred alternative alignment, which is mostly setback from the river or located in areas that are already highly disturbed (along the freeway right-of-way), minimizes the potential for indirect impacts. However, their maybe some development in areas that are better protected with the levees in place, unless local laws prevent development from occurring.

4.4.3.3 Skookumchuck Dam Modifications

Short-Term Effects

The Skookumchuck Dam modifications would not result in direct loss of wetlands and riparian areas, but may alter respective characteristics based on the operational plan for releases from the reservoir. No short-term impacts are associated with construction of the dam modifications.

Long-Term Effects

There are a limited number of wetlands and riparian areas along the Skookumchuck River. There are no wetlands or regularly flooded riparian areas surrounding the reservoir. The existing wetlands and riparian areas are linear features likely influenced by annual high water periods. The preferred alternative would change the duration and frequency of floods, especially between the 5- and 10-year floods; these floods would occur less frequently⁷. For example, the current 10-year event, after project construction, would have the characteristics of the current 50-year event.

⁷ Yearly floods and 2-year floods will occur with the same frequency and duration as the current condition under the preferred alternative.

The change in these flood events are not likely have any noticeable effect on wetlands within the preferred alternative footprint because these systems are much more influenced by frequency of events rather than by magnitude. Riparian areas, however, rely on higher magnitude events for recruitment of seed sources, scouring of weedy vegetation, and input of sediment and organic materials. The degree to which riparian areas on the Skookumchuck River rely on these events is currently unknown, but the preferred alternative identifies riparian impacts on the Skookumchuck as the subject of study during the design process. Should impacts to riparian areas be indicated as a result of these studies, operational procedures at the dam will be evaluated to offset potential impacts. Mitigation would also be included as part of the preferred alternative should any unavoidable impacts be identified. If the additional water stored behind the modified dam is held longer than the authorized 5 days potential impacts to the surrounding habitat could occur. The severity of impacts are directly tied to the length of time past the initial 5 days and mitigation cannot be calculated at this time.

Indirect Effects

The Skookumchuck is an incised river within a terrace. The riparian areas and wetlands that are directly associated with the Skookumchuck River would be directly impacted, rather than indirectly from implementation of the preferred alternative. There are other wetlands within the study area surrounding the Skookumchuck, but their position in the landscape (in depressions or low-lying areas well away from the river floodplain) indicated that they are more influenced by ground and surface water than by flood events. The preferred alternative would likely have minimal impact on these systems.

4.4.5 Summary

In review of the information available and provided for above, the proposed project is determined not to significantly impact vegetation. Direct short- and long-term effects to wetlands caused by the preferred alternative could be significant due to the 34-acre emergent wetland impact; however, measures would be taken in design to further avoid and/or minimize those impacts. Proposed mitigation would offset the possibility of significant impacts to wetlands by restoring some of the historic function to the Chehalis River. No significant impacts are expected to occur to riparian areas. Measures would be taken in design to further avoid and/or minimize impacts to the 0.8-acre area that is currently within the preferred alternative footprint.

4.4.6 Mitigation

Throughout the development of the preferred alternative, mitigation of impacts to sensitive areas were included as a component of the alignment. Care was taken to stay close to developed areas and keep the alignment setback as far as possible from the Chehalis River, tributary streams, wetlands, and riparian areas. The design also incorporated areas of existing levees or tied into an existing levee system. Lastly, floodwalls were incorporated into the design where levees would have encroached upon the river. With emergent wetlands being the type most impacted by the project the ratio is set at 2:1 resulting in 68 acres required for wetlands mitigation.

The Corps will continue to evaluate measures during the design process to avoid direct impacts to vegetation, wetlands, and riparian areas. These measures may include:

- additional adjustments to the levee alignment, where possible, to avoid direct impacts;
- evaluation of the changes to the flood regimes of the Skookumchuck River.

Measures that would avoid and or reduce potential indirect impacts include:

- strict controls on stormwater during construction to avoid direct discharges to wetlands and other aquatic habitats;
- placement of construction areas away from wetland and riparian habitats;
- placement of construction access roads outside of wetland and riparian areas.

4.4.6.1 Levee and Floodwall Alignment

Under the preferred alternative, unavoidable impacts include disturbance to approximately 45 acres of existing upland vegetation (although this consists of disturbed communities and/or farmed areas), 34 acres of wetland impacts (based on the extent of hydric soils) and .8 acre of riparian area impacts. These numbers may be reduced through design, but the following mitigation scenario is intended to offset impacts to the full impact area. Functions associated with these impacts include migratory and passerine bird habitat, small mammal habitat, floodwater retention and detention, low flow augmentation, habitat biodiversity, groundwater recharge, nutrient and sediment removal, nutrient and organic input to other aquatic ecosystem (streams, rivers), passive recreation and aesthetics.

Mitigation for unavoidable impacts to vegetation, wetlands and riparian areas from the preferred alternative will be incorporated into the Scheuber Floodplain plan as described in Chapter 4 (Introduction). (See Figure 4.4.6-1) This includes:

- Reconnecting an abandoned oxbow south of SR-6 to the Chehalis River and connecting this 21-acre feature to a series of interconnected ponds and wetlands north of SR-6, near the confluence of an unnamed creek and Scheuber ditch. The pond/wetland area would cover approximately 80 acres.
- The pond/wetland complex will be connected to the Scheuber ditch. A second wetland complex would be created/restored at the north (downstream) end of the ditch. This area would be similar to the southern wetland complex. The complex would receive inflow from Coal Creek and Scheuber ditch from the south. These would provide flow through the wetland into the Chehalis River. The wetland would also receive backwater from the Chehalis. The north wetland complex would encompass approximately 46 acres.
- Approximately 7,500 feet of Scheuber ditch would be re-aligned to a more natural looking feature.
- Approximately 8,000 feet of a 400-foot riparian zone (200 feet on each side) would be planted with native vegetation along the newly aligned Scheuber ditch.
- Additional riparian plantings would be done around the wetland complexes.
- Invasive species would be removed from the mitigation area.

The proposed mitigation area contains farmed areas that are both upland and wetland. Due to the difficulties in inventorying emergent wetlands, onsite delineation of the mitigation would occur during design to determine the extent of restored wetland versus created wetlands. Onsite wetland and riparian delineations will also be done for the preferred alternative footprint to determine the exact extent of impact area. If more mitigation acreage is needed after this evaluation, this proposed area of mitigation will likely be able to incorporate additional acreage of created and/or restored wetland and riparian areas.

This page was intentionally left blank.

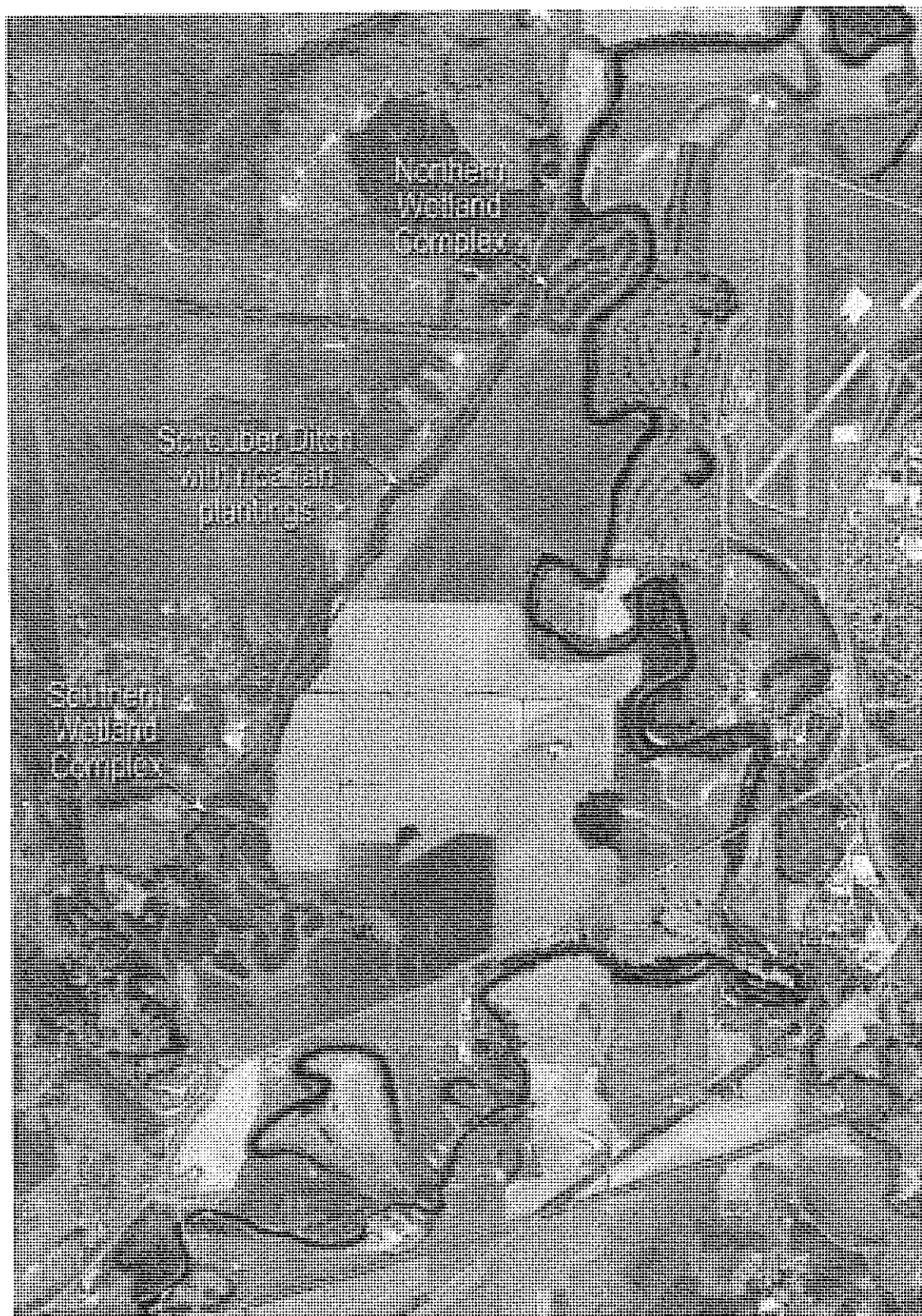


Figure 4.4.6-1. Mitigation for unavoidable impacts, preferred alternative.

Additional areas at Dillenbaugh Creek are also being evaluated as potential mitigation sites, if necessary. This would include relocation of Dillenbaugh Creek away from I-5 and the enhancement of wetland areas that are currently in pasture grass production.

The intent of the proposed mitigation is to restore some of the historic function of the Chehalis River and the associated wetland and riparian areas. These functions include low flow augmentation, organic input, passerine and migratory bird habitat, fishery support habitat, sediment and nutrient trapping (water quality improvement), groundwater recharge, habitat biodiversity, and floodwater retention and detention. It also is in a fairly visible area from I-5, SR-6, and Scheuber Road, which would increase the aesthetic values of the area and provide passive recreation opportunities.

4.4.6.2 Skookumchuck Dam Modifications

In summary potential long-term impacts to Skookumchuck River riparian areas remain largely unknown, although wetland impacts are not expected to occur. If design analysis indicates substantial impacts are expected to occur to either wetland or riparian areas (or both), re-evaluation of the proposed dam operation would occur. The significance of potential impacts and the ability of mitigation to offset the impacts would also be re-evaluated. Mitigation would be incorporated for any unavoidable impacts to wetlands and/or riparian areas.

4.5 BIOLOGICAL RESOURCES - WILDLIFE

4.5.1 No Action Alternative

Under this alternative, the Corps would take no action that would result in changes to the existing conditions. There would remain concerns over the historical loss of riparian habitat, wetlands, and connectivity. Assuming WSDOT implements plans for improving I-5, flood proofing measures such as raising portions of the roadway or constructing levees would likely result in loss of wetlands that provide habitat for wildlife. Other development in the area would continue to occur in accordance with local comprehensive plans and would likely result in some losses of wetlands, riparian areas, and uplands that are used by wildlife species.

4.5.2 Criteria for Determining Significance of Effects

The following criteria were used to evaluate the significance of effects on wildlife within the project area. A significant effect would occur if construction and/or operation activities would:

- decrease remaining riparian habitat;
- cause reduction of remaining wetlands;
- cause reduction or loss of remaining habitat connectivity.

4.5.3 Preferred Alternative

4.5.3.1 Short-term Effects

The noise and activity associated with levee construction would cause disturbance of songbirds, waterfowl, raptors, small mammals, deer, and other wildlife that use habitats within or near the construction area. This disturbance would be temporary and displaced animals would be expected to use other nearby habitats while construction of the levee system is underway. Because the species that inhabit these areas are generally tolerant of human activity, this temporary disturbance is not expected to have significant adverse effects on wildlife.

4.5.3.2 Long-term Effects

Because the levees are set back from the mainstem of the Chehalis and the Skookumchuck rivers, effects on riparian habitat and habitat connectivity will be minimized. Within the levee footprint, areas of riparian forest and wetland would be permanently converted to upland habitat. Areas to be converted currently provide habitat for a variety of wildlife, including some game species, small mammals, reptiles and amphibians, and songbirds. The maximum area of impact to wetland habitats is estimated to be approximately 34 acres. Levee segments adjacent to the western edge of I-5 would affect emergent wetlands that provide habitat for these animals as well as for migratory waterfowl. In upland areas within the levee footprint, topography and vegetation communities would be permanently modified by levee construction. Following construction, the levees would provide some wildlife habitat, although the quality of this habitat would be limited by the need to perform periodic maintenance and by type of vegetation (mainly grass and shrub cover) that would be allowed to colonize the levee slopes.

4.5.4 Dam Modifications

4.5.4.1 Short-term Effects

Short-term effects to wildlife from construction of the Skookumchuck Dam outlet facility is limited to temporary disturbance at the site and along associated transportation corridors. Noise associated with construction and vehicular traffic may cause some wildlife species to relocate to less disturbed areas.

4.5.4.2 Long-term Effects

Dam modifications should not have impacts to wildlife habitat as long as the high pool does not exceed 5 consecutive days of storage. Exceeding high pool events may cause stress to the reservoir vegetation community. Frequency of events requiring storage above 477 feet should not occur more often than every other year to avoid impacts to the habitats surrounding the reservoir.

4.5.5 Summary

The mainstem of the Chehalis has poor wildlife habitat because of inadequate off-channel habitat and wetlands. Riparian habitat along the mainstem of the Chehalis River has been largely lost through various land use practices or processes resulting in a limitation of riparian habitat to narrow bands along tributaries and around confluences. By 1938, significant changes had already occurred due to conversion to agricultural fields making it difficult to determine what habitats have been lost. Along the South Fork of the Chehalis River riparian vegetation is rated poor for 70 percent of the sub-basin and is particularly sparse in the mid and lower reaches. This lack of riparian vegetation compounds the forest connectivity loss that is present along the entire length of the Chehalis River within the project area (Appendix A). The smaller tributaries such as Salzer Creek, China Creek, Big Hannaford Creek, and Elk Creek are also lacking in riparian vegetation. It has been suggested that before development of this area into agriculture farmlands and residential development, the area consisted of predominately bottomland hardwood forest, indicative of a floodplain for this area. No mature forests exist within the project area.

By combining the levee construction and dam modifications there will be no additional impacts to the marginal wildlife habitat that currently exist in the project area other than wetland impacts. However, there is potential to have a positive effect on wildlife by creating additional wetlands,

connectivity, and additional riparian zones. There will be no loss in remaining habitat connectivity, riparian habitat or remaining functional wetlands. Impacts to wetlands will be on the marginal converted wetlands that are now used for farming.

4.5.6 Mitigation

The preferred alternative will impact approximately 34 acres of wetlands and the mitigation for that impact will occur in the SR-6, Scheuber ditch, and Oxbow area. That mitigation will consist of creating a riparian zone 200 feet wide on either side of the ditch. It is anticipated that the mitigation for the wetlands may also offset the impacts to wildlife habitat for the preferred alternative by mitigating for impacted habitat connectivity, wooded wetlands, and riparian zones.

4.6 BIOLOGICAL RESOURCES- THREATENED AND ENDANGERED SPECIES

Threatened and endangered species include those named by the USFWS as appearing on the List of Endangered and Threatened Wildlife and Plants, as authorized by the Endangered Species Act of 1973, as well as species listed by the State of Washington.

4.6.1 No Action Alternative

Under the no action alternative, the Corps would take no action that would result in changes to the existing conditions. Concerns would remain over the historical loss of riparian habitat, wetlands, and connectivity. Assuming WSDOT implements plans for improving I-5, flood proofing measures such as raising portions of the roadway or constructing levees would likely result in loss of wetlands that provide habitat for wildlife. Other development in the area would continue to occur in accordance with local comprehensive plans and would likely result in some losses of wetlands, riparian areas, and uplands that are used by threatened and endangered species.

4.6.2 Criteria for Determining Significance of Effects

The following criteria were used to evaluate the significance of effects on threatened and endangered species within the project area. A significant effect would occur if construction and/or operation activities would cause:

- substantial disruption to the magnitude and frequency of water flow through the project

- area, such that existing hydrologic processes are interrupted;
- substantial loss and or degradation of riparian and shoreline vegetation that provide critical habitat to threatened and endangered species;
- substantial loss and or degradation of wetland hydrology or vegetation that provide critical habitat to threatened and endangered species;
- substantial reduction or loss of habitat connectivity critical to providing transportation, refuge and other habitats critical to threatened and endangered species.

4.6.3 Preferred Alternative

The project is not expected to result in significant effects to sensitive species. Less than 1 acre of riparian habitat, and between 18 and 34 acres of wetland habitats (all of them pastures) would be covered or otherwise destroyed by project construction. None of these riparian areas and wetlands is known to provide habitat to sensitive species, based on searches of the PHS and Natural Heritage databases. No nest or roost trees of bald eagles would be affected by the project, and project construction activities are not expected to significantly affect bald eagle nesting. Following are brief discussions of the general nature of the project's effects on specific habitat types.

4.6.3.1 Wetland Species

The levee would cause a relatively significant reduction in the areal extent of flooding in the lower Skookumchuck River valley in the Centralia area. However, increases in the peak stage within the Skookumchuck River channel would occur as a result of the levees keeping a higher proportion of the flow confined to a smaller floodplain area (i.e., less out of channel flow entering the floodplain due to the levees).

The alteration in duration and frequency of flooding in the floodplain results in adverse effects to the floodplain habitats, including the riparian areas and adjacent wetlands. These effects can result in loss of native plant seed dispersal and seedling desiccation, as well as allow invasion of exotic invasive species (Duncan 1993; Nilsson 1982; Meffe 1984; Moyle 1986—all in Poff 1997). A lack of seedling recruitment would result in a long-term decay and turnover to a less desirable plant community (Bren 1992). Aquatic species that have adapted to the natural variation of a free-flowing river will lose their ecological advantage over less variable-tolerant species, and result in a change in the overall dynamic of the aquatic ecology (Cushman 1985; Petts 1984; Travnichek *et al.* 1995). Wetlands may not be maintained if not frequently flooded.

Having acknowledged these potential effects from altered hydrologic regimes, it must be said that these effects will scarcely be noticeable in the Chehalis and Skookumchuck Basins. The levee system is designed to contain the 100-year flood. While this means that lesser flood flows will be contained within the levees and not be allowed to enter the larger floodplain, for the most part very little habitat would be affected. The levee system will remove flooding from built-up areas. It is designed to have minimal environmental effects, by virtue of being set back as far as possible in every location. What this means is that the levee would be built against road shoulders; along fence lines; along residential back yards. In a few cases, structures will be sacrificed in order to preserve additional habitat. The primary area of impact to wetland habitat would be along the lower two miles of Salzer Creek; the levee in this location would cut across approximately twenty acres of wet pasture, removing about half of it from flooding. However, investigations of groundwater in the basin appear to show that it is fed and recharged primarily by rainfall, rather than flooding. Thus the wetlands in this area (and elsewhere in the project area where wetlands would be cut off from flooding) are expected to remain functional (USACE 2002). While these wetlands are considered to have limited functional value for aquatic life because they are all wet pasturelands and well removed from the streams due to the levees being set back, certainly some loss of function will result by removing floods—seed dispersal, organic/detrital inputs, flood storage, water quality improvement, wildlife habitat (refuge during floods), and perhaps others. On a basin-wide scale, these minor losses of function are considered to be insignificant. This is especially so when the mitigation and restoration plans are factored in, which are expected to fully compensate for the lost function caused by levee construction.

4.6.3.2 Riparian Species

While the project will affect riparian habitats in subtle ways, no direct losses of riparian trees would occur, with the exception of three short stretches along the Chehalis River. One of these locations is approximately 1/8 mile in length; just a few trees would be lost from another site (near Mellen Street); and a number of trees would be lost from the SR-6 restoration effort to reconnect the oxbow to the river. It is likely that some nest trees for all of these species could be lost (buffleheads and wood ducks are cavity nesters; ospreys place a nest in the top of a large, broken-top snag or on top of a transmission line pole; great blue herons build nests in colonies in various kinds of trees—however, no great blue heron colonies are found within the action area (WDFW 2002). The loss of these few trees is not expected to be significant to these species.

On the Skookumchuck River, flood events under the proposed project will represent a change from the current condition. Existing operations do not mitigate for downstream flooding which results from overbank flows upon reaching full pool. The proposed project will store the peak of flood flows behind the reservoir and release water to maintain flows of less than 5,000 cfs at Pearl Street in Centralia. The result will be the elimination of large overtopping events (greater than 2 years) as they are replaced with smaller events of greater frequency and duration. Refer to Section 2.4 for sediment routing and timing effects.

In most urbanized and altered river systems, overbank flooding does not allow for adequate return pathways to the river. The result is often juvenile and adult salmon stranded in pasturelands, roadside ditches and suburban neighborhoods with no mechanism for reentry to the river. Under natural conditions, where reaches have good connectivity by way of small tributaries, extensive side channel habitats or wetlands, overtopping events represent rearing opportunities for juvenile salmon and provide refuge for adults to escape the turbulent, debris filled mainstem. Field investigations along the Skookumchuck found most tributaries had good connectivity to the mainstem. In contrast, there were few mainstem reaches with connected side channel habitat and floodplain connectivity (PIE 2000).

Potential effects to river channel vegetation are primarily due to the lack of overbank flooding at flows above 3,000 cfs at the dam and 5,000 cfs at the mouth. Vegetation reliant upon flows under these levels should continue without harm and may even increase as high flows are moderated during floods. Thus the primary impact of the project is the loss of the larger overbank events and their effects on future woody debris recruitment. Much of the river length would still be overtopped by a 2-year event (Appendix B). Therefore, riparian habitat recruitment is expected to continue, helping to maintain a supply of LWD and other organic materials to the river.

4.6.3.3 Prairies, Forests, and Other Habitats

This project would not affect prairie habitats, as the levee system will not be constructed in prairies, and the limits of flood control effects would not reach prairie habitats. No fast-moving, cold-water streams would be affected by the project, nor would off-channel, slow-moving, warm-water habitats. The potential exception to the latter is the mainstem Chehalis River itself, through which lampreys and anadromous fish migrate. The infrequent changes to river flows resulting from the project would be indistinguishable to these fish. Open spaces where peregrines typically hunt will remain intact with this project; furthermore, no nests of peregrines are known in the action area (WDFW 2002). Finally, no talus slopes would be affected by the project.

4.6.4 Summary

Endangered Species Act Section 7 consultation has been initiated with USFWS. A biological assessment has been transmitted to the USFWS for their review and is attached (Appendix E). Determinations for bald eagle and bull trout are not likely to adversely effect. The remaining species determinations are no effect. There would be no substantial disruption, loss, or degradation of riparian, shoreline vegetation, connectivity, wetland hydrology or vegetation within the proposed project area.

4.6.5 Mitigation

The preferred alternative will impact approximately 34 acres of wetlands and the mitigation for that impact will occur in the SR-6, Scheuber ditch, and Oxbow area. That mitigation will consist of creating a riparian zone of 200 feet wide on either side of the ditch. It is anticipated that the mitigation for the wetlands will also offset the impacts to wildlife habitat for the preferred alternative, by mitigating for connectivity, wooded wetlands, and riparian zones. Specific mitigation requirements for threatened and endangered species will be negotiated through the ESA Section 7 consultation process.

4.7 BIOLOGICAL RESOURCES - FISH

4.7.1 No Action Alternative

4.7.1.1 Short-term Effects

Short-term effects to fisheries from the no action alternative arise principally from urban development needs of the basin as well as construction related impacts from planned transportation projects. There are no anticipated short-term project related impacts to fish from agricultural practices under the no action alternative. Existing agriculture conditions will remain unchanged without the preferred project. Fish impacts from levee construction would be avoided.

Short-term effects to fish from urban and infrastructure development include only those projects reasonably foreseeable in the absence of the preferred project and related to flood control. The relocation of the wastewater treatment plant is likely to have some short-term impacts by way of vegetation loss, elevated turbidity and potential for small-scale contaminant releases.

Modifications to I-5 to reduce future flooding may also have some short-term impacts to fish, as the potential exists for elevated turbidity and short-term water quality impacts. Planning and construction methods and monitoring will determine significance of these short-term impacts.

4.7.1.2 Long-term Effects:

Chehalis River and Tributaries

Long-term effects to the environment under the no action alternative from agricultural practices are limited to impacts from the continuance of existing farming and livestock practices as well as from natural sources within the project area. Activities in the project area will continue to provide high summer levels of fecal coliform and turbidity to the project area from natural processes, livestock, heavy vegetation management, irrigation and frequent disturbance of unprotected soils. Fish impacts are those related to the continued loss of off-channel and wetland habitats, loss of riparian corridor and the associated loss of cover and food productivity. Sources of degraded water quality will also continue. Water quality impacts to fish are principally those of elevated pesticides and turbidity. Low dissolved oxygen, altered pH and elevated levels of suspended solids, metals and other contaminants may also continue to the detriment of fish resources.

Long-term urban impacts from industrial and residential sources under the no action alternative will be limited to existing impacts from development and industrial activities. Runoff from developed areas, sewer and wastewater outfalls will continue to enter the Chehalis River. Additional wetland and riparian habitat loss will continue as natural habitats are converted through residential development, urban growth and associated infrastructure improvements. Fish impacts are those related to the continued loss of off-channel and wetland habitats, loss of riparian corridor and the associated loss of cover and food productivity. Sources of degraded water quality will also continue. Water quality impacts are principally those of elevated fecal coliform from upland runoff, pesticides, and elevated metal concentrations from industrial and residential practices as well as road runoff. Low dissolved oxygen, altered pH and elevated levels of suspended solids, metals and other contaminants may also continue to the detriment of fish resources. Foreseeable long-term benefits are also possible. A planned relocation of the Chehalis Wastewater Treatment Plant from its current location on the Chehalis River may provide some opportunities to reduce fecal coliform and related water quality problems.

Long-term urban impacts from planned infrastructure improvements under the no action alternative will be limited to impacts from the raising of I-5 and multiple smaller improvements throughout the cities. Under current proposal is a project to raise portions of I-5 in the project area to protect against flooding and closure. The resulting impacts to fish may include a loss of some accessible wetlands and minor removal of vegetation within the project footprint.

Skookumchuck River

Skookumchuck reservoir will continue to remain at full pool between late winter and spring allowing for water levels to remain adjacent to the vegetated shorelines of the reservoir. When the reservoir begins to recede in the summer, access to upper benthic communities and terrestrial prey input for resident and anadromous fish will become restricted. Reservoir drawdown will continue to deny fish the shade, productivity and shoreline cover afforded by reservoir vegetation. Reservoir operations will continue to inundate some areas of potential steelhead and resident trout spawning habitat in the tributaries, notably Fall Creek, Turvey Creek and the Skookumchuck River.

The existing Skookumchuck Dam trap and haul facility will continue to operate for adult migrating steelhead. The steelhead will continue to be collected at the downstream weir, and be transported above dam for release. The existing outmigration chute and flume bypass system on top of the dam will continue to pass the majority of juvenile steelhead. Sluice gate operation may continue to affect some portion of outmigrating fish.

Temperature control of the lower river by Skookumchuck Dam would remain unchanged. The manner in which the Skookumchuck Dam is operated, which affects fish spawning and rearing habitat, will continue to result in summer water temperature at or below 50° F to 55° F. During the period 1 April through 31 August, Skookumchuck Dam will continue to provide a maximum flow of 95 cfs or natural flow plus 50 cfs, whichever is less. It would continue to provide minimum instream flows of 140 cfs 1 September through 31 October for fish spawning and 95 cfs 1 November through 31 March for incubation.

The existing "fill-and-spill" operation will continue to provide a nearly natural winter hydrograph for spawning, incubating and rearing salmonids in the river. Negative flood impacts from existing operations on aquatic resources may continue in the form of excessive redd scour in confined or steep sections of the river and as severe overtopping in areas of limited mainstem connectivity. Positive benefits associated with overtopping in areas of extensive mainstem connectivity may continue resulting in unrestricted access to accessible overwintering areas and

improving overwintering success by passing natural freshets. Flooding will continue to be a source of water quality degradation from petrochemicals, fecal coliform, metals and possibly other chemicals that are mobilized during overbank flooding and potentially transported into the channel.

Drawdown will remain a natural event resulting from reduced inflows above Skookumchuck Dam during this period. The Skookumchuck River downstream of the dam will continue to mimic natural inflow. Fish impacts may include dewatering of late spawning salmonids and stranding of juvenile fish in off-channel ponds as the waters recede. However, the prolonged nature of drawdown in the Skookumchuck River should allow for fish to adjust to the receding hydrograph and minimize the occurrence of stranding.

4.7.2 Criteria for Determining Significance of Effects

A determination on significance of impacts from the preferred alternative is based on the existing conditions briefly described below. Criteria for significance have been developed to determine the project's potential to add or detract from the existing environmental conditions of the Chehalis River study area. Through this planning process, opportunities to avoid and minimize negative impacts have been identified and unavoidable adverse impacts flagged for further consideration. Additional information on impacts from flood control operations within the Skookumchuck River can be found in Appendix B. The potential for effects on fish resources are further defined as short-term and long-term effects. A significant effect on fish and fish habitat would occur if construction and/or operation activities would result in:

- substantial disruption to the magnitude and frequency of water flow through the project area such that existing hydrologic processes are impacted;
- substantial loss and or degradation of riparian and shoreline vegetation that provides critical invertebrate production and migratory habitat to anadromous and resident fish;
- substantial loss and or degradation of low flow fish habitat that provide critical habitat to anadromous and resident fish;
- substantial loss or degradation of gravels that provide critical spawning habitat to anadromous and resident salmonids;
- substantial loss or degradation of winter off-channel and backwater habitats that provide critical refuge habitat to anadromous and resident fish;
- substantial loss or degradation of tributary mouths such that headcutting or similar erosion impacts fish passage.

4.7.3 Preferred Alternative

The preferred alternative is described in detail within Chapter 2 and also within the Skookumchuck Dam Re-operation Report (Appendix B). Briefly, the preferred alternative includes modifications to Skookumchuck Dam for flood control and a levee system consisting of 16 reaches.

4.7.3.1 Short-Term Effects

Short-term impacts to fish from the preferred alternative are likely to be construction related effects or short-term water quality degradations likely to occur as the project area adapts to landscape changes (elevated turbidity, loss of riparian habitat). Short-term impacts to fish may result from modifications to Skookumchuck Dam in support of flood control and the construction of a new levee alignment. These impacts are primarily related to short-term riparian disruption and water quality problems.

Chehalis River and Tributaries

Project area short-term impacts from the construction of levees are most likely to be associated with a temporary reduction in water quality as soils are disrupted by clearing and filling and increased construction traffic. Even with runoff controls in place, elevated levels of turbidity are likely. Actual effects on fish resources will be dependent on the size and location of the levee alignment with fish effects increasing with proximity to the river.

Fish resource impacts specifically from levee construction are anticipated to be those associated with loss of riparian vegetation, loss of off-channel habitats and floodplain disconnection. Fish impacts will be directly related to the proximity of the levee prism to the riverbank and its location within the floodplain. Constructing levee systems outside the riparian buffer areas will provide opportunity for riparian development and reduced impacts to fish.

Requirements for adequate riparian buffers are dependent on the size of the river and regulatory statutes. Most existing requirements found to be currently accepted, recommend riparian buffer zone requirements between 50 feet (for water quality) and 300 feet (riparian function) from the river's edge. Since larger rivers have larger riparian needs, levee prisms built within 300 feet from the river should be considered to have indirect effects on fish, and levee construction within 100 feet of the river considered to have direct effects to fish habitat, which may result in a reduction in productivity.

Habitat changes from encroachment on a riparian buffer may range from simplifying or altering existing riparian vegetation and habitats to heavy alteration of the banks and underwater habitats. Associated impacts to fish from these alterations are considered larger in cases where stream bank habitats are lost or where off-channel habitats and tributaries are made inaccessible. If bank alterations or riparian alterations are large enough, the capacity of a river system to hold and support fish resources may be reduced.

The current levee alignment for the preferred project recommends a total of 80,000 linear feet of levee construction or upgrading, most of which is located away from fish bearing rivers and creeks. Of the total construction length, 15,350 feet or 20 percent of the overall length is located within 300 feet of the river. The length of levee closer than 100 feet and more likely to have direct effects on fish resources is 8,700 feet or 10.8 percent of the overall length. Not all levees currently proposed closer than 100 feet of the river are located directly on the riverbank. Bank stabilization and direct impacts to aquatic habitat is limited to 1,900 feet (2 percent) of the total levee alignment and dispersed among six distinct locations. Some 78 percent (6,800 feet) of levee proposed within 100 feet of a fish-bearing stream will affect tributaries directly. The remaining 1,900 feet (22 percent) of levee will be located adjacent to the Chehalis River.

The size and nature of levee construction is in keeping with typical levee construction and rehabilitation projects permitted elsewhere in the basin and throughout the State of Washington. The proposed levee construction is a mixture of several cross-sections and floodwalls with an average width of 33.4 feet, but ranging between 15.5 and 49 feet wide (Figure 4.7.3). Anticipated short-term impacts to fish resources from construction of each reach are described below according to levee reach.

Reach 1- Fords Prairie (CH-1)

None anticipated.

Reach 2. Sewage Treatment Plant (CH-2)

In this reach, 300 feet of levee alignment will be constructed approximately 200 feet from the Chehalis River. The levee is located around and behind existing sewage treatment plant structures. Short-term impacts could include minor and temporary turbidity increases. The existing riparian cover is limited in this reach. Salmon spawning or rearing habitat should not be affected.

Reach 3. Mellon Street to Salzer Creek Bridge (CH-3)

A combination of floodwall and levee construction is proposed within this reach to limit impacts to the Chehalis River. Attempts to limit Chehalis River interaction with the alignment has resulted in only two locations closer than 300 feet of the channel for a total length of 1,450 feet. Impacts from the levee proposed within 100 feet will be limited to 250 feet. A floodwall is proposed for all areas where the river is closer than 300 feet to the alignment. Short-term impacts to fish will be limited to potential increases in construction runoff and traffic. Salmon spawning or rearing habitat should not be impacted.

Reach 4. Salzer Creek Right Bank (CH-5N)

Levee construction in this reach is designed to prevent floodwaters from the Chehalis River from backing up Salzer Creek. The levee alignment follows the right bank of Salzer Creek and will be constructed within 300 feet of the creek for approximately 2,750 feet of which 1,800 feet is proposed within 100 feet of the creek. An existing levee will be utilized along an additional 2,150 feet of length but all work will be conducted landward of its existing location. The end of this reach will tie into an existing levee. The alignment will not directly cross the confluence of Salzer Creek but the levee will require placement of armor rock along 150 feet of the right bank bridge abutment of I-5. Short-term impacts will most likely be temporary increases in turbidity and construction related spills and debris. Armoring of the bridge abutment will be conducted outside the creek channel and carry no significant short-term impacts. Some riparian loss may occur if the existing levee needs cleaning before additional construction landward of its location.

Reach 5. Salzer Creek Left Bank (CH-5S)

As with Reach 4, the intent of this levee section is to prevent Chehalis River flooding from entering the Salzer Creek basin. It does not propose to cross the Salzer Creek confluence but will require approximately 150 feet of armor rock along the left bank bridge abutment at I-5. The remainder of the levee system ties into an existing railroad grade and then, after turning and crossing Coal Creek, it ties into an existing levee. The constructed levee section crossing the confluence of Coal Creek will receive a culvert and flap gate structure to maintain Coal Creek flow and connectivity. Short-term impacts are associated with levee and flap gate construction and are likely limited to temporary increases in turbidity to Salzer Creek and the potential for construction related spills. Riparian loss will be limited since the majority of this levee section parallels a railroad grade that is principally unvegetated. The bridge abutment armoring will be conducted outside the creek channel and carry no significant short-term impacts. Salmon spawning or rearing habitat should not be impacted.

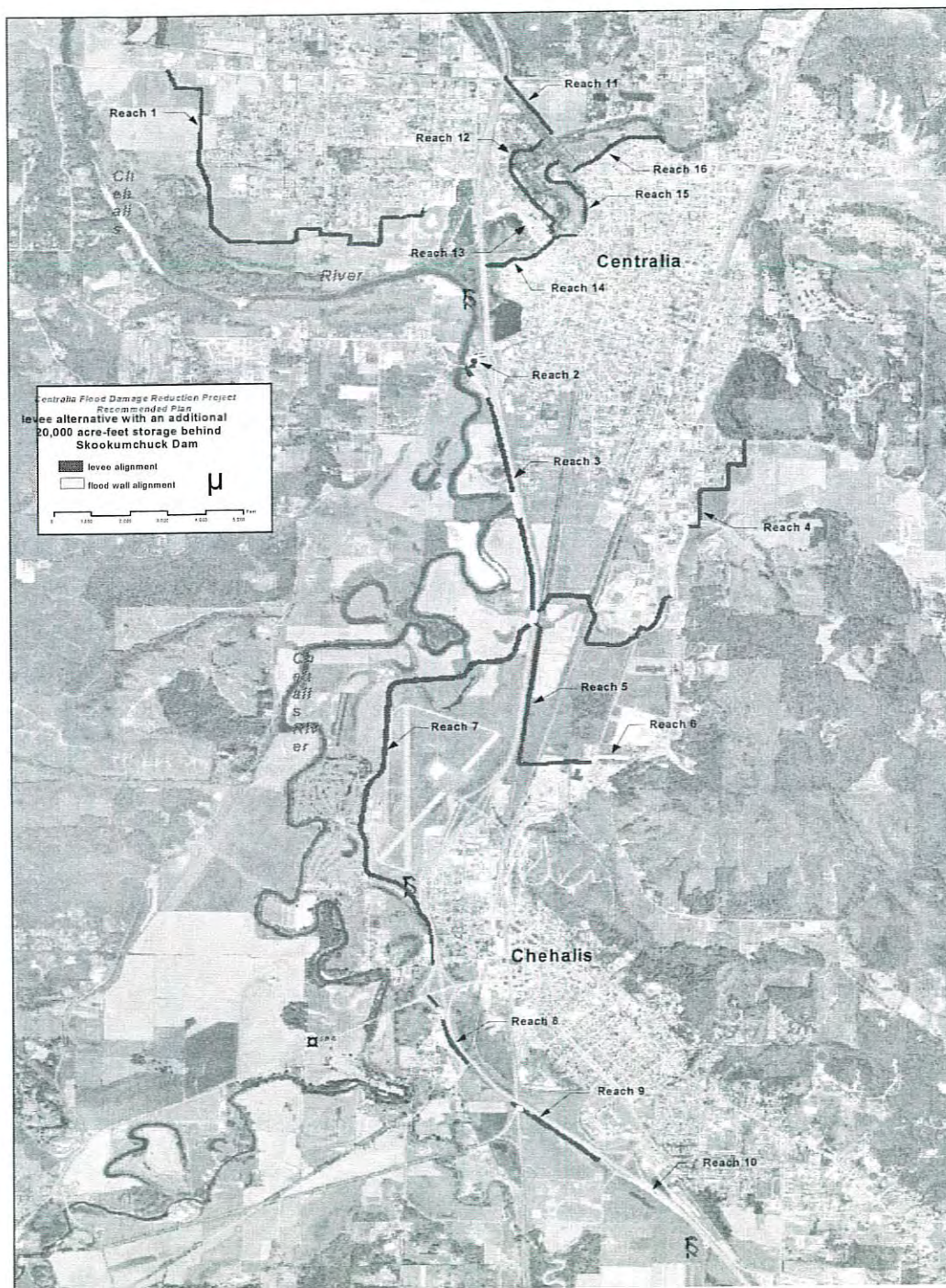


Figure 4.7.3. Levee and floodwall alignment.

Reach 6. Coal Creek. (CH-6)

None anticipated.

Reach 7. Salzer Creek to Airport (CH-4)

This alignment follows along Airport Way with Airport Way located between the levee or floodwall construction and the Chehalis River until it connects to an existing airport levee. The existing levee will be widened from the landward side. None of the levee alignment is in proximity to the Chehalis River or other fish bearing streams except for approximately 250 feet near the Salzer Creek Bridge. In this reach, the creek may require armoring but the levee alignment does not propose construction within the Salzer Creek channel. An existing levee on the south side of Airport Way will be removed out of consideration for an environmentally sensitive area located on the south side of the road. Short-term impacts in this reach are limited to potential riparian loss in the area around the Salzer creek armoring and minor potential for construction related spills and turbidity. Some riparian loss may occur along 4,650 feet of the existing airport levee if it is cleaned prior to landward levee construction. Vegetation along the existing levee to be removed may also be removed and temporarily lost.

Reach 8. SR-6 to Railroad Underpass (DB-2)

Levee construction in this reach will not come near fish bearing creeks except where it crosses Dillenbaugh Creek. The levee will cross Dillenbaugh Creek perpendicularly at the point where it exits a large wetland complex east of I-5. A control box with a flap gate will be installed at this crossing to prevent Chehalis River floodwaters from entering the wetland at extremely high floods (1 foot below the 100-year event) and from flooding residences. Short-term impacts may include temporary creek disturbance in the location of the levee crossing and minor riparian loss in proximity to Dillenbaugh Creek.

Reach 9. Dillenbaugh Creek (DB-3)

This levee reach is designed to protect I-5 from Chehalis River floodwaters. The levee alignment has been offset 78 feet to compensate for planned widening of I-5 in the project area.

Dillenbaugh Creek follows a straight ditch along this levee reach for 3,100 feet and will require relocation to allow for the levee prism. An additional 1,150 feet of levee will be constructed within 100 feet of the creek, which may pose some direct impact but will not require channel relocation. Dillenbaugh Creek also enters the wetland complex east of I-5 in this reach. A control

box with a sluice gate at the point where the creek enters the wetland will be necessary to prevent Chehalis floodwaters from flooding the wetland and residences at extreme high floods (1 foot below 100-year event). The short-term impacts of this reach include temporary riparian loss at the relocation reach and adjacent levee sections as well as increased potential for turbidity and construction related spills. Although the reaches of Dillenbaugh Creek in this levee section are channelized and disrupted, there is a potential for temporary loss to spawning and rearing habitat if construction is not timed appropriately. The establishment of accepted work windows and precautionary guidelines should ensure no significant short-term impacts occur during construction of this levee section.

Reach 10. Dillenbaugh South (FW-2)

Construction of this reach is necessary only if Rice Road is not raised prior to implementing the preferred project. If needed, the project proposes a short floodwall to be located east of Dillenbaugh Creek where it comes within 300 feet of the creek in two locations for a total of 1,100 feet. Of that length, 750 feet appears closer than 100 feet from the creek. Potential short-term impacts are most likely to be temporary increases in turbidity to Dillenbaugh Creek from levee construction and an increased risk of construction related spills. Temporary riparian loss may be short-term impact for the levee portions closest to Dillenbaugh Creek but no construction is likely on the banks of the creek.

Reach 11. West Reynolds Ave. to BNSF (SK-1)

No effects anticipated.

Reach 12. Chehalis Western Railroad to Borst Park (SK-2)

This reach roughly follows the left bank of the Skookumchuck River for approximately 2,050 feet, all of which is closer than 300 feet to the river. Of that length, approximately 700 feet is closer than 100 feet but none is proposed for construction adjacent to the riverbank. Still, the orientation of the levee will require approximately 300 feet along the outside bend to be armored from flood related erosion. Some existing armor rock may need to be maintained in the vicinity of the Harrison Street right bank bridge abutment. Short-term impacts from this levee construction are anticipated to be loss of riparian vegetation mostly associated with the armoring of the outside bend and possible temporary increases in turbidity from construction.

Reach 13. Harrison Street Bridge to I-5 Right Bank (FW-3)

This levee reach follows Hayes Lake for the protection of residences near the Skookumchuck River confluence with the Chehalis River, but the levee is not in close proximity to either river.

Reach 14. Left Bank I-5 to Harrison Street Bridge (SK-3)

This reach follows the left bank of the Skookumchuck River between the Harrison Street bridge and I-5. The alignment is in proximity to the Skookumchuck River and approximately 1,000 feet of the levee will be near or on the riverbank. Where possible a floodwall is proposed to limit riparian disturbance. The alignment near the river increases to 2,100 feet when areas closer than 300 feet are included. Armor rock will be necessary in areas adjacent to the riverbank to prevent scour and erosion from floodwaters. Short-term impacts will be loss of riparian and possibly aquatic habitat from the construction of levee adjacent to the riverbank as well as potential increases in turbidity and risk of construction related spills. The channel adjacent to the levee area is considered marginal spawning habitat. There are no notable off-channel or other rearing habitats in the levee reach.

Reach 15. Harrison Street Bridge to Chehalis Western Railroad. (SK 4)

This reach follows existing road infrastructure and may come into proximity with the Skookumchuck River in two locations for a combined 950 feet but does not appear to come closer than 300 feet at either location. Short-term impacts include the potential for increased turbidity from construction.

Reach 16. Chehalis Western Railroad to BNSF (SK-5)

This reach ties into the existing levee system of the Skookumchuck River and comes within 300 feet of the river in one location for 500 feet. Of that length, 100 feet is closer than 100 feet from the river. The levee reach is setback from the river except where it is necessary to connect with the existing levee system. Short-term impacts from this levee reach may include temporary loss of riparian corridor and some aquatic habitat as the levee comes to the riverbank to join with the existing levee, and a potential for increased turbidity and construction related spills. The riparian corridor in this area is narrow in the reach affected by the levee construction, and riparian disturbance is not anticipated to be significant.

Skookumchuck River

Short-term impacts to fish anticipated from modifications to Skookumchuck Dam may be associated with outlet gate construction. More information on Skookumchuck modifications and impacts can be found in Appendix B. In summary, impact from structural modification is anticipated only for concrete work in and around the dam. However, concrete pouring, drilling and mixing can have impacts to fisheries and wildlife by raising pH levels or elevating water temperatures if conducted in small poorly circulated aquatic environments, if allowed to cure in

large quantities underwater, or if concrete dust and slurry are inappropriately managed. Since most of the construction is conducted upland and the Skookumchuck River is large enough to ameliorate the effects of curing small concrete projects, events of elevated pH, temperature or extended turbidity are not anticipated. Cofferdams may be employed to further minimize water quality degradation from construction activities at Skookumchuck Dam. Similarly, construction activities may alter access to fish passage routes or temporarily reduce passage efficiency. Construction of spillway gates may cause some disturbance to outmigrating juvenile salmonids if not timed and conducted appropriately. Adherence to accepted construction windows and proper sediment and construction management should reduce opportunity for significant short-term effects from Skookumchuck Dam modifications.

4.7.3.2 Long-term Effects

Long-term effects to the environment from the preferred alternative will most likely include impacts from maintenance of the proposed levees and operation of the Skookumchuck Dam flood control plan. Long-term impacts are anticipated principally from loss of riparian and aquatic habitat from portions of the proposed levee system; changes in adult and juvenile migratory pathways during major flood events, tributaries habitat/flow alterations, and flow changes from the operation of Skookumchuck Dam as a flood control project.

Chehalis River and Tributaries

Long-term impacts from the preferred alternative are most likely to be associated with a permanent reduction in riparian corridor succession and loss of instream habitat from bank stabilization and altered fish accessibility to tributaries during flood events. Actual effects on fish resources will be dependent on the size and location of the levee alignment as the effects on fish habitat increase with proximity of the levee to the river.

As stated earlier, the current levee alignment for the preferred project indicates a total of 80,000 linear feet of levee construction or upgrading, most of which is located away from fish bearing rivers and creeks. Of the total construction length, 15,350 feet or 20 percent of the overall length is located within 300 feet of the river. The amount of levee less than 100 feet and therefore more likely to have direct effects on fish resources is 8,700 feet or 10.8 percent of the overall length. Not all levees currently proposed closer than 100 feet of the river are located directly on the riverbank. Bank stabilization and direct aquatic impacts are limited to 1,900 feet (2 percent) of the total levee alignment and further dispersed among six distinct locations. Approximately 6,800 feet (78 percent) of the levees within 100 feet of a fish-bearing stream affect tributaries.

The remaining 1,900 feet (22 percent) of levee is located adjacent to the Chehalis River. General alignment and levee features can also be found in Technical Memorandum No. 4 (USACE 2000a).

Reach 1- Fords Prairie (CH-1)

None anticipated.

Reach 2. Sewage Treatment Plant (CH-2)

Long-term impacts at this reach should be limited to indirect effects to fish resources from loss of floodplain connectivity along the stretch nearest the Chehalis River (300 feet). Direct impacts to instream habitat, rearing habitat and other habitat requirements for anadromous and resident fish are not anticipated.

Reach 3. Mellon Street to Salzer Creek Bridge (CH-3)

Long-term impacts at this reach will include indirect and direct impacts to fish resources from loss of floodplain connectivity along the 1,450-foot reach of levee within 300 feet of the Chehalis River (at 300 feet). Direct impacts to instream habitat, rearing habitat and other habitat requirements are not anticipated but some long-term reduction in woody debris recruitment or drainage patterns may occur.

Reach 4. Salzer Creek Right Bank (Ch-5N)

This levee reach will require at least 1,800 feet of levee construction in proximity to Salzer Creek. While the levee is not expected to be on the riverbank, some loss of riparian cover is likely and may result in reduced terrestrial prey production, canopy cover and woody debris recruitment from levee maintenance. There are no significant off-channel habitats in the reach, but some small reduction in mainstem rearing habitat may occur depending on final placement location. A 150-foot section of levee located near the Salzer Creek bridge will require armoring for erosion protection and may result in direct loss of instream habitat if constructed below ordinary high water. Significant impacts to spawning and migration of adult and juvenile fish are not anticipated, as the levee alignment does not directly alter tributary connectivity with the Chehalis River.

Reach 5. Salzer Creek Left Bank (CH-5S)

As with Reach 4, the intent of this levee section is to prevent Chehalis River flooding from within the Salzer Creek basin. Long-term impacts from this levee section are limited to possible direct impacts from armor rock placement near the Salzer Creek bridge. A 150-foot section of

levee located near the Salzer Creek bridge will require armoring for erosion protection and may result in direct loss of instream habitat if constructed below ordinary high water. Significant impacts to spawning and migration of adult and juvenile fish are not anticipated, as the levee alignment does not directly alter tributary connectivity with the Chehalis River.

Reach 6. Coal Creek. (CH-6)

None anticipated.

Reach 7. Salzer Ck to Airport (CH-4)

This alignment follows along Airport Way with Airport Way located between the levee floodwall construction and the river until it connects to an existing levee around the airport. The existing levee will be widened from the landward side. None of the levee alignment is in proximity to the Chehalis River or other fish bearing streams except for approximately 250 feet near the Salzer Creek bridge which may require armoring but is not proposed for construction within the Salzer Creek channel. Direct effects from this armoring will be seen only at high water events and only for the length of levee armored. Removal of the old levee may increase floodplain connectivity to previously isolated habitats and wetlands. Long-term vegetation maintenance may result in some loss of riparian function but the setback nature of the levee alignment should result in minimal impacts to fish.

Reach 8. SR-6 to Railroad Underpass (DB-2)

Levee vegetation management along this levee reach could create long-term impacts through maintained reductions in riparian vegetation and canopy cover along the levee alignment. Impacts are most likely where the levee parallels a large wetland complex and at the site of the control box installation. Additionally, the control box structure may prevent adult access and juvenile passage when closed during large flood events. The frequency of control box operation is anticipated to be sporadic and not likely to cause significant limitations to fish use of the wetland. The wetland should also remain open at the control box site during the outmigration period. Salmon spawning or rearing habitat should not be affected.

Reach 9. Dillenbaugh Creek (DB-3)

This levee reach is designed to protect I-5 from Chehalis River floodwaters. The alignment has been offset 78 feet to make room for expected widening of I-5 in the project area. Dillenbaugh Creek in this reach is degraded and contained within a straight ditch for 3,100 feet. The levee will require a portion of the creek to be relocated to allow room for the levee prism. This creek relocation may prove to be beneficial if opportunities to reestablish sinuosity, vegetation,

overstory and aquatic habitats are incorporated into design. Long-term impacts will be negative and possibly significant if the creek is simply relocated without enhancement. An additional 1,150 feet of levee alignment will not require creek relocation but will be within 100 feet of the bank and may result in some maintained loss of canopy cover as a result of levee vegetation maintenance. Currently, there is no riparian vegetation within these reaches of Dillenbaugh Creek. Rearing and other aquatic habitats are likely to be affected as a result of the channel relocation. Properly designed, the relocated channel should provide better aquatic conditions than the current condition. Additionally, the control box structure may prevent adult access and juvenile passage during large flood events. The frequency of control box operation is anticipated to be sporadic and not likely to cause significant limitations to fish use of the wetland. The wetland should also remain open at the control box site during the outmigration period. There is no spawning habitat within these reaches of Dillenbaugh Creek.

Reach 10. Dillenbaugh South (FW-2)

Construction of this reach is necessary only if Rice Road is not raised prior to implementing the preferred project. The reach consists of a short floodwall located east of Dillenbaugh Creek where it comes within 300 feet of the creek in two locations for a total of 1,100 feet. Of that length, 750 feet appears closer than 100 feet from the creek although not on the banks of Dillenbaugh Creek. Potential long-term effects are a maintained lack of riparian canopy. The floodwall approach should reduce the footprint and allow for a reduced need to manage vegetation.

Reach 11. West Reynolds Avenue to BNSF (SK-1)

No adverse effects are anticipated.

Reach 12. Chehalis Western Railroad to Borst Park (SK-2)

Long-term effects from construction of this levee reach are associated with indirect fish habitat impacts from the 2,050 feet of levee within 300 feet of the bank and some degree of direct impact from the 700 feet of levee construction within 100 feet of the riverbank. The most likely source of long-term fish effects may result from the 300 feet of levee that will require armor rock for erosion protection. This 300 feet may result in some long-term habitat impairment, vegetation loss and loss of riparian canopy. A reduction in woody debris recruitment may also occur. The conversion of approximately 700 feet of stream bank habitat to levee could represent a permanent habitat loss if the construction is not planned and mitigated appropriately.

Reach 13. Harrison Street Bridge to I-5 Right Bank (FW-3)

None anticipated.

Reach 14. Left bank I-5 to Harrison Street Bridge (SK-3)

Long-term impacts from construction of this levee reach are associated with indirect fish impacts from the 2,100 feet of levee within 300 feet of the bank and some level of direct habitat or fish impact from the 1,000 feet of levee construction within 100 feet of the riverbank. Within this reach, most of the 1,000 feet proposed levee will be on or near the riverbank increasing the potential for riparian and aquatic habitat impacts. The reach is not generally considered highly productive spawning habitat. Further detailed planning is still necessary. The conversion of approximately 1,000 feet of stream bank habitat to levee could represent a permanent habitat loss if the construction is not planned and mitigated appropriately.

Reach 15. Harrison Street Bridge to Chehalis Western Railroad (SK 4)

None anticipated.

Reach 16. Chehalis Western Railroad to BNSF (SK-5)

Long-term impacts from construction of this levee reach are associated with indirect fish impacts in one location totaling 500 feet of levee of the bank and some level of direct habitat or fish impact from the 100 feet of levee to be constructed within 100 feet of the riverbank increasing the potential for riparian and aquatic habitat impacts. The reach is not generally considered highly productive spawning habitat. Further detailed planning is still necessary. The riparian corridor in this area is narrow in the reach affected by the levee construction and riparian disturbance is not anticipated to be significant from conversion of approximately 100 feet of stream bank habitat.

Skookumchuck River

Long-term impacts to fish anticipated from modifications to Skookumchuck Dam are most likely associated with the management of the Skookumchuck River system to accommodate flood control needs and can be separated into two geographic areas. First is the possible long-term effect of operating a flood control dam on the reservoir. Second is the possible long-term impact on downstream fish resources from flood control construction and dam operations. The following section is a summary of potential long-term impacts from operation at Skookumchuck Dam. Additional information on Skookumchuck Dam modifications and impacts can be found in Appendix B.

Reservoir operations will increase winter pool fluctuations and require fish-bearing tributaries around the reservoir to adapt to a winter varial zone. These difficulties are not likely on the Skookumchuck River due to its size and winter flow volume but may occur on smaller tributaries. Absent a flood event, the preferred project would strive to keep a winter pool at elevation 455 feet, which will result in a reduction in availability of shoreline vegetation to fish until the February refill. In addition, the lower reservoir may increase the opportunity for cutthroat trout to prey upon juvenile steelhead as surface acreage becomes smaller and terrestrial food sources become less available. Fish passage issues may also become a long-term adverse impact if the tributaries cut through unconsolidated soils exposed by the lowered reservoir. Heavy tributary scour through the reservoir sediments can create fish passage difficulties for resident fishes during the winter. Changes to sedimentation, woody debris movement, channel movement and other channel maintenance processes are not anticipated.

At the dam, the creation of a flood control project will allow all flows to be passed through the new larger gates and it may influence fish migration pathways. Since flow is a primary factor for passage selection, some percentage of steelhead and resident trout moving through the dam between November and February would likely travel through the new outlets, even if access to the spillway were available. In the winter however, fish passage would be limited to some adult steelhead that fall back after transfer, and resident trout. Steelhead out-migration generally occurs after the flood control season. If the new outlet structures are inefficient or otherwise compromise fish passage efficiency, it should be considered a long-term fish impact. Planning is ongoing to design outlets that minimize or avoid impacts to fish passage and consider its reconnections to the river.

The preferred project would not allow the reservoir to refill in winter as it does currently. Early winter freshets that are normally captured in the reservoir would be passed to maintain a reservoir elevation of 455 feet. These freshets may have positive effects on fish migration as they can influence adult salmon movement. Adult salmon may use inflow pulses caused by fall rains to begin moving toward their spawning grounds where they may continue to have benefits by helping to initiate spawning. Juveniles rearing in the river may also use fall freshets to begin moving into side channels and other overwintering habitat prior to the onset of winter. It is presumed the reservoir will be managed to maintain the minimum pool in anticipation of floods, which would result in most freshets being passed quickly. If the flood control operation calls for capture of the freshets until the pool has filled to a critical point, then the benefits of the freshets would be diminished.

Downstream of the project, late fall flood flows could have long-term impacts to spawning salmon depending on the duration of high flow events. Freshets captured and then released over an extended timeframe, may artificially elevate river stage and put redds built by salmon on high gravel bars at risk of desiccation. This impact is most commonly a problem in spring when high flows are less likely to keep higher elevation redds watered and typically affects spawning steelhead most heavily. Conversely, a modified hydrologic regime that allows for extensive and frequent connections to side channel complexes and other off-channel rearing areas may benefit rearing juvenile salmon. Juvenile benefits from frequent and low level flooding of off-channel habitats are predicated upon having good habitat in reaches with good connectivity by way of small tributaries, extensive side channel habitats, or wetlands. Overtopping events in these reaches may represent a long-term benefit by providing rearing opportunities for juvenile salmon and refuge for adults to escape the turbulent and debris-filled mainstem. Areas of poor river connectivity would not realize these benefits and may even constitute a significant long-term risk of adult and juvenile salmon stranding. Most likely in the urbanized and altered sections of the river, overbank flooding in these areas would not allow for adequate return pathways to the river and possibly result in excessive juvenile and adult salmon stranding in pasturelands, roadside ditches and suburban neighborhoods with no mechanism for reentry to the river.

River fluctuations as a result of flood operations may also constitute a long-term impact to both juvenile and adult salmon. However, since flood operations are halted prior to the spring and summer, stage fluctuations attributable to dam operations will be minimal and act to avoid many stage-induced impacts. Juvenile stranding in side channels can be exacerbated by rapid drawdown of river stage particularly in the spring when river inflow is lowering and subsequent opportunities to reestablish flows that reconnect side channels are lessened. During the fall periods, natural inflows allow for multiple opportunities for side channel connections. Arguably, the reduction of extremely high flood flows would reduce access to upland depressions and other areas likely to place juvenile and adult fish in areas where later reconnection is unlikely. Adult spawning impacts from river fluctuations are also most pronounced in the spring when steelhead spawning during artificially high river stages can be impacted as stage drops leaving redds spawned at the rivers margin to become desiccated as the stage drops.

4.7.4 Summary

4.7.4.1 Chehalis Levees

In general, areas directly impacted by the preferred alternative include opportunities for further minimization of impacts. Minimization techniques will be necessary to avoid excessive impacts from long-term loss of instream habitat, juvenile cover and refuge habitats and reductions in riparian canopy.

Despite additional minimization techniques however, vegetation maintenance in these areas may still propagate a long-term reduction in riparian habitat by limiting overstory growth, associated prey resources, woody debris recruitment and cover habitat. Areas of indirect impact to fish from levee construction (construction between 100 and 300 feet from fish habitat) could also have long-term impacts to water quality, nutrient transport and runoff, but the limited amount of this type of impact should not result in significant impacts to resident or anadromous fish.

Long-term impacts from the construction of these tributary levee systems and control structures are different for each tributary. Levee construction around the tributary confluences has associated long-term impacts similar to those of the Chehalis River levee. Potential impacts include a loss of riparian overstory and a related reduction in woody debris requirement, reduction in shading and terrestrial prey production. The degree of this impact is directly related to the proximity of the levees to the tributary.

Watershed-scale long-term impacts should not be appreciable as the amount of Chehalis River and tributary floodplain will be allowed to remain largely intact. Significant alterations to groundwater flow and sediment transport are not anticipated under the preferred alternative. Allowing floodwater inundation over a large segment of the existing floodplain may minimize future human development and institutionalize the presence of necessary floodplain processes.

4.7.4.2 Skookumchuck Dam Modifications

Impacts most likely above the dam appear related to increased reservoir fluctuations, which may cause fish to adapt to water surface fluctuations, create potential fish blockages at tributary mouths and increase turbidity potential. Alterations to sedimentation, woody debris movement, channel movement and other reservoir maintenance processes are not anticipated.

Impacts to fish at the dam are not anticipated. Construction of the outlet facility should occur outside the fish migration window and be done principally in the dry. When completed, the outlet should pass fish effectively or provide a full pool prior to the onset of outmigration. A full pool condition would allow for fish to outmigrate through the existing spillway.

Below the dam, the preferred project would allow for early winter freshets that are normally captured in the reservoir to be passed to maintain a reservoir elevation of 455 feet, potentially benefiting juvenile and adult salmon. Flow fluctuations may provide an opportunity for annual high flow events but would eliminate large-scale flooding. Annual overbank flooding events may represent a long-term benefit by providing rearing opportunities for juvenile salmon and refuge for adults to escape the turbulent and debris-filled mainstem. Areas of poor river connectivity would not realize these benefits and may even constitute a significant long-term risk of adult and juvenile salmon stranding.

4.7.5 Mitigation

Proposed mitigation for fish impacts will be managed principally through avoidance and minimization techniques aimed at reducing the amount of direct and indirect impact to fish and fish habitat through construction timing, levee alignment and location. Fish impacts associated with changes to the Skookumchuck River hydraulic regime during the flood control season will require further study. During the PED phase, operational features of the dam will be defined and appropriate mitigation identified that may include habitat improvements, acquisition and protection. Additional recommendations for mitigation of fish impacts can be found in Appendix B.

The creation of a Scheuber ditch connection through SR-6 may also be constructed for the benefit of fish and fish habitat. Construction of the SR-6 bypass for mitigation purposes along with oxbow connections will enhance fish habitat in that reach while allowing juvenile fish off-channel habitat during high flow events. Specific engineering criteria related to channel formation, access, and reconnection will need to be defined in PED to ensure adequate access and survival of fish using the site. The combination of a Scheuber ditch bypass and habitat efforts on the Skookumchuck should provide opportunity for adequate mitigation of unavoidable adverse impacts to fish and fish habitat resulting from the preferred project. A final evaluation and accounting will occur during the design phase.

4.8 LAND USE AND PLANNING

4.8.1 No Action Alternative

Under the no action alternative, no project features would be constructed. Consequently, lands that are currently within the 100-year floodplain would remain prone to flooding. Undeveloped lands within the floodplain that are located within designated urban growth areas established by city or county comprehensive plans would undergo development in accordance with applicable requirements under the Growth Management Act (GMA) (RCW 36.70A). In accordance with the GMA, growth outside the designated urban growth boundaries could occur only if it were not urban in nature.

4.8.2 Criteria for Determining Significance of Effects

The following criteria were used to evaluate the significance of effects on land use. A significant effect would occur if construction and/or operation activities would:

- physically divide an established community;
- result in the dislocation of large numbers of residents or businesses;
- lead to major changes in land ownership or use patterns;
- result in major changes in population density or growth rates;
- conflict with applicable land use plans, policies, or regulations of any entity with jurisdiction over the area, including local comprehensive plans and zoning ordinances as well as federal and state policies and regulations for development in floodplains.

4.8.3 Preferred Alternative

Under this alternative, a series of levees would be constructed in and around the cities of Centralia and Chehalis. Levees would be constructed at selected locations along the Chehalis and Skookumchuck rivers as well as along several tributaries (i.e., Salzer Creek, Dillenbaugh Creek). The levee alignment would protect residential, commercial, and industrial structures, as well as transportation corridors and other infrastructure from flooding during the 100-year event.

Direct impacts to current land uses as a result of levee construction would include the permanent conversion of lands (approximately 66 acres) within the levee footprints and, potentially,

temporary disruption of land uses in construction staging areas. Design objectives intended to minimize the impacts of levee construction on adjacent land uses include using the existing levee system to the extent possible, using existing roads as levees where possible, and avoiding the relocation of structures and residential areas.

These design objectives also minimize impacts to the Chehalis River shoreline that is designated as a shoreline of statewide significance. Levees, floodwalls, and bank stabilization features would be placed along or immediately adjacent to the Chehalis River shoreline in two locations in the reach between Mellen Street and the Salzer Creek bridge, where there is limited area between the riverbank and the I-5 embankment. For the most part, however, project features would be set back 200 feet or more from the river, and overall impacts on the Chehalis River shoreline would be negligible.

4.8.3.1 Centralia Area

The levee alignment places levees within a variety of land use designations in and around the City of Centralia. In the Fords Prairie area, the levee footprint falls within several zoning districts, including light industrial and Port of Centralia master plan property immediately south of Galvin Road. The levee footprint continues south then east through unincorporated areas, continuing into the low-density residential land use designation within Fort Borst Park.

Levees would also be placed west of I-5 in low-density residential lands near Graf Road, within medium density residential and limited business district lands northeast of the hospital, and along Cooks Hill Road between land designated as low-density residential to the north and high-density residential to the south.

Several levee segments would be constructed along the Skookumchuck River within Centralia. One segment would be constructed along the north side of the river extending from approximately RM 1.4 to the west side toe of I-5. The levee would more or less follow the course of the river, with the footprint located in low-density residential, highway commercial, and core commercial zones. A second levee segment would be constructed south of the Skookumchuck River from approximately RM 2.1 west to the toe of I-5. The levee footprint would affect primarily low-density residential lands, with medium density residential land being affected adjacent to I-5. A third levee segment would be constructed north of the river, adjacent to and east of the BNSF rail line at approximately RM 1.5. This levee segment would be located outside Centralia city limits.

There are also several areas north of Salzer Creek that would be affected by the levee alignment footprint. The footprint in this area would begin east of I-5 at Salzer Creek, then continue north and east through city-designated light industrial lands west of the fairgrounds. The footprint would pass south of the fairgrounds outside of city limits, then north again through lands designated for general commercial use. The levee would then proceed outside city limits again to the east. In this area, the levee footprint would border a county-designated low-density residential zoning classification to the east.

Levees would also be placed adjacent to the Centralia Wastewater Treatment Plant, with one segment continuing south under Airport Road through commercially designated lands before leaving Centralia city limits. The levee footprint in this area borders undeveloped land north of the airport designated as commercial.

4.8.3.2 Chehalis Area

The levee alignment footprints in and around the City of Chehalis would also affect a variety of land use designations. East of I-5 south of Salzer Creek, the levee alignment would cross commercial and residential high-density multi-family zoning designations. The actual land use in this area is primarily commercial, with some undeveloped parcels present. South of the airport, the levee alignment would border several areas designated as residential transition. Further south along the west side of I-5, the levee system would border areas designated as residential high-density multi-family. The southern-most levee footprints, adjacent to I-5 and Dillenbaugh Creek, would occur within planned unit development lands south of the city.

4.8.3.3 Protected Areas

Under the alternative, the levees would be set back away from the Chehalis and Skookumchuck rivers as far as possible; therefore, there would not be large areas of currently undeveloped land that would be protected by the levees. However, there are some isolated areas of undeveloped land that would be afforded protection by the levees. These include areas north and south of Centralia High School, lands adjacent to I-5 northwest of the fairgrounds, and lands immediately north of the Centralia-Chehalis airport. Several small tracts of undeveloped land adjacent to I-5 in the Chehalis area would also be protected.

There are several areas where currently undeveloped lands within city or county growth management boundaries would be protected. These undeveloped lands within unincorporated

areas include land designated as low-density residential adjacent to Centralia High School, commercially designated lands north of the airport adjacent to I-5, and several low-density residential and commercial parcels northwest of the fairgrounds and southeast of Summa Street and Kresky Avenue.

Undeveloped, protected parcels located within the City of Centralia growth management boundaries include light industrial and Port of Centralia master plan properties south of Galvin Road, light industrial lands east of the fairgrounds, and commercial properties located north of the fairgrounds and south of the Centralia Wastewater Treatment Plant.

Within the City of Chehalis there is one parcel of land within the growth management boundaries that would be protected under the preferred alternative. The parcel is designated as commercial and is located immediately north of the airport.

Urban development would not occur in areas protected by the levees unless they are located within city or county growth management boundaries. Protected lands within the growth management boundaries would be developed in accordance with jurisdictional growth plans adopted under the GMA. Any changes to the jurisdictions' growth plans would require amendment under the GMA process.

With respect to the goals and policies for land use established in the Lewis County, City of Centralia, and City of Chehalis comprehensive plans, the proposed levees would provide a positive benefit for land use in the Centralia/Chehalis area. The levees would protect existing residential, commercial, and industrial structures from damage during flood events.

The protection of existing residential, commercial, and industrial properties is vital to the achievement of the goals and policies set forth in the city and county comprehensive plans. One common goal stated in the comprehensive plans is the protection and continued growth of the area's commercial and industrial sectors. The protection of these properties, as well as transportation corridors and infrastructure, would allow for their continued growth under the policies and requirements set forth in the adopted land use plans. Protection of residential areas within the floodplain would ensure that managed growth can occur to accommodate the projected population growth rates in the area.

4.8.4 Summary

4.8.4.1 Chehalis levees

Lands that would be affected by levee construction are currently designated rural open space under the Lewis County Comprehensive Plan, and are primarily devoted to agriculture.

4.8.4.2 Skookumchuck Dam Modifications

Modifications to the Skookumchuck Dam have been designed to improve water storage efficiency and would contribute to the management of flood flows in the area. Construction of the dam modifications would have little direct effect on land use in the area, although operations at the dam and reservoir would be subject to temporary disruption during construction.

Fluctuations in reservoir levels are not expected to change land uses within the reservoir area; logging operations in the vicinity of the reservoir should not be affected. However, the modified reservoir operations would provide a significant reduction in flood stage near Bucoda, and protect existing residences and commercial establishments within Bucoda that are currently subject to flooding from the 100-year event. Protected parcels that are currently undeveloped would be subject to growth management restrictions under the Thurston County Comprehensive Plan.

Overall, the effects of the preferred alternative on land use are expected to be positive, as the alternative would afford protection to existing residential, commercial, and industrial areas and supporting infrastructure. Based on the above criteria, there would be no significant direct impacts on land use. Implementation of the preferred alternative is not expected to induce significant development outside established urban growth boundaries, nor result in major changes in land use patterns.

4.8.5 Mitigation

None anticipated.

4.9 RECREATION AND AESTHETIC RESOURCES

4.9.1 No Action Alternative

There are no effects associated with recreational activities under the no action alternative. Development of planned recreational resources and opportunities would continue unaltered by the proposed project. The aesthetic values of the study area would remain unaffected. Development along travel corridors would continue as planned under existing conditions.

Recreational activities associated with river access would not be affected by construction or operations of the levees, since boat ramps will not be removed and the existing parks will remain in place. Some positive effects could result from the creation of proposed wetlands and riparian areas as either mitigation or restoration activities to offset the levees. The Skookumchuck Reservoir already has restricted access and therefore no effects on recreation can be expected from dam modifications. During project construction, access will be limited or denied to those areas where the levees are located. This will be a temporary negative effect.

4.9.2 Criteria for Determining Significance of Effects

The following criteria were used to evaluate the significance of effects on recreation and aesthetics. A significant effect would occur if construction and/or operation activities would cause:

- displacement of fishing and hunting opportunities;
- displacement or preclusion of hiking and other related outdoor activities;
- alteration of current landscape and scenery.

4.9.3 Preferred Alternative

The aesthetic environment around the levee alignment will be affected by the preferred alternative. Some of the levees will have aesthetic impacts by altering the views surrounding the project area. Following roads, existing levees and existing features to reduce the changes in aesthetics and utilize existing topography, have minimized this impact. The levees will be planted with grasses and maintained to keep a more natural character within the project. Most views will not be blocked by the levees themselves and background aesthetics should remain

unchanged. There are temporary aesthetic effects during project construction while heavy machinery, increased activity, and exposed soils alter the existing views.

4.9.4 Summary

Riparian plantings and wetland creation conducted as a part of the preferred alternative would not preclude or eliminate any recreational opportunities post-construction. The visual impact of levee construction will occur temporarily, but this is not expected to be a significant effect on the long-term aesthetics of the project area. The project would not alter the rural aesthetic in the project area nor reduce hunting or fishing opportunities.

4.9.5 Mitigation

None anticipated.

4.10 TRANSPORTATION AND TRAFFIC

4.10.1 No Action Alternative

Under the no action alternative, no project features would be constructed. Roadways that are currently subject to inundation during flood events would remain vulnerable to flooding. During floods, road access to major healthcare facilities would still be eliminated, and access to convalescent facilities, isolated residential areas, and public health and safety facilities would still be impeded. The existing levee around the airport would continue to be overtopped during the 50-year flood and larger events. SR-6 would still be regularly overtopped by floodwaters, and I-5 would remain subject to closure during larger floods. Widening of I-5 and other improvements that are necessary to address design deficiencies and meet the expected 2020 travel demand could not be undertaken in the Centralia-Chehalis area unless the highway grade were raised in portions of the floodplain in order to meet state and federal highway flood clearance requirements.

4.10.2 Criteria for Determining Significance of Effects

The following criteria were used to evaluate the significance of effects on transportation in the study area. A significant effect would occur if construction and/or operation activities would:

- result in permanent road closures;
- result in temporary road closures that would redistribute traffic in a way that would cause peak-hour traffic volumes to exceed available capacity on any roadway;
- result in temporary road closures requiring lengthy detour routes to be established;
- cause substantial disruption of rail traffic through the area.

4.10.3 Preferred Alternative

4.10.3.1 Levee Construction

During levee construction, there would be an increase in traffic on local roads as construction equipment, supplies, and workers are transported to and from the area. Temporary haul roads will need to be constructed in some locations; these roads would be a minimum of 12 feet wide for one-way traffic and 24 feet wide in locations where two-way traffic must be accommodated. Some existing roadways would also be used as haul roads; these would be surveyed before and after project construction and restored to pre-project condition. The local sponsor would select the routes used for hauling of construction materials. The hours of operation would be specified to minimize traffic delays as much as possible.

There would be temporary closures on roadways adjacent to or within the levee footprint. Roads that could be affected by closures during construction include secondary routes in the Fords Prairie area, Airport Road, routes near the fairgrounds, and routes in the vicinity of the Harrison Street bridge. Temporary road closures could also occur in other areas. During construction, temporary access ramps would be provided at road crossings and driveways.

An assessment of the I-5 embankment material would be done to verify that using portions of the highway as a levee would not affect the integrity of the roadway or embankment. Project construction is not expected to cause major disruption of traffic on I-5, but modifications to the Salzer Creek bridge that would be needed to address flooding problems there may entail temporary traffic delays. Safety measures will be coordinated with WSDOT for levee construction immediately adjacent to I-5.

Several roads in the project area may be raised or relocated on top of the levee, although it would be possible to build a levee or a floodwall parallel to existing roads in some areas. The local

sponsor would review the options and determine the best approach for the local community. In locations where roads are raised or levees are constructed adjacent to driveways, permanent ramps would be constructed or a flood fight plan would be established to close off low-lying driveways during flood events. In a number of areas, openings in floodwall segments would be needed to provide access to commercial buildings. Flood fight plans would be developed for these locations.

Construction of the levee system would eliminate inundation of I-5 during the 100-year flood event. Transportation routes in virtually all of the Fords Prairie area would be protected. Transportation corridors in large portions of Centralia would be protected. The Mellen Street underpass would be protected from backwater flooding, maintaining a critical open access route to the hospital. However, portions of Cooks Hill Road, a primary route to the hospital, would still be inundated during the 100-year flood. The next phase of the project will include an investigation of options for protecting Cooks Hill Road to ensure that access to the hospital remains open during large floods. Flooding and interior drainage problems in China Creek would leave roadways adjacent to China Creek and east of the BNSF tracks south to Salzer Road vulnerable to flooding. A separate investigation to address problems with China Creek will be conducted in the next phase of the project. The Chehalis-Centralia Airport and adjacent areas would be protected from flooding during the 100-year event, although a section of the south end of Airport Road would still be subject to inundation. South of Salzer Creek, portions of the BNSF tracks and National Avenue would also remain subject to inundation during larger flood events.

4.10.3.2 Skookumchuck Dam Modifications

Construction of the Skookumchuck Dam modifications would cause a minor, temporary increase in traffic on SR-507 and Skookumchuck Road as construction equipment, supplies, and workers are transported to and from the site. The modified reservoir operations would provide a significant reduction in flood stage near Bucoda, and reduce flooding of roadways in the Bucoda area that are currently subject to flooding from the 100-year event.

4.10.4 Summary

Overall, the effects of the preferred alternative on transportation would be beneficial, as it would protect existing transportation infrastructure from inundation during large floods. There would be no permanent road closures, and temporary closures are not expected to cause significant peak-

hour traffic delays. Lengthy detour routes would be avoided. There may be some disruption of rail traffic during construction, but this is not expected to be substantial. Based on the above criteria, there would be no significant impacts on transportation.

4.10.5 Mitigation

Several project construction procedures and design considerations are intended to mitigate temporary and long-term impacts on transportation. As described above, existing roadways used as haul roads would be surveyed before and after construction and restored to pre-construction conditions. Temporary access ramps would be installed at road crossings and driveways to provide access during construction. Permanent ramps would be installed in locations where roads are raised or levees are constructed adjacent to driveways, or a flood fight plan would be established to close off low-lying driveways during flood events. In a number of areas, access to commercial buildings would be provided by openings in floodwall segments, and flood fight plans would be developed for these locations.

4.11 AIR QUALITY

4.11.1 No Action Alternative

Air quality would remain similar to existing conditions under this alternative. If the construction associated with the preferred alternative does not occur, air quality within the region would not be affected in the short-term by construction.

With the no action alternative, uncontrolled floodwaters would be allowed to collect and pass through urbanized portions of the project area, causing damage to homes, businesses, and existing flood control devices. During and after significant flood events it may become necessary to utilize heavy equipment to clear debris, remove sedimentation and repair existing levees. These emergency operations will generate additional short-term pollutants.

4.11.2 Criteria for Determining Significance of Effects

The following criteria were used to determine the significance of effects on air quality. A significant effect would occur if construction and/or operation activities would:

- violate any NAAQ or SWCAA standard or contribute substantially to an existing or projected air quality violation;
- expose sensitive receptors to substantial concentrations of pollutants;
- result in substantial emissions;
- result in deterioration of air quality.

4.11.3 Preferred Alternative

4.11.3.1 Short-Term Effects

Two potential sources of air emissions are construction activities and construction related motor vehicle traffic. Construction includes excavation and the moving of earth to create the levees and the Skookumchuck Dam modifications. It is assumed that the project would generate pollutants of CO, ROG and NO_x, and PM₁₀ during the construction period.

Excavation activities would release dust particles as a result of wind erosion over exposed earth surfaces and from the activities of construction vehicles and equipment. Dust releases generally constitute the largest source of PM₁₀ during construction. Although most of the dust particles would settle out immediately adjacent to construction areas, a small fraction would temporarily contribute to the area's ambient PM₁₀ level. Exhaust from construction vehicles may increase concentrations of pollutants such as CO in the project area. CO emissions emitted as vehicle exhaust are the primary pollutant of concern because of their potential to cause CO hotspots. Concentrations of pollutants such as CO and elevated levels of PM₁₀ may occur in the immediate vicinity of the excavation area.

Air quality effects due to excavation activities and construction vehicle emissions are temporary unavoidable significant adverse impacts. Impact would be considered less than significant with implementation of construction mitigation measures. All site work will comply with SWCAA regulations, which require reasonable precautions such as application of dust suppressants to avoid dust emissions.

4.11.3.2 Long-term Effects

The levee, flowway bypass, and dam modifications are passive flood control features. These features are not anticipated to generate operational air pollutants. No stationary sources of air

pollution will be associated with the operation of these flood control features; therefore, no significant long-term effects are expected.

4.11.4 Summary

Air quality impacts due to construction activities and vehicle emissions are temporary and occur only when construction activities are taking place. All site work will comply with SWCAA regulations, which require reasonable precautions such as application of dust suppressants to avoid dust emissions. Unfavorable effects would be considered less than significant with implementation of construction mitigation measures. There will be no substantial emissions or deterioration of air quality.

4.11.5 Mitigation

Implementation of the following mitigation measures will reduce construction impacts to a less-than-significant level:

- water all active construction areas at least twice daily;
- cover all trucks hauling soil, sand, and other loose materials or require all trucks to maintain at least 2 feet of freeboard;
- apply water three times daily or apply (non-toxic) soil stabilizers on all unpaved access roads, parking areas, and staging areas at construction sites;
- sweep daily (with water sweepers) all paved access roads, parking areas, and staging areas at construction sites;
- limit traffic speeds on unpaved access roads to 15 mph;
- install sandbags or other erosion control measures to prevent silt runoff to public roadways;
- suspend excavation and grading activity when winds (instantaneous gusts) exceed 25 mph;
- limit the area subject to excavation, grading, and other construction activity at any one time.

No additional mitigation is anticipated.

4.12 NOISE

4.12.1 No Action Alternative

No construction would occur with this alternative, and as a result, noise levels within the project area would not be affected by short-term construction. Noise levels would remain similar to existing conditions.

4.12.2 Criteria for Determining Significance of Effects

The established daytime standard cited by all respective noise elements is 60 dBA Ldn. Potential noise effects of the project were evaluated based on the following criteria. A significant effect would occur if construction and/or operation activities would:

- result in noise levels that would exceed the adopted noise standards of the City of Centralia or current state standards;
- require construction activities that create short-term impacts exceeding local requirements at sensitive receptors in the area;
- be incompatible with the noise environment in the area.

4.12.3 Preferred Alternative

4.12.3.1 Short-Term Effects

Typical construction noise levels at 50 feet from the source are summarized in Table 4.12-1. The types of construction equipment expected for this project include trucks, backhoes, bulldozers, and loaders. Table 4.12-2, which assumes this combined source-noise level, summarizes predicted noise levels at various distances from an active construction site. These estimates of noise levels take into account distance attenuation (6 dBA per doubling of distance), attenuation from molecular absorption, and anomalous excess attenuation (Hoover 1996). Assuming an attenuation of 6 dBA per doubling of distance, construction equipment noise in the range of 70 to 96 dBA would generate noise levels of up to 66 dBA at a distance of 1,000 feet from construction equipment, which is above typical ambient noise levels. Noise levels for construction and excavation activities associated with the SR-6 floodplain modification and dam modifications features will most likely be similar to the construction of the levee system.

However, the area to be excavated is in a sparsely populated, mostly agricultural area, and therefore has a lower level of human receptors. The dam site is not close to residential, commercial or industrial development, and therefore, human receptors are limited.

Table 4.12-1: Typical Construction Equipment Noise Levels

Type of Equipment	Noise Level in dBA at 50 feet
Bulldozer	85
Front Loader	85
Grader	85
Backhoe	80
Scraper	89
Electrical Generator	81
Roller	74
Compactor	82
Crane with Headache Ball	88
Concrete Pump	82
Concrete Vibrator	76
Concrete and Dump Trucks	88
Air Compressor	81
Pile Driver (Peak)	101
Pneumatic Tools	85

Table 4.12-2: Construction Noise in the Vicinity of an Active Construction Site

Distance (feet)	Noise Level (dBA)	Distance (feet)	Noise Level (dBA)
50	94	1,500	62
100	88	2,000	59
200	82	2,500	56
500	73	3,000	53
600	71	4,000	49
800	69	5,280	45
1,000	66	7,500	38

Notes: The following assumptions were used: Basic sound-level drop-off rate = 6.0 dBA/doubling. Molecular adsorption coefficient = 0.7 dB/1000 feet.

Anomalous excess attenuation = 1.0 dB/1000 feet.

Reference noise level = 94 dBA.

Distance for reference noise level = 50 feet.

This calculation does not include the effects, if any, of local shielding, which may reduce sound, levels further.

4.12.3.3 Long-Term Effects

Maintenance of the levee systems would include the control of vegetation growth if the levees were revegetated. Control may include use of power lawn mowers. The typical range of sound of a power lawn mower is usually 80 to 95 dBA, which is above typical ambient noise levels. The addition of periodic mowing along the I-5 corridor would not significantly impact noise levels in the project area. However, periodic maintenance of levees near residential areas, such as Fords Prairie and the Skookumchuck River, would be more significant, depending upon levee distance from the houses.

4.12.4 Summary

Noise levels will vary in proportion to the level of urban development within each reach. Noise associated with operation of earth-moving equipment usually exceeds background levels for short periods of time during construction. Noise effects would be mostly temporary and with construction noise abatement should be less than significant. Additional periodic noise created by levee maintenance would be an adverse unavoidable effect. All noise levels will not exceed noise standards of current city or state standards.

4.12.5 Mitigation

To reduce the potential for temporary, adverse noise impacts associated with construction, the contractor should be required to comply with all federal, state, and local regulations relating to construction noise. The following measures should be incorporated into contract specifications to help reduce the effects of construction noise:

- Restrict construction within 1,000 feet of residences to daytime hours. No construction should be performed within 1,000 feet of an occupied dwelling unit on Sundays, legal holidays, or between 10:00 p.m. and 6:00 a.m. on other days. Any variance from this condition would require approval.
- All equipment should have sound control devices no less effective than those provided on the original equipment. No equipment should have unmuffled exhaust.
- As directed by the construction manager, the contractor should implement appropriate additional noise mitigation measures, possibly including changing the location of stationary construction equipment, shutting of idling equipment, rescheduling construction activity, notifying adjacent residents in advance of construction work, or installing acoustic barriers around stationary construction noise sources.

No additional mitigation is anticipated.

4.13 HAZARDS AND HAZARDOUS MATERIALS

4.13.1 No Action Alternative

No hazardous materials concerns would be associated with this alternative as no action would be taken that would result in impacts to the project area. Hazards and hazardous materials concerns would remain similar to existing conditions under this alternative.

4.13.2 Criteria for Determining Significance of Effects

The following criteria were used to evaluate the significance of effects of the preferred alternative on HTRW sites. These criteria are based on Corps Regulation No. 1165-2-132. A significant effect would occur if construction and/or operation activities would:

- create a potential public health hazard;
- involve the use, production, or disposal of materials or wastes that pose a hazard to people, animals, or plant populations in the affected areas.

4.13.3 Preferred Alternative

4.13.3.1 Chehalis Levees

As this is a passive flood control feature not anticipated to generate hazardous materials with no source of hazardous materials associated with operation of these flood control features, significant long-term effects are not expected. Known soil and groundwater HTRW contamination will be avoided. However, this alternative places levees near or on sites that may be potentially contaminated as listed in Section 3.13. If unknown contaminated soils or groundwater is encountered, construction could increase contaminant flow into the river or cause a groundwater plume to spread, both of which would be considered to be long-term significant effects. Other concerns include effects from hazardous materials associated with construction activities.

Potentially beneficial effects of the preferred project include protection of contaminated sites from floodwaters, limiting environmental and human exposure to hazardous materials. Examples of areas that would be protected include the Centralia Municipal Landfill Superfund site, the former American Crossarm and Conduit Superfund site, and the industrial area between Centralia and Chehalis.

4.13.3.2 Dam Modifications

Short-term concerns consist of hazardous materials associated with construction activities. As this is a passive flood control feature not anticipated to generate hazardous materials with no source of hazardous materials associated with operation of these flood control features, no significant long-term effects are expected.

4.13.4 Summary

The preferred alternative should not directly contribute to long-term effects involving hazardous materials because the project does not expect to include the long-term use, storage, or disposal of hazardous materials. The hazardous waste mitigation measures identified in Section 4.13.5 would ensure that construction activities associated with the proposed action would not contribute to effects from hazardous materials on people or the environment. The proposed action should have less-than-significant negative hazards or hazardous materials effects assuming measures to minimize adverse project effects would be implemented and operation and maintenance of the project does not create adverse effects; therefore, there would be no public health hazard or the use of materials or wastes that would pose a hazard to people, animals or plant populations.

4.13.5 Mitigation

Although not expected, accidental spills of construction materials, such as concrete, fuels, oil, and sealants, can adversely impact streams and waterways. Careful adherence to the project's spill prevention and emergency cleanup plan will ensure that a management system is in place to prevent or respond to accidental spills. The spill prevention and emergency cleanup plan defines the requirements for storage, handling, and containment of hazardous materials to emphasize protection of water quality. Requirements of the spill prevention and emergency cleanup plan may include:

- the proper storage of hazardous materials on impervious bermed areas;
- handling and disposal of onsite hazardous materials during construction in a manner that does not cause contamination of stormwater;
- easy access to spill cleanup and containment equipment that should be located onsite;
- maintenance of construction vehicles and equipment outside the river channel;
- staging areas located 50 to 100 feet from the waterway to reduce the loss of riparian vegetation and limit potential damage from any spills;
- fueling and maintenance of equipment away from streams and waterways.

Soil excavated from any site in the project area may have some level of contamination. Despite attempts to identify all contaminated areas within the project area, there is a possibility that additional contamination may be discovered during construction. While there are no known concentrations of compounds, it is possible that some hazardous waste could exist in the subsurface environment. These compounds could result from agricultural land use within the project area, petroleum hydrocarbon storage or use, or placement of contaminated fill material that was not known, or never recorded. If hydrocarbon (or other) contaminated soil is encountered during site construction, there could be effects to worker safety if the concentrations of contaminated soil encountered exceed worker health and safety standards.

No additional mitigation is anticipated.

4.14 CULTURAL RESOURCES

The following sections discuss potential effects on cultural resources for both the no action and preferred alternative. It should be emphasized that, because most of the cultural resources within the project area have not been evaluated for eligibility to the National Register of Historic Places (NRHP), this analysis is necessarily based on very incomplete information.

4.14.1 No Action Alternative

Impacts to cultural resources involved with the no action alternative would include effects derived from the continued development and expansion of the communities of Centralia and Chehalis and the natural effects from continued flooding by the Skookumchuck, Newaukum, and Chehalis rivers.

4.14.2 Criteria for Determining Significance of Effects

The following criteria were used to evaluate the significance of effects on cultural resource sites. A significant effect would occur if construction and/or operation activities would:

- cause the disturbance or loss of known cultural resource sites;
- preclude the use of landscape features for cultural resources purposes.

4.14.3 Preferred Alternative

The Skookumchuck Dam modifications and Chehalis River levees are the preferred alternative based on the available information, and with consideration for project purposes. The levee construction would impact archaeological sites; such was the determination of Jones *et al.* (1978). However, alignments of proposed levees are now more generally confined to the boundaries of urban development where the propensity for sites is typically lower than near landforms such as oxbow lakes, river meanders.

4.14.3.1 Chehalis Levees

The impacts to cultural resources involved with the implementation of this project feature have been summarized by Jones *et al.* (1978). The archaeological reconnaissance related to this project alternative was directed towards proposed levee alignments, as they existed in August of 1977. Jones *et al.* (1978) identified 20 previously unrecorded sites and 7 known sites within the area to be affected by the levee alignment.

In regard to cultural resources present within the project area, of the currently known sites, 14 would be directly impacted or at least partially destroyed by the construction of levees along currently proposed alignments. On the basis of a partial inventory, it is estimated that an additional 40 to 50 sites might be located along the remainder of the proposed alignments. While many of the sites within the project's primary impact area undoubtedly would provide significant information about the regional cultural record, available reconnaissance inventory data are not sufficient for making significant determinations on a site-by-site basis. Nevertheless, current information is sufficient to lead to the conclusion that potentially significant cultural resources will be affected by project actions and that further steps should be initiated to develop management alternatives that will enhance the preservation and protection of significant cultural resource properties (Jones *et al.* 1978:128).

Jones *et al.* (1978) proposed management recommendations consisting of two-part cultural resources inventory and subsequent testing. They recommended collection of site inventory data for both primary and secondary impact areas with a 100 percent effort directed at primary areas and a 5 to 15 percent effort directed at secondary areas (Jones *et al.* 1978:132). Testing of archaeological sites identified by a cultural resource inventory would be directed in accordance with the final location of proposed levee alignments. Testing at these locations would be aimed at assessing eligibility of sites for the National Register of Historic Places (Jones *et al.* 1978:137).

4.14.3.2 Skookumchuck Dam Modifications

The proposed modifications to Skookumchuck Dam are largely structural, however, the resulting change in reservoir levels would affect cultural resources present within the drawdown zone (Schalk *et al.* 2001). These modifications would effectively expand the maximum reservoir capacity an additional 15 feet (the capacity to inundate an additional 50 acres) bringing the maximum pool elevation up to 492 feet above mean sea level (Schalk *et al.* 2001:1).

Proposed structural changes to the dam include: the construction of a separate intake tower, the construction of a new spillway with two sluice gates, and a new intake structure atop of the existing spillway chute. Schalk *et al.* (2001:38-39) describe the following potential effects to cultural resources present in Skookumchuck Reservoir if this alternative should be implemented.

Raising the pool level of Skookumchuck Reservoir has potential to adversely affect archaeological sites in a variety of ways. First, for those sites that have flat benches or terraces that extend inland from the current upper pool elevation, reservoir erosion effects may be extended to inland portions of those sites that have as yet not been subjected to erosion.

Lithic or other cultural remains may be eroded out of intact sediments and contextual information thereby lost. Sites 45TN202, 45TN245, and 45TN247 each appear to have some potential for this type of adverse effect.

A second possible adverse effect is that raising the pool level is likely to produce impacts on archaeological deposits that are located in the *present* drawdown. A higher pool level implies that fine sediments removed from the margins of the higher pool will be redeposited on archaeological deposits that would be located within the lower portion of the drawdown. This

siltation process has the potential to bury archaeological deposits, making them inaccessible to archaeological investigation.

A third kind of effect on archaeological sites that may occur as a result of raising the maximum pool level in the reservoir is the erosion of as yet unrecorded archaeological sites that may be present within that rather narrow band of land that lies between elevations 477 feet and 492 feet. Although landforms suitable for occupation are quite limited in the project area, such areas do exist. These locations are densely vegetated at present and very difficult to survey.

If tree removal is carried out in the elevation zone between 477 and 492 feet, then this action could also cause project effects on cultural resources. Construction of access roads and operation of heavy equipment could cause impacts on known or as yet unidentified cultural resources.

No impacts of the proposed raise in maximum pool level on the (granite) quarry can be identified at this time. The project should have no adverse effect on this site (Schalk *et al.* 2001:38-39).

For a more detailed discussion of cultural resources present in Skookumchuck Reservoir in relation to the Centralia Flood Damage Reduction Project, refer to Schalk *et al.* 2001.

4.14.4 Summary

Several factors make assessing the various alternatives in terms of their relative impacts on cultural resources quite difficult and subjective. First, data on cultural resources is uneven across various alternatives and totally lacking for some. The recent archaeological survey (2001), for example, was limited to those properties for which Rights of Entry were available and cannot be considered a representative sample of the APE. Although substantial cultural resource information was collected in the late 1970s for the preferred alternative, the proposed levee alignments have changed since the original fieldwork, reducing the relevance of the original study to the currently proposed footprint. Second, while many sites have been previously recorded within the area encompassed by the various alternatives, information on the horizontal extent, depth, and integrity is lacking for most.

Given the widespread tendency for dense vegetation and poor surface visibility conditions in the project area, these aspects of archaeological sites are not reliably estimated from survey data. Without testing, the actual subsurface character of most of the archaeological sites in the project area is not known. Third, lacking such information that can usually only be obtained in settings

like this by archaeological testing, the status of most of the sites in terms of eligibility for the NRHP is unknown.

Simple site counts by alternative or projected numbers of sites do not accurately allow quantitative comparisons of the relative impact of the different alternatives. However, based on the two largest cultural resource survey efforts that have been carried out within the general project vicinity, site densities can be estimated. Site density data from the Jones *et al.* (1978) study and the 2001 survey suggest an average of about one archaeological site per 19 acres. The determination of a preferred action alternative in regard to cultural resources is dependent upon several factors including the structure of the final footprint per alternative, the degree to which cultural resources will be affected, and mitigation protocols for cultural resources as dictated by Corps and the Washington State Office of Archaeology and Historic Preservation (OAHP). The Corps also anticipates developing a memorandum of agreement (MOA) with SHPO regarding any cultural resources encountered with the project.

4.14.5 Mitigation

Cultural resource evaluations will be conducted in the Planning, Engineering and Design Phase of the project. At that time, an MOA will be developed among consulting parties for the care of cultural resources. Discussion and recommendations within the MOA will address specific mitigation needs and approaches for the project. Possible mitigation may include the process for data recovery, monitoring needs, additional consultation requirements and site protection measures.

4.15 ENVIRONMENTAL JUSTICE

4.15.1 No Action

The no action alternative would continue the existing population demographics, although Lewis County is growing in population. What future changes will happen is unknown.

4.15.2 Preferred Alternative

The preferred alternative (and the study area) is located in an area with a slightly greater than average white population for Washington State, with the exception of the reservation lands. The

reservation had a much greater percentage of American Indian population (56.2) than the state percentage. The study area, with the exception of Rochester and Thurston County, is higher than the state percentage for both families and individuals living below the poverty level. The Hispanic and Latino population is higher than the state percentage for the cities of Centralia and Chehalis and the towns of Rochester and Grand Mound. The groups of potential concern are the American Indian and Native American population, the Hispanic and Latino population and the low-income population.

The preferred alternative would not disproportionately impact the identified groups. The Confederated Tribes of the Chehalis Reservation lands will not be subjected to any greater flooding events than have already occurred, although they are not included in flood damage reduction measures for the study area. The Corps has been involved in sovereign nation coordination with Native American tribes (Section 6.1.5). The towns of Rochester, Pe Ell and Grand Mound will not be subjected to any greater flooding events than have already occurred, although they are not included in the flood damage reduction measures for the study area.

The majority of the study area will not be subjected to greater flooding than has already occurred and most will receive greater protection from flood damages. There is a small area of eight houses in unincorporated Lewis County that may experience greater duration of flooding events, although this area does not have a distinct low-income and/or minority community. These houses will be raised for flood proofing.

The public disclosure process includes a wide variety of interest groups that were actively involved in the study process as well as intensive efforts to utilize the local media and local community groups.

4.15.3 Finding of Significance

No disproportionately high and adverse human health or environmental effects on low-income or minority populations are identified for any of the alternatives. The public disclosure process actively sought out interests from all people living within the study area. As such, there are no significant impacts associated with environmental justice issues.

4.15.2 Mitigation

None anticipated.

4.16 SOCIOECONOMICS

4.16.1 No Action Alternative

Under the no action alternative, the regional economic forces in the project area would continue to progress. Urban and agricultural businesses affected by flooding in the project area would continue to incur damages of variable magnitude. Commerce and distribution reliant upon major infrastructure may be occasionally disrupted as floodwaters inhibit transportation across I-5 and major arterials of the project area.

4.16.2 Criteria for Determining Significance of Effects

The following criteria were used to evaluate the significance of effects on socioeconomics of the immediate area:

- flooding potential;
- recreation;
- fishing;
- regional economic effects;
- water supply.

4.16.3 Preferred Alternative

It is anticipated that existing fishery resources may be impacted in a positive way. These effects have not been quantified or translated into monetary values due to uncertainties regarding the actual timing and effects of alternatives on recreation, and regarding plans and policies for recreational facilities and marketing. Lacking a clear vision of these pertinent factors at this time, quantifying recreational effects of the preferred alternative or any of the other alternatives would be speculative.

There is potential for the preferred project to have a positive effect on the regional economics of the area, although these positive effects would possibly be limited to the time frame required for construction of the preferred project. The location of the proposed levee system and Skookumchuck Dam modifications will not directly impact local businesses. The location does not require the moving of any locally or otherwise owned businesses. However, the resilience of

local economies and the cohesion of the local communities to agricultural conversion depend on a variety of factors, including age, ethnic, and racial composition of the community and income, unemployment, and poverty levels. It is anticipated that conversion of agricultural lands will be minimal in comparison to the amount of land that is active in agriculture functions.

4.16.4 Summary

In reviewing existing information, it has become evident that additional socioeconomic details will be needed following this report. Although anticipated to be positive, more socioeconomic information will be collected as this project proceeds to the next phase of planning. With the information available to the Corps at this current time there would be no significant impacts to recreation, fishing, regional economics, water supply, or an increase in flooding for the overall project.

4.16.5 Mitigation

Additional quantification of impacts during specific design of the project may be necessary but specific mitigation beyond avoidance and minimization is not anticipated.

Table 4.16-1: Table of Quantification

	Avoidance Measures	Minimization Measures	Compensatory Mitigation
Hydrology and Hydraulics	Levees setback or tied into existing levees to avoid changes to the floodplain	Floodwalls used in selected areas to minimize changes to floodplain and sensitive habitats	Chehalis River reconnected to flood plain at SR-6 underpass to increase flood attenuation at Scheuber floodplain (Chehalis River) 15 acres
Geomorphology	Levees setback or tied into existing levees to avoid changes to river dynamics	Floodwalls used in selected areas to minimize changes to river processes	Possible operational changes at Skookumchuck (more study necessary). Increased groundwater recharge at low frequency floods in Scheuber floodplain. 5 acres
Water Quality	Setback majority of levees away from water bodies.	Maintain a 50-foot buffer where possible. Construction stormwater controls. Minimal in-water work	NA
Biological Resources (Vegetation, Wetlands, and Riparian Areas)	Majority of levee alignment set away from sensitive areas and designed to avoid all existing riparian habitat. Construction staging and access all places out of wetlands or riparian habitats	Floodwalls placed in selected areas to minimize encroachment into wetlands. 50-foot buffer maintained where possible	Creation and restoration of Chehalis floodplain wetlands and waterways in the Scheuber floodplain, restore Scheuber ditch to more natural character. Removal of invasive plant species at mitigation site. 37 acres
Wildlife	All riparian areas avoided	50-foot buffer maintained where possible	Increase habitat and connectivity on Scheuber floodplain. 6 acres
T&E Species	Best management practices during construction	Best management practices during construction	N/A
Fish	Avoid existing riparian habitats and waterways for majority of levee alignment	Floodwalls placed in selected areas to minimize encroachment into wetland adjacent to waterways. 50-foot buffer maintained where possible. Work within biological windows.	Reconnection of Chehalis with floodplain (Scheuber floodplain) includes fish passage, resting, feeding areas within wetland/stream complex. Possible operational changes at Skookumchuck Dam (with further study). 5 acres

	Avoidance Measures	Minimization Measures	Compensatory Mitigation
Land Use Planning	No changes to existing land uses	N/A	N/A
Recreation and Aesthetic Resources	No degradation to existing resources	N/A	N/A
Transportation and Traffic			Provide temporary access ramps
Air Quality		Control dust and loose materials at the construction site. Limit traffic speeds on unpaved access roads. Suspend excavation and grading during high wind conditions. Limit the area of any earth moving activities at any one time	Restore any roads used as construction haul road to pre-construction conditions. Create traffic plans for access and protection during flood conditions NA
Noise		Restrict construction times near residences. Require sound control on construction equipment and at the construction site	NA
Hazardous Materials	Require proper storage and handling of hazardous materials at the construction site. Require cleanup and containment equipment to be located at construction sites. All construction vehicles and equipment will be stored and maintained away from waterways.		NA
Cultural Resources	To be determined from consultation process	To be determined from consultation process	To be determined from consultation process
Environmental Justice	No changes to existing conditions	N/A	N/A
Socioeconomics	No changes to existing conditions	N/A	N/A

End Part 1

Chapters 5-10 in Part 2



U.S. Army Corps
of Engineers
Seattle District

Centralia Flood Damage Reduction Project Chehalis River, Washington General Reevaluation Study

**Final Environmental Impact Statement
Part 2, Chapters 5-12
June 2003**

This page was intentionally left blank.

TABLE OF CONTENTS

TABLE OF CONTENTS	i
LIST OF TABLES	ii
APPENDICES	iii
5. MITIGATION	257
5.1 BACKGROUND	258
5.1.1 Preferred Flood Reduction Alternative	258
5.1.2 Impacts of Selected Flood Damage Reduction Plan	258
5.1.3 Selected Mitigation Plan	259
5.2 MODIFIED EVALUATION METHODOLOGY	260
5.2.1 Mitigation Requirements.....	260
5.2.2 Original Method.....	260
5.2.3 Modified Method	260
5.2.4 Modification of Selected Mitigation Plan	267
5.2.5 Final Mitigation Plan and Habitat Outputs.....	268
5.3 mitigation design.....	269
5.3.1 Chehalis River Stage Data	269
5.3.2 Depth of Channel Excavation	270
5.3.3 Area of Riparian and Wetland Habitats	271
5.3.4 Depth of Wetland Excavation	271
5.3.5 Height of Berm.....	271
5.4 Cost estimate.....	272
5.4.1 Description of Costs and Preliminary Construction Sequence.....	272
Cost Estimate Summary.....	275
6. CUMULATIVE IMPACTS	257
6.1 Introduction.....	280
6.1.1 Historic Impacts to the Study Area	280
6.1.2 Current Condition in the Study Area.....	283
6.2 Reasonably Foreseeable Impacts to the Study Area	285
6.2.1 Cumulative Impacts Associated with the Preferred Alternative.....	286
6.3 Findings of Significance	294
7. CONSULTATION & COORDINATION COMPLIANCE	295
7.1 NEPA Compliance.....	295
7.1.1 Public Involvement	295
7.1.2 Scoping Process	296
7.1.3 Public Scoping Meetings.....	296
7.1.4 Endangered Species Act, Section 7.....	296
7.1.5 Fish and Wildlife Coordination Act.....	297
7.1.6 National Historic Preservation Act Consultation and Native American Graves Protection and Repatriation Act	304

7.1.7 Environmental Protection Agency	305
7.1.8 Washington State Department of Transportation	305
7.1.9 Washington Department of Ecology Dam Safety	305
7.1.10 Executive Orders and Other Guidelines	305
7.1.11 Clean Water Act of 1972.....	306
8. DOCUMENT RECIPIENTS	308
8.1 Federal Agencies (Headquarters Offices)	308
8.2 U.S. Congressional Delegation	311
8.3 Washington State Legislature	312
8.4 Federal Agencies-Regional or Local Levels	313
8.5 Indian Tribes	316
8.6 State and Local Government Agencies	316
8.7 Libraries	318
8.8 Media	319
8.9 Private Organizations	319
9. COMMENTS AND RESPONSES TO DEIS	321
Submitted Written Comments from 22 August 2002 public meeting.....	321
Oral Comments from Aug 22, 2002 Public Meeting	349
EPA's Detailed Comments to the Corps	353
Final US Fish & Wildlife Coordination Act Report follows	378
10. LIST OF PREPARERS	451
11. REFERENCES	452
12. GLOSSARY OF ACRONYMS, ABBREVIATIONS AND TERMS	461
12.1 Glossary of Acronyms and Abbreviations	461
12.2 Glossary of Terms	463

LIST OF TABLES

Table 5.2-1: Revised Evaluation Methodology for Wetland Habitats	262
Table 5.2-2: Habitat Quality Scores for the Modified Method	268
Table 5.3-1: WSEL Data for the WWTP Gage Location and the Project Site	Error! Bookmark not defined.
Table 5.4-1: Oxbow/SR-6 Mitigation Plan Cost Estimate Summary	275
Table 5.4-2: Recommended Plantings for Wetlands and Riparian Areas and Associated Costs.....	276
Table 7.1: Table of Compliance	307

APPENDICES

Appendices are available on the enclosed CD-ROM

APPENDIX A – FISH, RIPARIAN, AND HABITAT STUDY

APPENDIX B – SKOOKUMCHUCK DAM RE-OPERATION REPORT

APPENDIX C – WETLAND AND RIPARIAN SURVEY

APPENDIX D – HAZARDOUS, TOXIC, AND RADIOACTIVE WASTE

APPENDIX E – BIOLOGICAL ASSESSMENT

APPENDIX F – DRAFT FISH AND WILDLIFE COORDINATION ACT REPORT

APPENDIX G – 404(b)(1) ANALYSIS

This page intentionally left blank

5. MITIGATION

Once the preferred alternative was selected, it was necessary to identify a suitable mitigation plan. Within the GRR/EIS process, a number of potential restoration plans were developed, which could also be used as mitigation. The Corps has selected the Scheuber Ditch/SR-6 mitigation plan to compensate for habitat losses associated with the construction of levees. The objective of this chapter is to evaluate the Scheuber Ditch/SR-6 mitigation plan to determine its suitability to mitigate for loss of wetland and riparian habitat throughout the levee footprint. If necessary, the selected mitigation plan may also be reconfigured in Preconstruction Engineering and Design (PED) to ensure optimum and appropriate mitigation levels.

Evaluation of the mitigation plan was accomplished through the use of the habitat evaluation methodology previously described in the GRR/EIS. However, the evaluation methodology was modified specifically to evaluate the types of impacts associated with the selected flood control alternative. Modifications made to and details of using the evaluation methodology are provided below.

Evaluation of results from the previous application of the habitat evaluation methodology (referred to in this chapter as the "Original Method") as documented in the GRR/EIS resulted in the finding that the Scheuber Ditch/SR-6 mitigation plan likely overcompensated for habitat losses associated with the setback levee construction and included elements that are out-of-kind of the type of impacts expected (proposed mitigation included extensive side channel habitat). As a result, the mitigation plan is reconfigured as documented in this chapter to more appropriately address necessary mitigation needs as quantified in a modified evaluation methodology (hereafter referred to as "Modified Method"). The reconfigured plan, referred to as the Oxbow/SR-6 mitigation plan, includes the following components: (1) connection of the mainstem Chehalis River to an oxbow near the intersection of SR-6 and South Scheuber Road, (2) connection of an unnamed tributary that flows beneath South Scheuber Road to the oxbow, (3) modification of SR-6 to a bridge where the new channel passes beneath the road, (4) the creation of 68 acres of wetlands along the length of the new channel, west of SR-6, and (5) creation of 20 acres of riparian buffer around the wetland.

The plan views and cross sections are provided as attachments to this chapter and show the aerial view of the proposed mitigation plan. Quantities for excavation were derived from these drawings, and combined with unit cost assumptions, were the basis for the cost estimate. The

Corps MCACES cost estimating software package was used to develop a cost estimate for the mitigation plan. The total cost of the selected mitigation plan is \$9,783,777.

5.1 BACKGROUND

5.1.1 Preferred Flood Reduction Alternative

The preferred alternative includes the construction of levees, modifications to the Skookumchuck Dam, and several non-structural components. Specifically, the following components will be included in the selected alternative:

1. Levee construction of 100-year level protection on the Chehalis River using both earthen levees and floodwalls;
2. Levee construction of 100-year level protection along the Skookumchuck River and Salzer and Dillenbaugh Creeks;
3. Modified Outlet Works and New Gates on the Spillway at Skookumchuck Dam for the addition of 20,000 ac-ft of flood control storage;
4. Non-structural features including elevation of structures that would incur increased inundation as a result of the project to mitigate for induced damages. The local sponsor is updating 100-year FEMA floodplain mapping, improving a flood warning system, along with continued restriction of development within the floodplain, continued restriction of fill in the floodplain, and institution of storm water management controls.

5.1.2 Impacts of Selected Flood Damage Reduction Plan

Initial evaluation indicates that a number of acres of wetland and a small portion of riparian habitat would be eliminated as a result of levee construction. Wetlands within the levee footprint are predominantly emergent wetlands, and their quality was evaluated using the modified evaluation methodology described in the following section of this chapter. The current estimation of wetland impacts is based on limited groundtruthing and the use of aerial photographs and hydric soils maps. Complete USACE wetland delineations and a functional assessment will be completed along the entire length of the proposed levee alignment, where hydric soils are present, prior to further design of this mitigation plan. At this time, it is estimated that these wetlands would be either Class III or Class IV wetlands (per the Washington State Wetlands Rating System (WDOE 1993) which are of low to moderate habitat quality. The

selected Oxbow/SR-6 mitigation plan presented in this chapter is intended to mitigate for the estimated loss of 102.1 habitat units (HUs) provided by the 34 acres of Class III or IV wetlands. Additionally, 108 acres of 2-year floodplain wetlands would be isolated from flood flows because of the construction of the levees. While it does not appear that the only source of hydrology for these wetlands is flood flows, the loss of this component of hydrology will adversely affect these wetlands. The quality score for the remaining wetlands is thus reduced.

While these effects on low to moderate quality wetlands and some riparian habitat appears to be moderate, it is estimated to result in a significant loss of groundwater recharge and other biogeochemical functions (such as sediment retention, pollutant retention and uptake, etc.). The loss of these types of functions is extremely important to the regulatory agencies involved in the study's Restoration Working Group. A major issue in the Chehalis River basin is the loss of floodplain storage, groundwater recharge, and chemical and sediment retention. The cumulative loss of these functions has significantly contributed to the poor water quality and quantity conditions in the river and its tributaries and has significantly reduced accessibility and habitat for resident and anadromous salmonids and other native fish species.

5.1.3 Selected Mitigation Plan

An incremental cost analysis (ICA) was conducted on the alternative restoration measures to determine which specific components of the mitigation plan provided the most habitat benefits (as quantified by the original habitat evaluation methodology as documented in the GRR/EIS) for the least cost. The most cost effective configuration of the plan included the connection of Scheuber Ditch to the mainstem Chehalis River via the oxbow near SR-6. Components of this configuration also included re-meandering of the Scheuber Ditch and creation of wetlands at the downstream confluence of the ditch and the mainstem Chehalis. However, the final configuration of the mitigation plan has been changed as a result of the Modified Method analysis. The process by which the original mitigation plan was reconfigured into the currently selected plan is described in the following sections.

5.2 MODIFIED EVALUATION METHODOLOGY

5.2.1 Mitigation Requirements

As previously stated, the total loss of wetlands is estimated to be 34 acres, based on the current level of delineation that has been completed. As a starting point for developing the mitigation plan, we utilized a 2:1 replacement mitigation ratio for the 34 acres of wetland habitat that would be eliminated, which would involve the creation or enhancement of 68 acres of wetland. The Washington Department of Ecology frequently requires such a replacement ratio. Also, the additional acreages of wetland would also compensate for the loss of hydrologic functioning to the other 108 acres of floodplain wetland. The loss of riparian habitat is very small, only estimated at about 1 acre. However, in order to create properly functioning wetlands the plan will require a 100-foot riparian buffer and the construction of an appropriate inlet to allow high flows into the site from the river, which will more than compensate for the loss of riparian habitat and compensate for the loss of floodplain connections to the 108 acres of wetland.

5.2.2 Original Method

Previously, a habitat evaluation methodology was developed for evaluation of the several potential restoration projects in the basin during the feasibility phase. This method was developed and used with extensive input from an interagency Restoration Working Group. This Original Method was also utilized to evaluate preliminary flood control alternatives and the proposed mitigation plan to ensure that it would provide an appropriate level of mitigation. However, following selection of the preferred flood control alternative, it was determined that the Original Method needed modifications that focused on the types of habitats that would be specifically affected by the flood control project in order to provide a suitable evaluation of the mitigation plan.

5.2.3 Modified Method

The Modified Method retains many of the parameters developed by the Restoration Working Group. However, there are two primary differences in the Modified Method: (1) where the methodology once characterized separate parameters for watershed and localized scales, the current methodology characterizes parameters for the entire project footprint (at a sub-basin scale), and (2) the definitions for parameters have been modified to focus on wetland habitats.

Scores are given to each parameter based on the entire project area. The sub-basin is defined as the mainstem Chehalis and its floodplain from Claquato to Fords Prairie, the lower 2 miles of Skookumchuck River, and Salzer Creek.

Existing condition (without-project) scores for the Modified Method were a direct combination of the existing scores in the Original Method for the mainstem Chehalis, Skookumchuck River, and Salzer Creek for all categories that remained the same or similar. Future without-project conditions assume some continued incremental degradation of habitat quality beyond the existing condition due to continued development, likely piece-meal flood control actions, and continued increase of non-native species; but some are likely to have at least small improvements in water quality due to TMDLs and other actions by state and federal agencies. The wetland habitats are primarily reed canary grass dominated and will continue to be so for the foreseeable future. No known future development is likely to eliminate these wetlands because they are primarily within road right-of-ways, the airport, or other areas unlikely to be subject to development.

Future with-project (with levee) conditions were then scored using the Modified Method definitions. Scoring for future with-project plus mitigation (with levee and mitigation) conditions required additional modification, described in the remainder of this paragraph. The Original Method gave scores to restoration projects based on a template. The template reflected a set of target scores that are likely to be achieved through restoration. That original template is not appropriate to the revised sub-basin scale, since the sub-basin scale is much larger than a localized scale and benefits will be muted at the larger scale. As a result, scores are modified for categories that had previously been assessed at the localized scale to account for the anticipated level of impact/benefit on the sub-basin.

Ultimately, the purpose of the Modified Method is to translate the loss of wetland habitats into a Habitat Unit (HU) output score. Then it is possible to also convert future with-project mitigation actions into a score of wetland HUs gained that can be compared to the expected loss. The table below provides the Modified Method definitions for wetland parameters.

Table 5.2-1: Revised Evaluation Methodology for Wetland Habitats

Parameter	Rating	Definition
Hydrology	5	Peak flows; base flows, and flow timing characteristics differ only slightly from undisturbed conditions throughout most of the watershed. Undeveloped land uses dominate the watershed. Wetlands are inundated or saturated as expected for geomorphic setting.
	4	Watershed hydrograph has moderate changes from undisturbed conditions. Baseflows reduced somewhat by water withdrawals, but floodplain recharge still occurs in many areas of the watershed at flows >2 yr event. Peak flows generally occupy undeveloped floodplain.
	3	Changes in the watershed hydrograph from undisturbed conditions are significant; base flows are reduced due to water withdrawals and reduced groundwater discharge. Floodplain recharge occurs in ~50% of watershed at flows >5-10 yr event.
	2	Pronounced changes in watershed hydrograph. Flooding of structures and low flow problems due to development of floodplain are common in parts of the watershed. Limited floodplain recharge occurs because <50% of floodplain connected below 2.5-year event. Lack of access to floodplain has increased flooding downstream.
	1	Hydrograph is completely altered. Frequent flooding of developed floodplain areas and low flow problems occur in most of the watershed. Less than 25% of floodplain is connected below a 50-year event. Lack of floodplain has substantially increased flooding in lower watershed.
Sediment	5	Fine sediment deposition/erosion occurs infrequently and is primarily trapped by wetlands and riparian zone. Extent of clean spawning gravels abundant and appropriate to geomorphic setting throughout watershed.
	4	Fine sediment deposition/erosion apparent in less than 20% of watershed. Wetlands and riparian zones trap the majority of fine sediments. Clean spawning gravel present in majority of watershed as appropriate to geomorphic setting.
	3	Coarse sediment sources are moderately inaccessible due to moderate amount of bank armoring and loss of floodplain connectivity. Fine sediment deposition/erosion apparent in ~30% of watershed. Wetlands and riparian zones retain fewer fines due to limited size. Clean spawning gravel is present primarily only in the tributaries.
	2	Coarse sediment sources are infrequently accessible, due to extensive bank armoring and significantly reduced channel migration. Dams or channelization accelerate downstream movement of coarse sediment. Fine sediment deposition/erosion common in ~50% of watershed. Wetlands and riparian areas do not provide sufficient sediment retention due to limited size. Clean spawning gravel infrequent.

Table 5.2-1: Revised Evaluation Methodology for Wetland Habitats

Parameter	Rating	Definition
	1	Coarse sediment sources inaccessible except at >100 yr events. Fine sediment deposition/ erosion common in majority of watershed. Wetlands and riparian areas provide no sediment retention. Clean spawning gravel rare.
	5	Overbank flows occur at a ~2 year flow and occupy a majority of the floodplain. Channel armoring occurs rarely within watershed. Natural floodplain plant communities extensive; wetlands are present as expected for geomorphic setting.
	4	Overbank flows occur at ~5 year flows and occupies a majority of the floodplain. Channel armoring occasional throughout watershed. Natural floodplain plant communities common, particularly along tributaries; disturbance is localized. Wetland habitats present in majority of watershed as appropriate to geomorphic setting; few constraints to channel migration.
	3	Overbank flows occur at >5-10 year flood levels. Channel armoring in approximately a third of the watershed. Natural floodplain plant communities present in less than 50% of watershed; many wetland areas modified for timber harvest, agriculture or development. River is disconnected from ~50% of its former off-channel areas. Channel migration significantly reduced in 30-50% of watershed.
	2	Overbank flows are typically restricted to ~25 year flood levels. Channel armoring or other channelization widely distributed in the watershed. Characteristic floodplain plant communities are infrequent or highly fragmented. Wetlands are highly altered and/or have low functional value.
	1	Overbank flows restricted to ~100 yr flood levels. Channel armoring occurs in most of the watershed. Natural floodplain communities rare or absent. Wetlands are rare or absent.
Floodplain Interactions	5	Abundant LWD of all size classes, but including primarily large-sized pieces, present throughout wetlands, creating habitat diversity and complexity.
	4	Abundant LWD of all size classes present throughout wetlands, creating habitat diversity and complexity.
	3	Moderate amounts of LWD of any size classes present throughout the majority of the wetland.
	2	Low levels of LWD present throughout the majority of the wetland, does not significantly contribute to increased habitat diversity or complexity.
	1	LWD absent or rare.
LWD		

Table 5.2-1: Revised Evaluation Methodology for Wetland Habitats

Parameter	Rating	Definition
Water Quality	5	Wetland functions are sufficient to remove the majority of sediment, nutrients, heavy metals, and toxic organics from water. Multiple vegetation classes present, including forested, scrub-shrub, and emergent wetland, and wetland is inundated throughout the growing season.
	4	Wetlands functions are sufficient to remove a significant portion of sediment, nutrients, heavy metals, and toxic organics from water. Multiple vegetation classes are present and wetland is inundated during part of the season.
	3	Wetland functions provide removal of some pollutants. More than one vegetation class is present and wetland is inundated during part of the season.
	2	Wetland functions are limited and do not provide significant removal of pollutants from water. One vegetation class is dominant throughout most of the wetland and only inundated during small portions of the season.
	1	Wetlands do not provide sufficient function to remove pollutants. One vegetation class is present and inundation occurs for only brief periods during the growing season or not at all.
Terrestrial Habitat	5	Adjacent floodplain and upland areas provide a diverse mix of habitat types. Habitats are well connected to provide migration corridors and connections between the wetland and upland areas. Disturbance is limited to sparse residential or agricultural/timber harvest.
	4	Adjacent floodplain and upland habitats provide a moderately diverse mix of habitat types with minor fragmentation. Migration corridors are still common between the wetland and upland areas. Watershed has low-moderate level of development or agricultural/timber harvest, which has fragmented some corridors and reduced overall terrestrial habitat.
	3	Adjacent floodplain and upland habitats are moderately disturbed. Migration corridors primarily only intact along the riparian zone with few connections between wetland and uplands. Residential, agricultural/timber harvest, and commercial development are common throughout the watershed and terrestrial habitat is significantly reduced.
	2	Floodplain and upland habitat is highly fragmented. Migration corridors barely intact along wetlands, and are further fragmented as a result of roads and bridges. Development and agricultural/timber harvest, and have significantly reduced available habitat.
	1	Terrestrial habitat and migration corridors limited. Development, agricultural/timber harvest, and roads/bridges cause severe disturbance in majority of watershed.
Wild and Life Refu	5	Refugia for fish and wildlife are widely available throughout the project area in the form of wetlands, as appropriate to geomorphic setting. These habitats provide protection from elements and predators and are adequately buffered from human disturbances.

Table 5.2-1: Revised Evaluation Methodology for Wetland Habitats

Parameter	Rating	Definition
	4	Wetland refugia are present in majority of the project area. Existing refugia have adequate buffering.
	3	Wetland refugia exist in less than 50% of the project area and are typically small in size. Existing refugia may have inadequate buffering.
	2	Wetland refugia are uncommon and many are not adequately buffered.
	1	No wetland refugia in project area.
Habitat Complexity/ Connectivity	5	Wetland habitats are highly diverse. Wetlands are inundated throughout the growing season and much of the year. Multiple native vegetation communities and classes are present and well interspersed. Microhabitats are diverse with abundant and varying water depths; cover types, rearing and basking sites. Wetlands throughout the project area are well connected.
	4	Wetland habitats are moderately diverse. Wetlands are inundated throughout majority of growing season. Multiple native vegetation communities and/or classes present and moderately interspersed. Microhabitats include moderately diverse water depths; cover types, rearing and basking sites. Wetlands throughout project area are typically connected, with few roads or bridges.
	3	Wetland habitats are of moderate to low diversity. Inundation occurs through only a portion of the growing season. Native vegetation is dominant, but communities and microhabitats are of low diversity and interspersed. Wetlands have low connectivity with large areas of fragmentation.
	2	Wetland habitats are of low diversity. Two or fewer vegetation classes are dominant and microhabitats have limited diversity. Non-native or invasive species are dominant in many areas. Local habitat is significantly fragmented.
Species Diversity	1	Wetland habitats are not diverse. Vegetation is dominated by non-native species and microhabitats are not diverse. Habitats are not connected and do not provide a migratory link between upstream and downstream habitats.
	5	Localized habitat support multiple native species of fish and wildlife and plants, including rare species. Habitat structure complex and provides suitable habitat for a variety of life history stages. Adjacent habitats are well connected to localized habitat.
	4	Localized habitat support multiple native species of fish and wildlife and plants, although only occasionally for rare species. Provides habitat for a variety of life history stages, although fragmentation of habitats may create slight disconnectedness from adjacent areas.
	3	Localized habitat supports common native species. Exotic species are present but are not dominant in any habitat. Fragmentation has occurred between habitats for different life history stages, and habitats primarily support one or two life history stages.

Table 5.2-1: Revised Evaluation Methodology for Wetland Habitats

Parameter	Rating	Definition
	2	Localized habitat supports common native species. Exotic species are present and are dominant in some areas. Significant fragmentation between life history stage habitats, and habitats primarily support one life history stage. Fish and wildlife populations reduced due to lack of necessary habitats.
	1	Localized habitat supports few native fish; wildlife or plant species and exotic species are frequently dominant. Localized habitat is completely isolated from adjacent habitats. Habitat is poor even for one life history stage. Most fish and wildlife populations not present due to lack of necessary habitats.

5.2.4 Modification of Selected Mitigation Plan

Previously, incremental cost analysis in the draft GRR/EIS indicated that the most cost effective mitigation plan design would include the re-meandering of Scheuber Ditch and creation of wetlands at the north (downstream) end of the ditch. However, upon applying the Modified Method to determine suitability of mitigation, it was found that that plan overcompensated for impacts of the selected flood damage reduction alternative. It was also found that the re-meandering of the nearly 10,000 foot long Scheuber Ditch and associated riparian revegetation provided significant habitat benefits but with significant cost and not necessarily in-kind mitigation value. As a result, alternative mitigation designs in the vicinity of Scheuber Ditch and SR-6 were evaluated to determine which configuration would provide the appropriate level of mitigation, without incurring unnecessary expenses from out-of-kind mitigation measures.

Although mitigation requirements for the project are primarily for wetlands, there will be significant impacts to floodplains as a result of levee construction. Approximately 108 acres of 2-year floodplain wetlands will be disconnected by levees, which will incrementally reduce groundwater recharge and sediment and pollutant retention in the sub-basin. The loss of floodplain connectivity is not quantifiable, but the design of the mitigation plan should include floodplain connections wherever feasible. Creation of wetlands at the south (upstream) end of the floodplain, with a connection to the Chehalis River beneath SR-6 can provide increased floodplain interactions. There would then be more frequent flood connections to the undeveloped floodplain along Scheuber Ditch. This revised plan would provide in-kind mitigation (wetlands and floodplain interactions) without providing the out-of-kind mitigation included in the previous plan. The significant loss of floodplain in the area has resulted in a great need for increased groundwater recharge in the basin to maintain base flows in the river. The configuration of the selected Oxbow/SR-6 mitigation plan will allow greater floodplain connectivity with the Chehalis River and increased groundwater recharge on a frequent basis.

The proposed wetland mitigation will create or enhance 68 acres of wetland immediately north of SR-6 in the undeveloped floodplain. This will require the excavation of a new channel between the Chehalis River and the oxbow immediately south of SR-6. The channel will continue westward across the undeveloped floodplain and will connect to a tributary that passes beneath South Scheuber Road. The tributary will be diverted into the new channel to provide another source of hydrology for the wetlands and channel and be designed to have positive

drainage back to the Chehalis River to prevent fish stranding. Wetlands will be connected to the newly excavated channel and will also have positive drainage back to the Chehalis River to prevent fish stranding. The channel and wetlands will be designed to have a frequent surface water connection with the Chehalis River during winter flows. A berm will be constructed between the new channel and Scheuber Ditch to prevent flows below the 2-year flood elevation from connecting to the ditch (to prevent fish stranding and also prevent fish from entering the very poor quality habitat in Scheuber Ditch except during flood flows when the entire floodplain is connected. A portion of SR-6 will be replaced with a bridge to accommodate the new channel and allow the floodplain interactions. A 100-foot riparian buffer will be planted along the new channels and around wetlands to ensure proper functioning of the wetlands. Large woody debris (LWD) will be placed to enhance fish and wildlife habitat. A plan view of the Oxbow/SR-6 mitigation is attached to this report.

5.2.5 Final Mitigation Plan and Habitat Outputs

Scoring for each wetland parameter at a sub-basin scale for the selected mitigation plan is shown in Table 5.2.5. The total score for each condition is summed and divided by the total possible score to find the index score, which is a number between 0 and 1. The index score is then multiplied by the acres of wetland to find the habitat unit (HU) output score.

The total wetland HUs lost with the construction of the levee is 102.1. The implementation of the selected mitigation plan provides a recovery of 115.4 HUs of wetland, which adequately compensates for the original wetland loss. This surplus will adequately address the direct loss of 34 acres of wetlands plus the degradation of 108 acres of floodplain wetland, as well as providing a buffer against any risk and uncertainty associated with creation of wetlands.

Table 5.2-2: Habitat Quality Scores for the Modified Method

Wetland Parameters	Existing Conditions (2003)	Future Without-Project Conditions (2053)	Un-impacted lands with Project	Mitigation Value of impacted acres with Project
Hydrology	2	1.9	1.9	1.7
Sediment	2	1.9	1.9	1.6
Floodplain Interactions	1.7	1.6	1.6	1.7
LWD	1	1	1	1.3

Water Quality	1.5	1.7	1.7	1.7
Terrestrial Habitat	1.5	1.4	1.4	1.8
Fish and Wildlife Refugia	1.2	1.1	1.1	1.8
Habitat Complexity/Connectivity	2	1.9	1.9	2.5
Species Diversity	1.2	1.2	1.2	1.5
Total Score	14.1	13.8	13.8	15.6
Total Possible Score	45	45	45	45
Index Score	0.31	0.30	0.30	0.35
Acres of Wetland in 2-year Floodplain	1342	1342	1308	68
Habitat Units (HUs)	416.02	402.6	392.4	23.8
			416.2	
HABITAT UNITS GAINED WITH MITIGATION = 115.4				
NET EFFECT = 13.3 HABITAT UNITS GAINED				

Wetland acreages were calculated using National Wetland Inventory (NWI 2001) mapping. The NWI mapping does not include many emergent wetlands, but is suitable for comparing affected wetland habitats as a result of flood control actions. All wetlands within the 2-year floodplain, as delineated by Corps mapping, were summed to get the total wetland area for existing conditions. Total mapped wetland area within the project sub-basin was 1,342 acres. For the purposes of estimating future without-project conditions the wetland acreage remained the same as now, because no projects that might eliminate these wetlands are known. For the with-project condition, an estimated total of 34 acres of wetland will be eliminated as a result of levee construction. Thus, the total wetland acreage in the 2-year floodplain will decrease from 1342 to 1308 acres. Approximately 108 acres of wetlands mapped within the 2-year floodplain will also be disconnected from the river by levees. These wetlands will be further fragmented with levee construction and will have a change in hydrology and thus the quality scores go down.

5.3 MITIGATION DESIGN

5.3.1 Chehalis River Stage Data

In order to ensure a frequent surface water connection between the mainstem Chehalis and mitigation wetlands during winter flows, it was necessary to obtain data regarding the average

surface water elevation of the Chehalis River between November and March. Chehalis River stage data were downloaded from the USGS website. This stage data indicates the water surface elevations (WSEL) for the river during the winter months. However, the stage recorder data utilized comes from a gage station located near the wastewater treatment plant (WWTP) in Chehalis, Washington. The project location is located approximately 3 river miles upstream. Comparison of the WSEL, surveyed by the Corps of Engineers in August 1999, shows a drop of about four vertical feet between the project site and the gage location. The following table summarizes the measured and estimated water surface elevation data. Three years of data were available for this particular site (2000-2003), which is located downstream of the project site.

Table 5.3-1: WSEL Data for the WWTP Gage Location and the Project Site

	Gage		Project Site	
	(Chehalis River at WWTP)		(estimated as WWTP+4')	
	All Data	Winter	All Data	Winter
	(2000 - 2003)	(Nov-Mar)	(2000 - 2003)	(Nov-Mar)
Average	152.9	154.8	156.9	158.8
Maximum	175.9	175.9	179.9	179.9
Minimum	147.2	147.2	151.2	151.2
90% Exceedence	148.6	149.1	152.6	153.1
10% Exceedence	160.0	162.8	164.0	166.8
2-year (approx.)	172.0		176.0	
Design Invert at Connection			151.0	

These values are rough approximations only. A thorough analysis of the floodplain model results would better predict water surface elevations adjacent to the project site for varying flow conditions and will be necessary for detailed design. Additional gage data from other sites with longer records should be analyzed before proceeding with more detailed project designs.

5.3.2 Depth of Channel Excavation

The lowest WSEL (at WWTP) between November and March is 147.2 feet. This stage reading was recorded on November 1, 2002, so it represents the lowest winter flow for the period of record as well. The corresponding WSEL adjacent to the project site would be approximately 151.2 feet. A design invert for the Chehalis River connection was selected as 151 feet to provide frequent flow during the winter months (November to March). This is an initial approximation only; further detailed hydrologic analysis may yield a different design invert. A higher invert could result in cost savings to the project, but might be connected less frequently at shallower

depths. Conversely, a lower invert might also be selected to provide additional connections during the low-flow periods. The existing ground elevations along the proposed channel alignment generally range between 165 and 180 feet, giving excavation depths between 15 and 30 feet.

5.3.3 Area of Riparian and Wetland Habitats

The total riparian area at the site will be 20 acres. The total wetland area will be 68 acres. It is assumed that 60 percent of the wetland area, or 41 acres, will be scrub-shrub wetland, while the remaining 27 acres will be emergent wetland. The estimated total habitat output of the site is estimated at 154 HUs (102 HUs plus 13% R&E factor). Specifications for species to be planted are shown in Table 5 below. Although this is different in size and appearance than the area depicted in figure 2.6 this figure has the more accurate size for mitigation. The larger area depicted in figure 2.6 has potential to be utilized in possible restoration projects in the future.

5.3.4 Depth of Wetland Excavation

Existing ground elevations vary between 165 and 168 feet in the area of wetland excavation. The excavation requirements and wetland design is based on the assumption that it would be necessary to excavate a minimum of 24 inches to get to hydric soils or groundwater from the 165 foot elevation. This assumption is based on best professional judgment and would need to be verified through soil tests and piezometer installation before proceeding with more detailed designs. Approximately 30 percent of the wetland footprint falls between elevations of 165 and 166 feet. That means that 30 percent of 68 acres, or 20 acres, needs to be excavated down by 2 feet. Approximately 60 percent of the wetland footprint falls between elevations of 166 and 167 feet, resulting in a total of 41 acres that would have to be excavated down by 3 feet. The remaining 10 percent of wetlands falls between elevations of 167 and 168 feet. This results in 7 acres that would have to be excavated down by 5 feet. Excavation rates at each elevation would vary to provide microtopography and increase diversity of aquatic habitats. However, the uniform rates of excavation in this paragraph provide an estimate of excavation requirements for the cost estimate.

5.3.5 Height of Berm

According to the draft GRR/EIS, the reach *Chehalis 2* has a 2-year flood event that reaches WSEL 172 feet. A WSEL adjustment of +4 feet for the project area (there is no significant

difference between the *Chehalis 2* Reach and gage at WWTP) gives a 2-year flood event WSEL at the project site of 176 feet. The berm between the tributary and Scheuber Ditch will have to be built up to at least 176 feet to prevent a connection between the two at flows less than the 2-year event. These values should be verified against the result of the floodplain modeling efforts before proceeding with more detailed designs. Flows at or above the 2-year event will be assumed to connect to Scheuber Ditch and flow out to the Chehalis through the ditch and floodplain. An overflow spillway would need to be constructed to prevent the berm from washing out during flood flows. The length of the berm spans the existing ground elevation to the 176 feet level.

5.4 COST ESTIMATE

5.4.1 Description of Costs and Preliminary Construction Sequence

Mobilization costs of \$50,000 are assumed, amounting to approximately 1 percent of total construction costs. This could be higher, depending on the type of equipment used. Mobilization costs for dredge equipment varies significantly, depending on the size and capacity of the dredge. Due to the uncertainty in the construction methods and design inverts, a relatively high contingency of 35 percent has been assumed. Additional costs, such as higher mobilization costs for large dredge equipment, are within contingency estimate.

The project would most likely begin with the construction of a temporary roadway around the excavation area for the bridge. Once the roadway is constructed, demolition of the existing roadway at the crossing would be followed by approximately 10,000 CY of excavation to shape the new channel banks beneath the bridge. A dewatering cost of \$10,000 is assumed for this area.

This number could be higher, depending on the soils and groundwater characteristics. The excavated material could be used to construct the new berm, which would need to follow guidelines for levee construction. The soil's suitability for use as fill material would need to be tested. Testing results will also show the appropriate side slopes for the berm, which are currently assumed at 3:1. A rip rap overflow spillway could be located near the Scheuber Ditch crossing to allow flood flows to pass through Scheuber Ditch back to the Chehalis River downstream. The costs of the riprap for the overflow weir are assumed to be wrapped up in the unit costs for placing and compacting the fill material for the berm.

Traffic control during connection and disconnection of the temporary roadway is assumed to amount to be approximately \$10,000. This could vary depending on the duration of road closure. The presence of utilities in the area is unknown, but these would need to be disconnected or realigned prior to commencement of excavation. A placeholder of \$10,000 is used until further information becomes available.

After excavation, abutments and pier foundations would need to be constructed. A cost of \$20,000 per bridge abutment is assumed at this level. Soil test results will determine the need for piling to support the abutments and piers, which could raise the costs significantly. A 150-foot span is considered for the crossing. A center pier would not be advisable, so the design could use three 50-foot spans with two sets of piers. The bridge girders and deck slabs are assumed to be precast units delivered to the site. A 150-foot span would require approximately 2:1 side slopes beneath the bridge, which is different than the 3:1 slope used elsewhere in the excavated channel. Bank stabilization techniques may be required to sustain a 2:1 side slope, depending on soil test results. The bridge span could be shortened if soil conditions or bank stabilization allow for steeper side slopes.

A deck width of 32 feet is assumed, which allows for two lanes of traffic with narrow shoulders. The existing roadway in the surrounding area is approximately 45 feet wide. Wider shoulders across the bridge would increase the costs proportionally. The bridge deck is assumed to cost \$100 per square foot. Depending on the use of piers and the selected bridge type, this number could be higher. Once the bridge is in place, traffic could be rerouted over the bridge. The remaining excavation in all areas not affected by the rerouted traffic could take place concurrently with bridge construction.

It is anticipated that the channel excavation would begin near the Chehalis River connection using a dredge operation. The suitability of dredge operation will depend on a number of factors including the availability of flow, the disposal area used (considering the distance and elevation difference), and water return requirements, specifically if water needs to be returned to the river to maintain flows. Conditions are assumed to be conducive to dredging operations although they have not been investigated at this level. If land-based equipment is used, dewatering costs could increase the overall excavation costs. Haul distances and suitability for use of the soil as fill material elsewhere is unknown at this point, but could affect the unit costs of transporting the material significantly. The potential to utilize excavated material in construction of the levees should be investigated.

The alignment of the channel excavation is shown through the upstream end of the existing oxbow, which would follow the most natural flow pattern. If, instead, the downstream end of the oxbow were to be used, it would result in a shorter path to the road crossing (about 1,000 lineal feet shorter). This might result in cost savings for excavation but flood flows would not follow the historical flow path, which could have some disadvantages as far as sedimentation, erosion, or other unanticipated results. The advantages and disadvantages of the selected alignment, or other alternative alignments, should be examined in more detail during the PED phase.

The wetland excavation area appears to be largely devoid of trees and large shrubs thus, clearing and grubbing are not listed as separate line items. The unit costs for excavation and planting are assumed to include minor clearing and grubbing, in addition to stripping, stockpiling, and replacing the topsoil. LWD would be placed in the channel and wetland areas at four per acre, with an additional 50 pieces in the channel area. The LWD would be approximately 20 feet long with root balls intact. A unit cost of \$750 is assumed, which accounts for burying and stabilizing LWD. The costs could be higher if complex anchoring techniques are employed.

In addition to the 35 percent contingency, a construction administration and inspection fee of 12 percent of construction costs is added to the total construction costs. A summary of the PED and Construction cost estimates is provided in Table 4. The MCACES cost estimate is provided as an appendix to this FEIS. Note that the total initial project cost reported in Table 4 is slightly different from the total project cost determined through MCACES. This is a result of specific tax rates utilized by MCACES. The total project cost according to MCACES is \$9,784,000. The construction period for the mitigation plan is estimated to span 180 days.

Costs for operation and maintenance (O&M) of the mitigation plan are shown on the cost estimate summary below. Essentially, costs are associated with maintaining the mitigation project after it is built or repairing the project after a flood event or other natural disaster. It is estimated that some amount of vegetation will have to be replaced during the establishment period (annually for the first 5 years). Sediment that settles into the wetlands or channel, compromising the habitat quality, will need to be excavated periodically. Areas that erode significantly may require repair. A one-time project cost of \$10,000 is assumed for repairs needed following a large event, such as the 100-year flood. Costs for maintaining the SR-6 Bridge are estimated to be 1 percent of the total bridge construction cost. This translates into an annual cost of \$5,800 for the life of the project. A summary of the O&M cost estimates is provided in Table 4. Expected average annual O&M costs for the mitigation plan are estimated to be approximately \$20,000 per year.

COST ESTIMATE SUMMARY

Table 5.4-1: Oxbow/SR-6 Mitigation Plan Cost Estimate Summary

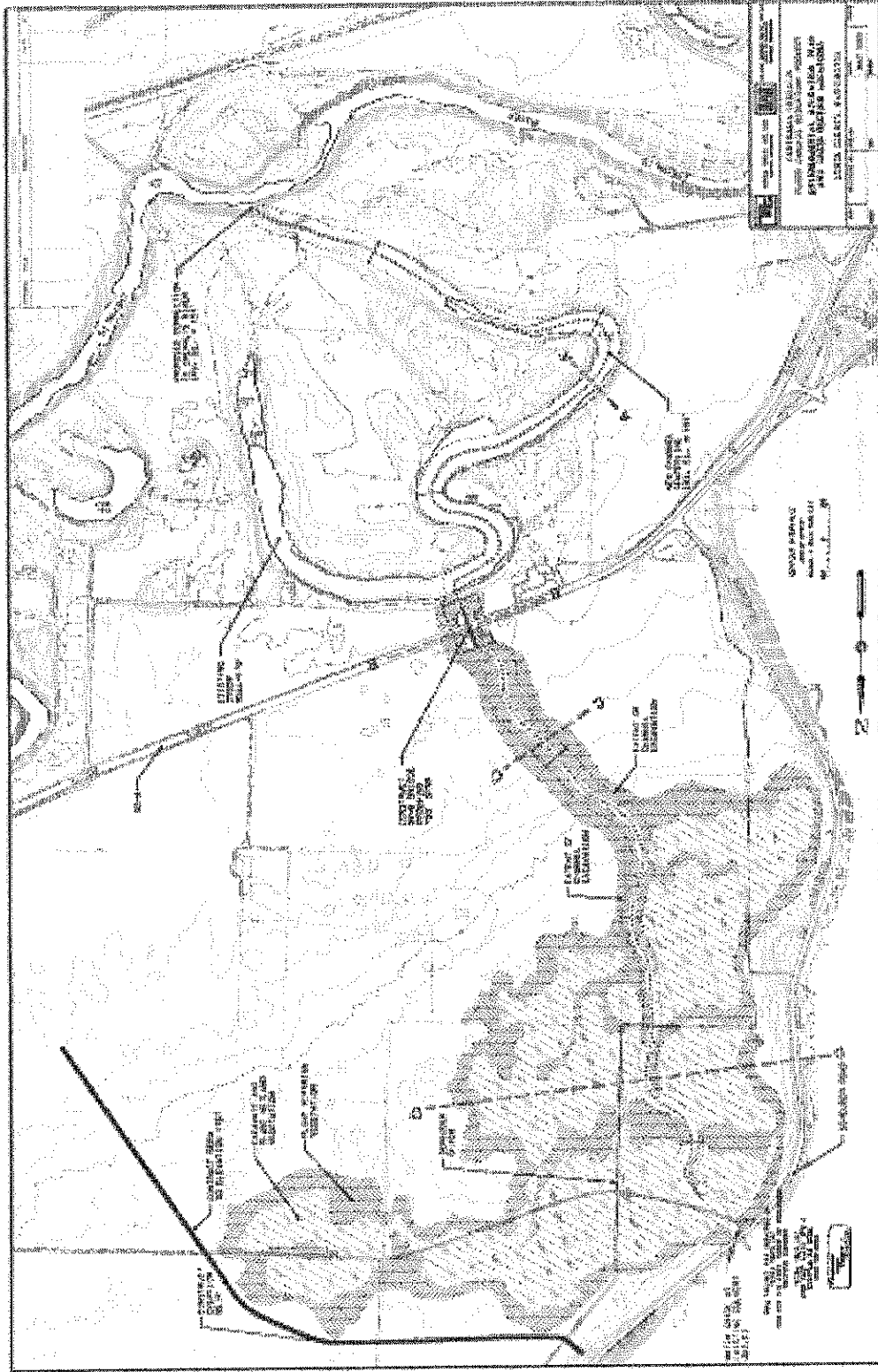
Task	Quantity	Unit	Unit Cost	Total Cost	Notes
Mob/Demob	1	ls	\$ 50,000	\$ 50,000	~1% of construction subtotal
Dewater	1	ls	\$ 10,000	\$ 10,000	Culvert area only, assume oxbow dredged
Excavate/Haul Oxbow	215,000	cy	\$ 7	\$ 1,563,050	10' bottom 3:1 SS = 1250 sf section * 4650 lf; dredge transport 1-2 miles
Traffic Control	1	ls	\$ 25,000	\$ 25,000	Signage/flagging, temporary road construction around bridge excavation area (incl. demo)
Relocate Utilities	1	ls	\$ 10,000	\$ 10,000	Assume buried cable, telephone, power
Demo Ex Roadway	1,250	sf	\$ 4	\$ 5,513	45' x 250' asphalt
Excavate/Haul Bridge Mat'l to Prop. Grade	10,000	cy	\$ 4	\$ 40,000	150' x 150' x 30' with 2:1 SS
Foundation Work for Bridge Abutments	2	ea	\$ 20,000	\$ 40,000	Drive piles and cast abutments in place
Reinforce Side Slopes beneath Bridge	7,500	sf	\$ 3	\$ 22,500	Protect 2:1 Side Slopes with Geomat or similar
Install Precast Bridge Girders	4,800	sf	\$ 100	\$ 480,000	Fabricate, deliver, and install 32' x 150' girders, cast deck in place
Construct Approach Slabs	1	ea	\$ 15,958	\$ 15,958	Construct approach slabs, repave transitions
Excavate/Haul Channel Mat'l	220,000	cy	\$ 6	\$ 1,251,800	10' bottom, 3:1 SS, Avg xs 1600 sf, 3700 ft length; haul 5 miles
Excavate/Haul Rip/Wetland Mat'l	303,000	cy	\$ 6	\$ 1,724,070	Avg 3' depth, 68 acres; haul 5 miles
Exc/Place Fill for Scheuber Ditch Berm	7,000	cy	\$ 4	\$ 28,000	Reuse cut mat'l onsite, fill berm to 176' (2-yr flood), 3600x 5' avg ht, 2:1 SS
Plant Riparian Vegetation	20	ac	\$ 7,560	\$ 151,200	Riparian footprint measured from CAD
Plant Emergent Wetland Vegetation	27	ac	\$ 4,255	\$ 114,885	Wetland footprint measured from CAD, 40% emergent
Plant Scrub-shrub Wetland Vegetation	41	ac	\$ 3,300	\$ 135,300	Wetland footprint measured from CAD, 60% scrub-shrub
Place LWD	322	ea	\$ 700	\$ 225,400	Place and bury 4 pieces per acre of riparian/wetland area + 50 for channel
Construction Subtotal				\$ 5,892,676	
Contingency		35%		\$ 2,062,436	
Subtotal				\$ 7,955,112	
Construction Admin & Bond and profit Inspection		22.95%		\$ 1,825,698	Same percents as used in USACE Flood Control MCACES Estimates
Total Initial Cost				\$ 9,780,810	
Operation and Maintenance Requirements				\$ 2,000	Replace vegetation annually during establishment period (5 years)
				\$ 10,000	1-time cost during project life for major flood damage
				\$ 2,000	Annual cost during project life for excavation of settled sediment and bank repair
	1% of bridge costs			\$ 5,800	Annual cost during project life for maintaining bridge

Table 5.4-2: Recommended Plantings for Wetlands and Riparian Areas and Associated Costs

Species	Common Name	Size	Quantity per Acre	Cost Each Installed	Cost Total per Acre
Scrub-shrub Wetland					
<i>Spirea douglasii</i>	Douglas' spirea	1 gal	200	\$4.00	\$800.00
<i>Salix lucida</i>	Pacific willow	cuttings	250	\$1.00	\$250.00
<i>Salix scouleriana</i>	Scouler's willow	cuttings	250	\$1.00	\$250.00
<i>Rubus spectabilis</i>	Salmonberry	1 gal	200	\$4.00	\$800.00
<i>Acer circinatum</i>	Vine maple	1 gal	200	\$4.00	\$800.00
<i>Malus fusca</i>	Western crabapple	1 gal	100	\$4.00	\$400.00
					\$3,300.00
Emergent Wetland					
<i>Salix geyeriana</i>	Geyer willow	cuttings	200	\$1.00	\$200.00
<i>Salix sessifolia</i>	Soft-leaved willow	cuttings	200	\$1.00	\$200.00
<i>Sagittaria latifolia</i>	Wapato	tuber	100	\$0.75	\$75.00
<i>Juncus oxymeris</i>	Pointed rush	rhizome	1200	\$0.50	\$600.00
<i>Juncus patens</i>	Grooved rush	rhizome	1200	\$0.50	\$600.00
<i>Carex densa</i>	Dense sedge	bareroot	1200	\$0.50	\$600.00
<i>Carex lenticularis</i>	Lenticular sedge	seeds	2	\$30.00	\$60.00
<i>Carex stipata</i>	Sawbeak sedge	bareroot	1200	\$0.50	\$600.00
<i>Eleocharis palustris</i>	Creeping spikerush	rhizome	1200	\$0.50	\$600.00
<i>Beckmannia syzigachne</i>	American sloughgrass	plug	1200	\$0.50	\$600.00
					\$4,255.00
Upland Riparian					
<i>Populus balsamifera</i>	Black cottonwood	1 gal	80	\$4.00	\$320.00
<i>Fraxinus latifolia</i>	Oregon ash	1 gal	80	\$4.00	\$320.00
<i>Alnus rubra</i>	Red alder	1 gal	50	\$4.00	\$200.00
<i>Thuja plicata</i>	Western red cedar	2 gal	80	\$6.00	\$480.00
<i>Abies grandis</i>	Grand fir	5 gal	50	\$15.00	\$750.00
<i>Pseudotsuga menziesii</i>	Douglas fir	2 gal	80	\$6.00	\$480.00
<i>Acer macrophyllum</i>	Big-leaf maple	2 gal	80	\$6.00	\$480.00
<i>Tsuga heterophylla</i>	Western hemlock	2 gal	60	\$6.00	\$360.00
<i>Amelanchier alnifolia</i>	Serviceberry	2 gal	50	\$6.00	\$300.00
<i>Cornus nuttallii</i>	Pacific dogwood	2 gal	30	\$4.00	\$120.00
<i>Cornus sericea</i>	Red osier dogwood	1 gal	200	\$4.00	\$800.00
<i>Salix lucida</i>	Pacific willow	cuttings	200	\$1.00	\$200.00
<i>Salix scouleriana</i>	Scouler's willow	cuttings	200	\$1.00	\$200.00

Table 5.4-2: Recommended Plantings for Wetlands and Riparian Areas and Associated Costs

Species	Common Name	Size	Quantity per Acre	Cost Each Installed	Cost Total per Acre
<i>Lonicera involucrata</i>	Twinberry	1 gal	200	\$4.00	\$800.00
<i>Physocarpus capitatus</i>	Nine-bark	1 gal	75	\$4.00	\$300.00
<i>Sambucus cerulea</i>	Blue elderberry	2 gal	50	\$7.00	\$350.00
<i>Rosa pisocarpa</i>	Swamp rose	1 gal	200	\$4.00	\$800.00
<i>Crataegus douglasii</i>	Douglas hawthorn	1 gal	75	\$4.00	\$300.00
					\$7,560.00





6. CUMULATIVE IMPACTS

6.1 INTRODUCTION

The combined, incremental effects of human activity, referred to as cumulative impacts, pose a serious threat to the environment. While they may be insignificant by themselves, cumulative impacts accumulate over time, from one or more sources, and can result in the degradation of important resources. Because federal projects cause or are affected by cumulative impacts, this type of impact must be assessed in documents prepared under NEPA.

Cumulative impacts result when the effects of an action are added to or interact with other effects in a particular place and within a particular time. It is the combination of these effects, and any resulting environmental degradation, that should be the focus of cumulative impact analysis. While impacts can be differentiated by direct, indirect, and cumulative, the concept of cumulative impacts takes into account all disturbances since cumulative impacts result in the compounding of the effects of all actions over time. Thus the cumulative impacts of an action can be viewed as the total effects on a resource, ecosystem, or human community of that action and all other activities affecting that resource no matter what entity (federal, non-federal, or private) is taking the actions.

Cumulative impact analyses typically review historic impact, current conditions and reasonably foreseeable future impacts. In the following sections, historic, current, and reasonably foreseeable conditions are summarized for the study area and then examined in relationship to the preferred alternative and its potential to result in cumulative impacts to each subject area (biological resources, cultural resources, etc.)

6.1.1 Historic Impacts to the Study Area

The study area experienced various forms of development since the mid-19th century. Development activities included extensive logging, diking, road and highway construction, navigational improvements, damming, grazing, agriculture, and residential and commercial development.

The most dramatic changes to the Chehalis River occurred during aggressive efforts by the federal government to improve the navigability of the river in the late 1800s and early 1900s (for example, see Secretary of War 1890). This included the removal of snags, overhanging trees, logjams, drift heaps, shoals, and other obstructions to navigability. In one year (1887), 293 large snags were removed from the main channel, beginning at Claquato and ending near Oakville (approximately 16 miles), and masses of log drifts and logjams were loosened or burned (Secretary of War 1887). The practice of removing woody obstructions continued for decades through this reach for purposes of floating logs generated by timber operations (Secretary of War 1892, Wendler and Deschamps 1955).

Logging development also made dramatic changes to the study area. The earliest logging dams were built in the 1880s and continued through the 1920s. Splash dams were built on Elk Creek, Hope Creek, Chehalis River, South Fork Chehalis, Deep Creek, and the Skookumchuck River. The length of time that the dams remained in the streams ranged from less than 1 to more than 50 years, with an average of about 20 years. All splash dams were removed, washed out, or burned prior to 1944 except for one splash dam that may remain intact on Elk Creek (as of 1955) (Wendler and Deschamps 1955).

Splash dams were intentionally destroyed to carry logs downstream, a process termed "splashing." This process significantly affected channel dynamics. The floods of logs and water scoured or moved the gravel bars, leaving only barren bedrock or heavy boulders (Wendler and Deschamps 1955). New channels were created in some areas and/or the geometry (width, depth, cross-section shape) of existing channels was changed. Splashing occurred on the average of once each week, but in some cases once a day. If the sudden influx of logs into a stream below the dam caused a logjam, dynamite or black powder was used to clear the obstruction (Wendler and Deschamps 1955). Natural logjams were removed in the process as well. The lack of logjams and the scour from splash dams has resulted in a simplified stream system in which water and sediment is routed much faster than prior to basin settlement.

Logging and agricultural development resulted in clearing of vast areas of native vegetation, including wetlands and riparian areas as well as upland forests. Much of the historic wetland area in the Chehalis Valley had drainage tiles or ditches or both constructed to facilitate agricultural use. Many of the riparian areas were either logged or cleared to open more area for agricultural or residential and commercial development.

Most of the residential and commercial development has occurred around the cities of Centralia and Chehalis. These two cities occupy portions of the floodplain, while their associated infrastructure crosses the river, its tributaries, and their floodplains.

As the population of the area increased over time, the surrounding floodplain experienced a relative increase in the amount of development pressure. Residential and agricultural developments occurred within flood-prone areas to accommodate the increased population. These newly developed areas required transportation corridors and other infrastructure, as well as commercial businesses to support them. As a result, damage to buildings and infrastructure from flooding increased as development of the floodplain proceeded.

The road system in the study area developed in response to population increases and the establishment of farms, residential areas, industries, and commercial businesses in the mid to late 1800s. Land uses and the transportation system built to serve these uses were influenced by the opportunities and constraints presented by natural land features, including steep slopes, rivers and streams, and floodways. Rail lines were constructed to transport the agricultural commodities, timber, and lumber produced in the area, and subsequent patterns of industrial and commercial growth were largely determined by the locations of the rail lines and depots. I-5 was later constructed along the general corridor established by the rail lines. The construction of I-5 included the relocation of the lower portion of the Skookumchuck River.

Flooding of roadways and rail lines was historically a problem in large portions of the study area; for example, photographs of downtown Centralia taken in the early 1900s show vehicles axle-deep in floodwaters. Flood damages in the area increased as more development occurred in the floodplain.

The changes brought about by navigation work, logging, agriculture and residential and commercial development had a significant impact on the biological resources of the study area. The major impacts included:

Loss of wildlife habitat. Clearing of native vegetation and the construction of major transportation corridors virtually eliminated large mammal populations from the area. Remaining wildlife habitat is scattered in a scattered areas around the floodplain and no longer provides pathways for animal migration.

Loss of fishery habitat. The Chehalis River once supported a complex aquatic community, including anadromous and resident fish species. Back channels, braided channels, shallow gravel beds, and pool and riffle complexes allowed for highly productive habitats. Navigation work and land use practices resulted in altered hydrology and sediment transport into streams and rivers and a reduction in biodiversity to the detriment of fish spawning and rearing habitat. The clearing of wood jams and snags from the Chehalis River (including the tributaries) changed the fish habitat creation and nutrient retention patterns within the floodplain. The influence of woody debris jams on the creation of off-channel and other rearing habitat had been similarly reduced.

Loss of wetlands and riparian areas. Clearing of wood jams and snags from the Chehalis River system (including the tributaries) also changed the flooding and ponding patterns within the floodplain, which reduced the extent of wetlands and riparian areas. Wetlands were also drained throughout the study for agriculture and filled for development. Riparian areas were logged and cleared for both agricultural and development purposes. This resulted in losses of fish and wildlife habitat, decreases in water quality, loss of floodwater retention and detention, and loss of low flow augmentation to the Chehalis River and its tributaries.

Loss of native vegetation. Grazing and clearing of the native prairies (as well as clearing in other habitat types) resulted in a loss of biodiversity and habitat.

Loss of migration corridors for plant and animal species. Construction of major features such as I-5 and development of the floodplain resulted in the fragmentation and isolation of habitat. This essentially created islands of habitat and plant populations. The result of this is the outright loss of plant and animal species or much smaller populations of both. This has reduced both the biodiversity and the ecological health of the entire basin ecosystem.

The principle pathways of the impacts identified above are: (1) modification of the waterways; (2) modification of the floodplain; (3) agricultural and silvicultural practices; and (4) the development of urban centers and major transportation corridors.

6.1.2 Current Condition in the Study Area

Current conditions in the study area are largely a result of the historic changes to the Chehalis River system. Although the majority of the Chehalis River floodplain remains in agricultural use, the severity of floods in the area appears to be increasing, and flood damages have risen significantly. As recorded at the Grand Mound gage, the February 1996 and January 1990 floods

represent the first and second highest floods, respectively, observed in the Chehalis Basin since 1929. Six other major floods occurred in the past decade. These include the third and sixth highest floods of record, which occurred in November 1986 and November 1990, respectively. Because the Skookumchuck confluence was relocated to its present location, the additional water raises the water surface within the Chehalis River downstream of the confluence and creates a backwater effect upstream of the confluence.

The floodplain currently shows numerous oxbows and other features formed by cutoff of meander bends. Aerial photographic analysis indicates that these features formed sometime before 1949 (earliest available aerial photographs of the study area) and have changed little in the past 50 years. These features are not ancient, and are likely no more than a few hundred years old. Given the extremely low gradient of the channel and floodplain through the study area, the oxbows present on the floodplain can be interpreted as features that were formed during a period when large woody debris (LWD) was abundant within the Chehalis River. LWD probably caused the formation of side channels and oxbows. This is supported by the observation that no new oxbows or channel features have formed in the past 50 years even though the basin experienced several large flood events.

The study area still plays an important ecological role because it continues to support remnant forest, prairie, riparian and wetland ecosystems as well as providing support for fisheries and wildlife. Current practices of development and land use include modification of the floodplain through development and ongoing agricultural and silvicultural practices. These would likely continue to diminish beneficial functions associated with the remnant ecosystems.

Current land uses in the study area are composed primarily of residential, agricultural, and silvicultural uses, although commercial and light industrial uses have been increasing in recent years. Commercial development has been focused primarily along the I-5 corridor in Centralia and Chehalis. Improvements to transportation corridors in the area are ongoing. The area is expected to continue to undergo development in accordance with locally adopted comprehensive plans.

Portions of I-5 are subject to inundation during large flood events, which has resulted in the multi-day closure of the freeway between Chehalis and Centralia. Primary arterials, including all north-south roads between Chehalis and Centralia, are also inundated with floodwaters during larger floods. Flooding has accelerated the deterioration of the substructure of some arterial routes in the area, causing damage to the roadway sub-base and pavement (City of Chehalis

1999). Larger floods also cause portions of the rail lines to become temporarily unusable when the subgrade becomes saturated or the rail lines are overtopped by floodwaters.

6.2 REASONABLY FORESEEABLE IMPACTS TO THE STUDY AREA

Residential, commercial, and industrial development within flood-protected areas would continue, primarily within designated urban growth boundaries in and around Chehalis and Centralia. This development would increase the extent of impervious surfaces, resulting in additional runoff and decreasing groundwater recharge in these areas. Management of stormwater runoff from developed areas would be subject to local and state guidelines and requirements. The effects of a decrease in groundwater recharge from these areas are expected to be minor, as they represent a relatively small portion of the overall basin, and are generally located on fine-grained soils with low infiltration rates.

The Washington State Department of Transportation (WSDOT) is currently evaluating traffic improvements to I-5, which may include widening of the freeway and the reconstruction of existing freeway exit and entering ramps. There is no timetable for these actions but they are likely to be proposed within the next 5 to 10 years. These improvements would potentially impact the land use adjacent to the freeway and the interchange areas. Lewis County is also sponsoring a proposal for new interchanges and connections to the local road system in the vicinity of the existing LaBree Road overcrossing and in north Lewis County. The local jurisdictions would continue to develop maintenance, safety and capacity improvements, and street extensions as part of their comprehensive and capital improvement planning activities.

Relocation of the municipal sewage treatment plant is foreseeable in the next 5 years and changes in operation at the PacifiCorp Steam plant may alter needs for Skookumchuck River withdrawals.

The Corps of Engineers in partnership with Grays Harbor County has begun study of the entire Chehalis Basin (Chehalis Basin Ecosystem Restoration Project). The purpose of this study is to select a myriad of project alternatives, which both recover the degraded ecosystem, primarily for salmonid recovery, and provide ancillary flood damage reduction benefits to the basin. This is in addition to and inclusive of watershed management planning and analysis currently underway by state and local agencies within the basin.

The study includes intensive public and agency involvement with the purpose of selecting projects that will benefit the goals of ecosystem restoration with ancillary flood damage reduction. The current understanding is that the selected projects would be implemented over a 10 to 15 year period.

6.2.1 Cumulative Impacts Associated with the Preferred Alternative

6.2.1.1 Hydrology and Hydraulics

The preferred alternative would result in little change to flooding within the active portions of the Chehalis River floodplain and its tributaries. Significant changes to the extent of flooding in the Chehalis River valley would occur only during large floods. Areas that would be prevented from flooding are generally not within the active floodway, but instead are backwater or temporary storage areas where short-duration flooding occurs. Modifications to the Skookumchuck Dam and reservoir operations would eliminate large overtopping floods on the Skookumchuck River and replace them with smaller events of greater frequency and duration.

Substantial increases in flood stage or flow velocities within and upstream or downstream from the study area are not expected. The preferred alternative would have no significant effect on recharge of groundwater resources. The long-term changes associated with development of the basin would continue to dominate the hydrology and hydraulics of the Chehalis River system, and would be little affected by project implementation. Mitigation actions associated with the preferred alternative would reconnect portions of the Chehalis River to the adjacent floodplain. These actions would be expected to enhance local groundwater recharge associated with minor (1- to 2-year) floods.

The preferred alternative would alter flood stages and timing of flows in the study area and potentially could contribute to the cumulative effects of past hydrologic and hydraulic modifications. Future development in areas that would be protected from flooding would result in changes in runoff and infiltration. However, design considerations incorporated into the preferred alternative would avoid unnecessary impacts, minimize unavoidable impacts, and provide mitigation to offset potential impacts and restore some historic functions of the Chehalis river floodplain. No specific information is available on likely future development, including improvements to I-5, however, these projects would also be rigorously analyzed for impact

avoidance and minimization. No significant cumulative impacts to hydrology and hydraulics are expected.

6.2.1.2 River Geomorphology

The anticipated effects on river geomorphology in response to predicted changes in hydrology and hydraulics are negligible. The long-term channel changes associated with the historical removal of LWD and the relocation of the Skookumchuck River confluence would likely continue unaffected by the preferred alternative. While there is currently a very limited source of LWD along the Chehalis River within the study area, the preferred alternative allows for the future establishment of a restored riparian zone that could supply LWD to the channel through bank erosion and channel migration in the future. No specific information is available on likely future development, including improvements to I-5, however, these projects would also be rigorously analyzed for impact avoidance and minimization. No significant cumulative impacts to river geomorphology are expected.

6.2.1.3 Cumulative Impacts on Water Quality

Construction of the project in the Chehalis River watershed have the potential to cause temporary and intermittent increases in suspended solids or concentrations of biostimulatory nutrients (nitrogen and phosphorus) in the Chehalis River (and tributaries) for those portions of the project that are located in close proximity to the river and tributaries; the major portion of the levee and floodwall alignment is setback away from the river and tributaries. Any soil-disturbing activities during construction would be conducted in compliance with state-approved construction stormwater management plans. Past impacts have resulted in the majority of the concurrent water quality concerns (specifically, seasonal high temperatures and low dissolved oxygen). This project is not expected to degrade the current condition. Impacts from the preferred alternative are not likely to result in significant cumulative impacts to water quality as a result of construction.

After construction, the preferred alternative would have limited potential for impacts to water quality because of its setback location. The preferred alternative would not change normal flows or velocities of the river and tributaries, would not degrade existing conditions by being a source of contaminants, and/or would not result in changes to temperature, turbidity, and dissolved oxygen conditions. There would be some changes in the duration of larger magnitude floods within the Chehalis Valley study area, which may result in increased sedimentation, scour, and bank erosion. However, it would be difficult to differentiate specific impacts associated with the

preferred alternative because of the catastrophic nature of the flood itself. The preferred alternative may result in cumulative impacts to water quality during the flood events, but this would be episodic in occurrence and likely of short duration. As stated above, past impacts have resulted in the majority of impacts to water quality and the preferred alternative will not degrade the existing condition. As such, no significant cumulative impacts to water quality as a result levees and floodwalls in the Chehalis Valley and lower Skookumchuck River are expected.

Changes to the operation of the Skookumchuck Dam, which would result in changes to frequency and duration of floods on the Skookumchuck River, may result in cumulative impacts to water quality. Specifically, changes in the frequency of lower magnitude floods (5- and 10-year events) may change beneficial uses associated with riparian and wetland habitats. The major impacts associated with the Skookumchuck River have occurred from past actions, however, changes in operations may affect the current condition. This potential impact would be further evaluated during design.

No specific information is available on likely future development, including improvements to I-5. However, water quality on the Chehalis River is of concern to both state and local agencies and these projects would also be rigorously analyzed for impact avoidance and minimization.

Proposed mitigation plans for the preferred alternative, which include increased canopy cover and wetland creation and restoration should decrease summer water temperatures and improve dissolved oxygen conditions during low flow periods in the Chehalis River. These actions are intended to improve baseline conditions of the river. This action may help restore some of the historic functions of the Chehalis.

6.2.1.4 Biological Resources – Vegetation, Wetlands, and Riparian Areas

The preferred alternative would result in modification of Skookumchuck Dam and the modification of the floodplain through the construction of the levees and floodwalls. The floodplain modifications have been focused on avoiding unnecessary impacts to critical habitats (wetlands and riparian areas). The major impacts to wetlands and riparian areas occurred as a result of past actions. No information is available to evaluate the extent of future actions, although future projects, including I-5, are likely to result in wetland losses. Compensatory mitigation for the preferred alternative would increase the function and extent of wetlands and riparian areas as well as increase the overall vegetation biodiversity in the project area and may serve to offset cumulative impacts as well as restore some historic functions. Future development

that includes impacts to biological resources would likely require avoidance, minimization, and compensation measures. What remain unknown are the potential impacts to the wetland and riparian areas of the Skookumchuck River from the change in operation of Skookumchuck Dam. However, the potential for cumulative impacts would be associated with the first reach between the dam and the first tributary. This reach is the only reach on which a modified dam would have direct and cumulative impacts.

6.2.1.5 Biological Resources – Wildlife

The preferred alternative would result in the loss of land that could be potentially modified into habitat for wildlife, both within the alignment footprint and on the levees. In order for the levees to maintain their structural integrity, woody vegetation would be regularly removed thus reducing the potential use as wildlife habitat.

The proposed mitigation would increase the habitat for wildlife by creating additional riparian habitat, connecting oxbows, creating and restoring wetlands. This would restore some of the historic habitat for smaller wildlife species, although it would not restore habitat for larger species such as elk and deer. The major impacts from connectivity issues associated with the transportation corridors and development of the floodplain use are too large to be overcome by the preferred alternative, however, the project will not result in any degradation of existing conditions. No information is available on the extent of potential future actions, but these actions would be subject to avoidance, minimization, and mitigation requirements. No significant cumulative impacts to wildlife are expected.

6.2.1.6 Biological Resources – Fish

The preferred alternative would result in modification of Skookumchuck Dam and the modification of the floodplain through the construction of the levees and floodwalls. The floodplain modifications have been focused on avoiding unnecessary impacts to critical habitats (wetlands and riparian areas). The majority of impacts to fisheries are associated with past actions (floodplain modification and development, removal of LWD, habitat modification, etc.). The preferred alternative would not result in any degradation of existing conditions within the Chehalis River floodplain. Compensatory mitigation would increase biodiversity, improve fish habitat, increase primary and secondary productivity, and increase flood storage opportunities, which would restore some of the historic function. No information is available on the extent of potential future actions, but these actions would be subject to avoidance, minimization, and mitigation requirements.

What remain unknown are the potential impacts to the fishery support functions of the Skookumchuck River from the change in operation of the Skookumchuck Dam. No conclusions can be made regarding potential cumulative impacts to fish as this time, but this resource would be the subject of further evaluation during the design phase of the preferred alternative.

6.2.1.7 Land Use and Planning

Several design features of the preferred alternative are intended to minimize the impacts on land uses. The levees and floodwalls would be set back away from the Chehalis River and its tributaries to the greatest extent practicable, while offering protection to significant tracts of developed land. Existing roads, levees, and other structures would be incorporated into the design wherever possible to reduce impacts to these existing features. Additionally, floodwalls would be used in certain areas to minimize the footprint of the structure and to avoid impacts on existing buildings and infrastructure.

The preferred alternative has been designed so that it does not afford flood protection to large tracts of undeveloped land within the floodplain. This is consistent with Executive Order 11988, which requires federal agencies to minimize harm to floodplain areas and avoid adverse effects associated with incompatible development in floodplains. Further, these unprotected areas would not be expected to undergo urban-type development because they generally lie outside designated urban growth boundaries established under the state GMA. Undeveloped lands that would be protected as a result of the preferred alternative lie, for the most part, within urban growth boundaries and would undergo development in accordance with the local jurisdictions' comprehensive plans. These plans would be periodically reviewed and amended in accordance with the GMA.

The preferred alternative also incorporates modifications to the Skookumchuck Dam to aid in the reduction of peak flows during flood events. These modifications would provide additional flood control storage that would significantly reduce peak flood stages in communities downstream, thereby reducing flood damage to structures located in the floodplain. However, areas within the floodplain that are protected would only undergo development under the purview of comprehensive plans adopted under the Growth Management Act.

The dominant land uses in the study area are expected to remain agricultural and residential with a gradual increase in commercial and industrial land uses as the population in the area increases,

which is consistent with expectations of existing conditions. The design considerations incorporated into the preferred alternative would minimize the potential for impact to surrounding land uses. No information is available on the extent of potential future actions, but these actions would be subject to current and future land use requirements. No significant cumulative impacts are expected.

6.2.1.8 Recreation, Public Access, and Visual Resources

Cumulative impacts for recreation would involve dispersal of recreation activities to other areas, as opportunities under the preferred alternative would become limited during construction. However, recreational opportunities could return to areas immediately impacted as construction progressed to other areas within the study area. The preferred alternative will result in no changes to existing conditions. No information is available on the extent of potential future actions, but these actions would be subject to avoidance, minimization, and mitigation requirements. No significant cumulative impacts to recreation, public access and visual resources are expected to result from the preferred alternative.

6.2.1.9 Transportation and Traffic

The preferred alternative would result in the permanent modification of some roadways, including raising a portion of SR-6 and raising or relocating portions of arterial and secondary routes on top of the levees. However, the modifications would have a beneficial effect on transportation systems, since the preferred alternative would provide flood protection for the portion of I-5 that is currently subject to flooding, as well as protection for local roadways, the airport, and rail lines. This is a change from past conditions, but is considered a beneficial change. No information is available on the extent of potential future actions, but these actions would be subject to transportation and traffic analysis. No significant cumulative impacts to transportation and traffic are expected to result from the preferred alternative.

Although there would be temporary impacts on transportation during construction, the preferred alternative is designed to avoid unnecessary impacts and minimize unavoidable impacts to existing roadways and rail lines. Overall, the preferred alternative is expected to provide a significant benefit to transportation systems in the area. It would reduce flooding of local roadways, rail lines, and airport facilities, and provide the flood clearance that is needed in order to implement improvements to I-5 in the Centralia-Chehalis area. No significant cumulative adverse impacts to transportation are expected as a result of the preferred alternative.

6.2.1.10 Air Quality

The preferred alternative consists of passive flood control features. These features are not anticipated to generate air pollutants. There would be no change to existing conditions. No information is available on the extent of potential future actions, but these actions would be subject to avoidance, minimization, and mitigation requirements. No cumulative effects to air quality in the study area are expected.

6.2.1.11 Noise

Noise associated with the construction of the preferred alternative is temporary and does not contribute to cumulative effects to the study area. Long-term noise created by the operation and maintenance would be limited to periodic mowing. These structural features of the preferred alternative would not generate operational noise. No change to existing conditions is expected. No information is available on the extent of potential future actions, but these actions would be subject to avoidance, minimization, and mitigation requirements. No significant cumulative effects to the study area are expected.

6.2.1.12 Hazards and Hazardous Materials

Accidental spills of construction materials harmful to the environment, such as concrete, sealants, oil and other fuels, during construction of the preferred alternative could contribute to cumulative impacts on water quality. Although they would be infrequent and not intentional, accidental spills could occur during construction near stream channels or on the banks of stream channels.

The cumulative impacts of toxic contaminants would be less than significant because toxic material control and spill-response plans would be implemented for major construction projects in the watershed to avoid or control potential accidents. Hazardous waste mitigation measures would ensure that construction activities associated with the proposed action would not contribute to effects from hazardous materials on people or the environment. No changes to existing conditions are expected. No information is available on the extent of potential future actions, but these actions would be subjected to rigorous generation and handling controls if hazardous substances are associated with any proposed project.

The preferred alternative would not directly contribute to cumulative effects involving hazardous materials because this alternative would not include the long-term use, generation, storage, or disposal of hazardous materials. No significant cumulative effects to the study area are expected.

6.2.1.13 Cumulative Impacts on Cultural Resources

The preferred alternative has the potential to adversely affect historic properties or culturally important resources if they are present within the area proposed for project implementation. Historic properties are a finite resource; only some have survived the damages caused by time, natural degradation, and continuing land uses. The goal of federal resource protection is to preserve the best available examples of resource types. The preferred alternative is likely to affect prehistoric archeological sites, traditional cultural properties, or early settlement or industrial sites. There is potential to affect locations of cultural importance to tribes that are not encompassed by federal historic preservation law. The degree to which cultural resources would be affected is based on the actual footprint of the preferred alternative. The alignment of the preferred alternative is confined to the boundaries of urban development and set back from the river and major features of the floodplain (oxbow lakes and meanders). This may reduce the extent of the potential impacts.

The major factor of right of entry makes assessing the cumulative impact of the preferred alternative on cultural resources quite difficult and subjective. The data on cultural resources is uneven due mainly to the right of entry problems encountered during review of the known sites. Without testing, the actual subsurface character of most of the archaeological sites in the study area is unknown. Plus, lacking such information that can usually be obtained in settings like this by archaeological testing, the status of most of the sites in terms of eligibility for the National Registry is unknown. Potential cumulative impacts cannot be concluded at this time, but would be the subject of investigations during the design phase.

No information is available on the extent of potential future actions, but these actions would be subject to avoidance, minimization, and mitigation requirements.

6.2.1.14 Irreversible and Irretrievable Commitment or Resources

Construction of the proposed alternative will include many features considered permanent, or modifications to existing features. Project features that may be considered irreversible would be construction of the levees and the dam modifications. Resources that could be considered

irreversible and irretrievable would be the commitment of resources such as state and federal funding to purchase lands and labor, and to operate and maintain the alternative. At this time there are no commitments of resources that are irreversible and irretrievable except for the cost of producing this FEIS.

6.2.1.15 Relationship Between Short-term Uses and Long-term Productivity

While regional conditions may improve, short-term or localized conditions should improve after the initial impact of construction. Overtime the entire area should improve dramatically for existing wildlife resources. Further studies and monitoring will be critical to the over all recovery and maintenance of habitat for wildlife and fisheries in this area.

6.3 FINDINGS OF SIGNIFICANCE

No significant cumulative impacts are expected to occur due to the preferred alternative for hydrology and hydraulics, river geomorphology, wildlife, land use and planning, recreation, public access and visual resources, transportation and traffic, air quality, noise, and hazards and hazardous materials. In consideration of past, ongoing and reasonably foreseeable impacts, the project has the potential to cumulatively impact water quality, fisheries, and wetlands and riparian areas; additional study during design would be focused on potential cumulative impacts associated with the Skookumchuck Dam. Cumulative impacts to cultural resources cannot be concluded without additional study. This would be done during the design of the preferred alternative.

7. CONSULTATION & COORDINATION COMPLIANCE

Public involvement is a critical element in the feasibility of project development. Interested individuals, organizations, agencies, and governmental entities are solicited for comments and concerns relative to a proposed project. This chapter describes the Corps effort to establish dialogue with a variety of interests involved with the Centralia Flood Damage Reduction Project. The Corps in part is obligated to engage in this process through a variety of state and federal regulations. Discussion among interested parties is scheduled to continue through PED of the project as well as during the processing of this document. The Corps will consider the information collected in its decision making process to select a preferred alternative that has the least adverse environmental effect.

7.1 NEPA COMPLIANCE

Environmental, socio-economic, hydrologic and water quality information on this project has been compiled, and a DEIS for the Centralia Flood Damage Reduction Project was prepared from March to July 2002. A systematic interdisciplinary approach to planning has been utilized; all reasonable alternatives have been studied, developed and described; and all pertinent information, including hydrologic, environmental and water quality modeling and ecological field studies have been developed, carried out and utilized. The DEIS was coordinated with Native American tribes, state, federal and local agencies, non-governmental agencies, and the public for a period of not less than 45 days.

7.1.1 Public Involvement

The Corps has informed the public of the proposed project through several public meetings held in the affected area and press releases published in local print media. In addition to providing information to the public regarding the draft environmental impact statement (DEIS), the Corps solicited responses regarding the public's needs, values, and evaluations of the proposed alternatives. Both formal and informal input has been encouraged and considered by the Corps.

7.1.2 Scoping Process

A scoping process is a requirement of the environmental impact statement (EIS) preparation (49 Code of Federal Regulations [CFR], Part 1501.7). Scoping, as defined in the Council of Environmental Quality (CEQ) regulations of 1978, is “an early and open process for determining the scope of issues to be addressed and for identifying the significant issues related to a proposed action.” The scoping process facilitates:

- identification of issues, concerns, and possible impacts;
- identification of existing information sources;
- development of alternatives.

On 9 September 1999, the Corps initiated the scoping process by publishing in the *Federal Register* a Notice of Intent to prepare a DEIS on the Centralia Flood Damage Reduction Project. The Corps notified all potentially interested parties about the flood reduction DEIS scoping process, and provided opportunities to comment. The Corps also provided a press release about the scoping meetings to the news media and local newspapers.

7.1.3 Public Scoping Meetings

The Corps held two consecutive scoping meetings on 28 and 29 September 1999 in Rochester and Chehalis, Washington, respectively. At these meetings, the Corps presented the proposed alternatives currently under consideration and invited comments and suggestions for other alternatives to reduce flooding and minimize and or avoid potential environmental impacts.

7.1.4 Endangered Species Act, Section 7

Section 7 (a)(2) of the Endangered Species Act (ESA) of 1973 PL 93-205; 16 USC 1531 *et seq.*, as amended) requires federal agencies to consult with the U.S. Fish and Wildlife Service (USFWS) and National Marine Fisheries Service (NMFS) when a federal action may affect a listed threatened and or endangered species or critical habitat. The purpose of this legislation is to ensure that any action authorized, funded, or carried out by a federal agency is not likely to jeopardize the continued existence of a listed species or result in the destruction or adverse modification of a species-critical habitat.

The Corps initiated consultation with the USFWS and NMFS, and, as required by Section 7 (a)(2), prepared a separate biological assessment (9 July 2002) addressing the potential effects on threatened and endangered species that occur and or may occur within the vicinity of the study area. The findings of the consultation have been presented in this Final EIS.

7.1.5 Fish and Wildlife Coordination Act

The Fish and Wildlife Coordination Act (PL85-624; 16 U.S.C. 661 *et seq.*) (FWCA) requires federal agencies to coordinate with the USFWS and state wildlife agencies when planning new projects or when modification to an existing project occurs. The purpose of the legislation is to ensure that the welfare of wildlife resources receives appropriate consideration with other project objectives and features.

The USFWS has provided a final FWCA report regarding the flood damage reduction project, in accordance with Section 2(b) of the Fish and Wildlife Coordination Act, and it is included at the end of Chapter 9, Comments and Response to the DEIS. The draft FWCA report is included as Appendix F. The Corps has coordinated with USFWS on the proposed project through written correspondence (Planning Aid Letters) that was prepared on nine separate occasions between 21 April 2001 and 27 February 2002. The following paragraphs contain recommendations as presented in the Fish and Wildlife Coordination Act Report prepared by the U.S. Fish and Wildlife Service and responses to the recommendations prepared by the Corps.

7.1.5.1 U.S. Fish and Wildlife Service Draft Fish and Wildlife Coordination Act Report Recommendations

Comment 1. Details about the re-operation of the dam should include: a) the expected future water and power needs for the Centralia Steam Plant and the associated co-generation plant; b) the status of discussions between Lewis County and PacifiCorp for transferring flood control operating authority and/or ownership rights for the dam and reservoir; c) the potential for fish stranding in the reservoir during drawdown and how this could be minimized; d) the potential that insufficient water would be available to provide minimum flow requirements downstream; e) the likelihood of shutdowns in dam operation and severe ramping downstream; and f) the feasibility of providing overbank flows in excess of a 2-year event while limiting flows at the Pearl Street gage in Centralia to 5,000 cfs.

Response 1.a. There is no change in the future needs for water supply by the Centralia Steam Plant. The water right for the steam plant is 50 cfs at the point of removal from the river. The dam operation will need only to maintain this flow. In regards to the Centralia Steam Plant power needs, we are unaware of any future changes to the power that would require additional water supply rights from the Skookumchuck. In regards to the power facility at the dam, this power plant will be decommissioned by the new owners, a flood district (made up of Lewis county entities).

1.b. Lewis County and PacifiCorp are still conducting negotiations with the current owners for transferring the ownership of the dam to a flood control district that will operate and maintain the facility for flood control.

1.c. Reservoir operations are generally comprised of rules and constraints to address flood conditions and other conditions that are related to the pool and downstream impacts. If fish in the reservoir proper are a concern, reservoir draw during floods can be limited in rate and extent so as not to strand or otherwise take fish. Assuming there is a minimum pool that does not greatly diminish flood control, limiting evacuation to minimize stranding can be established as a constraint, just as the “turbidity pool” is a constraint at Howard Hanson Dam.

1.d. Minimum flows for downstream obligations are often a constraint that reservoir operations are required to meet. In flood season, reservoir operations are predicated on projected rainfall-runoff, reservoir pool, downstream channel conditions and inflow to the reservoir. Meeting minimum flow requirements during flood season should not be an issue and can be accommodated based on measured inflow and pool conditions. This could limit the ability for providing adequate minimum flows downstream. However, this condition would occur regardless of the dam configuration, assuming the refill rule is constructed to reflect current conditions.

1.e. During major floods, the objective is to limit the flow downstream to meet non-damaging conditions or constraints. Since the Skookumchuck Dam does not control the entire basin, the maximum flood reduction impact that could be achieved from the dam is to completely shut off the flow. However, if there are minimum low flow criteria immediately downstream of the dam (at least to the first flow contributing tributary), then dam operation rules would include those constraints as long as they do not impair or greatly diminish flood reduction benefits that justified the project. Further, ramping rates are typically imposed on the downstream channel so

as not to strand fish or create channel instability on ramping-down or create a health risk on ramping-up.

1.f. There may be opportunities for controlled channel exceedance as long as the operation does not, or can not be construed as, purposely contributing to damage. Current uncontrolled flooding that is unavoidable is one thing, but purposely flooding areas that we can not control once out of bank is not something we should do. However, if there are specific target out-of-bank flooding areas that can be controlled and that have been identified as having environmental benefits directly linked to out-of-bank flooding, we could configure overtopping “scenarios” that would take advantage of that linkage.

Comment 2. The following details should be provided to clarify design for the levee system: 1) a map showing the extent of existing levees and embankments, where these would be increased in height, and where new levees would be constructed; 2) maps modeling the extent of inundation at selected flood events, including 2-year, 5-year, 10-year, 35-year, 50-year and 100-year events for pre- and post-levee project; and 3) an assessment of downstream impacts caused by limiting floodplain storage for selected flood events and the distance downstream where those impacts might be evident.

Response 2.1. Maps for all the levee system will be produced prior to the preconstruction, engineering, and design (PED) planning and engineering phase of the proposed project and will contain the existing levees (all available data about their construction) and the planned new levees.

2.2. Most of these maps have been completed and presented to the environmental working group during the early phase of developing the criteria for the DEIS. However, a copy of those maps can be provided upon request.

2.3. There will be minimal impacts to the downstream portions of the Skookumchuck Dam based on the suggested re-operation plan. However, during the planning phase of this project any expected or suspected impacts will be assessed and evaluated for mitigation.

Comment 3. The Corps should provide details about the SR-6 bypass and restoration for our consideration during the preparation of this final document. We would like the opportunity to work with you in developing this component of the recommended plan. Our information needs include: a) details about the “concrete flowway” under SR-6 and ways of altering this concept to

provide better benefit to fish; b) flows predicted to provide access to the oxbow and to the bypass floodway; c) the potential for fish stranding and how that would be mitigated; d) the potential for fish loss due to entrapment and predation and ways of mitigating; e) anticipated maintenance needs; f) how much material would be excavated and where it would be placed; and g) the feasibility of purchasing land or obtaining conservation, erosion, and drainage easements to insure that restoration would remain viable.

Response 3.a. The concrete flowway under SR-6 will be designed to allow proper fish passage based on the coordination with the resource agencies, tribes, and other interested parties.

3.b. All flows will be better understood during the PED of the proposed project.

3.c. The project will be designed to protect fish and to help prevent fish from becoming stranded; therefore, mitigation will not be required.

3.d. During the PED phase of this project entrapment will be a major design consideration and all efforts will be put into place to reduce entrapment of fisheries. Predation is a natural process of fisheries and the project will not be designed to encourage predation; therefore, predation should not be mitigated for.

3.e. During the PED phase all maintenance needs will be identified.

3.f. This feature includes a 400-foot-wide excavation of SR-6, with an invert elevation of 179 feet. This would involve excavating and grading approximately 65,000 cubic yards of material, and elevating the roadway to provide clearance for reconnecting the floodplain by providing overbank flows; an environmental condition of significant importance to fish and wildlife species in the study area. The material removed, such as the construction materials, asphalt/concrete, etc., will be properly disposed of. Any material that can be utilized in the construction of the levees will be used.

3.g. A gross appraisal has been conducted in this area; the local sponsor will be required to purchase the property in fee.

Comment 4. All recommendations presented in the Corps' fisheries review document should be incorporated into the re-operation plan and the revised rule curve for the Skookumchuck Dam with the following exceptions or additions:

a) Rather than proposing the 2-year event as the maximum allowable flow in the river, we recommend that the Corps determine the flows at which critical functions occur (such as channel maintenance and the creation and maintenance of off-channel habitats) and work backward to determine how those natural flows can be incorporated. The Corps should work with resource agencies to determine critical functions.

b) Because the formation of new off-channel habitats along the Skookumchuck River may be diminished with the flood control project, the Corps should consider enhancing existing off-channel habitats and wetlands along the Skookumchuck River in addition to identifying and protecting them;

c) Alterations to the dam should include safe downstream passage for juveniles, smolts, and kelts, (i.e., adult steelhead that return to the ocean after spawning);

Response 4.a. It is unlikely that a maximum flow event of 2 years can be maintained due to the influence of the tributaries along the Skookumchuck River. Criteria for all fisheries and their habitat will be incorporated in the re-operation plan for the dam. All of these efforts will be coordinated with the resources agencies and tribes.

4.b. The Corps will look at all off-channel habitat on the Skookumchuck River and look at ways to enhance those areas. Areas of major importance to the environment will be reviewed to determine the potential for protecting that particular area.

4.c. Alterations to the dam will incorporate all possible safe passage designs for juveniles, smolts, and kelts.

Comment 5. The Corps should develop a monitoring and adaptive management plan that would set goals, report changes, and trigger changes in management of various aspects of the recommended plan. Issues that should be monitored include, but are not limited to, fish passage at the dam, functioning of restoration and mitigation projects, and alterations to downstream habitats resulting from changes in flows released from the dam. The plan should include monitoring for pre-project baseline, during construction, and post-project conditions and should be developed with participation from resource agencies. The monitoring plan should be developed to ensure that assumptions about fish passage and impacts from alterations of flows are correct.

Response 5. The Corps will develop a monitoring plan that will be developed with the coordination of all resource agencies and tribes associated with this project.

Comment 6. The Corps should develop a monitoring and adaptive management plan that would set goals, report changes, and trigger changes in management of various aspects of the recommended plan. Issues that should be monitored include, but are not limited to, fish passage at the dam, functioning of restoration and mitigation projects, and alterations to downstream habitats resulting from changes in flows released from the dam. The plan should include monitoring for pre-project baseline, during construction, and post-project conditions and should be developed with participation from resource agencies. The monitoring plan should be developed to ensure that assumptions about fish passage and impacts from alterations of flows are correct.

Response 6. See above response to Comment 5.

Comment 7. Fill that results from excavation of the floodplain should be placed outside the floodplain or used in the construction of the levees.

Response 7. Agree. The Corps is committed to utilize the material to the maximum extent practicable.

Comment 8. The existing embankments that will be part of the levee system and levees that will be newly constructed should be planted with native trees and shrubs to increase the value of these areas for fish and wildlife.

Response 8. In order to maintain the structural integrity of the levees it is not possible to plant trees and shrubs on the levees to increase values for fish and wildlife. If a tree were to die and the root system were to rot, there would be potential for a weak spot to develop in the levee. The levee's are being set back in order to meet the potential to develop areas between the levee and the river into functional riparian and wetland areas.

Comment 9. The Corps should clarify how non-structural measures will be implemented, including: a) details about how the "no net loss" of floodplain policy will be developed, implemented, and enforced; b) details about implementation of the moratorium/restriction on

further development in the floodway; c) status of the new floodplain maps; and d) how and when floodplain maps will be incorporated into land use practices by the county and city governments.

Response 9.a. The “no net loss” of floodplain policy will be developed with the active sponsor. The non-structural measures are discussed in Chapter 2, and how they are incorporated in the preferred alternative.

9.b. The moratorium/restrictions on further development in the floodway will be investigated during the planning phase of the project.

9.c. At this time it is the Corps’ understanding that FEMA will address that issue after the project is in the PED phase.

9.d. The use of floodplain maps has not been determined by the county and city governments. This area will be addressed in the PED phase of the project.

Comment 10. The Service, other resource agencies, and the tribe should be given the opportunity to participate in the development of a monitoring and adaptive management plan, a mitigation plan, design of restoration projects and dam operations and facilities that affect fish passage or fish habitat during the next phase of Corps planning.

Response 10. It is the intent of the Corps to include all the above-mentioned agencies, including the tribes, and to include members of the local community to be part of a working committee to insure all entities are involved in all phases of the project.

Comment 11. The Corps should evaluate the importance of groundwater recharge from flooding to base flows and the potential impact of reducing flood storage to base flows in the Chehalis River. Details should include groundwater movement, how soil types influence recharge, and location of important recharge areas.

Response 11. Please refer to the FEIS Chapter 4 for coverage of those issues. Plus, additional analysis will be performed if further review of all available data during the PED phase does not produce sufficient answers to the above comment.

Comment 12. The Corps should provide transfer funds during the next phase of study for our continued participation in developing a mitigation plan, restoration projects (including the SR-6

bypass complex), fish passage issues at the dam, groundwater study, sediment effectiveness studies for Skookumchuck River, design work for the levee system, and refining the plan for non-structural measures to be incorporated into the levee system.

Response 12. The Corps intends to continue to work closely with the Service to enable them to participate in the development of this project. A specific commitment per guidance under the Fish and Wildlife Coordination Act is not feasible at this time.

Comment 13. The Corps should revisit those restoration opportunities developed as part of the flood project to determine the feasibility of including them as part of the restoration actions proposed by the Chehalis Basin Study.

Response 13. All restoration areas that were developed are carried forward in the FEIS as potential restoration sites. Sites that are not used in this project could be utilized in the Chehalis Basin Study.

Comment 14. The Corps should obtain an evaluation by a geomorphologist to determine the potential for avulsion across the SR-6 bypass and the potential impacts should that occur.

Response 14. Those issues about or involving avulsion will be addressed during the PED phase of the project. All aspects of geomorphology will be addressed during that time.

7.1.6 National Historic Preservation Act Consultation and Native American Graves Protection and Repatriation Act

The National Historic Preservation Act of 1966 (NHPA) (as amended in 1992) requires that federal agencies consider the effects of a proposed project upon sites of historic significance. Section 106 of this act and its implementing regulations (36 CFR Part 800) provides guidance that federal agencies can follow in order to be in compliance with NHPA on specific undertakings. The Archeological Resources Protection Act of 1979 and the Native American Graves Protection and Repatriation Act of 1990 are two other pieces of federal legislation promoting the protection of historic and archeological resources.

To comply with Section 106 of NHPA, federal agencies must consult with the State Historic Preservation Officer (SHPO), Native American tribes with a traditional or religious interest in the study area, and interested members of the public. Federal agencies must demonstrate that a

good faith effort has been made to identify historical properties in the area of potential effect for a project. Identified properties should be evaluated on the basis that they are eligible for the National Register of Historic Places. The effect of the proposed activity on eligible properties must also be determined at this time. The federal agency must consider how to address adverse effects on the characteristics that make a site "historic". Cultural resource investigations will be ongoing to determine effects to historic properties during the planning phase of this project. When completed, results will be coordinated with the State Historic Preservation Officer and the Advisory Council on Historic Preservation.

7.1.7 Environmental Protection Agency

Coordination activities have been ongoing with the Environmental Protection Agency because of agency's role in the National Environmental Policy Act (NEPA) review process.

7.1.8 Washington State Department of Transportation

Coordination activities have been ongoing with the Washington State Department of Transportation in conjunction with the department scheduled activities on the I-5 Improvement Project. Coordination will continue throughout the duration of the proposed project.

7.1.9 Washington Department of Ecology Dam Safety

The Washington Department of Ecology Dam Safety Unit would be provided an opportunity to review and comment on the proposed design and construction plans for the structural modification portion of the preferred alternative.

7.1.10 Executive Orders and Other Guidelines

Executive Order (EO) 11990 requires minimization of wetland destruction, loss, or degradation and preservation and enhancement of the natural and beneficial values of wetlands. Wetlands are recognized as important wildlife habitat resources and are necessary for the survival of a disproportionately high percentage of endangered and threatened species. A second requirement of EO 11990 is public disclosure of a project's effect on wetlands. Chapter 4 of this FEIS provides that disclosure.

Executive Order 13007 (Indian Sacred Sites) requires the project proponent identify Indian sacred sites that may be affected by the project. The Corps has consulted with the Chehalis Tribe of Indians in a good faith effort to locate Native American sites of historical significance within the proposed project area. Efforts to identify Indian sacred sites are described above under National Historic Preservation Act Consultation.

Executive Order 12898 established environmental justice as a federal agency priority to ensure that minority and low-income groups are not disproportionately affected by federal actions. The Corps has invited minority and/or low-income members of the population within the project area to participate in public meetings. It has also been determined that minority and low-income groups would not be disproportionately affected by the proposed action. This is based on the projection that the largest anticipated economic impacts of project implementation would be because of project spending on construction, land purchases, operation and maintenance.

Executive Order 11988 requires agencies to avoid, where possible, short and long-term adverse impacts associated with floodplain development. Federal agencies are required to reduce the risk of flood loss and restore and preserve the natural and beneficial values served by floodplains. The Corps has no intention to engage in any action that would result in either short- or long-term impacts with floodplain development. Consultation with local Native American tribes has occurred from the beginning of the development of alternatives and will continue until completion.

7.1.11 Clean Water Act of 1972

The study is in full compliance at this stage. As the project progresses into the planning and development stage, a complete 404(b)(1) analysis will be conducted to ensure water quality standards will be maintained. This will precede the requirement of a state water quality certification that will be obtained prior to construction of any component that may impact wetlands or water resources of any kind. At present there is sufficient information to likely obtain a 401 certification from the state when the planning phase is in process.

Table 7.1: Table of Compliance

Law/Regulation/Treaty	Status of Compliance
National Environmental Policy Act (NEPA)	Will be complete after EIS is approved and ROD is signed.
Endangered Species Act	Consultation ongoing
National Historic Preservation Act	Consultation ongoing
Clean Water Act	A 404(b)(1) analysis will be prepared in PED and NPDES construction permits will be obtained
Clean Air Act	In partial compliance
Fish and Wildlife Coordination Act	In partial compliance
Migratory Bird Treaty Act	In partial compliance
Executive Order 12898, Environmental Justice	In partial compliance
Executive Order 11990, Protection of Wetlands	In compliance
Executive Order 11988, Floodplain Management	Will be completed prior to signing the PCA and starting construction.
Indian Treaty Rights	Will be in compliance through public review process
State Environmental Policy Act	Lewis County will adopt Final EIS
Washington Hydraulic Code	Lewis County will obtain required permits
Water Quality Certification	Corps will obtain required permits
Growth Management Act	In compliance
Model Toxics Control Act	Lewis County will obtain any necessary approvals
State Aquatic Lands Management Laws	Consultation ongoing
Lewis County Regulations	Lewis County will obtain all required permits
City Regulations and Ordinances	Lewis County will obtain all required permits

8. DOCUMENT RECIPIENTS

This Final EIS is being sent to federal, state, and local Native American tribes, interested non-government organizations and other interested parties. The FEIS is being sent to the same distribution list as the DEIS, as well as all groups and individuals who submitted written comments or who made comments at the public hearings. Other copies will be sent on request. This document is also available at local libraries in Chehalis, Centralia, and Montesano, Washington and on our web site: http://www.nws.usace.army.mil/ers/doc_table.cfm

8.1 FEDERAL AGENCIES (HEADQUARTERS OFFICES)

Advisory Council on Historic Preservation
ATTN: Mr. Ronald Anzalone
Advisory Council on Historic Preservation
Office of Prog. Review and Education
1100 Pennsylvania Avenue NW, #803
Washington, DC 20004-2501

U.S. Coast Guard
U.S. Coast Guard
Commandant
2100 Second Street SW
Washington, DC 20593-0001

Environmental Protection Agency
U.S. Environmental Protection Agency
Office of Federal Activities
EIS Filing Section
Mail Code 2252-A, Room 7241
1200 Pennsylvania Avenue NW
Washington, DC 20044

Federal Energy Regulatory Commission
ATTN: Mr. Pat Wood III, Chairman
Federal Energy Regulatory Commission
888 First Street NE
Washington, DC 20426

Department of Agriculture
U.S. Department of Agriculture
U.S. Department of Agriculture
14th and Independence Avenue SW, Room 200-A
Washington, DC 20250-0001

Forest Service
USDA Forest Service
PO Box 96090
Washington, DC 20090-6090

Department of Commerce
U. S. Department of Commerce
U.S. Department of Commerce
14th and Constitution Avenue NW
Washington, DC 20230

National Oceanic and Atmospheric Administration
ATTN: Mr. Steve Kokkinakis
NOAA
Office of Strategic Planning
Room 6121
Washington, DC 20230

National Marine Fisheries Service
National Marine Fisheries Service
NOAA Fisheries
1315 East West Highway, SSMC3
Silver Springs, MD 20910
Department of Energy
Office of Environmental Management
ATTN: Mr. Steve Frank
NEPA Compliance Officer
Division of NEPA Affairs
1000 Independence Avenue SW
Washington, DC 20585

Department of Health and Human Services
ATTN: Mr. Richard Green
U.S. Department of Health and Human Services
Cohen Building, Room 4700
200 Independence Avenue SW
Washington, DC 20201

Department of the Interior
Bureau of Indian Affairs
ATTN: Mr. Neil A. McCaleb
Interior Assistant Secretary - Indian Affairs
Bureau of Indian Affairs
1849 C Street, MS 4140
Washington, DC 20240

Fish and Wildlife Service
Department of the Interior
U.S. Fish and Wildlife Service
Public Information
Washington, DC 20001

Geological Survey
ATTN: Mr. Charles S. Groat, Director
U.S. Geological Survey
John W. Powell Federal Building
12202 Sunrise Valley Drive
Reston, VA 20192

Office of Environmental Policy and Compliance
ATTN: Mr. Willie R. Taylor
U.S. Department of the Interior
Office of Environmental Policy and Compliance
1849 C Street NW, M/S 2340
Washington, DC 20240

National Park Service
ATTN: Ms. Fran P. Mainella, Director
National Parks Service
1849 C Street NW
Washington, DC 20240

Department of Transportation
U.S. Department of Transportation
400 7th Street SW
Washington, DC 20590

Federal Railroad Administration
ATTN: Mr. Allen Rutter, Administrator
Federal Railroad Administration
1120 Vermont Avenue NW
Washington, DC 20590

Office of Management and Budget
ATTN: Mr. Mitchell E. Daniels, Jr., Director
Office of Management and Budget
725 17th Street NW
Washington, DC 20503

8.2 U.S. CONGRESSIONAL DELEGATION

Representative Brian Baird
Representative Brian Baird
Representative in Congress
Capital Hill, U. S. House of Representatives
Washington, DC 20515-4703

Senator Patty Murray
Senator Patty Murray
United States Senate
2985 Jackson Federal Building
915 Second Avenue
Seattle, WA 98174

Senator Marie Cantwell
Senator Marie Cantwell
United States Senator
717 Hart Senate Office Building
Washington, D.C. 20510

Representative Norman Dicks
Representative Norman Dicks
Representative in Congress
1717 Pacific Avenue, Suite 916
Tacoma, WA 98402-4411

8.3 WASHINGTON STATE LEGISLATURE

Representative Tom Mielke
ATTN: Representative Tom Mielke
Washington State House of Representatives
18th Legislative District
PO Box 40600
Olympia, WA 98054-0600

Representative Ed Orcutt
ATTN: Representative Ed Orcutt
Washington State House of Representatives
18th Legislative District
PO Box 40600
Olympia, WA 98054-0600

Representative Brian Hatfield
ATTN: Representative Brian Hatfield
Washington State House of Representatives
19th Legislative District
PO Box 40600
Olympia, WA 98054-0600

Representative Mark Doumit
ATTN: Representative Mark Doumit
Washington State House of Representatives
19th Legislative District
PO Box 40600
Olympia, WA 98054-0600

Representative Richard Debolt
ATTN: Representative Richard Debolt
Washington State House of Representatives
20th Legislative District
PO Box 40600
Olympia, WA 98054-0600

Representative Gary Alexander
ATTN: Representative Gary Alexander
Washington State House of Representatives
20th Legislative District
PO Box 40600
Olympia, WA 98054-0600

Representative Jim Buck
ATTN: Representative Jim Buck
Washington State House of Representatives
24th Legislative District
PO Box 40600
Olympia, WA 98054-0600

Representative Lynn Kessler
ATTN: Representative Lynn Kessler
Washington State House of Representatives
24th Legislative District
PO Box 40600
Olympia, WA 98054-0600

Representative Kathryn M. Haigh
ATTN: Representative Kathryn M. Haigh
Washington State House of Representatives
35th Legislative District
PO Box 40600
Olympia, WA 98054-0600

Representative William Eikmeyer
ATTN: Representative William Eikmeyer
Washington State House of Representatives
35th Legislative District
PO Box 40600
Olympia, WA 98054-0600

8.4 FEDERAL AGENCIES-REGIONAL OR LOCAL LEVELS

Advisory Council on Historic Preservation
ATTN: Ms. Claudia Nissley
Advisory Council on Historic Preservation
Western Office Project Review
12136 West Bayaud Avenue, Suite 330
Lakewood, CO 80228
Department of Agriculture
U.S. Department of Agriculture
U.S. Department of Agriculture
1835 Black Lake Boulevard SW, Suite B
Olympia, WA 98501-5715

Forest Service
ATTN: Ms. Linda Goodman, Acting Regional Forester
USDA Forest Service – Pacific Northwest Region
7333 SW First Avenue
Portland, OR 97204-3440

Natural Resources Conservation Service
ATTN: Mr. Marty Cheney
USDA Natural Resources Conservation Service
300 Desmond Drive SE, Suite #106
Olympia, WA 98503-1273

Department of Army
U.S. Army Corps of Engineers
Forester Einarsen
CECW-PC
441 G. Street NW
Washington, DC 20314

Department of Commerce
National Marine Fisheries Service; Portland, Oregon
U.S. Department of Commerce
National Marine Fisheries Service
525 NE Oregon, Suite 500
Portland, OR 97232

National Oceanic and Atmospheric Administration
ATTN: Mr. Bob Lohn
Regional Administrator
NOAA
7600 Sandpoint Way NE
Seattle, WA 98115-0070

Environmental Protection Agency
U.S. Environmental Protection Agency
Region 10
1200 Sixth Avenue
Seattle, WA 98101

Federal Emergency Management Agency
ATTN: Mr. John Pennington, Region X Director
Federal Emergency Management Agency
Federal Regional Center
130 228th Street SW
Bothell, WA 98021-9796

Federal Energy Regulatory Commission; Portland, Oregon
Federal Energy Regulatory Commission
Regional Director
Portland Regional Office
101 SW Main Street, Suite 905
Portland, OR 97204

Department of Interior
U.S. Fish and Wildlife Service; Lacey
ATTN: Mr. Lynn Childers
U.S. Fish and Wildlife Service
510 Desmond Drive SE, #102
Lacey, WA 98503-1292

U.S. Geological Survey
ATTN: Mr. John "Doug" Buffington, Western Regional Director
U.S. Geological Survey
Office of the Western Regional Director
909 First Avenue, Suite 704, MS 150
Seattle, WA 98104

Department of Transportation
Federal Railroad Administration
U.S. Department of Transportation
Federal Railroad Administration
703 Broadway, #650
Vancouver, WA 98660

Federal Highway Administration; Portland, Oregon
ATTN: Mr. Pat Clark
U.S. Department of Transportation
Federal Highway Administration
222 SW Columbia Street, Suite 600
Portland, OR 97201

Federal Highway Administration; Olympia, Washington
ATTN: Mr. Daniel M. Mathis
Division Administrator
Federal Highway Administration
Evergreen Plaza
711 South Capital Way, Suite 501
Olympia, WA 98501-1284

o

Washington Department of Transportation
Becky Michaliszyn
P.O. Box 1709
Vancouver, Washington 98668-1709

8.5 INDIAN TRIBES

Confederated Tribes of the Chehalis Reservation
ATTN: Mr. David Youckton
Confederated Tribes of the Chehalis Reservation
PO Box 536
Oakville, WA 98568-9616

Northwest Indian Fisheries Commission
ATTN: Fran Wilshuaen
Northwest Indian Fisheries Commission
6730 Martin Way East
Lacey, WA 98506

Quinault Tribe
Quinault Tribe of the Quinalt Reservation
Business Committee
PO Box 279
Taholah, WA 98587-0189

8.6 STATE AND LOCAL GOVERNMENT AGENCIES

State of Washington
Department of Ecology, Olympia
ATTN: Ms. Barbara Ritchie; Mr. Dan Sokol
WA Department of Ecology
Environmental Review
PO Box 47760
Olympia, WA 98504-7706

Department of Fish and Wildlife
ATTN: Ms. Cynthia Pratt
WA Department of Fish and Wildlife
PO Box 45200
Olympia, WA 98504-3155

ATTN: Ms. Sue Patnude, Regional Director
WA Department of Fish and Wildlife - Region 6
48 Devonshire Road
Montesano, WA 98563

ATTN: Lee Van Tussenbrook, Regional Director
WA Department of Fish and Wildlife – Region 5
2108 Grand Boulevard
Vancouver, WA 98661

Department of Natural Resources, Olympia
ATTN: Mr. Doug Sutherland
Commissioner of Public Lands
WA Department of Natural Resources
PO Box 47001
Olympia, WA 98504-1004

ATTN: Mr. Dave Dietzman
WA Department of Natural Resources
PO Box 47015
Olympia, WA 98504-7015

Department of Transportation
ATTN: Mr. Larry Ross
WA Department of Transportation
Environmental Affairs Office
PO Box 47331
Olympia, WA 98504-7331

Governor
Governor Gary Locke
Office of the Governor
PO Box 40002
Olympia, WA 98504-0002

Office of Archaeology and Historic Preservation, Olympia
ATTN: Robert G. Whitlam
Office of Archeology and Historical Preservation
1063 South Capitol Way, Suite 106
Olympia, WA 98504-8343

Parks and Recreation Commission, Olympia
ATTN: Bill Koss
Parks and Recreation Commission
PO Box 42668
Olympia, WA 98504-2668

Utilities and Transportation Commission, Olympia
ATTN: Ms. Marilyn Showalter, Chairwoman
Washington Utilities and Transportation Commission
PO Box 47250
Olympia, WA 98504-7250

Chehalis River Council
ATTN: Ms. Margaret Rader, Chairwoman
Chehalis River Council
417 North Pearl Street
Centralia, WA 98531

Grays Harbor County
Grays Harbor County
Board of Commissioners
Grays Harbor County Administration Building
100 West Broadway, Suite #1
Montesano, WA 98536

Thurston County
ATTN: Ms. Cathy Wolfe, Chair
Thurston County Board of Commissioners
Thurston County Court House
Building One, Room 269
2000 Lakeridge Drive SW
Olympia, WA 98502-1045

Lewis County
Lewis County Board of Commissioners
500 NW Chamber of Commerce Way
Chehalis, WA 98532

Lewis County Conservation District
1554 Bishop Road
Chehalis, WA 98532

8.7 LIBRARIES

Chehalis
Chehalis Timberland Library
76 NE Part Street
PO Box 419
Chehalis, WA 98532-0419

Centralia
Centralia Library
Timberland Regional Library District
110 S Silver
Centralia, WA 98531-4296

Montesano
Montesano Library
Timberland Regional Library District
125 South Main Street
Montesano, WA 98563

8.8 MEDIA

Coordination through Seattle District Public Affairs Officer
David G. Harris, Chief of Public Affairs
U.S. Army Corps of Engineers
Seattle District
4735 East Marginal Way South
Seattle, WA 98124-3755

8.9 PRIVATE ORGANIZATIONS

Ducks Unlimited
ATTN: Ms. Mae Schultz, Regional Vice President – Region 16
Ducks Unlimited
Western Regional Office
3074 Gold Canal Drive
Rancho Cordova, CA 95670

PacifiCorp
PacifiCorp
825 NE Multnomah
Portland, OR 97232

Trout Unlimited
ATTN: Mr. Bill Robinson, Executive Director
Trout Unlimited
2401 Bristol Court SW
Olympia, WA 98502

Washington Forest Protection Association
Washington Forest Protection Association
724 Columbia Street NW, Suite 250
Olympia, WA 98501

Weyerhaeuser Corp.
Weyerhaeuser Corp.
PO Box 9777
Federal Way, WA 98063-9777

9. COMMENTS AND RESPONSES TO DEIS

SUBMITTED WRITTEN COMMENTS FROM 22 AUGUST 2002 PUBLIC MEETING

Comment 1:

Richard P. Thomas
738 SW Hillburger Rd.
Chehalis, WA 98532

I don't know who did your impact study, but I do know that there are more than 8 houses that would need to be raised with this plan. Also, this plan will put an additional (possible) 6"-12" of water in my house. In '96 we had 20 inches. That was more than enough thank you! You state that only 8 houses will need to be raised. What do we do with our livestock & farm equipment? We currently have a small area to put these items, but with your proposed increase, all will be in water for a greater amount of time. I am greatly disturbed with this plan & feel it is not a fair proposal for all. <signed>

Response: It appears your house is very close to the confluence of the Newaukum and Chehalis Rivers (close to Chehalis RM 75). Based on the preferred alternative (Chehalis River Levees, flood control regulation at Skookumchuck Dam, levees along lower Skookumchuck, and the mitigation area that includes the 400-foot-wide SR-6 excavation), the post-project peak stages at your property will actually be lower than under current pre-project conditions. Peak flood stages could be up to 1.0 foot lower at your property during a 25-year event and roughly 0.6 foot lower during a 100-year event. The lower stages in this area under the preferred alternative are attributable to the proposed excavation under SR-6.

The non-structural component of our project (raising adversely impacted homes) was based on screening residential structures outside the area of protection that might experience increased flood stages due to the project. This screening was based on comparing first floor elevations of all residential structures to the 100-year water surface elevation, with and without the project. Based on this evaluation, it was determined that 8 homes would experience increased flood depths averaging .34 foot with the project in place.

Comment 2:

Mary Swafford
1311 NW Airport Rd.
Chehalis, WA 98532

I am in favor of the plan that is recommended by Lewis County. Please give that plan every consideration as I feel it is the best for all concerned. <dated 8/22/02>

Response: We appreciate your comment.

Comment 3:

What is being done to cleanup & keep clean China Creek?

What is being done & how will any projects being done to lessen the impact of flooding in the N. Pearl area. The SR-507 is always impacted when it floods up by Carson & N. Pearl.

Response: Clean-up of China Creek was not apart of the scope of this study. The Corps and the City of Centralia will conduct additional study, separate from this project, of China Creek flooding.

Comment 4:

John P Penberth
PO Box 162
Pe Ell, WA 98572

1) The proposed ditch on Hwy #6 will move water away from Chehalis for a while and what happens when the ditch is full [during] deeper floodwaters? Fish will be trapped in this ditch.

Response: This area of concern is part of the design process to ensure fish will not be trapped in the ditch.

2) What land will be bought to put the dikes on?

Response: A large portion of the proposed levee system design incorporates utilization of existing levees; therefore, much of the land purchased by Lewis County for the proposed levees will be under and/or near the existing levees. In addition, levee segments are proposed over parcels that include agricultural, residential and commercial land uses throughout the Chehalis/Centralia area. Therefore, there is a diversity of lands use types and locations that will need to be acquired by Lewis County to insure adequate real estate for the proposed levee system.

3) Who will maintain the dikes, who will be responsible if the dikes fail or [are] not tall enough to hold the water back?

Response: A local flood control district will maintain the levees. This group will be formed by the county and local communities.

4) The ACE will destroy 34 acres of wetlands that are a natural part of this system. This is should NOT be done!

Response: The only wetlands that will be impacted by the proposed project are prior converted wetlands that are now agriculture fields.

Comment 5:

John P Penberth
PO Box 162
Pe Ell, WA 98572

1) The issue of downstream flooding (below Cent.) has not been properly addressed. Cent. & Cheh. will increase river height with the levee system and this could cause a higher rise down river FASTER.

***Response:** The issue of potential impacts of the preferred alternative to reaches of the Chehalis River downstream of the project area (i.e., downstream of Centralia) has been studied extensively. In particular, the hydraulic model used to evaluate the Chehalis River in the vicinity of the project area was extended to reaches of the river downstream of Centralia to evaluate potential downstream impacts. While it is true that the addition of levees along the Chehalis River has the potential to cause slight (i.e., up to 0.5 foot) increases in peak water levels in the Chehalis River along a limited reach upstream of Centralia during large flood events, any potential effects of the levees on peak water levels downstream of Centralia will be offset by proposed flood control operations at Skookumchuck Dam. In particular, modifications to Skookumchuck Dam proposed as part of the preferred alternative will allow the Skookumchuck reservoir to be operated for flood control purposes. As a result, reduced flows in the lower Skookumchuck River as a result of flood control operations at the reservoir will offset any flow increases in the Chehalis River downstream of Centralia that are attributable to the proposed levees. The net result of the effects of all components of the preferred alternative will actually be a slight reduction in peak water levels in the Chehalis River downstream of Centralia during flood events.*

2) P.9 1.5.1.6 Reconsolidates tribes - What tribes? There is only one tribe, the Chehalis.

***Response:** This should state "Confederated Tribes of the Chehalis." This will be corrected in the FEIS.*

3) 1.5.1.10 Refers to loss and degradation to critical habitat, why not the area outside of the "study area." What problems & loss will occur here?

***Response:** During the preliminary studies that have been accomplished, there was no indication of significant loss or problems outside the study area.*

Comment 6:

John P Penberth
PO Box 162
Pe Ell, WA 98572

1) The placement of dikes will have a negative effect on critical fisheries within the Chehalis Basin.

Response: *The proposed levee alignments for this project have been intentionally and thoughtfully placed away from the river to allow for the establishment of natural riparian communities and floodway processes, and to significantly reduce levee impacts to aquatic resources. The location of levees in a floodplain could have a negative effect to fish resources if the levees were placed next to the water's edge. The further the levees are removed from the water's edge the more significant the reduction of impacts. There are a couple of locations however, that must be located near the water's edge principally due to the placement of Interstate 5. Mitigation that has been proposed will fully offset any potential impacts that may occur due to the location of the levees. These locations are near a bend in the Chehalis River and will have minimal impacts.*

2) P6.14 Why was 500-year floodplain used for the economic analysis? Never has the 500-year flood number been used. Nothing in this report is preparing for a 500-year flood and this is a major misrepresentation of facts to force the program on the taxpayers of this county and our country. This project is not about flooding; it's about economic development. As per ER 1105-2-100, "Planning Guidance Notebook", Appendix E.

3) Report Procedures For Risk and Uncertainty. To assist reviewers in assessing response to risk, summarize the following separately and display the information in tabular form:

a) Flood with two-tenths of 1 percent chance of occurrence. Fully describe the flood with two-tenths of 1 percent chance of occurrence (500-year frequency) with and without the plan.

The economic evaluation employs the discharge versus frequency curve, which ranges from a 0.999 frequency event (approximately 1 year) all the way up to a 0.001 frequency event (a 1000-year event). This is simply the range that a discharge versus frequency curve spans. A stage versus damage curve is also included in the economic analysis for determining the damages that can be expected, on average, in any given year. To be consistent, that stage damage curve needs to span the same range as the discharge versus frequency curve. A 500-year event is often used to define that upper limit for each curve and the 500-year floodplain is used to define the upper limit damages. Additionally, there are other requirements that mandate that we develop and display the 500-year event and associated 500-year floodplain. First, we have a requirement to show the 500-year floodplain, without the project and with the project in place, in an effort to show overall risk to a community. In other words, just how much area can be inundated in a very rare event (the 500-year is used for that) and what are the limits of that flooding. It is simply a way to show the citizens and decision makers the overall risk and to assess the response to that risk. And secondly, part of the requirements for a FEMA flood mapping effort is to show the 500-year floodplain limits. In summary, we have three basic reasons to develop and display the 500-year floodplain: the economic evaluation, the display of risk, and the mapping requirement for FEMA. This is certainly not to say that the project goal is to achieve a "500-year level of protection". The economic evaluation will determine what size of project is justified based on expected annual damages versus expected annual net benefits. The 500-year event is simply used to frame the upper limit for those evaluations and to define the limits of risk.

Comment 7:

B Ramacher
1330 NW River St.
Chehalis, WA 98532

According to your information paper, 20,000 acre-feet of water above the dam is dangerous - Liquefaction could occur on a 3.5 earthquake and there would be hell to pay downstream.

There has been lots of filling in floodplain - that wasn't allowed before the rules got changed.

I have lived here for over 58 years and there have been a lot of changes that weren't good and I could name who were responsible for that.

***Response:** According to seismologists, if a magnitude 3.5 earthquake originated at or near the dam, the level of shaking would be near or less than 0.1g (gravitational acceleration). This is about what the dam experienced during the Nisqually earthquake last year. PacifiCorp, the dam owners, reported no damage. Our studies indicate that the soil, at the dam site are prone to liquefy when the level of shaking approaches 0.2 g. Therefore, FERC the regulatory agency responsible to ensure that the current owners are operating a safe dam, are reviewing the information available and will require the current owner to conduct additional tests, and if they conclude that there is a dam safety issue the current owner will be required to fix the dam. All of this will be done prior to the dam becoming part of the flood reduction project.*

Comment 8:

John C. Westall
325 NW Georgia Ave.
Chehalis, WA 98532-1209

I own 7 residences in the area between river miles 71 and 74 that are just south of the Chehalis-Centralia Airport. One is my own residence. There are many more houses in this area than the eight homes to be raised. What criterion was used to select 8 houses out of the many in the area? What compensation will be forthcoming to the others in the area that will see a raise in flood levels. My wife and I have gone to considerable expense to raise our home and the other rental homes that we own. Present level of our houses, while affording protection from floods, will be less adequate with increased levels. Using taxpayer money to increase our vulnerability to flood damage without due compensation is unethical - if legal. All the homes in the area should be raised at least as much as the increase in flood level.

<signed>

***Response:** The non-structural component of our project (raising adversely impacted homes) was based on screening residential structures outside the area of protection that might experience increased flood stages due to the project. This screening was based on comparing first floor elevations of all residential structures to the 100-year water surface elevation, with and without the project. Based on this evaluation, it was determined that 8 homes would experience increased flood depths averaging .34 foot with the project in place.*

Comment 10:

Dave Palmer
7475 State Route 12
Oakville, WA 98568
360/273-8117
dave@theblackriver.net
www.theblackriver.net

Thank you for the opportunity to comment on the Draft EIS for the Centralia Flood Reduction Project.

I have been involved in the rivers of the Chehalis system for many years.

As a resident I had floodwaters in our house during the 1990 (2 inches) and 1996 (2 feet) floods. Any time the Chehalis gage at Grand Mound reaches 15 feet we can count on being confined to our home by floodwaters. The 1996 flood cost over \$40,000 in damage and repairs and we fully understand the concerns of residents in Centralia and Chehalis.

I've a well established record as a watershed volunteer. I played a role in the creation of the Chehalis River Basin Action Plan (1990) and I founded the Chehalis River Council in 1994 and served as Chairman of the Board of Trustees until my retirement last year. It was in 1997, at the Chehalis River Council office and at the invitation of the CRC that county representatives of Thurston, Lewis and Grays Harbor first met to discuss flooding issues and solutions.

These comments concerning the Draft EIS are based upon a desire to see a river system, which supports traditional river uses. I also want residents to safely enjoy the benefits of a healthy watershed without concern for the flood protection efforts of their neighbors. My concerns deal with downstream impact, appropriate land use restrictions, "no net loss" of flood capacity and the safety of the Skookumchuck Dam. Each of the following is an item which I feel has to be resolved in order to obtain approval of this Draft EIS and/or before federal funding is provided.

A. All flood events are my concern. I do not have enough information to predict what the impact of longer periods of high water will do to our property and access to our home. Reducing the flood impact in one area only increase it somewhere else.

In the "Appendix A: Hydrology and Hydraulics of the Draft General Reevaluation Report, July 2002"--- it was written: "The cumulative effects of all the changes are insignificant. Comparing with the results of the 15 May 2001 model, the maximum change in stage is less than 0.5 foot at high water calibration points listed in table 3-4. The accuracy of the computed water surface elevation is within 0.5 foot compared with observed high water marks." Insignificant? Remarks like that help me to understand the writer has never endured a flood. 6 inches can make the difference between a loss of a car engine, loss of hardwood floors or wall to wall carpeting or the loss of a heat pump.

I am concerned that here at the confluence of the Black River and Chehalis River we will see the combined impact of upstream levees as well as the longer sustained releases from the proposed Skookumchuck Dam operation.

Response: *The issue of potential impacts of the preferred alternative to reaches of the Chehalis River downstream of the project area (i.e., downstream of Centralia) has been studied extensively. In particular, the hydraulic model used to evaluate the Chehalis River in the vicinity of the project area was extended to reaches of the river downstream of Centralia to evaluate potential downstream impacts. While it is true that the addition of levees along the Chehalis River has the potential to cause slight (i.e., up to 0.5 foot) increases in peak water levels in the Chehalis River along a limited reach upstream of Centralia during large flood events, any potential effects of the levees on peak water levels downstream of Centralia will be offset by proposed flood control operations at Skookumchuck Dam. In particular, modifications to Skookumchuck Dam proposed as part of the preferred alternative will allow the Skookumchuck reservoir to be operated for flood control purposes. As a result, reduced flows in the lower Skookumchuck River as a result of flood control operations at the reservoir will offset any flow increases in the Chehalis River downstream of Centralia that are attributable to the proposed levees. The net result of the effects of all components of the preferred alternative will actually be a slight reduction in peak water levels in the Chehalis River downstream of Centralia during flood events (i.e., this slight reduction in peak water levels during flood events would also occur in the Chehalis River at the confluence with the Black River).*

Under the preferred alternative the Skookumchuck reservoir will be operated to store floodwater during the peak of a flood event. Water will be released from storage to the Skookumchuck River once the downstream flood threat has sufficiently subsided (i.e., releases of stored water will be made primarily based on river conditions downstream of the dam in both the Skookumchuck and Chehalis rivers). Releases will be made to evacuate stored water from the reservoir in a reasonable amount of time to make storage space available in the reservoir for future flood events without aggravating downstream flooding in either the Skookumchuck or the Chehalis rivers.

What are the downstream impacts created by the loss of upstream floodplain storage? How far downstream will they be felt? How will longer periods of standing water change our pastures?

Response: *With the exception of some of the proposed levee sections along the lower reach of the Skookumchuck River, most of the proposed levee sections will be set back significantly from existing stream channels. This limits the loss of floodplain storage attributable to the project. For instance, proposed levees along the Chehalis River will be mostly set back significantly from the east side of the channel (there is no levee along the west side of the channel) and will be mostly situated adjacent to I-5. As a result, flooding in the active portion of the existing floodplain on the west side of I-5 under the preferred alternative will be very similar to pre-project flooding (i.e., the spatial extent and depth of flooding will be largely unchanged). The most notable change to flooding along the Chehalis River under the preferred alternative is that flooding will be greatly reduced in the mostly urban areas along the east side of I-5. Most of the areas on the east side of I-5 that have historically flooded from the Chehalis River have generally functioned mostly as backwater storage areas during flood events and have had very*

limited function in terms of providing downstream conveyance of flood flows. As a result, potential increases in peak water levels upstream of Centralia during flood events attributable to lost floodplain storage as a result of the proposed levees would be slight (i.e., generally several inches or less) and would be limited to a relatively short reach of the river. As discussed in the previous response, operation of the Skookumchuck reservoir for flood control purposes will offset any downstream flow increases in the Chehalis River attributable to the proposed levees. The net result of the effects of all components of the preferred alternative will actually be a slight reduction in peak water levels in the Chehalis River downstream of Centralia during flood events.

B. I have long spoken out in favor of land use regulations that prohibit development in the areas that flood frequently. I believe any solution to Chehalis flooding has to incorporate stringent land use restrictions by tribal, county and city government. Local government has to stop using outdated FEMA maps.

C. "No net loss" of flood capacity must become a cornerstone of development in this three county area. However it is done we have to educate planners, developers and builders in the proper mitigation techniques. For example: digging a hole in a floodplain does not mitigate fill in the same floodplain.

D. Item 1 (in the attachment) recites a number of my questions and answers from the Corps of Engineers. Many of these question/answers seem to relate to the economic component of the proposed plan. In short does the county, the operator, or the taxpayer know the real cost of this project -especially when the dam safety issue has not been resolved?

- One has to be concerned that there is no known operator of the proposed dam.
- When will taxpayers learn about the creation of a local flood control district?
- When will taxpayers learn about their real estate tax paid share of the dam operating costs?
- When will taxpayers learn about their real estate tax paid share of levee maintenance costs?

Response: *Costs for operating and maintaining the dam have been included in the costs for the project and the local sponsor is aware of these costs. The costs will be finalized in the project cooperation agreement to be signed by the local sponsor prior to implementation of the project. The county and local cities will be working with communities to form a flood district. The timeline for this is unknown at this time, but will be further addressed during design.*

E. I am not convinced that all the facts are publicly known about the Skookumchuck Dam modifications and dam safety or failure. Even the Draft EIS (Item 2) hides the issue.

- The dam is described (Draft EIS, Skookumchuck Dam Re-operation Report, Appendix B, page 5) as a current capacity of 35,000 acre feet within a 540 acre reservoir at a maximum elevation of 477 feet mean sea level.

- The additional 15 feet of elevation would add an additional 9,000 ac-ft (Draft EIS page 23) or a very significant 25.7"10 increase over the current dam capacity.
- Item 2 and Item 3 (in the attachment) describe the same test scenarios. Item 3 specifically identifies "liquefied soils" and "factor of safety less than 1".
- Item 3 defines a remediation effort that will be 100 percent cost to the current owner and the costs are not NED costs and are not included in the cost estimate for the selected plan.
- It seems that major work remains to be done to identify and correct deficiencies related to structural dam safety. I am concerned that the environmental impact and the economic impact of this issue are not sufficiently documented or known.

Response: *The additional 9,000 acre-feet of storage is within the dam's capacity but above the spillway's capacity. There are current potential dam safety issues that are being reviewed by FERC the regulator of the dam, by the current owner and the Corps. The dam will not be incorporated as part of a federal project until the Corps is satisfied that the dam safety issues have been resolved or mitigated for at the dam. Any costs of dam safety work will be the responsibility of the current owner.*

To summarize, as a "downstreamer" I am very concerned about downstream impact, land use, no let loss of flood capacity and dam safety. I appreciate the opportunity to share these concerns.
<signed> Dave Palmer

Appendix to letter:

Item I: While attending a public Draft EIS meeting (July 9, Chehalis, W A) I submitted a number of questions. I received a response on August 29 from Leslie Kaye, Public Affairs Specialist Seattle District Army Corps of Engineers. These selected questions and answers are reproduced here.

1) What agency will own, operate and manage the dam?

Answer: Local flood control district

2) Who has ultimate authority to operate the dam?

Answer: PacifiCorps owns the dam. They are seeking a buyer an/or agreement to purchase from Lewis County. During times of flooding, the Army Corps reservoir Control Center will regulate the operation of the dam.

5) What is the annual dam maintenance cost?

Answer: The annual operation and maintenance project costs are estimated at \$600,000

6) Is dam maintenance cost budgeted, approved and allocated?

Answer: It is a part of the project costs; the O&M is the responsibility of the dam owner.

7) Is the dam maintenance cost paid by all taxpayers or just those who benefit?

Answer: This would be the responsibility of the flood control district

9) How much will it cost to maintain the levee system? Who pays? Is it budgeted?

Answer: Levee maintenance cost is estimated at \$8,000 per mile/per year. Fifteen miles of levee are planned for the flood reduction in this area. Therefore the approximate cost per year for maintenance would be \$120,000. This would be the responsibility by a local flood district.

10) Who maintains the levee?

Answer: Flood Control District.

11) How is the property for the levee system obtained?

Answer: The Local Sponsor is responsible for acquisition of property and easements; this is part of their local share. However, during construction a Right-of-Entry issued by the Army Corps of Engineers Real Estate Section is distributed to any private or commercial landowner. The property owner then has the choice to allow or not allow the government to access their land to build/construct the levee.

Correction: *Actually, it is during the feasibility or planning and design phases of a project when rights-of-entry are sought from landowners within study areas. Landowner cooperation is voluntary during the study phase and may refuse to grant the county or the Corps permission to conduct investigations on their lands.*

Once the project construction phase begins, the county will begin acquiring project lands. Easements will be sought for levee elements and fee simple interests acquired for mitigation lands. Lewis County will contact affected landowners regarding lands that are needed for the project. The county will then conduct real estate appraisals of necessary lands, and make offers to landowners for purchase of such lands.

12) How much will the levee improvement add to the value of a typical house inside the levee area?

Response: *Detailed amounts or percentages would have to be obtained by the county assessor's office, but generally speaking flood insurance cost will decrease and land value will increase.*

13) Will homes and property in the outside unprotected area be granted a property tax relief?

Response: *This is another question for Lewis County.*

Item 2: "Skookumchuck Dam: The geotechnical studies for Skookumchuck Dam included a site-specific ground motion study due to increased estimations of the seismic risk in the Pacific Northwest. Past seismic studies were evaluated using present state-of-the-art practice and existing literature. A seismic analysis of the dam embankment stability based on dynamic loading methods followed the ground motion study. A soil exploration program was conducted beneath portions of the downstream dam embankment berm to determine liquefaction susceptibility of dam foundation silt and alluvium. An exploratory core-drilling program was conducted to support rock cut slope stability and dewatering." (USACE DEIS July 2002 pg 11)

Item 3: "During original construction of the dam, while stripping the foundation, a deposit of silt north of the original river channel was discovered. The initial exploration programs for the dam

did not reveal the silt layer. An exploration program was undertaken to define the extent and thickness of this silt deposit. A decision during construction of the dam was made to leave the silt layer alone. After 20 to 25 feet of embankment material was placed on the silt layer, there were indications that embankments would become unstable in their original design. It was judged that the silt body could be contained and stabilized by adding massive toe berms where the embankment shells are founded on the silty clay material; these were constructed.

"In the investigations conducted by the Corps in 2001, based on recent seismic information, the study concluded that the sandy gravel soils underlying the silts appear to be liquefiable under all design Maximum Credible Earthquake (MCE) ground motions. In 2001, a similar stability analysis was performed utilizing subsurface explorations, the liquefaction data, and seismic hazard analysis from recent studies. This included evaluation of the existing static and post - seismic stability of the downstream slopes of the dam and berm using a limit-equilibrium approach. The extent of liquefied soils is uncertain beyond the area of investigations with Becker and SPT borings, thus slope failures were calculated for five different ranges of liquefied soils. The calculations indicate a factor-of-safety below 1.0 for conditions where liquefied soils are present from the core to the toe of the downstream berm.

"Currently, FERC is reviewing the information provided by PacifiCorps (the current owner) as required by the regulatory permit for operating a hydroelectric facility and the results of the Corps investigation described in the above paragraph. Based on a May 17th meeting with FERC, the regulatory agency will be issuing a letter to the owner in June 2002 recommending that they conduct further investigations to determine the extent of the liquefiable material. Based on this investigation the owner will be required to conduct remediation to the downstream berm to ensure that the dam meets dam safety requirements in a post seismic event. The current owner prior to the local sponsor taking ownership of the facility will conduct this effort. This remediation effort will be 100 percent cost to the current owner and the costs are not NED costs and are not included in the cost estimate for the selected plan." (USACE DGRR, July 2002, pg 163-164)

Comment 12:

Chehalis River Council
417 North Pearl Street:
Centralia, WA 98531
phone (360) 807-0764
fax (360) 807-0765
email crc@crcwater.org

I am making these comments on behalf of the board of trustees of the Chehalis River Council, a grass-roots, all volunteer environmental organization dedicated to the preservation and conservation of natural resources in the greater Chehalis River Basin. We are concerned about water-related issues in the entire Basin, from the headwaters near Pe Ell to Grays Harbor.

The Chehalis River Council is pleased that we have finally reached a stage in the Flood Reduction Study that has promise of leading to actual construction of at least partial solutions to Lewis County's flooding problems. As a basic position, we agree that the preferred alternative is

the best choice to protect the environment while at the same time providing cost-effective flood protection.

We would have liked to have seen the non-structural methods combined with the levee approach since these would be complementary and contribute to flood stage reduction. The EIS incorrectly states that watershed management and reforestation do not affect flood stage elevations (page 34, Evaluation of Alternative 6, non-structural methods for flood reduction). Improving land cover conditions in the watershed would add storage and attenuate hydrographs, resulting in lower flood levels.

Response: *The DEIS states these measures do not directly affect flood reduction. Any type of watershed management and reforestation will have some type of impact on flood reduction.*

Additional comments and questions on the Draft EIS follow:

Section 2.4, Evaluation of Alternatives, pages 41-48: This section needs a systematic evaluation of how each alternative meets the environmental criteria (criteria 8 -avoid adverse impacts, and criteria 9 -incorporate fish and wildlife habitat creation, enhancement, and restoration), similar to the evaluation table provided for monetary benefits and costs.

Response: *This has been revised in the FEIS.*

Non-structural features of the preferred alternative (page 55): The City of Chehalis ordinances do not appear to prohibit development within the floodway. Would this be addressed as a condition of the project? The text recommends compensatory storage requirements for fill in the floodplain, but ordinances in Centralia and Chehalis allow uncompensated fill in the floodplain fringe. Would this be addressed as a condition of the project?

Response: *The local sponsor is required to develop a floodplain management plan that incorporates the flood damage reduction project, per Executive Order 11988. This management plan has to be completed prior to any construction of the project starting.*

Potential Restoration Sites (page 57): This section lists ideas for restoration sites but does not provide a measure for how much restoration should be done. With no measure of success, it is possible that restoration elements would be the first to be cut if the project budget becomes tight.

Response: *These sites have been evaluated for what habitat they would provide for the cost of constructing them. This evaluation will be utilized to determine the order of constructing them. In addition, the Chehalis Basin Ecosystem Restoration Study will also be considering these sites. Therefore any site that does not get constructed under the flood damage reduction project could be constructed under the ecosystem restoration project.*

Water Quality (page 89): The TMDL section should also mention the Department of Ecology's Fecal Coliform TMDL in Grays Harbor, which identifies the upper Chehalis watershed as a major source of fecal coliform in the Grays Harbor estuary.

Geomorphic Impacts of Skookumchuck Dam modifications (page 174): As the text states, the dam will affect the hydrologic regime of the Skookumchuck River and will have impacts on river geomorphology. These potential impacts need to be defined in more detail so that appropriate mitigation can be defined.

Response: *Based on the review by the Corps Hydrologist the potential impacts to the Skookumchuck River will not change over what they are without the project. In other words the area of impact will be between the dam and the first tributary as it occurs now.*

Ongoing monitoring and evaluation. The plan needs to describe a mechanism for ongoing monitoring and evaluation of flood impacts, both in the project area and downstream. Climate change in the future may lead to a need to reevaluate modeling parameters, and downstream impacts need to be assessed after completion of the project to ensure that the project indeed does not worsen flood conditions in the Rochester/Grand Mound/Oakville area. If there is more downstream impact than expected, there should be provision written into the project for some kind of mitigation.

Response: *In the formulation of the project the future climate is evaluated. The method of doing this is to evaluate the project under a wide variety of flood events (2-year up to 500-year events). This allows us to evaluate the benefits/impacts of the project under a very wide variety of conditions. Therefore a climate change wouldn't necessitate a need to re-evaluate modeling parameters. The primary impact of future climate change from a hydrologic standpoint would be potential changes to the flood-frequency relationship. For example, if future climate change were to cause us to adjust the 100-year peak flow estimate at Grand Mound to 85,000 cfs (as an example), this would still be within the range of flood events that we have already evaluated (our current estimate of the 500-year peak flow at Grand Mound is on the order of 100,000 cfs).*

We appreciate the opportunity to comment on this important project.

<signed>

Margaret Rader
Chair, Board of Trustees,
Chehalis River Council

Comment 13:

United States Department of the Interior
Office of the Secretary
Office of Environmental Policy and Compliance
500 NE Multnomah Street, Suite 356
Portland, Oregon 97232-2036

The Department of the Interior has reviewed the Centralia Flood Damage Reduction Project Draft Environmental Impact Statement (DEIS). We offer the following comments with regard to your agency's proposed project.

Project Description

The proposed project is intended to provide flood hazard protection for I-5 and the cities of Centralia and Chehalis in Lewis County, southwest Washington State. Since 1998, the Western Washington Fish and Wildlife Office (FWS) has been actively involved in planning for this project. Detailed comments were provided to the U.S. Army Corps of Engineers in a draft Fish and Wildlife Coordination Act Report (CAR) dated July 10, 2002.

General Comments

The proposed project includes two major components: 1) a setback levee system and 2) modifications to the operation of Skookumchuck Dam. As described below we support the setback levees, and our support for the modification to the dam is qualified.

With respect to the setback levee system portion of the project, we support the selection of the setback levee as the least environmentally damaging alternative, as summarized in the CAR. This position is based on the fact that the setback levees would primarily be upgrades to existing levees. Where new levees are constructed, they would generally be set back from the river to allow natural floodplain function, and consequently would limit the opportunity for further urban development of the floodplain. With the incorporation of the FWS's recommendations about non-structural measures and mitigation and restoration features, we believe this portion of the recommended plan could result in benefits to fish and wildlife. Our anticipation of beneficial results is tempered, however, by the fact that many details remain to be developed, including design details of the Scheuber Ditch/SR-6 bypass and restoration, a mitigation and monitoring plan for the project, and other issues detailed in the CAR.

With respect to modifications to operation of the Skookumchuck Dam, we have concerns about the potential impacts to channel processes, spawning and rearing habitat and riparian and wetland systems that could occur from alteration of flows in the Skookumchuck River. In certain instances, the DEIS concludes that the effects will be insignificant but provides no supporting evidence for that conclusion. We urge the Corps to take the necessary time to scope and conduct studies for determining impacts in the Skookumchuck Basin and to work with resource agencies and tribes to develop a mitigation and monitoring plan once those impacts have been fully evaluated. Given the uncertainties about impacts in the Skookumchuck River, our support for the dam modification depends upon a defensible demonstration of the insignificance of those impacts or else a high level of mitigation and restoration in that sub basin to offset those uncertainties. We also recommend the Corps demonstrate a strong commitment and financial backing for monitoring and adaptive management.

***Response:** The Corps of Engineers will develop a monitoring plan and use adaptive management for the mitigation area being developed for the proposed project. Additional hydraulic studies of the Skookumchuck River will occur prior to development of the project. Adaptive management will be implemented based on those findings.*

As the Corps enters the Preconstruction Engineering Design phase of planning, we recommend including the FWS, other resource agencies, and the tribes in developing more specific plans and

designs for those project features related to fish and wildlife habitat, including: 1) the re-vegetation projects along the Newaukum and Chehalis Rivers, 2) the Scheuber Ditch/SR-6 bypass and restoration, 3) relocation of Dillenaugh Creek, 4) development of a rule curve for the revised operation of Skookumchuck Dam, and 5) work on new or existing levees adjacent to the river in order to investigate the feasibility of incorporating fish benches, large woody debris, and riparian vegetation. In addition, we note that sizeable impacts to wetlands would occur from the proposed setback levees. We recommend that the Corps work with the resource agencies and tribes to determine how these impacts to wetland area and function can be avoided, minimized and, for unavoidable impacts, compensated. This information should be included in the Final EIS, or potentially in a Supplemental DEIS.

Response: *The Corps will continue to work with the same working group that was heavily involved in the development of this proposed project.*

Specific Comments

We provide the following specific comments about the DEIS. We have provided page numbers for more detailed discussion about certain topics in the CAR.

Page 16. Section 2.1.2. Alternatives Development: The "Alternative Proposed by interagency Committee," also known as the "Alternative Subcommittee alternative," should be described as a sequential process that first looks at non-structural means of reducing the risk of flood hazard and then goes on to evaluate the increase in flood protection from structural measures. We believe it is important to capture this idea. The intent, as we understand it, was to determine environmentally benign ways in which flood risk reduction could take place and apply those measures first. Structural components, which generally have greater impacts, would be added only as needed to provide flood risk reduction necessary for the project.

Response: *The description of Alternative 7 in Section 2.3 emphasizes that "Alternative 7 focused first on reducing flood hazards and increasing floodwater storage through regulatory and voluntary measures. The connectivity of the Chehalis River to its floodplain would be maintained and enhanced using land use and development regulations before implementation of any costly structural solutions...Finally, Alternative 7 included a sequence of actions that required analysis before additional actions would be proposed." The Corps believes that this discussion captures the idea of the sequential process that is the basis of Alternative 7.*

Page 17. Section 2.1.4: The FWS understood that non-structural measures were to be incorporated along with restoration measures in all alternatives. This concept should be stated in this paragraph.

Response: *As noted in the description of Alternative 6 (Non-structural Alternative) in Section 2.3, non-structural flood management measures would be incorporated into any recommended plan; however, they were not a part of all of the original alternatives. Therefore, this paragraph will remain as originally written.*

Page 19. Section 3: Please edit the last sentence for clarity, as the meaning is not clear.

Response: *The sentence will be edited as requested.*

Page 45. Section 2.4. Paragraph 2. Sentence 2: Our understanding is that the moratorium on floodplain development would be incorporated as a mandatory condition of federal assistance, not an optional measure. The Corps and public agencies have undertaken an enormous effort to assess alternatives that will reduce the risk of flood hazard. Meanwhile development and fill of the floodplain has continued unabated, meaning that much of this planning will need to be revisited prior to construction. Our concern as it relates to fish and wildlife is that floodplain development alters hydrology and channel dynamics, reduces floodplain functioning and destroys habitat. We recommend that a moratorium be placed on further development of the floodplain until the new Federal Emergency Management Agency maps, based on a more accurate and current estimation of the extent of flooding, can be adopted by the local jurisdictions. The Final Environmental Impact Statement (FEIS) should capture the discussion that went into the development of this measure, and if the moratorium will not be mandatory, the FEIS should explain why.

Response: *A moratorium on further developments is not within the regulatory jurisdiction of this agency. A discussion will be added to the FEIS regarding a moratorium on development. FEMA is currently moving forward with development of new floodplain mapping that will be more accurate than the current mapping.*

Page 55. Restriction of Fill in the Floodplain: See the comments on page 53 in the CAR. The wording of this requirement needs to be carefully developed to ensure that the intent of this measure is captured. Development and fill of the floodplain in the Chehalis Valley has continually encroached upon the river. Our understanding is that this measure was supposed to promote "no net loss" of floodplain function by mitigating any new fill with removal of fill that was previously placed in the floodplain.

Response: *It is the understanding of the Corps that the current ordinances of the local communities, within the project area, are to promote the no net loss. This is conducted by mitigating any new fill with the removal of fill from the floodplain as stated on page 56 of the DEIS.*

Page 69. Section 3.1. Hydrology and Hydraulics: This section mostly addresses surface water hydrology and flooding, but does not address the relationship between groundwater, flooding, aquifer recharge, hyporheic flows, and base flows. We recommend that the discussion on groundwater recharge on page 170 and 171 be relocated to this section. Also, because many questions have arisen about groundwater movement and the effect of the project on groundwater/aquifer recharge and base flows, we recommend that the conclusions made here be supported by reference.

Response: *Thanks for your suggestion. The Corps believes the locations should remain the same as they work best for this document.*

Page 80. Section 3.2.2.4: Please define the term "core reach," mentioned in the first paragraph.

Response: *The "core reach" refers to the section of the Chehalis between the confluences with the Newuakum and Skookuchuck rivers mentioned in the previous sentence.*

Page 169. Section 4:1.3.2. Long-term Effects: The DEIS states that the preferred alternative will have "relatively little effect on the active floodplain," that it will "generally function" similar to existing conditions, and that the extent of flooding would be only "slightly modified." Given the level of concern raised about these questions, we recommend the Corps quantify the area that would be flooded under various flooding events as compared to existing conditions. It would also be helpful to quantify the area that currently floods that is covered by impervious surfaces.

Response: *The most notable change to flooding within the Chehalis River valley under the preferred alternative would be a reduction in flooding in the mostly urban areas along the east side of I-5. It is estimated that the preferred alternative would eliminate flooding over an area of roughly 2,500 acres in the vicinity of Chehalis and Centralia during a 100-year flood event. Most of this area is highly urbanized land located on the east side of I-5. A large percentage of this area is covered by impervious surfaces (i.e., roads, parking lots, buildings, etc.). Additionally, most of the areas on the east side of I-5 that have historically flooded from the Chehalis River have generally functioned mostly as backwater storage areas during flood events and have had very limited function in terms of providing downstream conveyance of flood flows. Because most of the active floodplain will be unaltered by the project, use of set back levees to eliminate flooding in the mostly urban areas outside of the active floodplain will have only a slight impact (generally several inches or less) on flood stages within the active floodplain. Furthermore, operation of the Skookumchuck reservoir for flood control purposes will provide up to 20,000 acre-feet of flood storage that will offset the loss of flood storage attributable to the proposed levees and will hence offset any downstream peak water surface increases attributable to the proposed levees. The net result of the effects of all components of the project will actually be a net increase in flood storage resulting in a slight reduction in peak water levels in the Chehalis River downstream of Centralia during flood events.*

Page 171: Virtually eliminating overbank flooding could have much more serious environmental consequences than implied here (please see the CAR page 22-24 and 54-55). The CAR recommends geomorphology and sediment studies to help quantify impacts so that an appropriate level of mitigation may be developed. Apparently these studies would have been difficult, if not impossible to accomplish, given the goal of obtaining Water Resources Development Act (WRDA) 2002 funding. We now understand that WRDA 2002 funding may no longer be a reasonable goal, and we urge the Corps to begin scoping these studies as soon as possible. If these studies are not done to provide greater certainty about the potential impacts, then our support for the dam modification will depend upon a much higher level of mitigation and restoration in the Skookumchuck sub-basin to cover those uncertainties. With or without the studies, an appropriate mitigation and monitoring plan should be developed in coordination with the resource agencies and tribes, for potential impacts to channel processes, in-channel habitat, wetlands, and loss of riparian or wetland function due to alteration of flows.

Response: *The Corps is still on schedule to complete this study for a WRDA 2002 authorization. The Corps is planning to conduct additional studies during design to assist in finalizing the re-*

operation plan for Skookumchuck Dam. This additional work as with the design of the project will be coordinated with the resource agencies and tribes to ensure that all impacts are minimized to the maximum extent practical.

Page 174. Section 4.2.3: The discussion refers to "rapid" ramping rates (i.e., 95 cfs up to 3,000 cfs) as the dam is operated for flood reduction. We are assuming that the actual rates are consistent with the fishery agreement and are not exceeding the rates presented in Appendix A of the DEIS. Please clarify in the Final EIS whether this is the case and how ramping rates protective of fisheries would be handled during flood season.

Response: *All ramping rates will be based on fisheries requirements except in a catastrophic event.*

Page 175. Section 4.2.4. Summary: The summary states there will be "no net loss in flushing flows or increase in flood duration" from revised operation of the Skookumchuck Dam. These conclusions don't appear to be supported by the discussion in the DEIS. As discussed in the CAR, page 54-55, a sediment effectiveness analysis, or similar study, would be valuable in determining the flows at which channel maintenance occurs presently in this system. A conclusion regarding the degree to which channel maintenance would be affected by the flow characteristics resulting from the proposed alternative would be much more supportable with that information at hand.

Response: *Flow operations from Skookumchuck Dam during non-flood events will be similar to the operation that is in place today. Except for flood events, post-project outflows should continue to follow historic outflows as recorded by the Bloody Run gage located slightly downstream of the dam (Table 1). In the absence of a flood, Skookumchuck Dam is expected to operate for the benefit of both PacifiCorp and the natural resources of the River (see Table 2). However in the existing operations guidance, not all areas of routine operation are clearly described. For instance, there is little discussion of proper ramping rates. The WDFW/PacifiCorp agreement of May 1998 simply states: "Flow reductions under this Agreement shall be accomplished in a manner that minimizes the stranding of juvenile fish". Specific criteria were not provided initially because the bypass reach between the dam and its hydropower unit was so short and no other opportunities to significantly modify flows existed at the dam. With the installation of flood control capability however, large changes in river stage will become possible.*

The Bloody Run gage shows wide flow variations through the years. In general, daily discharge trends show flow increasing from a low of about 100 cfs in the late summer (August) to a mean monthly flow in January and February around or exceeding 1,000 cfs. This pattern can vary widely by year although the summer month regimes are quite consistent.

Page 217. Section 4.8.3.1. Centralia Area. Paragraph 2: Our understanding is that levees will not be placed anywhere west of the Chehalis River. This paragraph contradicts that understanding. Please explain if this is a new design feature or delete, if this is an error. This element is not shown on the map of levee alignments and should be indicated there.

Response: *Your understanding is correct. This was a typographical error that will be corrected. The sentence should read: "Levees would be placed west of I-5 in low-density residential lands..."*

Page 257. Section 6.1.5. Fish and Wildlife Coordination Act: Please clarify that the FWS sent you a draft CAR. Section 2(b) of the Fish and Wildlife Coordination Act is not fulfilled until the final CAR is received.

Response: *Changed to read as above.*

Thank you for the opportunity to comment on this document. We look forward to working closely with your agency and providing you with the best possible recommendations and analyses required to complete the final document. For information or questions, please contact Lou Ellyn Jones at (360) 753-5822 or Lynn Childers at (360) 753-5831, at our Western Washington Fish and Wildlife Office in Lacey, Washington.

<signed>
Preston Sleeper
Regional Environmental Officer

Comment 14:
Curtis Du Puis
PO Box 184
Centralia, WA 98531-0184
Home: 360.273.8685
Email: curtisdupuis80@hotmail.com

Executive Summary Page V, ...For levee alignments ...at Ground Mound the peak flood stage would decrease 0.2 foot. Between Grand Mound and Porter, the peak flood stage decrease would vary from as much as 0.39 foot to as little as 0.06 foot.

At the Grand Mound flood gauge, using the 1996 flood data, please compare the volume of floodwater passing through the gauge before and after the levee alignment project.

Is the total volume of floodwater after the levee alignment equal, less than or greater than the total floodwater volume of 1996?

Please chart the timeline and floodwater volume comparing the 1996 flood as it occurred compared to the impact of the proposed levee alignment.

Your assumptions can include the following:

Only the levee alignment has occurred; and

That the Skookumchuck improvements and the levee alignment has occurred

Response: The overall volume of floodwater passing this gage during a specific flood event would be the same for both pre-project and post-project conditions. Based on the combined effects of all components of the project, the preferred alternative would cause a shift in the timing of the flood event by slightly reducing the peak of the flood event at the Grand Mound gage and slightly increasing flows at Grand Mound during the falling limb of the hydrograph (i.e., period of hydrograph recession). Most of this shift is attributable to the use of the Skookumchuck reservoir for temporary flood storage. Because floodwater would be released from the reservoir following the downstream flood peak, the overall volume of the flood hydrograph would be unchanged. This temporal shift in the hydrograph would also occur during a flood event similar to the February 1996 flood.

After the floodwater passes through the Grand Mound flood gauge, where do you anticipate the floodwater will pond?

Will this project result in a longer duration of flooding and a higher level of flooding in the ponding area?

Response: As noted in the previous response, the proposed project will have little impact to flooding along the Chehalis River downstream of Centralia other than a relatively minor temporal shift in the flood hydrograph. The temporal shift will cause a slight reduction in the downstream flood peak and a slight increase in the falling limb of the hydrograph. Downstream increases in the falling limb of the hydrograph, which would be attributable to the release of stored floodwater in the Skookumchuck reservoir, would be made such that any natural downstream flooding is not worsened. As a result, the spatial extent of flooding downstream of Grand Mound should be virtually unchanged by the proposed project. Specifically, the project would likely result in a slightly lower level of flooding along the Chehalis River downstream of Centralia (i.e., a lowering of the peak flood stage on the order of about a tenth of a foot). Release of stored floodwater in the Skookumchuck reservoir following the flood peak may cause a slightly higher duration of near bank-full conditions in the Chehalis River downstream of Centralia but should not increase the duration of downstream flooding.

If the Chehalis Indian Reservation flood ponding area is flooded earlier (perhaps closing the reservation access roads) or at a higher level (causing damage to existing structures) because of the levee alignment:

How does the Corps propose to mitigate the impact?

Do you have a statutory obligation to mitigate the impact?

Response: The preferred alternative, which includes multiple features (new levees, SR-6 bypass feature, improved flood control at Skookumchuck reservoir), will not cause areas in the vicinity of the Chehalis tribal lands to flood earlier or flood at a higher level relative to existing (pre-project) conditions.

Introduction, page 1: Figure 1.1 (page 2) shows the inundation within the project area during the 100-year flood:

What year is the date of the flood map?

Response: *This figure is based on a hypothetical 100-year flood event in the Chehalis River, which was derived based on a statistical analysis of multiple stream flow records collected in the Chehalis River basin. It should be noted that the hypothetical flood event was calibrated to a 70-year record of stream flow data collected in the Chehalis River at Grand Mound. A recent statistical analysis of these data suggests that the 100-year peak discharge in the Chehalis River at Grand Mound is about 74,500 cfs. The peak of the hypothetical 100-year flood is also about 74,500 cfs.*

Introduction, page 5, 1.4 Study Area. After the floodwater leave the Centralia -Chehalis area, the water seems to pond within and near the boundaries of the Chehalis Indian Reservation.

Why do you not include the Chehalis Indian Reservation in the Study Area?

Response: *The Chehalis Indian Reservation is not within the scope of the project.*

Alternative 3, Page 25, Centralia Overbank Excavation: This would involve excavation of approximately 2.4 million cubic yards of material...

Where will this fill be deposited?

Response: *Overbank excavation will not be part of the project.*

Alternative 7 -Interagency Committee Alternative: Measure 1 -Moratorium on Floodplain Development (page 36). In the interim, a moratorium on floodplain development would be implemented...

Within the existing FEMA (1992?) floodplain map, Lewis County, the cities of Centralia and Chehalis have never ceased development in the floodplain; how do you proposed these entities t will implement a moratorium of development in the newly designated floodplain?

Response: *In order to implement the Corps project following authorization, the local sponsor must commit to a post-project floodplain management plan that is in compliance with NFIP and federal regulations regarding development in the floodplain. If Alternative 7 were to be carried forward as the preferred alternative, a temporary moratorium would be a part of the new management plan. (However, it should be noted that NFIP does not require such a moratorium to be in placed until new floodplain maps are adopted.) A moratorium could be adopted through legislative action of the city councils and county commissions.*

2 Preferred Alternative, 2.5.1 Setback levees, page 48: ...Large areas of the floodplain that are not developed would not be protected, so construction of the levee system would not encourage new floodplain development.

In spite of the existing FEMA floodplain (1992?) map, K-Mart, Wal-Mart, new Centralia waste treatment plant, and the Chehalis Burger King are all located in the floodplain, so how will this statement be honored by Lewis County and the cities of Centralia and Chehalis?

Response: *In order to implement the Corps project following authorization, the local sponsor must commit to a post-project floodplain management plan that is in compliance with NFIP and Executive Order 11988. Executive Order 11988 is intended to avoid to the extent possible the long- and short-term adverse impacts associated with occupancy and modification of floodplains and to avoid direct and indirect support of floodplain development wherever there is a practicable alternative. It should be noted that the Corps' study team conducted a thorough review of county and city floodplain regulations and their enforcement and found that all local jurisdictions are in compliance with federal NFIP and state floodplain regulations.*

2.5.3 Non-Structural Features. Define a new 100-year FEMA Floodplain: A new 100-year floodplain map will be generated... The communities will adopt this map.

Is there a projected date for this map to be adopted?
<signed>

Response: *There is no specific projected date for adoption of a new 100-year FEMA floodplain map. FEMA is planning on starting the process for remapping prior to the construction of the project and then undertaking additional mapping when construction of the project begins. In addition, Lewis County and the other local jurisdictions are committed to using the best available information in the administration of local floodplain development ordinances, and the hydraulic modeling completed in the course of this project may allow Lewis County to become a Cooperating Technical Partner with FEMA. This could facilitate reconciliation of FEMA flood maps with "best available" flood information for the existing condition and would allow the local jurisdictions to begin using the new information in regulating land uses in the area. It would also set the stage for adoption of new FEMA flood maps in digital format.*

Comment 15:

R.C. Jacobson
7300 Prather Rd. SW
Centralia, WA, 98531

Since the enclosed "Study Area Location" map indicates my ranch along the west side of the Chehalis River is within the study area I am vitally concerned about the risks of the preferred alternative.

In 1989 the Thurston County Engineering Dept. eliminated a 360-foot floodway adjacent to the Prather Road bridge reconstruction and replaced the floodway with 2 8ft culverts. These culverts did not carry the overflow volume of the 1990 flood and the road embankment was sanctioned by a change in the F.E.M.A. floodway map in response to the Thurston County Engineers Request.

The road embankment was constructed in Jan 1990 as originally designed and was again washed into the downstream field during the 1996 flood. The road embankment was again reconstructed with the addition of Gabion's on each side.

The Thurston County Engineer was advised by me and others that 2 8-foot culverts were inadequate, prior to construction in 1988, to replace a 360-foot floodway bridge to no avail.

The subsequent damage to my ranch and the riverbank on the west side of the river down stream was severe. These effects were caused by a change in the flow of water beneath the bridge resulting in flood whirlpools traveling downstream along the banks of the river and under-mining the bank and trees. This seriously reduced shading and fish habitat for about 3,000 feet of the west bank in addition to the removal of about 2 acres of farmland.

The Prather Road bridge is presently a stream flow restrictor similar to the Mellon Street bridge in Centralia. These restrictors are dramatically illustrated by the WSDOT aerial photos of the 1990 and 1996 floods.

The preferred alternative appears to satisfy criteria 1 and 2, which suffer the major financial impact during a major flood event. However, it appears by logical deduction that a restriction of the flood storage area in the Centralia and Chehalis cities will raise the elevation of floodwaters and therefore the velocity of the floodwaters in downstream Chehalis River areas. While the Skookumchuck Dam modifications will reduce the volume of floodwater from that watershed, a significant part of that basin is downstream of the dam and rainfall in this area will not be restrained.

Page 170 of the Draft E.I.S., in the second paragraph, my conclusions are supported by the statement "The peak flood stage would increase between RM 70.74 and 78." However, a following statement "The 100-year peak flood stage would decrease by 0.18 foot at the Galvin Road bridge and by 0.24 foot at Grand Mound," has no supporting evidence and defies logic. Other statements say a study of this effect was made but no supporting data was indicated.

Response: *The text on Page 170 of the Draft EIS that characterizes the reach of the Chehalis River that would experience slightly higher flood stages as a result of the preferred alternative is unfortunately in error. The increases in the peak Chehalis River stage as a result of the preferred alternative would be limited to the reach between roughly RM (river mile) 70.9 to 74.1. Furthermore, the maximum increase in peak flood stage during a 100-year flood event would be about 0.5 foot (not 0.61 foot as stated in the DEIS) near RM 72.8.*

The issue of potential impacts of the preferred alternative to reaches of the Chehalis River downstream of the project area (i.e., downstream of Centralia) has been studied extensively. In particular, the hydraulic model used to evaluate the Chehalis River in the vicinity of the project area was extended to reaches of the river downstream of Centralia to evaluate potential downstream impacts. While it is true that the addition of levees along the Chehalis River has the potential to cause slight (i.e., up to 0.5 foot) increases in peak water levels in the Chehalis River along a limited reach upstream of Centralia during large flood events, any potential effects of the levees on peak water levels downstream of Centralia will be offset by proposed flood control

operations at Skookumchuck Dam. In particular, modifications to Skookumchuck Dam proposed as part of the preferred alternative will allow the Skookumchuck reservoir to be operated for flood control purposes. As a result, reduced flows in the lower Skookumchuck River as a result of flood control operations at the reservoir will offset any flow increases in the Chehalis River downstream of Centralia that are attributable to the proposed levees. The net result of the effects of all components of the preferred alternative will actually be a slight reduction in peak water levels in the Chehalis River downstream of Centralia during flood events.

Having observed the flood events over the past 28 years at the Grand Mound Gaging Station, which is situated on my ranch, I am concerned about increased velocity and elevation of these flood events, which cause damage to my ranch and many other downstream properties. These increased velocity and elevation floods have indicated that the Chehalis River will probably change course and relocate its streambed. Such a course change will have devastating consequences to private and public property downstream without additional solutions and modifications to the present river channel.

One modification is the re-establishment of the floodway east of the Prather Road bridge.

Other comments are:

1. The SR-6 floodwater storage area of 170+ acres appears inadequate to compensate for the reduced floodwater storage area around Chehalis and Centralia.

***Response:** The purpose of this site is first to provide habitat mitigation. This feature also reduces water levels in the Chehalis area.*

2. Notwithstanding the comments on pages 171 and 172 concerning hydraulic modeling and bank erosion, I disagree based on 28 years of observations.

<signed>

<graphic attached>

Comment 16:

Dale R. Rancour
Thurston County Engineer
2404-A Heritage Ct. SW
Olympia, WA 98502

Due to the short time for review of this document, I have not had the opportunity to coordinate this response with my colleagues in Thurston County. The following is my response as Thurston County Engineer of Roads and Transportation Services based primarily on past comments by Thurston County officials.

I support the need to study the reduction of flood hazards to the cities of Centralia and Chehalis and the adjacent urban area; and to improve fish and wildlife habitat where possible and

appropriate. I have great concerns and a great need to be an active participant because of the possible project elements and impacts in our county.

My following comments are based on the public information meeting held on January 27, 1999 in the Town of Bucoda, and the attached letter dated February 4, 1999 from the Town of Bucoda.

While flooding is a major concern of the town and the county, so is erosion. While the town has taken steps to elevate buildings to address flooding concerns, I still have concerns that the Skookumchuck Dam flood control plan may result in longer and more frequent river flows filling the main channel and increasing bank erosion. The floods of 1990 and 1996 caused considerable riverbank erosion, which left the banks sensitive to higher flows.

***Response:** The flood control plan will not increase the frequency of bank-full flows downstream of the dam (this includes the reach at Bucoda). One of the primary goals of the proposed Skookumchuck Dam flood control plan will be to limit damaging (i.e., damaging to property and infrastructure) flood events downstream of the dam. The project will therefore be operated to limit channel overtopping events in critical areas when feasible. For instance, during smaller flood events that currently cause some channel overtopping and damage, the Skookumchuck Dam would likely provide sufficient flood protection to prevent damaging flooding along the downstream Skookumchuck River. In this scenario flows may reach bank-full conditions but wouldn't exceed bank-full conditions in critical reaches vulnerable to flood damage. During larger flood events, the Skookumchuck Dam would reduce downstream peak flows relative to current conditions but may not be able to eliminate downstream flooding (in this scenario there may be sufficient unregulated runoff entering the Skookumchuck River downstream of the dam to cause flooding). As a result, downstream reaches may still flood during large flood events but the extent of flooding (spatial extent and depth) would be less relative to current conditions. In summary, the flood control plan would likely result in a similar frequency of bank-full events along the Skookumchuck River relative to current conditions. The flood control plan would result in a lower frequency of damaging, channel over-topping events relative to current conditions.*

Except for vague statements such as the following on page 15, the report does not address erosion concerns: "Sediment sampling and analysis was performed to evaluate the impact of alternative projects on the sediment regime and to develop potential project operation and maintenance costs. A probabilistic risk and uncertainty analysis was performed for the selected project to help determine the recommended plan."

In answer to questions from the resource agencies, about channel stability of the Skookumchuck River, the report (on page 103) acknowledges that additional evaluation of the alternative 2404-An impact on environmental resources would be needed. Will this evaluation address the concerns of the Town of Bucoda? Does the reference to "downstream environmental requirements related to reservoir operation and flood control regulation will continue to be a part of the operation plan" on page 149, mean that the river channel stability costs will be paid by the local agencies? If so, I don't agree.

***Response:** The reference on page 103 documented initial screening of the alternatives; further evaluation of the alternatives impact was conducted and is documented in the EIS. This will be*

further clarified in the final GRR. As far as the Town of Bucoda's concerns, they will be further evaluated during the design and finalization of the dam re-operation plan. Referencing page 149, this discussion was describing the current summer low flow environmental requirements and not any addition channel stability requirements.

In addition to erosion concerns regarding the dam modifications, here are some other comments:

1. Skookumchuck Dam stability evaluation. It is my understanding that the current owner is responsible for remediation of existing safety needs. Assuming these repairs are made, will the dam be suitable for the proposed flood flow modifications?

Response: *Yes, if the dam stability remediation is completed, the dam will be suitable for the flood control modifications.*

2. What are the environmental impacts and mitigation for raising the dam reservoir? The only project environmental mitigation features I have found in the report are on page 149 in the vicinity of State Route 6 and the Scheuber Drainage Ditch. Are these intended mitigations for the dam modifications? Are these sufficient mitigations?

Response: *Based on the current configuration of the dam the typical maximum annual reservoir elevation is about 477 feet. This elevation is largely controlled by the current crest elevation of the spillway (spillway crest elev. is 477 feet). Because the current spillway does not have control gates, discharge through the spillway is essentially uncontrolled. This means that once the reservoir fills in the fall and reaches the spillway crest inflows into the reservoir are generally passed with little attenuation over the spillway and into the downstream reach of the river. As a result, the reservoir elevation is generally maintained at a constant elevation of roughly 477 feet during most of the typical flood season (i.e., late October through March).*

The proposed flood control project will include modifications to Skookumchuck Dam to better utilize the reservoir for flood control purposes. Modifications mostly consist of adding a gated outlet tunnel to allow better control of reservoir discharges and modifying the current spillway to allow storage in the reservoir to a maximum elevation of 492 feet when needed. From an operational sense the biggest change in reservoir operations will be a lowering of the reservoir at the onset of the flood season to about elevation 455 feet to create available storage space in the reservoir in the event of a flood. Under most circumstances the reservoir will be maintained at an elevation of about 455 feet throughout the flood season. The reservoir will typically exceed elevation 455 feet only during flood control operations when the reservoir is used to store high inflows. The maximum pool elevation reached during a flood control operation will be dependent on the flood event. During most flood events water would be stored to a maximum elevation of about 477 feet or less. Only during very large (and infrequent) flood events would the maximum reservoir elevation exceed 477 feet. Only under very rare and extreme floods would the reservoir reach an elevation of 492 feet. Furthermore, it is important to note that most flood control operations only last several days. As such, water stored in the reservoir above elevation 455 feet would be evacuated from the reservoir as soon as the downstream flood threat is diminished. As a result, the flood control project would result in a lower reservoir elevation during the flood season relative to current operations under most conditions. In other words,

while the current operation results in a typical reservoir elevation of 477 feet between November and March, the proposed operation would result in a typical reservoir elevation of 455 feet during this period. The proposed plan would result in only infrequent reservoir elevations greater than 455 feet, with elevations greater than 477 feet occurring rarely. This proposed operation actually results in a decreased downstream dam-break risk since the typical flood season reservoir contents will be less relative to current operations.

Regarding the possibility of a dam-failure flood entering the Scatter Creek basin, please note that the current operator of the project (PacifiCorp) is required by FERC to maintain an Emergency Action Plan (EAP) for this project. One of the primary functions of an EAP is to address potential dam failure scenarios and provide inundation mapping for a catastrophic dam failure scenario. Please refer to the inundation mapping in PacifiCorp's EAP for the Skookumchuck Dam as this should show whether a dam-break flood has the potential to enter the Scatter Creek basin.

The mitigation at present is sufficient for the proposed project. If future studies indicate additional mitigation is required that area will be addressed at that time.

3. Is there an increased need for more emergency warning systems with the raising of the dam?

Response: *The dam will not be raised. Modifications to the dam do not include raising the structure, but allowing for additional storage in the reservoir. Additional emergency warning system is not deemed necessary.*

4. What are the impacts of wider flows from a potential dam failure? Would these flows spread to the Scatter Creek Basin?

The report is unclear on the project impacts downstream of Centralia for the selected plan. Do the levee and Skookumchuck Dam modifications discussed on page 94 relate to the selected plan? Relative to downstream of Centralia, would levels likely be lower relative to the peak stages under existing conditions? Is this for all flood events? Some of this area floods under relatively minor flood events.

Response: *The proposed project would not lead to increased flood stages along the Chehalis River downstream of Centralia. Hydraulic modeling indicates that the combined effect of all components of the project will lead to a slight reduction (on the order of several tenths of a foot) in the peak flood stage in the Chehalis River downstream of Centralia relative to existing (pre-project) conditions.*

Are there any adverse maintenance and operations for the selected plan due to sediment or erosion downstream of Centralia? On page 15 it is noted that a sediment sampling and analysis was performed.

Response: *The sediment study referred to on page 15 of the DGRR is referring to a study conducted on the Chehalis River. This study showed that the selected plan would have little to no impact on addition erosion or sediment transport.*

I will refer Institutional Studies on page 18 to our legal staff. It is my understanding that Thurston County still has authority over anything that impacts them financially or regulatory. If my understanding is correct, "Thurston County Regulations" needs to be added under the column "Law/Regulations/Treaty" of Table 6-4, Status of Compliance With Environmental Laws/Regulation/Treaties on page 169.

Response: *This will be corrected in the FGRR*

I am unclear on the selected plan impacts to Coffee Creek. This is a flat gradient creek from its outlet to the Skookumchuck River, which is also close to the Chehalis River.

Response: *There is some backwater effect into Coffee Creek; for this reason the plan does have levee wall protection. There is no additional protection from flooding resulting from Coffee Creek.*

If the Corps develops a monitoring and adaptive management plan as recommended by some of the services, these costs should be part of the overall construction project and not passed on to the local agencies.

Response: *The operation and maintenance costs are a part of the overall project costs, but these costs are the responsibility of the local sponsor.*

Thurston County Development Services Department will want to participate in any mitigation plans relative to impacts in Thurston County. These mitigation plans need to be part of the construction project.

Response: *The Corps will continue to coordinate with Thurston County during the design of the project.*

Thanks for the work and opportunity to review. If you have any questions, please feel free to call me at (360) 786-5134.

<signed>

Dale R. Rancour, PE
County Engineer

ORAL COMMENTS FROM AUG 22, 2002 PUBLIC MEETING¹

MR. CARNS: Summary: Mr. Carns, on behalf of State Senator Zarelli, made a comment expressing his interest in finding solutions to the flooding problems in Lewis County.

Response: We appreciate State Senator Zarelli's interest in this project.

MR. LOTTO: Good evening, Corps representatives. My name is Bill Lotto with the Lewis County Economic Development Council. We are not surprisingly vitally interested in this project and seeing progress made on this project. I think for decades and decades the emphasis has been far too heavily on process, not product. I think we're moving quickly to the point where we would really need and want to see product or outcomes.

Two things that we would really encourage you to go back and take a serious look at that I think that the Economic Development Council thinks are probably missing today, and that is all of the discussion in support for widening the Mellen Street to expand the floodway improvements through that area; and, second, to ensure that we go with the maximum possible, highest possible level in regards to the Skookumchuck Dam improvement.

Response: Skookumchuck Dam at 20,000 acre-feet storage capacity is a part of the recommended locally preferred plan. The Corps evaluated the widening near Mellon St. to create a bypass. During the evaluation process this alternative was found to be economically unjustified for cost-sharing by the Federal government, and is not part of the plan recommended to Congress. In addition, several environmental issues regarding this action could not be addressed during the study.

MR. CAMPBELL: My name is Dave Campbell. I'm with the City of Chehalis, the position of City Manager.

We are pleased with the proposed project as far as it goes right now. We've been a partner with Lewis County, Lewis County being the local lead agency or local sponsor for this project, and we want to continue in that role of partnering with the County and plan to as this project hopefully does go forward.

We would like to see more consideration given to the higher dam alternative, or the Skookumchuck. We believe that is important, not so much for the local area, but for more benefit downstream, and there have been agencies and others downstream that have been supportive of this project, and we'd like to see their needs and concerns addressed. And also the Mellen Street bypass in the vicinity of the Mellen Street bridge is certainly important to the city of Chehalis, as

¹ Some comments have been edited to include main points. Several comments were also submitted as formal written comments, which are presented earlier in this chapter.

it affects upstream reduction of flooding levels. So those two aspects of the project are something that we'd like to see continued as available for further study and consideration; we think they're important.

***Response:** Skookumchuck Dam at 20,000 acre-feet storage capacity is a part of the recommended locally preferred plan. The Corps evaluated the widening near Mellon St. to create a bypass. During the evaluation process this alternative was found to be economically unjustified for cost-sharing by the Federal government, and is not part of the plan recommended to Congress. In addition, several environmental issues regarding this action could not be addressed during the study.*

MR. HUBBERT: My name is Buck Hubbert. I'm president of Tires, Inc., in Chehalis and also I'm on the Industrial Commission. I was on the original Flood Action Council in 1996. Our business on State Street exit at 79 had six feet of water in the 1990 flood, and we had nine feet in the total corporation in the retread plants in '96. We can't stand anymore of this. Our business suffers gravely by it, everything we're involved with in the area; if we don't do something here, we're going to just go out of business.

The flood project as it's written looks promising. The reduction project looks like it will work. If it worked for the best interests of anybody, then you believe it will have the less impact. There are other problems in the area that we need to address, but we think that the thing that should be added was, again, like what Bill Lotto and Dave said, is that the Skookumchuck should be to the maximum height in case of the worst events we could have.

And the other thing is Mellen Street, to keep the water from backing up on us in this area and further south. If we could get that done, we just think this would be great, and we'd like to get started on it. All the meetings, all the people I meet with, the only thing that's going to happen is to get it going, and some of the good things will happen to the area. And we will have the money from our budgets for more business.

***Response:** The proposed plan does included 20,000 acre feet of storage for the Skookumchuck dam. As addressed in comments by Mr. Lotto and Mr. Campbell, the Corps evaluated the widening near Mellon St. to create a bypass, but found it to be economically unjustified and raised too many environmental issues.*

MR. GREEN: My name is Judy Green. I'm also a resident of the Newaukum River. Our farm has been flooded in '91 and '96, and my question is to the Army Corps of Engineers. Has there been a study on what impact the changes made on the Chehalis River will have on the backup and flooding of the Newaukum River? Have the hundreds of thousands of yards of fill put in the last five years at Exit 72 area been included in any such studies? And that is including today because there have been hundreds of thousands of yards put in on the west side of the freeway this past year.

Did your new floodplain map also mention that Exit 72 was closed in '91 and '96?

***Response:** See written comments section. The comment by Ms. Spencer pertains to this.*

MS. FIELDS: My name is Gusty Fields, and I've been living in North Centralia and living in this area on and off since 1971.

Ever since we've ever been in North Centralia, whenever there's been any type of flooding, we have always been landlocked one way or the other, so even though the water hasn't impacted our own land or house, we couldn't get out, and neither could our neighbors, and I am seriously concerned about the landfill problems the last gentleman spoke of, too, because it seems like it hasn't helped.

So whatever comes up and whatever you all do about it, keep that in mind that the north end usually suffers water and usually up by Carson. I'm also concerned about what happens in China Creek because that seems to impact the downtown area. So think about this before you all do it.

Response: We appreciate your comments and will consider them through our process.

MS. POWE: Julie Powe. I have several comments. I haven't been involved in this as long as some people, but over the last couple of years, we did some serious consideration on this. I really have to say in the end I do not feel that the dike system is the right system.

I also disagree with the wetland. There's talk about taking a section of wetland out, but they're replacing it with wetland along the Highway 6. I disagree with it also, where the wetlands are right now is wetland, always been wetland. The only thing taking that wetland's benefit would be some more large businesses moving in and filling it up and building something. They're taking prime farmland out of circulation by putting the wetland right in the center of it.

And I also wanted to agree about the fill. The fill is -- I still see filling in the storm area, and, again, that has to stop. We need to fix it from the bottom up, and the dike here is not the answer.

Response: We would also like to state that wetlands have immense environmental benefits, as well as improving the flood capacity. See response to Mr. Campbell's comment about the Mellon St. bypass earlier in this section.

MR. CALKINS: I'm Terry Calkins. I'm the Community Development Director of the City of Centralia. Centralia also suffers with substantial flooding problems in her downtown area on China Creek. We've talked extensively about the issue with the Corps. They're all part alternatives for flood control and have been identified and would like to encourage the Corps, if there is a federal interest, to continue participating with the China Creek Project and address the environmental issues at an appropriate time.

I don't see much -- I have yet to find references to China Creek in the Environmental Impact Statement. If they're not there, I would like those added to the document to make sure that there is the appropriate references. Centralia, again, concurred with the Flood Project Executive Committee that the preferred alternative for our community was a conveyance way alternative, which is a combination of alternative 2 and 3. We understand why the Corps has chosen the levee alternatives, but we do believe that some portions of the conveyance way alternative

should be implemented, including the Mellen Street bypass alternative in conjunction with the reservoir alternative.

Response: China Creek discussion is included in the GRR document and will be looked at further to determine federal interest in finding a remedy for the flooding caused by China Creek. The Mellon St. bypass is not recommended on account of the environmental impact and the lack of economic support.

EPA'S DETAILED COMMENTS TO THE CORPS

The objective of this flood damage reduction project is to reduce flooding along the mainstem of the Chehalis and major tributaries (the Skookumchuck and Newaukum rivers) within the vicinity of the cities of Chehalis and Centralia with the goal to protect flood prone areas and to incorporate appropriate fish and wildlife habitat restoration and protection.

Purpose and Need Statement Additions

Unified Federal Policy (UFP) and Environmental Sustainability

The Purpose and Need Statement's (Statement) goals and objectives should incorporate the UFP and environmental sustainability. We recommend that the goals and objectives describe other issues that need to be resolved as part of a successful solution to problems occurring within the project area. Issues that will be addressed by the Flood Damage Reduction Project (Project) should go beyond reducing flood hazard and improving habitat issues identified in the Project purpose. The goals and objectives of the Project should support sustainability at the watershed level.

As a fellow federal signatory to the UFP, we recommend that the Corps address and integrate the goals and objectives of the UFP into the Final Environmental Impact Statement (FEIS). Along with six other federal agencies, both the Corps and EPA signed in 2000 the UFP on Watershed Management. The UFP has two goals: "(1) Use a watershed approach to prevent and reduce pollution of surface and groundwaters resulting from Federal land and resource management activities; and (2) Accomplish this in a unified and cost-effective manner."

Since the UFP addresses adaptive management, best management practices, and a watershed approach, it can be used as a model for managing resources at a broad sub-basin scale. The proposed floodplain project area encompasses a critical sub-basin within the Chehalis watershed, namely, the middle segments of the Chehalis system's floodplain and tributaries along the mainstem from RM 88.3 downstream to RM 60.0 near Grand Mound. In light of the prevalence of impaired water bodies in the project area due to water quality pollution (primary parameters being temperature, fecal coliform, and sediment), we suggest that the Corps consider this project area from a sub-basin perspective to improve prescriptive elements within the FEIS to address Clean Water Act concerns.

In memorandums and discussions during 2001 and 2002 between EPA's Office of Federal Activities and the Corps's Office of Wetlands, both agencies have acknowledged the importance of interagency support and collaboration on environmental sustainability for civil works projects which focuses on maintaining "a healthy, diverse and sustainable condition to life" (memorandum of June 2002). We acknowledge the Corps' positive planning efforts since the proposed Centralia Flood Damage Reduction Project will support ecosystem restoration projects. These efforts are in the spirit and direction of the memorandum. However, in reviewing the

DEIS, efforts to address environmental sustainability are not apparent and need to be more clearly stated. EPA further encourages the Corps to disclose in the FEIS action elements that will restore riparian and floodplain functions and processes and reduce water pollution issues within the project area, such as non-structural floodplain modifications.

Response: The Corps is already using the goals and objectives of the UFP. Although the exact wordage UFP is not mentioned in the DEIS the goals and objectives are being met throughout this proposed project. The Corps is and will continue to use consistent and scientific approaches to manage the federal lands and resources to assess, protect and restore wetlands within the project area. In good faith to the guidelines of the UFP a working group was formed from tribal, federal, state, and local governments to develop restoration sites and provide input on the preferred alternative decision process. To ensure that UFP objectives are met during the construction of the proposed project, UFP wordage will be added to the FEIS. For individuals that are not familiar with UFP it must be explained that UFP is a policy and not a rule.

The preferred alternative includes a conceptual-level description of habitat restoration actions. This includes identification of potential restoration sites and a description of the types of actions that would be taken at the sites. The Corps believes this level of detail is appropriate for EIS at this stage of the project. However, additional information can be found in the Draft Restoration Report, which is available from the Corps upon request. The Draft Restoration Report includes site rankings, acreage, and habitat outputs for each of the potential restoration sites. Additional detail will be developed during the project design phase. That work will include additional investigation of existing site conditions, final identification of sites to be restored, and development of construction plans and specifications for each restoration site.

The Corps of Engineers will employ adaptive management techniques to the SR-6/Scheuber Ditch mitigation site. This will consist of a monitoring plan being developed and a monitoring at years 1, 3, 5, 7, 10. The vegetation will be measured at a 80 percent success and at the same time a survey of wildlife use will occur. The ditch will be monitored for fish usage during these monitoring events. At anytime during or if notified that the project is not meeting expectations, adaptive management will occur.

Restoring Floodplain Functions of the Chehalis River and Tributaries

The Purpose and Need Statement of the FEIS should disclose the importance of not only restoring stream habitat functions but also of restoring floodplain [hydrologic] functions of the Chehalis River and its tributaries within the project area to effectively address and manage a wider range of flow events.

In the DEIS, the purpose of the proposed project is to reduce flood hazards to the study area and to incorporate appropriate fish and wildlife habitat improvements. Major needs of the flood project are to reduce depressing economic effects due to the damages and uncertainty associated with future floods and to improve degraded areas along the Chehalis River or its tributaries so as to sustain and improve existing fish and wildlife resources in the Chehalis Basin. As written, there exists a disconnect between the DEIS purpose and need statement and the proposed range of alternatives. While the proposed range of alternatives includes both structural alternatives

(e.g., overbank excavation and flowway bypass, levee system improvements, and dam modifications) and non-structural alternatives (e.g., upstream flow restrictors and upstream storage enhancement), this intent or direction is not reflected in the statement.

Response: Thank you for your views on the DEIS. Alternatives do not or are not required to meet the purpose and need statements to be considered during the evaluation process. That is why all alternatives considered are part of the DEIS and the FEIS. The importance of restoring floodplain functions is stated near the end of the purpose and need statement in the DEIS.

Range of Alternatives -Existing and Proposed

Alternative 1 -No Action

The DEIS does not state if the cost benefit analysis of the no action alternative includes the elevation and widening of Interstate 5 (1-5). The DEIS states (No Action, page 22) that "Under the no action alternative, flood damage would continue to cost the local economy an estimate of \$9,122,060 annually..." The FEIS should disclose if the projected annual costs of continued flooding to the local economy includes the current WSDOT proposal to elevate 1-5 above the 50 year floodplain, which likely would occur under the no action alternative. This proposal is currently being considered to solve some of the flooding problems of 1-5 that the action alternatives are designed to address. The FEIS should include an analysis of the foreseeable costs and benefits to the local economy of elevating 1-5 under the no action alternative.

Response: The estimated annual cost has been revised to \$9,122,060.00. This does not include costs associated with raising I-5 to meet flood clearance requirements. This will be clarified in the FEIS.

Alternative 4 -Levee Setback

The FEIS needs to expand or clearly state that Alternative 4, the Levee Setback Alternative, alone does not meet one of the critical criteria of the Flood Hazard Reduction Project. This issue is a very important factor in evaluating the downstream impacts of flooding to the Chehalis Tribe. The DEIS states that this alternative would slightly increase downstream flood stages and this impact would not be significant because of Skookumchuck Dam modifications. (As stated in meetings with the tribe, even a slight increase would cause significant impacts and hardships to the tribe.) If for some reason the dam is not part of the final Corps project, additional measures would need to be incorporated to meet the downstream flood stage criteria. The Corps needs to address these measures here or in another section in the FEIS.

Response: As noted in the DEIS, the downstream flood stage increases would be very small. Analysis indicates that construction of the Chehalis River levees without the addition of the Skookumchuck Dam modifications would cause the 100-year flood peak stage to increase by a maximum of 0.1 foot downstream of Centralia. This information will be included in the FEIS. Modification of the Skookumchuck Dam is a part of the preferred alternative; therefore additional measures to meet downstream flood stage criteria are not included here or elsewhere in the EIS as part of this alternative.

Alternative 6 -Non-structural Alternative

Alternative 6, the Non-structural Alternative, should be carried through in the FEIS because it will lay out a template for the county to address flooding if federal funding does not become available for a more structural approach. Alternative 6 was developed to evaluate other options to reduce flood hazards in the project area compared to structural components (e.g. dams, excavated channels and levees) that were proposed in this document and in past planning documents. This alternative also includes Lewis County's commitment to develop an effective floodplain management plan and to implement strong enforcement of a floodplain policy to reduce future flood damage in the project area.

***Response:** The Corps' study team conducted a thorough review of county and city floodplain regulations and their enforcement and found that all local jurisdictions are in compliance with federal NFIP and state floodplain regulations. In order to implement the Corps project following authorization, the local sponsor must commit to a post-project floodplain management plan that is in compliance with NFIP and Executive Order 11988. Although the existing flood maps accurately represent flooding conditions in significant portions of the project study area, hydraulic modeling completed in the course of this project may allow Lewis County to become a Cooperating Technical Partner with FEMA. This could facilitate reconciliation of FEMA flood maps with "best available" flood information for the existing condition and would allow the local jurisdictions to begin using the new information in regulating land uses in the area. It would also set the stage for adoption of new FEMA flood maps in digital format.*

Alternative 7 -Interagency Committee Alternative

The FEIS needs to fully evaluate Alternative 7, the Interagency Committee Alternative, similar to the in-depth evaluation given to Alternative 2 in the DEIS and carry out through more aggressively in the FEIS. EP A has been working with the Corps Lewis, Washington Department of Transportation, the Chehalis Tribe, and state and federal resources agencies for the past three plus years in looking at alternatives that meet the purpose and need of the flood hazard reduction project and incorporate long range environmental sustainability. Out of this effort, Alternative 7 was submitted to the Corps and Lewis County that the Interagency Committee to be fully evaluated in the EIS.

Alternative 7 takes a long range systematic approach regarding the historic flooding of the Chehalis River, including environmental degradation of the aquatic environment. Moreover, Alternative 7 focuses on non-structural solutions first and then moves towards structural approaches when non-structural approaches are not adequate. The interagency committee expected that this alternative, or a similar alternative, would be carried forward into the FEIS and equally compared to the other remaining alternatives.

***Response:** This alternative was carried further in the evaluation of alternatives, cite page 41 of the DEIS. Hydraulic and economic modeling was conducted on Alternative 7, utilizing the systematic approach that the committee developed. During this stage of the evaluation, Alternative 7 was determined not to be the preferred alternative. The alternative was not economically beneficial, that is the costs of construction exceeded the benefits of the flood reduction. This discussion is on page 45 of the DEIS.*

Preferred Alternative -Alternatives 2 and 4

The FEIS should identify what parts of the preferred alternative could be funded by the Corps and what parts would be under the control of the other federal and state agencies, local governments.

Response: *Section 2.5.3, Non-Structural Features, indicates the non-structural features from Alternative 6 that are incorporated as part of the preferred alternative. These include (1) elevation of structures, (2) definition of a new 100-year FEMA floodplain, (3) appropriate improvements in the flood warning system, (4) restriction of development in floodways and other critical floodplain areas, (5) restriction of filling in the floodplain, and (6) appropriate improvements to local stormwater management plans. As stated in Section 2.5.3, the local sponsor will implement the listed actions to the maximum extent possible; the actions will be included in the revised floodplain management plan for the project. The Corps will review and approve the revised plan to insure that the non-structural project components are appropriately incorporated into the plan, and will provide technical support to assist in development of non-structural features to assure the integrity of the project structural components.*

EPA Proposed Alternative

Alternative 8

EPA recommends that a sustainable alternative be developed which combines the Corps preferred alternative with elements that incorporate fish and wildlife habitat improvements. This 8th Alternative would move to meet all critical criteria and use a systematic and phased environmental sustainable approach that is supported by Corps Headquarters and would more fully incorporate fish and wildlife recovery using a watershed approach.

Below is a short list of potential elements that could be included into the Proposed Alternative. This list includes elements from all action Alternatives (2, 3, 4, 5, 6, and 7). Viable elements in Alternative 3 include floodway modifications to the Mellen Street bridge and SR-6 Bypass excavations to reconnect segments of the historic floodplains. Viable elements in Alternative 4 include setback levees and floodwalls. Viable portions of Alternative 6 include restrictions on floodplain development and improved watershed management (active reforestation and timber harvest control). Viable portions of Alternative 7 include acquisition of frequently flooded areas and structures, improved upland storage, and relocation or elevation of structured.

We see viable elements in Alternative 5 that support small headwater dams. The Corps rejected Alternative 5 (Flow Restrictors) because the flow restrictors could not significantly reduce flooding during the 100-year flood event. This alternative was presented by the Chehalis Tribe knowing that it would not prevent flooding at the 100 year flood level. The tribe suggested, however, that the flow restrictors could be incorporated to reduce flood hazards on smaller flooding events.

The benefits of this proposed alternative is that it is less environmentally disruptive and promotes restoration of watershed processes. Currently, floodplain functions and processes have become disconnected from the river. As stated in the DEIS, the "Chehalis River has been remarkably stable during the last 50 years, with [minimal] lateral migration" (page 81) in spite of the large

floods of 1990 and 1996. Furthermore, "human activities have led to widespread riparian vegetation loss, reduced shading levels, and floodplain isolation contributing to increase water temperatures" (page 88). To restore watershed processes within a portion of the Chehalis River watershed, our suggestions are to:

- Reconnect the mainstem and tributaries to abandoned backwater areas and oxbows by assisting lateral stream migration within the floodplain to improve floodplain hydrologic processes and storage capacity,
- Promote revegetation of the riparian corridor to improve shading and filtration processes which will improve habitat and water quality, and
- Mitigate for critical structural impacts within the floodplain. For example, modifications to the Mellen Street bridge could greatly improve existing bottleneck conditions that restrict passage of flood event flows.

***Response:** Hydraulic modeling showed that all of the structural measures of Alternative 7 would have to be implemented to meet project criteria. This resulted in costs that could not be economically justified. However, as described in the DEIS, the Corps further evaluated additional configurations of Alternative 7 (e.g., with levees, with various dam modifications) to determine if this alternative could be made viable. Although the Corps did not call out the additional configurations of Alternative 7 as a separate alternative, we believe that this additional effort is consistent with EPA's recommendation that an 8th alternative be developed and evaluated.*

Floodplain Management

Executive Order 11988

The project should comply with Executive Order (EO) 11988, Floodplain Management. The objective of EO 11988 "is to avoid to the extent possible the long and short-term adverse impacts associated with the occupancy and modification of floodplains and to avoid direct and indirect support of floodplain development wherever there is a practicable alternative. "Residential and commercial construction activities are still being permitted by the local governments in the Project's floodplain study area. These actions appear to be in conflict not only with the intent of EO 11988, but would directly affect the cost benefit analysis and impact alternative analysis. EPA understands that the Corps can not restrict current land use development. However, the Corps may find itself in conflict with EO 11988 if residential and commercial development continue to occur in the flood hazard areas prior to the Record of Decision on the Project.

***Response:** FEMA is working on remapping, that will include the floodways, and these should be in place prior to the construction of the project. The Corps will work with the local communities to avoid, to the extent practical, any proposed development that would adversely impact the selected alternative or would be in conflict with Executive Order 11988. As stated the project will not be implemented without a new floodplain management plan that reflects the project.*

Approved Floodplain Maps

The Corps should require that the floodplain mapping and Lewis County's Flood Plan be completed and approved before the PHIS is issued so that alternatives can be better evaluated

and be better drafted to comply with EO 11988. Without approved and accurate floodplain and floodway maps, alternatives can not be adequately evaluated either during the development of the cost benefit analysis or in meeting the purpose of the DEIS in addressing flood hazard reduction in the project area.

Response: *FEMA is currently working to coordinate initiation of remapping in the project area. FEMA will be utilizing the existing conditions analysis work conducted for this study to develop new mapping for the area prior to a flood reduction project being completed. It is not likely that the new maps will be completed prior to the completion of the EIS, however.*

The issue of finalizing the 100 year floodplain in Lewis County has been a continual topic for the past four years and has caused frustration with the resource agencies as we attempted to develop a flood hazard reduction plan alternative. EPA has requested a number of times that the 100 year floodplain maps be finalized before any further development be permitted in flood prone areas within the project study area, and that the Corps require finalization before they complete the FEIS. EPA and the other resource agencies find it very difficult to address flooding and the environmental impacts in the project area as ongoing land use decisions are being made by the county that affect the alternatives that are being developed by the Corps and identifying potential restoration actions. In addition, the lack of these maps creates a significant information gap and may not comply with Executive Order 11988 Floodplain Management Guidelines. Floodplain mapping should be one of the priorities of the FEIS study to directly assist in assessment and decision-making, and new floodplain maps should be completed and approved by Federal Emergency Management Act (FEMA) before the FEIS is developed.

Response: *The FEMA approval process takes several years to develop new floodplain mapping. FEMA will be utilizing the existing conditions analysis work conducted for this study to develop new mapping for the area prior to a flood reduction project being completed. It is not likely that the new maps will be complete prior to the completion of the EIS, however, the Corps and FEMA have initiated discussions as to intent and general scheduling of the new mapping. FEMA does intend to start remapping to include the project when construction of the project begins.*

Lewis County's Flood Plan

EPA recommends that the Corps be one of the approving agencies of the Lewis County Flood Plan that the Plan be approved prior to the implementation of the Project and that a clarifying statement be added stating that the county's new Flood Plan must be approved by the Corps prior to the implementation of the flood hazard reduction project. Although it is unclear who would be approving the county's new floodplain management plan, EPA believes that the Corps should be a part of this approval process so that the new floodplain management plan meets the requirements of Executive Order 11988.

Indirect and Cumulative Impacts

Section 4.1.3.2- Long-term Effects (page 169)

Additional information is needed to fully understand the long-term impact of the preferred alternative. As stated in the DEIS, the preferred alternative " would alter flood hydrology and hydraulics in the project area. ..[and] ...would result in some reduction of the floodplain area that

is inundated and alter floodwater storage." The DEIS needs to further expand this section by (1) approximating amount of acres historically within the floodplain; (2) specifying the current extent of lost flood storage capacity; and (3) use the acreage analysis to aid in describing other areas of impacts for clarification. This information is needed to evaluate cumulative impacts directly linked to past, present, and reasonably foreseeable future effects as required by NEPA (40 CFR 1508.7). This would include addressing a number of activities that are being planned in the floodplain (e.g. widening of I-5, commercial development) that would add impervious surfaces to the floodplain and likely effect the hydrology and hydraulics of the Chehalis River watershed.

Response: With the exception of some of the proposed levee sections along the lower reach of the Skookumchuck River, most of the proposed levee sections will be set back significantly from existing stream channels. This limits the loss of floodplain storage attributable to the preferred alternative. For instance, proposed levees along the Chehalis River will be mostly set back significantly from the east side of the channel (there is no levee proposed along the west side of the channel) and will be mostly situated adjacent to Interstate 5. As a result, flooding in the active portion of the existing floodplain on the west side of I-5 under the preferred alternative will be very similar to pre-project flooding (i.e., the spatial extent and depth of flooding within the active floodplain will be largely unchanged).

The most notable change to flooding within the Chehalis River valley under the preferred alternative is a reduction in flooding in the mostly urban areas along the east side of I-5. It is estimated that the preferred alternative would eliminate flooding over an area of roughly 2,500 acres in the vicinity of Chehalis and Centralia during a 100-year flood event (this compares with an inundation area of roughly 16,000 acres in the vicinity of Chehalis and Centralia during a 100-year flood under pre-project [existing] conditions). Most of the area eliminated from flooding is highly urbanized land located on the east side of I-5. A large percentage of this area is covered by impervious surfaces (i.e., roads, parking lots, buildings, etc.). Additionally, most of the areas on the east side of I-5 that have historically flooded from the Chehalis River have generally functioned mostly as backwater storage areas during flood events and have had very limited function in terms of providing downstream conveyance of flood flows. Because most of the active floodplain will be unaltered by the preferred alternative, use of set back levees to eliminate flooding in the mostly urban areas outside of the active floodplain will have only a slight impact (generally several inches or less) on flood stages within the active floodplain. Furthermore, operation of the Skookumchuck reservoir for flood control purposes will provide up to 20,000 acre-feet of flood storage that will offset the loss of flood storage attributable to the proposed levees and will hence offset any downstream peak water surface increases attributable to the proposed levees. The net result of the effects of all components of the preferred alternative will actually be a net increase in flood storage resulting in a slight reduction in peak water levels in the Chehalis River downstream of Centralia during flood events.

Section 4.3- Water Quality (page 175)

Clarify what effects, if any, the proposed Project would have on water quality within the project area, especially Clean Water Act (CWA) 303(d) waters. The Chehalis River is currently on the state list of CWA303(d) impaired water bodies for temperature and fecal coliform. Under this

designation no activity should occur that will negatively affect a listed impaired water body. This would include activities that may have either temporary or long-term water quality impacts.

Response: *Section 3.3 describes in detail the current condition of the water quality in the upper Chehalis Basin and the impacts from human actions. However, the section referenced in the above comment has been edited to include brief descriptions of water quality issues.*

Potential Restoration Sites

Section 2.6- Potential Restoration Sites (page 57)

The Corps has identified 16 potential environmental restoration sites. More details need to be provided in this section, including:

- A ranking of each potential site for restoration,
- Types of functions that this restoration would replace,
- Estimated cost to restore targeted functions, and
- Required monitoring for each restoration site.

Response: *The Corps is including as an appendix to the FEIS the report that was accomplished on the restoration sites. However, it must be understood that some of the proposed restoration sites have been changed to the mitigation site. It also must be understood that restoration is the burden of the sponsor to obtain the real estate for restoration to occur.*

Additional Comments

Section 1.1 -Figure 1.1 (page 2)

It would be helpful to label the Skookumchuck and Newaukum rivers.

Section 2.2 -Major Project Criteria

Figure 2.1, page 18 -This figure is bleached and unreadable.

Response: *This has been corrected.*

Criteria 2 (page 19) -Decrease the transportation closure during flooding...

Regarding the third sentence wherein it states that Washington State Department of Transportation is widening 1-5 in this portion of the project area to not only improve "safety, efficiency, and convenience," but to add capacity by adding two additional lanes of freeway. This proposed modification needs to be stated in the FEIS.

Response: *This will be added in the FEIS.*

Please state in the FEIS where Federal Highway Administration flood clearance requirements are not currently being met in the project area (e.g. 50 year flood level).

Response: *This information will be provided in the FEIS.*

Table 2.4-1- Project Economic Analysis (pages 42- 44)

This is good information for the public in describing the economic outcomes of the alternatives. However, it is very difficult to follow. Please expand Table 2.4-1 so it is easier to read and more clearly describes the alternative that is being evaluated.

Response: *The table will be revised as suggested.*

Section 2.5.3- Non structural Features

Regarding: Table 2.5.3-1 - *Cost of Elevating Structures with Induced Flooding* (page 53): Please state if this table was developed using the old 100 year floodplain maps or the new floodplain map developed but not approved by the county.

Response: *Table 2.5.3-1 was developed using the new floodplain map that was developed as part of the project. Please refer to earlier discussion regarding adoption of the new FEMA floodplain map.*

Define a New 100 year FEMA Floodplain (page 53)

Expand this section to clearly layout the procedures needed to approve of the new FEMA floodplain map. It is very important to accurately address economic impacts and costs associated with a 100 year flood with a updated FEMA map. It is EPA's understanding that the new map has been developed and is awaiting approval.

Response: *Please refer to earlier discussion of adoption of the new FEMA floodplain map.*

Section 3.2 -River Geomorphology

We highly recommend that the FEIS include relevant geomorphological information of regional glacial activity to clarify why the Chehalis River valley in the project area is so flood prone. The FEIS should examine and disclose how historical glacial activity affected landform morphology in the project area. In reviewing recent geological information, no other land forming activity has influenced the current characteristics within the project area as the extensive glacial ice sheets that occupied northwestern North America in the early to late Pleistocene. Especially relevant to the Puget Sound area is the Puget Lobe of the Cordilleran Ice Sheet and its associated meltwater channels that aided in formation of the nearly level to gently sloping alluvial lands of the Chehalis valley.

Response: *The glacial activity that occurred in this area actually stopped just north of Centralia. This area would have been a runoff area for the melting glaciers.*

Section 3.9- Land Use and Planning

The FEIS should disclose information on all floodplain influences attributed to proposed I-5 improvements. I-5 existing influences and any proposed infrastructure changes on Chehalis floodplain dynamics were not adequately disclosed within the DEIS.

Response: *The floodplain influences of the I-5 roadway are part of the existing condition, and as such were accounted for in the modeling conducted for this project. I-5 is only one feature that has had an impact on basin dynamics; historically, there have been many others. The EIS will not evaluate in detail the historic impacts of any one particular feature. The effects of I-5*

construction on the basin are described generally in Section 6, as are the effects of historic navigation projects, logging, agricultural development, residential and commercial development, and construction of rail lines and other roadways. All of these actions and features have had an effect on the basin, and the major impacts are listed and discussed in 7.1.1.

Section 3.13.3- Potential Hazardous Toxic and Radioactive Waste Concerns (page 155)

To better transmit the information to the concerned public and government agencies, this section should list which of these sites is under federal clean up authority and which are under state authority. In addition, an area map showing their location is needed.

Response: *An appendix was prepared (Appendix D) for the DEIS that provides the information requested, describes a preliminary assessment as well as lists all sites within the study area. Maps of the project and study area are provided, either within the appendix or as an attachment.*

Chapter 4 -Environmental Effects -Scheuber Ditch/SR-6 Mitigation (page 166)

The Corps has presented the Scheuber Ditch/SR-6 Mitigation as the main action to offset the aquatic resource impacts identified by the preferred alternative. EPA would like to see a conceptual drawing or figure so as to assist reviewers in showing the extent of the proposed mitigation plan. The Corps will also need to conduct a wetland functions and values analysis of the current conditions within the mitigation site and then determine what benefits the proposed mitigation would have on these existing conditions. This evaluation will then be used to determine if the proposed mitigation compensates for the lost wetland functions and values of the built project.

Response: *A conceptual site plan of the Scheuber ditch mitigation area will be included in the FEIS. Additional work at the mitigation site will be done as part of final design. That work will include specific delineation of existing wetlands at the mitigation site as well as an assessment of wetland functions currently being provided by the site.*

Section 4.1.5- Mitigation (page 172)

This section needs to be expanded to explain the actions the Corps will undertake to minimize impacts on the hydrology of the Chehalis River. These actions would include showing where floodwalls may be constructed to avoid wetlands, and where proposed levees have been shifted away from aquatic areas.

Response: *This section will be expanded to include this information.*

Section 4.3.6 -Mitigation (page 177)

The mitigation section for water quality should specifically explain how these proposed actions would mitigate for potential project impacts to water quality, what these actions are and how they will be implemented. In addition, an additional mitigation measure should identify which land use activities would be permitted within the project area and in particular within the levee setbacks.

Response: *This section has been edited to increase detail of mitigation. The Corps is working with the local and state agencies to develop a floodplain management plan that would*

discourage or restrict development within the floodplain. Regarding floodplain development, the local sponsor must commit to a post-project floodplain management plan that is in compliance with NFIP and Executive Order 11988 in order to implement the Corps project. The executive order is intended to avoid to the extent possible the impacts associated with occupancy and modification of floodplains and to avoid direct and indirect support of floodplain development wherever practicable. Land use development restrictions fall under the jurisdiction of state and local authorities

Section 4.4 – Biological resources – Vegetation and Wetland and Riparian Areas (page 178)

To help in clearly identifying impacts to wetlands, riparian habitat and their buffers, the Corps needs to expand the discussion to include impacts to wetland and stream buffers. This could be done by adding these elements to Table 4.4-1 (page 182). In addition, a series of maps should be included showing the preferred alternative along with the wetland, riparian habitat and buffers that would be impacted by the levee system

***Response:** The purpose of the set back levees is to remove them from the riparian areas and this was accomplished. There are a couple of locations that the levee system will be very close to the rivers edge, however, there is no riparian area there as the interstate abuts the riverbank at those locations. The impacts to the wetlands are the wetlands that are marginal and are agriculture in use at this time. These are prior converted wetlands.*

Section 4.4.6- Mitigation (page 187)

The Corps will need to conduct a wetland function value analysis on all wetlands impacted by the preferred alternative. To EPA's knowledge, and in reviewing Appendix C "Wetland and Riparian Report," this has not been done. Once this has been completed, these losses can be weighted against those being developed in the Scheubert Ditch mitigation site.

***Response:** During final design, additional site work will be done to more precisely determine project impacts to wetlands and riparian areas. This work will include specific delineation of wetlands affected by project components as well as an assessment of functions being provided by these wetlands.*

Section 4.8- Land Use and Planning (page 215)

4.8.2- Criteria for Determining Significance of Effects (page 216)

An additional screening criteria for significance needs to be added that would weight the compliance with applicable land use requirements. In particular, compliance with Executive Order 11988 on floodplain development.

***Response:** Compliance with Executive Order 11988 and other applicable federal land use requirements is included in the final bullet item, which includes "land use plans, policies, or regulations of any entity with jurisdiction over the area... [emphasis added]."*

Thank you for the opportunity to partner with your agency and Lewis County on this important project. We also appreciate the opportunity to review the draft EIS/GRR for the Centralia Flood Damage Reduction Project.

Generally, the alternative selected eliminates many of the project elements that posed the most risk to transportation infrastructure and the environment. A number of concerns expressed about the 40 percent draft document were associated with the Floodplain Excavation and Floodway Bypass alternative. Resolution of these concerns speaks positively of the alternative selection process, which despite being arduous has selected what appears to be the best alternative in terms of reducing flood hazard, while minimizing environmental impact as well as potential impact to the transportation infrastructure. We feel that this also speaks well of the cooperative working relationship that has developed between the Corps of Engineers, Lewis County, and WSDOT over the course of this process.

WSDOT has the following specific comments on the completed draft EIS/GRR for the Chehalis Flood Hazard Reduction Project:

The 18th Amendment to the State Constitution requires state gas tax dollars to be spent directly on highways. WSDOT is prohibited by this amendment from using R51 gas tax revenue to fund any local rights of way buy-ups above and beyond the NED plan as alluded to on page 170 of the GRR and other locations in the document. WSDOT does not oppose the "additional buy-ups", but we find it important to clarify inferences of funding such buy-ups.

Response: *Agreed. This will be apart of the final financial plan for the project.*

It would be nice to refer to our agency as WSDOT, not WDOT, DOT, & WA-DOT throughout the documents.

Response: *This will be corrected.*

General reference throughout all documents, regarding Reach 9 & 10, that WSDOT may construct their project before the NED Plan is constructed; therefore alleviating the need to relocate Dillenaugh Creek is not valid. It may take the WSDOT ten to twenty years to improve this section. It is highly unlikely I-5 will be widened in the locations where it was overtopped by floodwaters before the Corps project or another solution is in place. Therefore, this assumption should be changed throughout the document.

Response: *This will be corrected in the FGRR and detailed in further design effort, in coordination with WSDOT.*

DGRR, Page 5, paragraph 2, line 2, states that the grade of I-5 would need to be raised 12 feet; yet in the DEIS, Page 143, paragraph 1, second to the last line, states the grade would need to be raised up to 6 feet. For consistency reasons, the "up to 12 feet" reference would be more appropriate. We also recommend that the flood elevations be verified to the I-5 Freeway elevations.

Response: *This will be corrected in the FEIS.*

DGRR, Page 60, paragraph 1, last line, states 12 percent truck traffic, WSDOT data identifies this percentage to be 18.

Response: *This will be corrected in the FGRR.*

DGRR, Page 80, paragraph 2, line 4, 1-5 should be I-5.

Response: *This will be corrected in the FGRR.*

DGRR, Page 138, first bullet, oxbow (north of SR-6) should be oxbow (south of SR-6).

Response: *This reference is correct, that plan had an additional oxbow reconnection north of SR-6.*

DGRR, Page 166, Table 6-2, what is the significance in the reference to (WSDOT) in the table?

Response: *This reference is to identify the agency that real estate will need to be coordinated with. The reference will be removed.*

DEIS, Page C23, the paragraph after the tables states that the relocation of Dillenbaugh Creek will not be required nor will any wetlands be impacted. WSDOT's preliminary design for this interchange requires a bigger footprint in this area. Previous discussions with the Corps identified the need to relocate Dillenbaugh Creek further west and that a levee would be used for flood protection, possibly becoming a part of the Labree road extension.

Response: *This will be corrected in the FEIS.*

Description of Preferred Alternative (DEIS, page 50), Hydrologic Impacts (DEIS, page 170), Long-term Impacts to Fish (DEIS, page 197): As we mentioned in our comments on the 40 percent draft document, there needs to be some discussion of how the flap gate on Dillenbaugh would operate, and the impacts of this structure on hydrology and fish passage.

- How often would the gate close (what frequency of flood event)?
- What effect would gate closure have on upstream flooding along Dillenbaugh?
- Are there impacts to fish passage when the gate is closed?
- Flap gates are notorious for failing at critical times. How would debris and sediment impacts to the structure be addressed?
- Would there be special provisions for maintenance of the gate, and what would be the impacts of gate failure?

Response:

- *The gate would only be closed at 100-year event to ensure that the levee will provide 100-year protection.*
- *The gate closure will not affect upstream flooding. The purpose of the gates is to protect against Chehalis backwater during that 100-year event.*

- *Because the operation of this structure is only during a 100-year event, the impact to fish would be negligible. During low flow conditions the structures would be fish passable.*
- *The design of this structure is not a typical flap gate, though these concerns will be taken into consideration during the final design of the structures.*
- *The operation and maintenance will be built into the design and operations plan that will be executed by the county emergency management office. Maintenance inspections will be conducted annually. If the gates do fail, flooding will not be significantly worse than under existing conditions.*

DEIS, Page 279, please change the Department of Transportation contact to the following:

Becky Michaliszyn
Washington Department of Transportation
P.O. Box 1709
Vancouver, WA 98668-1709

Response: *This will be corrected in the FEIS.*

Throughout the documents, Reach 9 and 10 are incorrectly described and drawn according to future WSDOT needs in this area. We have contacted Beth Coffey and Norman Skjelbreia regarding this matter and we requested that these two reaches be refined to represent our needs for the future interchange configuration.

Response: *These will be further detailed during design, per discussions with WSDOT.*

The Green Hill wetland mitigation site is funded by the WSDOT, and is intended for WSDOT mitigation needs resulting from I-5 widening. The site is located in the northwest quadrant of the Rice/13th Street interchange. Dillenbaugh Creek flows between the freeway right of way line, on the west side and the easterly property line of the Green Hill wetland bank.

Response: *This description will be incorporated into the FEIS.*

Thank you again for the opportunity to partner on this project.

<signed>

Bart S. Gernhart, P.E.
Project Development Engineer

Wetlands, Riparian and Mitigation Comments:

Is enhancement the major portion of the proposed wetland mitigation? It appears more mitigation area may be required to meet regulatory conditions if enhancement is the major driver of the proposed mitigation.

Response: *The mitigation actions will include a combination of creation, restoration, and enhancement of wetlands, as well as creation and restoration of open water areas and riparian habitats. Under existing conditions, the mitigation site includes upland areas and wetlands, as well as areas with mapped hydric soils that likely have been tilled and drained, and which no*

longer exhibit the vegetation or hydrologic characteristics of wetlands. A specific delineation of existing wetlands at the mitigation site will be done as part of final design. As currently envisioned, the mitigation actions would provide up to 126 acres of wetland complex and up to 75 acres of riparian habitat; because these actions would be focused at a single site, they are expected to provide habitat and hydrologic benefits at the landscape scale. Since the total acreage of wetland loss from the project is estimated at approximately 34 acres, the mitigation proposal should be adequate to offset the loss of wetland area and function. In the unlikely event that more mitigation is needed, the site provides ample opportunity for additional mitigation actions.

Has or will the design of the mitigation take into account the “high flow episodes” that will occur?

Response: Yes. Because a fundamental goal of the mitigation actions is to reconnect the Chehalis River with a portion of its historic floodplain, the mitigation site will be designed to accommodate flows from the 1- to 2-year event as well as larger, less frequent floods. As such, the mitigation areas will be designed to mimic wetland and riparian habitats that likely existed at one time in the floodplain. Those wetlands and riparian areas would have been subjected to episodic flows from floods ranging from annual high winter flows to major events. Site elevations, species planted, and stabilization measures selected during final design will take into account the potential effects of high flows on the mitigation site.

Mitigation ratios for mitigation begin at 2-3:1 for creation / restoration and 4-6:1 for enhancement. These are beginning numbers and can move up or down depending on a number of variables, some of which are: the type of wetlands impacted, type of wetland proposed for mitigation, the quality of the proposed mitigation, amount of wetland impacted, temporal considerations and location.

There are possible wetland impacts from the higher Skookumchuck Dam storage elevations. Have the wetlands around the lake been delineated? Any discussions on what potential impacts could occur? It is discussed that storage of floodwaters would only be held approximately 5 days but table 3.1-1 shows that storms can last 3 to 4 days or more and release a large amount of water. Keeping hydrology at higher levels behind the dam could cause impacts to wetland areas especially during periods of spring growth.

Response: A report (Fish, Riparian and Wildlife Habitat Study) was completed by Pacific International Engineering and GeoEngineering for Lewis County in November 2001 that looked at the habitat surrounding the Skookumchuck reservoir and they found no wetlands that could be impacted by the project. The plan is to hold the water at the higher elevation for a maximum of 5 days only and then start the release.

There are more impacts than just the footprint of the levels to consider. Hydrology impacts to wetlands bisected or disconnected from its hydrology source(s) also need to be considered. Buffers will also need to be implemented to protect wetland functions. There needs to be some explanation on what the Corps means between “buffers” and “setback”.

Response: *Setback means the levees will be setback from the levee as far as design will allow to reduce the potential impacts. A buffer is an area that has been protected from impacts by the project. Only prior converted wetlands (agriculture & developed) will be disconnected from the floodplain and those areas are minimal by design.*

Excavation in existing wetlands could be considered impact depending on what ecological functions are being addressed. The mitigation plan will need to explicitly describe the impacts and proposed environmental gains.

Response: *Potential impacts of the mitigation actions are described in the introduction to Chapter 4 in the FEIS. During final design, additional site work will be done to more precisely determine project impacts to wetlands and riparian areas. Environmental gains are described in the subsections for each discipline; in particular, please refer to Section 4.1.5, 4.4.6, 4.5.6, 4.6.5, and 4.7.5. Specific environmental gains will be further defined during the project design phase.*

Was the information in Tables 3.4-1 & 2 and 4.4-1 taken off NWI and soil surveys? NWI maps are known to under-estimate forested wetland area and misrepresent emergent wetland area. A detailed delineation of the immediate project wetlands will be needed to determine wetland characteristics impacted by the project.

Response: *A complete delineation of all wetlands associated with the project will be carried out before construction.*

Riparian habitat is driven by a pretty precise hydrologic regime; have hydrologic studies been done to help evaluate if this type of mitigation is feasible at the location(s) proposed?

Response: *Riparian habitat throughout the project area has been observed in inundated, saturated, depressional, and upland conditions and has, as is typical of riparian communities, adapted to a variety of moisture regimes, including those that fluctuate seasonally. The species composition of the riparian community varies with the hydrology at each location. Soil surveys at the proposed mitigation site indicate that the water table is near the surface throughout most of the growing season. Hydraulic modeling indicates that flows can be introduced to the site with regular frequency to support wetland and riparian vegetation. Further hydrologic studies are not necessary to evaluate the feasibility of the mitigation proposal.*

How does the habitat restoration plan project fit in with this project?

Response: *The habitat restoration plan will be used as property becomes available for use. Habitat restoration will be actively pursued based on the restoration plan to the maximum extent allowable.*

Floodplain Comments:

What will flows be in 2yr, 10yr, 25yr and 50yr events? What does modeling show the floodplain will look like in these episodes?

Response: Peak flows during these events vary depending on the specific stream reach. For instance, estimated peak flows in the Chehalis River at a location just upstream of its confluence with the Skookumchuck River for the preferred alternative for the 2-year, 10-year, 25-year, and 50-year events are about 19,500 cfs, 34,000 cfs, 42,500 cfs, and 48,700 cfs, respectively. The spatial extent of flooding during these events for the preferred alternative will depend on the specific stream reach. For instance, flooding within the active floodplain of the Chehalis River along its reach between Chehalis and Centralia will be spatially similar for these events compared to flooding under pre-project conditions. Because the proposed levee along this reach is significantly set back from the east side of the channel (there is no levee along the west side of the channel) and is mostly situated adjacent to I-5, flooding in the active portion of the existing floodplain on the west side of I-5 under the preferred alternative will be very similar to pre-project flooding (i.e., the spatial extent and depth of flooding will be largely unchanged). The most notable change to flooding along this reach under the preferred alternative is that flooding will be greatly reduced in the mostly urban areas along the east side of I-5. Spatial changes in flooding will depend on the particular flood event. For instance, the preferred alternative will likely have little effect on flooding on the east side of I-5 during a 2-year event since this area generally doesn't flood under pre-project (existing) conditions. Conversely, the preferred alternative will greatly reduce the spatial extent of flooding on the east side of I-5 during a 50-year event (most of the area protected from flooding on the east side of I-5 is highly urbanized and much of the area is covered by impervious surfaces). However, it should be noted that areas on the east side of I-5 that have historically flooded from the Chehalis River have generally functioned mostly as backwater storage areas during flood events and have had very limited function in terms of providing downstream conveyance of flood flows.

What about upstream actions that have taken place which will further compound potential problems in this area. Have these issues (i.e. Napavine) been addressed and discussed? Figure 2.1 (pg 18) shows the study area to include the area near Exit 72 on I-5. Large amounts of fill have been placed in this area, which will alter the characteristics of the Newaukum River and the Chehalis River. Has this been studied and discussed?

Response: Figure 2.1 shows the general extent of the study area. The actual extent of the study area is largely reflected by the spatial extent of floodplain areas that were incorporated into the hydraulic model used to evaluate various project alternatives. The hydraulic model only covers the lower 4 miles of the Newaukum River and therefore does not extend sufficiently far enough upstream to the reach of the river near exit 72 of I-5. (Note that the limited extent of hydraulic modeling along the Newaukum River is largely dictated by limited backwater effects from the Chehalis River, which only affect the lower 1 or 2 miles of the Newaukum River.) As a result, potential changes to the Newaukum River floodplain in the vicinity of exit 72 are outside of the current study area. Furthermore, while the localized placement of fill along this reach of the Newaukum River may have localized impacts to flooding in this area, this action is not expected to impact downstream flooding along the Newaukum or Chehalis River. As a result, this action is not expected to negatively impact the preferred alternative.

A general comment on the EIS is that it would be helpful if there were an addendum that describes how this project has been evaluated relative to the requirements found in Federal Executive Orders 11988 (Floodplain Management) and 11990 (Wetlands Protection).

Response: Chapter 4 of the DEIS provides the disclosure for the Federal Executive Order 11990. As noted in the DEIS (11988) the Corps is maintaining a large portion of the floodplain by restricting the levee system to the current planned location. This will help to preserve the benefits of the floodplain while reducing the flood losses. Basically, the entire DEIS constitutes the evaluations used for the above-mentioned executive orders.

On pages 23-24 and 231 and other areas of the report that deal with the Skookumchuck Dam modifications, further information is needed regarding: A) the potential downstream impacts of the various alternatives relating to the dam modifications and why no warning system for downstream residents is proposed and B) a description of the plan for operation and maintenance of the dam post-modifications and a plan for transfer of ownership to a designated entity.

Response: Additional information will be added to the FEIS to address the operation and maintenance of the dam and the plan for the transfer of ownership to a flood district. The plan does not include a warning system for downstream residents.

On page 124, Section 3.8.1.3, there is a statement that, "a new 100-year floodway has been calculated." It logically follows then that a new 100-year floodplain has also been delineated for this area. It would be helpful to learn why this information/data has not been submitted to the Federal Emergency Management Agency for the preparation of revised flood hazard maps.

Response: FEMA will take the mapping from this study and develop new FIRM maps to delineate the floodplain and floodway. FEMA will be utilizing the existing conditions analysis work conducted for this study to develop new mapping for the area prior to a flood reduction project being completed.

On page 147, Section 3.10.7, there is a statement that, "During flood events interchanges 81 & 82 are impassable" (as are other interchanges). This needs to be clarified to identify the magnitude of the "flood event."

Response: The vulnerability of I-5 interchanges to flooding under existing (pre-project) conditions is dependent on the specific characteristics of each interchange. For example, factors such as road surface elevations within the interchange, proximity to river reaches (i.e., Chehalis or Skookumchuck River), and local features that influence the spatial extent of flooding (i.e., local topography and anthropogenic features such as levees and transportation corridors) determine the vulnerability of a specific interchange to flooding. The vulnerability of interchanges at milepost 81 (Mellen St.) and milepost 82 (Harrison St.) to flooding under existing conditions was estimated based on a comparison of simulated peak river stages during specific flood events with existing roadbed elevations within these interchanges. This evaluation suggests that the interchange at milepost 81 (Mellen St.) becomes impassible during a Chehalis River flood event with a return interval of approximately 25 years or greater while the interchange at milepost 82 (Harrison St.) becomes impassible during a Skookumchuck River flood event with a return interval of approximately 5 years or greater (flooding from the Skookumchuck River rather than from the Chehalis River appears to have the most significant influence on flooding at the Harrison St. interchange). It should be noted that while the provided

flood return intervals represent the estimated return intervals at which the given interchange areas will begin to flood, critical transportation corridors that connect the interchanges to surrounding streets may in some cases have a higher vulnerability to flooding relative to the interchanges.

Shoreline Management Act, Shoreline Master Program and Shoreline Permit Comments:

Each municipality and county listed in Section 3.8 (Land Use) of the DEIS has its own shoreline master program with its own set of regulations and policies regarding development on shorelines within its jurisdiction. Development associated with this project must be consistent with the regulations and policies of the Shoreline Master Program for the jurisdiction within which it occurs. Of particular importance in regard to this project is fill in the floodway, water ward of ordinary high water mark, or in wetlands is prohibited outright in the shoreline master programs for the cities of Chehalis and Pe Ell. (See General regulations and Landfill regulations in the Chehalis SMP and Landfill Regulations in the Pe Ell SMP.)

Subsection 173-27-060(2) of the Washington Administrative Code spells out the circumstances when shoreline permits are not required for federal agency actions. It is important to note, however, that even if permits are not required, the proposal must be consistent with the policies and provisions of the Shoreline Management Act and the local Shoreline Master Program.

Any development proposed on a Shoreline of Statewide Significance must be consistent with the use preferences in Section 20 of Chapter 90.58 RCW (Shoreline Management Act of 1971). The application should clearly demonstrate that the project:

- 1) Recognizes and protects the state-wide interest over local interest
- 2) Preserves the natural character of the shoreline
- 3) Results in long-term over short-term benefit
- 4) Protects the resources and ecology of the shoreline
- 5) Increases public access to publicly owned areas of the shorelines
- 6) Increases recreational opportunities for the public in the shoreline.

The information necessary to complete an application for a shoreline permit are listed at 173-27-180 of the Washington Administrative Code. A permit or determination of consistency may not be issued until this information has been received. Of particular concern with this project are the upstream and downstream impacts to and from tributaries to the Chehalis. Especially troublesome is the lack of analysis of the impact of the significant filling occurring within the floodplain of the Newaukum River.

Response: *Currently the Corps does not require shoreline permits but is required to follow the guidelines to the maximum extent practicable.*

Comments related to known and suspected hazardous waste sites, underground storage tank and leaking underground storage tank sites, and facilities that generate hazardous substances:

Page 13-14: If waste were found during construction of the preferred alternative, the DEIS states that the site would be remediated. Who would do the remediation is unclear. The Army Corps? EPA? Washington State? That should be made clear. Certainly, if waste materials are found during construction of a levee, my expectation is that the Corps and their contractors would have to deal with it. EPA or Ecology could help with the follow-up, but the initial work would have to be done by the Corps so they can try to remain on schedule.

Response: *Per ER 1165-2-132 U.S. Army Corps of Engineers Hazardous, Toxic and Radioactive Waste (HTRW) Guidance for Civil Works Projects, if suspected hazardous waste is discovered during construction, the Corps is responsible for conducting a site characterization analysis. If the Corps determines that the site is a hazardous waste site, then responsibility for the site is turned over to the local sponsor. The local sponsor is responsible for additional analysis that may be required and for any remedial action. All site characterization and remedial work must be completed prior to continuing construction at that location. A contingency plan will be included in the Project Work Plan to cover for such an event.*

Page 96: The DEIS mentions several (3 or 4) contaminated sites with groundwater contamination. There are other sites in the study area that are not mentioned on that list with groundwater contamination, such as various LUST (Leaking Underground Storage Tank) sites.

In the electronic copy of the DEIS, it identifies Appendix D (Hazardous Toxic, and Radioactive Waste), but it is not included. I assume the appendix includes the large map prepared by the Corps of the study area and all the waste sites on it. If not, it should. The map identifies the following types of known facilities: hazardous waste generators; LUST facilities; state cleanup sites; Superfund cleanup sites; Toxic Release Inventory sites, and Voluntary Cleanup sites. One class of sites not included on the map, but mentioned in the text of the DEIS, are both underground storage tank (UST) sites and above ground storage tank (AST) sites. Should these types of tanks be impacted by levee construction or flooding, those are likely to cause contamination. I believe the Corps has Ecology's list of UST sites. To the best of my knowledge, Ecology does not maintain a list of ASTs. EPA might or certainly, the local fire departments should because of their potential threats to public safety. I believe above ground fuel tanks are permitted by the local building departments and/or fire departments.

Response: *The appendix contains a map of the project area, a list of all regulated sites (federal, state, USTs, LUSTs, etc), and a report from the preliminary assessment. A large map of the project area with all known sites has been added as an attachment. Regarding the ASTs, neither the local Centralia fire department nor the Centralia and Lewis County Emergency Management agency have a list of ASTs in the project area. Site inspections did reveal a few ASTs in the project area, but it was determined that they were either sufficiently flood protected or would not be affected by the project.*

Other Permit Comments:

Specific permits may be required before actual construction begins on any phase of the project. A water quality certification may be required from the Department of Ecology in conjunction with the U.S. Army Corps of Engineers' permit for this project.

Response: *Correct, and those permits will be obtained at the appropriate time.*

General Comments:

It is interesting that the preferred alternative is a combination of a project that was authorized previously and the focus project of a previous study (Page 3 - Section 1.3.1.1; page 16 - Section 2.1.1.2; page 29 - Alternative 4 description, third paragraph).

To minimize impacts on the floodplain, and to help mitigate for the effects of past filling in the floodplain, it would be a positive thing if the source of fill for the setback levees is the floodplain within the project boundaries.

Response: *This will be considered in design.*

Comments with specific text citations:

Executive Summary, page iii, 2nd paragraph "Habitat conditions for fish and wildlife in the Chehalis Basin are limited by several factors, including... This DEIS describes seven different alternatives that were investigated to address those limiting factors while reducing flood damage to the basin."

This statement implies that factors limiting habitat for fish and wildlife are the first priority, which is clearly not the intent of the project. This is clear in several other statements in the DEIS (Executive Summary, page vi 2nd paragraph; Page 1-Section 1.2 are just two examples).

Page 17 - Section 2.1.4 "Therefore, development of a new floodplain management plan was considered a part of each action alternative"; page 52 - 1st paragraph "These actions will be included in the revised floodplain management plan for the project. This plan will be completed prior to the signing of the cooperative agreement for project implementation."

Thank you for assuring that revised floodplain management plans will be completed prior to signing the cooperative agreement for project implementation. We assume that no work on project implementation can occur until the revised floodplain management plan(s) are done.

Response: *Although this is not the intent of the project it is, however, a very important decision making factor that carries considerable weight in the decision making process for alternatives. Correct, no work on the project, (i.e., construction) will start until the new plan is done.*

Page 18 - 1st paragraph "the criteria are in no order of priority; each was considered equally important for meeting the project purpose." and Page 21 - Criteria 9 "A requirement of each alternative is that it be evaluated on the feasibility of incorporating appropriate fish and wildlife habitat measures."

The evaluation of alternatives that follows these statement frequently fails to mention whether an alternative meets, or does not meet, this criteria. Other criteria (usually #1, 2, 5, 6 and 7) are

almost always mentioned in this section, leading one to conclude that the evaluation is skewed. This is reinforced by the fact that none of the alternatives meet all criteria but somehow the alternatives that meet some criteria, but perhaps not #9, are selected for further evaluation. Examples of this include: Page 22 - Alternative #1 (no mention of not meeting criteria #9); page 23 - Alternative #2 (again, no mention of criteria #9); page 28-29 - Alternative #3 (apparently only looks at criteria #9 for one bypass, the SR-6 Bypass; page 30 - Alternative #4, bottom of the last paragraph "Setting the alignment away from the river's edge may also allow opportunities for environmental restoration (doesn't address criteria #9).

Response: *Alternative 1 could not meet any of the criteria as stated and therefore Criterion 9 was not listed. Alternative 2 should have had the statement that it does not meet Criterion 9 as a stand-alone alternative. Alternative 3, the alignment away from the river's edge does in fact meet Criterion 9 as stated in the sentence previous to the above-mentioned sentence, "additional studies will be required". Anytime the project can be kept away from the river's edge, an environmental benefit is gained by not having a direct impact to the riparian areas.*

Page 34 - 2nd paragraph "Although Alternative 5 met some of the project criteria, none of the design options could reasonably meet all of the criteria. Alternative 5 was therefore dropped from further evaluation."

This same thing could be said about all seven of the Alternatives (none could reasonably meet all of the criteria). This reinforces that not all the criteria are considered "equally important for meeting the project purpose."

Page 45 - 2nd paragraph "However, many of the non-structural features of Alternative 7 **would** be incorporated in any alternative identified as the preferred alternative. Non-structural measures that **would not be** specifically included....but, which **could be** undertaken by local jurisdictions... The local jurisdictions **would adopt**..."

First, please identify those non-structural features that would be incorporated in any alternative identified as the preferred alternative versus those that could be undertaken by local jurisdictions. Second, what control does USGS have over the adoption of the new FEMA 100-year floodplain maps?

Response: *The non-structural features from Alternative 7 that are incorporated as part of the preferred alternative. These include (1) elevation of structures, (2) definition of a new 100-year FEMA floodplain, (3) appropriate improvements in the flood warning system, (4) restriction of development in floodways and other critical floodplain areas, (5) restriction of filling in the floodplain, and (6) appropriate improvements to local stormwater management plans. As stated in Section 2.5.3, the local sponsor will implement the listed actions to the maximum extent possible; the actions will be included in the revised floodplain management plan that is required by E.O. 11988 for the project to be constructed. The Corps will review and approve the revised plan to ensure that the non-structural project components are appropriately incorporated into the plan, and will provide technical support to assist in development of non-structural features to assure the integrity of the project structural components. The elevation of structures is included*

as part of the cost-shared project. Eight homes showed to be economically justified for flood protection through elevating the structures.

Page 53 - middle paragraph "A new 100-year FEMA floodplain map will be generated...The communities will adopt this map.

What will happen if they don't adopt the new 100-year FEMA floodplain map?

Response: *The local communities can choose to adopt a new map based on the draft mapping prior to FEMA completing the final mapping and approval process. After FEMA has completed the new floodplain map, no adoption is required.*

Page 57 - Section 2.6 "Incorporating appropriate fish and wildlife habitat restoration measures to the maximum extent practicable is one of the defining criteria of the project and consistent with the Corps mission for environmental sustainability."

It seems that most of the other criteria rely on some form of cost/benefit analysis and yet the success of the criterion relating to habitat is measured by general statements such as "to the maximum extent practicable." How can you possibly compare one criterion with a cost/benefit analysis to another criterion that will be implemented "to the maximum extent practicable?" How do you define "To the maximum extent practicable?"

Response: *This is defined and based on what impacts a particular alternative would have and what would be required to either mitigate or, if mitigation is not required, what restoration could be accomplished to enhance the environment.*

Page 58 - 2nd paragraph (under Section 2.6 Potential Restoration Sites) "Each of the potential restoration measures is conceptual at this point and may be altered, eliminated, or combined with others as more detailed design studies are conducted."

This language could lead to the conclusion that very little actual potential restoration is guaranteed. At least make a commitment to a certain dollar amount or percent of the project budget that will be spent on restoration.

Response: *We are unable to commit to a percentage or dollar amount for restoration. Restoration is above and beyond what would have to be mitigated for. Restoration depends on the funds the sponsor has, obtainable real estate, and size of the restoration project.*

Page 84 - bottom of the last paragraph

Please clarify that only the water quality criterion for dissolved oxygen is relaxed, and it is only relaxed for the period from June 1 to September 15.

Response: *The sentence was edited to include the timeframe mentioned.*

Page 85 - last paragraph "The Centralia reach is a natural sill in the river..."

More accurately, the Centralia reach is caused by a natural sill.

Response: *The sentence in question was edited to reflect this information.*

Page 89 - second paragraph

The City of Centralia is no longer just proposing to build a new WWTP-- they are constructing a new one. In addition, it is not being built with the capacity necessary to serve as a regional facility. That capacity would have to be added later.

Response: *The sentence in question was edited to incorporate this information.*

Page 90 - last paragraph

The Temperature TMDL was approved by EPA in December of 2001

Response: *The sentence in question was edited to incorporate this information.*

Page 169 - 1st paragraph of Section 4.1.3.1 and page 176 Section 4.3.3.1

Any construction project disturbing more than 5 acres is required to have a site-specific stormwater pollution prevention plan. This plan must be available onsite and followed during construction.

Response: *Comment noted. A SWPPP will be prepared for the project and followed throughout project construction.*

Page 177 - 4.3.5 Summary

This paragraph references a section (4.13) that does not appear to relate to the text of this section. Is this a typo?

Response: *The typographical error has been corrected.*

Page 179 - Vegetation Impacts

Mitigation for vegetation impacts could include riparian planting of tree species that would provide a positive shade benefit over time. This would help meet the intent of the temperature TMDL for the Upper Chehalis River.

Response: *The Corps agrees that planting of tree species could provide shade benefit over time and help with the temperature issue. However, we must look at this as restoration as we are mitigating for the loss of wetlands and not vegetation.*

Page 180 - 2nd paragraph

This is probably stated somewhere else in the DEIS, but who is responsible for maintaining the levees once they are constructed?

Response: The local sponsor will be forming a diking district/flood district.

FINAL US FISH & WILDLIFE COORDINATION ACT REPORT FOLLOWS ...



United States Department of the Interior

FISH AND WILDLIFE SERVICE

510 Desmond Drive SE, Suite 102
Lacey, Washington 98503
Phone: (360) 753-9440 Fax: (360) 753-9008

Colonel Ralph H. Graves, District Engineer
Corps of Engineers, Seattle District
Attn: Beth Coffey
P.O. Box 3755
Seattle, Washington 98124-2255

Dear Colonel Graves:

Subject: Final Fish and Wildlife Coordination Act Report for the Centralia-Chehalis Washington General Reevaluation Report (Centralia Flood Study)

Enclosed are five copies of our final Fish and Wildlife Coordination Act report (CAR) on the Centralia-Chehalis Washington General Reevaluation Report (Centralia Flood Study). It is being provided under the provisions of the Fish and Wildlife Coordination Act (48 Stat. 401, as amended; 16 U.S.C. 661, *et seq.*) and fulfills Section 2(b) of this Act.

We have been actively involved in the alternative formulation and selection process, review of technical documents, and planning of mitigation and restoration elements. We have closely coordinated with other resource agencies, including the Washington State Department of Fish and Wildlife (WDFW) and Chehalis Indian Tribe. We provided the WDFW and the tribe with copies of our Draft CAR and received verbal comments, which we have incorporated into this final document. We provided the Corps with our draft CAR prior to issuance of the draft EIS. We have revised our final report to reflect the Corps' comments as presented in draft EIS.

We appreciate the direction the Corps has taken with this project and the coordination done in selection of the least environmentally damaging alternative. We support the concept of the setback levees. However, the short planning timeline for this project has meant that many details we had hoped would be finalized by now are yet to be developed.

First, we are concerned about how well nonstructural measures will actually contribute to the protection of natural flood plain functions on the river side of the levees. If nonstructural measures do little to restrict further commercial development and fill of the flood plain, then one of the major benefits of the setback levee approach—natural flood plain function—would be limited.

Second, the Corps has not coordinated with resource agencies and tribes to determine the adequacy of mitigation to compensate for project impacts. The Corps has proposed the SR-6/Scheuber Ditch mitigation project, which we support, but has not demonstrated that it alone is

sufficient as mitigation. In addition, many details remain to be developed about how this mitigation project would function.

Third, we do not yet know specifics about the impacts that could occur from altering flows in the Skookumchuck River, nor are we certain about how these would be mitigated. We would not support mitigation for those impacts in a different basin. The Corps has indicated that geomorphic and sediment studies will commence during the next phase of planning to help determine the significance of these impacts in the Skookumchuck River. As of yet, we have not participated in the scoping or planning of these studies.

Fourth, although the project purpose identifies habitat enhancement as an important part of the project, the Corps has not selected any restoration projects above and beyond the SR-6/Scheuber Ditch mitigation proposal. It has not indicated that it will undertake additional restoration.

Finally, the Corps has not yet discussed details about monitoring and adaptive management with our agency or other resource agencies. This is a huge project with many potential impacts. Assumptions have been made about the magnitude of impacts that we are not certain are correct. The short timeline has meant that many contingencies have not been well thought out. A few years from now, we may discover that the project needs to be operated differently for flood control, or that mitigation sites are not functioning well, or that impacts are much greater than predicted. We need to have the ability to take corrective actions should they be necessary.

We want to make sure that the issues described above are addressed with sufficient detail and clarity to alleviate our concerns about potential impacts. Accordingly, we are recommending that the Corps convene a mitigation workgroup, composed of the U.S. Fish and Wildlife Service, affected resource agencies and the tribes, to participate in the development of these plans and studies. Our support for the proposed project will depend upon the quality of the plans described above, the commitment to their implementation, and the degree to which the Corps coordinated with others while developing them.

Thank you for the opportunity to work with you and your staff on this project. For further information, please contact Lou Ellyn Jones at 360-753-5822 or Lynn Childers at 360-753-5831.

Sincerely,

Original signed by Lynn P. Childers

Ken S. Berg, Manager
Western Washington Fish and Wildlife Office

cc:

WDFW, (Olds)
WDOE (Sokal)
WSDOT (Park)
Chehalis Tribe (McGinnis)
EPA (Clark)

U.S. Fish and Wildlife Service

FINAL

Fish and Wildlife Coordination Act Report

**CHEHALIS, WASHINGTON, GENERAL RE-EVALUATION REPORT
AND ENVIRONMENTAL IMPACT STATEMENT**

**Prepared for
U.S. Army Corps of Engineers
Seattle District**

December 20, 2002

**Prepared by
Lou Ellyn Jones, Biologist
U.S. Fish and Wildlife Service
Western Washington Fish and Wildlife Office
Lacey, Washington**

TABLE OF CONTENTS

(page numbers shown are internal to this EIS, not the original FWCAR)

	<u>Page No.</u>
INTRODUCTION	383
PROJECT LOCATION AND SETTING	384
PROJECT BACKGROUND	390
PROPOSED ACTION	393
LEVEE SYSTEM.....	393
SR-6/SCHUBERT DITCH PROJECT	394
MODIFICATIONS TO SKOOKUMCHUCK DAM	394
NONSTRUCTURAL MEASURES	395
MITIGATION AND RESTORATION	396
ALTERNATIVES CONSIDERED	397
RELATED ACTIONS AND PRIOR STUDIES	398
FISH AND WILDLIFE RESOURCE CONCERNS	400
SALMONIDS AND SALMONID HABITAT	400
HISTORIC CONDITIONS.....	401
HABITAT-FORMING PROCESSES	403
TERRESTRIAL HABITATS	416
COVERAGE OF RESOURCE TOPICS	419
RESOURCE PROBLEMS, PLANNING	419
OBJECTIVES AND OPPORTUNITIES	419
EVALUATION METHODS	420
FISHERY RESOURCES	422
WILDLIFE AND BOTANICAL RESOURCES	424
ALTERNATIVE SELECTION PROCESS	427
FUTURE WITHOUT THE PROJECT	429
FUTURE WITH THE PROJECT	431
DISCUSSION	433
RECOMMENDATIONS	439
SUMMARY	444
LITERATURE CITED	446

INTRODUCTION

For over a century, urban, residential and road development within the Chehalis River floodplain in and near the cities of Centralia and Chehalis, Lewis County, southwest Washington State, has increased risk from flood hazard. In recent years, flooding was severe in both of these cities and closed Interstate Five (I-5) on several occasions. In addition to flooding, the Chehalis Basin ecosystem is degraded and populations of anadromous fish have declined. The southwest Washington population of coastal cutthroat trout is a species of concern and coho salmon is a candidate species under the Endangered Species Act. The U.S. Army Corps of Engineers proposes a setback levee system and modifications to the Skookumchuck Dam as the most feasible solution to flood problems. Included with the project proposal are nonstructural measures to reduce the risk of flood hazards.

This Fish and Wildlife Coordination Act Report (CAR) presents the U.S. Fish and Wildlife Service's (Service) conclusions on the benefits and adverse impacts to fish and wildlife expected to occur if the proposed action goes forward. This CAR is provided under the provisions of the Fish and Wildlife Coordination Act (48 Stat. 401. as amended: 16 U.S.C. 661, et seq.) and fulfills Section 2(b) of this Act.

This report is based on our participation in the planning and development of the proposed project since scoping began in September 1999. Our staff also participated in the planning of a Corps project authorized in 1986 to raise the Skookumchuck Dam for flood control. That project did not go forward because it was found to be economically infeasible. The current project re-evaluates modifications to the 1986 authorized project.

The local sponsor and the Corps initially indicated a goal of obtaining Water Resources Development Act (WRDA) 2002 funding. The short time line implied by this goal has driven the alternative selection process and influenced decisions along the way. Our involvement has focused on encouraging the Corps to select a preferred alternative that would have the least environmental impacts.

We have been actively involved in the alternative formulation and selection process and review of technical documents. We expect to be involved in planning mitigation and restoration elements. We were not provided with the opportunity to participate in the scoping and implementation of the fish and wildlife habitat study (PIE 2001), although we provided comments once it was completed. This report is based on documentation provided by the Corps, on studies and reports done prior to or in conjunction with the feasibility study, and on field investigations, discussions with technical specialists, and literature reviews conducted independently. During our participation, we have coordinated closely with and obtained information from the Washington State Department of Fish and Wildlife (WDFW), the Chehalis Indian Tribe, the Washington State Department of Ecology, and the Environmental Protection Agency. We provided the Chehalis Indian Tribe and the Washington State Department of Fish and Wildlife with copies of our Draft CAR. We have received verbal comments about the report, which we have incorporated into this final version. We provided the Corps with our draft CAR

prior to issuance of the draft EIS. We have revised our final report to reflect the Corps' comments as presented in draft EIS.

Corps authority for this project includes the authorization of the Skookumchuck Dam Modification Project under Section 401(s) of the 1986 Flood Control Act (PL 99-662), the project that was dropped. In 1998, Congress adopted Resolution 2581, authorizing the Corps to determine whether the recommendations made under the previous study should be modified "with particular reference to flood control and environmental restoration and protection, including nonstructural floodplain modification."

PROJECT LOCATION AND SETTING

The Chehalis River Basin, in southwestern Washington State, is the second largest watershed in the state, draining approximately 2,660 square miles (Chehalis River Council 1992) (Figure 1). The basin includes Water Resource Inventory Areas (WRIAs) 22 and 23. Only the Columbia River basin is larger.

From its headwaters in the Willapa Hills in eastern Pacific County, the Chehalis River flows east (Figure 2). It turns abruptly north near the city of Chehalis, where it is joined by the Newaukum River. Downstream, at the confluence with the Skookumchuck River and near the city of Centralia, the river trends northwest and begins to drain the South Puget lowlands. The river then flows primarily to the west, draining the southern Olympic Range and finally emptying into the Pacific Ocean via Grays Harbor.

The project area is approximately in the middle of the upper Chehalis River Basin (WRIA 23), an area draining 1,294 square miles and defined as all waters passing the stream gauge at the town of Porter (Wildrick et al. 1995). Vegetation type in the basin is largely westside lowland conifer/hardwood forests as described by Johnson and O'Neil (2001) with a primary land use of forestry. Land ownership in the basin is largely private, with smaller areas of state, federal and tribal ownership (Figure 3). The Upper Chehalis River basin spans five counties: Lewis (60%), Thurston (24%), Grays Harbor (11%), Pacific (4%), and Cowlitz (1%).

The project area encompasses the cities of Centralia and Chehalis and is bisected by Interstate Five (I-5) (Figure 4). Land use includes forestry, agriculture, low density residential, and urban development. Development is occurring along the I-5 corridor, especially in Thurston County.

Figure 1 Chehalis Basin WRIAs 22 and 23

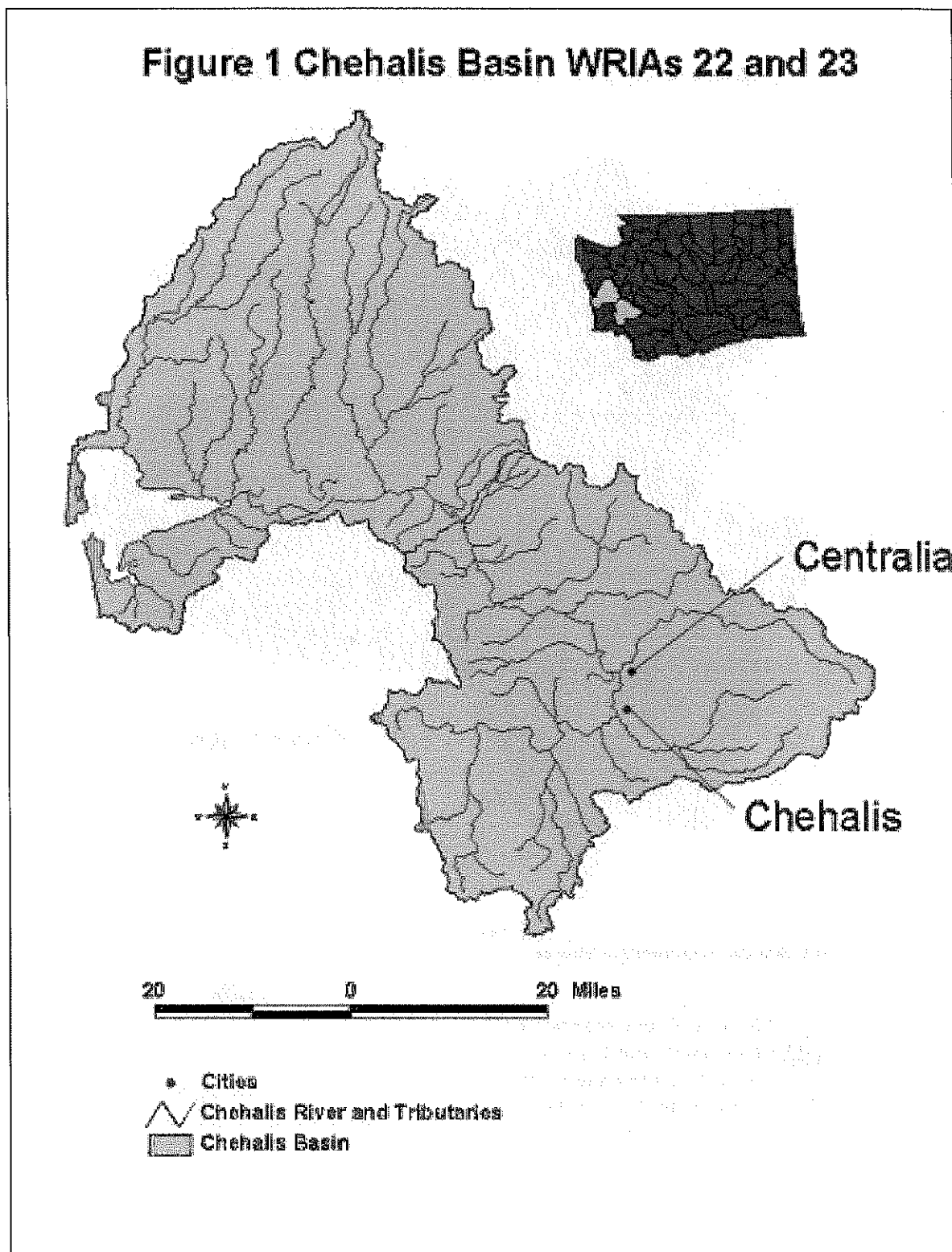
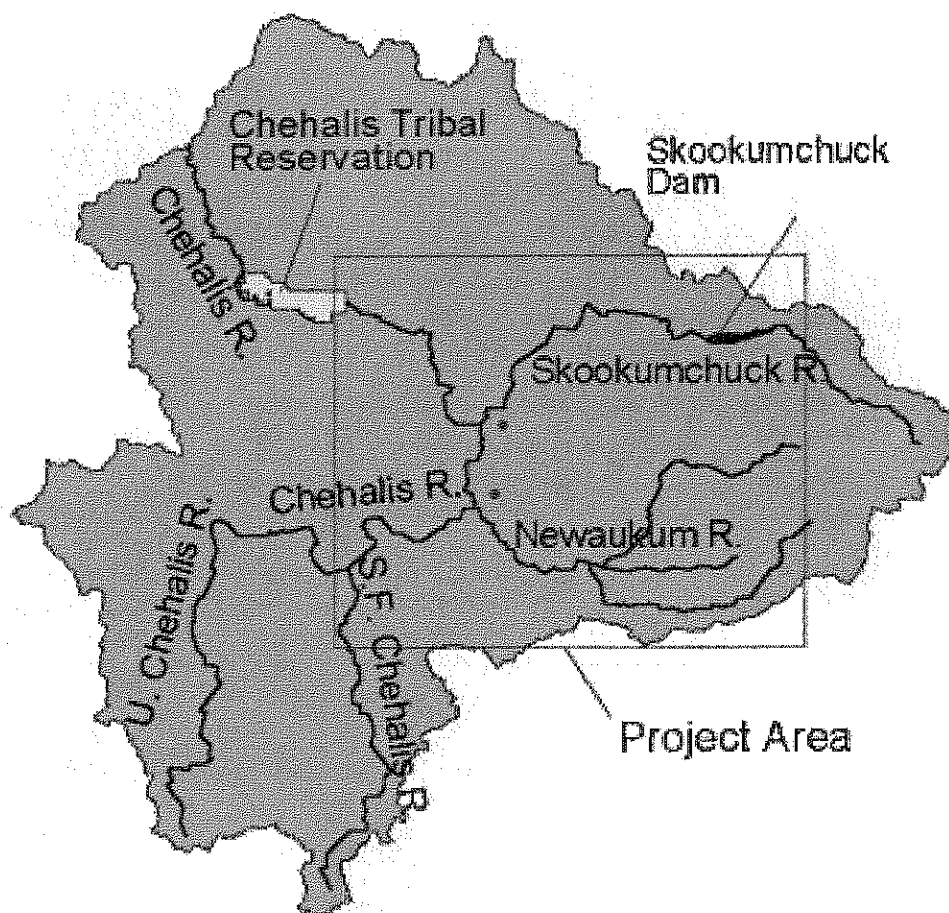


Figure 2 Upper Chehalis Major Tributaries

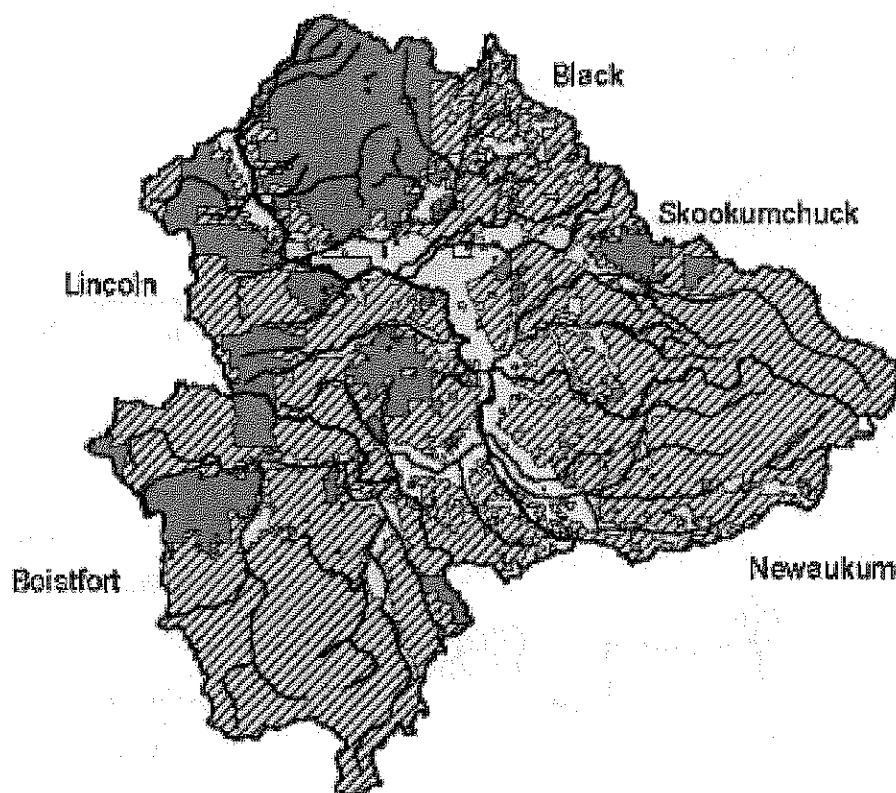


0 20 Miles

-  Chehalis Tribal Reservation
-  Skookumchuck Reservoir
-  Cities of Centralia and Chehalis
-  Chehalis River and tributaries
-  Upper Chehalis Basin



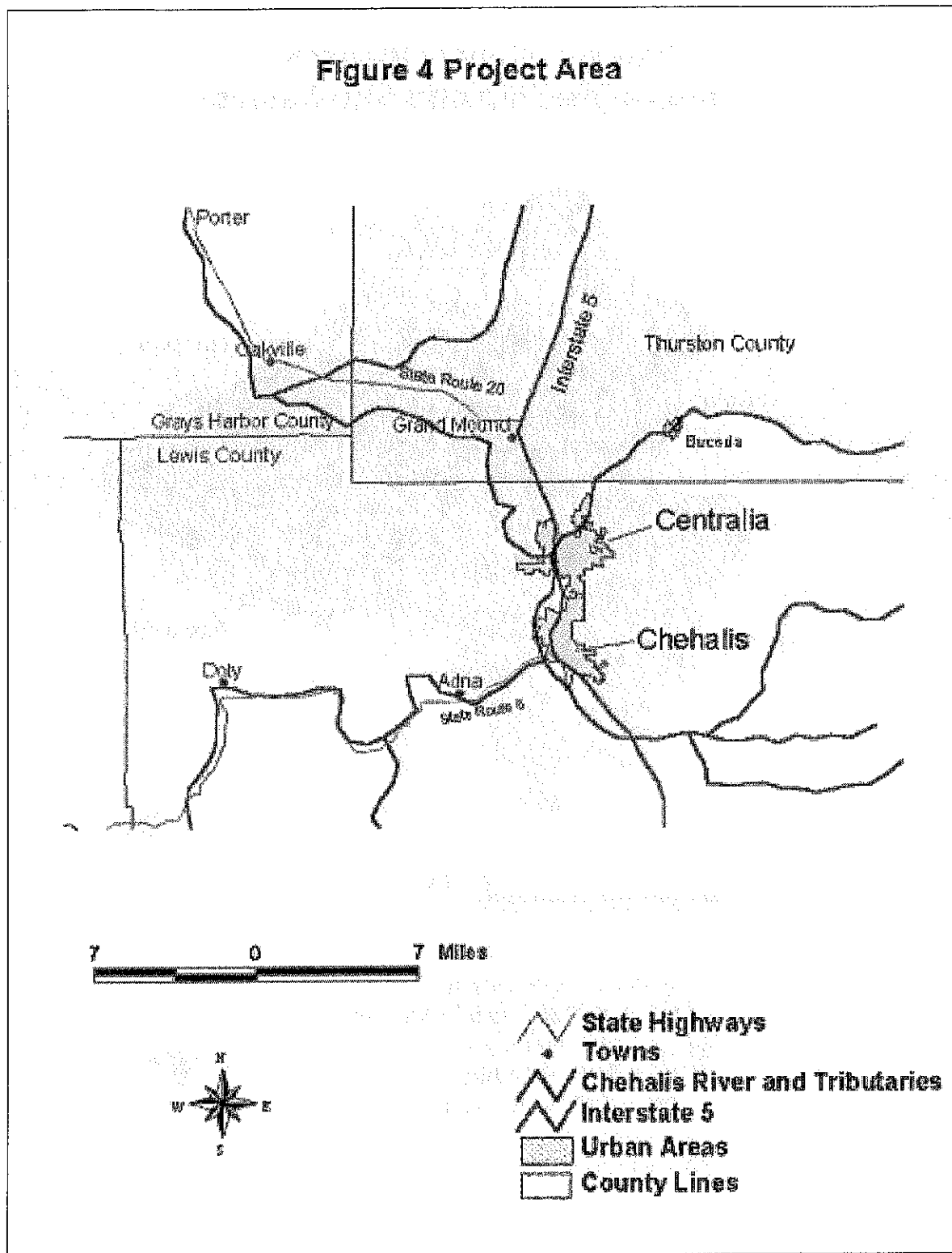
**Figure 3 Upper Chehalis
Land Ownership and Sub-basins**



0 20 Miles

-  WRIA 23 Sub Basins
-  Chehalis River and Tributaries
-  Private Forest Land
-  Private Non-Timber
-  State Fish and Wildlife
-  State Parks
-  State-owned Forest Land
-  Chehalis Indian Reservation





The Corps has identified the project area to include the Chehalis River main stem from Oakville (RM 47) near the Chehalis Indian Reservation upstream to Pe Ell (RM 100), and including portions of the Newaukum and Skookumchuck Rivers and Salzer Creek. The project area extends to the Skookumchuck Dam (RM 7.5) and includes the reservoir. The Skookumchuck River originates from the west slope of the Cascade Mountains, draining an area of approximately 183 square miles. Upstream of the Skookumchuck Dam, the sub-basin is hilly and in forestry land use. Downstream of the dam, the river enters a broad, flat valley and land use is primarily agriculture and rural residential. The confluence with the Chehalis River is at the city of Centralia.

CLIMATE AND HYDROLOGY

The Chehalis Basin lies in the Pacific Coast Ecoregion, west of the Cascade Mountain range in Western Washington as described by Naiman and Bilby (1998). The climate is typical of the Pacific Northwest maritime region, with cool, wet winters and warm, dry summers. Some parts of the basin capture more precipitation than others. The Willapa Hills, for example, average more than 120 inches of rain per year, while the cities of Centralia and Chehalis average only 40-50 inches per year. Peak flows in the sub-basins are variable depending upon rainfall, hill slope, and vegetation characteristics.

Most of the rainfall in the upper Chehalis basin occurs from October through May; December is the wettest month, and July and August the driest (Wildrick et al. 1995). Compared to more northerly rivers that derive much of their annual discharge from snowmelt, the Chehalis Basin is rain driven. This means that a high proportion of annual discharge occurs during the first three months of winter compared to snow melt basins where flows are highest during spring and early summer from the melting snow pack. Although large amounts of snow fall occur periodically in the upper tributaries and the headwaters, this is not usually a significant factor in the timing or magnitude of stream flows in the Chehalis (Wildrick et.al. 1995).

GEOLOGY AND TOPOGRAPHY

Continental glaciation during the Pleistocene period has strongly influenced present day geology and hydrology in the project area. Areas of the Skookumchuck River downstream of the dam and the upper South Fork Newaukum River have enormous quantities of both porous gravels and sands (outwash), that washed off the glacier as it was melting, and relatively impermeable hardpan (till) (Cherry 2001). The south and southwestern part of the basin is underlain by bedrock with a volcanic or marine sedimentary origin. Over time, fluvial and/or glacial deposits collected in the stream valleys over this bedrock. Streams then eroded these deposits to form a characteristic series of benches and terraces that get successively narrower and younger as they approach the river (Weigle and Foxworth 1962). The older terraces have eroded into a rolling, foothill appearance.

Alluvial and glacial deposits in the valley bottoms are usually no more than 100 feet deep and constitute surficial aquifers. These aquifers form a hydraulic connection between ground water

and surface waters and provide base flows for the Chehalis River and its tributaries during dry months (Wildrick et al. 1995).

Topography is gentle, with elevations ranging from 3,600 feet in the upper Skookumchuck Sub-basin to 150 feet in the "Centralia Reach," that portion of the river between the cities of Chehalis and Centralia. From its source, the main stem is steep, with a gradient of 16 feet per mile, flattening to 1 foot per mile at the confluence with the Skookumchuck River (Tetra Tech 2001). The river in the Centralia Reach is sinuous and the floodplain is broad with numerous oxbow lakes and meander scars.

PROJECT BACKGROUND

A significant amount of state and federal funding has been spent in the upper Chehalis basin to reduce flood hazard and to restore habitat for salmonids. Although initially configured solely as a flood risk reduction project, the Centralia Flood Study includes as part of its project purpose to "incorporate appropriate fish and wildlife habitat improvements."

In 1986, Congress authorized the Corps to construct "works of improvement" that would reduce flood damages in the Skookumchuck Valley, the city of Centralia, and the town of Bucoda. The authorized project was to modify an existing, private, water supply dam on the Skookumchuck River to provide extra flood storage. The project was subsequently dropped because it could not be justified economically.

Severe floods occurred in 1990 and 1996 that caused damage to the cities of Centralia and Chehalis and closed I-5 to traffic. According to the Corps, the closure of I-5 for three days caused a severe economic loss to the region. The local project sponsor, Lewis County, contracted with Pacific International Engineering (PIE) to identify modifications to the 1986 authorized project (the dam raising proposal) that might result in a more cost-effective project, taking transportation delays into account. This proposal, called the "Lewis County Alternative," was detailed in a Draft Interim Report (PIE 1998). That report proposed several variations of an alternative that would raise the dam, excavate a 2.5 million cubic yards flood bypass channel near the Mellon Street Bridge and use the resulting fill to construct a 1.5 mile long berm in the floodplain to divert flood waters. In 1998, Lewis County requested the Corps to resume design work on the originally-authorized project with PIE's proposed modifications. In 1998, Congress authorized the Corps to re-evaluate the authorized project along with other alternatives that would address flooding and environmental problems.

Degradation of salmonid habitat in the Chehalis River Basin has been a concern for years, and both state and federal funds have been used for restoration purposes. In 1990 Congress authorized the Chehalis River Basin Fishery Resources Study and Restoration Act. Under this authority, habitat degradations were studied throughout the Chehalis Basin (Wampler 1992), and Congress later recommended funding restoration projects through the Chehalis Fisheries Restoration Program, to be conducted by the U.S. Fish and Wildlife Service. Although Congress originally recommended \$1 million per year, the program has consistently received only about \$200,000 per year for restoration projects. In 1999, Puget Sound chinook salmon and Coastal

Puget Sound bull trout were listed as threatened under the federal Endangered Species Act. As the result of these listings, Washington State initiated a number of actions to restore salmonid habitat, including watershed planning, analyses of factors limiting to salmonids in various watersheds, and funding for restoration projects.

Although chinook salmon are present throughout the Chehalis basin, this population is not listed under the ESA. Bull trout have been observed in the lower Chehalis Basin but it is unknown whether they occupy the upper basin. Southwestern Washington populations of coho salmon, present throughout the basin, are candidates for listing.

As the Corps began its planning process in 1998, resource agencies and other local jurisdictions raised concerns about the momentum of the "Lewis County alternative" and the failure of the process to develop less environmentally-damaging alternatives that could also meet the project purpose. Accordingly, the Washington State Legislature provided funds for the Washington State Department of Transportation (WSDOT) to form an interagency workgroup that would develop an alternative that met a wider range of stakeholder needs. That workgroup, formed of resource agencies, local governments, citizen groups, and tribes, developed the "Interagency Alternative," a sequential process that assessed the benefit of nonstructural measures to reduce the risk of flood hazard before considering structural solutions. With input from this interagency workgroup, the Corps formulated several additional alternatives and measures to consider as part of its re-evaluation study.

In a related effort, the Corps has partnered with Grays Harbor County to assess historic and existing conditions of the Chehalis River basin in order to provide ecosystem restoration and ancillary flood damage reduction benefits throughout the basin. This Ecosystem Restoration General Investigation (GI) study, which we will refer to in this report as the Chehalis Basin Study, was authorized in 1999. It grew out of the conviction by the Corps, resource agencies and local communities that some of the local flooding and erosion problems in the basin were related to ecosystem degradation. It was assumed that a Corps project that addressed restoration on a grand scale would address some of the degradation and help salmonid populations. At the same time, local flooding problems might be decreased. Through our involvement with the flood project, we evaluated many restoration activities that would be appropriate for implementation by the broader study.

As part of its statewide proposal to widen I-5, the Washington State Department of Transportation (WSDOT) planned to raise the grade of I-5 near the cities of Centralia and Chehalis to prevent flooding. Because a Corps flood project would eliminate the need to raise I-5, WSDOT has provided local cost share for the project, although Lewis County remains the local sponsor. Protecting I-5 has been an important element in providing economic justification for the project.

BACKGROUND ON THE SKOOKUMCHUCK DAM

Skookumchuck Dam, built in 1970, is owned by a consortium of public and private utilities. PacifiCorp operates the dam to provide water to the 1,400 megawatt Centralia Steam Electric Plant and supplement flows to benefit fish. The dam operates so that the reservoir fills each year

with the first heavy rains in the fall and allows subsequent inflow to spill over the dam until the reservoir level drops down again due to decreasing inflows.

The 540 acre reservoir holds 38,700 acre feet of water between the normal minimum pool elevation at 400 feet to the spillway crest at elevation 477 feet mean sea level. The dam is an earth fill structure approximately 190 feet high with a crest at elevation 497 feet. During storm events, the flows top the spillway, however, there is limited capacity to release water once the pool elevation drops below 477 feet.

Water discharge from the dam depends upon pool elevation. Three intake structures at elevation 449, 420, and 378 lead to an outlet works consisting of two concrete encased steel pipes cut in rock under the dam. Outlet capacity, controlled by two 24 inch Howell-Bunger valves, is from 150 - 220 cfs. As the pool rises and reaches the level of each intake, outflows adjust on an continuum from 95 cfs with one intake submerged, 140 cfs with two intakes submerged, and 220 cfs with all three intakes submerged. Once the reservoir is filled, water is discharged both from the outlet works and over the spillway. Outflows from the dam average from 95 cfs to 1200 cfs, depending upon the month, with flows during a 100 year event reaching as high as 7,425 cfs.

Steelhead spawners are captured and hauled upstream of the dam but there is no other upstream fish passage. It is assumed that downstream migrants, including steelhead juveniles, smolts, and adults, and resident cutthroat trout, survive passage over the spillway or through the three outlets. However, we have seen no studies to confirm or deny this. We are uncertain whether the intake to the power generation facility has fish screens to prevent fish from being drawn into the turbines.

The three outlets allow water temperature below the dam to be maintained at less than 60 degrees for fish. Part of that water is used in a fish rearing facility owned by the Washington Department of Fish and Wildlife (WDFW) about 0.5 miles downstream of the dam.

The dam owners and the Washington State Department of Fisheries initially developed a fisheries agreement to set flow and temperature standards for fish, formalize dam operations that affect fish, and set hatchery operation to mitigate for fish habitat lost due to construction of the dam. A revised Skookumchuck Dam Agreement was prepared February 23, 1999 between PacifiCorp (representing a consortium of public and private utilities that own the Centralia generating plant, the coal mine, and Skookumchuck Dam) and the Washington State Department of Fish and Wildlife (WDFW) revising standards for in-stream flows to aid chinook spawning, flows for drought conditions, water temperatures, and Standard Operating Procedures for the winter steelhead program. There were no provisions for flood storage.

Lewis County and PacifiCorps are conducting negotiations with the current owners for transferring ownership of the dam to a flood control district that will operate and maintain the facility for flood control. We are uncertain whether the power facility at the dam will be decommissioned by the new owners.

PROPOSED ACTION

The recommended plan was developed with guiding principles that included 1) avoiding and minimizing environmental impacts, 2) minimizing initial construction and long-term maintenance, 3) minimizing project-induced damages within the project area and downstream, 4) avoidance of inundating or excavating hazardous materials, 5) maximizing transportation corridor and local infrastructure flood protection benefits, and 6) incorporating restoration opportunities.

The plan consists of several components: 1) a "setback" levee alignment to protect flood-prone areas in Chehalis, Centralia, and the airport, 2) a flood bypass under SR 6 to increase flooding of the floodplain to the north of State Route 6, intended as mitigation for project impacts, 3) operation of the Skookumchuck Dam for flood control, and 4) implementation of nonstructural measures developed by the Interagency Workgroup. Although the Corps had a Draft Restoration Plan prepared (Tetra Tech 2001), we are uncertain whether the Corps intends to incorporate any of these projects as part of the recommended plan.

LEVEE SYSTEM

This component is proposed to protect urban areas and I-5 by upgrading existing embankments and constructing new levees and/or floodwalls along the Chehalis and Skookumchuck River floodplains and tributaries to provide 100 year protection. Our understanding is that the Corps will be constructing 15.4 miles of new levees. We are still uncertain as to where, on the proposed levee alignment, the new versus upgraded levees will be. The Corps has stated that they will produce maps prior to the planning, engineering and design phase (PED) distinguishing the existing levees, where upgrades will take place, versus new levees planned for construction.

The Corps based the levee alignment on a proposal from the 1970s with refinements based on flood observations from the 1990 and 1996 floods. Hydraulic modeling allowed further refinements; for example, some levee segments could be deleted where flood protection was not needed, or better alignments could be found. For the most part, levees will allow the river to inundate the floodplain at small, frequent flood events but protect infrastructure such as residential and commercial structures, and transportation corridors, in more extreme events.

Because the levee system is intended to protect existing infrastructure rather than buildable land, the alternative is not expected to encourage further development of the floodplain. It appears, however, that local land use ordinances could allow some commercial development on the river side of the levees. Levee design was coordinated with WSDOT to ensure consistency with the widening of I-5.

The levee system will extend along the Chehalis River from approximately RM 75 to RM 64, along the Skookumchuck River from RM 5 to the confluence with the Chehalis River, and the lower two miles of Dillenbaugh and Salzer Creeks. The levees will have a 12-foot top width and 2:1 horizontal vertical slope. Where space for the levee footprint is limited, vertical floodwalls will be constructed.

SR-6/SCHEUBER DITCH PROJECT

The SR-6/Scheuber Ditch project is proposed to reduce flood stage in the Chehalis area by constructing a 400 foot flowway under a portion of SR-6 and elevating the roadway to provide clearance so that floodwaters would have better access to the floodplain. The opening would require excavation and grading of 65,000 cubic yards of material. The Corps states that excavated material would be used in levee construction where possible or disposed of in appropriate locations. We are uncertain whether disposal areas will be found outside of the floodplain. Flood flows would enter the floodplain to the north of SR-6 and return to the river at the downstream end of the floodplain storage area. In addition, two railroad openings and flow control boxes on Dillenbaugh Creek would be closed.

The Corps proposed the SR-6/Scheuber Ditch project as mitigation. The plan calls for connection of a large oxbow south of the SR 6 bridge and restoration of a connected wetland complex north of SR 6. Another wetland complex at the north end of Scheuber ditch would be connected to the Chehalis River. Tributaries currently flow into both of the proposed wetland areas. The proposal would include realignment of Scheuber Ditch to resemble a meandering stream, planting a 200 foot riparian buffer, and where possible, removal of agricultural drain tiles. The intent of these features is to provide summer rearing and overwintering habitat for coho salmon, to improve groundwater recharge and hyporheic connections, increase floodplain function, and improve wildlife habitat.

The Corps will develop more detailed plans for this mitigation feature during the PED phase in coordination with the resource agencies and affected Indian tribes. At that time, the Corps will better identify the flows needed for connection with the oxbow and bypass floodway, ways to minimize fish loss due to stranding, entrapment and predation, and anticipated maintenance needs. The local sponsor will be required to purchase in fee the property needed for the mitigation project.

MODIFICATIONS TO SKOOKUMCHUCK DAM

Proposed modifications to the structure and operation of Skookumchuck Dam would be intended to work with the levee system to reduce flood stage in Centralia. Flood control operations involve draw down in the summer through the fall to provide extra flood storage during the winter. The reservoir is planned to be at or below elevation 444 feet by early November, prior to the onset of flood season. Inflow to the reservoir would be passed through the outlet works to maintain the 444 foot pool elevation. The pool height is expected to remain fairly constant during the late spring, summer and early fall, would decrease in late fall, and may have large fluctuations in response to a flood event. Flood events are expected to be relatively short in duration, lasting around 4-6 days.

The current height of the dam is at elevation 497 feet; the crest of the spillway is at elevation 477 feet, providing a flood storage capacity of 11,000 acre feet. Initially, the Corps indicated that the levee with the "low dam" modifications (no increase in pool height above elevation 477 feet) comprised the National Economic Development Plan. Under this option, no additional flood storage would be created by use of a structure on top of the spillway. The levee and the "high

dam” modifications (i.e., use of a weir or gates to allow storage up to elevation 492 feet) comprised the locally preferred alternative.

We have since learned that the “high dam” option allowing an additional storage capacity of 9,000 acre feet will be part of the recommended plan. The spillway would be fitted with a pair of slide gates that would increase the maximum pool rise to elevation 492 feet.

Under the “high dam” alternative, the slide gates would not retain water at the higher pool elevation for longer than five days and would not be used more than once every other year. The Corps has stated that the gates, if constructed, would only be used for flood storage, and that they would only be used for a 70 year event, coming into full capacity at a 100 year event.

During a storm event, outflow from the dam will be controlled so that flow at the Pearl Street river gauge in Centralia does not exceed 5,000 cfs. Water would continue to be released after the storm event to lower the reservoir elevation and maintain flows at the Pearl Street gauge below 5,000 cfs.

During non-flood times, flows should continue to follow the patterns recorded at the Bloody Run gauge downstream of the dam. Flows at this gauge range from a low of about 100 cfs in the late summer to a mean monthly flow in late winter of 1,000 cfs to 3,000 cfs. The project proposes to continue operations under the fisheries agreement with the addition of more specific criteria for ramping rates for routine operations and times of flood control or spawning periods. Discharges would meet temperature requirements and meet or exceed existing minimum, in-stream flows. (See the Corps draft Skookumchuck Dam Fisheries review dated April 25, 2002).

NONSTRUCTURAL MEASURES

Some of the nonstructural elements discussed in the DEIS, such as elevating existing structures within the levees and a flood warning system, will provide flood hazard reduction with little environmental impact. For the protection of fish and wildlife habitat, the nonstructural measures need to also discourage continued urban development of the floodplain. The nonstructural measures that are most important in protecting a naturally-functioning floodplain include the following:

- 1) Adoption of a new regulatory 100 year floodplain map for use by the local communities in land use planning. This map would be an update of the existing FEMA map and would more accurately show the extent of flooding in the last few decades. The Corps states that the local communities will adopt the new floodplain map once FEMA has accepted that the proposed flood project will be completed. We are not certain of the time line for this to take place.
- 2) Restrictions or a moratorium on residential, commercial and industrial development in the newly defined floodway and flowpaths. During the PED phase of planning, the Corps will provide local governments, i.e., Lewis County and the cities of Centralia and Chehalis, with information on the post-project floodway and flowpaths, designations which will guide land use decisions. Two of the local jurisdictions, Lewis County and the

City of Chehalis, currently allow commercial development in the floodway provided it would not increase flood levels during a 100 year event. Our understanding is that this policy would not change appreciably post project. We are not certain whether development would be allowed on the river side of the proposed levees and if so, how extensive this might be in the future.

3) Restriction of fill in the floodplain (i.e., implementation of a “no net loss” policy for the capacity of the newly defined floodplain). In the DEIS, the Corps describes what a “no net loss” policy would be and how it might be implemented in a Comprehensive Flood Hazard Management Plan for Lewis County. However, we are uncertain whether the local sponsor intends to develop such a policy. According to information provided by the Corps, all three local jurisdictions have policies regarding fill in the floodplain, floodway or flood fringe. We are not certain to what extent these existing policies meet the intent of the recommended “no net loss” policy.

4) Development of a floodplain management plan consistent with the Executive Order on Floodplain Management, 11988. The Corps states that nonstructural measures that are part of the preferred alternative will be implemented to the maximum extent practicable by the local sponsor. The actions will be detailed in a revised floodplain management plan for the project, to be completed prior to signing of the cooperative agreement for project implementation. The Corps will work with the local sponsor to ensure that nonstructural actions support the integrity of the project’s structural components. The floodplain management plan will be developed during the PED phase of planning.

MITIGATION AND RESTORATION

Earlier in planning, the Corps provided us with a draft restoration plan that lists types of restoration “opportunities” that could be used to enhance fish and wildlife habitat (Tetra Tech 2001). We participated in the development of this conceptual plan (see Evaluation Methodology). At the time these were developed, no one was certain which alternative or combination of measures would be selected by the Corps as a recommended plan. The Corps and resource agencies generally agreed about the types of impacts expected to occur from various alternatives but we had no specific information about the magnitude of those impacts or how they should be mitigated. We assumed at that time that the “opportunities” would probably be appropriate as compensatory mitigation for certain types of impacts or as restoration projects to improve fish and wildlife habitat. To date we have not seen a mitigation plan, nor a determination of what specific restoration projects would be included as part of the proposed project.

Since we issued the draft CAR, the Corps has clarified the difference between mitigation and restoration for the proposed project. As we understand it, the SR-6 bypass project with enhancements of Scheuber Ditch and wetland complexes will be used as mitigation for the flood project. Restoration projects identified in the draft restoration plan are to be considered separately. We are uncertain what specific restoration projects will be incorporated as part of the Centralia Flood Study and whether the proposed SR-6/Scheuber Ditch project will adequately mitigate for project impacts.

ALTERNATIVES CONSIDERED

The following alternatives have been considered and evaluated during the project planning period.

NO ACTION

No flood damage reduction project would be constructed. It is assumed that flood damage would continue as documented. The WSDOT has stated that as part of their I-5 widening project, they would need to raise the grade of I-5 to 2.5 feet above the 100 year flood level, a stretch of freeway 2.9 miles long in the Centralia-Chehalis area.

SKOOKUMCHUCK DAM MODIFICATION

Modifications to the Skookumchuck Dam would provide flood storage in conjunction with other flood control measures to solve flooding problems along the Skookumchuck River, particularly in the town of Bucoda and the city of Centralia. This alternative would alleviate some of the back watering effect upstream of the confluence with the Chehalis River.

Various approaches to dam modification for flood control purposes have been developed for this project including, 1) the 1986 authorized project feasibility design, 2) two alternatives involving the installation of an inflatable rubber weir on top of the existing spillway crest; and 3) alterations to the outlet structure of the dam. Measures that increased the height of the dam would allow a pool elevation of 492 feet. Alterations to the outlet works would allow the rapid evacuation of stored water down to an elevation of 455 feet. Flood storage between elevations 455 and 492 feet would amount to about 20,000 acre feet.

FLOODPLAIN MODIFICATIONS

Several variations of floodplain modifications, including the "Lewis County Alternative," were developed to reduce flooding in the cities of Chehalis and Centralia, and to prevent overtopping of I-5 and SR-6. All of these were intended to work with some form of dam modification. Variations in these alternatives came from the need to evaluate different locations for the large excavation flowway bypass. The "Lewis County Alternative" was chosen for further consideration and included the following elements: 1) excavation of a flood bypass (from 1 to 2.5 million cubic yards) between River Mile (RM) 68 and RM 66 near Mellon Street Bridge, 2) modifications to the Skookumchuck Dam to provide flood storage, and 3) excavation to improve conveyance of flood waters under SR 6, and 4) creation of a 1.5 mile long berm to direct and attenuate flood waters. A document produced by PIE (1998) states that the extra flood storage provided by the dam would mitigate the downstream flooding expected to occur from the increased conveyance.

LEVEE

The levee proposal is intended to reduce flood damages, address flooding along Salzer and Dillenbaugh Creeks and the Newaukum River, and keep I-5 open. The basic levee alignment was developed through a previous study in the 1970s to protect flood prone areas in Chehalis and Centralia. The levee system would upgrade existing embankments or levees and construct 10-15 miles of new levees that would allow the river to access the floodplain during frequent flood events but protect infrastructure in more extreme events. This alternative was originally conceived without the modifications to Skookumchuck Dam.

FLOW RESTRICTION DEVICES

The initial concept of the flow restriction devices was to increase floodplain storage in the upper watershed through numerous log jams or other devices, providing benefits to wetlands, groundwater recharge, and fisheries. The basis for this idea was that numerous log jams or areas of channel roughening in the upper watershed could provide habitat benefits, and by encouraging the lateral movement of water, these projects could provide flood attenuation in the project area.

NONSTRUCTURAL MEASURES

This alternative includes watershed management, reforestation, flood-proofing structures, evacuation plans, removal of structures on the floodplain, and land use changes to restrict new construction in the floodplain. Although these measures do not address flood elevations, they are intended to reduce economic damages and increase safety.

INTERAGENCY COMMITTEE ALTERNATIVE

This alternative was intended to reduce flooding hazards and restore river hydrology and floodplain function to support salmonids. Measures include land use changes to restrict construction and filling in the floodplain, adoption of new FEMA maps, an improved flood warning system, upgrades to the city stormwater systems, reduction of transportation closures through a traffic bypass, and measures to reduce flood frequency and duration. The alternative is a sequential approach that requires analysis of benefits of the initial, nonstructural actions before proceeding to more structural solutions.

RELATED ACTIONS AND PRIOR STUDIES

Several other actions being considered under separate processes or authorities have a bearing on the proposed project because of their effect on in-stream flows, fish passage, habitat quality, and/or spawner escapement.

CHEHALIS BASIN STUDY

Initiated by the U.S. Army Corps of Engineers, this general investigation study was authorized under Public Law 106-60 dated September 29, 1999. The intent of this feasibility study is to

address problems associated with flooding and ecosystem degradation throughout the Chehalis Basin. This study will assess potential solutions to problems and recommend a series of actions and projects that have federal interest and local support. The project will have two phases: Phase 1 (the programmatic) will formulate, identify and screen potential restoration projects to carry into phase 2. Phase 2 (project specific) will involve detailed study of selected project alternatives leading to a feasibility report and an EIS. The study is currently in Phase 1.

CHEHALIS FISHERIES RESTORATION PROGRAM (CFRP)

The Chehalis Fisheries Restoration Program (CFRP), administered by the Service, was authorized under Public Law 101-452 in 1990 with a goal of optimizing natural salmon and steelhead production while maintaining the existing genetic adaptation of wild spawners and allowing the highest compatible level of hatchery production. Federal funding, which has consistently been below that authorized by Congress, has averaged about \$200,000 per year for restoration projects, which include fish passage projects, fencing, and riparian planting.

CHEHALIS RIVER BASIN FISHERY RESOURCES: SALMON AND STEELHEAD STREAM HABITAT DEGRADATIONS

The Service mapped areas of habitat degradation in the Chehalis Basin (Wampler, et al.1993). The degradations included areas where a) loss of riparian vegetation had occurred due to agriculture, logging, livestock or unknown causes, b) where livestock had access to streams, c) areas of excessive sediment in stream bed, whether from unknown sources or bank erosion, and d) fish passage barriers. The report identified the source of degradations in some cases (i.e., loss of riparian vegetation and livestock access in the stream), but was less useful in identifying the source in other instances (i.e., excess fine sediments observed in the stream do not indicate where they came from). It also identified beaver dams and log jams as degradations although in most cases these structures are actually valuable to salmonids.

TOTAL MAXIMUM DAILY LOAD (TMDL) PROCESS

Under the Clean Water Act, states are required to identify sources of pollution in waters that fail to meet state water quality standards and to develop a plan to address those pollutants. This process, called the TMDL, found high water temperatures and low dissolved oxygen near the towns of Centralia and Chehalis. Based on these findings, a number of state and local activities are focused on reducing sources of pollution, including improvements in dairy and other livestock operations, and improvements in septic and city storm water systems.

LIMITING FACTORS ANALYSIS (LFA)

This study, implemented by the Washington State Conservation Commission, identifies habitat limiting factors for salmonids in the Chehalis River Basin based on existing information. The report states that one of the biggest problems in assessing habitat conditions and limiting factors for salmonids in this basin is the lack of field data. Many data gaps exist for all parameters. The LFA prioritizes restoration activities needed for salmon recovery. Completed in June 2001, the LFA for the Chehalis River Basin (WRIA 22 and 23) was mandated and funded through the State Salmon Recovery Act RCW 77-85. The report is useful in that it identifies data gaps and

summarizes what is known, and based on that existing knowledge, identifies habitat limiting factors by sub-basin (Smith and Wenger 2001).

WATERSHED PLANNING

Under the State Watershed Planning Act RCW 90.82, a planning group for the Chehalis Basin was formed of local and state government, citizens, tribes, and non-governmental organizations. The group, the Chehalis River Basin Partnership is implementing watershed planning, with an emphasis on water quality, water quantity and fish habitat.

Three watershed analyses provide detailed information about areas of the upper watershed (the Upper Chehalis, the upper Skookumchuck and the Stillman Creek). The Skookumchuck analysis was based on the area above the dam, which is inaccessible to most anadromous fish. Although these analyses can help in understanding some aspects of downstream conditions in the project area, their usefulness in assessing conditions in the project area is limited.

SALMON RECOVERY FUNDING BOARD PROJECTS

As one of many steps taken by the state of Washington toward salmon recovery, this entity oversees state funds for salmon protection and restoration projects and related programs that benefit fish and habitat. Restoration projects funded by the SRFB are selected through partnerships with state, federal, and local agencies, local communities, and tribes. The Chehalis Basin is the recipient of funds for restoration projects through this entity.

FISH AND WILDLIFE RESOURCE CONCERNS

SALMONIDS AND SALMONID HABITAT

We have focused on the potential impacts of this flood project to salmonids because a) salmonids are considered a keystone species with high value to fish and wildlife and the functioning of the riverine ecosystem, b) they have high cultural and commercial value, c) a flood project has high potential to alter aquatic habitat critical to salmonids, d) many of the ecological processes and factors that are important to salmonids (hydrology, riparian areas, wetlands, and functioning floodplains), are also important to wildlife, and e) salmonid populations have declined in Western Washington, resulting in the proposal or listing of various populations under the Endangered Species Act. Bull trout are listed as threatened in this basin. Coastal cutthroat trout are a species of concern, and coho salmon are candidates for listing in this basin.

Although salmonid species differ in their specific habitat requirements for each life stage, they all (including resident fish such as rainbow trout and resident cutthroat trout) share some common needs, including sufficient invertebrate organisms for forage, clean well-oxygenated water, clean gravel for spawning and incubation, and access to and from spawning and rearing areas.

In-stream habitat conditions in selected reaches of the project area are reported in the fish and wildlife habitat study prepared by Pacific International Engineering (PIE 2001). This study includes the proportion of glides, pools and riffles, the location of side channels, condition of stream banks, presence of large woody debris (LWD) and likelihood of recruitment and retention, spawning habitat, off-channel rearing habitat and holding habitats. In addition, this study evaluates the shading potential of riparian vegetation.

Although conditions vary widely, in general, rearing and holding habitat are inadequate in the project area including the Chehalis River mainstem, the upper Chehalis River, and the Newaukum Rivers. Side channels and off-channel habitat are rare, and where they exist, they are often inaccessible during low flow periods. Pools of sufficient depth to provide adequate holding habitat for migrating fish are few in number or else have insufficient cover to provide refuge (2001). Riparian condition varies with adjacent land use, but is considered inadequate throughout the project area.

The Skookumchuck River has somewhat better in-stream habitat, with a low to moderate amount of rearing habitat. Thirty-six percent of the reaches surveyed (33 reaches of 54 possible) contain side channels or off-channel habitat, half of which are inaccessible to fish during part of the year. A third of the surveyed reaches have holding pools with the frequency of pools greater in the middle and lower reaches. The side channels offer rearing habitat for juvenile salmonids, refuge from predators and high velocities, and foraging habitat (PIE 2001).

The degree to which these habitat conditions exist depends largely upon the adequate functioning of physical processes including a natural range of variation of flows, and the routing and delivery of wood, sediments, temperature, and nutrients. Our emphasis in this report has been on understanding the current functioning of these physical processes and how they might be altered by the proposed project. This process-based approach has guided our input on alternative selection and conceptualization of appropriate mitigation and restoration projects. For purposes of this report, we focused on the following process-based factors limiting to salmonids in the upper Chehalis River Basin: 1) hydrology, 2) floodplain connectivity, 3) sediment supply and transport, and 4) riparian condition and large woody debris supply and transport. We have also included some discussion on water quality and fish passage barriers because they are considered limiting factors for salmonids in this basin and because the proposed project could indirectly alter these conditions. We discuss three terrestrial habitats (riparian areas, wetlands, and floodplains), because they could be altered by the proposed project and because they are valuable for both fish and wildlife.

HISTORIC CONDITIONS

Habitat in the upper main stem Chehalis River was much more complex historically than currently, with wetlands and sloughs, beaver ponds, logjams, scour pools, bars, in-channel islands and riparian forests across a broad floodplain (Cherry 2001). This system was hydrologically connected and dynamic with large amounts of organic material and shifting channels that would have supported a high diversity and abundance of aquatic invertebrates, anadromous and resident fish, and wildlife. Cultural resource sites indicate that this was a highly productive area important for food and materials for Native Americans (Corps 2002).

Fish and wildlife evolved in this very complex habitat. Accounts by early settlers indicate that flooding was a frequent event:

In summer, [Lincoln Creek] is an ordinary creek, but [in winter], log jams in the Chehalis River backed the water up the creek, making the valley a sea from hill to hill.. The river was full of brush and drift and there were plenty of [fish]. Frequently in winter, this whole area [Salzer Valley] was like one large lake about four miles across. Many older residents [said that] canoes often plied over this flooded section (Smith 1942).

Log jams and large woody debris played a key role in shaping complex channel structure, channel meanders, and cover. In 1890, the Secretary of War assessed navigation conditions in the Chehalis River from Elma to Claquato, "the river is practically blockaded during the summer and fall by snags, shoals, and a general lack of water; at this time the river is a succession of shoals and pools." (As cited by the Corps 2002). These records indicate the presence of two log rafts totaling two miles in length near the present day Chehalis Indian Reservation near Oakville (Corps 2002).

Large woody debris acts to trap coarse sediments, and create backwaters to help route waters onto the floodplain (Sedell and Luchessa 1981). According to a geomorphic evaluation provided by the Corps, large woody debris and log jams acted as "switches" to trigger lateral migration of the river, create avulsions, form side channels, and guide flows into floodplain sloughs (Cherry 2001). The sinuosity of that system is still evident from aerial photos which show meander scars, abandoned oxbows and side channels that have been cut off from the river (SAIC 2001).

Pristine conditions were altered through numerous events, including: 1) removal of huge amounts of wood by the Department of War to improve navigation, and until the 1970s by government fisheries offices under the belief that large woody debris was undesirable because it blocked fish passage; 2) construction and operation of splash dams and log ponds used to store and float logs downstream to mills; 3) timber harvest, which reduced the amount of LWD that could enter the stream system and also altered hydrology and sediment inputs; 4) building and operation of the Skookumchuck Dam, which altered flood hydrology and blocked fish passage; 5) bank armoring and dike construction which constrained channel migration, prevented interaction with the floodplain, and reduced the riparian trees available for recruitment as LWD; 6) installation of drain tiles and ditching to drain agricultural lands; and 7) development and the increase of impervious surfaces that altered basin hydrology (Cherry 2001).

The extensive degradation of riparian areas has impaired recruitment of adequate-sized quantities of LWD in Puget lowland rivers. Logs that do enter the river system are smaller than they once were and rarely function well as key pieces to anchor the formation of log jams (Collins et al. 2002). Although many of the practices listed above have been discontinued, degradation persists in most areas and physical processes that would create or maintain aquatic habitat are still disrupted.

Sand and silt dominate the main stem bed material in the project area. Only four in-channel sediment bars exist between the Newaukum and Skookumchuck confluences, and these are largely composed of sand and silt, with small amounts of gravel. The substrate is coarser in the

Newaukum and Skookumchuck Rivers than in the Chehalis main stem. The geomorphic summary states that sediment from the upper watershed appears to settle out prior to reaching the project area so that sediments accumulated in the project area may be controlled by the rate of local supply, i.e., local bank erosion and riverbed scour (Cherry 2001a). Another theory is that local bank erosion produces sediment in such volumes and of such fine caliber that it overwhelms the signature of sediment from upstream sources as the two mix (Bakke 2002, 2002a).

Many riverbanks in the project area have exposed soils and are actively eroding at the toe. This toe erosion undermines the silty, sandy banks and they collapse into the river, resulting in raw bank surfaces that discourage establishment of vegetation (Cherry 2001a).

The effects of channel clearing, loss of riparian vegetation, alteration of hydrology and alteration of sediment and LWD transport is evident in a comparison of aerial photos from 1938 and 1999. These show that the channel has become more simplified with time with fewer islands, side channels, and sloughs. The channel appears to have become more disconnected from the side channels and the floodplain, and little channel migration has taken place. Areal extent of riparian cover appears to have changed little except that the riparian vegetation that exists currently is more likely to be deciduous than coniferous (SAIC 2001). The Newaukum and Skookumchuck River channels have been more dynamic in the last 60 years (Cherry 2001a). The North Fork Newaukum has serious channel incision and terrace erosion, in some areas with cut banks more than 12 feet high (Bakke 2002).

HABITAT-FORMING PROCESSES

Physical processes that create and maintain aquatic habitat (hydrology, channel dynamics, routing of large wood and sediment, etc.) in the project area have been altered by human activities. The following processes are considered limiting factors to salmonid production in the Chehalis River system.

Hydrology

The hydrological regime is extremely important because it drives all other riverine processes that create and maintain habitat important to fish and wildlife. These processes include floodplain connectivity, routing of sediments, and routing of wood and nutrients. Because of their biological importance and the potential that the proposed project could further alter those flows, we have focused on the following categories of flows for discussion: 1) floods, 2) over-bank flows, 3) channel maintenance (or bank full) flows, and 4) low flows.

Floods

In 1997, the Corps re-computed flood frequency curves for the Chehalis River. These show that a flood once considered an extremely rare event with the probability of occurring every 600 years (i.e., a 600 year event) is now on a recurrence frequency of 100 years. What were considered 35 year events in 1980 are now 15 year events (PIE 1998). This information indicates that large scale floods now occur with greater frequency in the upper Chehalis River than they

did in the past. We are using the term, “flood,” here to mean a large infrequent event of greater than 25 year recurrence. We will use the term later in this report in a less specific sense to mean higher flows that overtop their banks and enter the floodplain.

For fish and wildlife habitat, these infrequent events are both an opportunity for the creation of new habitat and an environmental risk (Benda et al. 1998). Large floods modify floodplains through channel migration, deposition of sediment, accumulation of logs and woody debris, or carving new terraces and many other floodplain features. Often these events can create salmonid habitat by avulsions and creation of new side channels or islands, or weakening large trees so that they are eventually recruited as large woody debris. The dynamic working and re-working of the channel and floodplain creates habitat complexity and increases aquatic productivity (Schroeder and Savonen 1997).

Floods are also an environmental risk. They scour spawning gravels, bury redds with fine sediments, or flush away incubating larval salmon and macro invertebrates, the main food source of salmonids (Ziemer and Lisle 1998). Larval salmon and aquatic insects that inhabit the interstices of gravel may be crushed or exposed to high water velocities that sweep them away. Floods also deposit fines into the interstices of the gravel, smothering organisms that dwell there. The risks from floods to salmonids and their prey are lessened in hydraulically complex stream reaches (i.e., with large wood, complex channel structure, or pools) that offer low velocity refuge. In addition, hydraulically roughened areas act to trap spawning gravels and reduce the rate of downstream transport (Pearsons et al. 1992, Schroeder and Savonen 1997).

As floods increase in frequency and magnitude, wood and coarse sediments are more easily transported downstream, particularly in channelized areas. This is the case in many parts of the Chehalis River, which has been referred to as a “depauperate” system, meaning it has little LWD. High water events typically increase erosion or trigger development of side channels, but where banks are armored, as they frequently are in the Chehalis (with concrete, auto bodies, and rip rap), or the channel is hydraulically smooth without large wood, the water may begin to scour away the bed, resulting in channel incision. Channel incision, which exists in many parts of the Chehalis system, increases the disconnection of the river from the floodplain and offers little opportunity for new habitat to form or to be retained in the system.

We are concerned about the potential for dam modifications to eliminate flood events that create and maintain off-channel habitats, recruit spawning gravel, and flush fines out of gravel. The levee system may constrict the area available for lateral flooding during large scale events. This could pass a higher flood stage downstream, which could result in disturbance of habitats lower in the watershed and a proliferation of flood or bank stabilization projects that would further degrade the system.

Hydraulic modeling indicates that the levee system would result in an increase in flood stage at a 100 year event in some areas (between RM 70.74 and RM 78, with a maximum of 0.61 feet at RM 72.8) and a slight decrease (less than one foot) in other areas. Based on the hydraulic modeling and geomorphic evaluation provided by the Corps, we believe that these impacts from the setback levees would be relatively minor. The Corps plans to conduct sediment studies in the

Skookumchuck River that will provide better detail about the types of impacts expected to arise from dam re-operation and how to mitigate those impacts.

Over-bank flows

Over-bank flows in many systems occur on a 1 to 10 years recurrence interval (Hill and Platts 1991). Despite the altered hydrologic cycle in the Chehalis basin, over-bank flows occur in the project area approximately every 2-5 years, except where levees are located (Tetra Tech 2001).

Over-bank flows are important for recharging groundwater aquifers which supply water to the stream during the dry season. When a stream floods, the water is stored in streambanks, in floodplains, and in wetlands. When a flow rises to the top of the bank, water moves into the streambanks, called "bank storage." This bank storage returns to the stream within a few days or weeks and can help attenuate flood peaks. When a stream overtops its banks and spreads out into the floodplain, widespread recharge to the water table occurs. In this instance, the water takes a much longer time, i.e., weeks, months, or in some cases, years, to return to the stream (Winter et al. 1998). Ground water and surface water are interconnected to such a degree that they should be considered a single resource.

Areas with poor permeability contribute less and areas underlain by highly permeable sand and gravel (as exists in the northern part of the project area), contribute more to base flow. Studies have shown that ground water contributions to river flows, termed "base flow" range from 14% to 90% (Winter et al. 1998). Much of that groundwater is from upland sources derived from infiltrated precipitation as well as river flooding. The Corps has stated that base flows are derived mainly from infiltration of precipitation, and that the contribution from overbank flows and flooding is relatively small.

Over-bank flooding is critical for productivity and community composition of the floodplain and riparian areas (Mundie 1991). Riparian plants on floodplains grow along a gradient of moisture and oxygen which is related to the frequency, timing, and duration of flooding (Hughes 1997). When the flood retreats in sequence with the growing season, for example, it affects the type of riparian community that develops, and this governs the quality of habitat provided to wildlife species (Sparks et al. 1990). Most riparian species can withstand varying degrees of inundation, however the season in which inundation occurs can be critical (Naiman et al. 1998). When the over-bank flooding is reduced in frequency, the riparian community comes to resemble upland plant communities, which may support fewer wildlife species (Nilsson 2000). Migratory birds depend upon finding food at a particular time on flooded floodplains and their chances for survival may decrease if the timing is off (Sparks et al. 1990).

Modification to the operation of Skookumchuck Dam for flood control is expected to reduce the frequency and extent of overbank flooding to a 2 year event or less. Data provided by the Corps indicates that most (72%) banks of the river currently do not experience overbank flooding at the 2 year event. Under the re-operation of the dam, this would occur even less frequently (Corps 2002a). We are concerned that the reduction in overbank flooding will reduce wetland recharge and alter the function and value of wetlands, floodplains, and riparian zones. Existing off-

channel habitats, many of which are already inaccessible at low flows, would tend to get overgrown with vegetation and fill in with a reduction in overbank flows.

Depending upon the flows at which this river flushes fines from the gravel, we could also see a build up of fines in spawning gravels, resulting in less usable spawning areas for salmonids. We are also concerned that reducing overbank flooding would restrict one of the processes (floodplain flooding) by which trees are weakened, root systems scoured, and large woody debris is recruited into the river.

Channel maintenance flows (bank-full flows)

Depending upon the stream, the annual maximum flood exceeds bank-full flooding about once every 1.5 to 2 years (Montgomery and Buffington 1998). At bank-full stage and higher, a river reconditions its channel and cleanses fine sediment out of spawning gravels. These flows determine the ratio of pools to riffle, and the pattern of sinuosity (Mundie 1991). The bank-full discharge is important for transporting sediment, preventing vegetation growth in the channel, and maintaining channel form (Hill and Platts 1991).

Depending on the size of the sediment particles, bed load transport occurs over a wide range of flows. Where gravel is present, flows that move the bed load are important because they allow fine sediments that would suffocate larval salmon to flush downstream (Hill and Platts 1991). Channel maintenance flows generally occur from a 2 year to 5 year event (P. Bakke, pers. comm 5-16-02).

Timing of bank full flows is also important. Peak flows govern the timing and extent of fish spawning runs. When floods occur during spawning runs, the distribution of spawning salmon increases (Hill and Platts 1991).

Operating the dam for flood control is expected to result in more frequent and longer duration bank-full flows than occur presently. This type of flow alteration could result in increased scour and transport of spawning gravels and large woody debris so that these materials become less and less common in the river over time. In addition, increased bank erosion could result in increased bank armoring. In areas where bank armoring already exists, the increased bank-full flows could result in increased bed scour and channel incision. We expect this to have an influence on sediment and large wood transport and routing, on channel maintenance, and the quality of instream habitats such as pools, pool/riffle ratios, and spawning beds. The Corps plans to conduct sediment and geomorphic studies of the Skookumchuck River during the PED phase of planning. These studies should help to determine in better detail the nature of impacts and how to mitigate them.

Low Flows

Low base flows are a problem throughout the main stem Chehalis and many tributaries. Data taken from the Porter stream gauge, indicated that the main stem flows from the Upper Chehalis Basin decreased 19% since 1953 while precipitation decreased only 6% (Wildrick et al. 1995). Many of the tributaries in the upper basin are closed to further water allocation, including Salzer

Creek, Dillenbaugh Creek, and the South Fork Chehalis River. Minimum base flows set by state rule are frequently not met in the Skookumchuck and Newaukum sub-basins (Smith and Wenger 2001).

The low base flows are believed to be related to groundwater and allocation of water resources. During low rainfall months, the Chehalis River and tributaries are maintained mostly by groundwater discharge from aquifers, and in WRIA 23, base flows depend solely on ground water discharge. The rate averages about 3 cfs gain per river mile in the Chehalis mainstem (Wildrick et al. 1995).

This dependence on groundwater is explained by the geology of the upper Chehalis basin. Much of the project area is underlain by the East Chehalis Aquifer, a 52 square mile aquifer located in the valley of the upper Chehalis River. It extends upstream from the confluence of Scatter Creek and underlies the main stem and south fork Chehalis River. This aquifer consists mostly of alluvial deposits of gravel, sand, silt, and clay. North of Centralia, and along the Skookumchuck River, the aquifer consists of sandy gravel outwash. The aquifer is thicker in the north (about 90 feet) and thins to the south. The water from this aquifer flows into the Chehalis River ranging from 0.5 to 4.5 cfs per mile. These inflows are higher in the area near Centralia due to higher hydraulic conductivities and increased aquifer thickness (Larson 1994). Although flows in the Skookumchuck River are augmented by releases from the dam, these releases are a small part of the total flow in the Chehalis River (Wildrick et al. 1995).

The Upper Chehalis Basin is believed to be over appropriated for water withdrawals. Consumptive water use partially explains the reduction of stream flows in the Upper Chehalis Basin. This water is used for irrigation, municipal use and power. Irrigation accounts for the highest withdrawal, drawing from both ground and surface water sources. (Mendoza 1998). Although minimum in-stream flows were set by the state in 1976, it is unclear the degree to which biologists were consulted about those levels and whether they meet the needs for fish (email communication, Jennings 2001).

In addition to water withdrawal, there may be impaired natural groundwater recharge in the upper Chehalis River Basin, although the amount would be difficult to quantify. In many areas of the Chehalis River, levees, roads or incised channels prevent flood waters from reaching the floodplain where they could recharge groundwater. In other areas, over-bank flows occur in developed areas over impervious surfaces or agricultural drain tiles, where there is no opportunity for recharge. Loss of wetlands, artificial diversion of flood waters through ditching and ground water withdrawals all contribute to a loss of base flows and poor water quality. Low flows have little effect on channel morphology but they are important biologically (Montgomery and Buffington 1998), particularly for salmonids. Low flows limit the access of juvenile fish to summer rearing areas and dry out available habitat. They can limit available habitat to spawning salmon (Wildrick et al. 1995).

In the Chehalis system, the production of coho smolts is influenced by several variables, including winter flows (which cause gravel scour and influence egg survival), summer flows (that ensure rearing habitat), and fall flows (which limit spawner distribution). The most important variable appears to be spawning flows during November and December, which explain

much of the variation in the smolt production. The hypothesis is that fall flows provide access to upper portions of the watershed for spawning adults. After fry emerge from gravel, they distribute generally downstream despite flows that might enable them to rear higher up in the watershed (Seiler 2002).

Reduced flows exacerbate water quality problems, because sufficient water is needed to dilute the effects of pollutants (Benda et al. 1998). This is of particular concern in the Chehalis River which is on the Washington State 303(d) list for not meeting state water quality standards for temperature, dissolved oxygen, fecal coliform and PCBs. Fish and wildlife habitat is degraded in various areas due to seasonal low flows, high temperatures and low dissolved oxygen. Water quality problems that are not injurious to fish under adequate flows may become lethal or a blockage to migration under low flow conditions (Ziemer and Lisle 1998).

Based on an evaluation by Corps hydrologists, the baseflow in the Chehalis River is derived mostly from infiltration of precipitation throughout the watershed. Although baseflows may be augmented immediately after a flood, the effect is unlikely to last into the dry season when low flows are a problem for fish. Based on this information, the proposed project may have less impact on groundwater and base flows than originally thought.

Floodplain connectivity

Lack of off-channel habitat or functioning wetlands are considered limiting factors throughout the Chehalis basin (Smith and Wenger 2001). These conditions are related to the altered hydrologic regime, disconnection of the floodplain from the river, and loss of channel migration (Tetra Tech 2001). The Limiting Factors Analysis prepared by the state (LFA) rates floodplain conditions in the project area on the Chehalis River main stem as "poor" because of channel incision, with a low width to depth ratio, and steep high banks (Smith and Wenger 2001).

Side channel habitat is documented in a third of the reaches surveyed in the Skookumchuck River, most of those in the upper and lower reaches (PIE 2001). The Skookumchuck River below the dam is primarily in agricultural or rural residential land use. Much of the lower river has encroaching development, and the banks are commonly armored. Channel incision is common here although the upper reaches are less confined. The armoring and channel incision prevents lateral spreading of water during higher flows so that the flood energy cannot dissipate. This may result in bed and spawning redd scour, filling in pools, and excessive transport of LWD. Development and bank armoring in the Skookumchuck and Hanaford sub-basins have limited the opportunity for future side channels to develop. Other sub-basins in the project area also have channel incision and little off-channel habitat, including the Newaukum, Salzer, and China Creek.

The main stem Chehalis River is disconnected from the floodplain in many areas due to bank armoring, roads, levees, channel incision and channel re-alignments. These disconnections prevent lateral migration of the channel, recharge of wetlands, and formation of off-channel rearing habitat. The capacity of groundwater recharge is reduced because the water is not spreading into the floodplain, but rather is concentrated in the channel (Tetra Tech 2001). The river in the Centralia Reach is very deep and slow, with deep water extending close in to shore.

Many areas have clay banks at the water's edge overtopped by cut banks of loose fine material that is easily eroded. Many areas are armored with concrete or auto bodies.

The Limiting Factors Analysis states that channel incision occurs on the main stem between River Mile 57-79. Factors contributing to channel incision include debris torrents that have incised the channel in the upper watershed, loss of grade control, loss of upstream sediment sources, increased peak flows, reduction in hydraulic roughness, and channelization from levees or bank armoring or fill encroachment (Smith and Wenger 2001, Bakke 2002). A geomorphic evaluation provided by the Corps states that channel incision in the project area probably started with wood removal and was exacerbated by bank armoring. During peak flows, stream energy is unable to dissipate against the roughness of the wood and banks and instead concentrates on working the bed. Over time, the bed has eroded down so that the river is much lower than its floodplain and floods laterally less frequently than before (Cherry 2001). Channel incision inhibits the formation of side channels and results in a loss of habitat, as well as loss of opportunity for more habitat to form.

Functioning floodplains are biologically valuable for fish and for the processes that create and maintain habitat conditions. The lateral spreading of water and hydraulic detention helps attenuate the velocity and magnitude of floods downstream, and thereby the damaging disturbance potential of floods. In addition, the flooding of floodplains recharges groundwater aquifers and wetlands that help in maintaining base flows in the river and providing diverse terrestrial habitats. The off-channel habitats and side channels formed where the river is free to migrate laterally, are among the most productive habitats for salmonids (Sedell and Luchessa 1981). Floodplains also act as repositories for fine sediments deposited during floods, reducing the amount of silt passed downstream to degrade spawning gravels (Sedell and Luchessa 1981).

The reason floodplains are so highly productive is because of the disturbance regime provided by flooding and the deposition of sediments and nutrients. Invertebrate production, important as prey resources for fish, is one to two orders of magnitude greater in floodplain channels than in the adjacent main stem channel streams. A study done in California showed juvenile chinook salmon rearing in an agricultural floodplain channel had a higher growth and survival rate than those rearing in the adjacent river channel, a area with little shallow water and armored banks (Sommer et al. 2001).

High productivity occurs whether a floodplain is located higher or lower in a watershed. This is because most of the nutrients that provide high productivity are produced locally in the "moving littoral" of the advancing and receding flood rather than being carried to the area from upstream sources. This idea has important implications in degraded watersheds, because it means that floodplains-if they are connected- remain relatively in tact and productive despite conditions in upstream drainages (Sparks et al. 1990). This suggests that restoration of floodplain areas and alluvial reaches of rivers makes sense even when degraded conditions upstream in the watershed have not been addressed.

Dam re-operation would result in increased duration and frequency of bank full flows which can increase channel incision, especially in areas that are already armored. Elimination of all floods

over a 2 year event is likely to result in the loss of opportunity for side channels to form or existing ones to be maintained.

The levee system will contribute to loss of floodplain storage if fill is imported for constructing the levees. If development continues to occur riverward of the levee system, it would lead to further filling of the floodplain, increased disconnection of the river from its floodplain, increased wetland filling, and degradation of natural floodplain functions.

Sediment quality and quantity

The Chehalis basin is ranked “poor” in the limiting factors analysis for sediment conditions (Smith and Wenger 2001). Large sediment loads enter the Chehalis River upstream from its tributaries and locally from bank erosion. Tributaries in the project area that contribute the most sediment are the Newaukum, South Fork Chehalis, and upper Chehalis sub-basins.

An estimated 25% of the sediment load for the entire Chehalis Basin comes from the upper Chehalis basin, with most of that from the South Fork Chehalis, the Upper Chehalis, and Newaukum Rivers. Poor sediment conditions are due to increased peak flows coupled with a lack of channel roughness and LWD to hold sediments in place and erosion which transports fine sediments into the water. Excessive sedimentation is associated with a high density of roads, livestock access to the river, erosion, removal of riparian vegetation, clear cuts in the upper tributaries, and agriculture and urban land uses (Smith and Wenger 2001). Agricultural and urban areas contribute to bank erosion, which is common in the Skookumchuck, Newaukum, South Fork Chehalis and upper Chehalis sub-basins. In most tributaries, large sediment is too easily transported downstream (Cherry 2001).

Spawning gravels

The Skookumchuck River, an area that was glaciated, is dominated by very coarse gravels. Larger cobbles and small boulders are frequent in the upper and lower reaches, where anadromous spawning occurs. Anadromous fish spawning habitat is documented in all but three reaches in the areas surveyed. Resident fish spawning is also common, and believed to be especially prevalent in the middle reaches where the gradient is lower and gravel sizes smaller. Numerous tributaries provide spawning for resident fish species and coho salmon (PIE 2001). The Skookumchuck Dam blocks transport of gravels downstream although according to the Corps, gravel contributions from the tributaries and from bank erosion make up the dam impacts within 1,800 feet of the dam (Corps 2002a). Substrate size increases in reaches just downstream of the dam, to the extent of exposing bedrock in some places. In some places, the substrate below the dam is sand with flat rocks. At the stream gauge a half mile downstream of the dam, the substrate consists of gravel and larger cobbles. Bed movement is evident and there is little embeddedness (Bakke 2002). The quantity of gravel lower in the Skookumchuck River appears to be good.

The quantity and quality of sediment in a stream system can determine the quality of salmonid habitat. The amount and type of sediment in a basin varies with the watershed, topography, climate, soil type, soil saturation, up slope disturbance, vegetation, and hydrology. Sediment

quantity is also related to the efficiency of transport, retention, and supply mechanisms. Average annual transport depends upon the frequency and magnitude of flows, with higher transport tending to be associated with more frequent floods. Retention refers to the degree of channel roughness, especially large wood, which tends to hold sediments in place. Sediment supply depends upon coarse sediment input from upstream, which can be blocked by dams or culverts, or reduced through channelization that prevents lateral channel movement which might recruit those sediments. A high degree of channel roughness tends to balance increased discharge so that sediment transport becomes less excessive (Montgomery and Buffington 1998).

Fine sediments and turbidity

The Limiting Factors Analysis prepared for the Chehalis Basin (LFA) defines poor quality of spawning gravel as gravel with greater than 17% of fines. (Fines are defined as particles of less than 0.85 mm). Although several areas in the North and South Fork Newaukum River were rated "good" for sediment quality, most of the project area scored a "poor" for this parameter, or else there was a lack of data to assess it. Excess sediment delivery is considered a major problem throughout most of the sub-basins in WRIAs 23 and 22 (Smith and Wenger 2001).

The Skookumchuck Dam traps sediments and may provide some benefit in reducing turbidity for some distance downstream. However, the tributaries provide inflow and turbidity to the river. Big and Little Hanaford Creeks, major tributaries of the Skookumchuck River, deliver high levels of turbidity (Corps 2002a).

Salmonids are particularly sensitive to excess turbidity, which has both lethal and sublethal effects and is associated with loss or reduction of fish populations. Sub lethal effects include: 1) clogging gills, causing respiratory distress; 2) reduced ability to see and find prey species, which can result in a lower growth rate; 3) reduced tolerance to pathogens and contaminants; 4) physiological stress interfering with the ability to perform vital functions; and 5) avoidance of areas with turbidity so that migration and distribution is altered (Waters 1995, Newcombe and MacDonald 1991). Effects on reproductive success include: 1) burying spawning redds; 2) filling of the interstitial spaces in gravel so that eggs and larval salmon fail to get adequate water flow and oxygen; 3) smothering embryos and sac fry; and 4) entrapment of emerging fry (Waters 1995).

Suspended sediments in a stream also reduce the abundance of aquatic macro invertebrates, food resources for salmonids (Newcombe and MacDonald 1991). Impacts to aquatic invertebrates usually occur either directly by clogging feeding structures or limiting light penetration, or indirectly, through increasing the embeddedness of the stream bed. When fines settle into the interstices of cobbles and large particles, the spaces between large particles is eliminated, called "embeddedness." As fines increase, filter feeders decrease and burrowing invertebrates, which are not preferred food for fish, increase (Waters 1995, Newcombe and MacDonald 1991). Once the decrease in macro invertebrates occurs, it can persist until an area is colonized by flying adults, drifting insects from undisturbed upstream reaches, or the deposited sediments are flushed out (Waters 1995).

We are uncertain what effect the alteration of flows from the Skookumchuck Dam re-operation will have on sediment transport and routing. Altered flows may cause a shift in size classes of substrate and associated changes in habitat and the species of fish that depend upon it. With reduced overbank flooding, off-channel habitats may fill with sediments, become overgrown with vegetation, and become unusable as rearing habitat. If channel maintenance flows do not occur regularly, gravel may fill in with fine sediments, rendering it less usable to fish for spawning. With fewer overbank flows, fines will be passed down the river, instead of deposited on the floodplain. Increased bank-full flows may cause excessive transport of coarse sediments initiating a cycle of incision, increased bank erosion, and result in excess turbidity.

Large woody debris recruitment and routing

Rearing and holding habitat for salmonids is commonly created by the presence of large woody debris (LWD). Large woody debris is extremely important for salmonids and in stream ecology, including: a) it influences channel form and roughness; b) it causes deposition and retention of coarse sediments and particulate organic matter, which otherwise would rapidly flush downstream; c) it provides a substrate and food source for macro invertebrates; and d) it provides preferred habitat and cover for salmonids (Bilby and Bisson 1998).

The main stem Chehalis, Newaukum, Salzer and South Fork Chehalis sub-basins have extensive areas of riparian degradation or else lack a riparian zone altogether. Not surprisingly, the project area is generally considered “poor” in terms of large woody debris (LWD). Where levels of in-stream LWD are known, it is considered to be present in low quantities (Smith and Wenger 2001).

A fish and wildlife habitat study prepared by Pacific International Engineering mapped the near term recruitment potential for LWD, based on methods in the Watershed Analysis Manual developed by the Washington State Forest Practices Board. This method determines the near-term recruitment potential of a stream reach based on whether the channel has LWD in it, whether it would retain LWD, whether LWD would function for habitat purposes, and LWD loading potential (i.e., condition and composition of the riparian zone) (PIE 2001).

The report concluded that the project area is very degraded for this parameter. Most of the lower elevation areas, which have either an agricultural or residential land use, consist of a sparse hardwood canopy and if present, a shrub understory. This study showed that all reaches in the project area are at either high or moderate risk of negative impacts due to low levels of LWD, low potential for LWD recruitment, or low retention of LWD due to channel conditions. Many parts of the project area, especially the main stem Chehalis and Skookumchuck Rivers have no riparian zone with, therefore, no recruitment potential. The areas that have some potential for recruiting LWD (i.e., have riparian corridors with trees) have little retention potential (i.e., have high velocity flows or are not hydraulically rough). Many other areas have riparian vegetation, but it is sparse and small (PIE 2001).

The Centralia Reach has many areas with cut banks up to 10 feet high, with little opportunity for vegetation to become established. Some areas are well vegetated along the banks, although trees tend to be medium-sized. Where cattle are allowed access to the banks, vegetation cannot

become established, and the banks often collapse. Some large wood is evident in this main stem reach and in increasing amounts upstream of the SR-6 overpass. However, the opportunity for recruitment is small.

There is little opportunity for LWD recruitment to occur upstream of the project area. Three watershed analyses done in the upper Chehalis Basin (the Upper Chehalis, the upper Skookumchuck and the Stillman Creek) reported limited LWD in all areas surveyed and a low potential for in-channel habitat as a result. In addition, any LWD recruited from above the Skookumchuck Dam would not be transported past this blockage to downstream area. Lack of LWD in the channel and available for near-term recruitment was defined in these analyses as a key factor warranting improvement (Mendoza 1998).

Large woody debris benefits salmonids at multiple life stages, including recruitment and storage of spawning gravels, dissipating high energy flood flows during incubation, increasing pool density, providing cover for summer rearing, and low velocity refugia and cover for overwintering. Fish populations are larger in streams with large amounts of LWD than streams with low amounts, particularly coho and cutthroat trout (Bilby and Bisson 1998), both species that inhabit the Chehalis system. Where LWD is present, it helps to create, stabilize and provide cover in side channels for salmonids (Sedell and Luchessa 1981).

The dam re-operation would be expected to eliminate flooding over the 2 year event which could affect the structure and composition of the riparian area and could increase the invasion of exotic species. In addition, large floods weaken trees and cause recruitment as LWD. Increasing the duration and frequency of bank full flows may increase the transport of LWD out of the system.

Water Quality

Poor water quality in the upper Chehalis basin is well documented by the Washington State Department of Ecology, especially for temperature and dissolved oxygen (DO). The Skookumchuck River has a history of habitat degradation resulting in low DO, high temperatures, and increased turbidity, but these conditions have improved in recent years. Cold water releases from Skookumchuck Dam, in particular, have helped reduce water temperatures. One of the Skookumchuck's main tributaries, Hanaford Creek, has high levels of fecal coliform and turbidity (Corps 2002a).

Low flows worsen water quality problems, as mentioned previously. State standards for temperature, fecal coliform, pH, DO, and other criteria are often not met during low flow periods. Dissolved oxygen and temperature are particularly important factors for determining suitable habitat for salmonids (Mendoza 1998).

Dissolved oxygen is a measure of the oxygen-absorbing capacity of the water. The amount of DO determines habitat suitability for fish and invertebrates. Low DO reduces the swimming performance of juvenile and adult salmonids and may halt migration (Welch et al. 1998).

Causes of low DO are varied and interrelated with other physical and chemical processes in rivers. Dissolved oxygen decreases with increasing water temperature and increasing levels of

fine sediments and nutrients, such as fecal coliform. Low DO is associated with removal of riparian vegetation, factors which reduce stream flow, organic debris from logging, urban stormwater, sewage, food processing plants, and dairies. These inputs of nutrients increase the biological oxygen demand, which reduces the available DO in the water (Castro and Reckendorf 1995).

The mainstem between Newaukum and Skookumchuck Rivers is deep, slow moving and in the summer, the water near the bottom is very low in DO. This is a natural condition to some degree but is worse during algal blooms which result from high levels of nitrogen produced by the Chehalis waste treatment plant and upstream non-point sources. Algal decay stimulates bacteria growth, which consumes oxygen. This situation is worsened by higher temperatures. In summer, dissolved oxygen levels have been as low as 0-0.5 mg/l (Smith and Wenger 2001). Levels of DO also fluctuate diurnally.

Temperature provides a cue for many life history stages, such as insect emergence, or fish spawning. Warmer than normal water temperatures may cause premature emergence from the gravel, which reduces survival. In the summer, higher temperatures may cause thermal metabolic stress, higher competition for cool water refugia, and lower DO levels (Welch et al. 1998). For most aquatic species, thermal limitation is more important than the availability of specific types of food (Stanford et al 1996). Temperature increases may alter fish species composition, favoring warm water species over salmonids which then leads to increased predation on salmonids.

Physical factors that influence water temperature include riparian vegetation, ground water/hyporheic interactions, tributary inflow, water depth, water discharge, and air temperature (Welch et al. 1998).

The hyporheic zone, the area of interchange between surface and subsurface water, helps to cool water temperatures, crucial for fish production (Smith and Wenger 2001). Water cycles through the aquifers and hyporheic zone, mixing with groundwater from upland and floodplain sources. Surface water alternatively enters and exits the hyporheic zone, which acts to process nutrients and provides a thermal sink, cooling the river during warm low-flow periods. Fish use areas of upwelling and downwelling for spawning. In addition, they function in areas of upwelling or downwelling that create mosaics of different habitat based on soil moisture conditions and hydrology (Stanford et al. 1996).

We do not know the extent of the hyporheic system in the project area. Given the documented problems with temperature and low flows, we would be concerned about any activity that tends to increase channelization or that could interrupt the connection between surface water and ground water (i.e., constricting levees, removal of riparian vegetation, bank armoring). Correspondingly, we believe that restoration activities that increase roughness, natural channel dynamics and riparian vegetation would increase this connectivity.

The setback levees may improve water quality in those areas where contamination is currently allowed to enter the river in storm run off. Where levees are designed to surround these contaminated areas, run off into the river may be decreased, with an improvement in water

quality. Planting the levees with native shrubs and trees may improve water quality by buffering the effects of stormwater runoff into the river and its tributaries.

Fish passage barriers

The main stem Chehalis River has no human-made structures that block fish passage upstream or downstream, although water quality can be barrier to fish passage. During late summer, low flows, temperature and low levels of dissolved oxygen in the Centralia Reach often combine to block Chinook salmon that are attempting to go upstream to spawn (Hiss and Knudsen 1993). Numerous blockages or potential blockages to fish passage have been identified in streams throughout the project area. Most of these are improperly designed culverts. Lewis County plans to assess habitat above these blockages in order to prioritize projects for remediation.

The Skookumchuck Dam is a complete block to anadromous fish and is considered the greatest impediment to salmonid distribution in that sub-basin. The winter steelhead population is considered depressed, and it is unclear the degree to the dam has contributed to this decline (WDFW 1992). Wild winter steelhead are trapped and trucked around the dam to be released either in the reservoir or above the natural cascades in the main stem Skookumchuck River above the reservoir. It is assumed that wild steelhead spawners trapped below the dam each year are progeny from those fish hauled above the dam, but this assumption is by no means certain. The spawner returns could also be the progeny of hatchery steelhead that have spawned naturally in the Skookumchuck River. We are also uncertain how the current dam configuration provides downstream passage for adults or juvenile steelhead or resident cutthroat trout. It is possible that few smolts make it to the sluiceway or, if they do, survive passage through the dam. There are apparently no available studies to prove or disprove this. We are uncertain whether adults that would normally return to the ocean after spawning (kelts) survive passage downstream. We also do not know whether adult salmon of other species die in the plunge pool below the dam in unsuccessful attempts to migrate upstream.

When the dam was built in 1970, it eliminated 3.6 miles of spring and fall chinook habitat and 8 miles of coho habitat (Smith and Wenger 2001). Before construction of the dam, the Skookumchuck River above the dam provided holding, spawning and rearing areas for spring and fall chinook, coho and steelhead. Coho utilized the river up to an impassable falls near RM 28.9 (USFWS 1989). Resident cutthroat trout do spawn and rear above the dam. Juveniles may be swept over or through the dam occasionally.

Fish passage is not considered a problem in the main stem Chehalis River and major tributaries. Re-operation of the Skookumchuck Dam for flood control will include construction of larger outlets for better control of water release. We are uncertain what the existing condition is with respect to smolt survival past the dam. If these outlets are constructed to ensure fish passage for smolts as well as out-migrating steelhead adults (kelts), the project could improve conditions for winter steelhead.

TERRESTRIAL HABITATS

We have included the following three terrestrial habitats in our discussion because of their value to wildlife and their contribution to functioning riverine processes.

Riparian areas

As discussed earlier, the main stem Chehalis, Skookumchuck, Newaukum and South Fork Chehalis Rivers have poor riparian conditions overall, although some reaches in the upper watershed are considered “fair” or even “good” for riparian conditions (Smith and Wenger 2001). Much of the information that the LFA used for scoring riparian conditions was based on watershed studies done in the upper tributaries of the watershed and are not really applicable to most of the project area. A restoration plan provided by the Corps states that poor riparian conditions may be the most widespread problem throughout the basin (Tetra Tech 2001).

A study by Pacific International Engineering characterized riparian condition in the project area as inadequate. The report states that riparian areas, where they exist at all, are often narrow in width, sparsely vegetated, and/or have small or medium sized trees. Hardwoods or mixed hardwood/conifers are common; some areas have a low shrub layer. In the Chehalis main stem, more than two-thirds of the riparian areas lack vegetation or have only sparse riparian coverage. Only four reaches within the entire study area (in the upper Skookumchuck and Newaukum sub-basins) had adequate shading levels. All other reaches surveyed are considered at risk for stream shading (PIE 2001).

Riparian areas have been fragmented, degraded and eliminated by agriculture and residential development, timber harvest, fires, and dam break floods. The degradation results in poor buffering of runoff and human disturbance, increased water temperatures, sediment transport, scour, poor LWD recruitment, and few pools. The riparian zones have little value to wildlife as movement corridors (Tetra Tech 2001).

Riparian zones are extremely important to both fish and wildlife, providing nutrients, natural corridors for migration organic debris, diversity of structure, high edge to area ratios, microclimate, and habitat features for foraging, breeding, and cover. Riparian areas usually have complex plant communities due to the disturbance regime offered by the variability of river flows, flooding, and channel dynamics. This diversity of plants and physical structure provides habitat for many species of wildlife. Of the 593 wildlife species that occur in Oregon and Washington, for example, 319 (53%) use riparian zones (Johnson and O’Neil 2001).

Wildlife species use riparian areas disproportionately more than any other type of habitat. Although riparian areas occupy less than 1% of the area in the Western United States, they provide more habitat for breeding birds than any other vegetation type (Bolton and Shellberg 2001). Large rivers, like the Chehalis, provide habitat for a greater bird abundance, species richness, and species diversity than small rivers where bird communities tend to resemble upland bird communities. The wide rivers provide habitat for large-bodied birds, including waterfowl, heron, and osprey. (Kelsey and West 1998).

About 29% of wildlife species in the Pacific Coast Ecoregion are riparian obligates, depending upon riparian and aquatic resources for their survival (Naiman et al. 2000). Bird groups in this category include: loons, grebes, cormorants, ducks, geese, hawks and falcons, herons, rails, coots, kingfishers, and some of the passerine birds. Small mammals in this category include many shrews and voles, raccoons, otters, and beaver. Of the 30 amphibian species that occur in the Pacific Coast Ecoregion, 60% are riparian obligates, requiring aquatic habitat for reproduction (Kelsey and West 1998).

The value of riparian habitat for terrestrial species is high compared to upland areas, given the broad impacts of human activities. In the Pacific Coast Ecoregion, riparian areas historically differed little from pristine upland areas in their value to wildlife. This is because riparian areas and late successional forests provided plant composition diversity and structural complexity important to wildlife (Kelsey and West 1998). In developed landscapes, where much of the upland habitat has been converted to other land uses, riparian areas may be among the few places that provide complex habitat such as understory and mid story vegetation.

The Corps has stated that the flood storage capacity of the dam and reservoir at elevation 492 feet, the "high dam" option, would only be used for a 70 year event, coming into full capacity at a 100 year event. Provided that the higher level reservoir is retained for no longer than five days and is used no more than once every other year, we believe that impacts to shoreline vegetation from the "high dam" option would be minimal.

The elimination of most overbank flows in the Skookumchuck River as the result of dam re-operation could result in changes to the structure and plant community of the riparian zone. Construction of the levee system will result in the loss of some riparian vegetation.

Floodplains

Floodplains are the transition zone between the uplands and river, and surface water and groundwater environments (Stanford et al. 1996), and as such they are highly productive, biologically diverse areas. Floodplains are high in biodiversity for the same reasons as riparian areas with diverse plant, benthic insect, and fish and wildlife communities. When large floods occur, the vegetation community gets reset from late successional to early successional, thereby increasing habitat and species diversity. Floodplain productivity is related to the large area of habitat, frequency of flooding, patterns and timing, inputs and retention of nutrients and sediments, physical diversity of habitat (i.e., depressions, riparian plant communities, unvegetated and vegetated borders and backwaters, and seasonally flooded vegetation communities), decomposition, and decreased predation or competition (Sommers et al. 2001, Sparks et al., 1990).

Alterations to flows in the Skookumchuck River due to dam alteration may contribute to channel incision and loss of floodplain function and connectivity. The setback levee system would help to prevent further degradation of the floodplain provided that future development on the riverward side of the levees is restricted. Restoration in the form of riparian plantings, wetland restoration, reconnection of oxbows, and increasing floodplain storage could improve floodplain

function and value for fish and wildlife. We do not know the areal extent of floodplains in the project area or how much of what exists is covered by impervious surfaces.

Wetlands

The wetlands in the project area include forested, scrub shrub and emergent wetland types, all dependent upon the hydrologic cycle, including high seasonal water tables, periodic flooding and seasonal ponding. Agriculture, logging, urban development and transportation corridors have interrupted the hydrologic cycle of these wetlands and disrupted the ecological connectivity. These wetlands are important for flood attenuation, water storage that contributes to base flows in streams and for fish and wildlife. For wildlife, these wetlands provide habitat for feeding and migration. These wetlands are important to birds for nesting, foraging and resting. Their value for aquatic species includes providing organic debris, aquatic and terrestrial insects, and shade (Corps 2002).

Wetlands and hydric soils are extensive throughout the project area, particularly in the floodplain of the Centralia Reach. Hydric soils are extensive as well, indicative of either past hydrologic conditions or current conditions. The wetland and hydric soils are interspersed with broad areas of non-hydric soils (Corps 2002). The wetland complexes are less extensive along the Skookumchuck since the floodplain is smaller. Wetlands in the lower Skookumchuck floodplain were apparently part of a large system that has been almost completely altered by urban development (Corps 2002a).

Wetlands are important to fish and wildlife for many of the same reasons discussed in the section on riparian areas above. Johnson and O'Neil include riparian areas and riverine wetlands together in the same category in terms of their value for wildlife (2001). These areas are protected legally, but have declined in areal extent and quality over the years.

Johnson and O'Neil separate riverine wetlands and herbaceous, isolated wetlands, which include all freshwater aquatic bed habitats in isolated areas that are not hydrologically connected to drainages such as oxbow lakes, wet meadows, or potholes. Dominant plant species include various grasses or grass like plants such as cattails, bulrushes, sedges, and spike rush. Habitats are maintained in these isolated wetlands through hydrologic regimes that exclude colonization by large woody plants. The wetlands and oxbows in the project area are valuable habitat for a variety of wildlife, particularly waterfowl. Due to recent court cases, these areas have lost much of their legal protection federally, although they may be protected locally in some areas. Isolated wetlands have also declined in areal extent and quality over the years.

The SR-6/Scheuber Ditch proposal could result in improved wetland function, better hydrological connections to wetlands, and increased habitat value of wetlands in this area. The re-operation of the dam may decrease wetland function, areal extent and value to fish and wildlife by eliminating the hydrological connections to wetlands that will no longer flood under this plan. The Corps states that 34 acres of wetlands will be lost due to construction of the levees. Most of that loss is of emergent or prior converted wetlands. Although the Corps has updated the National Wetland Inventory maps that indicate the location and type of wetlands found in the

project area, site-specific information about the location, type, function, extent of these wetlands is still uncertain.

COVERAGE OF RESOURCE TOPICS

We are aware that the upper watershed is degraded and that this affects conditions in the lower reaches of the Chehalis River and its tributaries. However, we limited our geographic coverage to the project area for the following reasons: 1) the Corps has limited the scope of their study to the project area; 2) scientific literature supports the idea that restoration of alluvial reaches of rivers and floodplain function makes good ecological sense even when conditions in the upper watershed are still degraded; and 3) the state's limiting factors analysis has identified the main stem Chehalis, Skookumchuck, Newaukum, and South Fork Chehalis Rivers, all in the project area, as high priority sub-basins for remediation or restoration actions. This selection is based on the number of salmonid stocks and stream miles with known steelhead and salmon presence (Smith and Wenger 2001).

Although the following issues are considered limiting factors for salmonids in the upper Chehalis Basin, we have discussed them only minimally in this report. Our reasons for excluding these topics from detailed discussion include the following:

- 1) Fish passage barriers are not a significant problem in the main stem of the Chehalis River or the larger tributaries in the project area. We do discuss fish passage issues relative to the Skookumchuck Dam.
- 2) We have only minimally discussed water quality problems, which are well documented by the Washington State Department of Ecology (WDOE). The flood project could indirectly affect water quality by altering low flows or the buffering capacity of riparian vegetation, however we do not believe these impacts will occur to a significant extent.
- 3) We have only minimally discussed low flows, which are also well documented by the WDOE. WDOE is currently revisiting minimum flow standards for the Chehalis River. We have made the assumption that base flows could be improved by increasing the quality and areal extent of riparian conditions, restoring floodplain function, and maximizing the opportunity for wetland and aquifer recharge to take place.

RESOURCE PROBLEMS, PLANNING OBJECTIVES AND OPPORTUNITIES

Our major resource concerns for this project are organized into two categories: 1) alterations to physical processes that create or maintain aquatic salmonid habitat, including altered hydrology, disconnected floodplain (or channel incision); altered sediment supply and transport, and altered large woody debris availability and transport; and 2) alterations to terrestrial habitats important to fish and wildlife, and 3) direct impacts to species, particularly anadromous fish. We have discussed our resource concerns throughout this report.

We had three objectives for planning for this project. Our first objective, consistent with mitigation sequencing was to ensure that the alternative selected would be the least environmentally damaging. Mitigation is defined as a sequential process that seeks to: 1) avoid adverse impacts; 2) minimize impacts that can not be avoided; and 3) compensate for unavoidable impacts. By concentrating on the alternative selection process, we felt that many adverse impacts could be minimized up front or avoided altogether.

Our second objective was to define the potential impacts to the resources listed above that could result from the various alternatives being evaluated. In the initial evaluation and studies, certain alternatives appeared to involve more risk to the environment than others. If those higher-risk alternatives were to go forward for further consideration, we recommended more detailed studies to quantify those risks.

Our third objective was to identify projects that could serve as compensatory mitigation for unavoidable impacts or that might be incorporated as restoration projects to enhance conditions for fish and wildlife. The projects were based on our understanding of what is needed in the project area to improve habitat or habitat forming processes.

During our participation, we identified numerous opportunities to improve habitat conditions for fish and wildlife in the project area. These actions include, but are not limited to: restore riparian, floodplain, and wetland areas; increase plant diversity; increase remnant habitat areas and improve connection to other habitats; remove fill from historic wetland areas or floodplains; re-connect oxbows, wetlands, and old meanders; roughen the channel through addition of large woody debris, particularly log jams; remove or setback existing levees; remove drainage systems (drain tiles or ditches); operate the Skookumchuck Dam to mimic natural hydrologic flows; increase floodplain and wetland recharge areas; implement a "no net loss" policy for the floodplain (i.e., no import of fill in the floodplain); and protect existing floodplains, wetlands and off-channel habitat through land use regulations, conservation easements, or other nonstructural measures.

EVALUATION METHODS

One of the questions that arose repeatedly was how to assess the potential interaction between the proposed flood alternative and river morphology and geomorphic processes. A geomorphology analysis was conducted that involved four components: 1) aerial photographic analysis from multiple photo years; 2) field reconnaissance; 3) sediment characterization; and 4) sediment transport analysis. These four components were synthesized into a conceptual model to describe morphology and geomorphic processes within the project area (Cherry 2001a).

Studies conducted to help establish a baseline and assess impacts of this project include: 1) a literature review on geomorphology that takes a historical and physical perspective on the habitat conditions in the project area and the factors responsible for them (Cherry 2001); 2) an evaluation of riparian conditions, stream channel configuration and complexity based on a comparison of aerial photos taken in 1938 and 1999 and field visits (SAIC 2001); 3) a fish and

wildlife habitat study based on field surveys and aerial photos that maps spawning areas, wildlife habitat features, channel structure, off-channel habitat areas, riparian condition, and the recruitment potential for LWD (PIE 2001); and 4) a wetland report based on an update of the National Wetland Inventory and riparian vegetation mapping done through aerial photo interpretation and field surveys by USFWS and the Corps, the Lewis County soil survey, and analysis of wetland function based on a hydrogeomorphic assessment methodology developed the Washington State Department of Ecology (Hruby et al. 1999).

To understand baseline conditions of resources in the Upper Chehalis Basin, we conducted site visits, talked to resource experts familiar with the Chehalis Basin, participated in the planning of the Centralia Flood Study, and consulted the literature available about this area and the issues identified as problems in this area. Our literature review also included a search for information about impacts from traditional flood projects (dams, levees, and flood bypasses), and approaches to flood hazard reduction that include restoration, engineered log jams, and restoring incised rivers.

We participated in the Corps' Restoration and Flood Control Evaluation Methodology as part of the evaluation process for this project. This methodology was similar to that developed in the Bellingham Bay Pilot Project and the Green/Duwamish River Basin Restoration Program (Anchor Environmental 2000 and Ging 2000). These projects relied on an evaluation of both process-based and site-specific habitat conditions and how those could change with the project. They also focused on specific habitat requirements for threatened and endangered salmonids.

The Corps' evaluation framework for the Centralia Flood Study assesses two scales of impact or benefit: 1) effects on watershed-level processes and limiting factors; and 2) effects on local habitat quality. The framework assessed the effects of 18 restoration projects and 7 flood control alternatives on these factors. The methodology relies heavily on existing information, particularly the Limiting Factors Analysis (Smith and Wenger 2001) and best professional judgement by an expert panel with experience in the Chehalis River basin. Also important for some aspects of this evaluation process were the results of surveys done by Pacific International Engineering on fish and wildlife habitat (PIE 2001). The watershed-level processes or limiting factors as they are called include: a) an altered hydrologic regime; b) loss of floodplain connectivity; c) altered sediment supply and transport; and d) loss of riparian zone and LWD. The local habitat factors or site specific conditions include alterations to: a) spawning habitat; b) rearing habitat; c) water quality; d) wetlands; e) habitat complexity/connectivity; f) species diversity; and g) fish passage.

Under the evaluation framework, the expert panel ranked the functioning of each of the factors listed above for selected sub-basins in the project area. Based on a consensus, each factor was given a score to rank baseline conditions. These scores were then adjusted by the group to estimate how the scores would change given various flood or restoration projects. The expert panel consisted of representatives from the Corps, the US Fish and Wildlife Service, the US Environmental Protection Agency, the Washington Department of Fish and Wildlife, the Washington Department of Ecology, and the Washington Department of Transportation. More specific studies are planned for the next phase of the investigation, including a geomorphic and sediment study to help determine the significance of impacts in the Skookumchuck River

due to altered flows. In addition, wetland studies and a habitat evaluation program (HEP) may be needed to better quantify impacts to wetlands and terrestrial species. These studies would be used to develop a mitigation plan.

FISHERY RESOURCES

Salmonid stocks in the Chehalis basin include spring, summer, and fall chinook, chum, coho, summer and winter steelhead, bull trout/Dolly Varden, coastal (anadromous) cutthroat trout, and a great multitude of resident rainbow and cutthroat trout. There are no pink or sockeye stocks in the Chehalis (WDFW 2000, 1998, and 1994). Many of these stocks are found in the project area or could be affected by flood control projects in the project area.

Skookumchuck Dam is a block to anadromous fish passage. With the exception of winter steelhead, the anadromous salmonids known to use the Skookumchuck River are only found downstream of the dam. Steelhead are captured at a trap and haul facility and relocated upstream of the dam to spawn and rear (See our comments about fish passage at the dam under the Resource Concerns Section, Fish Passage). Resident cutthroat trout are known to spawn upstream of the dam. Downstream of the dam, fish resources include spring and fall chinook, coho, winter steelhead trout and anadromous and resident cutthroat trout. A chum salmon run that formerly occupied this sub-basin is now considered extinct (Corps 2002a).

CHINOOK SALMON

The spring chinook is managed for wild production with 90% of the spawning occurring in the Skookumchuck, Newaukum, and upper main stem Chehalis Rivers (WDFW 1994). Although the one summer chinook stock is primarily observed in the Satsop River, it has also been observed in the upper Chehalis Region. One of the fall chinook stocks (the Chehalis) occurs upstream of the confluence with the Satsop River tributary (Smith and Wenger 2001). Fall chinook occur throughout the upper basin, including the Black and Skookumchuck Rivers, and the Cloquallum and Porter Creeks and to a lesser extent, the Newaukum and South Fork Chehalis Rivers, and the Cedar and Stillman Creeks (WDFW 1994). The 1992 Washington State Salmon and Steelhead Stock Inventory (SASSI) states that both fall and spring Chehalis chinook are healthy stocks (WDFW 1994) with similar trends in the last decade (Smith and Wenger 2001).

CHUM SALMON

The Chehalis chum stocks are considered "wild" and "native," and although they are considered healthy, their numbers have declined over time. The Chehalis stock spawns in WRIA 22 and 23 (Smith and Wenger 2001). Chum salmon are found throughout the lower Chehalis River tributaries, and main stem Chehalis and Black Rivers, Cloquallum Creek and tributaries. Chum use these areas and side channels and/or spring or seep-fed sloughs for spawning. (WDFW 1994). Despite their occurrence primarily in the lower basin, chum occurring downstream of the project area could be affected by alterations to the flow regime, and sediment, nutrient or wood routing.

COHO SALMON

The Washington State Department of Fish and Wildlife has estimated coho production in the Chehalis River system for the last 20 years. Estimates are based upon annual trapping and tagging of wild smolts and sampling adults in the lower Chehalis River for coded-wire tags. The Chehalis River System produces the highest number of wild coho smolts of any coastal drainage (Seiler 2002). The Chehalis River coho are both wild and of hatchery origin. The Chehalis coho stocks spawn upstream of the confluence with the Satsop Rivers. Coho spawning occurs in the upper main stem, the main stem west and east forks of the Chehalis River, and in all suitable, accessible tributaries, including the Skookumchuck and Newaukum Rivers. The Chehalis coho stock was considered healthy in the 1992 SASSI (WDFW 1994). Average escapement in the upper Chehalis basin has dropped 20% in the last decade (Smith and Wenger 2001).

STEELHEAD TROUT

Little is known about spawning locations for summer steelhead, but the Chehalis stock is presumed to spawn in the upper Chehalis River. Two stocks of winter steelhead spawn in the project area: the Skookumchuck/Newaukum and the Chehalis (all spawners upstream of the confluence with the Satsop except the Skookumchuck and Newaukum Rivers). The Skookumchuck/Newaukum winter steelhead stock is considered depressed (WDFW 1994, Smith and Wenger 2001). The latter stock is considered a composite of hatchery and wild origin. Spawning of winter steelhead occurs in the main stem, and the smaller creeks and tributaries (Smith and Wenger 2001, WDFW 1994).

BULL TROUT/DOLLY VARDEN

As of 1998, the WDFW identified a distinct subpopulation of bull trout/Dolly Varden in the Chehalis River/Grays Harbor system. This native char was believed to occur in tributaries west of and including the Satsop River and may include the anadromous, fluvial and resident life histories. Adult char have been found in the estuary and lower tributaries of Grays Harbor, however a recent review of 11 years of records from downstream migrant traps, beach seining, and adult traps found no confirmed native char in the Chehalis River Basin (USFWS 2000a). Most of the upper Chehalis Basin is relatively low gradient, and many areas have water temperatures that exceed state standards, conditions that are not ideal for native char. Some areas in the upper watershed have been identified as having potential bull trout spawning habitat, although no bull trout have been observed. The Chehalis Basin and Columbia Rivers probably represent the southern end of the range of anadromous char on the west coast (WDFW 1998).

COASTAL CUTTHROAT TROUT

The southwestern Washington-lower Columbia River region, which includes the Chehalis Basin, historically supported healthy, highly productive populations of coastal cutthroat trout. Coastal cutthroat trout are present in nearly all tributaries and main stem reaches in one or more life history forms. Anadromous forms and fluvial forms inhabit main stem and accessible tributary reaches. Resident life history forms exist above fish barriers, such as the Skookumchuck Dam. Adfluvial forms live in most lakes throughout the basin (WDFW 2000).

Hatchery releases of cutthroat have been made throughout the basin, however most hatchery programs for cutthroat have been discontinued (WDFW 2000).

Although in some areas freshwater forms of coastal cutthroat remain healthy, rapidly declining numbers of the anadromous life form are considered a risk factor for coastal cutthroat trout in the Southwestern Washington/Columbia River ESU (NOAA 1999). Coastal cutthroat in the Chehalis Basin are a species of concern under the federal Endangered Species Act. Anadromous fish are important in maintaining genetic connectivity and reducing risk of extirpation of isolated populations. Freshwater, resident forms may be abundant in many streams, and may produce smolts that migrate downstream and become anadromous, provided habitat conditions allow their survival in the lower reaches of streams and near shore marine environments. However, this type of production has not successfully increased populations of anadromous forms (NOAA 1999).

NON-SALMONIDS

The Chehalis Basin is rich in fish species compared with other drainages in Puget Sound. Species richness in the Chehalis basin is related to the large size of the basin, the low gradient and the fact that the Chehalis River basin was not glaciated during the last ice age. The Chehalis, known as "the Chehalis Refuge" was the largest river left free of ice in Western Washington during the last ice age. As the ice melted, fish dispersed from the Chehalis River outward. There are 34 species of native fish in the Chehalis basin (Mongillo and Hallock 1997).

WILDLIFE AND BOTANICAL RESOURCES

The project area lies within the Puget Lowland Ecoregion as described by Johnson and O'Neill (2001). This area encompasses a range of conditions arising from geology and geological history, soils, topography, climate (past and present) and precipitation that support different vegetation communities and habitat for many species (2001). Habitats for this area include: 1) westside lowland conifer-hardwood forests; 2) westside riparian and wetland; 3) open water - lakes, rivers, ponds and reservoirs; and 4) agricultural, pasture and mixed environs. Small remnants of Westside oak and dry Douglas fir-woodland forests, westside grasslands (remnant prairie), and herbaceous wetlands are also found in the project area.

WESTSIDE LOWLAND CONIFER/HARDWOOD FORESTS

This habitat is the most extensive in western Washington and forms the matrix within which other habitats occur as patches, most important of which are the riparian, wetland, and open water habitats. Dominant tree species include western hemlock, Douglas fir, western redcedar, red alder or bigleaf maple. Dominant under story shrubs include salal, Oregon grape, vine maple, and salmonberry. Large areas of this habitat exist, although most of it is second growth Douglas fir, with few snags or downed logs. Forested areas are prevalent in the upper watershed, or as patches of forest within agricultural and rural residential areas in the floodplains.

Forested areas provide habitat for hawks, owls, woodpeckers, songbirds, and small mammals. Elk and blacktail deer inhabit the lower areas of the watershed.

WESTSIDE RIPARIAN/WETLANDS

This habitat exists in patches or linear strips along streams and in wetlands, oxbows, backwater areas and ponds or in areas within the floodplain. In forested areas along streams, the deciduous plant species include black cottonwood, red alder, and big leaf maple with an under story that includes such shrubs as snowberry, red osier dogwood, and Indian plum. Coniferous species include western red cedar, western hemlock, Douglas fir and Sitka spruce. Common understory shrubs include salmonberry, vine maple and salal (SAIC 2001).

Wildlife depending upon these aquatic habitats and transition zones include river otters, muskrats, beaver, great blue heron, belted kingfisher; and amphibians and reptiles such as salamanders, newts, toads, frogs, turtles, lizards and snakes. Deer, bear, and coyote use riparian and wetland areas for hiding and refuge as well as travel corridors. Small mammals such as racoons, beaver, mice and voles breed and rear young in dense riparian vegetation. Resident waterfowl and upland gamebirds probably use riparian areas for foraging, breeding and rearing. (PAL 1989). Migratory waterfowl, such as mallards, teal, pintails, and widgeon use the oxbows, slackwater areas and ponded areas as stopovers for resting and feeding (WDFW 2001).

AGRICULTURAL, PASTURES AND MIXED ENVIRONS

Much of the floodplain in the project area is in agricultural or rural residential use. Lack of connectivity is one of the biggest problems for wildlife in agricultural and rural residential areas. Repeated cultivation limits the habitat value of agricultural areas, although forbs and grasses provide forage for wildlife after crops are harvested. Upland shrub vegetation is found in many areas that have been disturbed by past human usage, such as grading, logging, or agriculture. Vegetation characterizing these areas includes vine maple, Himalayan blackberry, salal, snowberry, trailing blackberry, reed canary grass, bracken fern, and quackgrass.

Pooled flood water that is contained in agricultural floodplains is valuable for waterfowl during the winter and spring months. Generally, unimproved pasture has a high value for wildlife although areas that grow corn or other grain, are in pasture, or cultivated for hay provide valuable holding and feeding habitat for wintering waterfowl and shorebirds and the raptors that forage on them. The borders between fields, alongside roads and along wetlands and streams can provide cover, forage and nesting habitat for many species.

Urban areas encompass low density housing to high density urban land use with a high percentage of impervious surfaces. Similar to agricultural land that is highly altered and cultivated, habitat in urban areas tends to be concentrated in patches along streams or wetlands, or alongside roads. (Corps 2002).

The forbs and grasses provide forage for wildlife after crops are harvested. These areas support songbirds, small mammals, and other wildlife, such as blacktail deer, robins, and song sparrows. Open fields associated with the floodplain support small mammals, which attract a significant number of predators. Raptors in the project area include red tailed hawk, northern harriers, and American kestrels and many other raptors probably use the area as residents or during migration.

PRIORITY SPECIES

The project area supports numerous species meriting conservation and protection that have been identified by either federal or state fish and wildlife agencies. Species listed as threatened under the Endangered Species Act (ESA) by the federal government include the bald eagle, marbled murrelet, Northern spotted owl, bull trout, and golden paintbrush. Candidates for federal listing and species of concern include the coho salmon, coastal cutthroat trout, Mardon skipper; western pocket gopher; tailed frog; Van Dyke's, Olympic torrent and Columbia torrent salamanders; Pacific lamprey; and Western gray squirrel. Plant species of concern include tall bugbane and white-top aster.

Other species that may be found in the action area warrant special protection because they are either listed, proposed for listing, candidates for listing, or species of concern under state law. These species include the great blue heron, Olympic mud minnow, band tailed pigeon, wood duck, bufflehead, osprey, Paca butterfly, spotted frog, long eared myotis, olive-sided flycatcher, and western pond turtle. The Olympic mud minnow, a Washington State Sensitive Species, is found in only a few locations in Southwestern Washington. This species has been identified in the "Chehalis Reach" i.e., between the cities of Chehalis and Centralia.

Amphibian species generally are dependent upon winter charging of wetlands along river areas, and amphibian species richness is greatly influenced by the amplitude of floods and recharging of wetlands. Rapidly changing flows can affect amphibians. Specifically, the alteration of flood flows that recharge wetlands could affect Oregon spotted frogs, a federal candidate for listing under the ESA. There are two known populations, one in Thurston County and one in Klickitat County. There is believed to be potential habitat in the Centralia/Chehalis area. The range of this species used to be very large and it is possible that a population could exist in the project area in the Chehalis drainage (K. McAllister, WDFW, personal communications 12-27-01).

The Washington State Department of Fish and Wildlife identifies the following important fish and wildlife resources in the project area: regular, large concentrations of waterfowl, mink, breeding occurrences of cavity nesting ducks such as harlequin ducks and wood ducks, great blue heron, osprey, and bald eagle. The area is in the winter range for Roosevelt elk. Reported in the upper parts of the watershed have been breeding populations of osprey and bald eagle, tailed frog, Cope's giant salamander, and the Cascade torrent salamander. The upper watershed, including Lincoln Creek and the Upper Chehalis, have occurrences of Roosevelt elk, breeding occurrences of golden eagle, and Dunn's salamander. There have also been observations of tailed frog, marbled murrelet, spotted owls, Vauk's swift, great blue heron, cavity nesting ducks, bald eagle and osprey in the upper watershed of the Newaukum River and its tributaries.

The project area encompasses important overwintering areas for waterfowl, shorebirds and the raptors that depend upon these migrants for food. Waterfowl observed include mallards, pintails, wigeon, teal, mergansers, scaup, buffleheads, goldeneyes, and Aleutian, dusky, white-fronted, cackler, and Canadian geese. Also seen are less common visitors such as redheads, canvasbacks, cinnamon teal, and snow geese. Numerous shorebirds feed in the ponded areas after flooding. Raptors observed include the bald eagle, kestrel, peregrine falcon, and rough-legged, Swainson's, marsh, and red-tailed hawks. Important areas for these birds during flooding season

include the Big Hanaford Valley, the Centralia Reach and golf course, Stearns Valley, and to a lesser extent Newaukum Valley. Sand hill cranes and up to 200 swans have also been observed (S. Hager, USFWS biologist, pers. comm. 5-20-02).

ESA CONSULTATION

The Corps has prepared a Biological Assessment that discusses the occurrence of federally-listed species, their use of the project area, and the expected effect of the project on them. Species that could be affected by the project include the bald eagle and bull trout. The Corps determined that the proposed project may affect but is not likely to adversely affect these species. Based upon the location of bald eagle nest sites and bald eagle use of the project area and the low probability of bull trout presence in the upper Chehalis River basin, the Service concurs. The Service issued a concurrence letter for the project dated October 22, 2002.

ALTERNATIVE SELECTION PROCESS

The alternative selection process started off with ten screening criteria for an alternative to be carried forward for consideration. These criteria included: reduce flood hazards, decrease transportation closures, avoid increasing flood risks hazards downstream, avoid decreasing existing low flow benefits provided by Skookumchuck Dam, reduce flood damage and transportation delay costs, be cost effective, avoid, minimize and compensate for unavoidable adverse impacts, incorporate fish and wildlife habitat enhancement elements, and comply with environmental regulations. The alternative selection process started with seven alternatives:

- 1) No action alternative
- 2) Skookumchuck Dam modification (authorized in 1986 but not economically justified)
- 3) Overbank excavation and flow way bypass (Lewis County Alternative)
- 4) Levee system
- 5) Upstream flow restriction structures
- 6) Nonstructural alternative
- 7) Interagency alternative

For Phase 1 screening, the Corps weighed these seven alternatives against the project criteria, primarily insuring that remaining alternatives would reduce the risk of flood hazard, meet cost benefit criteria, and avoid and minimize environmental impacts. As the result of this screening, the Corps came up with four alternatives for further evaluation:

- 1) No action
- 2) Floodplain modifications (Lewis County alternative)
- 3) Levee system
- 4) Interagency alternative

As part of Phase 2 screening, the Corps used a hydraulic and economic model to select the National Economic Development (NED) plan. The levee system met this second phase screening. A preliminary geomorphic evaluation, based on concerns raised by the Service and

other natural resource agencies about the environmental risks of the Mellon Street bypass, selected the levee system as the least environmentally damaging alternative.

After determining that the levee system provided the NED plan, the Corps compared flood reduction benefits and costs of various modifications of the dam. 1) One modification, the “high dam” would increase pool storage from elevation 477 feet to elevation 492 for flood storage of 20,000 acre feet and modify the outlet works to provide better control over release of water from the reservoir at elevations lower than 477 feet. 2) The second choice, the “low dam” would be to make changes in the outlet structure only for flood storage at 477 feet of 11,000 acre feet. The Corps found that there is little difference in the flood reduction benefit between the two approaches but that there is a much larger cost associated with the increase in pool elevation, so that the high dam was not economically justified. The low dam, which meets the Corps NED plan, is also the recommendation of the Interagency Workgroup that developed the interagency alternative.

From the beginning of our involvement, we had concerns about the short time frame for planning and the momentum of the “Lewis County Alternative” (the floodplain modifications, especially the Mellon Street bypass). We were concerned that the Mellon Street bypass would be selected as a preferred alternative before other alternatives had been fully developed. Resource agencies raised many questions about potential impacts and their concern that other alternatives would not be given adequate consideration. The contractor for the local sponsor prepared a fish and wildlife habitat study that focused on areas that would be potentially affected by the Lewis County alternative. We were given no opportunity to provide input or to become involved with implementation of the study, although we did provide comments once the study was completed.

In response to continued concerns raised about the short time frame and potential impacts to channel processes of the Mellon Street bypass, the Corps provided several helpful changes to their planning. First, they improved the process so that it was more inclusive and communicated better with various stakeholders. Secondly, the Corps provided a geomorphic evaluation of all the alternatives being considered. That evaluation concluded that the levee alternative would have insignificant impacts to channel processes in comparison to the Mellon Street bypass. The report concluded that sufficient geomorphic information had been obtained to select a “least environmentally-damaging alternative,” i.e., the levees, but that should the Mellon Street bypass be selected, more detailed sedimentation and geomorphic studies should be undertaken to help quantify impacts to physical processes and help establish appropriate mitigation measures. Because of the short time frame, these studies could not be completed in time to keep the project on schedule for WRDA 2002 funding.

In following its planning process, the Corps selected the levee alternative with “low” dam modifications as its NED plan. In addition, early evaluation indicates that this alternative is the least environmentally damaging, a conclusion with which we agree. The Corps later selected the “high dam” option for the recommended plan. Operational restrictions are expected to keep the environmental impacts of the “high dam” option similar to that of the “low dam.”

FUTURE WITHOUT THE PROJECT

Conditions in the upper watershed of WRIA 23 should improve gradually with time. We expect to see this improvement because of re-establishment of riparian vegetation, an increase of large woody debris recruitment, a reduction of suspended sediments from upstream sources, and possibly some normalizing of the hydrograph (i.e., with better forest recovery and road drainage standards, we would expect to find greater evapotranspiration and interception of infiltration of precipitation and less connection of road surfaces to stream channels, resulting in increased runoff lag times).

We expect these improvements would result from several actions, including: 1) a habitat conservation plan (HCP) completed for state-owned (Washington Department of Natural Resources) forest lands; 2) revised forest practice rules, applicable on all private forest lands, which should result in improved riparian conditions, better potential for LWD recruitment, and reduction of fine sediment input to streams; and 3) road maintenance and abandonment plans which will be required on all forest roads within the next five years, and should result in fewer debris torrents and decreased inputs of sediment into the upper basin (M. Ostwald, USFWS, personal communication 4-24-02). The beneficial results of these actions could be dampened by the magnitude of channel incision and erosion in some reaches, such as the North Fork Newaukum River. Erosion increases sediment input locally despite improved conditions from headwater areas (Bakke 2002).

We expect to see an improvement in water quality with time under the TMDL process. We are uncertain of the degree of seepage from the contaminated sites in the project area and the plans for clean up or containment. We are also uncertain about the plans for improvement in sewage treatment plants, stormwater management by the cities, and improved dairy practices and food processing practices. Our assumption is that over time, and with the states' continued setting of standards for these water-quality-related issues, water quality will improve to some degree.

Currently the state's Salmon Recovery Funding Board and the federal Chehalis Basin Fisheries Restoration Program are funding salmon restoration projects throughout the basin. These typically average about 7 projects per year for each program. Types of projects include livestock exclusion, fish passage, riparian planting and, in the case of the state program, land acquisition and assessments. The federal program funds smaller projects, generally, than the state program (B. Peck personal communication 4-25-02). We would expect these projects to incrementally improve conditions for salmonids in the tributaries, although the effects on conditions in the project area are uncertain. We would expect the improvement to be most marked in the area of retrofitting culverts and fish passage barriers to provide better access to functioning habitat.

As part of the state's salmon recovery response, the watershed planning process is now underway in the Chehalis Basin. This process focuses on water rights, determining whether water is over-allocated, and the water needs for fish. Although the state is conducting studies this year to determine the flows needed for fish, the watershed planning process is controversial, and it is uncertain what the effect will be on water in the basin long term. The state has instituted new water policies that may show a positive effect over the years, but these are voluntary, including a program that encourages people to conserve water rather than "use it or lose it." The other

program pays people not to use water so that it will be available for fish. It is uncertain whether funds will be available for that program in future years or whether the water reserved in this manner will actually stay in the channel. Our assumption is that without a major change in how water rights are allocated, we do not expect to see major changes in the amount of water available for fish.

Our understanding is that without the project, the state's Department of Transportation would raise the freeway in the project area to reduce flooding and closure of the freeway. It is uncertain what the long-term effect of this would be on ecological functioning. The ecological conditions in the project area will depend largely on the amount of filling and type of development allowed to occur in the floodplain and floodway. The Corps states that Lewis County will adopt the new 100 year floodplain maps with floodways and flow paths marked on them, although we do not know when this will take place. Provided the county uses these maps and enforces regulations regarding development of floodplains, floodways and flow paths, we would expect conditions to remain fairly constant, in other words, degraded but probably not getting worse.

Without the project, and without a commitment to a floodplain management plan and land use and development regulations, we would expect to see development continue to some degree in the floodplain and floodways as has occurred in past years. Habitat for fish and wildlife would continue to be lost. Although future development would be limited by flooding, it has been allowed to occur in the past through imported fill and local diking practices. These practices result in cumulative channel simplification, continued loss of floodplain storage, degradation of riparian vegetation and wetlands, flashy hydrology, fine sediment input, and degradation of or lack of opportunity for re-creation of off-channel habitat and spawning and rearing habitat. Increases in impervious surfaces can be expected to exacerbate flashy hydrology, especially in smaller sub-basins, with associated increases in erosion and fine sediment input and proliferation of bank armoring projects. Recent court cases have challenged the Corps of Engineers and a state's authority to regulate filling of isolated wetlands. We expect to see an erosion of protection for isolated wetlands because of these legal challenges and increased filling of isolated wetlands.

Because significant changes in agricultural practices to benefit fish and wildlife have been difficult to regulate in Washington, it is difficult to predict future conditions in this area as well. Voluntary measures, restoration projects, and incentives are available that encourage farmers to exclude livestock from streams, plant riparian buffers, and restore wetlands. Land acquisition, incentive programs such as the federal Conservation Reserve Enhancement Program (CREP), and conservation easements would have a long-term beneficial effect, but it is difficult to determine how widely these programs will be used.

We would expect to see many areas of the floodplain continue in agricultural use. Currently agricultural fields that are seasonally flooded provide important foraging habitat for wintering waterfowl, shorebirds and the raptors that depend upon them. We would expect to see these floodplain agricultural areas continue to provide important wildlife habitat into the future as well.

Currently, large wood is removed from the river and streams by local residents. Without some educational or regulatory program in place, we would continue to see large woody accumulations disappear from the stream channel. Without the presence and retention of large woody debris, we

doubt that the river incision and channel simplification will change much in the future. Based on studies provided by the Corps (SAIC 2001), the extent of channel migration has not changed much in the last 60 years; channel incision and channel simplification have appeared to worsen over time. We would expect to see continued bank erosion, bed scour, and high, bare banks unless the river accumulates large woody debris and riparian vegetation.

SKOOKUMCHUCK DAM AND SKOOKUMCHUCK RIVER

We expect that without alterations to the operation of the dam, existing conditions would continue into the future. A 15-foot zone with no vegetation would continue to exist around the perimeter of the reservoir. Juvenile salmonids and, perhaps, amphibians and small animals, would benefit from the presence of shoreline vegetation when the pool elevation is high during the late winter and spring. The exposed substrate would continue to provide no cover, foraging or shade for fish and wildlife during the summer through fall when the reservoir is low.

Fluctuations in water levels will continue to leave the delta areas of tributaries in a state of constant degradation.

Fish passage around the dam would continue as currently. However the success of the current trap-and-haul and smolt out-migration for steelhead has not been evaluated. We are uncertain whether the water out take for the power generation facility has fish screens or, if present, whether they are successful at preventing injury to fish from entrainment.

Some aspects of habitat in the Skookumchuck River would no doubt remain the same or improve slightly. Continued dam operation to provide minimum flows and temperatures for fish spawning and rearing would result in future conditions that are similar to the present. Water quality would probably improve as the TMDL process continues. As the valley continues to develop, we would expect to see new bank armoring projects and local diking projects for erosion and flood control. Because the source of coarse sediments to the river is derived from bank erosion and tributaries, further bank armoring may reduce the supply of spawning gravels and create larger areas of bedrock, depending upon where the armoring takes place. Channelization may also contribute to greater losses of off-channel habitat, channel incision, redd scour, excessive sediment and LWD transport, and fish stranding during overbank flows.

FUTURE WITH THE PROJECT

UPPER CHEHALIS RIVER BASIN

Future "with project" conditions depend largely upon how well the Corps, local sponsor, and involved parties develop details about the following elements: mitigation, monitoring and adaptive management, the SR-6/Scheuber Ditch project, restriction of development riverward of the levees, design of the levee system, and restoration projects. With attention to how these elements are designed and implemented, we believe that the recommended plan could result in improved conditions for fish and wildlife in the Centralia Reach.

The levee system may contribute to improved water quality with time. It is being designed to contain contaminants on state or federal superfund sites that currently seep into the river.

We would expect to see more dense development occur outside the levee system as urban areas are protected from flooding. Without having a clearer idea about how nonstructural measures will actually be implemented, we are uncertain as to the future conditions of the land on the river side of the levees. Common sense would indicate that frequent flooding should limit urban development, however it has not done so in the past. Use of imported fill and local diking have enabled development to occur in the floodplain, resulting in loss of flood storage and natural floodplain function. It appears that local jurisdictions may allow commercial development in designated "floodways." If commercial development continues to encroach upon floodplain areas, it will limit the natural functioning of the floodplain and the value for fish and wildlife that makes the concept of setback levees so appealing.

According to documents provided by the Corps, the SR-6/Scheuber Ditch mitigation project will improve habitat for both fish and wildlife in the Centralia Reach. To what degree it will constitute an enhancement above and beyond mitigation for project impacts is uncertain. Implementation of restoration projects conceptualized in the Draft Restoration Plan may ensure that fish and wildlife habitat would improve in the future.

SKOOKUMCHUCK RIVER BASIN

As described in the fisheries review document, dam re-operation would result in an alteration of flows in the Skookumchuck River. We lack the information to predict the impacts of altering flows. We suspect that we might see fewer off-channel habitats accessible by fish, different species use of spawning gravels, degraded spawning beds, a riparian system that is less dynamic than currently with less species diversity and more exotic species invasion. With fewer overbank flows, fines may be passed down the river instead of being deposited on the floodplain with a resulting increase of turbidity downstream. Erosion may increase in certain areas, and bank armoring in response could also increase. Channel incision, particularly in areas with existing bank armoring, could increase. It is unknown how significant the long-term impacts might be. If the sediment and geomorphic studies proposed by the Corps indicate that these impacts are significant, it is unknown how the Corps would mitigate for them.

The environmental impacts of the "low dam" versus "high dam" alternatives are basically the same provided that the slide gates do not retain water at the higher ("high dam") pool elevation for longer than five days and that the high dam elevation is not used more than once every other year. Limiting the duration and frequency that the pool would be allowed to remain at elevation 492 feet would reduce the loss of shoreline vegetation due to long-term inundation.

Having freshets pass through the dam during the fall and winter may benefit fish downstream by triggering spawning and overwintering behavior, however it is difficult to say whether the benefits would outweigh the impacts to habitat from the dam re-operation. We are uncertain how alterations in fish passage at the dam might ultimately affect winter steelhead.

DISCUSSION

SETBACK LEVEES

We support the Corps' selection of setback levees as the least environmentally damaging alternative. We understand that: a) for the most part, the levee system would consist of an increase in height of existing levees or embankments; b) that new levees will be located close to developed areas and that undeveloped floodplains will be allowed to continue to flood; c) that there may be some reduction in flood storage at the largest events; d) that there will be little change for smaller, more frequent flood events; and e) that most areas protected from flooding probably did not function well for recharge or habitat because they are covered with impervious surfaces.

Based on the Corps' hydraulic modeling and the geomorphic evaluation, we would expect that the setback levees by themselves will have little effect on riverine or floodplain functions for most flood events. Although the areal extent of flooding would change significantly for events larger than a 2 year, the predicted rise in flood stage is minimal, even at the 100 year event. Downstream, the rise in flood stage would be much less. This effect is probably due to the Mellon Street Bridge, which acts as a "pinch point," retaining flood waters despite the decrease in flood storage resulting from the levees. In addition, the increased flood storage of the SR-6/Scheuber Ditch proposal may partially offset the loss of flood storage due to levees at certain events, although we do not know to what degree.

Aerial photos indicate that the river has not meandered much in the last 50 years. The levees are set back from the river channel so that in the future, should restored functions allow more meandering, the river would not be significantly constricted in most places. The floodplain areas would continue to function as natural floodplains.

Based on information from Corps hydrologists, it appears that groundwater recharge from large scale floods contributes minimally to continued base flows in this area. Whatever ground-water recharge takes place during flood events within an urban area is greatly altered because of impervious surfaces. Removing these areas from flooding should not significantly affect base flows in the Chehalis River. Removing agricultural drain tiles in some of the areas that will continue to flood would improve groundwater recharge and could improve the natural functioning of this floodplain.

The levees will cause significant unavoidable loss to wetlands and riparian vegetation. These impacts would occur directly from placement of the levee footprint as well as indirectly, where levees will alter the hydrology of these areas. The resulting changes in plant communities and physical structure would change the habitat value in the project area. The Corps expects that implementation of the SR-6/Scheuber Ditch mitigation project will compensate for those unavoidable losses, although we have not seen documentation that demonstrates this. We look forward to the establishment of a mitigation workgroup, which would coordinate with the Corps

in negotiating the adequacy of mitigation, the preparation of the mitigation plan, and design of the SR-6/Scheuber Ditch project.

The levees may also cause significant loss of aquatic habitat in those cases where the levees must be located closer than 100 feet to the river channel due to the proximity of roads or other infrastructure. Although 80% of the proposed 80,000 linear feet of new or upgraded levees will be located 300 feet or more from the river, approximately 8,700 feet of levees will be located closer than 100 feet. Impacts to the Chehalis River and its tributaries would include loss of riparian overstory, reduction in large woody debris recruitment, and a reduction in shading and terrestrial prey production. The impacts to fish of these more closely channelized areas could be minimized by incorporating fish benches, large woody debris, and riparian plantings into the levees.

The amount of fill previously placed in the floodplain has been considerable. We have recommended that the local sponsor develop a "no net loss" policy for floodplain filling. The policy would help ensure that if fill is placed in the floodplain, the loss of floodplain function and storage would be mitigated by removal of previously-placed fill. This policy should be crafted so that the goal is restoration of floodplain function and floodplain storage. Examples of this type of mitigation might include removal of piles of fill on the river side of the levees or reconnection of oxbows. The way in which this policy is developed and implemented could make a tremendous difference in restoring flood storage and natural function to the floodplain. We believe that the Corps has an obligation to consider "no net loss" of the floodplain in the construction of the levee system and to evaluate the potential to use previously-placed fill for construction of the levees.

The Corps has stated that it will not consider planting woody shrubs or trees in the levees out of a concern for the structural integrity of the levees. However, we note that in many levee systems in the Pacific Northwest, the Corps has allowed establishment and even planting of woody riparian vegetation. Our understanding is that the proposed levees would not be subject to high energy erosive forces in most cases, so that the structural needs for levees may vary depending upon their location and the forces they would be expected to endure. Riparian plantings and fish benches designed into the levees would provide edge habitat for fish and would be helpful in offsetting some of the negative impacts that would be caused by encroachment on the river.

Provided that further development is limited within the levee system, we believe that setback levees will encourage continued agricultural use of the floodplain. Continued agricultural land use would benefit wintering waterfowl and shorebirds that forage in flooded fields. The setback levees will allow the river to evolve more naturally than it would if increasingly channelized by armoring and hemmed in by further development. Setback levees also provide a foundation for many restoration activities that could be undertaken as part of this flood project or as part of the Chehalis Basin Study, such as wetland, floodplain or riparian restoration and re-connection of off-channel habitat.

Conservation, drainage or erosion easements or purchase or transfer of development rights are an important component of the levee system. Providing an incentive to continue agricultural land use and protection of riparian areas would be of long-term benefit to this area. Because livestock has prevented the establishment of riparian vegetation and trampled the banks in many areas of

the Centralia Reach, these areas should be fenced and riparian vegetation planted. The proposals to include wetland and riparian restoration and re-connection of off channel habitat should include conservation easements or other landowner agreements. These agreements are a critical part of ensuring that the restoration work remains in place long enough to benefit fish and wildlife. Erosion easements would decrease the incidence of future bank armoring.

NONSTRUCTURAL MEASURES

The nonstructural measures as originally proposed by the Interagency Workgroup are an important component of the levee system. Their main effect would be to discourage further urban development of the floodplain area within the levees. Limiting further development of these areas would decrease the degradation caused by filling the floodplain, encroachment of infrastructure on the river, elimination of riparian areas and fill of wetlands. However, the DEIS indicates that commercial development may be allowed to continue. If commercial development and landfill is allowed to continue within the levees, degradation of natural floodplain functions will also continue. All of the nonstructural measures discussed below are important to incorporate into the recommended plan.

1). Adoption of a new regulatory 100 year floodplain.

Land use regulations have allowed development to occur in areas that flood frequently. At least part of the reason for this is that local governments are using outdated FEMA maps showing a very limited extent of flooding. By locating residential and commercial development outside the 100-year floodplain as defined by recent hydraulic modeling, future development will have much less impact on river functions and fish and wildlife habitat and will be at less risk for flood damage.

2). Restrictions or a moratorium on development in the newly defined floodway and flowpaths.

This measure is also an important step in halting the ongoing filling and encroachment. We are concerned that commercial development will be allowed in the newly-defined floodway in both Lewis County and the City of Chehalis.

3). Implementation of a "no net loss" policy for floodplain capacity.

This would require that new fill be mitigated by removal of an equal volume of fill elsewhere in the floodplain or floodway. Our understanding of the intent of a "no net loss" of floodplain policy is that it would help retain floodplain storage, encourage the connection of the river with its floodplain, and provide for natural floodplain functioning. We caution that this policy could easily be misconstrued as to be completely ineffective. A hole excavated in the floodplain, for example, would provide no mitigation of lost capacity (since it would fill with groundwater during flood events) whereas removal of previously-placed fill would actually increase the area of lateral flooding. In addition, excavating a hole to compensate for the placement of fill may create areas where fish

would be trapped and stranded during flood events. This policy needs to be carefully developed so that the original intent is not lost.

Local jurisdictions have policies regarding fill of floodplain areas, but we are uncertain whether these meet the intent of the “no net loss” policy. The Corps has described how a “no net loss” policy could be developed, but it is not clear to what extent it is already met, or whether and how this measure will actually be implemented.

4) Development of a floodplain management plan in compliance with the Executive Order on Floodplain Management 11988.

This is also important because it provides a foundation for land use planning in these frequently flooded areas. The Corps has stated that this measure will be accomplished prior to signing of the cooperative agreement for project implementation. It is uncertain whether resource agencies will have the opportunity to provide input.

5) Stormwater management.

The local sponsor has adopted minimum requirements for new development and redevelopment from the state’s Stormwater Management Manual for Western Washington.

MITIGATION

The SR-6/Scheuber Ditch mitigation proposal is an extremely important part of the levee system. Conceptually, it would appear to mitigate for many of the unavoidable project impacts in the Chehalis River floodplain and would add significant value to fish and wildlife habitat in the project area. It appears to be implementable.

The Corps has indicated that the SR-6/Scheuber Ditch complex will be sufficient to address compensatory mitigation for project impacts as well as provide additional enhancement to fish and wildlife. While we strongly support the SR-6/Scheuber Ditch concept, we are not aware of any discussions or documents that have demonstrated that this mitigation proposal will be adequate to compensate for all project impacts. The Corps needs to convene a mitigation workgroup to negotiate the adequacy of mitigation before further details about the SR-6/Scheuber Ditch proposal are developed.

Many design details need to be developed, but the basic concept, if constructed, would be expected to increase flood storage, reconnect the floodplain with the river hydrology, provide overwintering and possibly summer rearing habitat for salmonids, restore wetlands and riparian habitat, restore an agricultural ditch to stream meandering and restore an area degraded by agricultural ditching and drain tiles. This project would improve floodplain connections, and we also believe it will help restore hyporheic connections and aquifer recharge which could have a small but beneficial influence on base flows and water temperatures.

The Chehalis Indian Tribe has proposed a concept for mitigation/restoration that needs to be explored further. The Tribe has undertaken numerous restoration projects for wild salmonids in the last decade and has a proven program for restoration. They have been successful at leveraging funds to get these projects implemented. The Tribe proposes that as a supplement to the proposed habitat enhancements, dedicated funds be found to provide for a program to restore habitat in the upper watershed for wild salmonids. In the past, mitigation for large federal projects was often in the form of hatcheries or other actions that failed to compensate for project impacts. Many times, impacts went unmitigated because the federal agency had completed its work by the time unforeseen impacts were discovered. The concept proposed by the tribe could be the means by which additional mitigation would be provided or corrective measures taken.

The Corps has committed to developing a mitigation plan during the PED phase of planning. The mitigation plan should be developed in close coordination with a workgroup consisting of resource agencies and tribes. The feasibility of the tribe's proposal (discussed in the paragraph above), the adequacy of proposed mitigation, goals of mitigation, performance standards for measuring success, and a monitoring and adaptive management plan should be developed with that workgroup. Detailed planning and design of the SR-6/Scheuber Ditch mitigation project should also be coordinated with this workgroup.

We recommend that impacts that may occur from dam re-operation in the Skookumchuck River be mitigated within the same sub-basin. We support the Corps in developing sediment and geomorphic studies to determine more carefully what the impacts of dam re-operation will be. Opportunities to minimize impacts from the dam re-operation should be vigorously explored.

RESTORATION

Part of the project purpose for the Centralia Flood Study is to "incorporate appropriate fish and wildlife habitat improvements." In keeping with this purpose, we want to make sure that restoration is a significant part of the proposed project. So far, the Corps has not selected any of the restoration projects from the Draft Restoration Plan (Tetra Tech 2001), for further planning and design, nor has it indicated that it intends to implement any of these restoration projects. Restoration opportunities described in the Tetra Tech report would result in a long-term improvement in conditions. These projects would include large and small-scale riparian plantings, re-connections of oxbows or other off-channel habitats, the addition of large woody debris, and channel roughening, increased floodplain area or function, and restoration of wetlands. In addition to restoration projects proposed in the Tetra Tech report, there are many opportunities in the upper watershed, outside the project area, that if implemented would enhance conditions for fish and wildlife.

One of the recommendations in the Corps' restoration plan was that cut, eroding banks in the Centralia Reach should be sloped back, trees planted, and the toe armored to prevent erosion at the base. We cannot wholeheartedly support toe armoring without understanding more about what is causing the channel incision to occur and how the river is responding to past impacts. Aerial photos indicate that there has been little channel meandering in the last 60 years; the restoration plan implies that toe armoring, therefore, would have little effect on channel migration and that it is needed to get vegetation established on the upper banks of the river. We

are uncertain that toe armoring is indicated. With the level of information available, we are more comfortable with a conservative approach of livestock exclusion, riparian plantings where there is a good chance of establishment, reconnecting oxbows, wetland restoration, and the addition of large woody debris. We believe that ultimately, channel incision in this area will not improve without the accumulation of large wood to help aggradation of the bed.

SKOOKUMCHUCK DAM

Our main uncertainty about the recommended plan lies with dam re-operation and alteration of flows in the Skookumchuck River. The Skookumchuck River is an important spawning area for spring chinook, with 90 % of the spawning in the entire Chehalis basin taking place in the Skookumchuck, Newaukum or Upper Chehalis Rivers. Fall chinook, steelhead, coho, and resident salmonids also spawn, rear and forage in the river. Alteration of flows could have serious implications for these salmonids.

First, we are concerned that rapid evacuation of the reservoir could have impacts on chinook salmon that spawn in the Skookumchuck River. Also, if the reservoir is evacuated late in the rainy season, we are concerned that too little water would remain to provide minimum instream flows for summer months through the fall spawning season to the end of the yearly dry season.

Second, if overbank flows are decreased, it could result in large scale changes in wetlands, riparian vegetation composition and function. Off-channel habitats are somewhat uncommon now in the Skookumchuck River and many are already inaccessible at low flows. With the decrease in frequency of peak flows, these habitats may fill with sediments and vegetation so that they become even less accessible in the future. Decreasing overbank flows would likely result in fewer opportunities for new side channels and off-channel habitats to be formed. Loss of overbank flooding would also reduce the opportunity for fine sediments to be deposited on the floodplain, meaning that they would be passed downstream to fill in gravel or affect salmonids directly. It may also reduce the potential for recruitment of large woody debris into the system.

Channel maintenance flows are extremely important in any river system with spawning salmonids because they cleanse the spawning gravels of fine sediments. Channel maintenance flows usually occur at a 2 to 5 year event (P. Bakke, pers. comm. 5-16-02), but we do not know the flows at which this function occurs in the Skookumchuck River. We are concerned that limiting flows may decrease channel maintenance functions. Shifts in flows would almost certainly create shifts in size classes of substrate, which may change the species that could use that substrate and the channel structure. Altered flows could also result in alterations of pool to riffle ratio, channel structure, floodplain connectivity, recruitment and transport of coarse sediments and large woody debris, and increased channel incision.

Our third concern with the dam modification is with respect to fish passage. The winter steelhead population is depressed. Information about how well the existing dam functions with respect to fish passage is lacking. Our understanding is that studies to determine whether steelhead smolts reach the dam or can survive downstream passage may have been done shortly after the dam was constructed, but that this information is not available currently. The returning steelhead spawners that are trapped and trucked to a release site above the dam are assumed to be progeny of wild

steelhead. However, they may well be progeny of hatchery steelhead that have spawned in the river. We are uncertain whether the trap and haul operation has been successful in producing smolts, or that any smolts produced actually reach the dam, given the assumed level of predation in the reservoir. We are uncertain whether juveniles, smolts or kelts (spawned-out adult steelhead that are returning to the ocean) can survive passage through the dam.

Our support for dam modifications will depend upon the several actions which need to be taken: a) questions about impacts from reservoir evacuation need to be discussed, clarified and resolved in coordination with resource agencies; b) completion of recommended geomorphology and sediment studies that would quantify potential impacts and help development of mitigation projects; and c) a determination of the adequacy of mitigation coordinated with the mitigation workgroup. Where significant uncertainties exist about the magnitude of impacts, our support for the dam modifications will depend upon the Corps' firm commitment to provide: 1) generous mitigation to offset potential impacts; and 2) restoration projects to enhance fish and wildlife habitat. These components should include adequate planning and time for agency participation and input.

We are still concerned about the possibility that the Mellon Street bypass (part of the Lewis County alternative) may appear later as a component of the recommended plan. We will not support the recommended plan if it includes the Mellon Street bypass unless specific geomorphology and sediment studies have been conducted that more definitively demonstrate either that impacts would be insignificant or that quantify potential impacts so that appropriate mitigation may be developed.

RECOMMENDATIONS

1. Consult with the Service and other resource agencies to determine the appropriate time to schedule in water work to decrease impacts to anadromous fish.

Response: Agree; consultation will be ongoing throughout the life of the project.

2. Fully implement all features in the design that minimize the impact of the project during the construction and operation as described in the Biological Assessment and NEPA documentation.

Response: Agree; impacts during construction and operation have been considered throughout the alternative development process.

3. Remove all man-made debris from the site after construction. Prevent any debris from entering rivers or streams throughout the project's construction.

Response: Agree; this will be part of the construction contracts when awarded.

4. The extent of riparian impacts must be minimized and native plantings must replace the lost function provided by any trees and shrubs removed by the construction.

Response: Agree; this will be looked at during the final planning phase of the proposed project and will be implemented where feasible.

5. Identify and protect, to the extent practicable, any existing large trees (in particular, conifers) within the construction site that are also within one site-potential tree height of any rivers or streams. Large trees that need to be removed from the construction site should be pushed over to maintain the root wad and placed in streams or rivers or within the riparian corridor following construction.

Response: Agree; this will be implemented where practicable during construction.

6. Refuel all machinery at least 300 feet back from wetlands or streams and identify sites suitable for refueling activities prior to commencing construction.

Response: Agree; this will be part of the environmental section of each contract.

7. Adhere to the Washington Department of Ecology's Water Quality Certification, when issued for the project.

Response: Agree; the Corps is required to adhere to the water quality certification guidance and directions.

8. An environmental monitor should conduct a site inspection prior to construction and should be present on site as often as needed to assure that actions to minimize impacts are followed. Protocols and contingencies for this person to follow should be provided in the monitoring and adaptive management plan.

Response: Disagree; the Corps believes that all necessary inspections will be concluded prior to construction and there would be no need to have an environmental monitor on site during construction. The project PM will be ultimately responsible for all construction activities and will ensure that all actions minimize impacts to the environment. In the event a situation arises that an environmental person is required on site the Corps will provide that person. However, the Corps agrees that a monitoring and adaptive management plan should and will be developed prior to construction.

9. All spoil areas should be identified prior to project construction to provide resource agencies the opportunity to assess impacts and recommend restoration measures.

Response: Agree; the Corps will work with the resource agencies during all phases of this project.

10. Sites of construction activities such as access roads, staging areas, borrow pits, etc., should be kept as small as possible in order to minimize disturbance and destruction of terrestrial wildlife habitat. Furthermore, the construction phase should also be as short as possible to reduce potential disturbance to fish and wildlife.

Response: *Agree; the Corps will implement those procedures during construction.*

11. The Corps should convene a "mitigation workgroup" composed of the Service and affected resource agencies and tribes. The mitigation workgroup would help the Corps determine the adequacy of mitigation for project impacts and participate in the development and completion of the following tasks:

a. Geomorphic and sediment studies on the Skookumchuck River. The intent of these studies is to determine the significance of and quantify the potential impacts of altering flows on spawning gravels, bed and bank scour, channel incision, off-channel habitat, riparian habitat, wetlands and other concerns that may be raised. These studies would be used in determining and planning mitigation actions to avoid, minimize and compensate for project impacts.

The Corps should consider a sediment effectiveness analysis to determine the competence of various flows to move sediment sizes in the Skookumchuck River. This analysis would help to determine the flows at which channel maintenance takes place now, the changes likely to occur with alterations in flows, and the significance of the project impacts to the channel and sediment routing post-project.

b. Wetland and terrestrial habitat studies. The Corps should coordinate with the workgroup to determine the adequacy of studies conducted so far to quantify impacts to wetlands and terrestrial vegetation. A wetland functional analysis and field verification of delineation may need to be conducted to more accurately quantify impacts to wetlands. In addition, the Corps may need to conduct a habitat evaluation program (HEP) to help quantify impacts to terrestrial habitat and selected species depending upon it.

c. Preparation of a Mitigation Plan. The intent of the mitigation plan is to quantify (where possible) the impacts of levees and dam re-operation on the Chehalis and Skookumchuck River systems; propose mitigation actions that will avoid, minimize and compensate for project impacts; and finally, to develop biological goals and objectives for the mitigation projects. Performance measures should also be developed that would be used in determining whether those goals were met or not. The mitigation plan should provide a justification for what is being proposed as mitigation and show how implementation would offset project impacts. Project impacts need to be mitigated within the same basin that they occur.

d. Monitoring and Adaptive Management Plan. The Corps needs to develop a monitoring and adaptive management plan that contains implementation and effectiveness components to ensure that the proposed project and mitigation actions are being implemented as described in Corps documents and that the biological goals of mitigation are being met. The adaptive management component is important so that corrective actions can be taken or additional mitigation provided in the event that changes have been or must be made to project operation, mitigation is not successfully offsetting impacts, or impacts are discovered to be greater than originally assumed. The monitoring plan should specify how this implementation and effectiveness monitoring should be done, who will

do it, appropriate review intervals, who and how reviews will take place, and how changes in mitigation or project operation should be negotiated.

e. Operation of Skookumchuck Dam. The Corps needs to coordinate closely with affected agencies and the tribes about how the dam will be operated for flood control. We are concerned with how quickly the reservoir will be evacuated for flood control and whether water evacuated very late in the season will be unavailable to provide minimum instream flows for salmonids during the summer.

Questions that remain unanswered should be addressed in this group, including the presence and functionality of fish screens on the power plant intakes and the success of fish passage past the dam and other issues as yet to be raised. The Corps should work with these agencies to ensure that management plans for the dam re-operation do not compromise existing fish passage at the dam, preclude improvements in fish passage for the future, or conflict with future restoration actions in the Skookumchuck River.

f. Design details need to be formalized on the SR-6/Scheuber Ditch mitigation project. Among the issues that need better clarification are: identifying the flows needed for connection with the oxbow and bypass floodway, ways to minimize fish loss due to stranding, entrapment and predation, and anticipated maintenance needs, among other issues that may be identified.

Response: *Agree; the Corps will utilize the original working group that produced the restoration protocol for the mitigation work group. This group well represents all agencies and tribes that may be affected by this project. The Corps has already implemented many of the comments listed above as the agency continues to work with the work group in the early stages of this project.*

12. Project monitoring and adaptive management should be undertaken for a minimum of ten years, with the provision to adjust the monitoring period to reflect the degree of project uncertainty.

Response: *Agree; this will be part of the monitoring plan when developed.*

13. Issues that should be monitored include, but are not limited to, fish passage at the dam, functioning of restoration and mitigation projects, and alterations to downstream habitats resulting from changes in flows released from the dam, including spawning gravels, bed and bank scour, off channel habitats, wetlands and riparian areas.

Response: *Agree; this will be part of the monitoring plan when developed.*

14. The Corps should consider incorporating riparian vegetation, fish benches, and large woody debris into the design of the setback levees, particularly in areas where the levees will be located closer than 100 feet to the river. We believe that these measures could offset some of the impacts associated with loss of riparian vegetation, edge habitat for fish, shade, and low velocity refuge for fish.

Response: *Disagree; the Corps maybe able to incorporate vegetation between the levee and the river but will not be able to place vegetation on the levee, as that would reduce the levee's stability.*

15. As part of the cooperative agreement for project implementation, the Corps should require the local sponsor to coordinate with the resource agencies and tribes in the development of the floodplain management plan. The plan should be fully implemented within three years after completion. Commercial development riverward of the levees should be specifically prohibited.

Response: *Disagree; a moratorium on developments is not within the regulatory jurisdiction of this agency.*

16. The Service should be funded during the next project phase so that we can continue to participate in the review of the updated project plans and design, the mitigation plan, the monitoring and adaptive management plan, and to help resolve any remaining fish and wildlife issues on a timely basis.

Response: *Agree; the Corps intends to fund the Service with Fish and Wildlife Coordination Act funds for as long as feasible.*

17. The Corps needs to commit more actively to restoration as an important component of the project purpose. The project purpose as stated in the DEIS is, "to reduce flood hazards to the study area. and to incorporate appropriate fish and wildlife habitat improvements." We recommend that the Corps select restoration projects from the Draft Restoration Plan for further development in addition to the SR-6/Scheuber Ditch mitigation project.

Response: *Agree; the Corps can and probably will recommend a number of restoration projects associated with this project; however, restoration is funded like any other civil works project in that it's a cost share agreement. The sponsor must have the funds in order to implement restoration projects.*

18. All recommendations presented in the Corps' fisheries review document should be incorporated into the dam re-operation plan and the revised rule curve for the Skookumchuck Dam with the following exceptions or additions:

- a) because the formation of new or maintenance of existing off-channel habitats along the Skookumchuck River may be diminished with the flood control project, the Corps should enhance existing off channel habitats and wetlands along the Skookumchuck River; and
- b) alterations to the dam need to include safe downstream passage for juveniles, smolts, and kelts, (i.e., adult steelhead that return to the ocean after spawning). Effective upstream fish passage needs to be assured.

Response: *Disagree with a. The Corps will evaluate the potential of the project adversely affecting off channel habitat and will at that point make a determination whether mitigation is required based on those findings. Agree with b.*

19. The Corps should obtain an evaluation by a geomorphologist to determine the potential for avulsion across the SR-6 bypass and the potential impacts should that occur.

Response: *Agree.*

20. The Corps should consider restoration actions outside of the project area in other parts of the watershed. In some cases, opportunities in the upper watershed can potentially provide better enhancement potential than those within the project area. This concept should be discussed by the mitigation workgroup during the next phase of planning.

Response: *Agree; the Corps agrees that this concept should be discussed further by the work group before any attempts are made to consider restoration projects outside the project area.*

21. The Corps should evaluate areas where fill has been previously placed to determine the feasibility of using this material for construction of the levees. Incorporating previously-placed fill into the levee construction would help restore flood storage and natural floodplain function to the Centralia Reach.

Response: *Agree; the Corps will attempt to use any and all available fill that will meet the criteria for levee construction for this project.*

SUMMARY

We appreciate the direction the Corps has taken with this project and the coordination done in selection of the least environmentally damaging alternative. We support the concept of the setback levees. However, the short planning timeline for this project has meant that many details we had hoped would be finalized by now are yet to be developed.

First, we are concerned about how well nonstructural measures will actually contribute to the protection of natural floodplain functions on the river side of the levees. If nonstructural measures do little to restrict further commercial development and fill of the floodplain, then one of the major benefits of the setback levee approach, i.e., natural floodplain function, would be limited.

Second, the Corps has not coordinated with resource agencies and tribes to determine the adequacy of mitigation to compensate for project impacts. The Corps has proposed the SR-6/Scheuber Ditch mitigation project, which we support, but has not demonstrated that it alone is sufficient as mitigation. In addition, many details remain to be developed about how it would function.

Third, we do not yet know specifics about the impacts that could occur from altering flows in the Skookumchuck River, nor are we certain about how these would be mitigated. We would not support mitigation for those impacts in a different basin. The Corps has indicated that geomorphic and sediment studies will commence to help determine the significance of these impacts in the Skookumchuck River, but we have not participated in the scoping or planning of these studies.

Fourth, although the project purpose identifies habitat enhancement as an important part of the project, the Corps has not selected any restoration projects above and beyond the SR-6/Scheuber Ditch mitigation proposal. It has not indicated that it will undertake additional restoration.

Finally, the Corps has not yet discussed details about monitoring and adaptive management with our agency or other resource agencies. This is a huge project with many potential impacts. Assumptions have been made about the magnitude of impacts that we are not certain are correct. The short timeline has meant that many contingencies have not been well thought out. A few years from now, we may discover that the project needs to be operated differently for flood control, or that mitigation sites are not functioning well, or that impacts are much greater than predicted. We need to have the ability to take corrective actions should they be necessary.

We want to be sure that the issues described above are addressed with sufficient detail and clarity to alleviate our concerns about potential impacts. Accordingly, we are recommending that the Corps convene a mitigation workgroup, composed of the Service, affected resource agencies and the tribes, to participate in the development of these plans and studies. Our support for the proposed project will depend upon the quality of the plans described above, the commitment to their implementation, and the degree to which the Corps coordinated with others while developing them.

LITERATURE CITED

- Anchor Environmental. 2000. Bellingham Bay Comprehensive Strategy Final Environmental Impact Statement. Prepared for the Washington State Department of Ecology October 2000.
- Bakke, P. 2002. Personal communication dated 5-20-02. U.S. Fish and Wildlife Service geomorphologist. Lacey, WA.
- Benda, L.E., D.J. Miller, T. Dunne, G.H. Reeves, and J.K. Agee. 1998. Dynamic Landscape Systems. Pages 261-288 *in* Naiman, R.J. and R.E. Bilby, eds. River Ecology and Management: Lessons from the Pacific Coastal Ecoregion. Springer-Verlag. New York.
- Bilby, R.E. and P.A. Bisson. 1998. Function and distribution of large woody debris. Pages 324-346 *in* Naiman, R.J. and R.E. Bilby, eds. River Ecology and Management: Lessons from the Pacific Coastal Ecoregion. Springer-Verlag. New York. .
- Bolton, S. and J. Shellberg. 2001. Ecological issues in floodplains and riparian corridors. Center for Streamside Studies, University of Washington, a white paper prepared submitted to the Washington State Departments of Fish and Wildlife, Ecology, and Transportation dated May 2001.
- Castro, J. and F. Reckendorf. 1995. Effects of sediment on the aquatic environment and potential NRCS actions to improve aquatic habitat. Working Paper No. 6. Natural Resources Conservation Service, Oregon State University, Department of Geosciences.
- Chehalis River Council. 1992. Chehalis River Basin Action Plan for the control of non-point source pollution. Prepared under the direction of the Lewis County Conservation District.
- Cherry, S. 2001. Literature review on Chehalis River Basin geomorphology. A technical memo prepared for the U.S. Army Corps of Engineers dated November 16, 2001 by Pentec Environmental. Edmonds, Washington.
- Cherry, S. 2001a. Executive Summary, Geomorphology study of the Chehalis River near Chehalis and Centralia, WA. A memorandum prepared for the U.S. Army Corps of Engineers dated December 17, 2001.
- Cherry, S. 2002. Chehalis River geomorphology study review meeting with USFWS and WDFW Pentec #4956-50. A letter to the Corps dated February 25, 2002.
- Collins, B.D., D.R. Montgomery, and A.D. Haas. 2002. Historic changes in the distribution and functions of large woody debris in Puget Lowland rivers. Canadian Journal of Fisheries and Aquatic Sciences 59:66-76.
- Department of Commerce, Department of the Interior Federal Register April 5, 1999 volume 64, Number 64. Page 16397-16414. 50 CFR parts 223, 224, and 226. Endangered and

Threatened Species, Threatened Status for Southwestern Washington/Columbia River Coastal Cutthroat Trout in Washington and Oregon, and Delisting of Umpqua River Cutthroat Trout in Oregon.

- Ging, G. 2000. Green/Duwamish River Basin Restoration Program-Fish and Wildlife Coordination Act Report dated September 2000. U.S. Fish and Wildlife Service, Lacey, WA.
- Hill, M.T. and W.S. Platts. 1991. Ecological and geomorphological concepts for in-stream and out of channel flow requirements. *Rivers* 2:198-210.
- Hiss, J.M. and E.E. Knudsen. 1993. Chehalis River basin fishery resources: status, trends, and restoration. U.S. Fish and Wildlife Service, Western Washington Fishery Resource Office, Olympia, WA.
- Hruby, T, T. Granger, and E. Teachout. 1999. Methods for assessing wetland functions. Washington State Department of Ecology Publication #99-116, Olympia, Washington.
- Hughes, FMR. 1997. Floodplain biogeomorphology. *Progress in Physical Geography (Prog. Phys. Geogr.)*, vol. 21, no. 4, pp. 501-529, 1997.
- Jennings, K. 2001. Email communication dated 24 September 2001 Washington State Department of Ecology.
- Johnson, D.H. and T.A. O'Neil, managing directors. 2001. *Wildlife-Habitat Relationships in Oregon and Washington*. Oregon State University Press. Corvallis, OR.
- Kelsey, K.A. and S.D. West. 1998. Riparian wildlife. Pages 235-258 in Naiman, R.J. and R.E. Bilby, eds. *River Ecology and Management: Lessons from the Pacific Coastal Ecoregion*. Springer-Verlag. New York. .
- Larson, A.G. 1994. Pesticide residues in the east Chehalis surficial aquifer. Washington State Department of Ecology Pesticides in ground water - report No. 5. 94-26. Prepared February 1994.
- Mendoza, C.C. 1998. An independent review of the Chehalis fisheries restoration program with applications of monitoring and evaluation, and project site selection. A report prepared for U.S. Fish and Wildlife Service dated March 1, 1998.
- Mongillo P.E. and M. Hallock. 1997. Distribution and habitat of native non-game stream fishes of the Olympia Peninsula. Washington Department of Fish and Wildlife Technical Report FRD 97-05.)
- Montgomery, D.R. and J.M. Buffington. 1998. Channel Processes, classification and response. from *River Ecology*. Pages 13-42 in Naiman, R.J. and R.E. Bilby, eds. *River Ecology and Management: Lessons from the Pacific Coastal Ecoregion*. Springer-Verlag. New York.

- Mundie, J.H. 1991. Overview of effects of Pacific Coast river regulation on salmonids and the opportunities for mitigation. *American Fisheries Society Symposium* 10:1-11.
- Naiman, R.J., R.E. Bilby, and P.A. Bisson. 2000. Riparian ecology and management in the Pacific Coastal rain forest. *BioScience* 50:996-1011.
- Naiman, R.J. and R.E. Bilby. 1998. River ecology and management in the Pacific Coastal Ecoregion. Pages 1-8 *in* Naiman, R.J. and R.E. Bilby, eds. *River Ecology and Management: Lessons from the Pacific Coastal Ecoregion*. Springer-Verlag. New York.
- Naiman, R.J., K.L. Featherston, S.J. McKay, and J. Chen. 1998. Riparian Forests. Pages 289-323 *in* Naiman, R.J. and R.E. Bilby, eds. *River Ecology and Management: Lessons from the Pacific Coastal Ecoregion*. Springer-Verlag. New York.
- Newcombe, C.P. and D.D. MacDonald. 1991. Effects of suspended sediments on aquatic ecosystems. *North American Journal of Fisheries Management* 11:72-82.
- Nilsson, C. and K. Beroggren. 2000. Alterations of riparian ecosystems caused by river regulation. *BioScience* 50:783-792.
- NOAA. 1999. Technical Memorandum NMFS-NWFSC-37. Status Review of coastal cutthroat trout from Washington, Oregon, and California. January 1999. U.S. Department of Commerce, National Oceanic and Atmospheric Administration, National Marine Fisheries Service.
- Ostwald, M. Personal communication dated April 24, 2002. U.S. Fish and Wildlife biologist, Lacey, WA.
- Pacific International Engineering. 2001. Fish, riparian and wildlife habitat study: Chehalis River flood reduction project. Submitted to Lewis County April 25, 2001.
- Pacific International Engineering and Pharos Corporation. 1998. Chehalis River Basin Flood Reduction Project - Draft Interim Report. Prepared for Lewis County November 1998.
- Pearsons, T.N., H.W. Li, and G.A. Lamberti. 1992. Influence of habitat complexity on resistance to flooding and resilience of stream fish assemblages. *Transactions of the American Fisheries Society* 121:427-436.
- Peck, B. Personal communication dated April 25, 2002. U.S. Fish and Wildlife biologist.
- Science Applications International Corporation (SAIC). 2001. Chehalis River flood control habitat evaluation using aerial photo analysis. A report prepared for the U.S. Army Corps of Engineers dated May 7, 2001.
- Schroeder, K. and C. Savonen. 1997. Lessons from floods. *Fisheries* 22:14-16.

- Sedell, J.R. and K.J. Luchessa. 1981. Using the historical record as an aid to salmonid habitat enhancement. Paper presented at the symposium on acquisition and utilization of aquatic habitat inventory information. Portland, Oregon, October 22-28, 1981.
- Seiler, D, G. Volkhardt, S. Neuhauser, P. Hanratty, and L. Kishimoto. 2002. 2002 wild coho forecasts for Puget Sound and Washington coastal systems. A report prepared by the Washington State Department of Fish and Wildlife.
- Smith, C.J. and M. Wenger. 2001. Chehalis watershed salmon and steelhead habitat limiting factors water resource inventory. Washington State Conservation Commission Final Report dated May 2001.
- Smith, H. 1942. Centralia, the First Fifty Years: 1845-1900. The Centralia American Revolution Bicentennial Committee.
- Sommer, T.R. M.L. Nobriga, W.C. Harrell, W. Batham, and W.J. Kimmerer. 2001. Floodplain rearing of juvenile chinook salmon: evidence of enhance growth and survival. *Can. J. Fish. Aquat. Sci* 58: 325-333.
- Sparks, R.E., P.B. Bayley, S.L. Kohler, L.L. Osborne. 1990. Disturbance and recovery of large floodplain rivers. *Environmental Management* 14:699-709.
- Stanford, J.A., J.V. Ward, W.J. Liss, C.A. Frissell, R.N. Williams, J.A. Lichatowich, and C.C. Coutant. 1996. A general Protocol for Restoration of regulated rivers. *Regulated Rivers: Research & Management* 12:391-413.
- Tetra Tech, Inc. 2001. Chehalis River at Centralia General Reevaluation Report/Environmental Impact Statement: Draft Restoration Plan: A report prepared for the U.S. Army Corps of Engineers dated September 2001.
- U.S. Army Corps of Engineers (Corps) 2002. Wetland impact assessment report: Centralia Flood Hazard Reduction Study. Prepared by Seattle District Corps, Lewis County, WA.
- U.S. Army Corps of Engineers. (2002a). Skookumchuck dam: fisheries review draft flood control operations plan dated April 25, 2002.
- U.S. Fish and Wildlife Service. 2000a. Formal Section 7 Consultation, Grays Harbor and Chehalis River Navigation Dredging, Grays Harbor, Washington. Western Washington Office. February 25, 2000.
- U.S. Fish and Wildlife Service. 1989. Planning Aid Report on the Skookumchuck River dated October 18, 1989. Western Washington Office.

- Wampler, P.L., E.E. Knudsen, M. Hudson, and T.A. Young. 1993. Chehalis River basin fishery resources: salmon and steelhead stream habitat degradations. U.S. Fish and Wildlife Service and the Washington Department of Wildlife, Olympia, WA.
- Washington State Department of Fish and Wildlife (WDFW). 2001. Fish and wildlife habitats and species map. Olympia, WA.
- WDFW. 2000. 2000 Washington state salmonid stock inventory, coastal cutthroat trout. Olympia, WA. June 2000.
- WDFW. 1998. Washington state salmonid stock inventory, bull trout/Dolly Varden. Olympia, WA. July 1998.
- WDFW and Western Washington Treaty Indian Tribes. 1994. 1992 Washington state salmon and steelhead stock inventory, Appendix two, coastal stocks. Olympia, WA August 1994.
- Waters, T.F. 1995. Sediment in streams: Sources, biological effects and control. American Fisheries Society Monograph 7, Bethesda, MD
- Weigle, J.M. and B.L. Foxworthy. 1962. Geology and ground-water resources of west-central Lewis County, Washington. Prepared in cooperation with United States Geological Survey, Ground Water Branch. Water Supply Bulletin #17.
- Welch, E. B, J.M. Jacoby, and C.W. May. 1998. Stream quality. Pages 69-94 *in* Naiman, R.J. and R.E. Bilby, eds. River Ecology and Management: Lessons from the Pacific Coastal Ecoregion. Springer-Verlag. New York.
- Wildrick, L., D. Davidson, R. Sinclair, and B. Barker. 1995. Initial watershed assessment: water resource inventory area 23 Upper Chehalis River. Open File Technical Report 95-03. A report for the Washington State Department of Ecology.
- Winter, T.C., J.W. Harvey, O.L. Franke, and W.M. Alley. 1998. Ground water and surface water: a single resource. U.S. Geological Survey Circular 1139. Denver, CO.
- Ziener, R.R. and T.E. Lisle. 1998. Hydrology. Pages 43-68 *in* Naiman, R.J. and R.E. Bilby, eds. River Ecology and Management: Lessons from the Pacific Coastal Ecoregion. Springer-Verlag. New York.

[End of Final FWCAR]

[End of Chapter 9, Comments and Responses to DEIS]

10. LIST OF PREPARERS

Matthew Boyle, Biologist
Pacific International Engineering

D. Shane Cherry, Geomorphologist
Pentec Environmental

Jeffery F. Dillon, Biologist
U.S. Army Corps of Engineers

Marie Garrett, Sr., Environmental Planner
Pacific International Engineering

George A. Hart, Environmental Coordinator
U.S. Army Corps of Engineers

Kathy Kunz, NEPA Coordinator
U.S. Army Corps of Engineers

Gwyn Puckett, Biologist
U.S. Army Corps of Engineers

11. REFERENCES

- Abbe, T. 2000. Patterns, Mechanics, and Geomorphic Effects of Wood Debris Accumulations in a Forest River System. Doctor of Philosophy, Department of Geological Sciences, University of Washington.
- Bodurtha, T. 1989. Centralia Flood Damage Reduction Study, Planning Aid Report. Prepared for U.S. Army Corps of Engineers by U.S. Fish and Wildlife Service, Olympia, Washington. 28p.
- British Columbia Ministry of Energy and Mines. 2002. Aggregate Operators Best Management Practices Handbook for British Columbia. Minerals, Oil and Gas Branch, Vancouver, British Columbia, Canada.
- Buchanan, J. B., L. L. Irwin, and E. L. McCutchen. 1993. Characteristics of spotted owl nest trees in the Wenatchee National Forest. *Journal of Raptor Research* 27(1): 1-7.
- Buchanan, J. B., J. C. Lewis, D. J. Pierce, E. D. Forsman, and B. L. Biswell. 1998. Characteristics of young forest used by spotted owls on the western Olympic Peninsula, Washington. *Northwest Science* 73(4): 255-263.
- Butkus, S. and K. Jennings. 1999. Upper Chehalis River Basin Temperature – Total Maximum Daily Load (Washington Department of Ecology).
- Cavender, T. M. 1978. Taxonomy and distribution of the bull trout, *Salvelinus confluentus* (Suckey), from the American Northwest. *California Fish and Game* 64: 139-174.
- Chehalis River Council. Information available at Internet website. <http://www.crcwater.org>
- City of Centralia. Centralia Comprehensive Plan. 1998. Centralia, Washington.
- City of Centralia. 1999. Wastewater Treatment Plant Draft Environmental Impact Statement. City of Centralia Utilities Department, Centralia, Washington.
- City of Chehalis. 1999. City of Chehalis: Comprehensive Plan and Environmental Impact Statement. 1999. Chehalis, Washington.
- Crawford, P. 1987. Dillenbaugh Creek Survey. Memorandum to J. Neel, (Washington Department of Ecology).
- DeWitt, J.W. 1954. A survey of the coastal cutthroat trout, *Salmo clarki clarki* Richardson, in California. *Calif. Fish Game* 40: 329-335.
- Dillon, J. 2002. Skookumchuck Dam Fisheries Reoperation Plan. Seattle District, Corps of Engineers, Seattle, Washington.
- Dvornich, K. M., K. R. McAllister, and K. B. Aubry. 1997. Amphibians and Reptiles of Washington State: Location data and predicted distributions, Volume 2 in Washington State Gap Analysis - Final Report, (K. M. Cassidy, C. E. Grue, M. R. Smith and K. M. Dvornich, eds.), Washington Cooperative Fish and Wildlife Research Unit, University of Washington, Seattle, Washington. 146 pp.

- Evans, R.L., and Fibich, W.R., 1987. Soil Survey of Lewis County Area, Washington, USDA Soil Conservation Service. 467 pp.
- Fielder, P. 1997. Personnel communication. Wildlife Biologist. Chelan County Public Utilities District.
- Franklin, J.F. and C.T. Dyrness. 1973. Natural Vegetation of Oregon and Washington. USDA Forest Service, General Technical Report PNW-8.
- Forsman, E. D. and A. R. Giese. 1997. Nests of the northern spotted owl on the Olympic Peninsula, Washington. *Wilson Bulletin* 109:28-41.
- Gerstung, E.R. 1997. Status of coastal cutthroat trout in California. Pg.43-56 in J.D. Hall, P.A. Bisson and R.E. Gresswell (eds.), *Sea-Run Cutthroat Trout: Biology, Management, and Future Conservation*. American Fisheries Society, Corvallis, Oregon.
- Giger, R.D. 1972. Ecology and management of coastal cutthroat trout in Oregon. Oregon State Game Commission, Corvallis, Oregon. Fisheries Resource Report No. 6.
- Glancy, P.A. 1971. Sediment Transport by Streams in the Chehalis River Basin, Washington, October 1961 to September 1965. U.S. Geological Survey Water-Supply Paper 1798-H. Government Printing Office, Washington, D.C.
- Goetz, F. 2000. Personal communication. U.S. Army Corps of Engineers, Seattle, Washington.
- Gore, J., B. Mulder, and J. Bottorff. 1987. The northern spotted owl status review. Unpubl. rep., USDI Fish and Wildlife Service, Region 1, Portland, Oregon.
- Haas, G.R., J.D. McPhail. 1991. Systematics and distributions of Dolly Varden (*Salvelinus malma*) and bull trout (*Salvelinus confluentus*) in North America. *Canadian Journal of Fisheries and Aquatic Sciences* 48:2191-2211.
- Hanson, E., D. Hays, L. Hicks, L. Young, and J. Buchanan. 1993. Spotted Owl Advisory Group (SAG), Spotted owl habitat in Washington, a report to the Washington Forest Practices Board. 20 December 1993. Olympia, Washington.
- Hays, D.W., K.R. McAllister, S.A. Richardson, and D.W. Stinson. 1999. Washington State Recovery Plan for Western Pond Turtle. Washington Department of Fish and Wildlife, Olympia, Washington.
- Holland, D.C. 1994. The Western Pond Turtle: Habitat and History. DOE/BP-62137-1. U.S. Department of Energy, Bonneville Power Administration, Portland, Oregon.
- Hubbard, L.L. 1991. Floods of January 9-11, 1990 in Northwestern Oregon and Southwestern Washington. U.S. Geological Survey Open File Report 91-72. Portland, Oregon. 10 p.
- Huhbard, L.L. 1994. Floods of November 1990 in Western Washington. U.S. Geological Survey Open File Report 93-631. Portland, Oregon. 10 p.
- Hunting, M.T., Bennett, W.A.G., Livingston, V.E., Jr., and W.S. Moen. 1961. Geologic map of Washington: Washington Division of Mines and Geology, scale 1:500,000.

IFR/EIS. 1982. See U.S. Army Corps of Engineers. 1982.

Ingles, L. G. 1965. Mammals of the Pacific states: California, Oregon, Washington. Stanford University Press, Stanford, California.

Jennings, K. and P. Pickett. 2000. Revised – Upper Chehalis River Basin Dissolved Oxygen Total Maximum Daily Load Submittal Report (Washington Department of Ecology).

Johnson, R. E. and K. M. Cassidy. 1997. Terrestrial mammals of Washington State: Location data and predicted distributions. Volume 3 in K. M. Cassidy, C. E. Grue, M. R. Smith, and K. M. Dvornich, editors. Washington State Gap Analysis - Final Report. Washington Cooperative Fish and Wildlife Research Unit, University of Washington, Seattle, Washington. 304 p.

Johnston, J.M. 1982. Life histories of anadromous cutthroat with emphasis on migratory behavior. Pages 123-127 in E.L. Brannon and E.O. Salo (eds.), Proceedings of the salmon and trout migratory behavior symposium, University of Washington School of Fisheries, Seattle, Washington.

June, J.A. 1981. Life History and Habitat Utilization of Cutthroat Trout (*Salmo clarki*) in a Headwater Stream on the Olympic Peninsula, Washington. M.S. Thesis, University of Washington, Seattle, Washington.

Koehler, G.M. and K.B. Aubry. 1994. Lynx. Pages 74-98 in L.F. Ruggiero, K.B. Aubry, S.W. Buskirk, L.J. Lyon and W.J. Zielinski (eds.), The scientific basis for conserving forest carnivores in the western United States. U.S. Forest Service, Rocky Mountain Forest and Range Experiment Station. General Technical Report RM-254. Fort Collins, Colorado.

Kraemer, Curtis. 1994. Some observations on the life history and behavior of the native char, Dolly Varden (*Salvelinus malma*) and bull trout (*Salvelinus confluentus*) of the north Puget Sound Region. WDFW. 35 pp.

Larsen, E.M., E. Rodrick, and R. Milner, tech. eds. 1995. Management Recommendations for Washington's Priority Species, Volume 1: Invertebrates. Washington Department of Fish and Wildlife, Olympia, Washington.

LeGore, R.S., and D.M. Des Voigne. 1973. Absence of acute effects on threespine sticklebacks (*Gasterosteus aculeatus*) and coho salmon (*Oncorhynchus kisutch*) exposed to resuspended harbor sediment contamination. Journal of the Fisheries Research Board of Canada 30 (8): 1240-1242.

Leider, S.A. 1997. Status of Sea-Run Cutthroat Trout in Washington. Pp. 68-76 in Oregon Chapter American Fisheries Society, Sea-Run Cutthroat Trout: Biology, Management, and Future Conservation, Corvallis, Oregon.

Lewis County. Lewis County Code. 2002. Chehalis, Washington.

Lewis County. Lewis County Comprehensive Plan and Environmental Statement. 1999. Chehalis, Washington.

Lewis County. Revised Shoreline Master Program, Lewis County, Washington. 1980. Chehalis, Washington.

- Lewis, J.C. and D.W. Stinson. 1998. Washington State Status Report for the Fisher. Washington Department of Fish and Wildlife, Olympia, Washington.
- Lowry, G.R. 1965. Movement of Cutthroat Trout (*Salmo clarki clarki* Richardson) in three Oregon Coastal Streams. Trans. Am. Fish. Soc. 94(4): 334-338.
- Lujan, M. Jr., D. R. Knowles, J. Turner, and M. Plenet. 1992. Recovery plan for the northern spotted owl - Draft. U.S. Fish and Wildlife Service, Portland, Oregon.
- Marti, P. 2001. American Crossarm and Conduit Monitoring Results, November 2000 and April 2000. (Washington Department of Ecology).
- McAllister, K.R. and W. P. Leonard. 1997. Status of the Oregon Spotted Frog in Washington (Draft Report). Washington Department of Fish and Wildlife, Olympia, Washington.
- McKelvey, K.S., K.B. Aubry, Y.K. Ortega. 1999a. History and distribution of lynx in the contiguous United States. In Ruggiero, L.F., K.B. Aubry, S.W. Buskirk, *et al.* (tech. eds.) The scientific basis for lynx conservation in the contiguous United States.. U.S. Department of Agriculture, Forest Service, Rocky Mountain Research Station. General Technical Report RMRS-GTR-30. Ogden, Utah.
- Michaud, J., Martin, S., Denman, B., Welch, K., Greenburg, J., Winters, N., Caldwell, J., and G. Konkle. 2000. Chehalis Basin Level 1 Assessment (Envirovision Corporation).
- Mongillo, P.E. 1993. The distribution and status of bull trout/Dolly Varden in the South Fork Hoh, Queets, Quinault, Elwha, and Sol Duc Rivers. Unpublished. In Washington State Salmonid Stock Inventory, Bull Trout/Dolly Varden, Washington Department of Fish and Wildlife, 1998. Olympia, Washington.
- Mongillo, P.E. and M. Hallock. 1999. Washington State Status Report for the Olympic Mudminnow. Washington Department of Fish and Wildlife, 1998. Olympia, Washington.
- Moyle, P.B. 1976. Inland Fishes of California. University of California Press.
- National Oceanic and Atmospheric Administration (NOAA). 2002. Green Sturgeon Questions and Answers. Information available at Internet website: <http://www.nwr.noaa.gov>
- Pacific International Engineering (PIE). 1996. Phase I Report – Evaluation of Preliminary Solutions and Strategy – Centralia-Chehalis Flood Control Project. Prepared for Lewis County, Washington. November 1996. Pacific International Engineering, Edmonds, Washington.
- Pacific International Engineering and Pharos Corp. (PIE). 1998. Chehalis River Basin Flood Control Project Pre-Feasibility Analysis of Alternatives. Prepared for Lewis County, Washington. Pacific International Engineering, Edmonds, Washington.
- Pacific International Engineering (PIE). 2001. Fish, Riparian, and Wildlife Habitat Study: Centralia, Washington. General Reevaluation Report and Environmental Impact Statement. Tacoma, Washington.
- Pauley, G. B., K. Oshima, K. L. Bowers, and G. L. Thomas. 1989. Sea-run Cutthroat Trout (Species Profiles: Life Histories and Environmental Requirements of Coastal Fishes and Invertebrates, Pacific Northwest). U.S. Fish and Wildlife Service Biological Report 82 (11.86). U.S. Army Corps of Engineers TR EL-82-4.

Pearcy, W.G., R.D. Brodeur, and J.P. Fisher. 1990. Distribution and Biology of Juvenile Cutthroat Trout (*Oncorhynchus clarki clarki*) and Steelhead (*O. mykiss*) in Coastal Waters off Washington and Oregon. *Fish. Bull.*, U.S. 88(4): 697-711.

Phinney, L.A., and P. Bucknell. 1975. A Catalog of Washington Streams and Salmon Utilization, Volume 2, Coastal. Washington Department of Fisheries.

Pickett, P. 1994. Upper Chehalis River Total Maximum Daily Load Study (Washington Department of Ecology).

Pickett, P.J. 1992. Historical Data Sources and Water Quality Problems in the Chehalis River Basin (Washington Department of Ecology).

Poff, N.L., J.D. Allan, M.B. Bain, J.R. Karr, K.L. Prestegard, B.D. Richter, R.E. Sparks, and J.C. Stromberg. 1997. The Natural Flow Regime: A Paradigm for River Conservation and Restoration. *BioScience* Vol. 47, No. 11, December 1997. pp. 769-784.

Potter, A., J. Fleckenstein, S. Richardson, and D. Hays. 1999. Washington State Status Report for the Mardon Skipper. Washington Department of Fish and Wildlife, Olympia, Washington.

PSMFC. 2002. Essential Fish Habitat, Pacific States Marine Fisheries Commission, 2002. Information available at Internet website: <http://www.psmfc.org>

Ralph, C.J., G.L. Hunt, Jr., M.G. Raphael, and J.F. Platt (eds.), Ecology and Conservation of the Marbled Murrelet, U.S. Forest Service Pacific Southwest Research Station General Technical Report PSW-GTR-152, Albany, California.

Reeves, G.H., J.D. Hall, and S.V. Gregory. 1997. The impact of land-management activities on coastal cutthroat trout and their freshwater habitats. Pg. 138-144 in J.D. Hall, P.A. Bisson and R.E. Gresswell (eds.), Sea-Run Cutthroat Trout: Biology, Management, and Future Conservation. American Fisheries Society, Corvallis, Oregon.

Rieman, B.E. and J.D. McIntyre. 1993. Demographic and habitat requirements for conservation of bull trout. U.S. Forest Service, Intermountain Research Station. General Technical Report INT-302.

Rodrick, E. and R. Milner. 1991. Management Recommendations for Washington's Priority Habitats and Species. Washington Department of Wildlife, Olympia, Washington.

Rountry, D. and G. Pelletier. 2002. Grays Harbor/Chehalis Watershed Fecal Coliform Bacteria Total Maximum Daily Load. Washington Department of Ecology, Olympia, Washington.

SASSI, Bull Trout/Dolly Varden. 1998. -- See Washington Department of Fish and Wildlife. 1998b.

SASSI, Coastal Stocks. 1992. -- See Washington Department of Fish and Wildlife and Western Washington Treaty Indian Tribes. 1992.

Scott, B.M.V. 1979. The Vancouver Island wolf (*Canis lupus crassodon*), an initial study of food habits and social organization. Master's thesis. University of British Columbia, Vancouver, British Columbia.

Secretary of War. 1887. Report of the Chief of Engineers, U.S. Army. Appendix TT.

- Secretary of War 1890. Report of the Chief of Engineers, U.S. Army. Appendix TT.
- Secretary of War 1892. Report of the Chief of Engineers, U.S. Army. Appendix TT.
- Steenhof, K. 1978. Management of Wintering Bald Eagles. U.S. Fish and Wildlife Service Biological Report (FWS/OBS-78-79).
- Stevens, V. and S. Lofts. 1988. Species notes for mammals. Vol. 1 in A. P. Harcombe, editor. 1988 Wildlife habitat handbooks for the Southern Interior Ecoprovince. Ministry of Environment and Ministry of Forests, Victoria, B.C. 180 p.
- Stolz, J.J. and Schnell (eds). 1991. Trout (the Wildlife Series). Stackpole Books, Harrisburg, Pennsylvania.
- Tetra Tech, Inc. 2002a. Chehalis River at Centralia General Reevaluation Report/ Environmental Impact Statement Final Restoration Report. Prepared for the U.S. Army Corps of Engineers, March 2002.
- Tetra Tech, Inc. 2002b. Chehalis River at Centralia General Reevaluation Report/ Environmental Impact Statement Supplemental Restoration Report: Scheuber Ditch/ SR-6 Alternatives. Prepared for the U.S. Army Corps of Engineers, June 2002.
- Thiel, R. P. 1985. Relationship between road densities and wolf habitat suitability in Wisconsin. American Midland Naturalist 113:404-407.
- Thomas, J. W., E. D. Forsman, J. B. Lint, E. C. Meslow, B. R. Noon and J. Verner. 1990. A conservation strategy for the northern spotted owl. Interagency Scientific Committee to Address the Conservation of the Northern Spotted Owl. May 1990. Portland, Oregon.
- Thurber, J. M., R. O. Peterson, T. D. Drummer, and S. A. Thomasma. 1994. Gray wolf response to refuge boundaries and roads in Alaska. Wildlife Society Bulletin 22:61-68.
- Thurston County. Thurston County Code. 2002. Olympia, Washington.
- Thurston County. Thurston County Comprehensive Plan. 1998. Olympia, Washington.
- Tomasson, T. 1978. Age and Growth of Cutthroat Trout, *Salmo clarki clarki* Richardson, in the Rogue River, Oregon. M.S. Thesis, Oregon State University, Corvallis, Oregon.
- Town of Bucoda. Town of Bucoda: Comprehensive Plan for Growth Management. 1994. Bucoda, Washington.
- Town of Pe Ell. Comprehensive Plan. 1997. Pe Ell, Washington.
- Trotter, P.C. 1997. Sea-run Cutthroat Trout: Life History Profiles. Pp. 7-15 in Oregon Chapter American Fisheries Society, Sea-Run Cutthroat Trout: Biology, Management, and Future Conservation, Corvallis, Oregon.
- U.S. Army Corps of Engineers (USACE). 1982. Interim Feasibility Report and Environmental Impact Statement, Centralia, Washington Flood Damage Reduction. Seattle District, Seattle, Washington.

U.S. Army Corps of Engineers (USACE). 1996. After Action Report for the February 1996 Flood Event. Seattle District, Seattle, Washington.

U.S. Army Corps of Engineers (USACE). 1997. Post Flood Study (draft), Federal Disaster 1159-DR-WA, Chehalis River at Centralia, Lewis County, Washington. Seattle District, Seattle, Washington.

U.S. Army Corps of Engineers (USACE). 2001a. Technical Memorandum, Levee Alignment. Seattle District, Seattle, Washington.

U.S. Army Corps of Engineers (USACE). 2002. Biological Assessment for the Centralia Flood Damage Reduction Project. Seattle District, Seattle, Washington.

U.S. Army Corps of Engineers (USACE). 2002. Draft Environmental Impact Statement, Centralia Flood Damage Reduction Project. Seattle District, Seattle, Washington.

USACE. 2003. Centralia Flood Damage Reduction Project Chehalis River, Washington. Draft General Re-evaluation Report/ Environmental Impact Statement.

U.S. Department of Agriculture (USDA). 1987. Soil Survey of Lewis County Area, Washington. Soil Conservation Service.

U.S. Department of Agriculture (USDA). 1990. Soil Survey of Thurston County, Washington. Soil Conservation Service.

U.S. Department of Agriculture (USDA). 2002. Forest Service. Internet website: <http://www.fs.fcd.us/>

U.S. Fish and Wildlife Service (USFWS). 1987. The northern spotted owl status review. 14 December 1987. Region 1, Portland, Oregon. 50 p.

U.S. Fish and Wildlife Service (USFWS). 1995a. Draft marbled murrelet (*Brachyramphus marmoratus*) (Washington, Oregon and California Population) recovery plan. Portland, Oregon.

U.S. Fish and Wildlife Service (USFWS). 1995b. Grizzly bear (*Ursus arctos horribilis*). Available from Internet website: http://fws.gov/r9extaff/biologues/bio_griz.htm

U.S. Fish and Wildlife Service (USFWS). 24 May 1996. Final Designation of Critical Habitat for the Marbled Murrelet. Federal Register 61(102): 26256.

U.S. Fish and Wildlife Service (USFWS). 1997a. Recovery plan for the threatened marbled murrelet (*Brachyramphus marmoratus*) in Washington, Oregon, California. Portland, Oregon.

U.S. Fish and Wildlife Service (USFWS). 1997b. Grizzly bear recovery in the Bitterroot Ecosystem, draft environmental impact statement. Missoula, Montana.

U.S. Fish and Wildlife Service (USFWS). 1998. A system for mapping riparian areas in the western United States. National Wetlands Inventory. June 1998.

U.S. Fish and Wildlife Service (USFWS). 1999. Section 7 Consultations on the Marbled Murrelet. Proceedings of the Biological Assessment Preparation and Review Workshop, U.S. Fish and Wildlife Service, Western Washington Office, March 1999.

U.S. Fish and Wildlife Service (USFWS). 2000. Letter -- Listed and proposed endangered and threatened species, candidate species and species of concern which may occur within the vicinity of the proposed Washington flood damage reduction general reevaluation report and environmental impact statement, Skookumchuck Dam unit, in Thurston County, Washington. Olympia, Washington.

Wampler, P., E. Knudsen, M. Hudson, T. Young. 1993. Chehalis River Basin Fishery Resources: Salmon and Steelhead Stream Habitat Degradation. U.S. Fish and Wildlife Service, Olympia, Washington.

Washington Department of Ecology (WDOE). Shoreline Management Act. 1971. Olympia, Washington.

Washington Department of Ecology (WDOE). 1993. Washington State Wetlands Rating System: Western Washington. Olympia, WA.

Washington Department of Ecology (WDOE). 1997. Water Quality Standards for Surface Water of the State of Washington 173-201A WAC.

Washington Department of Ecology (WDOE). 1998. Section 303(d) List for Impaired and Threatened Surface Waters.

Washington Department of Ecology (WDOE). 1999. River and Stream Ambient Monitoring Report for Water Year 1997. Pub. No. 99-332. Washington State Department of Ecology, Environmental Assessment Program, Olympia.

Washington Department of Ecology (WDOE). 2001. Stormwater Management Manual for Western Washington. Olympia, Washington.

Washington Department of Ecology (WDOE). 2002. Water Quality. Internet website:
<http://www.ecy.wa.gov/>

Washington Department of Fish and Wildlife (WDFW) and Western Washington Treaty Indian Tribes (WWTIT). 1992. Salmon and Steelhead Stock Inventory, Appendix Two, Coastal Stocks, Olympia, Washington.

Washington Department of Fish and Wildlife (WDFW). 1991. Past Distribution & Current Status of the Spotted Frog in Western Washington, 1990 Progress Report. Olympia, Washington.

Washington Department of Fish and Wildlife (WDFW). 1993a. Status of the Marbled Murrelet (*Brachyramphus marmoratus*) in Washington. Olympia, Washington.

Washington Department of Fish and Wildlife (WDFW). 1993b. Status of the Larch Mountain Salamander (*Plethodon larselli*) in Washington. Olympia, Washington.

Washington Department of Fish and Wildlife (WDFW). 1993c. Status report of the North American lynx (*Lynx canadensis*) in Washington. Unpublished report. Olympia, Washington.

Washington Department of Fish and Wildlife (WDFW). 1993d. Status of the Western Gray Squirrel (*Sciurus griseus*) in Washington. Olympia, Washington.

Washington Department of Fish and Wildlife (WDFW). 1998a. Ecology of Bald Eagles in Western Washington with an Emphasis on the Effects of Human Activity. Wildlife Research Division, Olympia, Washington.

Washington Department of Fish and Wildlife (WDFW). 1998b. Salmon and Steelhead Stock Inventory, Bull Trout/Dolly Varden. Olympia, Washington.

Washington Department of Fish and Wildlife (WDFW). 2002. Priority Habitats and Species Database. Washington Department of Fish and Wildlife, Olympia, Washington.

Wendler, H.O. and G. Deschamps. 1955. Logging Dams on Coastal Washington Streams, Fisheries Research Papers, Washington Dept. of Fisheries, Vol. 1, No. 3, pp. 27-38.

Western Washington Treaty Indian Tribes (WWTIT). 1992. Salmon and Steelhead Stock Inventory, Appendix Two, Coastal Stocks, Olympia, Washington.

Weston, R. F. 1992. American Crossarm & Conduit Remedial Investigation Report. Prepared for U.S. EPA, Region 10. (Roy F. Weston, Inc., Seattle, Washington).

Whitaker, J. O. 1980. The Audubon Society field guide to North American mammals. Alfred A. Knopf, New York, New York.

Willis, C. 2002. *In* Willamette Temperature Project Creates Turbidity, Columbia River News, 31 May 2002.

Wydoski, R.S. and R.R. Whitney. 1979. Inland Fishes of Washington. University of Washington Press; Seattle, Washington.

Zabel, C. J., K. McKelvey, and J. P. Ward, Jr., 1995. Influence of primary prey on home-range size and habitat use patterns of northern spotted owls (*Strix occidentalis caurina*). Canadian Journal of Zoology 73: 433-439.

12. GLOSSARY OF ACRONYMS, ABBREVIATIONS AND TERMS

12.1 GLOSSARY OF ACRONYMS AND ABBREVIATIONS

BA	Biological Assessment
BNSF	Burlington Northern Santa Fe
BOD	Biological Oxygen Demand
CERCLA	Comprehensive Environmental Response, Compensation, and Liability Act (Superfund)
CEQ	Council on Environmental Quality
CFR	Code of Federal Regulations
cfs	cubic feet per second
CO	carbon monoxide
Corps	U.S. Army Corps of Engineers
CWA	Clean Water Act
dB	decibel scale
DEIS	Draft Environmental Impact Statement
DO	Dissolved Oxygen
EPA	Environmental Protection Agency
ESA	Endangered Species Act
° C	degrees Celsius
° F	degrees Fahrenheit
FAC	Flood Action Council
FCZD	Flood Control Zone District
FEIS	Final Environmental Impact Statement
FEMA	Federal Emergency Management Agency
FHWA	Federal Highway Administration
FWCA	Fish and Wildlife Coordination Act
GMA	Growth Management Act
gpd	gallons per day
GRR	General Reevaluation Report
HAZMAT	Hazardous Material
HTRW	Hazardous Toxic and Radioactive Waste

IUGA	Interior Urban Growth Area
LWD	Large Woody Debris
mg/L	milligrams per liter
NAAQS	National Ambient Air Quality Standards
NED	Nationally Economic Development
NEPA	National Environmental Policy Act
NFIP	National Flood Insurance Program
NGVD	National Geodetic Vertical Datum
NHPA	National Historic Preservation Act
NHRP	National Register of Historic Places
NMFS	National Marine Fisheries Service
NO	nitrous oxide
NPDES	National Pollutant Discharge Elimination System
NWS	National Weather Service
PacifiCorp	Scottish paper
PCE	tetrachloroethylene
PED	Preconstruction Engineering Design
PFP	Probable Failure Point
PIE	Pacific International Engineering
PMF	Probable Maximum Flood
PNP	Probable non-failure Point
PSE	Puget Sound Energy
PUD	Public Utilities Division
RM	River Mile
ROG	Reactive Organic Gases
SARA	Superfund Amendments Reauthorization Act
SR	State Route
SHPO	State Historic Preservation Act
SWCAA	Southwest Clean Air Agency
TMDL	Total Maximum Daily Load
TOC	Total Organic Carbons
TN	Total Nitrogen
TP	Total Phosphorus
TPI	Total Personal Income
TSS	Total Suspended Solids
USACE	U.S. Army Corps of Engineers
USFWS	U.S. Fish and Wildlife Service
USGS	U.S. Geological Survey
VOC	Volatile Organic Carbons

WAC	Water Quality Standards Surface Water Washington State
WDFW	Washington Department of Fish and Wildlife (formerly Washington Department of Fish (WDF)
WDOE	Washington Department of Ecology
WRDA	Water Resource Development Act
WSDOT	Washington Department of Transportation
WWTP	Waste Water Treatment Plant

12.2 GLOSSARY OF TERMS

A

Acre-feet: The volume of 1 foot of water over the area of 1 acre. 325,872 gallons.

Adsorption: The adhesion of a thin layer of molecules to the surfaces of solid bodies or liquids with which they are in contact.

Affected environment: A physical, biological, social, and economic environment within which human activity is proposed.

Alternatives: The different means by which objectives or goals can be attained. One of several policies, plans, or projects proposed for decision making.

Anadromous: Those species of fish that mature in the sea and swim up freshwater rivers and streams to spawn. Salmon, steelhead, and searun cutthroat trout are examples.

Aquatic: Growing, living in, frequenting, or taking place in water; in this EIS, used to indicate habitat, vegetation, and wildlife in freshwater.

Aquifer: A zone, stratum, or group of strata acting as a hydraulic unit that stores or transmits water in sufficient quantities for beneficial use.

Areal: the spatial extent or location.

Artifact: An object made or modified by humans.

Attenuate: To lessen the amount, force, or magnitude of something, i.e., floodflow.

B

BA: See Biological Assessment.

Background: (scenic distance zone.) The distant part of a landscape. The seen or viewed area located more than four miles from the viewer, and generally as far as the eye can detect objects.

Base Flow: A sustained or fair-weather flow of a stream.

Baseline data: Data gathered prior to proposed action to characterize pre-development site conditions.

Berm: A mound or wall of earth, usually with sloping sides.

Best management practices (BMP): Management actions that are designed to maintain water quality by preventative rather than corrective means.

Big game: Large animals hunted, or potentially hunted, for sport. These include animals such as deer, bear, elk, moose, bobcats, and mountain lions.

Biological Assessment (BA): Refers to the information prepared by or under the direction of the federal agency concerning listed and proposed species and designated and proposed critical habitat that may be present in the action area and the evaluation of potential effects of the action on such species and habitat.

Biological Opinion (ESA): A document that states the opinion of the U.S.D.I. Fish and Wildlife Service as to whether or not the federal action is likely to jeopardize the continued existence of listed species or result in the destruction or adverse modification of critical habitat.

Biostimulatory nutrients: Substances that promote growth, usually of algal or other unicellular species, within a system by providing an excess of nutrients, which are limited under normal conditions. This commonly reduces available oxygen in a system, resulting in adverse effects on other organisms in the same system. Biostimulatory nutrients are commonly components of fertilizers, manures and silage.

C

CADD: Computer Assisted Drafting and Design.

Canopy: The more-or-less continuous cover of branches and foliage formed collectively by the crown of adjacent trees and other woody debris.

CFR: Code of Federal Regulations. A codification of the general permanent rules published in the Federal Register by the executive departments and agencies of the federal government.

cfs: Cubic feet per second; 1 cfs equals 448.33 gallons per minute.

Channel morphology: The dimensions and composition of a stream or river channel.

Char: Any of a genus (*Salvelinus*) of small-scaled trout with light-colored spots.

Climax plant communities: The stabilized plant community on a particular site. The plant cover does not change so long as the environment remains the same.

Climax species: Those species that dominate a climax stand in either numbers per unit area or biomass.

CMP: Corrugated metal pipe; culverts used in road/stream crossings.

Confluence: the place of meeting of two streams or the combined stream formed by conjunction.

Cover: Living or non-living material (e.g., vegetation) used by fish and wildlife for protection from predators, to ameliorate conditions of weather, or reproduce. The proportion of the ground occupied by a perpendicular projection to the ground from the outline of the aerial parts of the members of a plant species.

Criteria: Data and information, which are used to examine or establish the relative degrees of desirability among alternatives or the degree to which a course of action meets an intended objective.

Cultural resources: The remains of sites, structures, or objects used by humans in the past, historic or prehistoric. More recently referred to as heritage resources.

Cumulative effects or impacts: Cumulative effect or impact is the impact on the environment, which results from the incremental impact of the action when added to other past, present, and reasonable foreseeable future actions, regardless of what agency (federal or non-federal) or person undertakes such other actions. Cumulative impacts can result from individually minor but collectively significant actions taken place over a period of time (40 CFR 15089.7)

CY: Cubic yard.

D

dbA: Decibel scale, A-weighted to mimic the human ear.

Density: The number of individuals in a given area. Expressed per unit area.

Detrital: Loose material (soil, plant particles or other organic particles) that results directly from disintegration or decay.

Dike: An embankment to contain or convey water.

E

Ecosystem: An interacting system of organisms considered together with their environment; for example aquatic, marsh watershed, and lake ecosystems.

Effects: "Effect" and "impact" are synonymous as used in this document. Environmental changes resulting from a proposed action. Included are direct effects, which are caused by the action and occur at the same time and place, and indirect effects, which are caused by the action and are later in time or further removed in distance, but which are still reasonably foreseeable. Indirect effects may include growth-inducing effects and other effects related to induced changes

in the pattern of land use, population density, or growth rate, and related effects on air and water and other natural systems, including ecosystems.

Endangered Species: Any species of animal or plant that is in danger of extinction throughout all or a significant portion of its range. Plant or animal species identified by the Secretary of the Interior as endangered in accordance with the 1973 Endangered Species Act.

Environment: The physical conditions that exist within the area that will be affected by a proposed project, including land, air, water, minerals, flora, fauna, ambient noise, and objects of historical or aesthetic significance. The sum of all of the external conditions that affect an organism or community to influence its development or existence.

Environmental impact statement (EIS): An analytical document prepared under the National Environmental Policy Act (NEPA) and Washington State Environmental Policy Act (SEPA) that portrays potential impacts to the environment of a Proposed Action and its possible alternatives. An EIS is developed for use by decision makers to weigh the environmental consequences of a potential decision.

Environmental Protection Agency (EPA): An agency of the Executive Branch of the federal government, which has responsibility for environmental matters of national concern.

Ephemeral stream: A stream or portion of a stream that flows only in direct response to precipitation or snow melt. Such flow is usually of short duration.

Erosion: The wearing away of the land surface by running water, wind, ice, or other geologic agents, including gravitation creep.

ESU: Evolutionarily Significant Unit. A delineation of distinct populations of a species, used for determining population status apart from the species as a whole.

F

FEMA: Federal Emergency Management Agency

Fisheries Habitat: Streams, lakes, and reservoirs that support fish populations.

Floodplain: The lowland and relatively flat area adjoining inland waters, including, at a minimum, that area subject to a 1 percent or greater chance of flooding in any given year.

Fluvial: Of or relating to a stream or river.

Forage: All browse and non-woody plants that are available to livestock or game animals for grazing or harvestable for feed.

Forb: Broad-leaved, small plants composed of soft tissue, not woody material. Any herb other than grass.

Foreground: (scenic distance zone) A term used in scenic resource management to describe the area immediately adjacent to the observer, usually within ¼ to ½ mile.

fps: Feet per second, a measure of velocity, or speed.

Freeboard: Vertical distance above water surface elevation to top elevation of manmade or natural containment, such as stream banks, levees, dams, etc.

Freshet: A large increase in stream flow due to heavy rains or snowmelt.

FWS: Fish and Wildlife Service (U.S. Department of the Interior). Also, USFWS.

G

Game Species: Any species of wildlife or fish for which seasons and bag limits have been prescribed and which are normally harvested by hunters, trappers, and fisherman under state or federal laws, codes and regulations.

Geomorphic: Pertaining to the form of the surface of the earth.

Glacial till: Glacial materials deposited directly by ice with little or no transportation by water.

Glide: A portion of the stream where stream surface flow does not have increased turbulence resulting from flow interception with submerged obstructions during low flow conditions. A glide is differentiated from a pool by the relatively uniform streambed gradient and lack of a hydraulic control at the downstream end.

GMA: Growth Management Act. An Act of the Washington State Legislature to plan and control economic growth (RCW 43.330.120)

gpd, gph, gpm: Gallons per day, gallons per hour, gallons per minute.

Grass/forb: An early forest successional stage where grasses and forbs are the dominant vegetation.

Groundwater: Water found beneath the land surface in the zone of saturation below the water table.

GRR: General Reevaluation Report.

Guideline: An indication or outline of policy or conduct; i.e., any issuance that assists in determining the course of direction to be taken in any planned action to accomplish a specific objective.

H

Habitat capability: The estimated ability of an area, given existing or predicted habitat conditions, to support a wildlife, fish or plant population. It is measured in terms of potential population numbers. Often called carrying capacity.

Habitat: The natural environment of a plant or animal, including all biotic, climatic, and soil conditions, or other environmental influences affecting living conditions. The place where an organism lives.

Hazardous waste: A waste is considered hazardous by the EPA if it exhibits one or more of these characteristics: ignitability, corrosivity, reactivity, and/or toxicity. These are listed in 40 CFR 261.3 and 40 CFR 171.8.

HAZMAT: Related to hazardous materials.

HEC-RAS: A computer model used to simulate flows during various events, including floods, storms and drought conditions.

Howell-Bunger valve: A fixed-cone valve that discharges water in a radial pattern, designed to pass a controlled amount of water without damage to the immediate environment.

HTRW: Hazardous, Toxic and Radioactive Waste,

Hydraulic: Relating to water or other liquid in motion.

Hydric soils: Soils exhibiting properties that are characteristic of frequent prolonged inundation. Characteristics include mottled coloration, presence of reduced metals, presence of sulfur compounds or high percentage of organic materials.

Hydrograph: A graph depicting flows over time.

Hydrology: The distribution and circulation of water.

I

Incidental take (ESA): Refers to takings that result from, but are not for the purpose of, carrying out an otherwise lawful activity conducted by an agency or applicant.

Incised: A narrow, steep-walled valley caused by erosion.

Infiltration: The movement of water or some other fluid into the soil through pores or other openings.

Intermittent stream: A stream that runs water in most months, but does not contain water year round.

Interstitial: Occupying the spaces between sediment particles.

Inundate: Cover with water.

L

Landscape: The sum total of the characteristics that distinguish a certain area on the earth's surface from other areas. These characteristics are a result not only of natural forces but also of human occupancy and use of the land. An area composed of interacting and interconnected

patterns of habitats (ecosystems) that are repeated because of geology, landforms, soils, climate, biota, and human influences throughout the area.

Ldn: Day-Night Sound Level measurement descriptor of total outdoor noise environment

Levee: An embankment for preventing flooding.

Listed Species (ESA): Species that are listed as threatened or endangered under the Endangered Species Act of 1973 (as amended).

Lithic: Of relating to, or being a stone tool.

LWD: Large Woody Debris. Usually refers to woody material greater than 12 inches in diameter 25 feet from the base end of the log, within a stream channel. Upland large woody debris is often considered **Coarse Woody Debris**.

M

Mitigation: Reduction or reversal of an effect. For the purposes of this document, mitigation is design, planning or construction phases used to reduce, minimize or account for effects of a project on the environment, economy and population. Mitigation includes; (a) avoiding the impact altogether by not taking a certain action or parts of an action; (b) minimizing impacts by limiting the degree or magnitude of the action and its implementation; (c) rectifying the impact by repairing, rehabilitating, or restoring the affected environment; (d) reducing or elimination of the impact over time by preservation and maintenance of operations during the life of the action; and, (e) compensating for the impact by replacing or providing substitute resources or environments (40 CFR Part 1508.20).

N

NAAQS: National Ambient Air Quality Standards.

NFIP: National Flood Insurance Program.

Non-game species: Animal species that are not hunted, fished, or trapped.

NOx: Nitrogen Oxides

NPDES: National Pollutant Discharge Elimination System – A program authorized by Sections 318, 402 and 405 of the Clean Water Act, and implemented by regulations 40 CFR 122. NPDES program requires permits for the discharge of pollutants from any point source into waters of the United States.

NRHP: National Register of Historic Places;

O

OAHP: Office of Archaeology and Historic Preservation (Washington State).

Objective: A concise, time-specific statement of measurable planned results that respond to pre-established goals. An objective forms the basis for further planning to define the precise steps to be taken and the resources to be used in achieving identified goals.

Ogee: (Ogee spillway, Ogee crest) The work ogee describes the shape of the curve, in profile, on the crest of the spillway or dam. The shape is a reverse curve, similar to the letter "s".

Overtopping: Water surface elevations in exceedance of the elevation of manmade or natural containment, such as stream banks, levees, dams, etc.

Oxbow: (Oxbow lake) For the purposes of this document, an oxbow is a curved portion of a former channel that has been isolated from the main channel by bank erosion and remains in the floodplain, usually as a wetland or pond.

P

Passerine bird: Of or relating to the largest order (Passeriformes) of birds, consisting chiefly of songbirds of perching habits.

Percolation/infiltration: The act of water seeping or filtering through the soil without a definite channel.

Perennial stream: A stream that flows year round.

pH: Symbol for the negative common logarithm of the hydrogen ion concentration (acidity) of a solution. The pH of 7 is considered neutral. The pH number below 7 indicates acidity, and a pH value above 7 indicates alkalinity or a base.

PHS: Priority Habitats and Species. Priority species are defined by the State of Washington as species that require protective measures for their perpetuation due to their population status, sensitivity to habitat alteration, and/or recreational, commercial, or tribal importance. A priority habitat may consist of a unique vegetation type or dominant plant species, successional stage, or structural element.

Plant communities: A vegetation complex unique in its combination of plants which occurs in particular locations under particular influences. A plant community is a reflection of integrated environmental influences on the site such as soils, temperature, elevation, solar radiation, slope aspects, and precipitation.

PM10: Particulate matter less than 10 microns in diameter.

PMF: Probable Maximum Flood.

Pool: A portion of the stream with reduced surface turbulence and a hydraulic control at the downstream end. Pools often have a bowl appearance resulting from high-flow scour.

ppm: parts per million.

Project: The whole of an action, which has a potential for resulting in a physical change in the environment. An organized effort to achieve an objective identified by location, timing, activities, outputs, effects, and time period and responsibilities for executions.

Proposed action: A description of the project as proposed by a project proponent in a plan of operations.

Public participation: Meetings, conferences, seminars, workshops, tours, written comments, responses to survey questionnaires, and similar activities designed and held to obtain comments from the public about planning.

Public scoping: Giving the public the opportunity for oral or written comments concerning the intentions, activity, or influence of a project or an individual, the community, and/or the environment.

R

Raptor: Bird of prey, including eagles, hawks, falcons, and owls.

RCRA: Resource Conservation Recovery Act.

RCW: Revised Code of Washington.

Recharge: Absorption and addition of water to the zone of saturation.

Riffle: A portion of the stream where stream flow is intercepted by partially or completely submerged obstructions to produce increased surface turbulence and flow velocities during low flow conditions.

Riparian zone: Terrestrial areas where the vegetation and microclimate are influenced by perennial and/or intermittent water, associated high water tables and soils which exhibit some wetness characteristics; this habitat is transitional between true bottomland wetlands and upland terrestrial habitats.

Riparian: A type of ecological community that occurs adjacent to streams and rivers and is directly influenced by water. It is characterized by certain types of vegetation, soils, hydrology, and fauna and requires free or unbound water or conditions more moist than that normally found in the area.

Riverbed: The bottom of a river channel.

RM: River Mile. Distance upstream in statute miles from a zero benchmark established at the river mouth.

ROG: Reactive Organic Gases.

Rule curve: Operations procedures for flood control structures are designed to maintain reservoir elevations and downstream flows that vary throughout the year to meet biological and

economic needs. Illustrating these flows in a graph depicting flow volume over time results in a curve, the "rule curve".

Runoff: Precipitation that is not retained on the site where it falls, not absorbed by the soil; natural drainage away from an area.

S

Salmonid: Any of a family (Salmonidae) of elongate bony fishes (as a salmon or trout) that have the last three vertebrae upturned.

Scour: For the purposes of this document, scour is the erosional effect of flowing water and suspended material on the stream channel.

Sensitive species: Plant or animal species which are susceptible or vulnerable to activity impacts or habitat alterations. Those species that have appeared in the Federal Register as proposed for classification or are under consideration for official listing as endangered or threatened species, that are on an official state list, or that are recognized by the state as needing special management to prevent placement on federal or state lists.

SEPA: State Environmental Policy Act.

Setback: For the purposes of this document, setback describes the distance between a flood control structure and the associated stream bank.

Short-term impacts: Impacts occurring during project construction and operation, and normally ceasing upon project closure and reclamation. Each resource, by necessity, may vary in its definition of short-term.

Significant: Requires consideration of both context and intensity. Context means that the significance of an action must be analyzed in several contexts such as society as a whole, and the affected region, interests, and locality. Intensity refers to the severity of impacts. The severity of an impact should be weighted along with the likelihood of its occurrence.

Sluice: An artificial passage for water (as in a dam) fitted with a valve or gate for stopping or regulating flow.

Snag: A standing dead tree from which the leaves and most of the branches have fallen.

Socioeconomic: Pertaining to, or signifying the combination or interaction of social and economic factors.

Spillway: A passage for surplus water to run over or around an obstruction (as a dam).

Stand Diversity: Any attribute that makes one timber stand biologically or physically different from other stands. The difference can be measured by, but not limited to, different age classes, species, densities, or non-tree floristic composition.

Stream gradient: The rate of fall or loss of elevation over the physical length of a segment or total stream usually expressed in ft/ft (percent).

SWCAA: Southwest Clean Air Agency

T

Tainter gate: A gate designed to open or close by rotating on an axle in an arc perpendicular to the flow.

Talus: Heaps of coarse debris at the foot of cliffs and steep slopes resulting from gravity transport and weathering processes.

Terrestrial: Of or relating to the earth, soil, or land; an inhabitant of the earth or land.

Threatened species: Those plants or animal species likely to become endangered species throughout all or a significant portion of their range within the foreseeable future.

Transect: A sample area in the form of a long narrow continuous strip that is used for the tabulation of data.

Turbidity: Reduced water clarity resulting from the presence of suspended matter.

U

Understory: A foliage layer lying beneath and shaded by the main canopy of a forest.

USACE: United States Army Corps of Engineers; agency responsible for regulating and permitting wetland disturbances..

USDA: United States Department of Agriculture.

USFWS: United States Fish and Wildlife Service – United States Department of Interior.

USGS: United States Geological Survey – United States Department of Interior.

V

Velocity: Rate of speed along a straight line. For the purposes of this document, velocity refers to the speed of flow.

W

Water quality: The interaction between various parameters that determines the usability or non-usability of water for onsite and downstream uses. Major parameters that affect water quality

include: temperature, turbidity, suspended sediment, conductivity, dissolved oxygen pH, specific ions, discharge, and fecal coliform.

Watershed: The entire land area that contributes water to a particular drainage system or stream.

Weir: A dam in a stream or river to raise the water level or divert its flow; a fence or enclosure set in a waterway for isolating and removing fish.

Wetlands (Biological Wetlands): Those areas that are inundated or saturated by surface or groundwater at a frequency and duration sufficient to support, and that under normal circumstances, do support a prevalence of vegetation typically adapted for life in saturated soil conditions. Wetlands generally include swamps, marshes, bogs, etc.



U.S. Army Corps
of Engineers
Seattle District

Centralia Flood Damage Reduction Project Chehalis River, Washington

Final General Reevaluation Report
June 2003

PAGE INTENTIONALLY LEFT BLANK

**Centralia Flood Damage Reduction Project
Chehalis River, Washington**

General Reevaluation Study

Final General Reevaluation Report

**US Army Corps of Engineers
Seattle District**

June 2003

PAGE INTENTIONALLY LEFT BLANK

EXECUTIVE SUMMARY

The Seattle District, U.S. Army Corps of Engineers (Corps, USACE) and Lewis County, Washington, have collaborated to re-evaluate a previously authorized flood damage reduction project in the Chehalis River Basin. This general reevaluation study was conducted in response to Resolution 2581 of the U.S. House of Representatives Committee on Transportation and Infrastructure, which directed a review of past Corps report recommendations in the study area and a reevaluation of flooding and environmental problems and solutions.

The purpose of this General Reevaluation Report (GRR) is to document the planning and formulation of the recommended plan. Similar to a traditional feasibility report, the GRR documents all aspects of acceptability, completeness, effectiveness, and efficiency of a broad range of alternatives. The report also identifies requirements and responsibilities associated with project implementation, operation, and maintenance. The main text of the report summarizes major technical studies conducted. Technical appendices provide detailed descriptions of study methodologies and findings. An Environmental Impact Statement, that has been published under separate cover, accompanies the report.

A setback levee alternative that includes levees along the Chehalis and Skookumchuck Rivers was combined with a new formulation of the previously authorized modification to Skookumchuck Dam, non-structural flood damage reduction features, and environmental mitigation features to form the National Economic Development (NED) Plan and the Locally Preferred Plan (LP Plan). The report recommends a plan for authorization. The LP Plan differs from the NED plan by providing more storage in Skookumchuck Dam and 100- year protection levees on the Skookumchuck River. All other features are the same. The local sponsor will incur all costs above those of the NED plan.

The recommended plan will provide 100-year flood protection for the cities of Centralia and Chehalis, Washington. The recommended plan provides estimated annual benefits of \$8,949,000 including a reduction of \$6.7 million in flood related damages to structures and their contents, \$2.1 million in annual avoided costs associated with the need to elevate Interstate Highway 5 without the project, and an annual reduction of \$131,000 in traffic delays related to flooding. There are no avoided agricultural damages, nor does the recommended plan induce agricultural damages. Annual economic costs of the recommended plan are estimated at \$7,063,000, resulting in annual net benefits of \$1,886,000 and a positive benefit-to-cost ratio of 1.27 to 1. In contrast, the NED Plan would provide annual benefits of \$8,706,000 for an annual cost of \$6,496,000, providing net benefits of \$2,210,000 and a benefit-to-cost ratio of 1.34 to 1. The non-Federal sponsor, Lewis County, Washington, supports the recommended plan.

The recommended plan proposes a mitigation plan developed to avoid and minimize impacts, then mitigate. Mitigation selection was broken into three phases: 1. Mitigation sites were identified and evaluated for environmental and cost effectiveness; 2. Mitigation requirements for the NED and LP Plan were identified and the mitigation design was optimized; 3. The selected mitigation plan was assessed to ensure that it would meet the mitigation requirements. Levee designs were optimized to maximize setback and to minimize impacts to sensitive environments.

7. The setback levee alignment of the recommended plan would give the Chehalis River an opportunity to overbank during certain flood events and re-establish riparian zones along the river's banks, while protecting the main infrastructure of the cities of Centralia and Chehalis, and reducing flood damages to highways. Project features were formulated to address limiting factors for fish and wildlife in the basin and have been included in the recommended plan to mitigate for unavoidable impacts. The recommended plan will provide for future opportunities to establish restoration areas to enhance fish and wildlife habitat.

TABLE OF CONTENTS

EXECUTIVE SUMMARY	iii
TECHNICAL APPENDICES	x
LIST OF TABLES	xi
LIST OF PLATES	xiii
1. INTRODUCTION	1
1.1 Study Authority.....	1
1.2 Study Sponsorship	2
1.3 Study Area	2
1.4 Previously Authorized Project.....	2
1.5 Project History.....	3
1.6 Recent Local Activities.....	5
1.7.1 Skookumchuck Dam	7
1.7.2 Long Levee	7
1.7.3 Skookumchuck River Levee	8
1.7.4 Chehalis-Centralia Airport Levee	8
1.7.5 Salzer Creek Levee	8
1.8 Prior Reports.....	8
2. SCOPE OF GENERAL REEVALUATION STUDY	12
2.1 Survey and Mapping.....	13
2.2 Hydrology and Hydraulics	13
2.3 Economics.....	15
2.4 Engineering Design.....	15
2.5 Geotechnical Studies.....	16
2.5.1 Skookumchuck Dam Geotechnical Studies	16
2.5.2 Floodplain Investigations Geotechnical Studies	16
2.6 Institutional Studies	17
2.7 Real Estate Studies.....	17
2.8 Environmental Studies.....	18
2.8.1 EIS Preparation	18
2.8.2 Environmental Data Compilation.....	19
2.8.3 Riparian Survey.....	19
2.8.4 Wetland Survey.....	19
2.8.5 Fisheries Survey.....	19
2.8.6 Environmental Mitigation Measures	20
2.8.7 Endangered Species Act Coordination.....	20
2.8.8 Clean Water Act Section 404(b)(1) Evaluation.....	20
2.8.9 Fish and Wildlife Coordination Act Report	21
2.9 HTRW Studies.....	21
2.10 Cultural Resources Studies	22
2.11 Cost Estimating.....	23

2.12 Public Involvement	23
3. WITHOUT-PROJECT FLOODING AND FLOOD DAMAGE	26
3.1 Flooding	26
3.2 Recent Floods	27
3.2.1 January 1990 Flood	27
3.2.2 November 1990 Flood	28
3.2.3 February 1996 Flood	28
3.3 Flood Exceedance Frequency	29
3.4 Risk-Based Analysis for Flood Damage Reduction	30
3.4.1 Overview of RBA in Flood Damage Reduction Studies	31
3.4.2 Flood Damage Reduction Analysis Model	31
3.4.3 Uncertainties Specific to the Chehalis Study	31
3.4.3.1 Hydrologic Uncertainty	32
3.4.3.2 Hydraulic Uncertainty	33
3.4.3.3 Economic Uncertainty	34
3.4.4 Uncertainty of Existing Levee Performance	34
3.4.5 Expected Annual Damages	34
3.4.6 Expected Annual Exceedance Probability	35
3.4.7 Long Term Risk	35
3.4.8 Conditional Probability of Non-Exceedance	35
3.4.9 FEMA Certification	36
3.5 Without-Project Hydrology and Hydraulics	36
3.6 Expected Without-Project Flood Damages	46
3.6.1 Residential Structure and Content Damages	46
3.6.2 Residential Cleanup Cost	46
3.6.3 Emergency Costs	47
3.6.4 Commercial and Industrial Inundation Damage	49
3.6.5 Commercial and Industrial Cleanup Costs	50
3.6.6 Public Inundation Damage	50
3.6.7 Inundation Damage Summary	51
3.6.8 Residential, Nonresidential, and Public HEC-FDA Model Results	53
3.6.9 Agricultural Flood Damages	55
3.6.10 Summary of Agricultural Flood Damages	56
3.6.11 Transportation Related Damages	57
3.6.12 Avoided Cost of Interstate 5 Raising	59
3.6.13 Rail Freight Flood Impacts	59
3.7 Expected Annual Damage Summary	61
4. PLAN FORMULATION	62
4.1 Problems and Opportunities	62
4.2 Planning Objectives and Plan Formulation Overview	62
4.2.1 Planning Objectives	62
4.2.2 Plan Formulation Overview	63

4.3 Description of Preliminary Solutions.....	63
4.3.1 Alternative #1 – No Action Alternative	64
4.3.2 Alternative #2 – Skookumchuck Dam Modifications	64
4.3.2.1 Objective	64
4.3.2.2 Relation to Previously Authorized Project	64
4.3.2.3 Description	65
4.3.2.4 Dam Safety Considerations	65
4.3.2.5 Reservoir Regulation Considerations	66
4.3.2.6 Skookumchuck Dam Modifications, Sub-alternatives	66
4.3.2.7 Alternative 2B1 - Spillway Sluices with Gates and Rubber Crest Weir.....	67
4.3.2.8 Alternative 2B2 – Short Tunnel with Gates and Rubber Crest Weir.....	67
4.3.2.9 Alternative 2B3 – Tainter Gates in Rock Cut with Rubber Crest Weir.....	68
4.3.2.10 Alternative 2B4 – Tainter Gates in Rock Cut with Emergency Spillway	69
4.3.3 Alternative #3 – Overbank Excavation and Flowway Bypass	70
4.3.3.1 Objective	70
4.3.3.2 Relation to Previously Authorized Project.....	70
4.3.3.3 Description	70
4.3.3.4 Chehalis/SR-6 Area Floodplain Modifications	70
4.3.3.5 Alternative 3B – Skookumchuck Bypass	73
4.3.3.6 Alternative 3C – Centralia Hospital Bypass.....	73
4.3.3.7 Hump Excavation.....	73
4.3.4 Alternative #4 – Levee System	74
4.3.4.1 Objective	74
4.3.4.2 Relation to Authorized Project.....	74
4.3.4.3 Description	74
4.3.4.4 Design Objectives.....	75
4.3.4.5 Design Process	75
4.3.4.6 Levee Alignment.....	77
4.3.4.7 Planned Overtopping of Flood Control Levee.....	77
4.3.5 Alternative #5 – Upstream Flow Restriction Structures, and Upstream Storage	78
4.3.5.1 Flow Restrictors	78
4.3.5.2 Upstream Storage	79
4.3.6 Alternative #6 – Non-Structural Alternative	80
4.3.6.1 Objective	80
4.3.6.2 Relation to Authorized Project.....	81
4.3.6.3 Description	81
4.3.7 Alternative #7 – Interagency Committee Alternative	81
4.3.7.1 Objective	81
4.3.7.2 Relation to Authorized Project.....	82
4.3.7.3 Design Process Description.....	82
4.4 Hydrologic and Hydraulic Assessment of Preliminary Alternatives	86
4.4.1 Alternative 2 – Skookumchuck Dam Modifications	86
4.4.2 Alternative 3 – Excavation and Flowway Bypass.....	87

4.4.3 Alternative 4 – Levee System	88
4.4.4 Alternative 5 – Upstream Flow Restriction Structures	90
4.4.5 Alternative 7 – Interagency Committee Alternative	90
4.5 Phase 1 - Screening of Preliminary Alternatives	92
4.5.1 Phase 1: Preliminary Alternatives Screening Criteria	92
4.5.2 Phase 1: Results of Preliminary Alternatives Screening	96
4.6 Phase 2 – Formulation and Screening of Final Alternatives	101
4.7 Phase 2 – Description of Final Alternatives	102
4.7.1 Phase 2: Alternative 2 – Skookumchuck Dam Modifications Alternative	102
4.7.2 Phase 2: Alternative 3 – Overbank Excavation and Flowway Bypass Alternative	103
4.7.3 Phase 2: Alternative 4 – Levee Alternative	104
4.7.4 Phase 2: Alternative 7 – Interagency Alternative	106
4.8 Phase 2 - Summary of Final Alternatives	106
4.9 Phase 2 - Estimated Costs of Final Alternatives	107
4.10 Phase 2 - Risk-Based Assessment and Evaluation of Final Alternatives	110
4.10.1 With-Project Hydrology and Hydraulics	110
4.10.2 Residual Damages, Damages Reduced and Net Benefits	110
4.10.3 Project Performance	113
4.11 Phase 2 - Screening Results, Preliminary NED Alternative	113
4.12 Phase 3 – Optimization and Identification of NED Plan	114
4.12.1 Optimization	114
4.12.2 Identification of NED Plan	121
4.13 Evaluation of Project Performance	123
4.14 Phase 3 – Locally Preferred Plan	125
4.14.1 Elevation of Structures	126
4.15 Formulation of Environmental Mitigation Plan (Phase 1)	127
4.15.1 Environmental Evaluation	128
4.15.2 Potential Mitigation Features	129
4.15.3 Cost Effectiveness and Incremental Cost Analysis	129
4.16 Formulation of Environmental Mitigation Plan (Phase 2)	132
4.17 Formulation of Environmental Mitigation Plan (Phase 3)	134
4.17.1 Institutional Mitigation Requirements	135
4.17.2 Modification of Environmental Evaluation Methodology	135
4.17.3 Benefits and Costs of Phase 3 Mitigation Plan	135
5. RECOMMENDED PLAN	138
5.1 Description of Recommended Plan	138
5.2 Cost of Recommended Plan	138
5.3 Benefits of Recommended Plan	140
5.4 Structural Flood Control Features of Recommended Plan	141
5.5 Non-Structural Flood Control Features of Recommended Plan	142
5.5.1 New 100-Year FEMA Floodplain	143
5.5.2 Flood Warning System	143

5.5.3 Restriction of Development	144
5.5.4 Restriction of Fill in the Floodplain	145
5.5.5 Storm Water Management	146
5.5.6 Non-Structural Summary	146
5.6 Skookumchuck Dam Operational Modification Description	146
5.7 Environmental Impacts of NED and Locally Preferred Plans	147
5.8 Environmental Mitigation Features and Benefits of Recommended Plan	147
5.9 Real Estate Requirements of Recommended Plan	148
5.10 Operation and Maintenance Requirements of Recommended Plan	150
5.10.1 Chehalis/Skookumchuck River Levee System O&M	150
5.10.2 Skookumchuck Dam O&M	151
5.10.3 Environmental Mitigation O&M	153
5.10.4 Summary of O&M Costs	154
6. IMPLEMENTATION OF RECOMMENDED PLAN	155
6.1 Division of Responsibilities for Implementing the Recommended Plan	155
6.1.1 Federal Responsibilities	155
6.1.2 Non-Federal Responsibilities	155
6.2 Preconstruction Engineering and Design Phase	156
6.2.1 PED Procedural Overview	156
6.2.2 Issues Requiring Additional Study During PED	157
6.2.2.1 Interior Drainage Analyses	157
6.2.2.2 Skookumchuck Dam Stability Evaluation	161
6.3 Construction Phase	162
6.3.1 Project Cooperation Agreement	162
6.3.2 Project Construction	166
6.4 Operation and Maintenance	168
6.5 Cost Allocation	168
6.6 Cost Apportionment	168
6.7 Institutional Requirements	169
6.8 Environmental Requirements	170
6.9 Sponsorship Agreements	171
6.10 Sponsor's Financial Plan and Capability Assessment	171
6.10.1 Financial Analysis	171
6.10.2 Assessment of Financial Capability	172
7. LEGAL AND TECHNICAL REVIEW	173
8. DISTRICT COMMANDER'S RECOMMENDATION	175

TECHNICAL APPENDICES

APPENDIX A – HYDROLOGY AND HYDRAULICS

APPENDIX B – SKOOKUMCHUCK DAM DESIGN

APPENDIX C – LEVEE PLAN AND CIVIL DESIGN

APPENDIX D – ECONOMICS

APPENDIX E - REAL ESTATE PLAN

APPENDIX F – MCACES REPORT

LIST OF TABLES

TABLE 1-1 CHEHALIS RIVER AND TRIBUTARIES CHRONOLOGY OF FEDERAL STUDIES	4
TABLE 1-2 CORPS OF ENGINEERS FLOOD CONTROL REPORTS IN STUDY AREA	10
TABLE 3-1 ANNUAL FLOOD PEAKS AT 3 LOCATIONS SINCE 1971	27
TABLE 3-2 PEAK DISCHARGE FREQUENCY DATA FOR SELECTED LOCATIONS	29
TABLE 3-3 COMPARISONS OF FLOOD RECURRENCE INTERVALS AT GRAND MOUND	30
TABLE 3-4 FLOOD ANALYSIS DAMAGE REACHES	36
TABLE 3-5 STAGE DISCHARGE FUNCTIONS WITH UNCERTAINTY FOR CHEHALIS AND SKOOKUMCHUCK RIVERS	37
TABLE 3-6 UNET STORAGE AREAS AND LINKS TO INDEX CROSS-SECTIONS FOR THE HEC-FDA ANALYSIS	43
TABLE 3-7 NON-DAMAGING ELEVATIONS BY REACH	44
TABLE 3-8 WITHOUT-PROJECT DISCHARGE-PROBABILITY FUNCTION STATISTICS FOR HEC-FDA ..	45
TABLE 3-9 CHEHALIS RIVER RESIDENTIAL INUNDATION DAMAGE BY EVENT (\$)	46
TABLE 3-10 SKOOKUMCHUCK RIVER RESIDENTIAL INUNDATION DAMAGE BY EVENT (\$)	46
TABLE 3-11 RESIDENTIAL CLEANUP COSTS CHEHALIS RIVER BY EVENT (\$)	47
TABLE 3-12 RESIDENTIAL CLEANUP COSTS SKOOKUMCHUCK RIVER BY EVENT (\$)	47
TABLE 3-13 EMERGENCY COSTS – CHEHALIS RIVER (\$)	49
TABLE 3-14 EMERGENCY COSTS – SKOOKUMCHUCK RIVER (\$)	49
TABLE 3-15 CHEHALIS COMMERCIAL AND INDUSTRIAL INUNDATION DAMAGE BY EVENT (\$)	49
TABLE 3-16 SKOOKUMCHUCK COMMERCIAL/INDUSTRIAL INUNDATION DAMAGE BY EVENT (\$) ..	49
TABLE 3-17 CHEHALIS NONRESIDENTIAL CLEANUP COSTS BY EVENT (\$)	50
TABLE 3-18 SKOOKUMCHUCK NONRESIDENTIAL CLEANUP COSTS BY EVENT (\$)	50
TABLE 3-19 CHEHALIS PUBLIC STRUCTURE INUNDATION DAMAGE BY EVENT (\$)	50
TABLE 3-20 SKOOKUMCHUCK PUBLIC STRUCTURE INUNDATION DAMAGE BY EVENT (\$)	51
TABLE 3-21 CHEHALIS PUBLIC STRUCTURE CLEANUP COSTS BY EVENT (\$)	51
TABLE 3-22 SKOOKUMCHUCK PUBLIC STRUCTURE CLEANUP BY EVENT (\$)	51
TABLE 3-23 STRUCTURAL DAMAGE SUMMARY (\$)	52
TABLE 3-24 EXPECTED ANNUAL DAMAGE BY CATEGORY	53
TABLE 3-25 WITHOUT-PROJECT EXPECTED ANNUAL DAMAGES BY REACH	54
TABLE 3-26 LEWIS COUNTY CROP HARVESTS – 1996	55
TABLE 3-27 PER ACRE CROP DAMAGE	56
TABLE 3-28 PER ACRE FIELD CROPLAND RESTORATION COSTS	56
TABLE 3-29 AGRICULTURAL DAMAGES BY FLOOD EVENT (\$)	57
TABLE 3-30 EXPECTED ANNUAL AGRICULTURAL DAMAGE (\$)	57
TABLE 3-31 INTERSTATE 5 DAILY TRANSPORTATION DELAY COSTS WHEN FLOODED	58

TABLE 3-32 INTERSTATE 5 DAMAGES BY FLOOD EVENT.....	58
TABLE 3-33 RAILROAD DAMAGES BY FLOOD EVENT	60
TABLE 3-34 EXPECTED ANNUAL DAMAGE SUMMARY	61
TABLE 4-1 PRELIMINARY ALTERNATIVES	64
TABLE 4-2 ALTERNATIVES FOR PHASE 2 SCREENING.....	101
TABLE 4-3 FINAL ALTERNATIVES	107
TABLE 4-4 SUMMARY COST ESTIMATES FOR FINAL ARRAY OF ALTERNATIVES	108
TABLE 4-5 WITH-PROJECT ECONOMIC ANALYSIS.....	112
TABLE 4-6 PHASE 2 PERFORMANCE ANALYSIS	113
TABLE 4-7 PHASE 3 ALTERNATIVES.....	115
TABLE 4-8 PHASE 3 ALTERNATIVES NED BENEFITS.....	117
TABLE 4-9 COMPONENT COSTS.....	118
TABLE 4-10 TOTAL ANNUAL COSTS AND NED NET BENEFITS PHASE 3 ALTERNATIVES.....	119
TABLE 4-11 NED PLAN RESIDUAL DAMAGES	122
TABLE 4-12 ENGINEERING PERFORMANCE EVALUATION	124
TABLE 4-13 LP PLAN RESIDUAL DAMAGES.....	126
TABLE 4-14 COSTS OF ELEVATING STRUCTURES WITH INDUCED FLOODING	127
TABLE 4-15 POTENTIAL MITIGATION AREAS/COMPONENTS	129
TABLE 4-16 RESTORATION MEASURES, WITH COST AND OUTPUT*	130
TABLE 4-17 INCREMENTAL COST ANALYSIS.....	134
TABLE 5-1 MCACES COST ESTIMATE FOR NED PLAN.....	139
TABLE 5-2 MCACES COST ESTIMATE FOR RECOMMENDED PLAN(LOCALLY PREFERRED PLAN)...	139
TABLE 5-3 COST COMPARISON OF NED AND LOCALLY PREFERRED PLAN.....	140
TABLE 5-4 SUMMARY BASELINE COST ESTIMATE FOR REAL ESTATE (BCERE)	149
TABLE 5-5 LER ACQUISITION SCHEDULE	149
TABLE 5-6 DETAILED ANNUALIZED COSTS FOR EQUIPMENT MAINTENANCE AT SKOOKUMCHUCK DAM.....	153
TABLE 5-7 OPERATION AND MAINTENANCE COSTS (\$).....	154
TABLE 6-1 CHINA CREEK PRE-FEASIBILITY FLOOD REDUCTION ALTERNATIVES EVALUATION...	159
TABLE 6-2 CONSTRUCTION SEQUENCING.....	167
TABLE 6-3 CHEHALIS RIVER FLOOD DAMAGE REDUCTION COST APPORTIONMENT (\$).....	169
TABLE 6-4 STATUS OF COMPLIANCE WITH ENVIRONMENTAL LAWS/REGULATIONS/TREATIES ...	170

LIST OF PLATES

(All plates at back of GRR)

PLATE 1 – VICINITY MAP

PLATE 2 – CHEHALIS RIVER BASIN MAP

PLATE 3 – 2/5 YEAR FLOODPLAINS

PLATE 4 – 100/500 YEAR FLOODPLAINS

PLATE 5 – ECONOMIC DAMAGE REACHES

PLATE 6 – SELECTED PLAN ALIGNMENT

PAGE INTENTIONALLY LEFT BLANK

1. INTRODUCTION

The cities of Chehalis and Centralia and surrounding communities in Lewis and Thurston Counties, Washington, have a long history of flooding and flood damages. These problems have been acknowledged and studied for many years. More recently, heightened environmental awareness and the potential listing of area aquatic species as threatened and endangered have resulted in a need for increased focus on development of flood control alternatives that minimize environmental impacts and incorporate environmental features to mitigate any adverse impacts to fish and wildlife communities and habitats. This general reevaluation report documents the methods and findings of studies aimed to address these flooding and environmental problems.

The studies documented in this report are General Reevaluation Studies of the recommended project in the 1982 Feasibility Report titled *Centralia, Washington Flood Damage Reduction*. That report recommended modification of Skookumchuck Dam to provide for increased flood control storage. That recommendation was later found to be economically unjustified during the Preconstruction Engineering and Design (PED) phase and studies were terminated. The current General Reevaluation Study is in response to Congressional direction to reexamine previous recommendations for flood damage reduction in the vicinity of Centralia and Chehalis and to examine opportunities for ecosystem restoration.

1.1 Study Authority

Authority for the Centralia Flood Damage Reduction General Reevaluation Study is provided by the following Congressional actions:

Skookumchuck Dam Modification Project: Section 401(a) of 1986 Flood Control Act (PL 99-662) authorized construction of “works of improvement” substantially in accordance with the Report of the Chief of Engineers, dated 20 June 1984. The report was an interim report submitted (third in a series) under the Chehalis River and Tributaries Feasibility Study authority, originally authorized by a 19 April 1946 House of Representatives Flood Control Committee Resolution. A project to increase the dam to 28,500 acre-feet (ac-ft) of storage was recommended and was authorized in 1986.

Chehalis River & Tributaries General Reevaluation Study: On 9 October 1998, the U.S. House of Representatives Committee on Transportation and Infrastructure adopted Resolution 2581, requesting a review of past Corps report recommendations with a view to determining if the recommendations should be modified “with particular reference to flood control and environmental restoration and protection, including non-structural floodplain modification.” This resolution provided the authority and directive for the Corps to conduct this Flood Damage Reduction Study for the Chehalis River Basin.

1.2 Study Sponsorship

Although the City of Centralia was the local sponsor through the feasibility phase and initial PED work for the authorized Skookumchuck Dam Modification Project, it was Lewis County that requested the Corps resume PED work with a view to combining additional measures with the authorized dam modification element to form a more complete flood damage reduction plan for the Centralia-Chehalis urban area. Lewis County has agreed to serve as local sponsor for project construction and to provide the appropriate cost sharing for PED and construction costs when necessary. PED work was resumed in July 1998.

1.3 Study Area

The study area includes the mainstem Chehalis River, its floodplain and tributaries from the South Fork Chehalis River confluence to Grand Mound, and includes the cities of Centralia and Chehalis, in Lewis County, Washington. Tributaries entering the study area include the Skookumchuck and Newaukum rivers, Salzer, China, Coal, Bunker, and Lincoln creeks, among others. Studies along the Skookumchuck River extend upriver to Skookumchuck Dam and include the town of Bucoda in Thurston County.

1.4 Previously Authorized Project

The recommended project was authorized in 1986 with an estimated cost of \$19.9 million (\$30.2 million when converted to 2001 price level). It proposed adding a 12-foot-diameter, 1,200-foot-long, low-level, gated discharge tunnel through the dam’s north abutment and a bascule gate, 15 feet high by 136 feet wide, on the existing spillway crest. That project would provide up to 28,500 ac-ft of flood storage and reduce the Skookumchuck River 200-year flood flow (1985 analysis) from 13,300 cfs to 6,700 cfs (a flood depth reduction of 2 to 5 feet along the

Skookumchuck River in Centralia). With average annual benefits estimated at \$4.3 million (2001 price level), the project had a benefit-to-cost ratio of 1.4 to 1.0.

PED work on the Centralia project was previously underway from February 1988 through August 1990. Negotiations were undertaken with the dam operator, PacifiCorp, to identify the maximum amount of flood storage they would agree to provide at Skookumchuck Dam, which was about 12,000 ac-ft. Earlier hydrologic, hydraulic, and economic studies were updated from the Feasibility Report and preliminary spillway design layouts and cost estimates were refined. Design work was suspended after studies indicated that the recommended plan lacked economic justification. A Wrap-Up Report was provided to the local governments in May 1992 that contained the useful information that had been generated by the project's design work.

1.5 Project History

There is a long history of study activities related to potential flooding on the Chehalis River and its tributaries. The following is a brief chronology of Federal study activities in the area.

TABLE 1-1 CHEHALIS RIVER AND TRIBUTARIES CHRONOLOGY OF FEDERAL STUDIES

1931	Corps of Engineers reports on the Chehalis River and Tributaries were completed in 1931, 1935, and 1944 and all concluded that flood control improvements were not economically justified.
1944	In 1944 Congress authorized construction of a levee system to protect the communities of Hoquiam, Aberdeen, and Cosmopolis. The authorization expired in 1952 because local sponsors did not provide required items of local cooperation.
1965	Following serious flooding, study of the Chehalis River and Tributaries resumed in 1965 at the request of the city of Centralia and Lewis, Thurston, and Grays Harbor counties. Studies found that large multi-purpose storage projects in the Chehalis Basin were not economically justified and that levee and or channel modifications along with small headwater dams should be studied further (including in the vicinity of Centralia-Chehalis). Enlargement of Skookumchuck Dam to provide flood control storage was determined to be not economically feasible.
1972	The Chehalis Basin study was divided into separate geographically based studies. Interim reports were published for each area. One of the areas was Centralia-Chehalis.
1974	Findings of further studies of flood control alternatives in the Centralia area found that an urban levee system was the only alternative that appeared economically justified.
1980	Analysis of the Levee Alternative from 1975-1980 resulted in a tentative recommendation for a levee system providing a 200-year level of protection for 2,080 acres in Centralia. Levees to provide protection for other areas, including Chehalis, were not economically justified. Centralia requested that the Corps review the potential for modifying Skookumchuck Dam to provide flood control.
1982	Further feasibility studies during 1981-1982 of modifying Skookumchuck Dam indicated that the dam modification would be a better solution than the urban levee system. The feasibility report, produced in 1982, recommended dam modifications (provision of a low-level flood control outlet, and raising the reservoir elevation to provide flood control storage).
1986	The Water Resources Development Act of 1986 authorized construction of the Skookumchuck Dam modifications recommended in the 1982 Feasibility Report, <i>Centralia, Washington Flood Damage Reduction</i> .
1988-91	The Preconstruction Engineering and Design Phase followed the Feasibility Phase of study. In this phase, a limited reevaluation study was conducted to identify possible cost savings through design modifications and to update project economics to reflect revised mapping, revised water surface profiles, modified levee break assumptions, and revised stage-damage functions for frequent hydrologic events. Although project costs were significantly lowered through value engineering, the recalculation of economic benefits brought the benefit-to-cost ratio below unity. In 1991 the Corps' Northwest Division Engineer issued a public notice to terminate the study of the authorized modification to Skookumchuck Dam.
1990	The Salzer Creek Flood Damage Reduction Study, completed in September 1990, looked at flooding in the Salzer Creek basin, which occurs primarily from October through March. The primary plans considered were 6,000 feet of levee to protect the city of Centralia, and a small levee and pump plant to protect the cities of Centralia and Chehalis. The plan would protect portions of the cities of Centralia and Chehalis from the 100-year flood event on the Chehalis River and a larger event on Salzer Creek. The recommended plan consisted of a pump station, an approximately 1,000-foot-long levee that would cross Salzer Creek at I-5 and which would prevent Chehalis River backwater flooding, and still allow Salzer creek to flow through. Local funding issues precluded this project from proceeding to construction.
1998	In 1998, the U.S. House of Representatives Committee on Transportation and Infrastructure adopted Resolution 2581, requesting a review of past Corps report recommendations with a view to determining if the recommendations should be modified "with particular reference to flood control and environmental restoration and protection, including non-structural floodplain modification."
1998	Seattle District and Lewis County initiated the Chehalis River and Tributaries General Reevaluation Study. The study explores structural and non-structural flood control solutions.

1.6 Recent Local Activities

Following disastrous 1990 and 1996 flood events, a group of interested citizens in the spring of 1996 formed the Flood Action Council (FAC) to work on options to reduce or eliminate severe flooding in the Centralia-Chehalis area. With the help of a consultant team, the FAC developed a preliminary plan that combined modifying Skookumchuck Dam with overbank excavation at Centralia and additional upstream flood storage. Their proposal to form a Chehalis Basin (Lewis County) Flood Control District to implement that plan was rejected by the Lewis County Commissioners, because it did not meet legal criteria for creation. However, the Commissioners decided that the county would take the lead in identifying flood reduction measures and set up by ordinance a countywide Flood Control Zone District (FCZD).

Subsequently, Lewis County, using local and state funding and the same consultant team, conducted studies that identified possible modifications to the recommended project in the Chief's report that could result in a potentially economically justified project. Originally, these studies were developed to provide a community-based alternative to the Washington State Department of Transportation's (WSDOT) plan to raise the Interstate Highway 5 (I-5) grade near Centralia and Chehalis by up to 12 feet. Local governments wanted a plan for a comprehensive flood hazard management project that would provide flood relief as well as avoid raising I-5.

In May 1998, Lewis County completed a "Pre-Feasibility Analysis of Alternatives" report (similar in scope to a Corps reconnaissance study) identifying a plan that appeared to be economically justified and warranting further consideration. This plan was further refined in their November 1998 "Draft Interim Report." The version of the plan identified in that report combined dam modifications (sluices through the spillway and a rubber, weir-type gate on top of the spillway) with overbank excavation near Centralia and flood bypass measures near Chehalis.

The Chehalis River Basin Partnership (CRBP) was also established in 1998 by an inter-local agreement among cities, towns, counties and tribes in the Chehalis River basin. The CRBP aims to implement state mandated watershed planning, particularly addressing water quality, water quantity, and fish habitat.

In April 1998, the Washington State Legislature provided through the Department of Transportation \$600,000 to "establish alternatives for flood management and flood hazard reduction projects in the Chehalis basin." A provision in the legislation required that a Technical Committee be established composed of WSDOT, WDOE, USACE, FEMA (Federal Emergency

Management Agency), USGS (U.S. Geological Survey), and “affected counties and tribes, and other entities with critical knowledge related to flood hazard reduction projects.” In accordance with those provisions, the then existing Chehalis Basin Coordinating Committee (which had been established in 1997) was reconstituted to form the Technical Committee. It established an Alternatives Subcommittee to identify and develop flood damage reduction measures and combine them into alternative plans for comparison with the alternative already developed by Lewis County. Most of the 1998 WSDOT funding was provided to Lewis County to continue work on developing a flood damage reduction alternative for the Centralia-Chehalis area. In the 1999-2001 state budget an additional \$300,000 was included to continue this effort, concentrating on coordination with the Corps of Engineers, negotiation with PacifiCorp on dam ownership transfer, the NEPA/SEPA process, and general project coordination.

In addition, in May 1999, the Washington State Legislature provided the WSDOT \$800,000 “for activities considered essential to understanding flood hazard reduction options for I-5, State Route (SR) 12 and other chronic flood hazards to transportation within the Chehalis watershed.” The WSDOT and the local governments’ Executive Committee were required by the legislation to develop a Memorandum of Agreement to identify the tasks to be performed. A Memorandum of Agreement to “support community protection and salmon recovery efforts where possible” was signed.

1.7 Existing Projects in Study Area

1.7.1 Skookumchuck Dam

Skookumchuck Dam was completed in 1970 by Pacific Power and Light Company as agent for the owners, a group of eight public and private utilities. The dam is on the Skookumchuck River, 22 miles upstream from the river's confluence with the Chehalis River. The dam provides an assured water supply for the coal-fired Centralia Steam Electric Plant. The dam stores water during the late fall and winter for release during the low flow period of summer and early fall. The storage releases are carried instream for about 14 miles to a pumping plant that diverts water through a 3-mile pipeline to the plant. In July 1982, the Federal Energy Regulatory Commission (FERC) approved an application for exemption from license from Pacific Power and Light Company for a 980-kilowatt (kW) generating facility at Skookumchuck Dam that uses existing excess discharges from the dam to generate power.

On 15 July 1998, Lewis County asked the dam owner, PacifiCorp, to begin formal discussions on transferring flood control operating authority and/or ownership rights for the dam and reservoir. They signed a Memorandum of Agreement (MOA) on 30 June 1999 that identifies the process and procedures to follow to investigate and ultimately, if favorable, transfer ownership of the dam and reservoir.

1.7.2 Long Levee

The Long Road Flood Damage Reduction project was constructed under authority of Section 205 of the 1948 Flood Control Act, as amended. The project is just south of the City of Centralia in Lewis County, Washington. The levee project ties into the embankment of Interstate 5 near milepost 81. The project is designed to protect approximately 100 acres of land, residential homes, a church, and a 100-bed convalescent center from floods up to about the 40-year event, which is a flood that has about a 2.5 percent chance of occurring or being exceeded on any year. The area protected is within the Long Road Diking District.

The project consists of a 2,200-foot earthfill levee stretching between the Tacoma Eastern Railroad (TERR) and I-5 embankments in a reversed L-shape. Excavated material from the interior of the reverse-L created a ponding area and provides storage for the project. To drain the

interior storage area the project includes an outlet for the ponding area with two 30-inch culverts and flap gates, and a ditch and berm with two 30-inch culverts and flap gates.

1.7.3 Skookumchuck River Levee

Currently a levee exists along the Skookumchuck River, starting at Skookumchuck river mile¹ (RM) 2.2 for a length of .75 river miles. This small section of levee currently gets outflanked during flood events prior to being overtopped by floodwaters. This section of levee is not a Federal levee project.

1.7.4 Chehalis-Centralia Airport Levee

An existing levee protects the Chehalis-Centralia Airport, starting at Chehalis river mile 70.2 and extending for a length of 2.6 river miles. The levee is outflanked on the southern end of the airfield. This levee is not a Federal project.

1.7.5 Salzer Creek Levee

An existing levee runs along Salzer Creek starting at river mile .87 and extending upstream for .45 river miles for protection of the fairgrounds. This levee is not a Federal project.

1.8 Prior Reports

A series of Corps of Engineers reports related to flood control in the Chehalis River basin have been produced dating back to 1931. These reports are listed in Table 1-2 and are described in the following paragraphs.

Corps of Engineers reports on the Chehalis Basin completed in 1931, 1935, and 1944 all concluded that flood control improvements were not economically justified. However in 1944 Congress authorized a levee system to protect Aberdeen, Hoquiam, and Cosmopolis. The authorization expired in 1952. An interim report was transmitted to Congress in November 1978,

¹ All references to river miles (RM) on the Chehalis and Skookumchuck rivers (and other tributaries) start at the respective river's (in some cases, creek's) outlet. For example, Chehalis river mile 0.0 is at the outlet to Grays Harbor. Skookumchuck River mile 0.0 is at the river's outlet to the Chehalis River. All other river mile references refer to the miles upstream from the outlet.

recommending construction of a levee system to protect the south side of the Chehalis River at its mouth in the City of Aberdeen and town of Cosmopolis.

In the Chehalis-Centralia area, the lower 1,700 feet of Coffee Creek was modified in 1966 under the authority of Section 208 of the 1954 Flood Control Act. A floodplain information report was completed in June 1968 for the Chehalis River and Skookumchuck River in the Chehalis-Centralia area. A hydraulic floodway study for the same area was completed in August 1974. A second hydraulic floodway study was completed in March 1976 covering the Chehalis and Newaukum rivers in the vicinity of Chehalis. A comprehensive framework study of the water and related land needs of the Columbia River-North Pacific region was completed in 1972 under the direction of the Pacific Northwest Rivers Basin Commission, identifying the Chehalis-Centralia area as an area where levees should be constructed for urban flood damage reduction.

In 1982 the Corps released the Feasibility Report and Environmental Impact Statement for Centralia, Washington Flood Damage Reduction. The report recommended modifications to Skookumchuck Dam (provision of a low-level flood control outlet, and raising the reservoir elevation to provide flood control storage). This project was later found to be economically unjustified based upon updated economic studies during the PED phase. In February 1992 the Corps prepared the Skookumchuck Dam Modification Project, Centralia, Washington Wrap-Up Report, summarizing PED studies and data.

TABLE 1-2 CORPS OF ENGINEERS FLOOD CONTROL REPORTS IN STUDY AREA

Report	Date	Content
House Document 148 72 nd Congress 1 st Session	1931	Investigated improvements on the Chehalis River for navigation, flood control, hydropower development, and irrigation; concluded no improvements were justified
Preliminary Examination (not published as Congressional Document)	1935	Preliminary examination of flood control for the Chehalis River; concluded that flood control reservoir or channel improvements at Centralia-Galvin, Oakville, Malone, and Potter were not economically justified.
House Document 494 78 th Congress 2 nd Session	1944	Preliminary examination and survey for flood control on the Chehalis River and tributaries considering construction of a levee system to protect Aberdeen, Cosmopolis, and Hoquiam; concluded any additional flood control in the basin was not economically feasible. (Levee system was subsequently authorized by Congress in 1944. The authorization expired in 1952.)
Coffee Creek, Channel Excavation and Debris Removal under Section 208 of 1954 Flood Control Act	1965	Examined floodway problems along Lum Road in Centralia and recommended clearing and snagging on 1,660 feet of Coffee Creek (completed March 1966).
Floodplain Information, Chehalis and Skookumchuck River, Bucoda, Washington	1968	Delineated the floodplain along the Skookumchuck River from the Lewis/Thurston county line to about 1 mile upstream of Bucoda.
Floodplain Information, Chehalis and Skookumchuck Rivers, Centralia-Chehalis, Washington	1968	Delineated the floodplain along the Chehalis River from the Lewis/Thurston county line to Chehalis and along the Skookumchuck River from the mouth to the Lewis/Thurston county line.
Special Study, Suggested Hydraulic Floodway, Chehalis and Skookumchuck Rivers	1974	Delineated the suggested hydraulic floodway for the area covered by the June 1968 floodplain information report.
Special Study, Suggested Hydraulic Floodway Chehalis and Newaukum Rivers	1976	Delineated the floodplain and suggested hydraulic floodway for Chehalis River from Chehalis to Adna and the Newaukum River from its mouth to the I-5 bridge.
Centralia, Washington Flood Damage Reduction Feasibility Report and Environmental Impact Statement	1982	Documents investigation of the feasibility of reducing flood damages in the cities of Centralia and Chehalis and surrounding areas. Recommended modification of the existing Skookumchuck Dam to provide flood control storage. (Recommendation later found to be economically unfeasible during PED phase).

TABLE 1-2 CORPS OF ENGINEERS FLOOD CONTROL REPORTS IN STUDY AREA

Salzer Creek Flood Damage Reduction Report	1990	The Salzer Creek Flood Damage Reduction Study, completed in September 1990, looked at flooding in the Salzer Creek basin, which occurs primarily from October through March. The primary plans considered were 6,000 feet of levee to protect the City of Centralia, and a small levee and pump plant to protect the cities of Centralia and Chehalis. The plan would protect portions of the cities of Centralia and Chehalis from the 100-year event flood on the Chehalis River and a larger event on Salzer Creek. The recommended plan consisted of a pump station, an approximately 1,000 foot long levee that would cross Salzer Creek at I-5 and that would prevent Chehalis River backwater flooding, and still allow Salzer Creek to flow through.
Skookumchuck Dam Modification Project, Centralia, Washington	1992	Preconstruction Engineering and Design (PED) work on the Skookumchuck Dam Modification Project was suspended in August 1990 when the updates of the project's economic analysis found the project unjustified. The wrap up report was prepared to document the technical work that had been completed at the time the PED work stopped.
Post Flood Study, Chehalis River at Centralia, Lewis County, Washington	1999	Provides updated flood information on the discharge and stage for the 50-year and 100-year floods on the Chehalis River in the vicinity of Centralia. The update was necessary due to significant changes in the flood frequency relations caused by a series of record floods over the previous 20 to 25 years. The study also addresses the effects of raising the road surface elevation of I-5 in the Chehalis-Centralia corridor on flood levels in the area. Study found discharges and flood levels had significantly changed from those published in the 1980 FEMA report due to the change in the hydrologic record. The 100-year event at Grand Mound gauging station increased from 58,700 cfs to 74,300 cfs, or approximately .9 foot in stage.

2. SCOPE OF GENERAL REEVALUATION STUDY

The Chehalis River General Reevaluation Study is a Post Authorization Study being conducted by the U.S. Army Corps of Engineers, Seattle District, and Lewis County, Washington. A general reevaluation study is a reanalysis of a previously completed and authorized study, using current planning criteria and policies, which is required due to changed conditions and/or assumptions. The results may affirm the previous plan; reformulate and modify it, as appropriate; or find that no plan is currently justified. The results of the study are documented in this General Reevaluation Report (GRR).

As mentioned in Section 1 of this report, in 1998, the U.S. House of Representatives Committee on Transportation and Infrastructure adopted Resolution 2581, requesting a review of past Corps report recommendations (including the project authorized for construction in WRDA 1986) with a view to determining whether the recommendations should be modified “with particular reference to flood control and environmental restoration and protection, including non-structural floodplain modification.” Seattle District and Lewis County initiated the Chehalis River and Tributaries General Reevaluation Study to reevaluate previous and new configurations of structural and non-structural flood control solutions and ecosystem restoration features. The study involved analysis of many technical areas including:

- Survey and mapping
- Hydrology and hydraulics
- Engineering Design
- Geotechnical Studies
- Economic Analysis
- Institutional Studies
- Real Estate Studies
- Environmental Studies
- HTRW Studies
- Cultural Resources Studies
- Cost Estimating
- Public Involvement

The scopes of these technical studies are summarized in the following sections, followed by an overview of risk-based flood damage reduction analysis and its application in the General Reevaluation Study. Results of these studies are presented in detail in the respective technical appendices of this GRR and the associated Environmental Impact Statement (EIS) as appropriate. Those results that were key to the formulation and selection of the recommended plan are summarized throughout the following chapters in this report.

2.1 Survey and Mapping

To provide topographic input for the UNET1D computer models, an aerial photogrammetric survey was conducted for large portions of the Chehalis River basin including: Chehalis River floodplain from Cedarville (RM 42) through Pe Ell (RM 107). The existing Thurston County 2-foot contour interval (CI) topographic mapping was used for the study areas in Thurston County. New 2-foot CI mapping was prepared for the following river reaches in Lewis County: 46 miles on the Chehalis River, 6 miles on the Skookumchuck River, 9 miles on the Newaukum River, about 5 miles in the Lincoln Creek valley, 9 miles in the Hanaford valley, 4 miles in the Sterns Creek valley, and 8 miles in the South Fork Chehalis River valley. The maps incorporate 2-foot contour intervals, planimetric details and extensive spot elevations (at grade breaks, road and railroad alignments) with a vertical accuracy of ± 0.5 foot. New topographic mapping of 1-foot contour interval was developed for the immediate vicinity of the existing Skookumchuck Dam, its intake and outlet structures. New river cross-sections were obtained by field measures.

2.2 Hydrology and Hydraulics

Hydrologic and hydraulic study tasks were completed to update, calibrate, and operate a hydraulic model of the Chehalis River valley and to support all hydrologic and hydraulic design work associated with layout and design of the potential project. Previous Corps of Engineers archived databases and models were activated and updated as appropriate. The deregulated natural and existing condition flows on mainstem Skookumchuck and Chehalis rivers and tributaries associated with winter and spring floods of record were updated for use in hypothetical flood and dam regulation analyses. Historic and expected future changes in land use and population in the basin were researched and evaluated to assess influences on basin hydrology.

The Chehalis basin frequency curves were reviewed and, particularly the low flow curves, revised, and hypothetical floods developed for the 2-, 10-, 25-, 50-, 100-, 200-, 500-year, and larger events. Work developed the magnitude of flow versus timing relationships and updated observed and hypothetical flood routings for use in hydraulic model. Information was developed on the expected interior runoff for any areas protected by the potential alternatives. Risk and uncertainty associated with hydrologic data were identified.

Reservoir release options at Skookumchuck Dam were investigated regarding fishery impacts, river sedimentation, and water supply. The former reservoir temperature analyses were updated. The former Probable Maximum Flood and Standard Project Flood analyses were reviewed and updated using the new HMR57 model and routed through the reservoir for site-specific dam safety analysis and spillway discharge adequacy. Reservoir storage rule curves and gate operating schedules were revised and updated. A preliminary data-collection plan and preliminary reservoir operating plan was developed.

The existing UNET1D hydraulic model was updated to reflect revised hydrologic and topographic data. The model covers the river floodplain from the mouth at Aberdeen through Pe Ell (RM 107) with particular emphasis in the upper basin above Grand Mound (RM 60). The model includes 10 miles on the Black River, 22 miles on the Skookumchuck River, 9 miles on the Newaukum River, about 5 river miles in the Lincoln Creek valley, 9 river miles in the Hanaford Valley, and 8 river miles in the South Fork Chehalis River valley. An assessment of sediment transport in the river was prepared. After the models were calibrated to replicate past flood conditions accurately, the existing without-project flooding conditions were determined for the selected range of floods. In addition, an analysis was conducted to update the flood insurance floodplain and floodway maps for FEMA to publish on an interim basis until such time as a project(s) was constructed. At that time a revised version of the maps would be prepared as one of the work items during the construction phase.

The model was used to develop the with-project conditions and to formulate and screen potential flood damage reduction measures and help select the recommended project by identifying impacts associated with three alternative with-project conditions reflecting flood damage reduction measures and/or alternatives. Limited sediment sampling and analysis was performed on the Chehalis River to evaluate the impact of alternative projects on the sediment regime and to develop potential project operation and maintenance costs. A probabilistic risk and uncertainty analysis was performed for the alternatives to help determine the recommended plan.

2.3 Economics

The economic analysis involved studies pertinent to an economic cost/benefit analysis of alternative flood damage reduction plans.² Expected annual flood damages were estimated under the existing (without-project) and the alternative with-project conditions. An economic report is included as Appendix E to this GRR, and its information is summarized in the main report.

The principal controlling guidance of the analysis comes from the Corps' "Planning Guidance Notebook", ER 1105-2-100, with specific guidance from the regulation's Appendix D – Economic and Social Considerations. Additional guidance on the risk-based analyses is from the Corps' EM 1110-2-1619, dated 1 August 1996, "Engineering and Design - Risk-based Analysis for Flood Damage Reduction Studies." Guidance on agricultural damages has been derived from the Corps of Engineers Water Resources Support Center's "National Economic Development Procedures Manual – Agricultural Flood Damage," IWR Report 87-R-10, dated October 1987.

The economic analysis was conducted in several phases. First project mapping was reviewed and all structures within the 500-year floodplain were provided a unique identifier number and entered into a database. This was followed by a field survey to obtain relevant data on the structures for entry into the database. A risk-based economic analysis was performed to develop the stage-damage function for each category of structures. The stage-damage functions and structures database were combined with water surface profiles from hydraulic analysis into the HEC-FDA model to calculate expected annual damages for each alternative. The damages reduced by each plan were then compared to the cost of each plan to identify the plan that maximizes net benefits. The results of these analyses are further described in the section on plan formulation.

2.4 Engineering Design

Engineering design studies of alternative flood damage reduction measures were conducted in three segments. In the first segment, engineering design studies were performed at the minimum level needed to establish conceptual designs for alternative project features and elements that can be compared with each other. The second segment involved further development of selected measures and alternatives for comparison and evaluation and the formulation of a recommended

plan. The detailed design of the recommended plan (including mitigation features) was developed in the third segment, along with refinements to construction and operation and maintenance cost estimates and project construction schedules. All work was performed with a view to forming an appropriate basis for further design efforts, such as physical model tests and Feature Design Memorandums (FDM). A Cost Engineering appendix (Appendix D) to this GRR provides all design data analyses, a written description of the design features of the recommended plan, plates, and cost estimates.

2.5 Geotechnical Studies

Geotechnical studies for this study include the investigation, exploration, and analysis of foundations and materials conditions related to the selection and design of the alternative flood damage reduction measures. Geotechnical effort was divided into two distinct elements: Skookumchuck Dam investigations and analyses and floodplain investigations and analyses.

2.5.1 Skookumchuck Dam Geotechnical Studies

The geotechnical effort for Skookumchuck Dam included a site-specific ground motion study due to increased estimations of the seismic risk in the Pacific Northwest. Past seismic studies were evaluated using present state-of-the-art practice and existing literature. A seismic analysis of the dam embankment stability based on dynamic loading methods followed the ground motion study. Work included a reservoir slope slide evaluation and investigation and analysis for a sluiceway(s) through the spillway. A soil exploration program was conducted beneath portions of the downstream dam embankment berm to determine liquefaction susceptibility of dam foundation silt and alluvium. An exploratory core drilling program was conducted to support rock cut slope stability and dewatering.

2.5.2 Floodplain Investigations Geotechnical Studies

The geotechnical effort for study area floodplains included a review of available geotechnical information from previous studies and intrusive field investigations to physically characterize materials to be excavated, stability of cut slopes, soil erosion potential, permeability of soils,

² The economic analysis conducted for development of the without project and initial plan formulation for the general reevaluation study and presented in this report was based upon a 6.125 percent discount rate, 2002 price level, and 50-year period of analysis. The final costs and benefits for the NED and LP plans were revised to reflect the current 2003 price level and 5.875 percent discount rate.

seepage conditions, and potential borrow and materials sources. The exploration program involved auger drill borings, backhoe test pits, and the installation of piezometers. Appendix C, Levee Plan and Civil Design, and Appendix B, Skookumchuck Dam Design, to this GRR document the studies and their findings.

2.6 Institutional Studies

Institutional studies assess required institutional arrangements for funding project design, construction, operation, and maintenance; and identify, if any, necessary legislation requirements by the State of Washington to facilitate either project funding or construction. Institutional issues included:

- Coordination between the established governments was conducted to determine the legal entity that will serve as local sponsor for construction and operation
- Lewis County developed a legal analysis supporting their legal ability (or the legal ability of a new governmental entity) to provide the required items of local cooperation.
- Financial analysis in support of the construction recommendation was prepared by Lewis County to include a Statement of Financial Capability (SFC) and a Financing Plan (FP). The FP provides detail as to the anticipated funding authorities available to the sponsor and its specific plans for financing its share of project costs. The local sponsor prepared the SFC and FP, with review by the Corps and Corps preparation of a Financial Capability Assessment (FCA) for inclusion in this GRR.

Actions to be completed during PED include:

- negotiations between Lewis County and PacifiCorp regarding possible transfer of dam ownership; and
- coordination with FERC regarding a new license or exemption from license covering the changes in the spillway and/or project operations.

2.7 Real Estate Studies

Real estate studies involved the identification, assessment, and appraisal of all real property interests required to support the conduct of the feasibility study and the recommendations of the GRR. Specific real estate study tasks included:

- Rights-of-Entry (ROE) were acquired from landowners for survey and mapping, design, geotechnical, and hazardous, toxic and radioactive waste (HTRW) investigations, the cultural resources survey work, and site-specific environmental field studies.
- A gross appraisal of project land costs (including relocations as necessary) was prepared. Work included detailed determination of cost of lands, easements, and rights-of-way for the recommended plan.

A real estate plan is included as Appendix F to this GRR, describing the real estate requirements for the proposed project, the local sponsor's administrative acquisition costs, and Corps costs to review and advise the sponsor.

2.8 Environmental Studies

Environmental studies included environmental data collection and the determination of environmental impacts of alternative plans. Environmental study tasks included all activities required to comply with the National Environmental Policy Act (NEPA). Activities included literature searches and review of existing reports and field surveys to establish environmental baseline conditions; identification of future without-project conditions; determination of impacts of the alternatives; coordination with the U.S. Fish and Wildlife Service (USFWS), Environmental Protection Agency (EPA), Washington Department of Ecology (WDOE, Ecology), Washington Department of Fish and Wildlife (WDFW), Confederated Tribes of the Chehalis, and others; analysis of mitigation needs; development of potential habitat restoration opportunities; development and preparation of all appropriate NEPA documents; review of in-house reports; response to comments; and support to the project manager and others for the duration of the study.

2.8.1 EIS Preparation

The Corps prepared a draft and final EIS (published under separate cover) and public notice with assistance from the local sponsor. The EIS evaluated the environmental effects of the alternative plans and was coordinated with the tribal, Federal, state, and local governments and agencies, and interested groups and individuals. The Washington State Department of Transportation (WSDOT) was the cooperating agency for the EIS.

2.8.2 Environmental Data Compilation

A literature search and compilation of existing data was accomplished to collect all pertinent information for use in assessing project impacts. Some of the information is in the Geographical Information System (GIS) format and was entered on the Seattle District GIS for overlaying on study and/or report maps. The GIS information will be used as input to PED.

2.8.3 Riparian Survey

The study team reviewed existing information on riparian habitat, vegetation type and structure, and floodplains. A field survey was completed to evaluate the quality and extent of riparian areas along the Chehalis River and tributaries in the project area. The study team evaluated potential adverse impacts to riparian areas for each alternative.

2.8.4 Wetland Survey

Existing information on wetlands in the project area was reviewed and evaluated. Limited field surveys and hydric soil mappings were conducted to determine the extent of wetlands within the project area. Potential adverse impacts to wetlands were evaluated for each alternative.

2.8.5 Fisheries Survey

Existing information on fish distribution and use of the Chehalis River and tributaries was reviewed. Additional field investigations of instream habitats and fish distribution were conducted. Potential adverse impacts to fisheries were evaluated for each alternative. The study team conducted field surveys of instream habitats and fish use on the Skookumchuck River and fish use of portions of the Chehalis River during spawning, including the following:

- spawner surveys (Skookumchuck and mainstem Chehalis rivers);
 - habitat survey (above Skookumchuck Dam);
 - off-channel habitat surveys (Skookumchuck and mainstem Chehalis rivers) that assess functional connections with streams, access; temperature; and changes in off-channel habitat resulting from potential water level changes;
 - fish passage at the dam;
 - instream habitat effects of water level changes (proposed bypass reach); and
 - investigation of potential habitat restoration opportunities.
-

2.8.6 Environmental Mitigation Measures

The Corps, in coordination with the local sponsor and resource agencies, preliminarily reviewed the scale of adverse environmental impacts associated with each alternative. The alternatives were evaluated to avoid, minimize and, if possible, rectify potential adverse environmental impacts associated with each. Mitigation measures were identified for all adverse environmental impacts of the recommended plan.

Preliminary alternative environmental mitigation designs were developed that focused on both offsetting project impacts and addressing limiting fish and wildlife habitat factors identified in the basin. These designs were developed in sufficient detail to develop cost estimates. The plans are documented in the EIS. An evaluation methodology was developed to evaluate the habitat outputs of alternative mitigation designs.

An incremental cost analysis was performed to assist with development of cost effective mitigation plans. The purposes of the incremental cost analysis were to determine and show variations in costs across alternative mitigation plans, and to assist in selecting the mitigation plan.

2.8.7 Endangered Species Act Coordination

The Corps prepared a biological assessment (BA) to identify possible impacts to species listed as threatened or endangered under the Endangered Species Act (ESA). The BA, prepared in coordination with the USFWS, focused on species likely to be found in the project area. Limiting factors for endangered species in the area were identified and evaluated as part of the study. A range of environmental features throughout the study area was identified that addressed these limiting factors and could potentially be implemented for mitigation of negative project impacts.

2.8.8 Clean Water Act Section 404(b)(1) Evaluation

A 404(b)(1) analysis was conducted during feasibility. Seattle District has determined that the proposed levee construction and dam modification includes practicable steps to minimize impacts to the aquatic environment, and that there is no practicable alternative to the proposed project that would have less impact on the aquatic environment. Therefore, Seattle District has determined that the proposed project complies with the Clean Water Act, Section 404 (b)(1) guidelines. The Corps will coordinate with the Washington Department of Ecology (Ecology)

and the Chehalis Tribe to obtain Section 401 state water quality certification. Certification is usually done during PED (about 90 percent design level) when necessary information is developed. The 404(b)(1) report is available as Appendix G of the EIS.

2.8.9 Fish and Wildlife Coordination Act Report

The general reevaluation study includes coordination with, and studies conducted by, the USFWS, as required by the Fish and Wildlife Coordination Act (FWCA). The Corps developed a scope of work and transferred funds to the USFWS for interagency and tribal coordination, planning and evaluation of the impacts of alternative measures and plans on fish and wildlife resources, preparation of five planning aid letters (PAL), and a draft and final Fish and Wildlife Coordination Act Report for inclusion in the EIS. The USFWS effort includes environmental data collection and evaluation of the environmental resources of the study area. The USFWS reviewed alternative plans and assessed the effect on the environment within the study area. The USFWS provided recommendations concerning the formulation of the alternatives, and also prepared a FWCA Report documenting its findings. The Final FWCA Report is included in the EIS, and the Draft FWCA Report is included as an appendix to the EIS.

2.9 HTRW Studies

The Army Corps of Engineers Regulation 1165-2-132, Hazardous, Toxic and Radioactive Waste (HTRW) Guidance for Civil Works Projects, provides guidance for the consideration of issues associated with HTRW, which may be located within project boundaries or may affect or be affected by Corps civil works projects. This regulation outlines procedures to facilitate early identification and appropriate consideration of HTRW concerns in the reconnaissance; feasibility; preconstruction engineering and design; and operations, maintenance, repair, replacement, and rehabilitation phases of a project. Specific goals include (1) identification of level of detail for HTRW investigations and reporting for each phase of project; (2) promotion of early detection and response by the appropriate responsible parties; (3) determination of viable options to avoid HTRW problems; and (4) the establishment of a procedure for resolution of HTRW concerns, issues or problems.

For the general reevaluation study, HTRW studies were conducted to determine the presence and character of contamination, if any, on lands needed for the project. Lands potentially needed for the project were reviewed, and sites with possible contamination identified in an initial

screening. Further review of available information concerning those sites was conducted to estimate the volume and level of any contamination.

A preliminary HTRW assessment was conducted via the Internet and through coordination with the Department of Ecology Toxics Cleanup Program, SW Regional Office, for occurrence of HTRW on lands, including structures and submerged land, in the study area. The assessment included a project review, review of site literature and project features, database search, review of available records and aerial photography, site inspections and interviews. The following potential indicators were looked for: landfills, sumps, disposal areas, aboveground and underground storage tanks, vats, containers of unidentified substances, spills, seepage, slicks, odors, dead or stressed vegetation, water treatment plants, wells, ditches, abandoned buildings, and transport areas (such as boat yards, harbors, rail yards, airports, truck terminals, and fueling stations).

The assessment included a review of historical documentation; a review of regulatory listings and, if necessary, review of site files; site visits; and interviews with regulators, site owners and tenants where available or necessary. Regulatory lists reviewed included:

- EPA Lists: CERCLIS and the NPL; and
- Washington Lists: Confirmed and Suspected Contaminated Sites, State Cleanup Sites (MTCA), Voluntary Cleanup Sites, Hazardous Waste Generator Sites, Underground Storage Tanks, Leaking Underground Storage Tanks

The assessment covered all study regions, within the general vicinity of the proposed project or existing features proposed for significant modifications. Several site visits were conducted over the past few years and a preliminary site investigation was conducted for the recommended project that resulted in no findings of contaminated materials. The results of the field investigations, preliminary assessment, and database search are included as an appendix to the EIS.

2.10 Cultural Resources Studies

Cultural resource studies were conducted to locate, identify, and evaluate historic and prehistoric cultural resources (CR) possibly impacted by alternative measures. Previous CR studies identified numerous CR sites within the larger project area. The general reevaluation study

provided for completion of CR inventory (e.g., location and identification) and site evaluation in the study area. A preliminary evaluation of the effects of flood damage reduction alternatives upon historic properties was conducted.

These tasks were accomplished in consultation with the Washington State Historic Preservation Officer (SHPO). If required, site data recovery would occur during the project construction phase. The CR data recovery strategy will be developed in accordance with a Memorandum of Agreement between the Seattle District, the SHPO, the Advisory Council on Historic Preservation, and the Chehalis Tribe.

2.11 Cost Estimating

Preliminary alternative cost estimates were prepared to assist in the development and screening of alternative flood damage reduction measures and plans. The cost estimates included the preliminary construction costs for each alternative. Operation and maintenance costs were developed for each alternative as well. Mitigation and real estate costs were developed separately for the intermediate alternatives. Following initial screening and selection of an alternative, a detailed estimate of cost for the NED plan and recommended plan were prepared using MCACES software and are included in the Cost Engineering appendix (Appendix D).

2.12 Public Involvement

Public involvement activities were related to developing public information on the study and obtaining public comments during the study process. The public involvement/outreach strategy consisted of (1) a series of workshops and public meetings, (2) workshop and meeting notices, news releases, and public information brochures; and (3) speaking engagements at community service clubs and local organizations by Corps and Lewis County personnel. The study included extensive review throughout the process by agencies at the Federal, state, local and tribal governmental level, special interest groups, and the general public. Those entities most directly involved in review included Washington Department of Fish and Wildlife (WDFW), WSDOT, Department of Ecology, USFWS, NMFS, the Chehalis and Quinault tribes, local governments, and interest groups. The Corps and Lewis County jointly conducted workshops and public meetings and participated in the community outreach engagements.

Coordination with several groups was maintained to facilitate dialogue among basin residents and interest groups, including the following:

- Chehalis River Basin Partnership (CRBP). The CRBP was established in 1998 by local governments in the Chehalis River basin to implement state mandated watershed planning. CRBP's goals are to coordinate cooperative efforts on: 1) improvement of water quality, 2) management of water supplies for farms, fish, industry, and people, 3) reduction of effects of flooding, 4) increase in recreational opportunities, and 5) increase in public awareness through education. Their primary focus is on preparing a watershed management plan that will address water quality, water quantity, and fish habitat. Coordination will be maintained with the CRBP to identify any information that they collect or develop that would be beneficial in PED. As PED develops the flood reduction measures, these will be discussed with the CRBP to obtain their comments on the project features, their potential impacts, and questions and concerns that should be addressed as part of design.
- Technical Committee and Alternatives Subcommittee. The Technical Committee was established in 1998 to advise on the use of the money appropriated by the Washington State Legislature for flood hazard reduction projects in the Chehalis River basin. The Technical Committee in October 1998 formed an Alternatives Subcommittee to focus on identification of flood damage reduction measures and alternatives that could be discussed, screened, developed and compared with the one alternative previously developed by Lewis County.

A Notice of Intent (NOI) to prepare an EIS on structural and non-structural alternatives to address flood damage reduction in the Centralia/Chehalis area and an announcement of public scoping meetings appeared in Federal Register Volume 64, Number 174, on 9 September 1999. A meeting notice describing the project, requesting comments, and announcing the dates, times, and locations of the public scoping meetings was mailed to interested individuals, groups, agencies, and tribes. A press release announcing the public meetings was sent to local media.

The Corps held two public scoping meetings on 28 and 29 September 1999 at WF West High School in Chehalis and Rochester High School in Rochester respectively. The Corps presented alternatives being considered to address flood damage reduction in the Centralia/Chehalis/I-5 urbanized area and provided opportunities for interested parties to identify issues and concerns

associated with the proposed alternatives or to propose additional alternatives. Over 50 members of the public attended the two meetings and they were invited to comment orally or in writing. Over 75 comments were received at the meetings and in comment sheets sent in afterward.

The Corps continued to involve the local communities, state and Federal agencies and the tribes in the alternative selection process. In addition, since 1999 the Corps has presented project updates to the Chehalis River Basin Partnership, in order to keep the public informed of the process of the project. The Corps has also held several public information meetings regarding the selection of a recommended alternative.

3. WITHOUT-PROJECT FLOODING AND FLOOD DAMAGE

This section describes historic, current, and expected flooding and flood damage in the study area without the implementation of a project.

3.1 Flooding

In addition to extensive property damage caused by flooding in the cities of Centralia and Chehalis, floods have caused periodic closure of critical transportation routes resulting in significant economic losses. In closing transportation routes, the flooding also significantly disrupts emergency response by local governments, hurting public safety. Without implementation of flood hazard reduction measures, actions, or projects, the area will continue to suffer from damaging floods, and the local economy will continue to experience depressing economic effects due to the damages and uncertainty associated with future floods.

Stream flow generated within the Chehalis River Basin originates primarily from rainfall, although snowmelt occasionally augments runoff in the highest elevation reaches of the basin. The average annual runoff of the Chehalis River at its mouth (drainage area 2,114 square miles) and at the USGS stream gage near Grand Mound (drainage area 895 square miles), are estimated to be 6.4 million ac-ft and 2.0 million ac-ft, respectively.

Flows in the rivers and creeks of the Chehalis River basin show seasonal variation characterized by sharp rises of relatively short duration from October to March, corresponding to the period of heaviest rainfall. After March, the flows tend to gradually decrease to a relatively stable base flow, which is maintained from July into October.

Major flooding occurs during the winter season, usually from November through February, as the result of heavy rainfall occasionally augmented by snowmelt. Flooding may be either widespread throughout the Chehalis River basin or localized in sub-basins. Some storms may cover the entire basin and cause widespread flooding. Other storms may center over the Willapa Hills and cause flooding of the upper Chehalis River or center over the Black Hills and Cascade foothills and result in flooding of the Skookumchuck River and Newaukum River.

Table 3-1 lists the discharges and stages at three principal stream gauges chronologically for the 10 greatest floods since 1971. This table shows that the record flood in January 1972 near Grand Mound was exceeded in November 1986, January 1990, and again in February 1996.

TABLE 3-1 ANNUAL FLOOD PEAKS AT 3 LOCATIONS SINCE 1971

Gage:	Chehalis near Grand Mound			Skookumchuck near Bucoda			Newaukum R. near Chehalis		
Year ^{1/}	Stage	Disch.	Rank	Stage	Disch.	Rank	Stage	Disch.	Rank
Jan. '71	17.29	40,800	7	15.82	6,630	6	11.99	8,390	8
Jan. '72	18.21	49,200	4	16.82	8,190	4	12.12	9,770	6
Jan. '74	16.88	37,400	8	15.30	5,950	8	11.17	8,440	7
Dec. '75	17.73	44,800	6	15.42	6,110	7	10.85	8,020	9
Dec. '77	16.79	36,500	9	16.18	7,170	5	12.49	10,300	5
Nov. '86	18.41	51,600	3	15.01	5,770	9	12.76	10,700	2
Jan. '90	19.34	68,700	2	17.33	8,540	2	12.75	10,400	3
Nov. '90	18.12	48,000	5	17.23	8,400	3	12.73	10,300	4
Dec. '94	16.97	35,900	10	14.02	4,100	13	10.62	6,040	28
Feb. '96	19.98	74,800	1	17.87	11,300	1	13.34	13,800	1

^{1/}Flood dates are labeled by calendar year. The data is gathered by water years that begin in October and end in September. For instance, Jan. '90 is in water year 1990 and Nov. '90 is in water year 1991.

Source: Post Flood Study, USACE 1999.

3.2 Recent Floods

Brief descriptions of the three most recent, largest floods in the Centralia-Chehalis area (January 1990, November 1990, and February 1996 floods) are provided below.

3.2.1 January 1990 Flood

The January 1990 flood was primarily the result of a series of back-to-back storms accompanied by heavy rainfall over the 8-day period 3-10 January. The heaviest rainfall occurred on the seventh day of the storm, 9 January, causing extreme flooding because the rain fell on soils that were saturated from the preceding rainstorms.

The storm system was quite complex and included high winds and strong surges of precipitation. The Centralia climatological station recorded 8 inches of rain during the 8-day period. This 8-day total precipitation represents 19 percent of the total yearly precipitation recorded at the station on the average. The most intense precipitation in the basin occurred near the headwaters of the Skookumchuck and Newaukum rivers.

The surges in precipitation resulted in more than one flood peak in many of the rivers and creeks in the basin. The streams did not return to base flow between storm surges. The early precipitation saturated the soils in the basin and added greatly to the runoff potential when the heaviest rains arrived on 9 January.

3.2.2 November 1990 Flood

Above average precipitation in October and early November 1990 resulted in saturated soils that contributed to the flooding potential when the major storm arrived during the period of 21-25 November. During the period between a smaller storm in early November and the major storm, wet weather accompanied by cool temperatures continued and snow levels descended to about the 1,000-foot elevation. The Cascade foothills averaged 6 inches at elevations of 1,000 to 2,000 feet; 12 inches at 2,000 to 3,000 feet; and 12-18 inches at 3,000 to 4,000 feet. The water content of the snow was generally 10 percent or higher. As a warm front moved through western Washington on Wednesday, 21 November, snow changed to rain and temperatures rose. The warm front caused melting of snow up to elevations of 5,500 feet. Over the next 3 days, intense rain fell on drainages that were starting to swell from snowmelt runoff; disastrous flooding resulted. A cold front moved in from the north on 26 November 1990, lowered freezing levels and diminished precipitation, finally ending the severe flooding.

3.2.3 February 1996 Flood

The February 1996 flood is the flood of record, to date, on all the major drainages in the Chehalis River basin. Several of the main ingredients for a major storm flood were in place by 5 February. The ground throughout the basin was at or near saturation from above average precipitation, which had fallen in the preceding weeks. In addition, snow had recently fallen as low as 500 feet above sea level during a cold snap. Third, warm, moist subtropical air was being transported from the Pacific Ocean into the Pacific Northwest. The freezing level in this subtropical air mass was well above 8,000 feet, which meant warm rains on the snow pack in the foothills.

Next, there was a strong polar jet stream with maximum wind speeds in its core in excess of 150 knots. These strong winds extended out into the central and western Pacific. Storms fed upon the stream and this powerful jet sustained and strengthened the storms as they moved in off the eastern Pacific. Also, the atmosphere was set up in a blocking pattern, which meant the major troughs and ridges around the Northern Hemisphere were stationary. The Pacific Northwest was

situated between a major trough to the west and a major ridge to the east, ideal conditions for weather systems to be at maximum strength when they reached the area. The atmosphere remained in this general pattern for at least 96 hours during which copious amounts of rain fell and large quantities of water in the existing snow pack were released to flow into the rivers.

3.3 Flood Exceedance Frequency

To reflect the series of record floods over the last 25 years, the Corps recently updated their flood frequency curves for the Chehalis River in the vicinity of Centralia (USACE 1997b). The Corps previously published flood frequency curves for the Chehalis River for a 1980 FEMA report (ENSR 1994), and made revisions to the curves in 1989 (USACE 1992). Since 1980, there have been three floods of record, and several other major floods on the Chehalis River. Seattle District incorporated the data since 1980 and recomputed the frequency curves. The recomputed frequency curves data, shown as years of recurrence interval, are shown below. The recomputed frequency curves are significantly higher than those published in 1980 or 1989. Table 3-2 shows the updated peak discharge frequency data for selected locations in the study area. Table 3-3 shows the changes in flood recurrence interval from FEMA 1980 to the Corps updates in 1989 and 1998.

TABLE 3-2 PEAK DISCHARGE FREQUENCY DATA FOR SELECTED LOCATIONS

Location	2-Year Flow (cfs)	10-Year Flow (cfs)	25-Year Flow (cfs)	50-Year Flow (cfs)	100-Year Flow (cfs)
Chehalis near Grand Mound	25,000	43,800	55,000	64,300	74,300
Skookumchuck at Mouth	5,200	9,000	10,600	11,900	13,000
Skookumchuck at Pearl St.	4,800	8,450	10,100	11,300	12,500
Skookumchuck near Bucoda	3,900	6,900	8,300	9,300	10,400
Chehalis at Mellen St.	18,400	32,700	41,400	49,000	57,200
Chehalis above Salzer Creek	17,900	31,900	40,400	47,600	55,700
Newaukum near Chehalis	5,800	9,300	11,200	12,400	13,800

TABLE 3-3 COMPARISONS OF FLOOD RECURRENCE INTERVALS AT GRAND MOUND

Year	Date	Maximum Flow (cfs) at Grand Mound Gage	Flood Recurrence Interval (years)		
			USACE (1998 update)	USACE (1989 update)	FEMA (1980- present)
1996	Feb. 6	73,900	100	400	600
1990	Nov. 25	48,000	15	30	35
1990	Jan. 10	68,700	70	250	400
1972	Jan. 21	49,200	15	30	35

3.4 Risk-Based Analysis for Flood Damage Reduction

Risk involves exposure to a chance of injury or loss. Corps policy has long been to acknowledge risk and uncertainty in predicting floods and their impacts and to plan accordingly. Historically, planning relied on analysis of the expected long-term performance of flood management measures, on application of safety factors and freeboard, on designing for worse-case scenarios, and on other indirect solutions to compensate for uncertainty.

These indirect approaches were necessary because of both the lack of technical knowledge of the complex interaction of uncertainties in estimating hydrologic, hydraulic and economic factors and because of the complexities in performing the mathematics if the interactions were understood. However, with advances in statistical hydrology and the availability of analysis tools, it is now possible to describe the uncertainty in the choice of hydrologic, hydraulic, and economic functions, to describe the uncertainty in the parameters of the functions, and to describe explicitly in results when the functions are used.

Through this risk-based analysis (RBA), and with careful communication of the results, the public can be better informed about what to expect from flood management projects and thus can make better informed decisions. The RBA is integral to the Corps plan formulation process, which systematically reviews the characteristics of the problem to identify and evaluate promising candidate flood management measures or combinations of measures. The policies, methods and procedures for the RBA conducted in this effort are as detailed in ER1105-2-101, "Risk-Based Analysis for Evaluation of Hydrology/Hydraulics, Geotechnical Stability, and Economics in Flood Damage Reduction Studies" and in EM 1110-2-1619, "Risk-Based Analysis for Flood Damage Reduction Studies".

3.4.1 Overview of RBA in Flood Damage Reduction Studies

The determination of expected annual damage (EAD) in a flood damage reduction study must take into account complex hydrologic, hydraulic, geotechnical and economic information. Specifically, EAD is determined by combining the discharge-frequency, stage-discharge, and stage-damage functions, then integrating the resulting damage-frequency function. Uncertainties are present for each of these functions and are carried forth into the EAD computation. In addition, for the rivers being studied that have levees or alternatives that contain levee measures, geotechnical failure parameters become very critical to the analysis.

Once levees have failed and water enters the floodplain, then stages in the floodplain become more critical to the EAD computation than stages in the river channel. Additionally, economic efficiency of a plan or alternative is not the sole criterion for flood-damage reduction plan selection. Performance indices that assist in making informed decisions could include expected annual exceedance, long-term risk, and conditional probability of non-exceedance. These engineering performance indices allow for plan-to-plan comparison of risk of failure based on either the full range of floods or a specific flood. These indices are described below.

3.4.2 Flood Damage Reduction Analysis Model

The Corps primary model for performing flood damage reduction analysis is the Hydrologic Engineering Center's Flood Damage Reduction Analysis model (HEC-FDA, V1.2). The functions mentioned above are input into the model. HEC-FDA incorporates uncertainty for risk-based analysis using a Monte-Carlo simulation procedure. The two primary outputs from HEC-FDA include expected annual damage estimates and project performance statistics that are consistent with Corps guidance concerning the formulation of flood damage reduction plans.

3.4.3 Uncertainties Specific to the Chehalis Study

The Centralia Flood Reduction Project, as with any other flood damage reduction study, has critical uncertainties associated with the hydrologic, hydraulic, and economic data used to compute estimates of EAD and project performance statistics. The following discussion lists the important uncertainties for each of these disciplines and how they were (or were not) considered in this study.

3.4.3.1 Hydrologic Uncertainty

A number of factors contribute to hydrologic uncertainty. Such factors typically include limited or non-existent discharge data and uncertainty associated with existing discharge measurements. In situations where runoff modeling is used to estimate discharge, uncertainty exists in the rainfall-runoff relationship and is also associated with pertinent meteorological data (e.g., precipitation). In situations where stream flow is regulated by human activities, future regulation is subject to variability and uncertainty.

Hydrologic uncertainty is often expressed in terms of uncertainty in the discharge-probability relationship. Hydrologic uncertainty for this study was determined using one of two methods based on whether discharge at a given index location was significantly impacted by upstream regulation. Uncertainty in the discharge-probability relationship for unregulated flows was determined in the HEC-FDA program using Bulletin 17B procedures based on the mean, standard deviation, skew, and the equivalent record length. An equivalent record length of 70 years was used for index locations along the Chehalis River based on the period of record at the Grand Mound gaging station (USGS 12027500).

A similar procedure was used to characterize hydrologic uncertainty under existing conditions at index locations along the Skookumchuck River based on the observation that existing Skookumchuck reservoir operations have a generally limited impact on downstream peak annual discharge. An equivalent record length of 49 years was used for index locations along the Skookumchuck River based on an extension of existing Skookumchuck River discharge data using a two-gage comparison with Newaukum River discharge data. Hydrologic uncertainty at index locations along the Skookumchuck River under with-project conditions is based on the assumption that future flood control regulation at the dam will significantly change the discharge-probability relationship within downstream reaches of the Skookumchuck River. Uncertainty in the discharge-probability relationship in this case was determined using the graphical exceedance probability method in the HEC-FDA program. The graphical method uses a statistical method called ordered events, which determines standard errors of points along the curve from the relationship of each of the estimates to adjacent points and the slope of the function.

3.4.3.2 Hydraulic Uncertainty

Hydraulic uncertainty generally relates to uncertainty in the stage-discharge relationship (rating curve) at the location(s) of interest along a stream network. Hydraulic uncertainty is influenced by a variety of factors including the inherent uncertainty of using a numerical model to represent a natural stream network and uncertainty in hydraulic parameters (e.g., channel cross-section information, Manning's roughness coefficient, representation of off-channel storage). A sensitivity analysis of the UNET modeling to certain hydraulic parameters was performed for this study to identify the parameters that appear to have the most significant influence on the stage-discharge relationship. For instance, the sensitivity analysis suggested that the volume associated with off-channel storage areas could be altered significantly with little apparent impact to the simulated stage-discharge relationships. Conversely and not surprisingly, simulated rating curves were quite sensitive to variations in the Manning's roughness coefficient.

The roughness coefficient was varied during the sensitivity analysis to capture both the uncertainty and variability (i.e., spatial and seasonal variability) of this parameter. Changes to the roughness coefficient were made by varying this parameter as a percentage of the value determined through model calibration. It was ultimately determined that a 40 percent variation of the roughness coefficient (i.e., +/- 20 percent from the calibrated values) provided a reasonable representation of the variability and uncertainty of this parameter. Results of the UNET modeling based on a 20 percent reduction of the roughness coefficient from the calibrated values were used to estimate the approximate lower confidence limit of the simulated rating curves. Conversely, results of the UNET modeling based on a 20 percent increase of the roughness coefficient from the calibrated values were used to estimate the approximate upper confidence limit of the simulated rating curves. Hydraulic uncertainty at the index locations was characterized by assuming that the overall range between the upper and lower bounds of the rating curves based on the 40 percent variation in roughness coefficient represents a range of four times the standard deviation of the uncertainty function. (This assumes that roughly 95 percent of the uncertainty lies between the upper and lower confidence limits determined from the sensitivity analysis assuming a normal [Gaussian] distribution of the uncertainty function.) Hydraulic uncertainty at the index locations was characterized in the HEC-FDA program by assuming that the error (uncertainty) function is characterized by a normal distribution centered about the expected rating curve with a standard deviation as determined from the sensitivity analysis.

3.4.3.3 Economic Uncertainty

The @Risk program (described in Appendix E, Economic Report) was used in the Phase 2 economic analysis to develop stage-damage relationships with uncertainty. Damages were estimated by impact area and by damage category. Economic variables with uncertainty used in the @Risk model include structure value, content value, foundation height, and depth-damage percentage.

3.4.4 Uncertainty of Existing Levee Performance

The damage analyses for new or well-maintained Federal project levees have traditionally been based on the assumption that, until water stage exceeds the top-of-levee elevation, all damage is eliminated. The without-project impacts of four existing levees were evaluated as specified in Risk-Based Analysis for Flood Damage Reduction Studies, EM 1110-2-1619.

The existing 2,200-foot levee at Long Road is described in Section 1.7.2. The project is well-maintained and is assumed to provide flood protection for up to a 40-year event. The existing levee has a 2.5 percent chance of overtopping during any year. The without-project impact analysis assumed that damages did not occur until water stage exceeds the existing top-of-levee elevation.

The existing Skookumchuck River, Chehalis-Centralia, and Salzer Creek levees are described in Sections 1.7.3, 1.7.4, and 1.7.5, respectively. The levees are not Federal project levees and are of unknown construction. The levees are discontinuous and can be outflanked during flood events, causing performance uncertainties. The without-project damage impact assessment was based on the assumption that all three levees fail to provide flood protection.

3.4.5 Expected Annual Damages

The benefits and costs of a flood reduction study are expressed in average annual equivalents by performing appropriate discounting and annualizing. The expected value of annual damage is equivalent to integrating the annual damage-cumulative probability function. This function is developed by systematically combining the discharge-frequency, the stage-discharge and the stage-damage functions, including uncertainties. These functions are input into the HEC-FDA model. HEC-FDA incorporates uncertainty for risk-based analysis using a Monte-Carlo

simulation procedure. Expected annual damages are computed for both without- and with-project conditions. Benefits are the difference between without- and with-project damages.

3.4.6 Expected Annual Exceedance Probability

The “expected annual exceedance probability” (AEP) is the probability of a project or alternative being exceeded in any one year. This performance parameter is derived by tracking the number of “failures” in the Monte Carlo sampling within HEC-FDA, divided by the number of samples. For example, if a levee has a 0.04 probability of being overtopped, it is said that in any given year it has a 1 in 25 chance of failing.

3.4.7 Long Term Risk

Long-term risk characterizes the probability of a plan or alternative being exceeded in a specified period of time. This duration could be the proposed design life of the project, say 50 years, or the duration of a home mortgage, 30 years. For example, within the 30-year life of a conventional home mortgage, the probability of overtopping is 0.27 (or 27 percent). Such information is useful to help the public understand the risk of a given alternative and how it may apply directly to them.

3.4.8 Conditional Probability of Non-Exceedance

Conditional probability of non-exceedance is an index of the likelihood that an alternative will not be exceeded, given the occurrence of a specific hydrometeorological event. This index is similar to the AEP except the Monte Carlo sampling is performed at specific frequencies rather than sampling the entire range of frequencies. An example of the use of this index is, for the Levee Alternative, the probability of containing the 0.01 or the 100-year event is 87 percent. This index is similar to the classic definition of “level of protection” (LOP). The LOP can be expressed as the average return period in years of the largest flood that can be contained by an alternative with a very high conditional non-exceedance probability, say 90 percent (see FEMA Certification below). Under this definition, the example levee alternative above does not meet the definition of a 100-year LOP.

3.4.9 FEMA Certification

The "Guidance on Levee Certification for the National Flood Insurance Program" dated 25 March 1997 was used to evaluate levee alternatives for FEMA certification. The guidance states that a levee is certifiable if the levee elevation meets FEMA criteria of 100-year flood elevation plus 3 feet of freeboard and achieves a conditional probability of non-exceedance of 90 percent. When the FEMA criteria results in a conditional probability of non-exceedance greater than 95 percent, the levee may be certified at the elevation corresponding to 95 percent.

3.5 Without-Project Hydrology and Hydraulics

The study area was divided into eleven damage reaches for evaluating expected flood damages. Hydrologic and hydraulic modeling produced stage-discharge functions with uncertainty for the each damage reach. These damage reaches are listed in Table 3-4.

The historic changes in land use and population in the basin, expected future change, and relative influence on basin hydrology were researched and evaluated. It was determined that much of the upper basins will remain in forestry for the foreseeable future. The largest cities in the basin are Centralia and Chehalis whose populations are expected to grow in the next 15 years from 13,379 and 7,299 to 15,533 and 8,600 respectively. For all of Lewis County, the population has increased from 46,000 to 70,000 from 1972-1998. Expected land use and population changes were determined to not dramatically affect the runoff characteristics for the 895 square mile basin above Grand Mound.

TABLE 3-4 FLOOD ANALYSIS DAMAGE REACHES

Chehalis River

Reach Number	Extent of reach in terms of river miles (RM)	Index Cross-Section for Reach (RM) ¹	Description
Chehalis 1	RM 75.2 to RM 73	RM 74.02	Confluence of Chehalis/Newaukum Rivers to south end of airport
Chehalis 2	RM 73 to RM 71.5	RM 72.80	South end of airport to north end of airport
Chehalis 3	RM 71.5 to RM 69.2	RM 70.30	North end of airport to confluence of Chehalis River/Salzer Creek
Chehalis 4	RM 69.2 to RM 67.45	RM 68.67	Confluence of Chehalis River/Salzer Creek to Mellen St. Bridge
Chehalis 5	RM 67.45 to RM 66.9	RM 67.29	Mellen St. Bridge to confluence of Chehalis/Skookumchuck Rivers
Chehalis 6	RM 66.9 to RM 66.0	RM 66.30	Confluence of Chehalis/Skookumchuck Rivers to downstream end of proposed floodway excavation
Chehalis 7	RM 66.0 to RM 61.8	RM 65.20	Downstream end of proposed floodway excavation to Chehalis/Lincoln Creek confluence

1 - Index cross-sections for Chehalis River reaches are referenced to Chehalis River river mile (RM)

Skookumchuck River

Reach Number	Description of reach	Index Cross-Section for Reach (RM) ²	Description
Skookumchuck 1	Town of Bucoda	RM 10.56	Town of Bucoda
Skookumchuck 2	RM 5.08 to RM 3.85	RM 5.08	Skookumchuck river mile 5.08 to confluence of Skookumchuck River/Hanaford Creek
Skookumchuck 3	RM 3.84 to RM 1.57	RM 2.415	Confluence of Skookumchuck River/Hanaford Creek to confluence of Skookumchuck River/Coffee Creek
Skookumchuck 4	RM 1.57 to RM 0.22	RM 0.98	Confluence of Skookumchuck River/Coffee Creek to limit of backwater effect from Chehalis River on Skookumchuck River.

2 - Index cross-sections for Skookumchuck River reaches are referenced to Skookumchuck River river mile (RM)

The resultant stage discharge functions for each damage reach are provided in Table 3-5. The uncertainty (the standard deviation of error) was developed by varying Manning's n-value. An unsteady state hydraulic model that accounts for the variability of discharge over time and off-channel storage areas was used to determine the stage discharge functions. A trend in decreasing river mileage with decreasing stage and increasing discharge is typical of steady state models, not unsteady state models; therefore, variable stage and discharge by river mile is found in Table 3-5.

TABLE 3-5 STAGE DISCHARGE FUNCTIONS WITH UNCERTAINTY FOR CHEHALIS AND SKOOKUMCHUCK RIVERS

Reach Chehalis 1				
Index Cross-Section (RM) 74.02				
Return Period (years)	Probability of Occurrence	Discharge (cfs)	Stage (ft)*	Standard Deviation of Error (ft)
N/A	N/A	451	150.00	0.00
2	0.500	21,637	173.68	0.49
5	0.200	29,146	175.54	0.52
10	0.100	33,592	176.37	0.51
25	0.040	43,313	177.79	0.47
50	0.020	50,891	178.58	0.42
100	0.010	56,851	179.16	0.40
200	0.005	66,681	179.92	0.40
500	0.002	79,143	180.96	0.56
N/A	N/A	100,000	183.00	0.56

Reach Chehalis 2				
Index Cross-Section (RM) 72.80				
Return Period (years)	Probability of Occurrence	Discharge (cfs)	Stage (ft)	Standard Deviation of Error (ft)
N/A	N/A	451	149.95	0.00
2	0.500	20,231	172.34	0.57
5	0.200	28,237	174.47	0.54
10	0.100	32,582	175.32	0.51

25	0.040	42,186	176.77	0.47
50	0.020	48,736	177.53	0.50
100	0.010	52,747	178.12	0.54
200	0.005	60,574	178.89	0.73
500	0.002	67,166	180.06	1.02
N/A	N/A	90,000	182.50	1.02

* All of the elevations given in these tables are referenced to the NGVD 1929 vertical datum.

Reach Chehalis 3				
Index Cross-Section (RM) 70.30				
Return Period (years)	Probability of Occurrence	Discharge (cfs)	Stage (ft)	Standard Deviation of Error (ft)
N/A	N/A	451	149.90	0.00
2	0.500	18,648	168.22	0.59
5	0.200	27,623	170.45	0.58
10	0.100	32,011	171.62	0.67
25	0.040	41,029	173.58	0.93
50	0.020	46,116	174.81	1.07
100	0.010	49,638	175.86	1.14
200	0.005	54,031	177.05	1.18
500	0.002	60,445	178.58	1.10
N/A	N/A	80,000	182.00	1.10

Reach Chehalis 4				
Index Cross-Section (RM) 68.67				
Return Period (years)	Probability of Occurrence	Discharge (cfs)	Stage (ft)	Standard Deviation of Error (ft)
N/A	N/A	451	149.90	0.00
2	0.500	18,743	166.90	0.75
5	0.200	27,075	169.82	0.75
10	0.100	31,511	171.14	0.76
25	0.040	40,364	173.22	0.78
50	0.020	47,113	174.50	0.81
100	0.010	52,678	175.59	0.84
200	0.005	59,865	176.81	0.87
500	0.002	69,541	178.36	0.90
N/A	N/A	90,000	181.50	0.90

Reach Chehalis 5				
Index Cross-Section (RM) 67.29				
Return Period (years)	Probability of Occurrence	Discharge (cfs)	Stage (ft)	Standard Deviation of Error (ft)
N/A	N/A	471	149.90	0.00
2	0.500	18,718	165.45	0.78
5	0.200	27,071	168.36	0.72
10	0.100	31,396	169.59	0.70
25	0.040	40,512	171.42	0.68
50	0.020	47,289	172.47	0.68
100	0.010	53,343	173.40	0.69
200	0.005	61,636	174.40	0.74
500	0.002	72,201	175.72	0.86
N/A	N/A	95,000	178.50	0.86

Reach Chehalis 6				
Index Cross-Section (RM) 66.30				
Return Period (years)	Probability of Occurrence	Discharge (cfs)	Stage (ft)	Standard Deviation of Error (ft)
N/A	N/A	599	149.80	0.00
2	0.500	24,251	161.89	0.60
5	0.200	34,728	164.10	0.68
10	0.100	41,029	165.28	0.71
25	0.040	52,740	167.03	0.72
50	0.020	61,363	167.96	0.71
100	0.010	70,006	168.81	0.70
200	0.005	80,817	169.81	0.70
500	0.002	96,788	171.06	0.77
N/A	N/A	120,000	173.00	0.77

Reach Chehalls 7				
Index Cross-Section (RM) 65.20				
Return Period (years)	Probability of Occurrence	Discharge (cfs)	Stage (ft)	Standard Deviation of Error (ft)
N/A	N/A	323	143.75	0.00
2	0.500	24,260	157.97	0.66
5	0.200	34,717	160.67	0.63
10	0.100	41,006	162.01	0.61
25	0.040	52,754	163.70	0.59
50	0.020	61,399	164.67	0.57
100	0.010	70,026	165.51	0.56
200	0.005	80,800	166.50	0.55
500	0.002	96,802	167.77	0.55
N/A	N/A	120,000	169.50	0.55

Reach Skookumchuck 1				
Index Cross-Section (RM) 10.56				
Return Period (years)	Probability of Occurrence	Discharge (cfs)	Stage (ft)	Standard Deviation of Error (ft)
N/A	N/A	1,263	234.59	0.39
3.1	0.323	4,129	238.59	0.39
6.1	0.164	5,750	239.82	0.40
12.7	0.079	7,147	240.68	0.40
34	0.029	9,238	241.74	0.41
50	0.020	10,258	242.17	0.42
88	0.011	11,428	242.60	0.43
143	0.007	12,500	242.97	0.44
320	0.0031	14,331	243.60	0.46
482	0.0021	15,750	244.04	0.49
N/A	N/A	25,000	247.00	0.49

Reach Skookumchuck 2				
Index Cross-Section (RM) 5.08				
Return Period (years)	Probability of Occurrence	Discharge (cfs)	Stage (ft)	Standard Deviation of Error (ft)
N/A	N/A	1,319	195.60	0.39
3.1	0.323	4,191	200.89	0.39
6.1	0.164	5,797	202.01	0.36
12.7	0.079	7,355	202.89	0.33
34	0.029	9,393	203.62	0.27
50	0.020	10,561	203.92	0.24
88	0.011	11,804	204.19	0.21
143	0.007	12,940	204.43	0.20
320	0.0031	14,867	204.81	0.20
482	0.0021	16,137	205.04	0.23
N/A	N/A	25,000	206.70	0.23

Reach Skookumchuck 3				
Index Cross-Section (RM) 2.415				
Return Period (years)	Probability of Occurrence	Discharge (cfs)	Stage (ft)	Standard Deviation of Error (ft)
N/A	N/A	2,039	180.55	0.40
3.1	0.323	5,369	184.00	0.40
6.1	0.164	7,423	185.19	0.37
12.7	0.079	9,322	185.89	0.35
34	0.029	12,147	186.65	0.32
50	0.020	13,792	187.06	0.30
88	0.011	16,183	187.56	0.28
143	0.007	17,885	187.79	0.26
320	0.0031	21,158	188.07	0.24
N/A	N/A	40,000	189.50	0.24

Reach Skookumchuck 4				
Index Cross-Section (RM) 0.98				
Return Period (years)	Probability of Occurrence	Discharge (cfs)	Stage (ft)	Standard Deviation of Error (ft)
3.1	0.323	5,508	171.31	0.68
6.1	0.164	7,623	173.77	0.48
12.7	0.079	9,553	174.36	0.37
34	0.029	12,381	175.21	0.32
50	0.020	14,091	175.84	0.33
88	0.011	16,554	176.39	0.39
143	0.007	18,124	176.90	0.44
320	0.0031	21,195	177.69	0.56
N/A	N/A	40,000	181.00	0.56

In addition to the 11 damage reaches incorporated into the UNET hydraulic model, 25 hydraulic storage areas were also modeled. Each storage area was linked in the flood damage assessment model to a single index cross section on either the Chehalis or Skookumchuck Rivers. Table 3-6 lists the modeled storage areas and their linkages.

TABLE 3-6 UNET STORAGE AREAS AND LINKS TO INDEX CROSS-SECTIONS FOR THE HEC-FDA ANALYSIS

Storage Area Number ¹	River cross-section that storage area is hydraulically linked to ²	Associated Economics Reach ³	Associated Index Cross-Section ³
102	Newaukum RM 0.08	Chehalis Econ. Reach 1	Chehalis RM 74.02
101	Newaukum RM 0.08	Chehalis Econ. Reach 1	Chehalis RM 74.02
100	Chehalis RM 76.70	Chehalis Econ. Reach 1	Chehalis RM 74.02
301	Dillenbaugh RM 0.623	Chehalis Econ. Reach 1	Chehalis RM 74.02
302	Dillenbaugh RM 0.623	Chehalis Econ. Reach 1	Chehalis RM 74.02
303	Chehalis RM 74.57	Chehalis Econ. Reach 1	Chehalis RM 74.02
2	Chehalis RM 72.80	Chehalis Econ. Reach 2	Chehalis RM 72.80
3	Salzer RM 1.56	Chehalis Econ. Reach 4	Chehalis RM 68.67
4	Salzer RM 1.28	Chehalis Econ. Reach 4	Chehalis RM 68.67
5	Chehalis RM 68.05	Chehalis Econ. Reach 4	Chehalis RM 68.67
501	Chehalis RM 68.67	Chehalis Econ. Reach 4	Chehalis RM 68.67
601	Skookumchuck RM 2.99	Skookumchuck Econ. Reach 3	Skookumchuck RM 2.415
602	Skookumchuck RM 2.415	Skookumchuck Econ. Reach 3	Skookumchuck RM 2.415
603	China Creek - N/A ⁴	Not included in stage-damage function	N/A
604	China Creek - N/A ⁴	Not included in stage-damage function	N/A
605	China Creek - N/A ⁴	Not included in stage-damage function	N/A
606	Skookumchuck RM 2.00	Skookumchuck Econ. Reach 3	Skookumchuck RM 2.415
608	China Creek - N/A ⁴	Not included in stage-damage function	N/A
609	Skookumchuck RM 0.49	Skookumchuck Econ. Reach 4	Skookumchuck RM 0.98
610	Chehalis RM 67.36	Chehalis Econ. Reach 5	Chehalis RM 67.29
701	Skookumchuck RM 5.08	Skookumchuck Econ. Reach 2	Skookumchuck RM 5.08
702	Skookumchuck RM 5.08	Skookumchuck Econ. Reach 2	Skookumchuck RM 5.08
703	Skookumchuck RM 5.08	Skookumchuck Econ. Reach 2	Skookumchuck RM 5.08
704	Skookumchuck RM 5.08	Skookumchuck Econ. Reach 2	Skookumchuck RM 5.08
705	Skookumchuck RM 2.00	Skookumchuck Econ. Reach 3	Skookumchuck RM 2.415

1 - Storage Area number as related to the Chehalis UNET model and as delineated on the 1"=400' scale maps.

2 - Stream and river mile most closely associated with overflow to storage area.

3 - Economics reach and associated index cross-section that should be used to link the storage area to hydrologic (discharge-probability) and hydraulic (stage-discharge) information.

4 - Storage area is mostly flooded from China Creek (China Creek is not modeled hydraulically in the UNET model).

Table 3-7 provides the non-damaging elevation (bank-height) used for calculating damages in each study reach. These values are used in the analysis to identify the point at which water leaves the channel and damages may start to accrue.

TABLE 3-7 NON-DAMAGING ELEVATIONS BY REACH
Chehalis River Index Cross-Sections

Reach	Index Cross-Section (RM)	Estimated zero-damage elevation at Index Cross-Section (feet - msl)
Chehalis 1	74.02	172.5
Chehalis 2	72.80	172.3
Chehalis 3	70.30	169.2
Chehalis 4	68.67	166.2
Chehalis 5	67.29	168.0
Chehalis 6	66.30	164.0
Chehalis 7	65.20	160.0

Bank elevations are in feet (msl) as defined in the UNET model

Estimated zero-damage stage at index cross-section (to be used for stage-damage evaluation)

All of the elevations given in these tables are referenced to the NGVD 1929 vertical datum

Skookumchuck River Index Cross-Sections

Reach	Index Cross-Section (RM)	Estimated zero-damage elevation at Index Cross-Section (feet - msl)
Skookumchuck 1	10.56	240.6
Skookumchuck 2	5.08	201.5
Skookumchuck 3	2.415	184.5
Skookumchuck 4	0.98	173.0

Bank elevations are in feet (msl) as defined in the UNET model

Estimated zero-damage stage at index cross-section (to be used for stage-damage evaluation)

All of the elevations given in these tables are referenced to the NGVD 1929 vertical datum

Table 3-8 provides the frequency distribution for the annual peak flows for both the Chehalis River and the Skookumchuck River under the without-project condition. The uncertainty associated with these values is computed based on the equivalent length of record, which is 70 years on the Chehalis River and 49 years on the Skookumchuck River.

TABLE 3-8 WITHOUT-PROJECT DISCHARGE-PROBABILITY FUNCTION STATISTICS FOR HEC-FDA

Chehalis River Reaches

Reach	Chehalis 1	Chehalis 2	Chehalis 3	Chehalis 4	Chehalis 5	Chehalis 6	Chehalis 7
Index Cross-Section (RM)	74.02	72.80	70.30	68.67	67.29	66.30	65.20
Equivalent Record Length (years)	70	70	70	70	70	70	70
Exceedance Probability	Discharge (cfs)	Discharge (cfs)	Discharge (cfs)	Discharge (cfs)	Discharge (cfs)	Discharge (cfs)	Discharge (cfs)
0.999	14,516	10,455	5,079	8,549	8,448	11,683	11,688
0.500	21,637	20,231	18,648	18,743	18,718	24,251	24,260
0.200	28,285	27,181	26,573	25,951	26,030	33,620	33,632
0.100	33,715	32,444	31,978	31,429	31,606	40,892	40,906
0.040	41,835	39,889	38,958	39,202	39,539	51,392	51,408
0.020	48,878	46,043	44,257	45,645	46,132	60,233	60,251
0.010	56,851	52,747	49,638	52,678	53,343	70,006	70,026
0.005	65,898	60,078	55,132	60,384	61,259	80,847	80,869
0.002	79,781	70,871	62,613	71,750	72,958	97,060	97,085
0.001	91,971	79,974	68,458	81,352	82,862	110,942	110,970

Skookumchuck River Reaches

Reach	Skookumchuck 1	Skookumchuck 2	Skookumchuck 3	Skookumchuck 4
Index Cross-Section (RM)	10.56	5.08	2.42	0.98
Equivalent Record Length (years)	49	49	49	49
Exceedance Probability	Discharge (cfs)	Discharge (cfs)	Discharge (cfs)	Discharge (cfs)
0.999	573	549	976	1,029
0.500	3,200	3,200	4,050	4,200
0.200	5,109	5,170	6,508	6,713
0.100	6,525	6,645	8,471	8,712
0.040	8,470	8,683	11,358	11,642
0.020	10,025	10,321	13,819	14,133
0.010	11,666	12,057	16,562	16,903
0.005	13,402	13,900	19,620	19,987
0.002	15,856	16,515	24,212	24,606
0.001	17,841	18,638	28,152	28,561

3.6 Expected Without-Project Flood Damages

3.6.1 Residential Structure and Content Damages

In the study area there were approximately 4,000 residential units counted from base maps prepared by the Corps of Engineers, with a depreciated structural value of approximately \$383,517,000³, yielding an average residential unit cost of \$97,700. Residential flood inundation damages to structures referenced to the Chehalis River by event are shown in Table 3-9.

TABLE 3-9 CHEHALIS RIVER RESIDENTIAL INUNDATION DAMAGE BY EVENT (\$)

Flood Event	Structure	Content
25-year	8,487,000	4,949,000
50-year	14,072,000	8,117,000
100-year	19,552,000	11,187,000
500-year	50,953,000	28,297,000

Residential flood inundation damages to structures referenced to the Skookumchuck River by event are shown in Table 3-10.

TABLE 3-10 SKOOKUMCHUCK RIVER RESIDENTIAL INUNDATION DAMAGE BY EVENT (\$)

Flood Event	Structure	Content
34-year	4,709,000	2,826,000
50-year	6,362,000	3,785,000
88-year	9,086,000	5,349,000
143-year	12,753,000	7,479,000
320-year	18,783,000	10,853,000

3.6.2 Residential Cleanup Cost

Flooding not only causes damage to structures and contents but floodwaters present significant cleanup costs in their aftermath. Floodwaters leave debris, sediment and the dangers of diseases and mycotoxins throughout flooded structures. The cleaning of these structures is a necessary post-flood activity. Cleanup costs for the extraction of floodwaters, dry-out, and decontamination

³ All dollar values in this section are expressed at 2002 price level.

range from \$1 to \$4.75 per square foot, with a mean cost of \$3.65 and standard deviation of \$0.94 based on prior studies. Residential cleanup costs by location are shown in Table 3-11 and Table 3-12.

TABLE 3-11 RESIDENTIAL CLEANUP COSTS CHEHALIS RIVER BY EVENT (\$)

Flood Event	Cleanup Costs
25-year	2,976,000
50-year	4,377,000
100-year	5,510,000
500-year	9,481,000

TABLE 3-12 RESIDENTIAL CLEANUP COSTS SKOOKUMCHUCK RIVER BY EVENT (\$)

Flood Event	Cleanup Costs
34-year	2,139,000
50-year	2,672,000
88-year	3,454,000
143-year	4,657,000
320-year	5,853,000

3.6.3 Emergency Costs

ER 1105-2-100 states, "Flood damages are classified as physical damages or losses, income losses, and emergency costs." The ER then defines emergency costs as "those expenses resulting from a flood what would not otherwise be incurred..." The ER further requires that emergency costs should not be estimated by applying an arbitrary percentage to the physical damage estimates. As with all flood damage estimates and especially in the case of emergency costs, the potentials to double count damages are a distinct possibility and must be guarded against.

FEMA provides grants to assist individuals and families to find suitable housing when they are displaced in cases of Federally declared disasters. This assistance being directly attributable to the disaster and being an expenditure that would not be undertaken except for the disaster falls clearly under the emergency costs guidance of ER 1105-2-100. Therefore, funds expended by FEMA for Temporary Rental Assistance in the event of flooding are NED flood damages.

Complying with ER 1105-2-100, an Internet database search of FEMA disaster reports for flood and storm damage was performed. In these studies, the average per claim expenditure by FEMA

for TRA ranged from \$583 to \$2,034 with an overall average expenditure of \$1,537 per claim. The standard deviation of the average per claim expenditures is \$411. For risk-based modeling purposes it is assumed that TRA per claim expenditure is normally distributed with a mean of \$1,537 and a standard deviation of \$411.

FEMA will reimburse local and state governments and certain nonprofits up to 75 percent of eligible disaster response costs through the public assistance program. It includes all or parts of the following:

- debris removal;
- emergency protective measures;
- road systems and bridges;
- water control facilities;
- public buildings and contents;
- public utilities; and
- parks, recreational and other activities of a governmental nature.

These costs, as well as the 25 percent contribution by local and state governments and the nonprofits, are eligible NED emergency costs under ER 1105-2-100. Again, care must be taken to make sure double counting does not occur between public assistance expenditures and structural or other damage categories.

Total Public Assistance (PA) expenditures were found to be 3.01 times the expenditures on TRA. On an individual disaster basis, PA expenditures range from zero to an unknown factor based on the FEMA reports, with the highest reported factor of 9.45. Applying the four standard deviation rule, common to other HEC-FDA variance protocols, the risk-based function of PA is a mean damage of 3.01 times the individual TRA expenditure with a normal deviate of a multiple of 2.36 bounded by zero damage.

Emergency costs (temporary relocation and public assistance expenditures) by flood event and river are shown in Table 3-13 and Table 3-14.

TABLE 3-13 EMERGENCY COSTS – CHEHALIS RIVER (\$)

Flood Event	Temporary Relocation Assistance	Public Assistance
25-year	419,000	1,456,000
50-year	675,000	2,345,000
100-year	924,000	3,212,000
500-year	2,109,000	7,327,000

TABLE 3-14 EMERGENCY COSTS – SKOOKUMCHUCK RIVER (\$)

Flood Event	Temporary Relocation Assistance	Public Assistance
34-year	249,000	864,000
50-year	335,000	1,161,000
88-year	472,000	1,641,000
143-year	654,000	2,274,000
320-year	943,000	3,276,000

3.6.4 Commercial and Industrial Inundation Damage

Within the study area there are approximately 300 commercial and industrial properties with a total floor space of approximately 2,507,000 square feet. The total nominal depreciated structure value of these properties is \$146,730,000 with a total content value of \$189,575,000. The average square footage cost of these structures is \$46. Overall content-to-structure value ratio for these structures is 129.2 percent. Flood inundation damages to these structures by river and event are shown in Table 3-15 and Table 3-16.

TABLE 3-15 CHEHALIS COMMERCIAL AND INDUSTRIAL INUNDATION DAMAGE BY EVENT (\$)

Flood Event	Structure Damage	Content Damage
25-year	1,685,000	1,709,000
50-year	11,495,000	14,620,000
100-year	14,735,000	20,116,000
500-year	25,153,000	39,367,000

TABLE 3-16 SKOOKUMCHUCK COMMERCIAL/INDUSTRIAL INUNDATION DAMAGE BY EVENT (\$)

Flood Event	Structure Damage	Content Damage
34-year	2,481,000	2,122,000
50-year	2,927,000	2,602,000
88-year	4,317,000	4,020,000
143-year	5,007,000	5,345,000
320-year	6,114,000	7,204,000

3.6.5 Commercial and Industrial Cleanup Costs

Nonresidential cleanup costs are limited to public, commercial, and retail structures normally expected to engage with the public, e.g., restaurants, retail stores, office structures and other such businesses. Cleanup costs are not anticipated to occur with light industrial or other non-public commercial enterprises. Cleanup costs for commercial and industrial structures are presented in Table 3-17 and Table 3-18.

TABLE 3-17 CHEHALIS NONRESIDENTIAL CLEANUP COSTS BY EVENT (\$)

Flood Event	Cleanup Costs
25-year	310,000
50-year	2,905,000
100-year	3,768,000
500-year	5,609,000

TABLE 3-18 SKOOKUMCHUCK NONRESIDENTIAL CLEANUP COSTS BY EVENT (\$)

Flood Event	Cleanup Costs
34-year	461,000
50-year	481,000
88-year	643,000
143-year	1,004,000
320-year	1,022,000

3.6.6 Public Inundation Damage

The floodplain survey identified 138 public structures whose locations are shown in Table 5 of the Economics appendix. These structures cover an area of approximately 1,109,500 square feet and have a depreciated structural value of \$69,040,000 or approximately \$68 per square foot. Each public structure's content value was determined individually based on its function in coordination with past Corps evaluations of similar functions. The total for all public structures equals \$64,798,000, which yields an average content-to-structure ratio of 94 percent. Flood inundation damages to these structures by river and event are shown in Tables 3-19 and 3-20.

TABLE 3-19 CHEHALIS PUBLIC STRUCTURE INUNDATION DAMAGE BY EVENT (\$)

Flood Event	Structure Damage	Content Damage
25-year	537,000	359,000
50-year	3,965,000	3,267,000
100-year	4,978,000	4,050,000
500-year	10,239,000	9,836,000

TABLE 3-20 SKOOKUMCHUCK PUBLIC STRUCTURE INUNDATION DAMAGE BY EVENT (\$)

Flood Event	Structure Damage	Content Damage
34-year	1,188,000	1,364,000
50-year	1,621,000	1,684,000
88-year	1,767,000	1,975,000
143-year	2,989,000	2,837,000
320-year	3,453,000	3,788,000

Cleanup costs for public structures are presented in Table 3-21 and Table 3-22.

TABLE 3-21 CHEHALIS PUBLIC STRUCTURE CLEANUP COSTS BY EVENT (\$)

Flood Event	Cleanup Costs
25-year	16,000
50-year	379,000
100-year	422,000
500-year	1,398,000

TABLE 3-22 SKOOKUMCHUCK PUBLIC STRUCTURE CLEANUP BY EVENT (\$)

Flood Event	Cleanup Costs
34-year	132,000
50-year	242,000
88-year	258,000
143-year	397,000
320-year	543,000

3.6.7 Inundation Damage Summary

Table 3-23, following, presents a summary of the previously discussed damages.

TABLE 3-23 STRUCTURAL DAMAGE SUMMARY (\$)

Chehalis River											
Flood Event	Residential			Commercial			Public			TOTAL	
	Structure	Content	Cleanup	Structure	Content	Cleanup	Structure	Content	Cleanup	TRA	PA
25-year	8,487,000	4,949,000	2,976,000	1,685,000	1,709,000	310,000	537,000	359,000	16,000	419,000	1,456,000
50-year	14,072,000	8,117,000	4,377,000	11,495,000	14,620,000	2,905,000	3,965,000	3,267,000	379,000	675,000	2,345,000
100-year	19,552,000	11,187,000	5,510,000	14,735,000	20,116,000	3,768,000	4,978,000	4,050,000	422,000	924,000	3,212,000
500-year	50,953,000	28,297,000	9,481,000	25,153,000	39,367,000	5,609,000	10,239,000	9,836,000	1,398,000	2,109,000	7,327,000
											189,769,000

Skookumchuck River											
Flood Event	Residential			Commercial			Public			Total	
	Structure	Content	Cleanup	Structure	Content	Cleanup	Structure	Content	Cleanup	TRA	PA
34-year	4,709,000	2,826,000	2,139,000	2,481,000	2,122,000	461,000	1,188,000	1,364,000	132,000	249,000	864,000
50-year	6,362,000	3,785,000	2,672,000	2,927,000	2,602,000	481,000	1,621,000	1,684,000	242,000	335,000	1,161,000
88-year	9,086,000	5,349,000	3,454,000	4,317,000	4,020,000	643,000	1,767,000	1,975,000	258,000	472,000	1,641,000
143-year	12,753,000	7,479,000	4,657,000	5,007,000	5,345,000	1,004,000	2,989,000	2,837,000	397,000	654,000	2,274,000
320-year	18,783,000	10,853,000	5,853,000	6,114,000	7,204,000	1,022,000	3,453,000	3,788,000	543,000	943,000	3,276,000
											61,832,000

3.6.8 Residential, Nonresidential, and Public HEC-FDA Model Results

Stage-damage functions were developed for each damage category and were combined with the hydrology and hydraulic information into the HEC-FDA model for computation of the expected annual damages with uncertainty. The results of the HEC-FDA model are shown in Table 3-25. Total expected annual damage on the Chehalis River is \$6,590,730 and \$2,254,190 for the Skookumchuck River. The relative damage by category is shown below in Table 3-24 for each river.

TABLE 3-24 EXPECTED ANNUAL DAMAGE BY CATEGORY

Category	Chehalis River		Skookumchuck River	
	\$ Damage	Percentage	\$ Damage	Percentage
Residential				
Structure	1,789,290	27.15	663,700	29.44
Content	1,036,310	15.72	394,210	17.49
Cleanup	588,290	8.93	278,600	12.36
Nonresidential				
Structure	1,002,610	15.21	352,340	15.63
Content	1,119,860	16.99	311,300	13.81
Cleanup	239,120	3.63	62,240	2.76
Public				
Structure	229,080	3.48	22,800	1.01
Content	189,360	2.87	15,290	0.68
Cleanup	24,490	0.37	4,270	0.19
TRA	83,250	1.26	33,380	1.48
PA	289,070	4.39	116,060	5.15
TOTAL*	6,590,730	100.00	2,254,190	100.00

* Total may not add due to rounding

[illegible]

3.6.9 Agricultural Flood Damages

The Planning Guidance Notebook of the Corps (ER 1105-2-100) has specific rules on the treatment of agricultural crops. Agricultural crops are divided into two categories. The first is basic crops and the second is other crops. The guidance indicates that the loss in income is only applicable to basic crops and that damages to other crops are limited to the variable costs per the Corps' IWR Report 87-R-10. These conventions are the basis of the current agricultural analysis.

With no change in cropping patterns anticipated, benefits are restricted to damage reduction benefits. Damage reduction benefits are the increases in net income due to the plan, as measured by farm budget analysis. These income increases may result from increased crop yields and decreased production costs.

The study area contains approximately 2,200 acres of agricultural lands that are subject to flooding. Three crops are listed as the principal for the study area, as shown in Table 3-26.

TABLE 3-26 LEWIS COUNTY CROP HARVESTS – 1996

Crop	Acres	Percentage
Hay	1,320	60%
Green Peas – Process	550	15%
Sweet Corn – Process	330	25%
Total	2,200	100%

Source: Cooperative Extension Office – Lewis County

Agricultural acreage for the study is treated as having a composite crop based on the above three crops. The use of a composite crop was required because no formal survey of agricultural production by location was conducted. Agricultural production acreage and locations were ascertained through the use of an overlay of floodplain boundaries on aerial photography of agricultural production acreage. Farm budgets were obtained from the Cooperative Extension, Washington State University, and damages computed based on the monthly probability of flood occurrence. Through farm budget analysis the per-acre damage has been determined at the following values for the crops of the study area (Table 3-27).

TABLE 3-27 PER ACRE CROP DAMAGE

Crop Type	Per Acre Damage (\$)	Weight (%)	Weighted Loss (\$)
Hay	220.48	60	132
Corn	52.77	25	13
Peas	61.60	15	9
Total per acre loss			155

The requirement to restore agricultural land after flood inundation necessitates the reworking of fields at twice the level of normal land preparation and the application of additional cycles of fertilizer, weed control, and pest control, based upon consultation with the Lewis County Farm Advisor. The estimated net cost for agricultural land restoration on a per acre basis is presented in Table 3-28.

TABLE 3-28 PER ACRE FIELD CROPLAND RESTORATION COSTS

Operation	\$ Cost/per Acre
Disc (4 times)	60.00
Subsoil	9.00
Chisel Field (2 times)	15.00
Landplane (2 times)	24.00
Fertilize	64.00
Weed Control	45.00
Pest Control	26.00
Total	\$243.00

In addition to restoration costs, it is assumed that post-flood cleanup of debris and other matter will cost \$20 per acre for all agricultural land.

3.6.10 Summary of Agricultural Flood Damages

Agricultural damages by flood event are shown in Table 3-29.

TABLE 3-29 AGRICULTURAL DAMAGES BY FLOOD EVENT (\$)

Flood Event	Crop Damage	Land Restoration	Cleanup	Total
6-year	52,000	82,000	6,000	140,000
10-year	227,000	356,000	29,000	612,000
100-year	341,000	534,000	44,000	919,000
500-year	341,000	534,000	44,000	919,000

Expected annual agricultural damages were calculated using HEC-EAD. The results of the HEC-EAD model for agricultural damages are shown in Table 3-30.

TABLE 3-30 EXPECTED ANNUAL AGRICULTURAL DAMAGE (\$)

Category	Expected Annual Damage
Crop Damage	42,930
Land Restoration Costs	67,420
Cleanup Costs	5,500
Total	115,850

3.6.11 Transportation Related Damages

Chehalis River flooding presents a serious threat to interstate commerce. Past floods have necessitated the closure of I-5 to vehicle traffic, as well as the closures of two major railroad lines (Burlington Northern Santa Fe and Union Pacific Railroads). The costs associated with travel delays, diversion costs, and cleanup costs are valid project concerns on a National Economic Development (NED) basis. The following paragraphs explore these transportation related damages.

Mapping of the floodplains indicates that I-5 will be subject to closure from floods, and will be closed between Centralia and Chehalis. This mapping also indicates that a diversion around the floodplain will be required. This diversion will be quite lengthy, approximately 101 miles. The diversion, going southbound, involves leaving I-5 at its junction with SR-507 traveling northeast to Yelm, transitioning to SR-702 east and proceeding to SR-7. Proceeding southward on SR-7 for approximately 35 miles to Morton where a connection to US-12 westbound is taken to return to I-5. Northbound traffic would reverse the route.

The estimate of the traffic count involved in the diversion is taken from the WSDOT's Trips System for 2000. Average total daily through traffic between state route milepost 81.21 (before

ramp SR-507) and milepost 68.94 (after ramp SR-12) Bow Hill Road is estimated at 51,000. In the immediate vicinity of the cities of Chehalis and Centralia average daily volume reaches approximately 62,000, but this added traffic is assumed to not leave the area. The affected daily traffic for the analysis is a base flow traffic rate of 51,000. Further, the analysis employs the Trips System indication that 18 percent of the traffic is truck as measured by the Bow Hill Road indicator.

The analysis of transportation delays and costs was carried forward by employing the procedure in ER 1105-2-100, Appendix D, and as shown in Table D-4: Value of Time (VOT) Saved by Trip Length and Purpose of that appendix, with a measure of median household income for Lewis County of \$32,557 (1997 U.S. Bureau of the Census). A per vehicle passenger rate of 1.15 is assumed for the analysis. The diversion is estimated to take 3.16 hours, assuming a 32 mph diversion speed. Mileage rates are further assumed to be 34.5 and 48 cents for cars and truck, respectively. The above factors yield the following transportation related damages (Table 3-31).

TABLE 3-31 INTERSTATE 5 DAILY TRANSPORTATION DELAY COSTS WHEN FLOODED

								Daily Costs		
	Value of Time \$/hr	Occupancy Factor	Occ. Weighted VOT	Time Costs	Diversion Mileage Cost	Total Cost per Vehicle	Vehicle Units	Time	Mileage	Total
Cars	8.42	1.15	9.68	\$30.57	\$34.85	\$65.41	44880	\$1,371,783	\$1,563,844	\$2,935,627
Trucks	8.42	1	8.42	\$26.58	\$48.48	\$75.06	6120	\$162,662	\$296,698	\$459,360
							TOTAL	\$1,534,445	\$1,860,541	\$3,394,986

Transportation delay costs due to flood impacts are shown in the table below based on estimated closure durations for flooding and cleanup for Chehalis-Centralia area.

TABLE 3-32 INTERSTATE 5 DAMAGES BY FLOOD EVENT

Flood Event	I-5 Closure in Days	Total Cost (\$)
25	0	0
50	4	13,579,945
100	4.5	15,277,438
200	5	16,974,931
500	6	20,369,917

Applying these flood related values to the HEC-EAD model yields an estimate of equivalent annual damage of \$476,300. Based upon a planned elevation of I-5 in the without-project

condition, traffic delays were assumed to occur only through 2012 (estimated completion of elevation). Average annual traffic delay damages through 2012 amount to \$129,100.

3.6.12 Avoided Cost of Interstate 5 Raising

I-5 has been particularly susceptible to inundation in the project area and has been shut down twice in the last 10-years with floodwater up to 8 feet in depth over the roadway (closed for 4-days in 1996, and 1 day in 1990). Because of safety issues and the tremendous economic impacts associated with I-5 closures, WSDOT has stated that I-5 will require raising to above the 100-year flood elevation at the same time as other Federally mandated widening and upgrading is accomplished. The incremental cost of raising the freeway under the without-project condition has been estimated at \$44 million.

The plan for I-5 indicates that implementation would take place after the base year of any of the alternatives and would be finished in 2012. Discounting this future expenditure yields a current base year value of \$32,686,200. Amortization of this avoided cost yields average annual savings of \$2,110,000. Under with-project conditions and at least 100-year protection to this section of I-5, the incremental costs of raising the freeway would not need to be expended. Under this scenario, the avoided cost can be included as an NED benefit (though it is not included in the accounting of "damages").

3.6.13 Rail Freight Flood Impacts

The basis for the examination of NED costs from rail disruptions is the Pharos Corporation's "Chehalis River Flood Reduction Project" study of 2001 for Lewis County (Appendix D). The study reports that the Burlington Northern Santa Fe Railway (BNSF) owns and operates the rail line running north and south within the Chehalis floodplain. This double mainline track parallels I-5 within the floodplain and continues south to Eugene, Oregon, where it connects with the Union Pacific Railroad. BNSF traffic typically ranges from 30 to 40 trains per day, and trains are primarily composed of grain for export; forest products imported from Canada; and domestic shipments of metals and minerals, coal, chemicals, automobiles and consumer goods.

The second major rail service connected to the study area is the Union Pacific Railroad (UPRR). Although UPRR lines do not run directly within the floodplain, the UPRR operates its own trains over the BNSF's track in the Chehalis corridor to access and route shipments to many of their

western Washington rail customers via trackage rights. The number of UPRR trains utilizing the Chehalis corridor amounts to 18 to 20 trains per day.

Based on annual reports published by BNSF and UPRR and assuming a per rail car carrying weight of 268,000 pounds, the estimated daily rail car transit rate is 1,230 in the Chehalis corridor. In the event of a prolonged rail outage, these rail lines may be forced to reroute traffic via routes in either Pasco or Spokane, Washington. The shortest alternate route bypassing the Chehalis floodplain would increase trip mileage by 350 miles. BNSF estimates that the average mileage payout for equipment rent/car ownership at approximately \$0.40 per mile. Given the mileage increase of the shortest alternate route, the additional cost per railcar diverted equals \$140.00 or \$172,200 per day for all railcars being diverted.

Furthermore, depending on the alternate line's available capacity, the rerouted cars would likely be subject to a minimum of 48 hours of extended transit time for the additional 350-mile trip. Estimating from the 1999 primary carriers annual reports, the approximate average daily equipment expense per railcar is \$23.30. On an estimated daily volume of 1,230 railcars the rail lines would incur additional daily equipment expenses totaling \$28,659.

Potential flood related operation and equipment expenses to the rail lines by flood event are shown below in Table 3-33, Railroad Damages by Flood Event.

TABLE 3-33 RAILROAD DAMAGES BY FLOOD EVENT

Flood Event	Duration (days)	Railcars Affected	Reroute Expenses (\$)	Equipment Expenses (\$)	Total (\$)
50-year	4	4920	688,800	229,272	918,072
100-year	4.5	5535	774,900	257,931	1,032,831
200-year	5	6150	861,000	286,590	1,147,590
500-year	6	7380	1,033,200	343,908	1,377,108

Railroad damages were modeled in HEC-EAD to estimate expected annual damages. Applying a 25-year non-damaging event to the HEC-EAD model yields expected annual damage for railroads of \$32,200.

3.7 Expected Annual Damage Summary

Table 3-34 summarizes the expected annual damages from flooding along the Chehalis and Skookumchuck Rivers developed by the preceding analyses.

TABLE 3-34 EXPECTED ANNUAL DAMAGE SUMMARY

Damage Category	Expected Annual Damage (\$)
Structures	4,059,810
Contents	3,066,330
Cleanup	1,197,010
Temporary Relocation Assistance	116,630
Public Assistance	405,130
Agriculture	115,850
Interstate 5 Delays	129,100
Fill Costs Associated with Elevating I-5	0
Railroad Delays	32,200
Total	\$9,122,060

4. PLAN FORMULATION

4.1 Problems and Opportunities

Specific problems addressed by the study include:

- flood inundation damages to structures and contents;
- transportation delays as a result of flooding; and
- quantity and quality of aquatic and riparian fish and wildlife habitats.

Opportunities to address these problems include:

- implementation of flood damage reduction measures in study area to protect structures; and
- implementation of environmental measures to protect and restore sensitive fish and wildlife habitats in study area.

4.2 Planning Objectives and Plan Formulation Overview

4.2.1 Planning Objectives

The objectives of this project are to:

Engineering Objectives:

1. reduce flood hazards in the project area to the maximum extent practicable.
2. decrease the transportation closures during flooding on I-5 and other critical transportation corridors to the maximum extent practicable;
3. avoid increasing flood risks downstream from the project area; and
4. avoid decreasing any existing low flow benefits provided by Skookumchuck Dam.

Economic Objectives:

5. reduce flood damage costs in the project area to the maximum extent practicable
6. reduce transportation delay costs in the study area to the maximum extent practicable

Plan
Formulation

7. be cost-effective for both construction and maintenance.

Environmental Objectives:

8. avoid adverse impacts to the aquatic environment to the extent practicable and minimize and compensate for unavoidable adverse impacts to the aquatic environment;
9. incorporate appropriate fish and wildlife habitat creation, enhancement, and restoration measures to the extent practicable; and
10. comply with all Federal, state, and local regulations, including environmental regulations.

4.2.2 Plan Formulation Overview

To accomplish these objectives, a range of alternative plans were identified and evaluated. This formulation and evaluation process was conducted in three phases.

- **Phase 1:** For the study, seven preliminary alternatives were identified from previous studies, the local sponsor, interested agencies, and tribes. The preliminary alternatives were screened by their capacity to address planning objectives. Those alternatives that addressed objectives were carried forward for further modeling and evaluation.
- **Phase 2:** The final set of alternatives was more rigorously evaluated and screened based upon risk-based benefit-cost analysis utilizing the HEC-FDA program. All of the alternatives included in the Phase 2 analysis were designed to protect during the 100-year frequency flow. The final alternatives were evaluated both independently and in select combinations. This served to identify the first added elements as well as the performance and residual damages of combinations. This analysis identified the features for the NED plan and supported selection of the preliminary recommended plan.
- **Phase 3:** Finally, in the third phase, several different sizes of the NED plan features were evaluated for optimization of project size.

4.3 Description of Preliminary Solutions

Seven preliminary alternatives were identified for inclusion in the initial plan formulation and evaluation phase. These alternatives were based upon previous studies, new local studies, and interagency and tribal coordination. The preliminary alternatives are listed in Table 4-1 and are described in the paragraphs that follow.

TABLE 4-1 PRELIMINARY ALTERNATIVES

Alternative 1	No- Action Alternative
Alternative 2	Skookumchuck Dam Modifications Alternative
Alternative 3	Overbank Excavation and Flowway Bypass Alternative
Alternative 4	Levee System Alternative
Alternative 5	Flow Restrictors Alternative
Alternative 6	Non-Structural Alternative
Alternative 7	Interagency Alternative

4.3.1 Alternative #1 – No Action Alternative

Under the no action alternative, no project features are implemented. Technical studies conducted in the General Reevaluation Study indicate that this alternative would result in continued flooding in the study area. With no action, expected annual flood damages are estimated at \$9,122,060. In addition, I-5 would have to be raised at an annual cost of \$2,110,000.

4.3.2 Alternative #2 – Skookumchuck Dam Modifications

4.3.2.1 Objective

This alternative is intended to provide reductions in flooding along the Skookumchuck River. This is needed to address flooding problems in the area including in the town of Bucoda and the City of Centralia. This alternative may also provide some reduction in discharge in the Chehalis River downstream of the confluence with the Skookumchuck River.

4.3.2.2 Relation to Previously Authorized Project

Congress authorized a project modifying Skookumchuck Dam in 1986. The project recommended in the 1984 feasibility report envisioned modification of the existing, private, water supply dam on the Skookumchuck River to provide a maximum of 28,500 ac-ft of flood storage, reducing flood damages in the Skookumchuck valley, the town of Bucoda, and the City of Centralia. Most of the alternative configurations of dam modifications evaluated in this study (and described below) are improvements on the originally authorized project.

4.3.2.3 Description

Skookumchuck Dam is located on the Skookumchuck River at approximately RM 22. The dam was constructed in 1970 to supply water for the Centralia steam generating plant. The dam is an earthfill structure approximately 190 feet high with the top of the dam at elevation 497 feet. The dam has a 130-foot-wide uncontrolled spillway, on the left abutment, with a crest at elevation 477 feet. Outlet works consist of two 24-inch Howell-Bunger valves with a combined discharge capacity of 220 cubic feet per second (cfs).

This alternative consists of modifications to the existing Skookumchuck Dam for the purpose of providing flood control. The current dam has an uncontrolled spillway at elevation 477 feet and a limited capacity to release water from the reservoir when the pool is lower than elevation 477 feet. As a result, the current project configuration provides little flood control regulation since most incoming flow is passed through the reservoir with little attenuation. There is currently about 11,000 ac-ft of storage space available in the reservoir between elevation 455 feet (proposed lower elevation of flood control pool) and 477 feet.

Future modifications to the dam for flood control purposes could include modification of the outlet works to allow a maximum flood storage pool of elevation 492 feet (compared to the current maximum flood pool elevation of 477 feet). Modifications would also likely include additional low-level outlet works to allow the rapid evacuation of stored water above an elevation of about 455 feet. Storage of water to a maximum pool elevation of 492 feet would add an additional 9,000 ac-ft of flood control storage to the reservoir such that the total storage space between elevations 455 and 492 feet would be about 20,000 ac-ft.

4.3.2.4 Dam Safety Considerations

Any proposed modifications to Skookumchuck Dam must enable the project to safely pass the Probable Maximum Flood (PMF) outflow of 32,500 cfs at a maximum design pool elevation of 492 feet. The dam embankment elevation must be sufficient to prevent overtopping during the PMF, while accounting for contingencies such as surcharge, wind wave runup, and embankment settlement. The dam embankment currently has a top elevation of 497 feet. The maximum design pool level is at elevation 492 feet. Five feet between the top of the dam and the maximum pool level is considered adequate freeboard.

The Corps conducted additional studies during the General Reevaluation Study to assess the seismic stability of the dam. This was due to uncertainties about the nature of foundation

materials and properties, foundation liquefaction, and stability. In the investigations conducted by the Corps in 2001, based on recent seismic information, the study concluded that the sandy gravel soils underlying the silts appear to be liquefiable under all design Maximum Credible Earthquake (MCE) ground motions. In 2001, a similar stability analysis was performed utilizing subsurface explorations, the liquefaction data, and seismic hazard analysis from recent studies. This included evaluation of the existing static and post-seismic stability of the downstream slopes of the dam and berm using a limit-equilibrium approach. The extent of liquefied soils is uncertain beyond the area of investigations with Becker and SPT borings, thus slope failures were calculated for five different ranges of liquefied soils. The calculations indicate a factor-of-safety below 1.0 for conditions where liquefied soils are present from the core to the toe of the downstream berm. This is an issue that will be addressed by FERC and the current owner of the dam prior to the local sponsor taking ownership.

4.3.2.5 Reservoir Regulation Considerations

The Corps developed a preliminary flood control operation rule curve as part of its flood control operations investigation (USACE 1992). The USACE rule curve provided flood control storage of 11,900 ac-ft between elevations 453 and 477 feet, from 1 November to 1 February. After 1 February, the reservoir would be allowed to refill. Drawdown of the reservoir would begin each year in early to mid-September and would continue until elevation 453 feet was reached, usually around the first of November.

The current proposed dam modifications would provide flood control storage of approximately 20,000 ac-ft between pool elevation 455 and 492 feet. A new reservoir operation rule curve similar to the current Corps rule curve will have to be developed for the flood control operation during the finalization of the dam water control plan.

4.3.2.6 Skookumchuck Dam Modifications, Sub-alternatives

Four basic alternatives for modifications at Skookumchuck Dam are being studied, as follows.

- Alternative 2B1 – Spillway Sluices with Gates and Rubber Crest Weir
- Alternative 2B2 – Short Tunnel with Gates and Rubber Crest Weir
- Alternative 2B3 – Tainter Gates in Rock Cut with Rubber Crest Weir
- Alternative 2B4 – Tainter Gates Rock Cut with Emergency Spillway

These alternatives were chosen based on analysis and findings from previous studies. The following sections describe each of the alternatives in greater detail.

4.3.2.7 Alternative 2B1 - Spillway Sluices with Gates and Rubber Crest Weir

In this alternative, a section of the existing ogee spillway would be removed and a new spillway section containing three gated sluices would be constructed. The three sluice gates would each be approximately 10 feet wide and 10 feet high. An emergency bulkhead would be installed to allow for dewatering of the gates.

Design Objectives and Description:

- Pass PMF discharge event of 32,500 cfs
- Provide and maintain dam safety under all conditions
- Provide flood control storage
- Maintain provision of existing water supply demands
- Modify spillway to enable the use of the 15 feet of reservoir storage between elevation 477 and 492 feet for flood control and provide the PMF discharge capability
- Add a 15-foot-high by 130-foot-wide inflatable rubber weir to the existing spillway crest
- Excavate and lower the spillway ogee crest to make room for the new spillway sluices

4.3.2.8 Alternative 2B2 – Short Tunnel with Gates and Rubber Crest Weir

This alternative would consist of constructing an intake structure just upstream of the right abutment of the existing spillway bridge. The intake would lead to a short tunnel constructed in the rock forming the left abutment of the embankment dam. The intake would have two 8-foot by 11-foot slide gates. The tunnel would vary in shape from a 16-foot-diameter horseshoe to a 10-foot-diameter conduit. Flow would discharge through the tunnel into the existing spillway chute.

Design Objectives and Description:

- Due to concerns that the left abutment rock may be highly weathered or fractured, and thus not very suitable for tunneling, it was assumed that the tunnel would be constructed as a cut and cover structure.
- Cut down trench in stages with rock anchors being placed prior to the next excavation cut

- Construct a cast-in-place concrete tunnel at the bottom of the trench.
- Excavate approximately 12,600 cubic yards of rock for tunnel construction.
- Construct concrete walls at both the upstream and downstream ends of the trench and backfill the space between
- Drill new grout curtain holes to prevent the flow of water through the dam embankment
- The intake structure would be a freestanding tower with an invert elevation of 438 feet, and a top deck at elevation 497 feet.
- The tower would be approximately 28 by 30 feet in plan, and would contain the two control gates, two guard gates, and all the necessary hydraulic control equipment.
- An inclined trashrack would be provided at the tunnel entrance, as would bulkhead slots.
- The existing uncontrolled overflow spillway would be modified, and a 15-foot high inflatable rubber weir would be constructed on top.
- The outlet tunnel would be designed to discharge up to 8000 cfs during PMF with the remaining 24,500 cfs passing over the overflow spillway.

4.3.2.9 Alternative 2B3 – Tainter Gates in Rock Cut with Rubber Crest Weir

This alternative is similar to Alternative 2B2 described above. This alternative would consist of constructing an intake structure just upstream of the right abutment of the existing spillway bridge. The intake would lead to a channel constructed in the rock forming the left abutment of the dam. The intake would have a single 16-foot wide by 15-foot high tainter gate. Flow would discharge through the channel into the existing spillway chute.

Design Objectives and Description:

- A cast-in-place concrete lining would be constructed.
- Approximately 12,600 cubic yards of rock would have to be excavated for channel construction. A bridge structure would be incorporated to allow vehicles to pass over the outlet channel.
- New grout curtain holes would be drilled to prevent the flow of water through the dam embankment.
- The intake structure would be a freestanding tower with an invert elevation of 438 feet, and a top deck at elevation 497 feet.
- An inclined trashrack would be provided at the tunnel entrance, as would bulkhead slots.

4.3.3 Alternative #3 – Overbank Excavation and Flowway Bypass

4.3.3.1 Objective

The flowway bypass and overbank excavation features were developed in an effort to 1) reduce flooding in the City of Chehalis and to prevent SR-6 from overtopping in large floods through floodplain modification; and 2) to reduce flooding of I-5 and the City of Centralia by overbank excavation to increase channel capacity in the vicinity of Centralia. It was anticipated that the combination of these two features would provide significant flood damage reduction in these areas.

4.3.3.2 Relation to Previously Authorized Project

In order to provide flood damage reduction along the Skookumchuck River, these features were proposed for implementation in combination with modifications to Skookumchuck Dam.

4.3.3.3 Description

This floodplain modification alternative would consist of three primary components. The first component, common to all alternative variations of this feature, is modifications to Skookumchuck Dam to provide flood control storage. The second component is floodway modifications in the vicinity of Mellen Street bridge between RM 65.90 and RM 68.25. One of the alternatives would also include modifications to the existing Mellen Street bridge abutment. The third component is floodplain modifications in the vicinity of Chehalis/SR-6 to provide flood flow bypass and storage.

4.3.3.4 Chehalis/SR-6 Area Floodplain Modifications

Design Objectives and Description:

- Reduce flooding in the City of Chehalis between the 13th Street interchange and the Main Street (SR-6) interchange, along I-5
- Eliminate floodwaters from the Newaukum River from spilling through Stan Hedwall Park and into nearby Dillenbaugh Creek and then through the railroad openings to the east side of I-5.

- The existing uncontrolled overflow spillway would be modified, and a 15-foot high inflatable rubber weir would be constructed on top.
- The outlet channel would be designed to discharge up to 8000 cfs during PMF with the remaining 24,500 cfs passing over the overflow spillway.

4.3.2.10 Alternative 2B4 – Tainter Gates in Rock Cut with Emergency Spillway

This alternative includes a rock cut and tainter gates similar to Alternative 2B3; however, the rock cut and gates would be sized to pass the entire PMF flow. The existing overflow spillway would be raised to the reservoir freeboard elevation, and would serve as an emergency spillway. Alternative 2B4 consists of four main features:

- Construction of a new reinforced concrete control structure directly in the existing spillway discharge chute (SDC).
- Reconstruction of the existing SDC.
- Excavation of a new intake channel upstream of the new control structure.
- Excavation and rock bolting of SDC rock walls.

Advantages of Skookumchuck Dam Modifications Alternative 2B4 include:

- 2B4 is the only alternative that would pass the revised PMF of 32,500 cfs at a pool elevation of 492 feet while also providing a means of emergency control.
- Although 2B4 would probably require replacement of the existing low flow intake access bridge pier, it provides excellent unrestricted maintenance access to the new control structure and eliminates need for maintenance activities in the vicinity of the existing skewed access bridge and spillway ‘bottleneck.’
- Relocating and lowering the crest of the spillway ogee 34 feet essentially eliminates the “fill and spill” method of operation that has been used since dam construction. 2B4 would allow the dam to store spring inflows for possible summer fish augmentation releases.
- 2B4 provides improved hydraulic discharge conditions by allowing releases directly into the SDC.
- 2B4 provides a new low flow fish passage pipe.

Alternative Features:

- SR-6 Bridge Modification
- SR-6 Flood Bypass
- Chehalis Flowway Bypass Berm

4.3.3.4.1 SR-6 Bridge Area Modifications

- Floodway excavation on the Chehalis River from shortly downstream of the SR-6 bridge (RM 74.55) to the mouth of the Newaukum River (Chehalis RM 75.08)
- Excavate approximately 800,000 cubic yards of material from the floodway in this reach of the Chehalis River (would result in approximately 1.5 feet of peak flood stage reduction on the lower 1.5-mile reach of the Newaukum River and Dillenbaugh Creek east of I-5, for a flood event such as the February 1996 event; floodway excavation in this area would need to be substantially extended and increased downstream if further flood stage reduction is required.)
- Reconstruct the right bank approach of the existing SR-6 bridge
- Excavate floodway in the SR-6 bridge area (would also likely require extension of the abandoned Riverside Road bridge 0.25 mile upstream).
- Due to the large volume of excavation required, and the high cost related to the structural work, and the potential magnitude of environmental impact, this alternative was not considered further.
- The SR-6 flood bypass option discussed below provides a similar or better flood reduction benefit in the Chehalis area for less cost and with less environmental impact.

4.3.3.4.2 SR-6 Flood Bypass Works

- Modify a 1,500-foot section of the SR-6 roadway adjacent to an existing oxbow lake at RM 77 to prevent overtopping of SR-6 during floods up to the 100-year event, and to provide a flood flow bypass to the floodplain east of Scheuber Road,
- Excavate approximately 250,000 cubic yards of material and elevate the SR-6 roadway to provide a 5-foot vertical clearance for bypassing overbank flows to the floodplain.

- Excavate approximately 60,000 cubic yards (up to a 4-foot excavation depth) of a 500-foot by 1000-foot overbank area west of the oxbow lake between the Chehalis River and the roadway to provide more frequent overbank flow through this area.

4.3.3.4.3 Chehalis Flowway Bypass Berm

- Construct a north-south oriented 1.5-mile long curving berm on the floodplain north of SR-6. This floodplain fill is intended to form a drainage divide for creating two separate hydraulic regimes between the floodplain bypass/storage area and a 3-mile reach of the main stem Chehalis River downstream of the SR-6 Bridge (RM 74.6 to RM 71.6).
- Flood flows bypassing through the modified SR-6 overflow site to the floodplain would not return to the river until the flows reach the north end of the floodplain bypass/storage area. Returning flows would discharge first through the existing Scheuber drainage ditch and then over the low-lying overbank area between RM 71.6 and RM 72.4 of the Chehalis River.

4.3.3.4.5 Alternative 3A – Centralia Overbank Excavation

Among the variations modeled, floodway excavation between RM 65.90 and RM 68.05 appears to be the most efficient and cost-effective design.

Design Objectives and Description:

- Excavate approximately 2.4 million cubic yards of material.
- The floodway bench elevation was set to an elevation above the summer normal flow stage so that construction activities would be above the water level.
- At the upper end of the excavation around RM 68.05, the bench elevation would be approximately at elevation 158 feet. At the lower end of the excavation reach (RM 65.90), the bench elevation would be approximately at elevation 148 feet.
- Side slopes of the excavation were assumed to be two horizontal to one vertical (2:1). Channel velocities in the excavation reach would be reduced from a high of almost 8 feet per second to less than 4 feet per second.
- The Mellen Street bridge section of the Chehalis River is one of the most restrictive for flood flows. In order to alleviate this bottleneck, modifications to the bridge area would be necessary. The right bank (east bank) would be excavated. In conjunction

with the excavation, the bridge would be extended on piers to remain elevated above the excavated floodway.

4.3.3.5 Alternative 3B – Skookumchuck Bypass

This alternative would involve diverting a portion of the flow in the Skookumchuck River during flood events. This secondary overflow channel would start at approximately RM 1.5 of the Skookumchuck River.

Design Objectives and Description:

- Route channel under I-5 at Blakeslee Junction and connect with some existing small lakes, and then a remnant channel of the Chehalis River.
- The channel would empty back into the Chehalis River at approximately RM 60.5, 6.5 miles downstream of the Skookumchuck's confluence with the Chehalis River.
- It was assumed that the channel would be designed to divert up to 5,000 cfs.

4.3.3.6 Alternative 3C – Centralia Hospital Bypass

The bypass channel would start at about RM 68.0 and would end at the mouth of Scammon Creek at RM 65.9. The alignment would run roughly northwest following localized low ground and would pass immediately south of the hospital.

Design Objectives and Description:

- This channel alignment would require the construction of three bridges and would require excavating out lower Scammon Creek.
- The entrance to the bypass channel would be set at approximately elevation 165 feet. This is approximately the water surface elevation for the annual flood event.
- The channel would likely be grass lined and have a rock-armored entrance to prevent scour.

4.3.3.7 Hump Excavation

The “hump” area is located in the Chehalis River at approximately RM 67.1 to RM 65.9. The channel bottom at this location is approximately at elevation 148 feet. This is approximately 10 feet higher than much of the riverbed further upstream. This high bottom elevation appears to

restrict flow during the 100-year flood. There have been numerous suggestions that excavation of this “hump” would significantly increase hydraulic capacity of the channel during flood flows, and thus reduce upstream flooding.

To evaluate the effects of the hump on hydraulic capacity during flood flows, two excavation alternatives were analyzed. The maximum velocity reductions resulting from either alternative are insignificant in the excavation reach because during a flood, a significant portion of the flow is in the overbank area. Thus, the slight increase in channel area has only a marginal impact on the total flow area. This feature was not examined further.

4.3.4 Alternative #4 – Levee System

4.3.4.1 Objective

This project was designed to reduce flood damages associated with the Chehalis and Skookumchuck Rivers. It also addresses flooding along Salzer Creek, Dillenbaugh Creek, and the Newaukum River. This alternative reduces damages to structures and allows for I-5 to stay open for transportation.

4.3.4.2 Relation to Authorized Project

Various levee alignments in the study area were studied previously by the Corps in the 1970s. The Levee Alternative can be combined with Skookumchuck Dam modifications (Alternative 2) to provide more comprehensive flood damage reduction throughout the study area.

The basic levee alignment was originally developed through a previous study (circa 1970s). Local sponsors helped the study team develop the Levee Alternative. The plan was presented at public meetings for their review and comment. Draft reports were completed in 1976 and 1978.

4.3.4.3 Description

This alternative consists of constructing a system of levees to protect flood-prone areas in the vicinity of Chehalis and Centralia. Levees would be constructed at selected locations along the Chehalis and Skookumchuck rivers as well as along several tributaries (i.e., Salzer Creek, Coffee Creek). This alternative was considered both with and without the benefit of flood control

operations at Skookumchuck Dam. A total of 20,000 ac-ft of flood control storage was assumed available in the Skookumchuck reservoir for the levee plus Dam Modifications Alternative.

4.3.4.4 Design Objectives

In reviewing the work of previous studies, considering the increased importance placed on environmental concerns, and conducting site visits with shareholders, it became apparent that much coordination was necessary. This made it important to incorporate as many concerns as possible early in the design effort to avoid impacts later in the study. To facilitate the expedited study some guiding design objectives were considered throughout the project. These objectives also correlate to the project criteria. The following are the guiding design objectives:

- avoid environmental impacts to the maximum extent possible;
- minimize the environmental impact as much as possible;
- minimize the initial construction and long term maintenance;
- provide a minimum of a 50-year project life;
- minimize project-induced damages, both within the project area and downstream;
- avoid inundating or excavating of hazardous materials;
- maximize the transportation corridor benefits;
- maximize local infrastructure benefits; and
- incorporate restoration opportunities into project.

In addition, a general assumption in the initial levee system design was that it would provide 100-year protection from flooding of the Chehalis River. This includes protection from Chehalis River backwater on the tributaries, including on Dillenbaugh Creek, Salzer Creek, China Creek, Coal Creek and the Skookumchuck River.

4.3.4.5 Design Process

The study team took the levee alignment developed in 1976, made refinements based on flood observations in 1990 and 1996. The team investigated the project area, identified areas needing flood protection, aligned the levee to tie into existing levees, and adjusted the alignment to protect existing infrastructure while providing a floodplain. The team also adjusted the original alignment to have the least impact to community (residential) infrastructure, to the environment, and to WSDOT roadways.

Following initial hydraulic modeling, the team re-evaluated the levee segments. Some segments were deleted because 1) protection was not required, and 2) improved alignments were identified. Additional modifications and refinements to the levee plan were based upon coordination with WSDOT and their widening project of I-5, incorporating I-5 into the levee alignment where practical to reduce costs and minimize environmental impacts.

The standard Corps levee design consists of a 12-foot top width and 2:1 side slopes (2 horizontal to 1 vertical). The fill material must meet the gradation specification and be compacted to Corps standards for levees (see Appendix C, Levee Plan and Civil Design). A 6-inch layer of gravel is placed on the top surface to provide access during flood events and maintenance. Both sides of the levee are hydro-seeded with grass with 4 inches of topsoil over compacted embankment material. Most levees are set back levees, which do not require rock bank protection. For those few areas that do require bank protection, the protection includes 30-inch minus riprap about 3 feet thick, with a 1-foot layer of quarry spalls between the riprap and compacted embankment material.

Environmental impacts were identified and then avoided to the maximum extent possible. Unavoidable impacts were minimized with design modifications; for example, a levee was changed to a floodwall in certain areas of concern to minimize the footprint of the structure.

In the design process, designers also:

- Used 1976 levee alignment from previous study that had gone through public review process as a starting point.
- Standard Corps levee 12 feet wide and 2 horizontal to 1 vertical slopes were assumed as the primary levee design. Variations including vertical wall in tight area may be required in setback areas only.
- Toured the basin with plans in hand, with a Corps study manager who had been on-site during the 1996 flood event. This event was approximately the 100-year event. High water marks from that event were noted and incorporated into design with minor revisions.
- The plan was drawn onto CADD drawing and distributed to the study team for comments.

- Plan was revised by internal study team, and the drawings were sent out externally to local sponsors (county and cities), and agencies
 - Site visit/tour with local sponsors.
 - Site visit/tour with state agencies (environmental).
 - Meetings with WSDOT
 - WSDOT requested levee elevation for I-5 corridor be set at 2.5 feet above 100-year flood elevation. WSDOT is also doing environmental assessment of raising or protecting road.
 - Addressed concerns of culverts/underpasses.
 - Meetings and tours of area with Chehalis Tribe.
 - Meetings with Department of Ecology to obtain list of known HTRW sites and share proposed levee alignment.
 - Utilized wetland inventory to minimize and avoid wetland area impacts.
- The design team coordination with agencies included conducting multiple meetings showing plan and requesting comments, submittal of written requests for comments, and provision of study area tours upon request.

4.3.4.6 Levee Alignment

The proposed levee alignment protects residential and commercial structures, highway and other transportation infrastructure from flooding. Protection would extend along the Chehalis River from approximately RM 75 to RM 64, along the Skookumchuck River from approximately RM 5 to near the mouth, as well as along most of the lower 2 miles of both Dillenbaugh Creek and Salzer Creek. The proposed levee alignment is shown on Plate 6.

4.3.4.7 Planned Overtopping of Flood Control Levee

Levee designs using superiority can force initial overtopping in the least hazardous location in an attempt to minimize sudden levee failure and safety concerns. The planned overtopping analyses adhered to the Overtopping of Flood Control Levees and Floodwalls guidance (ETL 1110-2-299).

The selected area of planned overtopping is near the Chehalis-Centralia Airport, from RM 73.0 to RM 71.5. This reach is also described as economic damage Reach 2 (Section 3.5), and levee design Reach 7A (Appendix C). The levee ties into the west embankment of the I-5 freeway at Salzer Creek and proceeds south along the river side of Airport Road to the I-5/SR-6 junction south of the airport. Highest and best use of lands within this levee footprint include commercial/transportation on airport lands as well as two agricultural and one residential parcel. The levees will protect the airport and commercial-retail establishments located on the west side of the airport as well as the I-5 freeway from Salzer Creek south to the SR-6/I-5 junction. Access to the levee is available from public rights-of-way at Mellen Street and Airport Road.

The top-of-levee height will be lowered in this reach no more than 1.0 foot to allow planned overtopping. The length of the overtopping will be located within the design Reach 7 (economic Reach 2) from station 00+00 to 10+280. This will yield a levee that protects against the base 100-year flood level with 95 percent reliability performance (conditional non-exceedance for the 0.01 event). The final levee profile will be established during the final design phase. The buildings in this area are already flood proofed and the aircraft can either be evacuated during flood warnings or may be submerged in the aircraft hangars up to wheel height. There are three private owners and one public owner (Chehalis-Centralia Airport) affected by the proposed levees. The perpetual levee easement covers about 7.3 acres of land in public ownership and 3.6 acres privately owned.

4.3.5 Alternative #5 – Upstream Flow Restriction Structures, and Upstream Storage

4.3.5.1 Flow Restrictors

Objective:

Flow restrictors are intended to increase water surface elevation upstream of the flow restriction providing potential benefits to wetlands and fisheries. Currently there is a lack of off-channel habitat for salmon along the mainstem of the Chehalis River. If spring and summer flows could be backed up into adjoining low areas or disconnected oxbows, without also resulting in a stage increase during the 100-year flood event, then additional off-channel habitat could be created. The increased upstream inundation could also have a potential benefit in regards to increasing groundwater recharge.

UPSTREAM
Storage
Flow Restriction

Description:

Flow restrictors are any kind of structure that intentionally restricts and holds back flow in order to help reduce downstream flooding, or to increase upstream inundation. Increased upstream inundation can be beneficial for wetlands and fisheries in some cases. It was envisioned that these structures would be much simpler and of smaller scale than flood control dams, as well as less costly and more environmentally friendly.

For all structures, it was assumed that upstream inundation levels would not be allowed to exceed the current 100-year flood level. Known high water marks from the February 1996 flood were used as the criteria during modeling. For the first site studied, three different structure types were analyzed: a slot structure, a fixed weir structure, and a control type structure.

The control type was found to be the most effective of the three. For the remaining sites, only a control type structure was considered. Sites included:

- Mainstem Chehalis River at RM 87.56
- Mainstem Chehalis River at RM 89.61
- Mainstem Chehalis River at RM 104.09
- South Fork Chehalis River at RM 0.3
- Lincoln Creek
- Stearns Creek
- Salzer Creek

Two options were modeled. Option 1 had a single flow restrictor, and option 2 had four separate flow restrictors in combination, using the controlled structure sites. The modeling demonstrated no significant water surface reductions to the 100-year flood. Due to the fact the flow restrictor structures would have no significant water surface reduction for the 100-year flood in the Centralia-Chehalis area (because of the rather limited volume of flood control storage they would provide), other larger structures were considered in this alternative.

4.3.5.2 Upstream Storage

In order to create the volume of flood control storage necessary to effect significant water surface level reductions downstream, three basic alternatives were examined: individual flood control dams, multiple smaller headwater dams, and flood storage dikes on the floodplain. It was anticipated that all three options would have significantly greater environmental impact than the

initially proposed flow restrictor structures. It was found that none of these larger structures were economically feasible, and these were not carried forward for further study.

4.3.5.2.1 Upstream Flood Control Dams

The Corps investigated five potential locations for large multi-purpose storage dams in the upper Chehalis River basin in the course of its flood control studies (USACE 1982). The five locations consisted of two sites on the Newaukum River, one site on the South Fork Chehalis River and two sites on the mainstem of the Chehalis River, upstream of the Newaukum River. All five features were determined to be economically infeasible.

4.3.5.2.2 Small Headwater Dams

In its studies, the Corps also investigated the feasibility of building several small headwater dams (USACE 1982). The Corps evaluated 12 sites in the drainage above Centralia-Chehalis. The combined flood storage capacity of all 12 dams would be only 14,500 ac-ft, with an estimated reduction in flow at Grand Mound of 3,000 cfs for a 100-year flood event. The 3,000 cfs flow reduction would result in flood stage reduction of approximately 3 inches. In 2001 dollars, the Corps-estimated cost to construct the twelve dams would be approximately \$118 million, which would equate to approximately \$472 million dollars per foot of flood stage reduction. Because of the poor benefit-to-cost ratio, this feature was not investigated further.

4.3.5.2.3 Flood Storage Dikes on the Floodplain

The Corps also investigated the feasibility of flood storage areas in the floodplain. This would be accomplished by enclosing a large area with a dike. During floods, the floodwaters would overflow into the dike enclosed storage area. Stored floodwaters would then be released slowly through a downstream outlet. This type of flood storage operation would not be as efficient and effective as that provided by a flood control dam. Placing flood control storage in the floodplain is also not as effective as utilizing storage in the headwaters. In the floodplain, the flows are already rather attenuated and a much larger storage volume is required for an equivalent stage reduction.

4.3.6 Alternative #6 – Non-Structural Alternative

4.3.6.1 Objective

The intent of the non-structural alternative was to formulate a viable non-structural solution to reduce flood damages throughout the study area.

4.3.6.2 Relation to Authorized Project

This alternative does not include incorporation of the authorized project at Skookumchuck Dam.

4.3.6.3 Description

Non-structural measures include watershed management, flood proofing structures, evacuation plans, and removal of structures from the floodplain. Watershed management includes such actions as reforestation, timber harvest control, and restrictions on floodplain development. These measures do not directly address flood elevations, but reduce economic damages and safety hazards. Flood proofing structures would require elevation of residential buildings to the 100-year flood level, and making commercial first floor buildings watertight. Also, no new construction would be allowed in the floodplain. Evacuation plans assist floodplain dwellers in avoiding flooding impacts. Relocation of a selected number of structures in the floodplain, or even all the structures in the floodplain, has been proposed. Because there are no flood control structures proposed for construction, no footprint value is calculated. However, overall impact area would extend throughout the upper Chehalis Basin. For this reason, the entire project area, plus 10 percent, is included as the overall impact area (41,360 acres).

Impacts are negligible for this alternative. No structures are proposed for construction and several of the components of this alternative may actually improve floodplain and river conditions. Removal of structures and control of development would reduce the impervious surface area in the floodplain, improving groundwater recharge and base flows. Reforestation would increase the amount of riparian vegetation and increase large wood debris recruitment.

Any combination of restoration measures could be selected to provide restoration above the requirements for mitigation, since mitigation is not required for this alternative.

4.3.7 Alternative #7 – Interagency Committee Alternative

4.3.7.1 Objective

In the fall of 1996, the Washington Department of Ecology set up the Chehalis Basin Local Action Team, an internal team, to work with local governments and build partnerships to solve water problems in the basin. In 1998, a Technical Committee was formed, comprised of representatives of local, state and Federal agencies and tribes. During 1998, the Technical

CRBP
Alternatives
2003

Committee formed an Alternatives Subcommittee to identify and evaluate potential flood hazard reduction measures and to develop alternatives for meeting specific flood hazard reduction goals.

The purpose of this alternative is to provide short- and long-term actions that will reduce flooding hazards to the Centralia and Chehalis area residents, while at the same time, restore and enhance river hydrology and floodplain functions to support the basin's salmonid habitat base. This alternative seeks to reduce flood hazards and increase floodwater storage by focusing first on regulatory and voluntary measures. The connectivity of the Chehalis River to its floodplain is maintained and enhanced using land use and development regulations before implementation of any costly structural solutions. In addition, this alternative seeks to maintain vital I-5 and State Route access by constructing a traffic bypass and by reducing flood frequency and duration. Also advocated are the uses of floodplain easements, acquisition of frequently flooded areas and structures, relocation or elevation of structures, and improved upland water storage. Finally, the alternative is presented as a sequence of actions that require analysis before additional actions are proposed.

4.3.7.2 Relation to Authorized Project

This alternative was evaluated in combination with the modifications to Skookumchuck Dam.

4.3.7.3 Design Process Description

The Alternatives Subcommittee reviewed a variety of different flood hazard reduction measures and used a format of facilitated workshops to sift through potential combinations of measures. The approach that was agreed to begins by describing the major elements (these could be individual measures or measures in combination) that make up the combination alternative. These measures include:

- *Measure 1 – Moratorium on Floodplain Development.* In the interim, a moratorium on floodplain development is recommended until the new flood insurance rate maps are adopted. Lewis County, and possibly Grays Harbor and Thurston counties, and area cities should enact interim regulations that restrict new fills until the new FEMA floodplain and floodway maps are prepared and adopted.
- *Measure 2 - Adopt New FEMA Floodplain and Floodway Maps.* Define a new floodway based on a 0.2-foot rise in the water surface profile. Use the new topographic information for this analysis. These data are required for the accurate evaluation and implementation of this

alternative. The 0.2-foot rise and the new 100-year floodplain will be used to develop or update floodplain management plan and regulations governing future floodplain development.

- *Measure 3 – Develop Flood Warning System.* Develop and implement a basin-wide flood warning system. Ensure that the system is well coordinated and interconnected among the various jurisdictions and agencies that provide emergency services.
- *Measure 4 – Restrict Floodway Development.* Restrict development (residential, commercial, industrial) in the newly defined floodway; and have outstanding approved filling/floodplain development activities provide a hydraulic analysis to show a 0.2-foot rise or less in the floodwater surface elevation. Jurisdictions would review pending permits to ensure that the proposed development does not increase flood damage risk to adjacent, upstream, and downstream properties. Jurisdictions should also consider establishing a time limit on development permits.
- *Measure 5 – Restrict Development in Flow Path.* In addition to defining the 0.2-foot floodway as described in Measure 2 above, development should also be restricted within additional critical portions of the floodplain, specifically in areas considered to be significant flow paths. Flow paths are naturally occurring swales, which are normally dry, but which have historically conveyed significant amounts of flowing water during flood stage. These flow paths could be established by identifying split flow conditions as part of the HEC-RAS analysis, or by simply identifying flow paths from photos and observations. Generally these flow paths have floodwaters greater than 3 feet deep, and velocities greater than 3 feet per second, during the 100-year event. If blockage of a flow path produces more than 0.2-foot backwater, then it is a flow path and will be protected from future development and/or fill under this alternative.
- *Measure 6 – Restrict Floodplain Filling.* Restrict new filling by requiring that fill be mitigated by removal of equal volume of fill elsewhere in the floodplain or floodway. Cut and fill balances should be retained within the project site whenever possible.
- *Measure 7 – Preserve/Enhance Floodplain Flood Storage.* Conduct an analysis to quantify the potential amount of floodplain storage provided by existing, expanded and enhanced floodwater storage areas. Potential areas are south of SR-6 in the Newaukum basin, South Fork of the Chehalis River, and the area bordered by Ceres Hill and White Road, proposed

WSDOT wetlands mitigation site near Stan Hedwall Park, existing wetlands, connections to oxbows and historic flow paths, SR-6 floodplain storage, and upland storage. The analysis will provide an assessment of the storage capacity that could be gained by removing barriers that are no longer used or can be redesigned, such as railroad grades, roadways and bridges. The analysis will generate hydrographs demonstrating the role of storage, and may be used to implement measures such as voluntary buyouts, purchase of flow easements, etc.

- *Measure 8 – Restrict Upland Land Uses.* Utilize other land use measures that lower and slow the hydrologic response of the basin. For example, consider upland vegetation coverage, reduced development densities, and reductions in the amount of impervious surfaces. Avoid impacts to wetlands, preserve and maintain wetlands, critical areas, and farmlands that supply floodplain storage capacity.
- *Measure 9 – Flood Audits.* Conduct a flood audit for the cities of Chehalis and Centralia and surrounding communities in order to determine which structures would benefit from raising, flood proofing, or acquisition.
- *Measure 10 – Upgrade Stormwater Management Systems.* Perform analyses to determine the detention effects of a 25-year design storm versus a 100-year design storm throughout the basin. Stormwater management is an integral element of the National Flood Insurance Program (NFIP). It regulates new development throughout the watershed to ensure that post-development runoff is no worse than pre-development runoff; and it regulates new construction to minimize soil erosion, and protect water quality. Stormwater management is also mitigation for development. This alternative is based on judicious planned development to reduce flood reduction risks. However, mitigation for development is inadequate when communities do not have a local stormwater management program or use less than the 100-year design storm for their local programs. With this in mind, it is imperative that stormwater management programs are implemented consistently throughout the basin to mitigate for development. It is also equally vital that the design criteria used for these programs are high enough to be effective. Detention for design storms will be based on the 100-year event. Use of a 100-year, 24-hour design storm is a standard national and state design criteria for stormwater management. This design storm should not be confused with a 100-year flood event, which is based on physical characteristics, geology, climatologic, antecedent conditions, land use, river morphology, size, and development density of the watershed.

- *Measure 11 – Improve Alternative Transportation and Emergency Access Routes.* Identify alternative transportation and emergency access routes. The proposed priority would be to lower flood levels so that I-5 and the State Routes are not closed during a 50-year storm event and to maintain emergency access routes on local roads up to a 25-year event. The local medical facility is on Cooks Hill in Centralia, and the two routes via Scheuber Road and Mellen Street are linked to SR-6 and I-5. Improvements will be needed on portions of Scheuber Road along with modifications on the SR-6 bridge, Mellen Street bridge, and I-5. This local access road could be used as an I-5 alternate route. Depending on the severity of the flood, the local route may be closed during severe flooding conditions. Depending on the need to keep local roads open, there may be additional modifications to SR-6.
- *Measure 12 – Expand Capacity of Chehalis-Centralia Airport Dike Culverts.* This measure proposes modifications to culverts and levees affecting the duration of flooding on northbound lanes of I-5 (modifications would reduce duration only -- not the incidence or frequency of flooding). Recommended measures are to install flap gates and expand culverts to direct water to drain northerly. Flap gated culverts will be needed on the west side of the highway to drain the airport and the southbound lanes of I-5. An additional flap gate will be needed on the east side in order to drain the northbound lanes of I-5. Presently it is necessary to excavate an opening in the levee to release the trapped water on the west side, and the east side must flow through a small diameter culvert, which takes about 40 additional hours to drain down. This alternative would reduce the highway closure time from 72 hours to about 30 hours. This would cut economic losses associated with the closure of I-5 by more than half.
- *Measure 13 – Off Channel Storage and Upstream Flow Restriction Structures.* Investigate the flood reduction achieved by installing flow restrictors (such as artificial log jams or agricultural storm water ponds) at strategic locations that would allow for significant amounts of water to be temporarily stored during normal and large flood events. In all areas above flow restrictors and where buyouts or flood easements take place, the following restoration activities are recommended: 1) restore floodplain and riparian areas via revegetation and livestock exclusion, 2) maximize stormwater mitigation opportunities from urban areas, 3) mitigate agricultural ditch runoff (agricultural stormwater ponds), 4) restore wetland complexes (enhancement of summertime flows), and 5) re-establish oxbow/side channel habitat functions as they relate to over winter/summer habitat for salmon.

- **Measure 14 – Chehalis Flowway Bypass.** Begin by adding the floodwater bypass measure at SR-6 (measure is defined in Technical Memorandum No. 3) in combination with voluntary buyouts and flood easements required to attain enhanced floodwater storage capacities in areas identified in measure 7. Then, reassess and if still needed to reach goals go to measure 15.
- **Measure 15 – Excavate Overbank Downstream of “Hump”.** Add a carefully designed overbank excavation downstream of the hump. Any excavation should be strategically designed to align with old side channels, and to remove invasive species such as reed canary grass and restore native vegetation. Excavation should not be located where the banks are functioning well and mature riparian forest is established.
- **Measure 16 – Elevate Segments of Interstate Highway 5.** Add elevation to specific segments of I-5.
- **Measure 17 – Modify Skookumchuck Dam.** Finally, add modifications of Skookumchuck Dam to improve flow control, but do not increase the storage.
- **Other Measures If Required.** Following a detailed analysis of the flood hazard reduction achieved by the above listed measures, this alternative will consider a sequence of structural measures.

4.4 Hydrologic and Hydraulic Assessment of Preliminary Alternatives

The following paragraphs provide a brief summary of the hydrologic and hydraulic performance aspects of preliminary alternatives 2, 3, 4, 5, and 7. Alternatives 1 (No Action), and 6 (Non-Structural) did not involve hydraulic modifications to evaluate in the assessment.

4.4.1 Alternative 2 – Skookumchuck Dam Modifications

Summary of Hydraulic Aspects of Alternative 2:

1. Modifications to the Skookumchuck Dam as currently proposed for the purposes of flood control operation would have a significant impact on the areal extent of flooding along the Skookumchuck River and a significant reduction in the peak stage of the

Skookumchuck River. Reductions in peak stage would generally be greatest within the reach closest to the dam and would generally lessen in a downstream direction.

2. Flood control operations using the current maximum pool of elevation 477 feet (11,000 ac-ft of storage above elevation 455 feet) would be sufficient to provide significant flood reduction benefits along the Skookumchuck River below the dam during most moderate flood events (i.e., 2-year to 25-year flood events).
3. Flood control operations using an increased maximum pool of elevation 492 feet (20,000 ac-ft of storage above elevation 455 feet) would be sufficient to provide significant flood reduction benefits along the Skookumchuck River below the dam during most moderate to large flood events (considerable flood damage reduction would likely be realized during a 50-year event and possibly during a 100-year event).
4. Flood damage reduction benefits from this alternative are expected to be limited along the Chehalis River. No flood reduction benefits would be provided to the City of Chehalis. Very small reductions in the peak stage (up to 0.2 foot during a 100-year event) may occur in the Chehalis River between RM 70 and RM 67 (Chehalis/Skookumchuck confluence). Slightly larger reductions in peak stage (possibly up to 0.5 foot during a 100-year event) could occur in the Chehalis River downstream of RM 67. Flood reduction benefits to the Chehalis River from this alternative are limited given the large size of the Chehalis River basin (895 square miles at Grand Mound) relative to the small basin area draining to the Skookumchuck reservoir (on the order of 60 square miles).

4.4.2 Alternative 3 – Excavation and Flowway Bypass

Summary of Hydraulic Aspects of Alternative 3:

1. The bypass-only alternative would cause a relatively significant reduction in the areal extent of flooding and a significant reduction in the peak stage of the Chehalis River in the vicinity of the two bypass channels. Peak stage would be reduced by up to 3 feet in the vicinity of the bypass channels (RM 77 to 74 and RM 73 to 66) during the 10-year event and by up to 4 feet during the 100-year event.
2. The bypass-only alternative would cause a slight increase in the peak stage of the Chehalis River downstream of RM 66. Peak stage downstream of RM 66 would increase by about 0.2 to 0.7 foot during a 10-year event and increase by about 0.1 to 0.4 foot during a 100-year peak. Downstream increases in peak stage are attributed to a more

efficient routing of flood flows through the Chehalis-Centralia reach due to the bypass features.

3. With the exception of a very short reach of the Skookumchuck River near the Chehalis River confluence (RM 0 to 1), the bypass-only alternative would have no impact on stage and attendant flooding in the Skookumchuck River.
4. The bypass plus Skookumchuck Dam Modifications Alternative would cause a relatively significant reduction in the areal extent of flooding and a significant reduction in the peak stage of the Chehalis River in the vicinity of the two bypass channels (primarily attributed to the bypass features). Peak stage would be reduced by up to 3 feet in the vicinity of the bypass channels (RM 77 to 74 and RM 73 to 66) during the 10-year event and by up to 4 feet during the 100-year event.
5. The bypass plus Dam Modifications Alternative would have little to no impact to the peak stage of the Chehalis River downstream of RM 66. Peak stage downstream of RM 66 would be essentially equal to peak stage in this reach under existing conditions. Flood control operations at the modified Skookumchuck Dam would essentially offset any stage increases in this reach attributed to the bypass channels.
6. The bypass plus Dam Modifications Alternative would cause a relatively significant reduction in the areal extent of flooding and a significant reduction in the peak stage of the Skookumchuck River downstream of the dam. Reductions in peak stage would generally be greatest within the reach closest to the dam (peak stage reductions of 2 to 6 feet during the 100-year event) and would generally lessen in a downstream direction (peak stage reductions of 1 to 3 feet in the vicinity of Centralia during the 100-year event). With the exception of a very short reach of the Skookumchuck River near the Chehalis River confluence (RM 0 to 1), flood reductions along the Skookumchuck River under this option are attributed solely to modified flood control operations at the dam.

4.4.3 Alternative 4 – Levee System

Summary of Hydraulic Aspects of Alternative 4:

1. The levee-only alternative would cause a relatively significant reduction in the areal extent of flooding in the Chehalis River valley in the Chehalis-Centralia reach. Although the levees would cause relatively small (less than 1 foot up to a 100-year event) increases in peak stage within the Chehalis River channel, water levels would be reduced in targeted areas of the floodplain where damages are most likely to occur. Slight increases

- in the peak stage within the Chehalis River channel would occur as a result of the levees keeping a higher proportion of the flow confined to the channel (resulting in less flow leaving the channel and entering overbank and floodplain areas).
2. The levee-only alternative would cause a slight increase in the peak stage of the Chehalis River downstream of RM 66. Peak stage downstream of RM 66 could increase by about 0.1 during a 10-year event and could increase by up to 0.15 feet during a 100-year peak. Slight downstream increases in peak stage are attributed to a more efficient routing of flood flows through the Chehalis-Centralia reach due to the levee system.
 3. The levee-only alternative would cause a relatively significant reduction in the areal extent of flooding in the lower Skookumchuck River valley in the Centralia area. This is based on the assumption that a system of continuous levees would be placed along both banks of the Skookumchuck River along the lower 4 miles of the river. Although the levees would cause moderate (up to 1 foot during a 10-year event, up to 3 feet during a 100-year event) increases in peak stage within the Skookumchuck River channel, water levels would be reduced in targeted areas of the floodplain where damages are most likely to occur. Increases in the peak stage within the Skookumchuck River channel would occur as a result of the levees keeping a higher proportion of the flow confined to the channel (resulting in less flow leaving the channel and entering overbank and floodplain areas).
 4. The levee plus Skookumchuck Dam Modifications Alternative would have a similar reduction in the areal extent and depth of flooding along the Chehalis River as the levee only option. Additional flood damage reduction benefits to the Chehalis River from the modification of Skookumchuck Dam would be limited and would be primarily limited to reaches downstream of the Chehalis/Skookumchuck confluence. Possibly the biggest benefit of adding flood control regulation at Skookumchuck Dam to this alternative is that the slight increase in stage in the Chehalis River downstream of Centralia attributed to the levee system would be mitigated. As a result, the peak Chehalis River stages downstream of Centralia under the levee plus Dam Modifications option would likely be lower relative to the peak stages under existing conditions.
 5. The levee plus Skookumchuck Dam Modifications Alternative would cause a significant reduction in the areal extent and depth of flooding along the Skookumchuck River. The assumed system of levees along the lower 4 miles of the river would protect most of Centralia from Skookumchuck River related flooding, and flood control operations at the dam would cause a significant reduction in stage within the channel.

4.4.4 Alternative 5 – Upstream Flow Restriction Structures

Summary of Hydraulic Aspects of Alternative 5

1. Both options of the flow restrictors would lower stage along the mainstem Chehalis River within the Chehalis-Centralia area, but would have essentially no impact to stage in the Skookumchuck River (i.e., the flow restrictors have no beneficial impact on flooding attributable to the Skookumchuck River).
2. Option 1 (a single flow restrictor) would lower peak stage in the Centralia/Chehalis area (damage area) on the order of 0.1 to 0.3 foot during a 10-year flood event. Option 1 would lower peak stage in the damage area on the order of 0.1 to 0.3 foot during a 100-year flood event.
3. Option 2 (four separate flow restrictors) would lower peak stage in the damage area on the order of 0.1 to 0.45 foot during a 10-year flood event. Option 2 would lower peak stage in the damage area on the order of 0.1 to 0.5 foot during a 100-year flood event.
4. Both options would have little impact on the areal extent of flooding in the damage area.
5. Based on the assumption of a 20-foot-high structure, each flow restrictor could cause a relatively significant increase in the areal extent and depth of flooding upstream of the structure. For instance, a single flow restrictor located at RM 87.54 on the Chehalis River would apparently worsen flooding across sections of SR-6 and would likely worsen flooding at homes and property upstream of the structure. The increased stage associated with a single flow restrictor at RM 87.54 could reach as far as 4 miles upstream of the structure. There may also be short-term impacts to fish passage and sediment transport associated with the flow restrictors.

4.4.5 Alternative 7 – Interagency Committee Alternative

This alternative seeks to reduce the impacts of flooding by focusing first on regulatory and voluntary measures. This alternative is presented as a sequence of measures that require action before additional measures are proposed. The sequence of measures is listed below:

1. Moratorium on floodplain development.
2. Adopt new FEMA flood maps.
3. Improve flood-warning system.
4. Restrict floodway development.
5. Restrict development in flow paths.

ALT 7
Evaluation

6. Restrict floodplain filling.
7. Preserve/enhance floodplain storage.
8. Restrict upland land uses.
9. Conduct flood audits.
10. Upgrade stormwater management systems.
11. Improve alternative transportation and emergency access routes.
12. Expand capacity of Chehalis-Centralia Airport dike culverts.
13. Use of upstream flow restrictor structures.
14. Construction of Chehalis (SR-6) flowway bypass channel.
15. Excavation of the "hump" in the Chehalis River channel near Galvin.
16. Elevate segments of I-5.
17. Modify Skookumchuck Dam to provide flood control.

Items 1 through 11 are primarily non-structural items and, as such, the effects of these items cannot be modeled using the UNET hydraulic model. Items 12 through 17 are mostly structural in nature and therefore can be simulated using the UNET model. Three options were evaluated for the current analysis. Option 1 simulates the effects of Items 12 through 15; Item 13 is assumed to consist of four flow restrictors as discussed under Alternative 5, Item 14 is considered as discussed under Alternative 3. Option 2 simulates the effects of Items 12 through 16 (Items 13 and 14 are simulated as described under Option 1). Option 3 simulates the effects of Items 12 through 17 (Items 13 and 14 are simulated as described under Option 1, Item 17 (Skookumchuck Dam modification) assumes a maximum of 11,000 ac-ft of flood control storage (maximum pool elevation of 477 feet).

Summary of Hydraulic Aspects of Alternative 7:

- (1) Option 1 would reduce peak flood stages in the Chehalis River significantly in the vicinity of the SR-6 bypass (up to a maximum peak stage reduction of approximately 3.5 feet for the 10-year and 100-year flood events) but would result in little to no stage reductions downstream of the bypass (i.e., peak stage reductions in the Chehalis River downstream of RM 72 would be on the order of 0 to 0.5 foot during the 100-year event, no apparent reductions in peak stage would occur in the Chehalis River downstream of RM 72 during small to moderate [i.e., up to a 25-year event] flood events).
- (2) Option 1 would have no impact (i.e., no stage reduction) in the Skookumchuck River.
- (3) Option 2 would reduce peak flood stages in the Chehalis River significantly in the vicinity of the SR-6 bypass (up to a maximum peak stage reduction of approximately 3.5

feet for the 10-year and 100-year flood events) but would result in little to no stage reductions downstream of the bypass (i.e., peak stage reductions in the Chehalis River downstream of RM 72 would be on the order of 0 to 0.5 foot during the 100-year event, no apparent reductions in peak stage would occur in the Chehalis River downstream of RM 72 during small to moderate [i.e., up to a 25-year event] flood events).

- (4) Option 2 would have no impact (i.e., no stage reduction) in the Skookumchuck River.
- (5) Option 3 would reduce peak flood stages in the Chehalis River significantly in the vicinity of the SR-6 bypass (up to a maximum peak stage reduction of approximately 3.5 feet for the 10-year and 100-year flood events). Option 3 would reduce peak flood stages in the Chehalis River downstream of the bypass as a result of flood control operations at Skookumchuck Dam. Reductions in the peak stage in the Chehalis River downstream of RM 72 would be modest (on the order of 0.1 to 0.5 foot during a 10-year event, slightly greater during a 100-year event).
- (6) Option 3 would significantly reduce the peak stage in the Skookumchuck River as a result of flood control operations at Skookumchuck Dam. Reductions in peak stage would generally be greatest within the reach closest to the dam (peak stage reductions of 1.5 to 3.5 feet during the 100-year event) and would generally lessen in a downstream direction (peak stage reductions of 1 to 2 feet in the vicinity of Centralia during the 100-year event).
- (7) All three options were simulated based on the assumption of the installation of four upstream flow restrictors (see Alternative 5). Based on the assumption of a 20-foot-high structure, each flow restrictor could cause a relatively significant increase in the areal extent and depth of flooding upstream of the structure. For instance, a single flow restrictor located at RM 87.54 on the Chehalis River would apparently worsen flooding across sections of S-6 and would likely worsen flooding at homes and property upstream of the structure. The increased stage associated with a single flow restrictor at RM 87.54 could reach as far as 4 miles upstream of the structure. There may also be short-term impacts to fish passage and sediment transport associated with the flow restrictors.

4.5 Phase 1 - Screening of Preliminary Alternatives

4.5.1 Phase 1: Preliminary Alternatives Screening Criteria

Section 4.2.1 listed the planning objectives for this project. In plan formulation, alternatives were screened by their capacity to meet objectives. In the initial screening phase, the plan formulation

team reviewed results of preliminary modeling of initial alternatives to assess their ability to address the following criteria.

Engineering Criteria:

1. Reduce flood hazards in the project area to the maximum extent practicable.
2. Decrease the transportation closures during flooding on I-5 and other critical transportation corridors to the maximum extent practicable.
3. Avoid increasing flood risks downstream from the project area.
4. Avoid decreasing any existing low flow benefits provided by Skookumchuck Dam.

Economic Criteria:

5. Reduce flood damage costs in the project area to the maximum extent practicable.
6. Reduce transportation delay costs in the study area to the maximum extent practicable.
7. Be cost-effective for both construction and maintenance.

Environmental Criteria:

8. Avoid adverse impacts to the aquatic environment to the extent practicable. Minimize and compensate for unavoidable adverse impacts to the aquatic environment.
9. Incorporate appropriate fish and wildlife habitat measures to the extent practicable.
10. Comply with all Federal, state, and local regulations, including environmental regulations

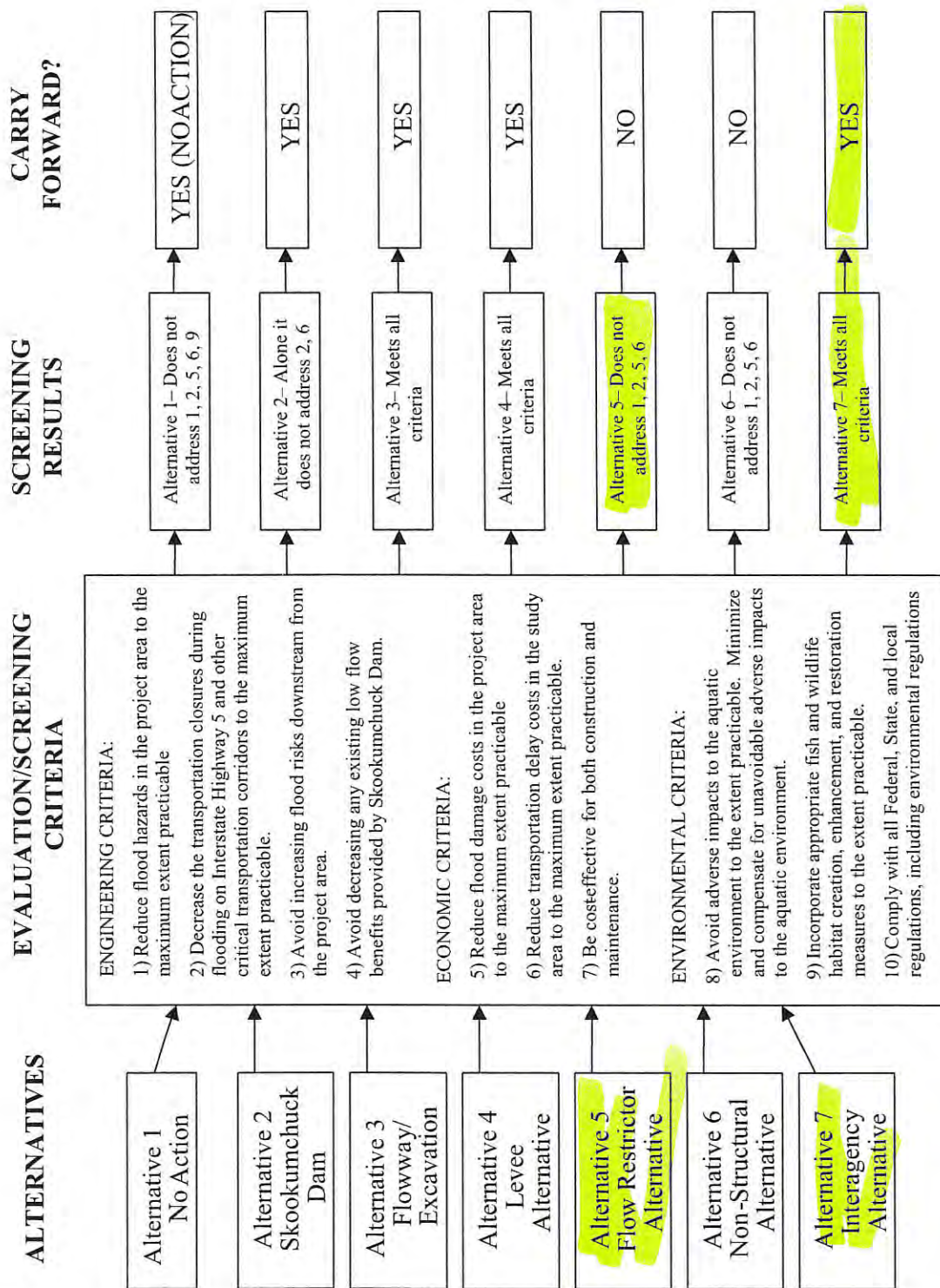
The first phase in the plan formulation process was to utilize the project criteria to screen each alternative. The formulation team used most current design, cost and modeling information that had been developed to determine if an alternative could possibly meet the criteria. If it was determined that an alternative could potentially meet all project criteria, or that it could be combined with other alternatives to help them meet all project criteria, then that alternative was carried forward for further evaluation in Phase 2. Several of the alternatives did not meet multiple criteria and were screened from further modeling and evaluation.

In addition to the design, cost and modeling information used to evaluate the preliminary alternatives, a limited environmental analysis of the impacts of the various alternatives was conducted. This included identification of the known HTRW sites in the project area. It also included working with the state and Federal agencies and the local tribes on a panel to identify the possible impacts of each alternative. It was this information that was utilized to identify the impacts and potential mitigation and associated costs of mitigation. Finally a limited investigation of the effect on the geomorphology of the Chehalis River by several of the

structural alternatives was conducted. The conclusions from this investigation were utilized in Phase 2 to confirm that the tentatively selected preferred plan did not have any significant impacts.

Several of the preliminary alternatives had various configurations or designs that had either been carried through from the previous feasibility studies or had been developed by the local sponsor previous to this study. Some of these designs were weighed against each other and eliminated from further study. Other configurations were judged to be more cost effective or more effective from an engineering standpoint.

The following flowchart documents the procedure for this phase of the formulation. It identifies the alternatives, the screening against the project criteria and whether an alternative was carried forward to Phase 2.



4.5.2 Phase 1: Results of Preliminary Alternatives Screening

Alternative 1 - No Action: The No Action Alternative would not reduce flood hazards in the project area, and would not meet Criterion 1; it would also do nothing to reduce flood-related transportation closures (Criterion 2). It would not reduce flood damage costs (Criterion 5), or transportation delay costs (Criterion 6). Under the No Action Alternative, flood damage would continue to cost the local economy an estimated \$9.1 million annually, and flood damage costs would increase as the cost of living increases. The No Action Alternative clearly could not reasonably meet the project criteria; however, it was carried forward for comparative purposes.

Alternative 2 – Skookumchuck Dam Modifications: This alternative was subjected to detailed economic and feasibility review, although it was evident early in the study process that it could not reasonably meet the project criteria as a stand-alone alternative. Modifications to Skookumchuck Dam would provide some flood damage reduction to Bucoda and parts of Centralia, but not to other parts of the study area (specifically, the City of Chehalis) and therefore could not fully meet Criteria 1 and 5 (maximum reduction of damage and damage costs). This alternative would have no effect on flooding of I-5 and other transportation routes and therefore could not meet Criteria 2 and 6 (maximum reduction of transportation delay and delay costs).

However, the Skookumchuck Dam modifications could provide flood damage reduction for portions of the study area. This alternative could also provide protection from some potential downstream flooding impacts by delaying flood flows on the Skookumchuck River until Chehalis River peak flows have passed. Alternative 2 was carried forward to evaluate the benefit of incorporating it into Alternatives 4 and 7. Skookumchuck Dam modifications are also a feature of Alternative 3. As part of this process, the four dam design variations were evaluated. The short tunnel with slide gates was the only design that proved to be feasible from an engineering standpoint.

Alternative 3 – Overbank Excavation and Flowway Bypass: As a result of the initial analysis, the Skookumchuck bypass, the Centralia Hospital bypass, and hump excavation components were dropped from this alternative. The Centralia overbank excavation and the SR-6 bypass were retained as components of Alternative 3. As noted earlier, modifications to Skookumchuck Dam (described in Alternative 2 above) would be included to provide flood damage reduction along the Skookumchuck River and reduce downstream effects.

Alternative 3 was then further evaluated based on the project criteria. The first stages of analysis indicated that this alternative met all of the project criteria. Hydraulic modeling demonstrated that Alternative 3 would reduce flood stages significantly within the study area; therefore, it met Criterion 1. Alternative 3 would provide 100-year flood protection for I-5 and significantly decrease the flooding of other transportation corridors (Criterion 2). With the inclusion of Skookumchuck Dam modifications, Alternative 3 would not result in any additional downstream flood risks (Criterion 3). Low flow benefits at Skookumchuck Dam would be maintained (Criterion 4). The screening indicated that the flood stage reductions would significantly reduce the flood damage costs (Criterion 5). Because flooding would be decreased on transportation corridors, transportation delay costs would be reduced (Criterion 6). Construction, operation, and maintenance appeared to be cost effective (Criterion 7).

With regard to Criterion 8, a number of environmental concerns and issues were raised about Alternative 3. For example, concerns raised by resource agencies included potential changes in sediment transport on the Chehalis River, changes in river geomorphology, effects on groundwater recharge, potential reduction in summer low flows, impacts on water quality, and loss of wetlands and riparian areas. This alternative appeared to have the potential for more than minimal environmental impacts. Additional studies would be needed to evaluate the alternative's impact on environmental resources. The SR-6 bypass would reconnect a portion of the historic floodplain to the Chehalis River and could be designed to maximize the environmental benefits of this reconnection (Criterion 9). Additional review would be necessary to determine compliance with all applicable rules and regulations (Criterion 10).

The screening indicated that this alternative was consistent with the project criteria, although there were issues that needed further investigation. Specifically, the economic benefits and environmental impacts warranted further review. This alternative was carried forward for further evaluation.

Alternative 4 – Setback Levees: The initial screening indicated that Alternative 4 would reduce flooding from the Chehalis River, Salzer Creek, Skookumchuck River and Dillenaugh Creek and would significantly reduce the flood hazards in Chehalis and Centralia (Criterion 1). Alternative 4 would meet Criterion 2 by protecting I-5 from flooding and providing protection to other critical transportation corridors in and around Chehalis and Centralia. This alternative would slightly increase flood stages downstream of the project area, potentially not meeting Criterion 3. However, further evaluation determined that these downstream risks would not be significant. By incorporating modifications to Skookumchuck Dam into the alternative, the risk

would be alleviated and no increase in downstream flood impacts would be experienced. Low-flow benefits of the Skookumchuck Dam would be maintained (Criterion 4). Alternative 4 would protect a significant portion of the existing residential and commercial infrastructure in Centralia and Chehalis area from flooding and protect I-5, thereby reducing flood damage costs and transportation delay costs (Criteria 5 and 6, respectively). The initial analysis indicated that Alternative 4 was cost-effective (Criterion 7).

With regard to Criterion 8, Alternative 4 could result in impacts to wetlands and riparian areas. The Skookumchuck Dam modifications could also result in adverse impacts to fish habitat and riparian areas along the Skookumchuck River, mainly between the dam and the first tributary downstream of the dam. Those impacts will be based on the dam re-operation process. Potential adverse impacts will be minimized by strict adherence to the proposed operation rule: not allowing additional water to be held behind the dam for a period longer than 5 consecutive days and release control based on fishery guidelines. The resource agencies raised questions about reductions in groundwater recharge, changes in sediment transport, channel self-maintenance, and channel stability. Additional evaluation of the alternative's impact on environmental resources would be needed. Although the levee alignment incorporated avoidance of environmental impacts within the design, additional adjustments to the levee alignment may further reduce adverse impacts to wetlands and riparian areas. Setting the alignment away from the river's edge may also allow opportunities for environmental restoration (Criterion 9). Finally, additional review would be necessary to determine compliance with all applicable rules and regulations (Criterion 10).

This alternative appeared to be consistent with the criteria, although there were issues that needed further investigation. Specifically, the economic benefits and environmental impact warranted further review. This alternative was carried forward for further evaluation.

Alternative 5 – Flow Restrictors: Preliminary hydraulic modeling of flow restrictors showed that they would not significantly reduce flooding in the project area and that they could cause a relatively significant increase in the areal extent and depth of flooding upstream of the structure. Therefore, Alternative 5 could not reasonably meet Criterion 1. Because flow restrictors would not decrease the flooding to I-5 or other critical transportation corridors in or around Chehalis or Centralia, the alternative would not meet Criterion 2. Any of the design options of Alternative 5 would avoid increased flooding downstream as the purpose would be to store water during a flood (Criterion 3). Alternative 5 does not include any modifications to Skookumchuck Dam, so low flow benefits would not be affected (Criterion 4). The flow restrictors would not reduce

flood stages and flood damages in the study area and would not meet Criterion 5. Alternative 5 would not decrease flooding to I-5 and the costs of transportation delay and would not meet Criterion 6. All design options of Alternative 5 had very high operational and maintenance costs because of the multiple structures and extensive area of coverage, and Criterion 7 would not be met. Although there may be short-term changes in sediment transport associated with installation of flow restrictors, this alternative would likely not have significant environmental impacts (Criterion 8). The flow restrictors have potential to create or enhance wetlands and create off-channel fish habitat, and would meet Criterion 9. Further investigation would be necessary to determine if this alternative would comply with all Federal, state, and local regulations (Criterion 10).

Although Alternative 5 met some of the project criteria, none of the design options could reasonably meet all of the criteria. Alternative 5 was therefore dropped from further evaluation.

Alternative 6 – Non-Structural Alternative: Alternative 6 would reduce some of the flood hazards in the study area by removing structures from the floodplain (Criterion 1) although it would not have any effect on closures of the existing transportation corridors (Criterion 2). Alternative 6 would not result in flooding impacts downstream of the study area (Criterion 3) or affect the low flow benefits of Skookumchuck Dam (Criterion 4). Alternative 6 would reduce flood damages (Criterion 5) but would not have any effect on reducing the costs of transportation delays (Criterion 6). The cost effectiveness of Alternative 6 was not fully evaluated because the initial screening showed that large-scale and relocation of residents and businesses would be cost prohibitive. For example, based on information provided by the City of Centralia (City of Centralia 1998) it has been estimated that as many as 3,000 structures could need to be removed from Centralia alone. Therefore, this alternative would not meet Criterion 7. With regard to Criterion 8, there would be at least temporary air quality, soil disturbance, hazardous waste, and water quality issues associated with the demolition and removal of structures, and substantial adverse impacts on the social fabric and economy of the area if large numbers of residents and businesses were required to relocate. These impacts would need further evaluation if the alternative were carried forward. Alternative 6 would have high potential for environmental restoration, including reforestation and reestablishment of wildlife corridor connectivity, and would meet Criterion 9. Further investigation would be necessary to determine if this alternative would comply with all Federal, state, and local regulations (Criterion 10).

Because Alternative 6 could not reasonably meet Criteria 2, 6, and 7, it was dropped from further investigation. However, many of the non-structural measures contained in this alternative could be incorporated into any recommended plan.

Alternative 7 – Interagency Committee Alternative: Alternative 7 combines several aspects of Alternatives 2 through 6 and therefore is a multiple-action alternative. Through discussion with the alternatives subcommittee, the subcommittee concurred with the Corps' findings regarding the use of flow restrictors (see discussion of Alternative 5) and excavation of the hump (see discussion of Alternative 3) and therefore dropped those measures from Alternative 7. However, the other actions remained as part of Alternative 7.

When structural measures are included, Alternative 7 would reduce flood hazards (Criterion 1) and decrease transportation closures (Criterion 2). Again, when structural measures are included, Alternative 7 would not result in downstream impacts (Criterion 3) or changes in the low-flow operation of Skookumchuck Dam (Criterion 4). Because flood hazards would be reduced, costs of flood damages would also be reduced (Criterion 5) as would the costs of transportation delay (Criterion 6). Costs of operation and maintenance would need to be further evaluated to determine if Criterion 7 could be met. With regard to Criterion 8, adverse environmental impacts such as loss of existing wetlands and riparian areas, corridor connectivity, and impacts to potential fish habitat would likely be similar to Alternatives 4 and 6 if all measures were implemented. Additional analysis would need to be done to evaluate the socioeconomic effects of development restrictions. Restoration opportunities would be similar to Alternatives 4 and 6 and inclusion of the SR-6 bypass would provide restoration opportunities described earlier for that component of Alternative 3 (Criterion 9). Further investigation would be necessary to determine if this alternative would comply with all Federal, state, and local regulations (Criterion 10).

This alternative appeared to be consistent with the criteria, although there were issues that needed further investigation. Specifically, the operation and maintenance costs and environmental impacts warranted further review. This alternative was carried forward for further evaluation.

Preliminary Alternatives Screening Summary: The conclusion of this process identified three alternatives that tentatively met all the project criteria; it also identified one alternative that could actually be a project feature for the other three alternatives. Consistent with NEPA requirements,

the No Action Alternative (Alternative 1) was also carried forward for further evaluation. The three alternatives that were carried through to Phase 2 are provided in Table 4-2.

TABLE 4-2 ALTERNATIVES FOR PHASE 2 SCREENING

• Alternative 1 – No Action Alternative
• Alternative 3A – Centralia overbank excavation and Chehalis SR-6 flow-way bypass (could be combined with the Dam Modifications, Alt 2)
• Alternative 4 – Levee System (could be combined with the Dam Modifications, Alt 2)
• Alternative 7 – Interagency Committee Alternative (combination of non-structural and structural features including the Dam Modifications, Alt 2)
• Alternative 2 – While Skookumchuck Dam Modifications did not meet multiple criteria, it was found to provide significant hydraulic reductions in flood stages along the Skookumchuck River and in parts of the City of Centralia. For this reason it was carried forward for further modeling and evaluation as a component to be considered for implementation in combination with other alternatives.

4.6 Phase 2 – Formulation and Screening of Final Alternatives

A risk-based analysis as described in Section 2.2.6, was performed for each alternative to determine residual damages, net benefits and project performance. The intermediate array of alternatives, as described in Section 4.5.2, is generally comprised of measures on both the Chehalis and Skookumchuck rivers. The formulation and screening strategy was developed to determine economic viability of each measure that comprises an alternative. The strategy first determines the measure that maximizes net benefits, then incrementally adds measures that (1) are incrementally justified; and (2) do not render the entire alternative unjustified. Each river, and the associated measures, were evaluated initially as hydraulically separable elements. The measure that yielded the highest net benefit became the first added measure. The evaluation separated the Chehalis and the Skookumchuck elements, however the influence (damages reduced) of one on the other was captured jointly as well as incrementally. The Chehalis River measures were evaluated as the first element, because those measures had the potential for the largest damage reduction. The Skookumchuck Dam element was the first added element, with other measures evaluated beyond the first added to determine if those measures were incrementally justified. The following paragraphs describe the risk based analysis (RBA) results for both damages reduced and project performance for each alternative.

4.7 Phase 2 – Description of Final Alternatives

In Phase 2, the initial alternatives carried forward from Phase 1 were further modified into multiple variations of each alternative. The Phase 2 modified alternatives were configured based on a common water surface profile from the hydraulic model. All alternatives analyzed in this phase used the 100-year frequency flow and the associated profile to define levee heights, bypass size, etc.; alternatives that did not reliably contain the 100-year flood event were not included. The 100-year frequency was selected as the common event for Phase 2 economic screening and also to allow comparison of engineering performance to the FEMA certification criteria.

4.7.1 Phase 2: Alternative 2 – Skookumchuck Dam Modifications Alternative

In Phase 2, a HEC-FDA analysis was conducted for the Skookumchuck River floodplain that evaluated benefits of the modifications at Skookumchuck Dam. The results showed the dam reduced damages and provided a positive benefit-to-cost ratio. To optimize the configuration, the team configured and modeled a "lower" pool (elevation 477 feet) to evaluate its costs and benefits.

The lower pool option does not raise the pool by inflatable rubber weir as with other alternatives, but focuses on the addition of an improved outlet structure. The variations on Alternative 2 that were evaluated in Phase 2 are listed below by the name of each variation. The configuration of each variation is described.

- **ExSkDam:** This configuration describes the existing Skookumchuck Dam that is not a flood control reservoir.
- **SKDam1:** This is the "lower dam" configuration that does not raise the pool (remains at elevation 477 feet) but improves the outlet structure (2B2, without pool raise); it has 11,000 ac-ft of flood control storage.
- **SKDam2:** This is the configuration described as Skookumchuck Dam Modifications 2B2. This alternative has 20,000 ac-ft of flood control storage by raising the storage elevation to 492.

In this phase a new configuration of 2B2 was utilized. It incorporated a design for both 11,000 ac-ft storage and 20,000 ac-ft storage. The reconfigured Alternative 2B2, Short Tunnel with

Slide Gates, would consist of constructing a short outlet works tunnel in the left abutment of the dam between the existing spillway and dam crest. An outlet works tower with slide gates would be built at the entrance to the new tunnel. The tunnel would discharge into the existing spillway chute, which would be modified to handle the full PMF flow. For the high flood storage pool option, 20,000 ac-ft, three steel tainter gates would be added to the top of the existing ogee spillway.

For the 11,000 ac-ft option, the existing overflow spillway would remain as it is with no control gates. For this case, the overflow spillway would have a total capacity of approximately 28,000 cfs. In order for the spillway to pass the full PMF flow of 32,500 cfs, the spillway chute entrance would have to be modified as was assumed in Alternative 2B1. Reference the Skookumchuck Dam Design appendix (Appendix B) for additional details.

4.7.2 Phase 2: Alternative 3 – Overbank Excavation and Flowway Bypass Alternative

The study team modeled this alternative as a separable first element measure and also in combination with the Skookumchuck Dam Modifications feature. This evaluation determined that the alternative, including the Chehalis bypass measures alone, did not provide sufficient damage reduction and subsequent net benefits to remain a viable stand-alone alternative. Therefore, a levee component was added around the Chehalis-Centralia Airport. The names used for the sub-alternatives of Alternative 3 in documentation of the Phase 2 screening are:

- **Bypass/APLev:** This configuration includes the Overbank Excavation and Flowway Modifications Alternative 3A with the addition of levee modification at Chehalis-Centralia Airport and Skookumchuck Dam Modifications 2B2 with 20,000 ac-ft of storage.
- **Bypass/SkDam1:** This configuration includes the Overbank Excavation and Flowway Modifications Alternative 3A plus Skookumchuck Dam Modifications 2B2 with 11,000 ac-ft of flood storage.
- **Bypass/SkDam2:** This configuration includes the Overbank Excavation and Flowway Modifications Alternative 3A plus Skookumchuck Dam Modifications 2B2 with 20,000 ac-ft of flood storage.

Another iteration of this alternative was added to the analysis process. This included adding the remainder of the Chehalis levee system to this alternative and modifying the configuration of the bypasses. This alternative combined elements of alternatives 3A, 2 and 4.

- **Hybrid Plan - SkookDam1:** This configuration included a modification to the bypass at Mellen Street and the SR-6 bypass. Both overbank excavations were reduced in size from the original Alternative 3A configuration, and the berm in the floodplain was removed. In addition the Chehalis levee system was added to this alternative. The levee heights were adjusted for the difference in hydraulic stages due to the influence of the overbank excavation areas. This also included the 11,000 ac-ft Skookumchuck Dam Modifications.
- **Hybrid Plan -SkookDam2:** This included the Hybrid Plan with the 20,000-ac-ft dam.

4.7.3 Phase 2: Alternative 4 – Levee Alternative

The Chehalis and Skookumchuck levees were evaluated separately to determine if the flood reductions measures for each segment were individually justified. Modeling runs indicated that the levees reduced damages significantly and were economically justified.

Seven sub-alternatives of Alternative 4 were developed and evaluated in this phase. These alternative configurations are as follows:

- **CheLev1:** This configuration includes levees on the Chehalis River at the original design height including levees along the Chehalis River, Salzer Creek and Dillenbaugh Creek.
- **CheLev2:** This configuration includes the levees on the Chehalis River elevated an additional 1.5 feet to the FEMA 100-year performance height.
- **CheLev1-SkDam1:** This configuration includes levees on the Chehalis River at the original design height combined with 11,000 ac-ft Skookumchuck Dam Modifications Alternative.
- **CheLev2-SkDam1:** This configuration includes levees on the Chehalis River elevated an additional 1.5 feet to the FEMA 100-year performance height combined with 11,000 ac-ft Skookumchuck Dam Modifications Alternative.

- ***CheLev2-SkDam2:*** This configuration includes levees on the Chehalis River elevated an additional 1.5 feet to the FEMA 100-year performance height combined with the 20,000 ac-ft Skookumchuck Dam Modifications Alternative.
- ***Skook Levee:*** This configuration includes the Skookumchuck River levees alone.
- ***CheLev1-SkLev:*** This configuration includes levees on the Chehalis River at the original design height combined with Skookumchuck River levees.
- ***CheLev2-SkLev:*** This configuration includes levees on the Chehalis River elevated an additional 1.5 feet to the FEMA 100-year performance height combined with Skookumchuck River levees.

Another set of iterations of this alternative was added to the analysis process. This included addition of SR-6 bypass to the levee combination and reduction of the length of the Skookumchuck River levees (from approximately 4 miles to approximately 2 miles), in combination with the original Chehalis levees and the Skookumchuck Dam. The following describes these additional alternatives:

- ***CheLev2- SR-6-SkDam1:*** This configuration includes levees on the Chehalis River at a 100-year protection, and the 11,000 ac-ft Skookumchuck Dam Modifications Alternative.
- ***CheLev2 -SR-6-SkDam2:*** This configuration includes the 100-year levees on the Chehalis River, a 20,000 ac-ft Skookumchuck Dam Modifications Alternative and the modified SR-6 bypass.
- ***CheLev2-SkDam1/SkLevee:*** This configuration includes the 100-year Chehalis levees, an 11,000 ac-ft Skookumchuck Dam and the addition of the Skookumchuck levees as a second added feature.
- ***CheLev2-SkDam2/SkLevee:*** This configuration includes the 100-year Chehalis levees, a 20,000 ac-ft Skookumchuck Dam and the addition of the Skookumchuck levees as a second added feature.

4.7.4 Phase 2: Alternative 7 – Interagency Alternative

Earlier hydraulic model runs showed that all the structural measures of Alternative 7 would need to be implemented in order to meet project criteria related to engineering effectiveness. This resulted in excessive costs that were not economically justified. In order to determine if this alternative could still be viable the team modified it to include levees and eliminated features such as flow restrictors and raising I-5 because they were too costly and did not provide substantial hydraulic benefits. Alternative 7 was reconfigured to include levees along I-5.

The resultant alternative configurations of Alternative 7 that were evaluated during Phase 2 are as follows:

- **Alternative 7:** This alternative included all the structural features listed in the description of Alternative 7 (measures 12 through 17). The non-structural measures could not be modeled or costed out for the study. This alternative did not reduce damages to the highway or the buildings; therefore it was not further evaluated.
- **Alternative 7A Combo- SkookDam1:** This configuration is the same as Alternative 7 above, but elevation of I-5 is not included and is replaced by implementation of levees along I-5. This alternative included a dam with 11,000 ac-ft flood storage.
- **Alternative 7A Combo- SkookDam2:** This configuration is the same as Alternative 7 above, but elevation of I-5 is not included and is replaced by implementation of levees along I-5. This alternative included a dam with 20,000-ac-ft of flood storage.

4.8 Phase 2 - Summary of Final Alternatives

Table 4-3 provides a summary list of the final alternatives to undergo Phase 2 screening.

TABLE 4-3 FINAL ALTERNATIVES

ALTERNATIVE	CONFIGURATION	DESCRIPTION
Alternative 1		No Action Alternative
Alternative 2	SKDam1 SKDam2 SKDam	Skookumchuck Dam Modifications Alternative Dam Modifications Alternative 2B2 without pool raise Dam Modifications Alternative 2B2 Existing dam
Alternative 3	Bypass – SkDam2 Bypass – SkDam1 Hybrid – SkDam1 Hybrid – SkDam2	Overbank Excavation and Flowway Bypass Alternative Bypass 3A with Dam Modifications Alternative 2B2 Bypass 3A with Dam Modifications Alternative 2B2 without pool raise Modified bypass with Levee Alternative with Dam Modifications Alternative 2B2 without pool raise Modified bypass with Levee Alternative with Dam Modifications Alternative 2B2 with pool raise
Alternative 4	CheLev2 - SkDam CheLev2 – SKDam1 CheLev2 – SKDam2 CheLev2- ExSkDam/SkLev CheLev2- SkDam1/SkLev CheLev2- SKDam2/SkLev	Levee System Alternative Chehalis River, Salzer Creek, Dillenbaugh Creek modified levee design to 100-year performance level with existing dam Chehalis River, Salzer Creek, Dillenbaugh Creek levee design to 100- year performance level with SKDam1 Chehalis River, Salzer Creek, Dillenbaugh Creek levee design to 100- year performance level with SKDam2 Chehalis River, Salzer Creek, Dillenbaugh Creek levee design to 100- year performance level with existing dam and Skookumchuck levees Chehalis River, Salzer Creek, Dillenbaugh Creek levee design to 100- year performance level with SKDam1 and Skookumchuck Levees Chehalis River, Salzer Creek, Dillenbaugh Creek levee design to 100- year performance level with SKDam2 and Skookumchuck Levees
Alternative 7	Alternative 7- existing dam Alternative 7- SkDam1 Alternative 7- SkDam2	Interagency Alternative All structural features without I-5 raise and with levees with existing dam All structural features without I-5 raise and with levees with low pool dam All structural features without I-5 raise and with levees with high pool dam

4.9 Phase 2 - Estimated Costs of Final Alternatives

Preliminary cost estimates developed during Phase 1 were refined for all final Phase 2 alternatives, as follows in Table 4-4:

TABLE 4-4 SUMMARY COST ESTIMATES FOR FINAL ARRAY OF ALTERNATIVES

ALTERNATIVES		First Cost of Alternative	O & M Costs (per year)	Real Estate Appraised Cost	Mitigation Costs	Interest During Construction	Total Costs w/o O&M	Total Annualized Costs
#2	Skookumchuck Dam Modifications							
	SkDam 1. This is the "lower dam" configuration that does not raise the pool (remains at 477 elevation) but improves the outer structure (2.b.2 without pool raise); it has 11,000 acre-feet of flood control storage.	\$6,034,053	\$448,297	\$0	\$3,270,000	\$569,873	\$9,873,926	\$1,085,698
	SkDam 2. This is the configuration described as Skookumchuck Dam Modification 2.b.2. This alternative has 20,000 acre-feet of flood control storage by raising the storage elevation to 492.	\$8,237,016	\$514,512	\$0	\$3,270,000	\$704,805	\$12,211,821	\$1,302,834
#3	Bypass							
	Bypass w/o Dam: This configuration includes the Overbank Excavation and Flowway Modifications Alternative 3A.	\$64,553,252	\$37,100	\$14,794,758	\$8,713,900	\$5,393,792	\$93,455,702	\$6,070,038
	Bypass - SkDam 1: This configuration includes the Overbank Excavation and Flowway Modifications Alternative 3A plus Skookumchuck Dam Modification 2.b.2 with 11,000 acre feet of flood storage.	\$70,587,305	\$448,297	\$14,794,758	\$11,983,900	\$6,024,915	\$104,390,878	\$7,187,144
	Bypass - SkDam 2: This configuration includes the Overbank Excavation and Flowway Modifications Alternative 3A plus Skookumchuck Dam Modification 2.b.2 with 20,000 acre of flood storage.	\$72,790,268	\$551,612	\$14,794,758	\$11,983,900	\$6,159,847	\$106,728,773	\$7,441,379
	Bypass - AP Levee SkDam2: This configuration includes the Overbank Excavation and Flowway Modifications Alternative 3A with the addition of levee modification at Centralia-Chehalis Airport and Skookumchuck Dam Modification 2.b.2 with 20,000 acre feet of storage.)	\$74,481,054	\$551,612	\$14,794,758	\$8,713,900	\$6,001,870	\$103,991,582	\$7,264,683
	Hybrid - SkDam1: This configuration included a modification to the bypass at Mellen Street and the SR6 bypass. Both overbank excavations were reduced in size from the original Alternative 3A configuration. And the berm in the floodplain was removed. In addition the Chehalis levee system was added to this alternative. The levee heights were adjusted for the difference in hydraulic stages due to the influence of the overbank excavation areas. This also included the 11,000 acre-foot Skookumchuck Dam.	\$61,135,412	\$547,789	\$14,794,758	\$8,713,900	\$5,184,449	\$89,828,519	\$6,346,578
	Hybrid - SkDam2 (This included the Hybrid plan with the 20,000-acre foot dam)	\$63,338,375	\$1,099,401	\$14,794,758	\$8,713,900	\$5,319,381	\$92,166,414	\$7,049,110

- continued next page -

ALTERNATIVES								
#4	Levee	First Cost of Alternative	O & M Costs (per year)	Real Estate Appraised Cost	Mitigation Costs	Interest During Construction	Total Costs w/o O&M	Total Annualized Costs
	CheLev2: This configuration includes the levees on the Chehalis River elevated an additional 1.5 feet to the FEMA 100-year performance height.	\$39,790,000	\$99,492	\$7,493,624	\$8,713,900	\$3,429,848	\$59,427,372	\$3,935,766
	CheLev2 - SR6Dam1: This configuration includes levees on the Chehalis River elevated an additional 1.5 feet to the FEMA 100-year performance height combined with Skookumchuck Dam Alternative.	\$45,824,053	\$547,789	\$7,493,624	\$11,983,900	\$3,999,722	\$69,301,299	\$5,021,464
	CheLev2 - SR6Dam2: This configuration includes levees on the Chehalis River elevated an additional 1.5 feet to the FEMA 100-year performance height combined with the 20,000 acre-foot Skookumchuck Dam Alternative.	\$48,027,016	\$514,512	\$7,493,624	\$11,983,900	\$4,134,653	\$71,639,193	\$5,139,107
	SR 6	\$2,907,935	\$10,000	\$2,000,000	\$0	\$300,611	\$5,208,546	\$346,232
	CheLev2-SR6Dam1-SR6: (This configuration includes levees on the Chehalis River at a 100 year protection, the 11,000 acre foot Skookumchuck dam alternative and a modified 400 foot wide SR6 bypass)	\$48,731,938	\$557,789	\$9,493,624	\$11,983,900	\$4,300,333	\$74,509,845	\$5,367,696
	CheLev2-SR6Dam2-SR6: (This configuration includes the 100-year levees on the Chehalis River, a 20,000-acre foot Skookumchuck dam alternative and the modified SR6 bypass)	\$50,934,951	\$624,004	\$9,493,624	\$11,983,900	\$4,435,264	\$76,847,739	\$5,584,832
	SkookLevee - 100 year: This configuration includes the Skookumchuck River levees alone.	\$10,360,000	\$19,025	\$2,802,000	\$0	\$806,173	\$13,968,173	\$920,726
	SkookLevee - Chehalis Backwater: This shows the cost of the Skookumchuck River Levees that are attributable to the Chehalis levees to mitigate against all backwater stage increases.	\$5,560,000	\$19,025	\$2,802,000	\$0	\$512,173	\$8,874,173	\$591,888
	CheLev2-SR6Dam1-SkookLevee: This configuration includes the 100-year Chehalis levees, an 11,000 acre-foot Skookumchuck Dam and the addition of the Skookumchuck levees as a second added feature.	\$56,184,053	\$566,814	\$10,295,624	\$11,983,900	\$4,805,894	\$83,269,471	\$5,942,190
	CheLev2-SR6Dam1-SkookLevee-SR6: This configuration includes levees on the Chehalis River at a 100 year protection, the 11,000 acre foot Skookumchuck dam alternative and a modified 400 foot wide SR6 bypass.	\$59,091,988	\$576,814	\$12,295,624	\$11,983,900	\$5,106,505	\$88,478,017	\$6,288,422
#7	Interagency Committee Alternative - Modified							
	Alternative 7A Combo-SkookDam1: This configuration is the same as Alternative 7 above, but elevation of 1-5 is not included and is replaced by implementation of levees along 1-5. This alternative included a dam with 11,000-acre foot flood storage.	\$55,336,224	\$251,080	\$12,493,624	\$11,983,900	\$4,888,592	\$84,702,340	\$5,718,953

4.10 Phase 2 - Risk-Based Assessment and Evaluation of Final Alternatives

The following paragraphs describe the RBA results for damages reduced for each measure and combination of alternatives. The analysis results and screening logic are described below.

4.10.1 With-Project Hydrology and Hydraulics

The with-project conditions for each measure were modeled by modifying the existing condition input data according to the results of the UNET modeling results. For example, if a particular discharge-frequency or stage-discharge function was altered as a result of a particular measure (levee, bypass, or reservoir), the appropriate without-project data set was modified and HEC-FDA recalculated residual damages and performance parameters. Total residual damages for each alternative were determined by coupling measures for each of the Chehalis River and the Skookumchuck River. For example, one alternative is comprised of levees on the Chehalis and levees on the Skookumchuck. The full array of intermediate alternatives is described in Section 4.7.

4.10.2 Residual Damages, Damages Reduced and Net Benefits

The Chehalis River Levee measures, as the first alternative element, were evaluated using the existing Skookumchuck Dam operation. The HEC-FDA results for residual damages are presented in Table 4-5. Table 4-5's Other Damages Reduced includes transportation delays, agricultural damages, and the avoided cost savings from eliminating raising I-5 during its scheduled modification as described in Section 6.3. Table 4-5 indicates that only three of the five general alternative plans presented in the table have a likelihood of meeting NED criteria. These three general plans are: (1) CheLev2, (2) Hybrid Plan, and (3) CheLev2 – SKLev. Each of these general plans may or may not contain a Skookumchuck Dam modification. The two general plan types that can be ruled out as potentially producing a NED candidate are Bypass and Alternative 7. These two general plan types are ruled out for further analyses by their negative net NED benefits showing at this level of plan formulation. The Hybrid general plan type is also eliminated from further analyses at this time given the disparity in net NED benefits in comparison to the other two general plan types. Although the Hybrid Plan type shows positive net NED benefits, it is unlikely that this plan type could close the annual benefit difference of \$324,000, given the level of feature overlap between the general plan types.

The general plan type with the highest net benefit is CheLev2 with a net annual benefit range \$1,677,000 to \$2,699,000. With the difference between the two remaining general plan types being only levees on the Skookumchuck River and that the general plan type with these levees (CheLev2 – SKLev) showing incremental justification of the Skookumchuck levees, the remaining analyses will focus on this general plan type.

Skookumchuck Dam was included in the evaluation as a first added element to determine the flood reduction effectiveness. There were two storage alternatives evaluated an 11,000 ac-ft dam and a 20,000 ac-ft dam. Each storage component was evaluated for each of the Chehalis plans. The incremental benefit for the CheLev2 plan with the 11,000 ac-ft dam is \$2,107 with an incremental benefit-to-cost of 1.94. The combined plan yields a net benefit of \$2,698.64 with a benefit-to-cost of 1.48. This includes the impacts of the dam on the Chehalis since the effects are captured in the resultant hydraulic analysis. The incremental benefit for raising the CheLev2 plan from 11,000 ac-ft to the 20,000 ac-ft dam is \$122 with an incremental cost of \$217, and an incremental benefit-to-cost of 0.56. Increasing the dam size from 11,000 ac-ft to 20,000 ac-ft is not justified, and for this reason the analysis assumes that the 11,000 ac-ft dam is incrementally justified as the first added element.

In an attempt to further reduce flooding on the Skookumchuck River, specifically in Reach 4, levees along the Skookumchuck River were analyzed. The incremental net benefit change from CheLev2 plan with the 11,000 ac-ft dam to the CheLev2 plan with the 11,000 ac-ft dam and Skookumchuck levees is -\$6,000; and given that the CheLev2 with 11,000 ac-ft dam alternative does not consider backwater effects on the Skookumchuck River at this stage, it is reasonable to assume that the CheLev2 – SKDam and SKLev plan type would most likely generate the NED recommended plan.

TABLE 4-5 WITH-PROJECT ECONOMIC ANALYSIS

Alternative	Expected Annual Damages (\$1,000s)*						Flood Damages Reduced	Other " Damages "	Other Damages Reduced	Total Damages Reduced	Cost	Net Benefit	B/C
	Chehalis			Skookumchuck									
	Res/Comm	Public		Res/Comm	Public	Total							
	6147.81	442.93		2211.84	42.36	8844.94							
No Action							0.00	2239.10	0.00	0.00	0.00	0.00	0.00
CheLev2 - Existing SkDam	2347.19	82.95		2392.52	46.94	4869.60	3975.34	2239.10	2239.10	6214.44	4537.06	1677.38	1.37
CheLev2 - SkDam 1	2081.67	70.05		595.59	15.34	2762.65	6082.29	2239.10	2239.10	8321.39	5622.75	2698.64	1.48
CheLev2 - SkDam 2	2057.19	68.37		504.68	10.57	2640.81	6204.13	2239.10	2239.10	8443.23	5839.89	2603.34	1.45
CheLev2SR-6 - Ex SkDam	2186.09	58.63		2290.11	42.72	4577.55	4267.39	2239.10	2239.10	6506.49	4863.89	1642.60	1.34
CheLev2SR-6 - SkDam 1	1893.35	45.85		694.59	14.09	2647.88	6197.06	2239.10	2239.10	8436.16	5949.58	2486.58	1.42
CheLev2SR-6 - SkDam 2	1876.98	43.86		498.56	10.30	2429.70	6415.24	2239.10	2239.10	8654.34	6166.72	2487.62	1.40
Hybrid Plan - Existing Dam	2231.15	61.06		1363.55	38.16	3693.92	5151.02	2239.10	2239.10	7390.12	5098.44	2291.68	1.45
Hybrid Plan - SkDam 1	1901.64	47.66		562.03	14.14	2525.47	6319.47	2239.10	2239.10	8558.57	6184.14	2374.43	1.38
Hybrid Plan - SkDam 2	1900.60	45.02		464.71	8.85	2419.18	6425.76	2239.10	2239.10	8664.86	6401.28	2263.58	1.35
CheLev2 - Ex SkDam/SKLev	2217.91	60.56		1677.61	42.06	3998.14	4846.80	2239.10	2239.10	7085.90	4865.90	2220.00	1.46
CheLev2 - SkDam 1/SKLev	1932.99	50.86		453.78	11.19	2448.82	6396.12	2239.10	2239.10	8635.22	5951.60	2683.62	1.45
CheLev2 - SkDam 2/SKLev	1924.27	48.05		337.42	9.32	2319.06	6525.88	2239.10	2239.10	8764.98	6168.73	2596.25	1.42
Bypass - Existing Dam	3404.44	30.56		2225.90	38.25	5699.15	3145.79	2239.10	0.00	3145.79	6070.04	-2924.25	0.52
Bypass - SkDam 1	2996.60	98.17		542.00	9.28	3646.05	5198.89	2239.10	0.00	5198.89	6882.46	-1683.57	0.76
Bypass - SkDam 2	2977.01	94.28		458.70	6.60	3536.59	5308.35	2239.10	0.00	5308.35	7526.87	-2218.52	0.71
Alternative 7 - Existing Dam	3382.07	97.10		2288.89	41.94	5810.00	3034.94	2239.10	0.00	3034.94	5081.55	-2046.61	0.60
Alternative 7 - SkDam 1	2899.76	74.89		601.44	18.63	3594.72	5250.22	2239.10	0.00	5250.22	5718.95	-468.73	0.92
Alternative 7 - SkDam 2	2869.41	70.80		526.26	7.69	3474.16	5370.78	2239.10	0.00	5370.78	5869.87	-499.09	0.91

*Numbers may not add due to rounding **Other Damages includes 1-5 avoided cost savings and traffic delay reductions through 2012.

4.10.3 Project Performance

In addition to the economic basis for screening alternatives, the engineering performance is also considered. The two performance indices targeted for this analysis were the Expected Annual Exceedance and the Conditional Probability of Non-Exceedance for the .01 event. A goal of the recommended alternative would be to provide certification to FEMA for providing protection against a 100-year flood event. The reporting of the performance is based on the controlling value at any of the index locations for each river. Table 4-6 below details the expected exceedance, the conditional probability of non-exceedance and the equivalent long-term risk.

TABLE 4-6 PHASE 2 PERFORMANCE ANALYSIS

Alternative	Expected Annual Exceedance %		Equivalent Long-Term Risk						Conditional Probability of Design Containing Indicated Event											
			10 Yrs		25 Yrs		50 Yrs		10%				4%				2%			
	Chehalis	Skook	Cheh	Skook	Cheh	Skook	Cheh	Skook	Cheh	Skook	Cheh	Skook	Cheh	Skook	Cheh	Skook	Cheh	Skook	Cheh	Skook
New Existing	59.6	21.1	100.0	90.0	100.0	100.0	100.0	100.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
CheLev2 - Existing SkDam	0.3	21.1	2.7	90.4	6.7	99.7	12.9	100.0	100.0	6.3	100.0	0.2	99.7	0.1	95.7	0.0				
CheLev2 - SkDam 1	0.3	5.5	2.5	43.3	6.1	75.8	11.2	94.1	100.0	87.6	100.0	48.6	99.7	4.2	95.9	0.1				
CheLev2 - SkDam 2	0.2	5.5	2.4	43.3	6.0	75.3	11.6	94.1	100.0	87.5	100.0	48.2	99.7	4.1	96.3	0.6				
CheLev2SR6 - Ex SkDam	0.2	21.1	2.0	90.6	4.9	99.7	9.5	100.0	100.0	6.4	100.0	0.2	99.7	0.0	97.3	0.0				
CheLev2SR6 - SkDam 1	0.2	5.4	1.7	42.7	4.3	75.2	8.3	93.8	100.0	87.8	100.0	51.8	99.8	3.3	98.1	0.1				
CheLev2SR6 - SkDam 2	0.2	5.4	1.7	42.4	4.1	74.8	8.1	93.7	100.0	87.7	100.0	52.4	99.8	4.3	98.2	0.5				
Hybrid Plan - Existing Dam	0.3	20.5	2.7	89.9	6.7	99.7	12.9	100.0	100.0	7.5	100.0	0.2	99.7	0.1	96.0	0.0				
Hybrid Plan - SkDam 1	0.2	2.4	2.4	50.4	6.0	82.6	11.6	97.0	100.0	79.1	100.0	37.6	99.8	3.7	97.5	0.1				
Hybrid Plan - SkDam 2	0.2	6.8	2.4	50.4	5.8	82.7	11.3	97.0	100.0	79.1	100.0	37.6	99.7	3.8	97.4	0.6				
CheLev2 - Ex SkDam/SKLev	0.2	21.0	2.2	90.5	5.4	99.7	10.6	100.0	100.0	6.4	100.0	0.2	99.6	0.0	96.9	0.0				
CheLev2 - SkDam 1/SKLev	0.2	6.7	2.1	50.1	5.1	82.4	9.9	96.9	100.0	80.6	100.0	35.7	99.6	3.7	96.9	0.1				
CheLev2 - SkDam 2/SKLev	0.2	6.7	1.7	50.1	4.6	82.4	9.0	96.9	100.0	80.6	100.0	35.7	99.8	3.6	97.8	0.7				
Bypass - Existing Dam	49.2	21.0	99.9	90.5	100.0	99.7	100.0	100.0	0.0	6.4	0.0	0.2	0.0	0.0	0.0	0.0				
Bypass - SkDam 1	49.2	6.7	99.9	49.8	100.0	82.2	100.0	96.8	0.0	80.2	0.0	38.1	0.0	3.4	0.0	0.2				
Bypass - SkDam 2	49.3	6.6	99.9	49.5	100.0	81.9	100.0	96.7	0.0	80.2	0.0	38.5	0.0	4.1	0.0	0.6				
Alternative 7 - Existing Dam	53.0	21.1	100.0	90.6	100.0	99.7	100.0	100.0	0.0	6.3	0.0	0.2	0.0	0.0	0.0	0.0				
Alternative 7 - SkDam 1	52.0	6.8	99.9	50.5	100.0	82.7	100.0	97.0	0.0	80.1	0.0	34.0	0.0	3.6	0.0	0.1				
Alternative 7 - SkDam 2	52.0	6.8	99.9	50.4	100.0	82.7	100.0	97.0	0.0	80.1	0.0	34.0	0.0	3.7	0.0	0.7				

4.11 Phase 2 - Screening Results, Preliminary NED Alternative

Based on economic performance and engineering performance evaluated in screening Phase 2, the most effective alternative for reducing flood damages was identified as a combination of the flood control features Chehalis Levee 2 and Skookumchuck Dam 1. This alternative produced the highest net benefits. The alternative producing the next highest level of net benefits was Chehalis Levee 2, Skookumchuck Dam 1, and Skookumchuck Levees. Because the net benefits of the two alternatives were very close, all three features were carried forward to the next iteration of plan formulation, Phase 3 - Optimization

At this time, no plan satisfies FEMA's Conditional Non-Exceedance Probability criteria for both rivers. However, the Chehalis Levee 2 Plan alternative meets the 0.01 Conditional Non-Exceedance Probability for the Chehalis River along the protected areas. To achieve the same performance along the Skookumchuck River, it appears that additional levees will need to be included along with a dam measure.

4.12 Phase 3 – Optimization and Identification of NED Plan

In the final phase of plan formulation, several different sizes of the plan features carried over from Phase 2 were further evaluated for optimization of project size. This optimization resulted in identification of the NED plan.

4.12.1 Optimization

The array of alternatives analyzed in this optimization phase consists of three basic features that are as follows.

- Skookumchuck Dam Modification;
- Chehalis River Levee Improvements; and
- Skookumchuck River Levee Improvements.

Each of these basic features has an array of its own. For Skookumchuck Dam, two storage capacity level increases were considered with these capacity increases, as follows:

- an 11,000 ac-ft increase; and
- a 20,000 ac-ft increase.

For the Chehalis and Skookumchuck Rivers, five levee improvement levels were considered for each with these levels, as follows⁴:

- a levee height 2 feet below the 100-year water surface elevation (WSE)⁵;

⁴ Additionally, levee heights at 2 and 3 feet below the 100-year WSE were evaluated on the Skookumchuck River.

⁵ As the study is conducted under a risk-based approach, the "100-year" flood consists of a distribution of floods defined by risk-based parameters as presented in hydraulics and hydrology appendices. For the 100-year WSE, the mean values of the risk parameters associated with the 1 percent chance flood were utilized to develop the water

- a levee height at the 100-year WSE;
- a levee height that has a 75-year level of flood protection;
- a levee height that has a 100-year level of flood protection;
- a levee height of approximately 200-year level of protection; and
- a backwater levee only option on the Skookumchuck River.

These basic modes were combined to form 54 potential alternatives, as shown in Table 4-7, below.

TABLE 4-7 PHASE 3 ALTERNATIVES

Existing	100	Backwater
11,000	100	Backwater
11,000	WSE -1	WSE -1
11,000	WSE -1	WSE
11,000	WSE -1	200
11,000	WSE -1	100
11,000	WSE -1	75
11,000	WSE	WSE -1
11,000	WSE	WSE
11,000	WSE	200
11,000	WSE	100
11,000	WSE	75
11,000	75	WSE -1
11,000	75	WSE
11,000	75	200
11,000	75	100
11,000	75	75
11,000	100	WSE-3
11,000	100	WSE-2
11,000	100	WSE -1
11,000	100	WSE
11,000	100	200
11,000	100	100
11,000	100	75
11,000	200	WSE -1
11,000	200	WSE
11,000	200	200
11,000	200	100
11,000	200	75
20,000	WSE -1	WSE -1
20,000	WSE -1	WSE
20,000	WSE -1	200
20,000	WSE -1	100
20,000	WSE -1	75

surface elevation. To provide protection of a given frequency, and as a flood of a given frequency consists of many differing levels, the height of the levee must contain 90 percent of that level's distribution of floods (100-year WSE + 3 feet).

20,000	WSE	WSE
20,000	WSE	200
20,000	WSE	100
20,000	WSE	75
20,000	75	WSE -1
20,000	75	WSE
20,000	75	200
20,000	75	100
20,000	75	75
20,000	100	WSE -1
20,000	100	WSE
20,000	100	200
20,000	100	100
20,000	100	75
20,000	200	WSE -1
20,000	200	WSE
20,000	200	200
20,000	200	100
20,000	200	75

The HEC-FDA model was employed to determine residual damages for all damages except for those damages related to agriculture and transportation. In the case of agricultural damages, the designs of the alternatives would not afford protection to the Chehalis River's west side in the area of agricultural production and agricultural damage reductions would be minimal, if at all. Therefore, no agricultural damage reductions are claimed for any alternative. In the case of rail freight transportation damages, the proposed alternatives would not fully protect the rail lines and transportation delays would continue during flooding events since the railroads would be inundated prior to entering the project area. Therefore, no damage reductions are claimed.

In the without-project condition, traffic on Interstate-5 experiences delays during flood events. I-5 is scheduled to have major modifications made by 2012 to increase its capacity and to eliminate flood-related delays. The without-project analysis indicates that the annual damages associated with traffic delays on I-5 are \$476,300. Full implementation of flood control operations for all alternatives is 2007. Applying a net present value approach to the expected annual traffic delay costs during the 2007 to 2012 timeframe yields an annual damage reduction of \$129,079, if a project that provides at least 100-year protection is implemented.

Currently there are plans to upgrade and modernize I-5 to increase its capacity and remove it from the threat of flooding. The current cost of this future modernization for elevating the roadway above the 100-year event is estimated at \$44,000,000. The plan for I-5 indicates that implementation would take place after the base year of any of the alternatives and would be

finished in 2012. If an alternative with at least a 100-year level of protection is implemented, modernization of I-5 would avoid the elevation expenditure of \$44,000,000. As this expenditure would occur in the future after the construction of an alternative, discounting this future cost yields a current base year value of \$32,686,200. Amortization of this avoided expenditure yields an annual savings of \$2,110,000.

NED benefits for the alternatives are shown in Table 4-8, below.

TABLE 4-8 PHASE 3 ALTERNATIVES NED BENEFITS
(\$1,000s, 2002 price level)

Skookumchuck Dam	Chehalis Levee	Skookumchuck Levee	Residual Damages*	Damage Reduction	I-5 Avoided Costs	I-5 Delay Benefits	Total Benefits
No Action	100	Backwater	4577.55	4267.37	2110.00	129.10	6,506.47
11,000	100	Backwater	2647.88	6197.04	2110.00	129.10	8,436.14
11,000	WSE -1	WSE -1	4340.59	4504.33	0.00	0.00	4504.33
11,000	WSE -1	WSE	4320.37	4524.55	0.00	0.00	4524.55
11,000	WSE -1	75	4305.28	4539.64	0.00	0.00	4539.64
11,000	WSE -1	100	4256.03	4588.89	0.00	0.00	4588.89
11,000	WSE -1	200	4213.24	4631.68	0.00	0.00	4631.68
20,000	WSE -1	WSE -1	4179.64	4665.28	0.00	0.00	4665.28
20,000	WSE -1	WSE	4157.31	4687.61	0.00	0.00	4687.61
20,000	WSE -1	75	4142.48	4702.44	0.00	0.00	4702.44
20,000	WSE -1	100	4087.72	4757.2	0.00	0.00	4757.20
20,000	WSE -1	200	4060.17	4784.75	0.00	0.00	4784.75
11,000	WSE	WSE -1	3695.48	5149.44	0.00	0.00	5149.44
11,000	WSE	WSE	3675.26	5169.66	0.00	0.00	5169.66
11,000	WSE	75	3660.17	5184.75	0.00	0.00	5184.75
11,000	WSE	100	3610.93	5233.99	0.00	0.00	5233.99
11,000	WSE	200	3568.13	5276.79	0.00	0.00	5276.79
20,000	WSE	WSE -1	3540.11	5304.81	0.00	0.00	5304.81
20,000	WSE	WSE	3517.77	5327.15	0.00	0.00	5327.15
20,000	WSE	75	3502.94	5341.98	0.00	0.00	5341.98
20,000	WSE	100	3448.18	5396.74	0.00	0.00	5396.74
20,000	WSE	200	3420.63	5424.29	0.00	0.00	5424.29
11,000	75	WSE -1	2983.3	5861.62	0.00	0.00	5861.62
11,000	75	WSE	2963.1	5881.82	0.00	0.00	5881.82
11,000	75	75	2948	5896.92	0.00	0.00	5896.92
11,000	75	100	2898.76	5946.16	0.00	0.00	5946.16
11,000	75	200	2855.97	5988.95	0.00	0.00	5988.95
20,000	75	WSE -1	2846.42	5998.5	0.00	0.00	5998.50
20,000	75	WSE	2824.1	6020.82	0.00	0.00	6020.82
20,000	75	75	2809.27	6035.65	0.00	0.00	6035.65
20,000	75	100	2754.5	6090.42	0.00	0.00	6090.42
20,000	75	200	2726.94	6117.98	0.00	0.00	6117.98
11,000	100	WSE-3	2591.48	6253.44	2110.00	129.10	8492.54
11,000	100	WSE-2	2556.29	6288.63	2110.00	129.10	8527.73
11,000	100	WSE -1	2533.37	6311.55	2110.00	129.10	8,550.65
11,000	100	WSE	2513.16	6331.76	2110.00	129.10	8,570.86
11,000	100	75	2498.06	6346.86	2110.00	129.10	8,585.96
11,000	100	100	2448.83	6396.09	2110.00	129.10	8,635.19
20,000	100	WSE -1	2409.98	6434.94	2110.00	129.10	8,674.04
11,000	100	200	2406.04	6438.88	2110.00	129.10	8,677.98
20,000	100	WSE	2388.65	6456.27	2110.00	129.10	8,695.37
20,000	100	75	2373.82	6471.1	2110.00	129.10	8,710.20
11,000	200	WSE -1	2337.05	6507.87	2110.00	129.10	8,746.97
20,000	100	100	2319.05	6525.87	2110.00	129.10	8,764.97

Skookumchuck Dam	Chehalis Levee	Skookumchuck Levee	Residual Damages*	Damage Reduction	I-5 Avoided Costs	I-5 Delay Benefits	Total Benefits
11,000	200	WSE	2316.83	6528.09	2110.00	129.10	8,767.19
11,000	200	75	2301.74	6543.18	2110.00	129.10	8,782.28
20,000	100	200	2291.5	6553.42	2110.00	129.10	8,792.52
11,000	200	100	2252.5	6592.42	2110.00	129.10	8,831.52
20,000	200	WSE -1	2223	6621.92	2110.00	129.10	8,861.02
11,000	200	200	2209.71	6635.21	2110.00	129.10	8,874.31
20,000	200	WSE	2200.67	6644.25	2110.00	129.10	8,883.35
20,000	200	75	2185.85	6659.07	2110.00	129.10	8,898.17
20,000	200	100	2131.07	6713.85	2110.00	129.10	8,952.95
20,000	200	200	2103.52	6741.4	2110.00	129.10	8,980.50

****Residual damages in this table do not include agriculture damages and rail damages – both these categories are not affected by proposed alternatives. Residual annual damages in these categories are \$115,850 for agriculture and \$32,200 for rail.**

Construction and annual costs for the various components are shown below in Table 4-9.

TABLE 4-9 COMPONENT COSTS
(\$1,000s, 2002 price level)

ALTERNATIVE	Total Construction Cost*	IDC	Total Economic Cost	Annualized Cost	O&M	TOTAL ANNUAL COST
Skookumchuck Dam						
Skookumchuck Dam 11,000 ac-ft	9,304.05	569.87	9,873.93	637.40	448.30	1,085.70
Skookumchuck Dam 20,000 ac-ft	11,507.02	704.80	12,211.82	788.32	514.51	1,302.83
Skookumchuck Levee						
Backwater	8,122.00	497.47	8,619.47	556.00	19.03	575.03
100yr WSE -3	9,006.00	551.62	9,557.62	617.00	19.03	636.03
100yr WSE -2	9,602.00	588.12	10,190.12	623.00	19.03	642.03
100yr WSE -1	9,774.00	598.66	10,372.66	669.00	19.03	688.03
100yr WSE	10,410.00	637.61	11,047.61	713.00	19.03	732.03
75yr Protection	10,952.00	670.81	11,622.81	750.30	19.03	769.32
100yr Protection	13,162.00	806.17	13,968.17	901.70	19.03	920.73
200yr Protection	14,482.00	887.02	15,369.02	992.13	19.03	1,011.16
Chehalis Levee						
100yr WSE -1	48,155.46	2,949.52	51,104.98	3,299.03	99.49	3,398.52
100yr WSE	50,705.46	3,105.71	53,811.17	3,473.73	99.49	3,573.22
75yr Protection	53,675.46	3,287.62	56,963.08	3,677.19	99.49	3,776.69
100yr Protection	60,905.46	3,730.46	64,635.92	4,172.51	99.49	4,272.00
200yr Protection	64,975.46	3,979.75	68,955.21	4,451.33	99.49	4,550.83

*includes Real Estate

These components in combination form the alternatives and have total costs and net benefits as shown in Table 4-10, below.

TABLE 4-10 TOTAL ANNUAL COSTS AND NED NET BENEFITS PHASE 3 ALTERNATIVES

(\$1,000s, 2002 price level)

Dam Size	Chehalis Levee*	Skookumchuck Levee*	Residual Damages**	Damage Reduction	I-5 Avoided Costs	I-5 Delay Benefits	Total Benefits	Skook. Dam Cost	Chehalis Levee Cost	Skook. Levee Cost	Total Cost	Net Benefits
11	100	-2	2,556.28	6,288.65	2,110.00	129.10	8,527.75	1,085.70	4,272.00	642.03	5,999.73	2,528.00
11	100	-1	2,533.37	6,311.55	2,110.00	129.10	8,550.65	1,085.70	4,272.00	688.03	6,045.73	2,504.92
11	100	BW	2,647.88	6,197.04	2,110.00	129.10	8,436.14	1,085.70	4,272.00	575.03	5,932.73	2,503.41
11	100	-3	2,591.48	6,253.44	2,110.00	129.10	8,492.54	1,085.70	4,272.00	636.03	5,993.73	2,498.81
11	100	0	2,513.16	6,331.76	2,110.00	129.10	8,570.86	1,085.70	4,272.00	732.03	6,089.73	2,481.13
11	100	75	2,498.06	6,346.86	2,110.00	129.10	8,585.96	1,085.70	4,272.00	769.32	6,127.02	2,458.94
11	200	-1	2,337.05	6,507.87	2,110.00	129.10	8,746.97	1,085.70	4,550.83	663.14	6,299.66	2,447.31
20	100	-1	2,409.98	6,434.94	2,110.00	129.10	8,674.04	1,302.83	4,272.00	663.14	6,237.97	2,436.07
11	200	0	2,316.83	6,528.09	2,110.00	129.10	8,767.19	1,085.70	4,550.83	711.09	6,347.62	2,419.57
20	100	0	2,388.65	6,456.27	2,110.00	129.10	8,695.37	1,302.83	4,272.00	711.09	6,285.92	2,409.45
11	200	75	2,301.74	6,543.18	2,110.00	129.10	8,782.28	1,085.70	4,550.83	769.32	6,405.85	2,376.43
20	100	75	2,373.82	6,471.10	2,110.00	129.10	8,710.20	1,302.83	4,272.00	769.32	6,344.16	2,366.04
11	100	100	2,448.83	6,396.09	2,110.00	129.10	8,635.19	1,085.70	4,272.00	920.73	6,278.42	2,356.77
20	200	-1	2,223.00	6,621.92	2,110.00	129.10	8,861.02	1,302.83	4,550.83	663.14	6,516.80	2,344.22
20	200	0	2,200.67	6,644.25	2,110.00	129.10	8,883.35	1,302.83	4,550.83	711.09	6,564.75	2,318.60
11	100	200	2,406.04	6,438.88	2,110.00	129.10	8,677.98	1,085.70	4,272.00	1,011.16	6,368.85	2,309.13
20	200	75	2,185.85	6,659.07	2,110.00	129.10	8,898.17	1,302.83	4,550.83	769.32	6,622.98	2,275.19
11	200	100	2,252.50	6,592.42	2,110.00	129.10	8,831.52	1,085.70	4,550.83	920.73	6,557.25	2,274.27
20	100	100	2,319.05	6,525.87	2,110.00	129.10	8,764.97	1,302.83	4,272.00	920.73	6,495.56	2,269.41
11	200	200	2,209.71	6,635.21	2,110.00	129.10	8,874.31	1,085.70	4,550.83	1,011.16	6,647.68	2,226.63
20	100	200	2,291.50	6,553.42	2,110.00	129.10	8,792.52	1,302.83	4,272.00	1,011.16	6,585.99	2,206.53
20	200	100	2,131.07	6,713.85	2,110.00	129.10	8,952.95	1,302.83	4,550.83	920.73	6,774.38	2,178.57
20	200	200	2,103.52	6,741.40	2,110.00	129.10	8,980.50	1,302.83	4,550.83	1,011.16	6,864.82	2,115.68
Ext	100	BW	4,577.55	4,267.37	2,110.00	129.10	6,506.47	0.00	4,272.00	591.89	4,863.89	1,642.58
11	75	-1	2,983.30	5,861.62	0.00	0.00	5,861.62	1,085.70	3,776.69	663.14	5,525.52	336.10
11	75	0	2,963.10	5,881.82	0.00	0.00	5,881.82	1,085.70	3,776.69	711.09	5,573.48	308.34
11	75	75	2,948.00	5,896.92	0.00	0.00	5,896.92	1,085.70	3,776.69	769.32	5,631.71	265.21
20	75	-1	2,846.42	5,998.50	0.00	0.00	5,998.50	1,302.83	3,776.69	663.14	5,742.66	255.84
20	75	0	2,824.10	6,020.82	0.00	0.00	6,020.82	1,302.83	3,776.69	711.09	5,790.61	230.21

Centralia Flood Damage Reduction Project
Final General Reevaluation Report

Dam Size	Chehalis Levee*	Skookumchuck Levee*	Residual Damages**	Damage Reduction	I-5 Avoided Costs	I-5 Delay Benefits	Total Benefits	Skook. Dam Cost	Chehalis Levee Cost	Skook. Levee Cost	Total Cost	Net Benefits
20	75	75	2,809.27	6,035.65	0.00	0.00	6,035.65	1,302.83	3,776.69	769.32	5,848.84	186.81
11	75	100	2,898.76	5,946.16	0.00	0.00	5,946.16	1,085.70	3,776.69	920.73	5,783.11	163.05
11	75	200	2,855.97	5,988.95	0.00	0.00	5,988.95	1,085.70	3,776.69	1,011.16	5,873.54	115.41
20	75	100	2,754.50	6,090.42	0.00	0.00	6,090.42	1,302.83	3,776.69	920.73	6,000.25	90.17
20	75	200	2,726.94	6,117.98	0.00	0.00	6,117.98	1,302.83	3,776.69	1,011.16	6,090.68	27.30
11	0	-1	3,695.48	5,149.44	0.00	0.00	5,149.44	1,085.70	3,573.22	663.14	5,322.05	-172.61
11	0	0	3,675.26	5,169.66	0.00	0.00	5,169.66	1,085.70	3,573.22	711.09	5,370.01	-200.35
20	0	-1	3,540.11	5,304.81	0.00	0.00	5,304.81	1,302.83	3,573.22	663.14	5,539.19	-234.38
11	0	75	3,660.17	5,184.75	0.00	0.00	5,184.75	1,085.70	3,573.22	769.32	5,428.24	-243.49
20	0	0	3,517.77	5,327.15	0.00	0.00	5,327.15	1,302.83	3,573.22	711.09	5,587.14	-259.99
20	0	75	3,502.94	5,341.98	0.00	0.00	5,341.98	1,302.83	3,573.22	769.32	5,645.37	-303.39
11	0	100	3,610.93	5,233.99	0.00	0.00	5,233.99	1,085.70	3,573.22	920.73	5,579.64	-345.65
11	0	200	3,568.13	5,276.79	0.00	0.00	5,276.79	1,085.70	3,573.22	1,011.16	5,670.07	-393.28
20	0	100	3,448.18	5,396.74	0.00	0.00	5,396.74	1,302.83	3,573.22	920.73	5,796.78	-400.04
20	0	200	3,420.63	5,424.29	0.00	0.00	5,424.29	1,302.83	3,573.22	1,011.16	5,887.21	-462.92
11	-1	-1	4,340.59	4,504.33	0.00	0.00	4,504.33	1,085.70	3,398.52	663.14	5,147.36	-643.03
11	-1	0	4,320.37	4,524.55	0.00	0.00	4,524.55	1,085.70	3,398.52	711.09	5,195.31	-670.76
20	-1	-1	4,179.64	4,665.28	0.00	0.00	4,665.28	1,302.83	3,398.52	663.14	5,364.49	-699.21
11	-1	75	4,305.28	4,539.64	0.00	0.00	4,539.64	1,085.70	3,398.52	769.32	5,253.54	-713.90
20	-1	0	4,157.31	4,687.61	0.00	0.00	4,687.61	1,302.83	3,398.52	711.09	5,412.45	-724.84
20	-1	75	4,142.48	4,702.44	0.00	0.00	4,702.44	1,302.83	3,398.52	769.32	5,470.68	-768.24
11	-1	100	4,256.03	4,588.89	0.00	0.00	4,588.89	1,085.70	3,398.52	920.73	5,404.95	-816.06
11	-1	200	4,213.24	4,631.68	0.00	0.00	4,631.68	1,085.70	3,398.52	1,011.16	5,495.38	-863.70
20	-1	100	4,087.72	4,757.20	0.00	0.00	4,757.20	1,302.83	3,398.52	920.73	5,622.08	-864.88
20	-1	200	4,060.17	4,784.75	0.00	0.00	4,784.75	1,302.83	3,398.52	1,011.16	5,712.51	-927.78

* For the Chehalis and Skookumchuck rivers, seven levee improvement levels are considered for each, with these levels being: "1" = A levee height 1 foot below the 100-year WSE; "2" = 2 feet below the 100-year WSE; "3" = A levee height 3 feet below the 100-year WSE; "4" = A levee height at the 100-year WSE; "5" = A levee height that has a 75-year level of flood protection; "100" = A levee height that has a 100-year level of flood protection; "200" = A levee height of approximately 200-year level of protection, and "BW" = A backwater levee only option on the Skookumchuck River. As the study is conducted under a risk-based approach, the "100-year" flood consists of a distribution of floods defined by risk-based parameters, as presented in Appendix A, Hydraulics and Hydrology. For the 100-year WSE, the mean values of the risk parameters associated with the 1 percent chance flood were utilized to develop the water surface elevation. To provide protection of a given frequency, and as a flood of a given frequency consists of many differing levels, the height of the levee must contain 95 percent of that level's distribution of floods.

**Residual damages in this table do not include agriculture damages and rail damages - Neither of these categories are affected by recommended alternatives. Residual annual damages in these categories are \$115,850 for agriculture and \$32,200 for rail. Additional project benefits categories of avoided cost of fill for elevating I-5 and reduced traffic delays are presented in other columns in the table.

Table 4-10 indicates that a levee scaled to 1-foot below the 100-year WSE provides greater net NED benefits than no levee construction on the Skookumchuck River other than the backwater levees required to mitigate the influences of the Chehalis River levee on the Skookumchuck River caused by the Chehalis River levees. This analysis showed that the -2 foot levee was the optimum elevation for Skookumchuck River levees.

4.12.2 Identification of NED Plan

Based on the above analyses, the structural plan that most reasonably maximizes net NED benefits consistent with protecting the environment, the NED Plan, consists of the following.

- an 11,000 ac-ft modification plan for the Skookumchuck Dam;
- levee construction of 100-year level protection on the Chehalis; and
- construction of a levee at 2 feet below the 100-year WSE on the Skookumchuck River.

For the identified NED Plan, the following tables reflect revisions in price levels and interest rates. All values are in October 2003 prices and are based on the current federal discount rate of 5.875 percent. Residual damages for the NED Plan are shown in Table 4-11, below.

TABLE 4-11 NED PLAN RESIDUAL DAMAGES

Expected Annual Flood Damage for the NED Plan*
11,000 ac-ft Skookumchuck Dam modification, 100-year Protection Levee Chehalis River, & 100-year WSE -2 Skookumchuck Levee
(Damage in \$1,000s, October 2003 Prices, 5.875 %, 50 year analysis period)

Alternative	Damage Categories											
	Com - Cleanup	Com -Cnt	Com - Str	PA	Res - Cleanup	Res - Cnt	Res - Str	TRA	Pub - Cleanup	Pub - Cnt	Pub - Str	Total
Without-project Damages	312	1463	1385	424	896	1466	2514	122	30	209	257	9078
NED Plan	28	206	180	168	325	588	1018	48	5	25	34	2625
Damage Reduction	284	1257	1205	256	571	878	1496	74	25	184	223	6453

*Damages in this table do not include agriculture damages and rail damages – both these categories are not affected by recommended project. Residual annual damages in these categories are \$119k for agriculture and \$34k for rail. Additional project benefits categories of NED plan include \$2,122k in avoided cost of fill for elevating I-5 and \$131k in reduced traffic delays. Incorporating these values results in the following:

Without-project damages including agricultural damages, rail damages, and traffic delays and cost of elevating I-5: **\$11,484**

NED Plan residual damages including agricultural damages and rail damages: **\$2,778**

NED Plan damage reduction including avoided cost of fill for elevating I-5 and reduced traffic delays: **\$8,706**

4.13 Evaluation of Project Performance

In addition to the economic basis for selecting an alternative to optimize, engineering performance as described in Section 3.4.5, is also considered. The three performance indices targeted for this analysis were the Expected Annual Exceedance and the Conditional Probability of Non-Exceedance for a series of events and the Long-Term Risks of Exceedance. Table 4-12 reports indices of engineering performance of the various alternative sizes. For reference, the median annual exceedance probability that corresponds to the top-of-levee stage is determined by direct reference to the stage-discharge and discharge-frequency relationships. The reporting of performance is based on the controlling value (lowest performing location) at any of the index locations for each river.

The Expected Annual Exceedance probability, with uncertainty analysis values, equals the annual exceedance probability with uncertainty included. These represent the protection provided, incorporating explicitly the uncertainty in predicting discharge associated with a specified probability and in predicting stage associated with discharge. In each case, the value is the probability with which the stage, with error included, exceeds the specified top-of-levee (or target elevation) in the simulation for economic evaluation. For example, with the Chehalis levee, the simulated water-surface elevation with errors included exceeded the top-of-levee elevation 61,000 times in 5,000,000 iterations. Therefore, the annual exceedance probability is $61/5,000 = 0.0122$. The Expected Annual Exceedance for the existing condition is 39.4 percent on the Chehalis and 17.2 percent on the Skookumchuck (Reach 4 only). The Expected Annual Exceedance for the Chehalis Levee 2, 11,000 ac-ft dam and 100Skook Lev Plan is 0.2 percent on the Chehalis and 0.3 percent on the Skookumchuck (Reach 4 only). The Expected Annual Exceedance for the Chehalis Levee 2, 20,000 ac-ft dam and 100Skook Lev Plan is 0.2 percent on the Chehalis and 0.2 percent on the Skookumchuck (Reach 4 only).

The Conditional Probability of Non-Exceedance of the various plans for four benchmark events is also presented in Table 4-12. The values shown are frequencies of not exceeding the levee capacity, given occurrence of the events shown. For example, for the Chehalis Levee 2, the conditional non-exceedance probability for the 0.01 exceedance probability event is 0.957. That means that should a 0.01 exceedance probability event occur, the probability is 0.957 that it would not exceed the capacity of the levee.

A local goal of a preferred alternative would be to provide certification to FEMA for providing protection against a 100-year flood. This requires the Conditional Non-Exceedance Probability to be a minimum of 90 percent (if freeboard is at least 3 feet) or 95 percent if freeboard is less than 3 feet (per Corps "Guidance on Levee Certification for the NFIP"). The Conditional Non-Exceedance Probability (0.01 event) for the existing condition is 0 percent on the Chehalis and 0 percent on the Skookumchuck (Reach 4 only). The Conditional Non-Exceedance Probability for the Chehalis Levee 2, 11,000 ac-ft dam and 100Skook Lev Plan is 97.7 percent on the Chehalis and 98.2 percent on the Skookumchuck (Reach 4 only). The Conditional Non-Exceedance Probability for the Chehalis Levee 2, 20,000 ac-ft dam and 100Skook Lev Plan is 97.8 percent on the Chehalis and 99.8 percent on the Skookumchuck (Reach 4 only). Therefore, the Chehalis Levee 2 and 100Skook Lev Plan can be certified to meeting the requirements of the FEMA and Corps guidance for 100-year protection.

The Long-Term Risks of Exceedance presents the probability that each alternative could be overtopped in a given period of time. For Levee 2, 11,000 ac-ft dam and 100Skook Lev Plan, for example, there is a 4.7 percent chance that the Chehalis levee would be exceeded in a 25-year period and an 8.7 percent chance for the Skookumchuck Levee (Reach 4 only) for the same term. Levee 2, 20,000 ac-ft dam and 100Skook Lev Plan, there is a 4.6 percent chance that the Chehalis levee would be exceeded in a 25-year period and a 4.7 percent chance for the Skookumchuck Levee (Reach 4 only) for the same term. For the same period, the existing condition long-term risk is 100 percent on the Chehalis and 99 percent chance on the Skookumchuck River.

TABLE 4-12 ENGINEERING PERFORMANCE EVALUATION

Alternative	Expected Annual Exceedance %		Equivalent Long-Term Risk						Conditional Probability of Design Containing Indicated Event							
			10 Yrs		25 Yrs		50 Yrs		10%		4%		2%		1%	
			Cheh	Skook	Cheh	Skook	Cheh	Skook	Cheh	Skook	Cheh	Skook	Cheh	Skook	Cheh	Skook
Existing	39.4	71.2	99.3	84.9	100.0	99.1	100.0	100.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
11k-100-200sk	0.2	0.2	1.9	1.9	4.7	4.6	9.1	8.9	100.0	99.9	99.9	99.9	99.8	99.9	97.7	99.9
11k-100-100sk	0.2	0.3	1.9	3.6	4.7	8.7	9.1	16.7	100.0	99.9	99.9	99.9	99.8	99.9	99.7	98.2
11k-100-75sk	0.2	0.8	1.9	7.6	4.7	18.0	9.1	32.7	100.0	99.9	99.9	99.9	99.8	99.3	97.7	73.3
11k-100-WSEsk	0.2	1.0	1.9	9.9	4.7	23.0	9.1	40.7	100.0	99.9	99.9	99.9	99.8	96.3	97.7	50.8
11k-100-WSE-1sk	0.2	1.5	1.9	14.1	4.7	31.6	9.1	53.2	100.0	99.9	99.9	99.7	99.8	79.1	97.7	20.6
11k-100-WSE-2sk	0.2	2.3	1.9	20.6	4.7	43.8	9.1	68.4	100.0	99.9	99.9	94.3	99.8	40.8	97.7	4.3
11k-100-WSE-3sk	0.2	3.9	1.9	33.0	4.7	63.2	9.1	86.5	100.0	96.6	99.9	67.3	99.8	10.9	97.7	0.5
20k-100-200sk	0.2	0.1	1.9	0.5	4.6	1.3	9.0	2.6	100.0	99.9	99.9	99.9	99.8	99.9	97.8	99.9
20k-100-100sk	0.2	0.2	1.9	1.9	4.6	4.7	9.0	9.1	100.0	99.9	99.9	99.9	99.8	99.9	97.8	99.8
20k-100-75sk	0.2	0.7	1.9	6.4	4.6	15.2	9.0	28.0	100.0	99.9	99.9	99.9	99.8	99.1	97.8	86.3
20k-100-WSEsk	0.2	0.9	1.9	8.6	4.6	20.2	9.0	36.3	100.0	99.9	99.9	99.9	99.8	95.5	97.8	68.3
20k-100-WSE-1sk	0.2	1.4	1.9	13.2	4.6	29.7	9.0	50.6	100.0	99.9	99.9	99.7	99.8	76.7	97.8	34.4

4.14 Phase 3 – Locally Preferred Plan

Following review of the optimization analysis results, the local sponsor (Lewis County) indicated preference for implementation of a Locally Preferred (LP) Plan that exceeds the performance, protection, and costs of the NED Plan. The county's preferred plan includes the same three features as identified in the NED Plan; that is, Chehalis River levees, Skookumchuck Dam modifications, and Skookumchuck River levees, however in a slightly different configuration as the NED Plan. The Locally Preferred Plan includes:

- the 20,000 ac-ft modification plan for the Skookumchuck Dam (as opposed to the 11,000 ac-ft modification in the NED Plan);
- levee construction of 100-year level protection on the Chehalis (the same as the NED Plan); and
- construction of a levee providing 100-year protection on the Skookumchuck River (as opposed to the levee at 2 feet below the 100-year WSE, as identified in the NED Plan).

No significant differences in adverse environmental impacts were identified in the EIS process between the NED Plan and the Locally Preferred Plan. For this reason, the same mitigation features and cost were applied to both plans.

Residual damages for the Locally Preferred Plan are shown in Table 4-13, below. All values are in October 2003 prices and are based on the current Federal discount rate of 5.875 percent.

TABLE 4-13 LP PLAN RESIDUAL DAMAGES

Expected Annual Flood Damage for the Locally Preferred Plan* 20,000 ac/ft Skookumchuck Dam modification, 100-yr Protection Levee Chehalis River, & 100-yr Skookumchuck Levee (Damage in \$1,000's, October 2003 Prices, 5.875%, 50 -year analysis period)												
Alternative	Damage Categories											
	Com - Cleanup	Com- Cnt	Com- Str	PA	Res- Cleanup	Res- Cnt	Res- Str	TRA	Pub- Cleanup	Pub- Cnt	Pub- Str	Total
Without-project Damages	312	1463	1385	424	896	1466	2514	122	30	209	257	9078
NED Plan	20	169	137	156	303	547	947	45	5	22	31	2382
Damage Reduction	292	1294	1248	268	593	919	1567	77	25	187	226	6696
<i>*Damages in this table do not include agriculture damages and rail damages – both these categories are not affected by the selected project. Residual annual damages in these categories are \$119k for agriculture and \$34k for rail. Additional project benefits categories of LP plan include \$2,122k in avoided cost of fill for elevating I-5 and \$131k in reduced traffic delays. Incorporating these values results in the following: Without-project damages including agricultural damages, rail damages, and traffic delays and cost of elevating I-5: \$11,484 LP Plan residual damages including agricultural damages and rail damages: \$2,535 LP Plan damage reduction including avoided cost of fill for elevating I-5 and reduced traffic delays: \$8,949 </i>												

4.14.1 Elevation of Structures

Both the NED and the Locally Preferred Plan structural alternative will result in slightly increased flood elevations over existing conditions (average of 4 inches for the 100-year event) for eight residential structures in the study area 100-year floodplain. The identified structures included six to the south of the Chehalis-Centralia Airport and two to the north of SR-6. To address this issue, a non-structural analysis was conducted of raising affected structures so that first floor elevations would be 1 foot above the with-project 100-year water surface elevation (WSE). The estimated implementation cost is based on cost data obtained for previous Corps studies, which indicate an average of \$25,000 per residence. Most of the costs of raising a structure are incurred in separating the structure from its foundations and installing a raised foundation. The height of this raised foundation is not generally a significant factor in the total cost and was not used in this estimate. However, the average number of feet these structures are below the 100-year WSE is included for information.

There are two study area sub-areas in which the affected structures are located. The eight structures would be raised an average of 1.85 feet for a total cost of \$200,000 (or an average annual cost of \$12,470). The flood damage reduction benefits of raising these structures were based on data taken from the HEC-FDA model results. This data indicated average annual flood damage reductions of \$1,730 per structure, or \$13,840 for all eight structures. Comparing average annual benefits of \$13,840 to average annual costs of \$12,468 results in a benefit-to-cost ratio of 1.1 to 1.0 for this non-structural project component.

Table 4-14 presents the two sub-areas with the number of affected residences, their average elevations below the 100-year without- and with-project WSE, and the first cost and average annual cost to elevate to 1 foot above the 100-year with-project WSE.

TABLE 4-14 COSTS OF ELEVATING STRUCTURES WITH INDUCED FLOODING

Sub-Area	Number of Affected Residences	Ave Elevation Below 100-yr WSE Without Project	Ave Elevation Below 100-yr WSE With Project	Average Change in 100-yr WSE due to project	First Cost Estimate	Average Annual Costs @ 5.875% over 50 Years
Below Airport	6	0.66	1.2	0.51	\$150,000	\$9,351
North of SR-6	2	0.29	0.5	0.18	\$50,000	\$3,117
Totals/Averages	8	0.475	0.85	0.345	\$200,000	\$12,468

4.15 Formulation of Environmental Mitigation Plan (Phase 1)

In the initial formulation of the proposed mitigation plan (referred to as Mitigation Phase 1 in this report), a variety of different environmental mitigation sites and features were evaluated to identify a cost effective mitigation plan. Identification of mitigation features was based upon findings of environmental studies conducted as part of the General Reevaluation Study that:

- identified basin-wide limiting factors to fish and wildlife production;
- assessed, quantified, and documented existing habitat conditions by sub-basins in the study area;
- identified geomorphic constraints and opportunities for restoring site-specific degraded habitats;
- identified watershed-scale opportunities to address limiting factors;
- formulated a range of potential environmental projects;
- developed an evaluation framework for quantifying environmental conditions;
- quantified environmental benefits of environmental projects;
- quantified environmental impacts of flood control alternatives; and
- identified cost effective mitigation strategies.

After reviewing the above listed parameters, mitigation features were identified and evaluated throughout the study area. These features were formulated to provide mitigation within the project area to address project impacts to significant sensitive resources.

4.15.1 Environmental Evaluation

An environmental evaluation methodology was designed for the study to provide a numerical estimate of the benefits provided by alternative mitigation plans. It also assisted in gathering information needed to assess mitigation needs and options during the formulation process. The framework was intended to differentiate benefits across alternatives and to provide information required for cost effectiveness and incremental cost analysis. An evaluation panel was utilized, composed of representatives from the tribes, Corps, U.S. Fish and Wildlife Service, EPA, Washington Department of Fish and Wildlife, Washington Department of Ecology, Washington Department of Transportation, Grays Harbor County, Thurston County, and Pacific International Engineering, Inc., representing the local sponsor, Lewis County, and facilitation by Tetra Tech, Inc. The evaluation panel met to determine habitat unit scores for both the existing and with-project conditions associated with each alternative mitigation feature. Generally, the score is a reflection of consensus among the panel members. The environmental evaluation methodology provided estimates, in terms of habitat units, of the impact of flood control alternatives as well as the impact of implementing various mitigation alternatives. The analysis is documented in detail in chapter 5 of the EIS.

The Corps will continue to evaluate measures during the design process to avoid direct impacts to vegetation, wetlands, and riparian areas. These measures may include:

- additional adjustments to the levee alignment, where possible, to avoid direct impacts;
and
- evaluation of the changes to the flood regimes of the Skookumchuck River.

Measures that would avoid and or reduce potential indirect impacts include:

- strict controls on construction stormwater to avoid direct discharges to wetlands and other aquatic habitats;
- siting of construction areas away from wetland and riparian habitats; and
- siting of construction access roads outside of wetland and riparian areas.

The EIS, Chapter 4, Environmental Effects, discusses specific effects on various reaches of the Chehalis and Skookumchuck rivers.

4.15.2 Potential Mitigation Features

A range of potential environmental projects were identified that addressed findings of the limiting factors analysis and would provide key habitats throughout the study area. The potential mitigation areas/components evaluated are presented in Table 4-15.

TABLE 4-15 POTENTIAL MITIGATION AREAS/COMPONENTS

Alternative
Scheuber Ditch Reconnection & Wetland Creation
SR-6 Oxbow Reconnection
Chehalis River Mainstem Oxbows Reconnections
Chehalis River Mainstem Riparian Revegetation, RM 66-80
Skookumchuck, Chehalis Confluence Revegetation
Skookumchuck Revegetation, RM 12
SF Chehalis Revegetation, RM 0-5
SF Chehalis, Chehalis Confluence Wetland Creation
Newaukum, Chehalis Confluence Revegetation and Wetland Creation
Newaukum, Stan Hedwall Park Side Channel and Wetlands
Newaukum Revegetation, RM 0-10
NF/SF Newaukum Confluence Wetland Creation
MF Newaukum Revegetation, Tauscher Road
NF Newaukum Revegetation, Tauscher Road
Salzer Creek, Chehalis Confluence Wetland Creation
Salzer Creek Wetland Creation, Frozen Foods Site
Salzer Creek, RM 3.1
Salzer Creek, RM 4.5

4.15.3 Cost Effectiveness and Incremental Cost Analysis

A cost effectiveness and incremental cost analysis was conducted to evaluate the relative effectiveness and efficiency of alternative mitigation measures at providing environmental benefits. The analyses provide a framework for comparing the differences in environmental output across alternative measures and the associated changes in cost. Cost and output estimates were developed for the components from Table 4-15. These estimates were used in the analyses to evaluate the cost effectiveness of the various mitigation options. The output estimates were derived by the evaluation framework process described in the paragraph above and are measured in habitat units. Cost estimates were developed that included design costs, construction costs, real estate costs, and operation and maintenance costs. This analysis is presented in chapter 5 of the EIS.

Eighteen potential mitigation sites were evaluated in the cost effectiveness and incremental cost analyses. The 18 sites are shown in Table 4-16 with cost and output estimates.

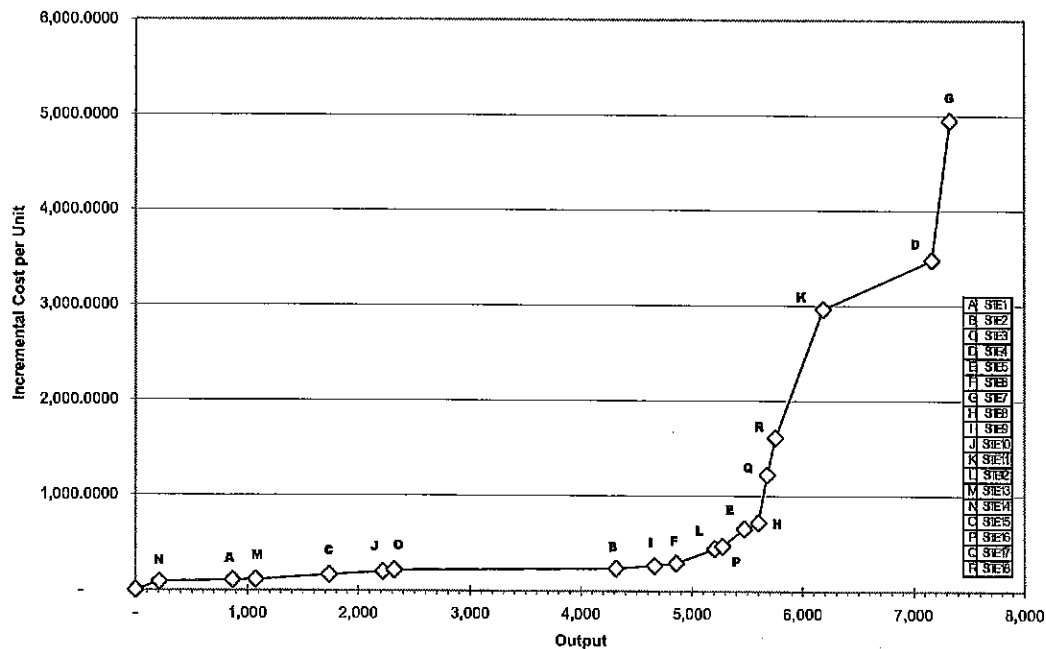
TABLE 4-16 RESTORATION MEASURES, WITH COST AND OUTPUT*

Code	Description	Average Annual Cost	Output
A	Site #1, SR6 Oxbow Reconnection	\$69,500	661.97
B	Site #2, Scheuber Reconnection & Wetland Creation	\$464,900	1994.79
C	Site #3, Mainstem Oxbows Reconnections	\$108,000	662.81
D	Site #4, Mainstem Chehalis Riparian Revegetation, RM 66-80	\$3,409,300	980.35
E	Site #5, Skookumchuck Confluence Revegetation	\$127,100	194.61
F	Site #6, Skookumchuck Revegetation, RM 12	\$56,600	194.57
G	Site #7, SF Chehalis Revegetation, RM 0-5	\$795,600	160.87
H	Site #8, SF Chehalis Confluence Wetland Creation	\$91,100	126.77
I	Site #9, Newaukum Confluence Revegetation and Wetland Creation	\$90,400	345.76
J	Site #10, Newaukum Side Channel and Wetlands, Stan Hedwell Park	\$95,500	483.35
K	Site #11, Newaukum Revegetation, RM 0-10	\$1,276,900	431.23
L	Site #12, NF/SF Newaukum Confluence Wetland Creation	\$155,000	349.38
M	Site #13, MF Newaukum Revegetation, Tauscher Road	\$23,100	207.23
N	Site #14, NF Newaukum Revegetation, Tauscher Road	\$17,800	206.77
O	Site #15, Salzer Creek Confluence Wetland Creation	\$21,600	100.78
P	Site #16, Salzer Creek Wetland Creation, Frozen Foods Site	\$33,400	71.14
Q	Site #17, Salzer Creek, RM 3.1	\$96,500	79.14
R	Site #18, Salzer Creek, RM 4.5	\$121,600	75.53
TOTALS:		\$7,053,900	7,327.05

*Data in Table 4-17 presented in 2002 price levels.

In the analyses, all combinations of the measures were evaluated to identify the most efficient combinations for producing environmental output. The results of the analyses show the order in which the potential mitigation sites would be implemented in combination if their output levels were determined to be worth their cost. Figure 4-1 shows the results of the analysis.

Figure 4-1. Incremental Cost Analysis (Sites 1-18)



The analysis also compared the output of combinations of mitigation sites with the preliminary estimated impacts of flood control alternatives. As indicated in Figure 4-1, output increases at a relatively greater rate than does incremental cost through addition of Plan H (Site 8). Plan H includes the following measures:

- N - NF Newaukum Revegetation, Tauscher Road
- A - Scheuber Ditch Reconnection & Wetland Creation
- M - MF Newaukum Revegetation, Tauscher Road
- C - Chehalis River Mainstem Oxbows Reconnections
- J - Newaukum, Stan Hedwall Park Side Channel and Wetlands
- O - Salzer Creek, Chehalis Confluence Wetland Creation
- B - SR-6 Oxbow Reconnection
- I - Newaukum, Chehalis Confluence Revegetation and Wetland Creation
- F - Skookumchuck Revegetation, RM 12
- L - NF/SF Newaukum Confluence Wetland Creation

- P - Salzer Creek Wetland Creation, Frozen Foods Site
- E - Skookumchuck, Chehalis Confluence Revegetation
- H - SF Chehalis, Chehalis Confluence Wetland Creation

After adding measure H, addition of any more measures is associated with greater increases in cost relative to increases in output and require more rigorous scrutiny. The first 13 projects appear cost effective, while the remaining five projects would require more evaluation and more rigorous justification if desired for inclusion in the mitigation plan.

4.16 Formulation of Environmental Mitigation Plan (Phase 2)

In Phase 2 of formulating the mitigation plan, the restoration work group reviewed the results of the Phase 1 evaluation and incremental cost analysis. Based upon this information and further analysis of potential impacts of the flood control project, the Scheuber Ditch/SR-6 area was identified by the resource agencies as a priority zone to focus further development of mitigation features. In the Phase 1 analysis, features in the Scheuber Ditch/SR-6 area ("A", Scheuber Ditch Reconnection and Wetland Creation, and "B", SR-6 Oxbow Reconnection) were found to be cost effective and incrementally justified through the preliminary cost effectiveness and incremental cost evaluations.

Evaluation of the impacts of the NED and LP plans provided an initial assessment of the loss of wetlands and riparian areas within the footprint of the proposed levees. The only wetland type within the project footprint is emergent wetlands. As such, the wetland impact acreage is based on extent of mapped hydric soils.

Total wetland loss is estimated to be 34 acres of wetlands over approximately 15 miles of levees and floodwalls. Approximately 14 miles of the recommended alternative consists of levees and 1 mile of floodwall. Mitigation will be required to offset this loss of wetlands/riparian areas.

There will be loss of vegetation, with the NED or LP Plan, though these impacts are being minimized with design refinements. The expected impacts to vegetation were not found to be significant enough to require mitigation.

While this loss of low to moderate quality wetlands and some riparian habitat appears to be moderate, it is estimated to result in a significant loss of groundwater recharge and other biogeochemical functions (such as sediment retention, pollutant retention and uptake, etc.). The

loss of these types of functions is extremely important to the regulatory agencies involved in the study's Restoration Working Group. A major issue in the Chehalis River basin is the loss of floodplain storage, groundwater recharge, and chemical and sediment retention. The cumulative loss of these functions has significantly contributed to the poor water quality and quantity conditions in the river and its tributaries and has significantly reduced accessibility and habitat for resident and anadromous salmonids and other native fish species. A more complete description of wetland functions is available in the EIS and the Mitigation appendix.

Throughout the development of the NED and LP Plans, minimization of impacts to sensitive areas was followed as a basis of design. Care was taken to stay close to developed areas, keeping the alignment setback as far as possible from the Chehalis River and its tributary streams, wetlands, and riparian areas. The design also incorporated areas of existing levees or tied into an existing levee system wherever practicable. Lastly, floodwalls were incorporated into the design where levees would have encroached upon the river.

Multiple combinations of environmental features in this area were developed and evaluated as a result. The same environmental evaluation methodology applied in Mitigation Phase 1 was applied in Mitigation Phase 2. Costs and outputs of the new features were compared with Phase 1 results to ensure that the new features were relatively cost effective mitigation components.

Cost effectiveness and incremental cost analyses were conducted to evaluate the relative cost effectiveness of the various alternative mitigation plans listed in Table 4-17. Only the most effective plans were retained. The cost effective plans were then added in different combinations to determine which combination of plans was the most cost effective.

The results of the incremental cost analysis are presented in Table 4-17 and graphically in Figure 4-2.

Mitigation Plan 2, described below, is the most cost effective combination of plans, and is therefore the proposed mitigation plan.

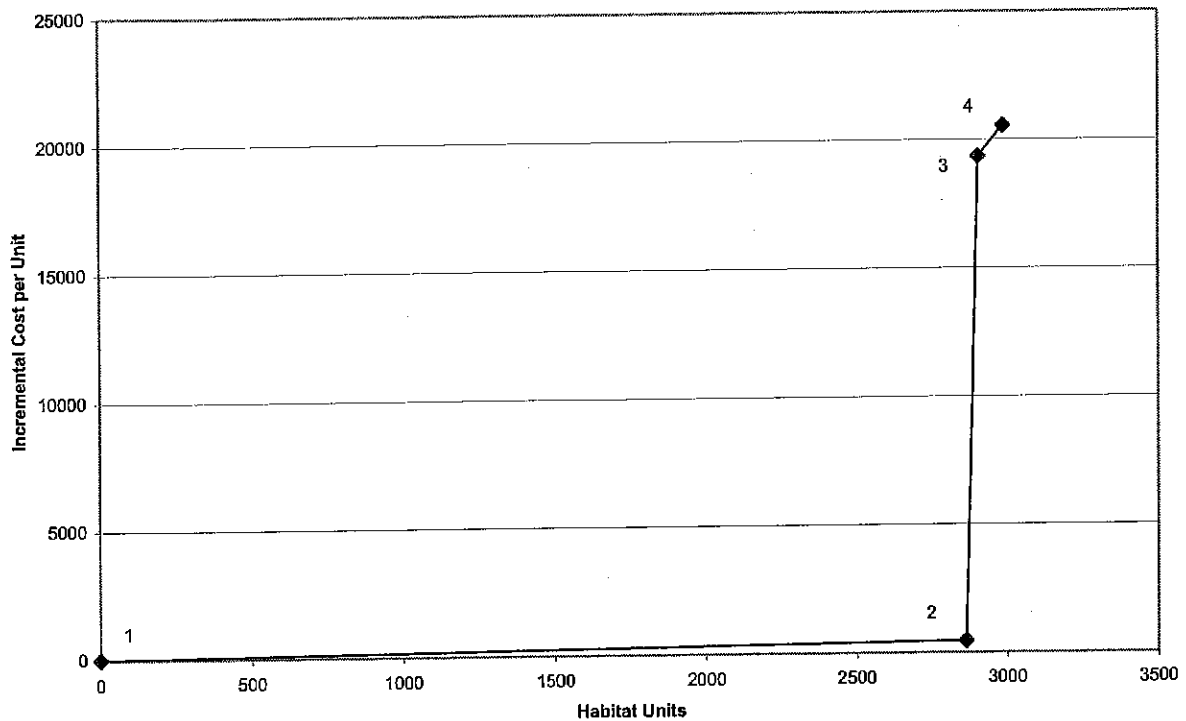
Features of Mitigation Plan 2 include:

- reconnection of oxbow (north of SR-6) to the Chehalis River in overbank events;
- conveyance of flows from reconnected oxbow under SR-6 to Scheuber Ditch Restoration Area; and
- development of wetland complex to the north of the Scheuber Ditch Restoration Area.

TABLE 4-17 INCREMENTAL COST ANALYSIS

Mitigation Alternative	Annual Cost	Output	Incremental Cost	Incremental Output	Inc Cost per Unit
1 No Action	0	0			0
2 Oxbow+Schueber Ditch+N Wetland	\$1,270,700	2,862.86	\$1,270,700	2,862.86	\$444
3 Oxbow+Schueber Ditch+S Wetland+N Wetland	\$2,104,300	2,905.96	\$833,600	43.10	\$19,341
4 Oxbow+Schueber Ditch+S Wetland+N Wetland+M Wetland	\$3,812,600	2,989.15	\$1,708,300	83.19	\$20,535

Figure 4-2 Incremental Cost Analysis of Mitigation Plans



4.17 Formulation of Environmental Mitigation Plan (Phase 3)

This is the final formulation of actual mitigation required based on the recommended flood damage reduction plan. The mitigation plan is described in Chapter 5 of the EIS. Following review of the information developed in Mitigation Phase 2 of the mitigation plan formulation, the study team refined the analysis of impacts of the proposed flood control project to ensure that the mitigation plan would provide adequate and appropriate environmental benefits commensurate with the level of institutional mitigation requirements and projected functional

impacts as identified by the modified environmental evaluation model. This evaluation is referred to as "Mitigation Phase 3" in this report.

4.17.1 Institutional Mitigation Requirements

As previously stated, the total loss of wetlands is estimated to be 34 acres, based on the current level of delineation that has been completed. As a starting point for developing the mitigation plan, we utilized a 2:1 replacement mitigation ratio for the 34 acres of wetland habitat that would be eliminated, which would involve the creation or enhancement of 68 acres of wetland. The Washington Department of Ecology frequently requires such a replacement ratio. Also, the additional acreage of wetland would compensate for the loss of hydrologic function to the other 108 acres of floodplain wetland. The loss of riparian habitat is very small, only estimated at about 1 acre. However, in order to create properly functioning wetlands the plan will require a 100-foot riparian buffer and the construction of an appropriate inlet to allow high flows into the site from the river, which will adequately compensate for the loss of riparian habitat and compensate for the loss of floodplain connections to the 108 acres of wetland.

4.17.2 Modification of Environmental Evaluation Methodology

The previously documented environmental evaluation methodology was developed for evaluation of the potential mitigation projects in the basin during the feasibility phase. This method was developed and used with extensive input from an interagency Restoration Working Group. This original method was also utilized to evaluate preliminary flood control alternatives and the proposed mitigation plan to ensure that it would provide an appropriate level of mitigation. However, following selection of the preferred flood control alternative, it was determined that the original method needed modifications that focused on the types of habitats that would be specifically affected by the flood control project in order to provide a suitable evaluation of the mitigation plan. The original method is documented in full in the EIS.

A modified method was developed that retained many of the parameters developed by the Restoration Working Group. However, there are two primary differences in the modified method: (1) where the original methodology characterized separate parameters for watershed and localized scales, the modified methodology characterizes parameters for the entire project footprint (at a sub-basin scale), and (2) the definitions for parameters have been modified to focus on wetland habitats as this was a primary impact of the proposed project.

Existing conditions (without-project) and future with-project (with levee) conditions were then scored using the modified method definitions. Ultimately, the purpose of the modified method is to translate the loss of wetland habitats into a HU output score. Then it is possible to also convert future with-project mitigation actions into a score of wetland HUs gained that can be compared to the expected loss to meet the goal of ensuring appropriate levels of mitigation that address institutional requirements and offset functional losses as identified by the modified evaluation methodology.

Upon applying the modified method to determine suitability of the mitigation plan developed in Mitigation Phase 2, it was found that the Scheuber Ditch/SR-6 mitigation plan overcompensated for impacts of the selected flood damage reduction alternative. It was also found that the re-meandering of the nearly 10,000-foot-long Scheuber Ditch and associated riparian revegetation provided significant habitat benefits but at significant cost and not necessarily in-kind mitigation value. As a result, alternative mitigation designs in the area were evaluated to determine which configuration would provide sufficient and effective mitigation, without incurring unnecessary expenses from out-of-kind mitigation measures.

Creation of wetlands at the south (upstream) end of the floodplain in the Scheuber Ditch/SR-6 area, with a connection to the Chehalis River beneath SR-6, was identified as an option to provide increased floodplain interactions. There would then be more frequent flood connections to the undeveloped floodplain along Scheuber Ditch. This revised plan would provide in-kind mitigation (wetlands and floodplain interactions) without providing the out-of-kind mitigation included in the previous plan.

The significant loss of floodplain in the area has resulted in a great need for increased groundwater recharge in the basin to maintain base flows in the river. The configuration of the selected Oxbow/SR-6 mitigation plan will allow greater floodplain connectivity with the Chehalis River and increased groundwater recharge on a frequent basis.

The proposed wetland mitigation will create and enhance 68 acres of wetland immediately north of SR-6 in the undeveloped floodplain. This will require the excavation of a new channel between the Chehalis River and the oxbow immediately south of SR-6. The channel will continue westward across the undeveloped floodplain and will connect to a tributary that passes beneath South Scheuber Road. The tributary will be diverted into the new channel to provide another source of hydrology for the wetlands and channel and be designed to have positive drainage back to the Chehalis River to prevent fish stranding.

Wetlands will be connected to the newly excavated channel and will also have positive drainage to the Chehalis River. The channel and wetlands will be designed to have a frequent surface water connection with the Chehalis River during winter flows. A berm will be constructed between the new channel and Scheuber Ditch to prevent flows below the 2-year flood elevation from connecting to the ditch. (This is to prevent fish stranding and also prevent fish from entering the very poor quality habitat in Scheuber Ditch, except during flood flows when the entire floodplain is connected.) A portion of SR-6 will be replaced with a bridge to accommodate the new channel and allow the floodplain interactions. A 100-foot riparian buffer will be planted along the new channels and around wetlands. Large woody debris (LWD) will be placed to enhance fish and wildlife habitat. The revised (Phase 3) formulation, evaluation, and design of the mitigation plan are presented in detail in chapter 5 of the EIS to this report.

4.17.3 Benefits and Costs of Phase 3 Mitigation Plan

The total wetland HUs lost with the construction of the levee is 102.1. The implementation of the selected mitigation plan provides a recovery of 115.4 HUs of wetland, which adequately compensates for the original wetland loss. This surplus will adequately address the risk and uncertainty associated with creation of wetlands in agricultural lands, as well as providing increased floodplain connections that were not quantified as impacts. Since the 68-acre design provides an appropriate amount of contingency, it was selected as the preferred plan.

The construction cost estimate for the Phase 3 mitigation plan is approximately \$9,780,800 in 2003 prices, with an average annual equivalent value of approximately \$610,000. The cost elements are described in detail in the chapter 5 of the EIS.

5. RECOMMENDED PLAN

5.1 Description of Recommended Plan

The plan selected for recommendation is the Locally Preferred (LP) Plan. This plan was selected because the local sponsor desired the added protection from the 20,000-ac-ft dam and FEMA certification for the 100-year flood for additional areas in Centralia.

The Locally Preferred Plan includes:

- the 20,000 ac-ft modification plan for the Skookumchuck Dam;
- levee construction of 100-year level protection on the Chehalis River;
- construction of a levee providing 100-year protection on the Skookumchuck River; and
- elevation of structures that would incur increased inundation as a result of the project to mitigate for induced damages.

5.2 Cost of Recommended Plan

A detailed cost estimate was developed for the recommended plan. The life-cycle project cost estimate, as shown in Table 5-3, is \$113,288,000 and includes design and construction costs, mitigation costs, operation and maintenance costs, real estate acquisition costs, contingency, and interest during construction.⁶ This is a difference of \$9,089,000 over the NED Plan, which has a life cycle project cost estimate of \$104,199,000. Both estimates include the addition of costs for elevating structures that would incur increased inundation with the project to mitigate for induced damages as described in Section 4.12.2. Complete estimates are presented in Appendix D, Economics.

The implementation cost estimate for the NED Plan and the recommended plan were developed using the Corps' Micro Computer Aided Cost Estimating Software (MCACES). Table 5-1 presents the NED cost estimate. Table 5-2 presents the recommended plan cost estimate. The differences in cost between the two plans are shown in Table 5-3. No significant differences in adverse environmental impacts between the NED Plan and the Locally Preferred Plan were

⁶These NED costs differ from those presented in Chapter 4, Plan Formulation, to reflect the most recent refinements in the cost estimate at the time of report publication. The differences were found to not have any significant effect on plan formulation and selection.

identified in the EIS process. For this reason, the same mitigation features and cost were applied to both plans.

TABLE 5-1 MCACES COST ESTIMATE FOR NED PLAN

CURRENT ESTIMATE PREPARED:					AUTHORIZ./BUDGET YEAR: 2004					FULLY FUNDED ESTIMATE				
EFFECTIVE PRICING LEVEL:					EFFECT. PRICING LEVEL: Oct-03									
ACCOUNT NUMBER	FEATURE DESCRIPTION	COST (\$K)	CNTG (\$K)	CNTG (%)	TOTAL (\$K)	OMB (%)	COST (\$K)	CNTG (\$K)	TOTAL (\$K)	FEATURE MID PT	OMB (%)	COST (\$K)	CNTG (\$K)	FULL (\$K)
04	<u>DAMS</u>													
	1. Lower Dam Alternative (11,000 acre feet)	4,827.2	1,690	35%	6,517	4.3%	5,304	1,690	6,517	Apr-06	6.9%	5,382	1,884	7,265
06	<u>FISH AND WILDLIFE</u>													
	1. Mitigation ¹	7,247.2	2,537	35%	9,784	0.0%	7,247	2,537	9,784	Apr-06	6.9%	7,748	2,712	10,460
11	<u>LEVEES AND FLOOD WALLS</u>													
	1. Chelalis Levee Alternative	29,421.5	7,355	25%	36,777	3.8%	30,534	7,634	38,168	Apr-06	6.9%	32,645	8,161	40,806
	2. Skookumchuck Region (-1' of 100 year WSE)	4,206.5	1,052	25%	5,258	3.8%	4,366	1,091	5,457	Apr-06	6.9%	4,667	1,167	5,834
TOTAL CONSTRUCTION COSTS		45,702	12,663	28%	58,365	3.3%	47,181	13,023	60,204		6.9%	50,442	13,923	64,365
01	<u>LANDS AND DAMAGES</u>													
	1. Real Estate	11,892.0	2,378	20%	14,270	3.8%	12,342	2,468	14,810	Jul-06	6.9%	13,195	2,639	15,833
30	<u>PLANNING, ENGINEERING AND DESIGN</u>	4,570.2	1,143	25%	5,713	3.8%	4,743	1,186	5,929	Apr-06	6.9%	5,071	1,268	6,339
31	<u>CONSTRUCTION MANAGEMENT</u>	4,570.2	1,143	25%	5,713	3.8%	4,743	1,186	5,929	Apr-06	6.9%	5,071	1,268	6,339
TOTAL PROJECT COSTS		66,735	17,295	26%	84,031	3.4%	69,069	17,663	86,732		6.9%	73,778	19,097	92,876

¹ Mitigation costs listed in account number 06 were estimated at Oct 2003 price levels. No pricing adjustment was applied to this feature.

TABLE 5-2 MCACES COST ESTIMATE FOR RECOMMENDED PLAN(LOCALLY PREFERRED PLAN)

CURRENT ESTIMATE PREPARED:					AUTHORIZ./BUDGET YEAR: 2004					FULLY FUNDED ESTIMATE				
EFFECTIVE PRICING LEVEL:					EFFECT. PRICING LEVEL: Oct-03									
ACCOUNT NUMBER	FEATURE DESCRIPTION	COST (\$K)	CNTG (\$K)	CNTG (%)	TOTAL (\$K)	OMB (%)	COST (\$K)	CNTG (\$K)	TOTAL (\$K)	FEATURE MID PT	OMB (%)	COST (\$K)	CNTG (\$K)	FULL (\$K)
04	<u>DAMS</u>													
	1. High Dam Alternative (20,000 acre feet)	6,589.6	2,306	35%	8,896	4.3%	6,872	2,405	9,277	Apr-06	6.9%	7,347	2,571	9,918
06	<u>FISH AND WILDLIFE</u>													
	1. Mitigation ¹	7,247.2	2,537	35%	9,784	0.0%	7,247	2,537	9,784	Apr-06	6.9%	7,748	2,712	10,460
11	<u>LEVEES AND FLOOD WALLS</u>													
	1. Levee Alternative	29,421.5	7,355	25%	36,777	3.8%	30,534	7,634	38,168	Apr-06	6.9%	32,645	8,161	40,806
	2. Skookumchuck Region (100 - year protection)	7,126.1	1,782	25%	8,908	3.8%	7,396	1,849	9,245	Apr-06	6.9%	7,907	1,977	9,883
TOTAL CONSTRUCTION COSTS		50,384	13,980	28%	64,364	3.3%	52,049	14,424	66,473		6.9%	55,646	15,421	71,067
01	<u>LANDS AND DAMAGES</u>													
	1. Real Estate	11,892.0	2,378	20%	14,270	3.9%	12,342	2,468	14,810	Jul-06	6.9%	13,195	2,639	15,833
30	<u>PLANNING, ENGINEERING AND DESIGN</u>	5,038.4	1,260	25%	6,298	3.9%	5,229	1,307	6,536	Apr-06	6.9%	5,590	1,398	6,988
31	<u>CONSTRUCTION MANAGEMENT</u>	5,038.4	1,260	25%	6,298	3.9%	5,229	1,307	6,536	Apr-06	6.9%	5,590	1,398	6,988
TOTAL PROJECT COSTS		72,353	18,877	26%	91,231	3.4%	74,849	19,507	94,355		6.9%	80,022	20,855	100,876

TABLE 5-3 COST COMPARISON OF NED AND LOCALLY PREFERRED PLAN

	Locally Preferred Plan	NED Plan	Cost Difference
Construction Cost*	\$56,689	\$50,420	\$6,269
Real Estate	\$14,810	\$14,810	\$0
Mitigation Cost	\$9,784	\$9,784	\$0
PED/Const. Mgmt.	\$13,072	\$11,858	\$1,214
Total First Costs	\$94,355	\$86,872	\$7,483
Interest During Construction	\$8,463	\$7,917	\$546
O&M Cost	\$10,470	\$9,410	\$1,060
Total Life Cycle Project Cost	\$113,288	\$104,199	\$9,089
Average Annual Equivalent Cost	\$7,063	\$6,496	\$567
Feasibility (sunk) costs	\$6,051	\$6,051	\$0
<i>All costs are in present value (October 2003 price level; dollars in \$1000) (Numbers may not add due to rounding)</i>			
<i>*Construction Cost does not include mitigation cost which is broken out separately.</i>			

5.3 Benefits of Recommended Plan

The recommended plan provides estimated annual benefits of \$8,949,000, including \$6.7 million in reduction of flood related damages to structures and their contents, \$2.1 million in annual avoided costs associated with the need to elevate I-5 without the project, and an annual reduction of \$131,000 in traffic delays related to flooding. Residual annual damages in the study area amount to \$2.5 million (including flood damages associated with structures and contents as well as residual agricultural damages and rail delay damages; neither of these latter two damage categories are affected by the NED or the selected Locally Preferred Plan).

Annual economic costs of the Locally Preferred Plan are estimated at \$7,063,000, resulting in annual net benefits of \$1,886,000 and a positive benefit-to-cost ratio of 1.27 to 1. The recommended project is supported by the local sponsor, Lewis County, Washington. The NED Plan will provide annual benefits of \$8,706,000 for an annual cost of \$6,496,000, providing net benefits of \$2,210,000 and a benefit-to-cost ratio of 1.34 to 1.

5.4 Structural Flood Control Features of Recommended Plan

The recommended plan includes a combination of structural flood damage reduction features. These include:

- Chehalis River Levee System
 - Chehalis River Mainstem Levees
 - Salzer Creek Levees
 - Dillenbaugh Creek Levees
- Skookumchuck River Levee System
- Modified Outlet Works and New Gates on the Spillway at Skookumchuck Dam for the addition of 20,000 ac-ft of flood control storage

Design of the levee system took advantage of opportunities to maximize levee setbacks, allowing floodplain and channel connectivity for environmental purposes. The setback levee alignment will protect existing residential and commercial structures, highway and other transportation infrastructure from flooding while not encouraging new floodplain development. Proposed protection would extend along the Chehalis River from approximately RM 75 to RM 64, as well as along most of the lower 2 miles of both Dillenbaugh Creek and Salzer Creek. In addition, levee protection will be provided on the Skookumchuck River for backwater effects of the Chehalis River and flooding from the Skookumchuck River. The affected reach (Skookumchuck River Reach 4) is approximately 2 miles upstream on the Skookumchuck to the confluence with Coffee Creek.

The levee system is intended to provide 100-year protection from the Chehalis River flooding. This protection also extends to the tributaries of the Chehalis River. The Chehalis backwater flooding is prevented from going upstream on the following tributaries: Dillenbaugh Creek, Salzer Creek, China Creek, Coal Creek and the Skookumchuck River.

A proposed modification to Skookumchuck Dam will provide flood control storage of approximately 20,000 ac-ft between pool elevation 455 and 492 feet. The current elevation of the existing spillway crest is 477 feet, with an uncontrolled spillway. With this flood storage pool elevation the reservoir would provide approximately 20,000 ac-ft of flood control storage.

The proposed design includes modification to the spillway chute and installation of a short tunnel outlet with slide gates; this is Alternative 2B2. Modification of the dam will reduce the flood stages along the lower Skookumchuck River up to 1 foot during a 100-year flood. There is more significant reduction in 10- to 50-year flood events, up to 2.4 feet reduction in stage. This will provide significant flood damage reduction to the communities along the river. In addition the dam will provide incidental hydraulic mitigation downstream in the Chehalis River. The modification will also allow for not only flood control but also for control on releasing summer low flows.

5.5 Non-Structural Flood Control Features of Recommended Plan

The Corps considered non-structural components during the evaluation process. As part of the recommended plan, several structures will be elevated in the floodplain. In addition, other non-structural features were also considered. Many of these features are already being implemented at the county and city level. They include ordinances on construction in the floodways, emergency warning systems and other non-structural solutions, such as raising of homes and businesses and property buyouts. Land use management options are also in the process of being revised by the local sponsor to have more restrictive requirements.

Several non-structural components that will be a locally provided element of the recommended plan, include new FEMA floodplain mapping, flood warning system, restriction of development, restriction of fill in the floodplain, and stormwater management. The following describes these features, how they are currently implemented and what additional measures are under consideration for the new floodplain management plan. These features are the responsibility of the local communities and are not required for the recommended structural features of the plan to function. Further effort on non-structural options will be evaluated during the development of a new floodplain management plan for the project area to be compliant with Executive Order 11988, concurrent with the design process for the recommended project.

The following are non-structural components that are being considered for implementation in the project area:

<u>Non Structural Feature</u>	<u>Lead Implementing Parties</u>
Elevation of Structures	Corps and local sponsor (component of cost-shared plan)
Define New 100-year FEMA floodplain	Local communities
Flood Warning System	Local communities
Restriction of Development	Local communities
Restriction of Fill in Floodplain	Local communities
Stormwater Management	Local communities

5.5.1 New 100-Year FEMA Floodplain

A new 100-year FEMA floodplain map will be generated after the recommended plan has been approved and FEMA has accepted that the project will be completed. This map will be adopted by the communities.

5.5.2 Flood Warning System

Currently the cities and the county utilize the Emergency Broadcast System (EBS) and other means, such as radio and television, to transmit emergency and warning transmissions for the area. Also, three local emergency/information phone numbers have been established to answer the public's questions or receive important flood information from residents. There are also neighborhood notification networks. Lewis County Emergency Management division is responsible for carrying out the emergency response program. The City of Chehalis has warning sirens to notify the community, as well as a telephone network through the Chamber of Commerce. They also utilize a website to show where flooding is occurring. The community is also working with the National Weather Service to post bulletins of flood hazards. The flood warning system will be further addressed in the flood management plan.

Additional initiatives that are being considered by the County include:

1) Installing additional river gauging stations to help in flood warning and emergency response activities. Potential additional gauges may include the following:

- a. Updating Newaukum gauge near Chehalis with telephone-linked capabilities.
- b. Add telephone linked gauge at South Fork Chehalis

- c. Install gages on other major tributaries within the Centralia/Chehalis area.
- 2) Personnel of the cities of Chehalis and Centralia and the County Engineer will coordinate the flood forecasting efforts.
- 3) Formalize and update road closure database creating a predictive tool by coordinating related flood stages to road closures.
- 4) Increase distribution of flood information materials to being not only available at the Emergency Management Office but also at libraries throughout the county.
- 5) Update Federal Insurance Rate Maps based on historical flood records to provide more accurate flood hazard information.
- 6) Provide a public disclosure ordinance of property's floodplain status at the time of purchase.
- 7) Document flood warning and emergency response activities for submittal to Community Rating System. These will count as credits to reduce flood insurance premiums.

5.5.3 Restriction of Development

The Corps will determine in the design phase the new floodway and flow paths within the project area after implementation of the structural features. The local community will utilize this information to ensure that their ordinances are being followed. This would include utilizing the newly developed 100-year floodplain and hydraulic modeling. The local jurisdictions can either adopt their own Flood Hazard and SEPA ordinances and their own Shoreline Master Programs, as directed under the state Shoreline Management Act, or utilize the state's guidelines. In addition to defining the 0.2-foot floodway, development is also discouraged within additional critical portions of the floodplain, specifically in areas considered to be significant flow paths. Flow paths are naturally occurring swales, which are normally dry, but which historically conveyed significant amounts of flowing water during flood stage. The following is a brief description of the current ordinances for floodway construction for Lewis County, City of Chehalis and the City of Centralia. These ordinances generally support having an approved filling/floodplain development plan, and allow a hydraulic analysis to show a 0.2-foot rise or less in the floodwater surface elevation.

- Lewis County - Development within the FEMA floodway is seriously discouraged. New residential structures are entirely prohibited. Commercial development is allowed, but only if accompanied by an engineer's certification that the proposed development would not raise flood levels at all during the 100-year flood. Variances are possible for development within the floodway from Lewis County.
- City of Centralia - Development is not allowed in the FEMA floodway. Request for variances are few and are seldom granted. The applicants whose properties lie in both the Floodplain Ordinance and the Shoreline Master Program areas are required to apply for, and obtain, both permits. In addition, any development within the FEMA flood fringe must be elevated to at least 1 foot above the elevation of the 100-year flood.
- City of Chehalis - Development within the FEMA floodway is seriously discouraged. New residential structures are entirely prohibited in special flood hazard areas. Commercial development is allowed, but only if accompanied by an engineer's certification that the proposed development would not raise flood levels at all during the 100-year flood. In addition, all new development and substantial improvements will comply with all applicable flood hazard reduction provisions of the city, state and Federal regulations.

5.5.4 Restriction of Fill in the Floodplain

This initiative is to ensure that there are restrictions to new filling of the floodplain by requiring that fill be mitigated by removal of an equal volume of fill at the site or elsewhere in the floodplain or floodway. Cut and fill balances should be retained within the project site whenever possible. The current Comprehensive Flood Hazard Management Plan for Lewis County is a method for reducing the effects of filling in the flood fringe. The plan includes adding the requirement for compensatory storage to the Flood Damage Prevention Ordinance. Whenever fill material is added to the flood fringe, the area that the fill occupies is removed from the potential flood storage area. Under compensatory storage requirements, any individual placing fill in the flood fringe must excavate an area of equivalent volume to eliminate the effects of the fill material on the flood storage.

- City of Centralia - Filling in the flood fringe landward of the floodway is allowed. All construction must be consistent with the model National Flood Insurance Regulations.
- Lewis County – The county's standard is that fill materials must be obtained from the site to the extent practicable. If the fill cannot be so obtained from the same site, it must be

obtained as practicable from the flood hazard area. In addition, the fill must have a beneficial use and be deemed necessary.

- City of Chehalis: As a part of the Shoreline Management plan there is a restriction of a one-to-one fill and cut within the floodplain area.

5.5.5 Storm Water Management

This initiative relates to increasing the detention from a 25-year design storm to meet the Washington State Department of Ecology storm water management criteria. The communities are evaluating these new criteria and determining whether they can meet the new Ecology regulation. A better management of stormwater will assist in reduction of flooding in the project area. The Corps will continue to evaluate the timing of stormwater versus the watershed runoff, to determine an optimum management of stormwater release during a flood event. Stormwater is only a small portion of the basin hydrology.

5.5.6 Non-Structural Summary

The elevation of homes is a cost-shared feature of the recommended plan. The local sponsor to the maximum extent practicable will implement the other non-structural features at 100 percent non-Federal cost. These actions will be represented in the revised floodplain management plan for the project as required by Executive Order 11988. This plan will be completed prior to the signing of the cooperative agreement. The Corps will provide technical support to assist in development of sound actions within the project area to assure the integrity of any project structural components.

5.6 Skookumchuck Dam Operational Modification Description

The hydraulic design of the flood control outlet works, and the flood control regulation rule curves for Skookumchuck Dam will need to be refined and finalized in the next phase of studies. Approval and implementation of the re-operation plan is the responsibility of the Corps' Water Management office. In addition to hydraulic and engineering considerations, downstream environmental requirements related to reservoir operation and flood control regulation will continue to be a part of the operation plan.

The dam modifications currently being proposed could provide, approximately, an additional 9,000 ac-ft of storage between pool elevation 477 and 492 feet, bringing the total storage at Skookumchuck Dam to 20,000 ac-ft. This additional storage could potentially be available to augment summer low flows downstream if it were determined that this would be environmentally beneficial. This would, however, require a change in the current reservoir conservation pool level and is not being proposed at this time for the flood reduction project. If this action were to be pursued in the future, any potential environmental impacts and dam safety issues associated with a higher conservation pool would need to be addressed.

5.7 Environmental Impacts of NED and Locally Preferred Plans

It is expected that the recommended flood control alternatives would not likely adversely affect federally listed fish and wildlife species. Impacts were identified however for riparian and wetland communities and for losses of floodplain connectivity. No significant differences in adverse environmental impacts were identified in the EIS process between the NED Plan and the Locally Preferred (LP) Plan. For this reason, the same impact estimate was derived for each plan.

The NED and LP Plans include the setback levees to protect developed areas, plus Skookumchuck Dam modifications. The recommended levee alignment runs from Ford Prairie south and east to I-5, south along the west side of I-5, around the Chehalis-Centralia Airport, and ends at the southern end of the airport adjacent to I-5. Additional levees are recommended on both banks of the Skookumchuck River between the Coffee Creek and Chehalis River confluences, on the north side of Salzer Creek from Salzer Valley Road to the connection with the I-5 levee, and along Dillenbaugh Creek from Chehalis Junction to Fern Hill Cemetery. The levee designs have been optimized to minimize the footprint (and impacts) of the levee system.

5.8 Environmental Mitigation Features and Benefits of Recommended Plan

Environmental mitigation features of the recommended plan are sited in the vicinity of SR-6 and the Scheuber drainage ditch. Mitigation features include:

- connection of the mainstem Chehalis River to an oxbow near the intersection of SR-6 and South Scheuber Road;
- connection of an unnamed tributary that flows beneath South Scheuber Road to the oxbow;
- modification of SR-6 to a bridge where the new channel passes beneath the road;
- creation of 68 acres of wetlands along the length of the new channel, west of SR-6; and

- creation of 20 acres of riparian buffer around the wetland.

The cost estimate for these features is \$9,784,000. As documented in the EIS, these features were determined adequate to offset adverse environmental impacts of the recommended plan's flood control features, including the 34 acres of impacted wetlands and 0.8 impacted acre of riparian habitats. These features are described in detail in chapter 5 of the EIS.

5.9 Real Estate Requirements of Recommended Plan

The recommended flood damage reduction project would require approximately 107 acres of land to implement the recommended levee and floodwall elements, 95 acres to implement the project mitigation elements and 871 acres at the Skookumchuck Dam site, which includes the current water impoundment area behind the dam, for a total project footprint of 1,365 acres. The project sites are proposed on lands that are currently in both public and private ownership: about 11 public owners and 185 private owners. Commercial borrow and disposal sites would be utilized. Standard estates to be acquired include fee simple, flood control levee easement, temporary work area easement, and a restrictive easement. In addition, non-standard estates developed for this project are being submitted with the project Real Estate Plan (REP) for higher authority review and approval with this report. The proposed non-standard estates include an estate to be used where an existing road is utilized as a flood protection levee, and an estate that will provide perpetual access to floodwalls and levees where access from a public right-of-way is not available.

Project implementation is planned to occur in three separate construction phases. After the Project Cooperation Agreement (PCA) is executed, the Non-Federal Sponsor (NFS, a.k.a. local sponsor) will have approximately 12 months to complete Phase 1 real estate acquisitions, 24 months to complete Phase 2 acquisitions, and 36 months to complete acquisitions for Phase 3. Table 5-5 below provides a summary of the proposed phased acquisition schedule. The NFS will have 180 days after certifying lands available for each construction phase to provide the Corps' Real Estate Division, Seattle District, with all supporting lands, easements and rights-of-way (LER) crediting documentation.

Appendix F, Real Estate Plan, provides additional real estate information, including real estate maps in Exhibit A. Exhibit B includes an assessment of NFS acquisition capability, while Exhibit C contains the Certification of Lands and Attorney's Certificate. Table 5-4 below provides a summary of the real estate baseline cost estimate (BCERE) for land values, NFS

administrative costs and Federal review and assistance costs for implementing the proposed project. A 20 percent contingency is utilized to cover possible land value variations over time. A 35 percent contingency is utilized for NFS administrative costs and Federal review and assistance due to various issues that must be addressed in the next project phase when the proposed project design is refined.

TABLE 5-4 SUMMARY BASELINE COST ESTIMATE FOR REAL ESTATE (BCERE)

Site Names	Acres	Land Values	NFS Admin Costs	NFS LERRD	FED S&A
Chehalis Levees	91	\$4,932,000	\$740,000	\$5,672,000	\$300,000
Dillenbaugh Levees	1	\$40,000	\$38,000	\$79,000	\$34,000
Skookumchuck Levees	15	\$2,459,000	\$463,000	\$2,921,000	\$250,000
Mitigation Sites	95	\$3,387,000	\$390,000	\$3,778,000	\$155,000
Skookumchuck Dam	871	\$1,515,000	\$66,000	\$1,582,000	\$46,000
TOTALS:	1265	\$12,333,000	\$1,697,000	\$14,032,000	\$785,000

land values include a 20% contingency, and NFS admin. costs, and Federal review and assistance costs both include a 35% contingency.

Project construction is expected to occur in three consecutive phases pursuant to the award of eight separate construction contracts (see Table 6-2, Construction Sequencing).

TABLE 5-5 LER ACQUISITION SCHEDULE

Phase 1 construction is anticipated to begin in early 2006. The NFS will require approximately 12 months from the date the PCA is executed to acquire and certify lands available before the respective Phase 1 contracts are advertised (Dec 05 – Feb 06). Phase 1 construction currently includes the following proposed project elements:

- Contract 1—I-5 levees from Mellon St. to Salzer Creek (WSDOT)
- Contract 2—Airport levee from Salzer Creek to SR-6

Phase 2 construction is planned to commence in the summer of 2005. The NFS will have approximately 24 months to acquire and certify lands available before Phase 2 construction contracts are advertised (Dec 05 – Mar 07). Phase 2 construction currently includes the following proposed project elements:

- Contract 2—Skookumchuck Dam
- Contracts 4, 5 & 6—Salzer Creek levees east of I-5
- Contract 7—Dillenbaugh Creek levees (WSDOT)

Phase 3 construction is expected to begin in the summer of 2006. The NFS will have approximately 36 months to acquire and certify lands available before Phase 3 construction contracts are advertised (Dec 05 – Mar 08) for the following project elements:

- Contract 8—Ford's Prairie levees
- Contract 9—Skookumchuck River levees
- Contracts 10 & 11—Project Mitigation Elements including SR-6 Bypass

5.10 Operation and Maintenance Requirements of Recommended Plan

The local sponsor, who is responsible for maintenance of the entire project, will be provided with an Operation, Maintenance, Repair, and Rehabilitation Manual (OMR&R) at the time that the project is accepted and turned over to the local sponsor. It will specify the maintenance and estimated rehabilitation required to meet Federal standards. A cost estimate and time schedule will be included for budgeting and planning purposes. It also specifies the consequences of not doing the prescribed maintenance. If the Federal government feels the project is in jeopardy of not functioning due to lack of maintenance, the government will do the work and bill the local sponsor for the effort.

5.10.1 Chehalis/Skookumchuck River Levee System O&M

For the levee system, a minimum of one inspection annually, and preferably an inspection after each major flood event, by the local sponsor will be submitted to the Corps, documenting levee conditions and any repairs or maintenance required or completed. For cost estimating purposes, the OMRR&R costs for levees is approximately \$8,000 per mile of levee. Approximately 15 miles of levees and floodwall are proposed in the recommended plan. In addition it is assumed that 50 percent of the rock will be replaced at year 25. Periodic government inspections will also be done to check that basic Federal standards are being maintained, including:

- no trees over 4-inch diameter;
- grassed side slopes;
- annual mowing for ease of inspection;
- maintained level gravel access road on top of the levee; and
- riprap rock sections monitored to assure bank protection, erosion control.

The government will identify any deficiencies in the maintenance or condition of the levee. A specific checklist of work items will be given to the local sponsor spelling out what is required to bring the project back into compliance, thus making the flood control structure eligible for Federal assistance when major rehabilitation is needed or in the event flood damage occurs. This includes eligibility for Federal funds through FEMA after a catastrophic disaster.

The OMRR&R will also include a Flood Fight Plan. Since flood fight efforts are an integral part of the levee system, it becomes critical that the necessary equipment, materials and personnel are available. In addition the plan must specify where and when flood fight actions need to take place, and who will be responsible for flood fighting.

This flood fight plan will need to be updated annually with points of contact, material and equipment inventory changes. Problem areas need to be identified and monitored, and then incorporated into the next year's maintenance plan.

5.10.2 Skookumchuck Dam O&M

Annual operation and maintenance (O&M) requirements for the flood control operation of Skookumchuck Dam were estimated based on the existing O&M requirements for a similar project, Wynoochee Dam. Wynoochee Dam is a multi-purpose project that is operated for hydropower, recreation, water supply, and flood control. The purposes of Skookumchuck Dam include flood control, water supply and currently limited hydropower (this last is to be decommissioned by the local sponsor). As with Wynoochee and several other flood control facilities in the region, during storm events, the Corps will take over flood control regulation of the dam.

The two projects are similar in size and have fairly similarly sized drainage basins with Wynoochee having 41 square miles and Skookumchuck having about 62 square miles. While the Wynoochee basin is smaller, the basin above Wynoochee Dam is of higher elevation and more mountainous than the basin above Skookumchuck Dam. Flood events at Skookumchuck Dam are not nearly as frequent or intense as events at Wynoochee Dam.

Skookumchuck Dam has no public access, and thus no costs are associated with the operation and maintenance of public facilities. At Skookumchuck Dam there is a small fish trap located at the base of the spillway stilling basin and a small operation is conducted to truck fish around the dam. Since only the flood control portion of the O&M costs are of interest here, these additional O&M costs have been excluded from consideration.

The recommended plan includes a gated structure on the spillway (unlike the low pool option without this requirement). Thus there will be added maintenance and operational expense for the gated structure. The additional maintenance is realized in the form of additional operation

requirements (time) due to the nature of the watershed. Due diligence must be exercised to ensure appropriate manipulation of the spillway gates during moderate to large events.

The O&M requirements for the flood control portion of Skookumchuck Dam include the annual maintenance, flood control operation, and fish migration due to flood control operations⁷. A 50-year project life was used with a discount rate of 5.875 percent. Labor rates, including all overhead costs, were assumed to be \$75 per hour, which is \$108,000 a year for the recommended plan. The maintenance costs were estimated at approximately \$13,500 per year for the recommended plan. The annual costs for Corps regulation is \$75,000 per year, and for the USGS gaging operations and hydromet operations the cost is \$45,000 per year. The costs also include administrative overhead and support. A detailed O&M cost summary is available in Table 5-6.

For flood control operation, it was assumed that there would be one fulltime person on site during the flood season, and an additional person would be assigned to the dam site during any storm events. It was also assumed that there would be a person onsite part-time for the remainder of the year. Offsite support and overhead costs, as well as miscellaneous costs and a contingency, were accounted for in both cases. Project costs for Corps flood regulation, USGS gaging and hydromet were kept the same as for the Wynoochee Project.

During flood control season, the dam will be operated in accordance with an O&M manual prepared by the Corps' Seattle District office. The project and flood control features would be inspected annually by the Corps to insure that any developing conditions that could adversely affect the flood control works are recognized and corrected in a timely manner.

⁷ O&M costs and requirements for Skookumchuck Dam address only the increment of O&M that is attributable to the recommended flood control project. Actual O&M costs to the sponsor will be higher due to O&M costs attributable to other elements of the dam.

TABLE 5-6 DETAILED ANNUALIZED COSTS FOR EQUIPMENT MAINTENANCE AT SKOOKUMCHUCK DAM

ITEM	11,000 AC-FT COSTS (\$)	20,000 AC-FT COSTS (\$)
Sluice Gates		
Seals	2,663	2,263
Hydraulics	1,770	1,770
Paint	885	885
Control House		
General	1,000	1,000
Tainter Gates		
Seals	N/a	3,319
Hoists	N/a	830
Paint	N/a	1,946
Electrical	1,500	1,500
Total Maintenance	7,818	13,513
Operation		
Flood season	72,000	108,000
Fish Migration	18,000	18,000
Other - Debris, etc	54,000	54,000
COE Regulation	75,000	75,000
USGS Gaging Operations	40,000	40,000
Hydromet Operations	5,000	5,000
Total Operation	264,000	300,000
Administrative Overhead and Support (67%)		
	176,880	201,000
Total Operation and Maintenance	448,300	514,513

5.10.3 Environmental Mitigation O&M

Operation and maintenance (O&M) costs of the mitigation plan are associated with maintaining the mitigation project after it is built or repairing the project after a flood event or other natural disaster. It is estimated that some amount of vegetation will have to be replaced during the establishment period (annually for the first 5 years). Sediment that settles into the wetlands or channel, compromising the habitat quality, will need to be excavated periodically. Areas that erode significantly may require repair. Costs for maintaining the SR-6 bridge are estimated to be 1 percent of the total bridge construction cost. This translates into an annual cost of \$5,800 for the life of the project. Total mitigation O&M costs over a 50-year period of analysis were estimated to have a present value of \$317,000, or an average annual value of \$19,800.

5.10.4 Summary of O&M Costs

The recommended plan includes annual O&M costs for its components. The annual O&M cost for each component is presented in Table 5-7. The table also provides a total present value of O&M requirements over the 50-year period of analysis. The total annual cost is \$652,800 per year.

TABLE 5-7 OPERATION AND MAINTENANCE COSTS (\$)

NED PLAN:	
Annual Chehalis River Levee O&M	99,500
Annual Skookumchuck River Levee O&M	19,000
Annual Skookumchuck Dam O&M*	448,300
Environmental Mitigation O&M	19,800
Total Annual O&M	586,000
Present Value O&M Stream	9,409,700
LOCALLY PREFERRED PLAN:	
Annual Chehalis River Levee O&M	99,500
Annual Skookumchuck River Levee O&M	19,000
Annual Skookumchuck Dam O&M*	514,500
Environmental Mitigation O&M	19,800
Total Annual O&M	652,800
Present Value O&M Stream	10,471,600

*Skookumchuck Dam O&M cost estimate includes only O&M requirements associated with flood control features.

6. IMPLEMENTATION OF RECOMMENDED PLAN

This chapter summarizes cost-sharing requirements and procedures necessary to implement the features of the recommended plan.

6.1 Division of Responsibilities for Implementing the Recommended Plan

The WRDA of 1986 (PL 99-662) and various administrative policies have established the basis for the division of Federal and non-Federal responsibilities in the construction, operation and maintenance of Federal water resources projects accomplished under the authority of the Corps. This is discussed in detail below. Sections 6.2 and 6.3 specify Federal and non-Federal responsibilities during the preconstruction engineering and design phase (PED) and construction phase.

6.1.1 Federal Responsibilities

The Federal government is responsible for conducting and completing the PED (detailed plans and specifications), advertising and administering the construction contracts after authorization and receipt of Federal and non-Federal funds, and managing the construction phase. The Federal government is responsible for supervisory and administrative support for the non-Federal (local) sponsor's LERRD activities. The Federal government is responsible for project inspections, and will provide 65 percent of the cost sharing for these project costs. The local sponsor is responsible for funding 35 percent of the costs of these project costs.

6.1.2 Non-Federal Responsibilities

The local sponsor is responsible for acquiring all real estate interests required to implement the recommended plan. The local sponsor is not required to provide this real estate until after the PCA is executed. The local sponsor will provide 35 percent of the cost sharing for further design, construction, construction management, Federal supervisory and administrative costs, and project monitoring for the NED plan. Additional work, or "betterments" to the NED plan will be 100 percent non-Federal cost responsibility. The local sponsor will receive credit for in-kind work per Chehalis River and Tributaries, House Report 106-1033 for Public Law 106-554, Section 118, which states: *"The project for flood control, Chehalis River and Tributaries,*

Washington, authorized by section 401 (a) of the Water Resources Development Act of 1986 (100 Stat. 4126), is modified to authorize the Secretary of the Army to provide the non-Federal interest credit toward the non-Federal share of the cost of planning, design, and construction work carried out by the non-Federal interest before the date of execution of a cooperation agreement for the project if the Secretary determines that the work is integral to the project. The local sponsor is responsible for obtaining all non-Federal permits and authorizations for the construction work. The local sponsor is also responsible for all future operation and maintenance.

6.2 Preconstruction Engineering and Design Phase

6.2.1 PED Procedural Overview

This phase of project development encompasses all planning and engineering necessary for project construction, and may commence after release of the Corps Division Engineer's Public Notice on a favorable study. These studies are required to review the earlier study data, obtain current data, evaluate any changed conditions, establish the most suitable plan for accomplishment of the improvement and establish the basic design of the project features in final detail. Preconstruction planning and engineering studies for projects authorized for construction will be programmed as "continuing" activities.

The results of preconstruction planning and engineering studies are presented in reports identified as "design memorandums." Preparation of design memorandums, and plans and specifications will be cost shared in accordance with the cost sharing required for project construction. Current engineering guidance respecting document preparation and approvals will be consulted (ER 1110-2-1150 9-2).

Since PED originally had been initiated prior to the policy change that requires upfront cost sharing of PED, all PED work will be performed at 100 percent Federal expense. PED will ultimately be cost shared at the rate for the project to be constructed with any adjustments necessary to bring the non-Federal contribution in line with the proper project cost sharing to be accomplished in the first year of construction.

After receiving Division approval of the project and an allocation of funds for future design studies, the Corps' Seattle District office will commence further design. The cost allocation will

include the flood control components that will be cost shared at 65 percent Federal, 35 percent non-Federal, and the additional components which will be 100 percent non-Federal.

6.2.2 Issues Requiring Additional Study During PED

6.2.2.1 Interior Drainage Analyses

The mainline project levee will include "minimum facilities" to relieve local runoff and potential ponding behind the levees for a low Chehalis River condition (i.e., gravity), as specified in EM 1110-2-1413. The minimum facilities will pass the local system design event without increasing interior flooding, therefore, no formal ponding areas are required.

6.2.2.1.1 China Creek Initiative

The local community will continue to look at what improvements can be constructed to solve all the flooding issues related to China Creek, which was not included in the Chehalis River Flood Reduction Study. The following describes the reconnaissance level study conducted by the local community to identify several alternatives to alleviate flooding in the China Creek Basin. The Corps will work with the community to see if China Creek qualifies for Federal interest under other Corps authorities.

A reconnaissance level evaluation was conducted to identify potential flood reduction alternatives for the China Creek drainage basin. The following structural flood control and reduction measures were reviewed and evaluated: pumping station, levee, gravity flood flow diversion, dry retention facilities for more storage capacity, channel modifications to increase channel hydraulic capacity, and creek relocation. Non-structural measures were reviewed but not evaluated. A preliminary evaluation of each of these flood reduction measures was conducted to identify potential flood reduction alternatives. The flood reduction measures were then evaluated independently, and in combination, to develop flood reduction alternatives capable of meeting the 100-year flood reduction design criteria. The size, location, flood reduction capability, cost, environmental impacts and benefits, and performance were factors in screening flood reduction measures to develop alternatives for the reconnaissance level evaluations. The construction cost for the 50-year and 25-year flood reduction design criteria was then determined for each alternative. The summary of this analysis is shown below.

The evaluation indicated that gravity flow diversion and creek relocation from China Creek, near STA 111+01, to the Skookumchuck River is feasible. Construction of a pumping station provides little additional benefit for significant additional cost. The Embankment Dam No. 2 requires substantial real estate acquisition and impacts existing residential neighborhoods. The Gold Street Ring Levee, Lower China Creek Excavation, and China Creek Floodwall do not provide sufficient capacity to be independent alternatives. They could provide economical flood reduction as a supplement to a larger flood reduction measure.

The conclusions of the reconnaissance identified the following as potential options: Flood Flow Diversion, Creek Relocation/Restoration, Gold Street Ring Levee, China Creek Excavation, and China Creek Urban Floodwall flood reduction measures. In addition, it is recommended that the China Creek channel excavation and floodwall components be further evaluated by the community for use with Alternative No. 8 (gravity flow bypass and ring levee) once additional data has been collected.

TABLE 6-1 CHINA CREEK PRE-FEASIBILITY FLOOD REDUCTION ALTERNATIVES EVALUATION

Flood Control Alternative	Preliminary Cost Estimate**	Flood Reduction (STA 55+20)	Pros	Cons
1. Pumping Station No. 1	\$10.7 million *(\$10.7 million)	400 cfs	• Failsafe operation at any flood event • Maximum operational flexibility to provide bypass regardless of Skookumchuck River/China Creek flood stage timing. • Minimal real estate acquisition	• High cost • Maintenance of pumping station • Large pumps required to pump long distance RR crossing • Coordination & timing of RR crossing construction with BNSF (3rd party)
2. Pumping Station No. 2 with Gold Street Ring Levee	\$11.4 million *(\$11.5 million)	380 cfs	• Failsafe operation at any flood event • Maximum operational flexibility to provide bypass regardless of Skookumchuck River/China Creek flood stage timing. • Minimal real estate acquisition	• High cost • Maintenance of pumping station • Coordination & timing of RR crossing construction with BNSF (3rd party)
3. Embankment Dam No. 1	\$7.6 million *(\$12.1 million)	420 cfs	• Flood reduction for larger length of creek	• Impact to local residential neighborhood/environment • Large real estate acquisition • Environmental Impact Issues • Impact to Hanaford Road
4. Embankment Dam No. 2 with Pumping Station No. 3	\$12.4 million *(\$13.5 million)	420 cfs	• Pumping Station provides additional capability for controlling peak flows	• High cost • Maintenance of pumping station • Impact to local residential neighborhood/environment • Large real estate acquisition • Impact to Hanaford Road
5. Embankment Dam No. 2 with Gold Street Ring Levee	\$7.4 million *(\$8.6 million)	400 cfs	• Levee provides supplemental flow reduction with minimal impacts to environment and adjacent property owners.	• Impact to local residential neighborhood/environment • Large real estate acquisition • High project cost
6. Embankment Dam No. 2 with Urban Flood Wall	N/A	400 cfs	• Floodwall provides supplemental flow reduction	• Impact to local residential neighborhood/environment • Bridge/culvert rehabilitation cost • Large real estate acquisition cost
7. Embankment Dam No. 2 with Creek Excavation	N/A	400 cfs	• Excavation provides supplemental flow reduction	• Bridge/culvert rehabilitation cost • Sediment deposition would reduce channel capacity
8. Flood Flow Diversion with Gold Street Ring Levee	\$7.3 million *(\$7.8 million)	395 cfs	• Low Cost • Minimal maintenance • Minimal land acquisition	• More detailed data collection and hydrologic analysis required to verify Skookumchuck River/China Creek flood stage timing • Coordination & timing of RR crossing construction with BNSF (3rd party)

TABLE 6-1 CHINA CREEK PRE-FEASIBILITY FLOOD REDUCTION ALTERNATIVES EVALUATION

Flood Control Alternative	Preliminary Cost Estimate**	Flood Reduction (STA 55+20)	Pros	Cons
9. Creek Relocation/ Restoration with Gold Street Ring Levee	\$9.6 million *(11.9 million)	590 cfs (diversion of entire flow)	- Stream/habitat restoration - Reduced China Creek bridge/culvert rehabilitation construction costs - Increased public shoreline access - Low maintenance	- Coordination & timing of RR bridge reconstruction at new location with BNSF (3rd party) - Impact to residential neighborhood - More detailed data collection and hydrologic analysis

*Cost includes assumed \$18,000/acre real estate acquisition and \$100,000/structure acquisition costs.

**Costs are based on 100-year flow or 1996 flood event.

6.2.2.2 Skookumchuck Dam Stability Evaluation

The Corps conducted Skookumchuck Dam geotechnical investigations in 2001. The results of these studies identified potential dam stability issues resulting from a seismic event, which will require further analysis.

During original construction of the dam, while stripping the foundation, a deposit of silt north of the original river channel was discovered. The initial exploration programs for the dam did not reveal the silt layer. An exploration program was undertaken to define the extent and thickness of this silt deposit. It was decided during construction of the dam to leave the silt layer alone. After 20 to 25 feet of embankment material was placed on the silt layer, there were indications that embankments would become unstable in their original design. It was judged that the silt body could be contained and stabilized by adding massive toe berms where the embankment shells are founded on the silty clay material; these were constructed.

In the investigations conducted by the Corps in 2001, based on recent seismic information, the study concluded that the sandy gravel soils underlying the silts appear to be liquefiable under all design Maximum Credible Earthquake (MCE) ground motions. In 2001, a similar stability analysis was performed utilizing subsurface explorations, the liquefaction data, and seismic hazard analysis from recent studies. This included evaluation of the existing static and post-seismic stability of the downstream slopes of the dam and berm using a limit-equilibrium approach. The extent of liquefied soils is uncertain beyond the area of investigations with Becker and SPT borings; thus slope failures were calculated for five different ranges of liquefied soils. The calculations indicate a factor-of-safety below 1.0 for conditions where liquefied soils are present from the core to the toe of the downstream berm.

The District has assembled a "dam safety team" regarding the potential seismic issues. This was established early in the study. This team will continue to coordinate until the issues are resolved. Currently, FERC is reviewing the information provided by PacifiCorp (the current owner) as required by the regulatory permit for operating a hydroelectric facility and the results of the Corps investigation described in the above paragraph. FERC will be issuing a letter to the owner recommending that they conduct further investigations to determine the extent of the liquefiable material. Based on this investigation the owner will be required to conduct remediation to the downstream berm to ensure that the dam meets dam safety requirements in a post-seismic flood event. The current owner, prior to the local sponsor taking ownership of the facility, will conduct

this effort. This remediation effort will be a 100 percent cost to the current owner and the costs are not included in the cost estimate for the recommended plan. The flood district will inherit all the liabilities of ownership. They will also inherit all the requirements of the FERC permit if the permit is transferred and not terminated.

6.3 Construction Phase

6.3.1 Project Cooperation Agreement

The PCA will define the local sponsor's responsibility to provide all lands, easements, rights-of-way, and suitable borrow and dredged or excavated material disposal areas required for the project (collectively referred to as LERRD requirements; Section 101(a) and (e), Section 103(a) and (j) of P.L. 99-662). The value of the required LERRD provided by the local sponsor will be credited up to a maximum share of 50 percent of the costs of construction. The Government will reimburse the sponsor for LERRD expenses that exceed the maximum share.

The PCA will discuss the authorization's "grandfathering" of non-Federal cost sharing. Since the original authorization occurred before the policy change that requires upfront cost sharing of PED, work performed during PED has been and will continue to be funded at 100% Federal expense. The local sponsor will also receive credit for services performed prior to signing of a PCA, as authorized by House Report 106-1033 for Public Law 106-554, Section 118.

The PCA will reflect that any required seismic remediation will be completed prior to the construction of flood control modifications. The costs of the remediation will be born by the current owner. The remediation will not affect the fair market value of the dam. The transfer costs will remain unchanged with the decommissioning of the hydropower at the dam. The flood control district will be the owners and accept any liability. In addition, they are planning to decommission the power at the dam and thus not be regulated by FERC, but by Washington dam safety office. The local sponsor understands the legal responsibilities and liabilities for dam safety. These dam safety requirements will be included in the PCA.

The PCA for the project will be negotiated between representatives of the district and the local sponsor. Once the project is authorized for construction, the budget/appropriations process drives the PCA process. Current policy dictates that PCAs will not be executed until: (1) the project document has been approved by HQUSACE; (2) the project is budgeted as a new construction

start or construction funds are added by Congress, apportioned by OMB, and their allocation approved by ASA(CW); (3) documentation of compliance with the National Environmental Policy Act (NEPA) and other associated environmental laws and statutes in the PCA checklist has been furnished; and (4) the draft PCA has been reviewed and approved by the Assistant Secretary of the Army (Civil Works).

All Civil Works projects are managed, planned, and executed under the Life Cycle Project Management System (LCPM), per ER 5-1-11. Consistent with ER 5-1-11, the forecast final cost estimate to be entered into PCAs for all specifically authorized new starts is based on the most current cost estimate prepared in accordance with the Micro-Computer Aided Cost Estimating System (MCACES) in the Code of Accounts format.

Under the terms of the PCA, when the Government determines that the entire project, or functional portion thereof, is complete, the Government will provide written notice to the local sponsor of such determination and furnish an Operations, Maintenance, Repair, Replacement, and Rehabilitation (OMRR&R) Manual to the local sponsor. The local sponsor is then responsible for the OMRR&R of the project, or functional portion. After completion and notice to the local sponsor, authority is considered to expire for expenditure of Federal funds for construction of additional improvements on the project or for maintenance thereof.

The following provisions will be included in the PCA:

(1) Provide a minimum of 35 percent, but not to exceed 50 percent, of total project costs allocated to flood control, as further specified below:

(a) Enter into an agreement with relation to design costs;

(b) Provide, during construction, any additional funds needed to cover the non-federal share of design costs;

(c) Provide, during construction, a cash contribution equal to 5 percent of total project costs allocated to flood control;

(d) Provide all lands, easements, and rights-of-way, including suitable borrow and dredged or excavated material disposal areas, and perform or assure the performance of all relocations determined by the Government to be necessary for the construction, operation, and

maintenance of the project;

(e) Provide or pay to the Government the cost of providing all retaining dikes, waste weirs, bulkheads, and embankments, including all monitoring features and stilling basins that may be required at any dredged or excavated material disposal areas required for the construction, operation, and maintenance of the project; and

(f) Provide, during construction, any additional costs as necessary to make its total contribution equal to at least 35 percent of total project costs allocated to flood control.

(2) Give the Government a right to enter, at reasonable times and in a reasonable manner, upon land which the local sponsor owns or controls for access to the project for the purpose of inspection, and, if necessary, for the purpose of completing, operating, maintaining, repairing, replacing, or rehabilitating the project.

(3) Assume responsibility for operating, maintaining, replacing, repairing, and rehabilitating (OMRR&R) the project or completed functional portions of the project, including mitigation features without cost to the Government, in a manner compatible with the project's authorized purpose and in accordance with applicable Federal and State laws and specific directions prescribed by the Government in the OMRR&R manual and any subsequent amendments thereto.

(4) Comply with Section 221 of Public Law 91-611, Flood Control Act of 1970, as amended, and Section 103 of the Water Resources Development Act of 1986, Public Law 99-662, as amended, which provides that the Secretary of the Army shall not commence the construction of any water resources project or separable element thereof, until the non-Federal sponsor has entered into a written agreement to furnish its required cooperation for the project or separable element.

(5) Hold and save the Government free from all damages arising from the construction, operation, maintenance, repair, replacement, and rehabilitation of the project and any project-related betterments, except for damages due to the fault or negligence of the Government or the Government's contractors.

(6) Keep and maintain books, records, documents, and other evidence pertaining to costs and expenses incurred pursuant to the project to the extent and in such detail as will properly

reflect total project costs.

(7) Perform, or cause to be performed, any investigations for hazardous substances that are determined necessary to identify the existence and extent of any hazardous substances regulated under the Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA), 42 USC 9601-9675, that may exist in, on, or under lands, easements or rights-of-way necessary for the construction, operation, and maintenance of the project; except that the non-Federal sponsor shall not perform such investigations on lands, easements, or rights-of-way that the Government determines to be subject to the navigation servitude without prior specific written direction by the Government.

(8) Assume complete financial responsibility for all necessary cleanup and response costs of any CERCLA regulated materials located in, on, or under lands, easements, or rights-of-way that the Government determines necessary for the construction, operation, or maintenance of the project.

(9) Agree that, as between the Federal Government and the non-Federal sponsor, the non-Federal sponsor shall be considered the operator of the project for the purpose of CERCLA liability, and, to the maximum extent practicable, operate, maintain, repair, replace, and rehabilitate the project in a manner that will not cause liability to arise under CERCLA.

(10) Prevent obstructions of or encroachments on the project (including prescribing and enforcing regulations to prevent such obstructions or encroachments) which might, reduce the level of protection the project affords, hinder its operation and maintenance, or interfere with its proper function, such as any new development on project lands or the addition of facilities which would degrade the benefits of the project.

(11) Comply with the applicable provisions of the Uniform Relocation Assistance and Real Property Acquisition Policies Act of 1970, Public law 91-646, as amended by title IV of the Surface Transportation and Uniform Relocation Assistance Act of 1987 (Public Law 100-17), and the Uniform Regulations contained in 49 CFR part 24, in acquiring lands, easements, and rights-of-way, and performing relocations for construction, operation, and maintenance of the project, and inform all affected persons of applicable benefits, policies, and procedures in connection with said act.

(12) Comply with all applicable Federal and State laws and regulations, including Section

601 of the Civil Rights Act of 1964, Public Law 88-352, and Department of Defense Directive 5500.11 issued pursuant thereto, as well as Army Regulation 600-7, entitled "Nondiscrimination on the Basis of Handicap in Programs and Activities Assisted or Conducted by the Department of the Army" and Section 402 of the Water Resources Development Act of 1986, as amended (33 USC 701b-12), requiring non-Federal participation and implementation of flood plain management plans.

(13) Provide the non-Federal share of that portion of the costs of mitigation and data recovery activities associated with historic preservation, that are in excess of 1 percent of the total amount authorized to be appropriated for the project, in accordance with the cost sharing provisions of the agreement;

(14) Participate in and comply with applicable Federal floodplain management and flood insurance programs;

(15) Do not use Federal funds to meet the non-Federal sponsor's share of total project costs unless the Federal granting agency verifies in writing that the expenditure of such funds is authorized.

(16) Inform affected interests, at least annually, regarding the limitations of the protection afforded by the project.

(17) Provide and maintain necessary access roads, parking areas, and other public use facilities, open and available to all on equal terms.

6.3.2 Project Construction

Construction is expected to occur over a period of 3 years (2006 to 2009). The local sponsor must provide all of their cost-sharing funds and real estate at the beginning of construction (prior to award of construction contracts) unless they specifically request a change to the PCA to allow provision of funds in a phased manner similar to the construction schedule.

Table 6-2 provides an estimated timeline from the release of a positive Chief of Engineers Report to project completion.

TABLE 6-2 CONSTRUCTION SEQUENCING

Description	Dates
Chief's Report	April 04
WRDA Authorization	Spring 04
Design Complete	Feb 06
All Permits Received	Jan 06
Project Cooperation Agreement Signed With Sponsor	Jan 06
Corps Receives Construction Funding	Feb 06
Sponsor Completes Real Estate Acquisition (Phase 1 will be completed in Jan 06)	May 08
Corps Advertises Construction Contract (First Contract)	April 06
Construction Contract Award (First Contract)	June 06
Contract Notice To Proceed: Phase 1. I-5 levees from Mellon St. to Salzer Creek Airport levee from Salzer Creek to SR-6 Phase 2. Skookumchuck Dam Salzer Creek levees east of I-5 Dillenbaugh Creek levees Phase 3. Ford's Prairie levees Skookumchuck River levees Project Mitigation Elements including SR-6 Bypass	July 06 July 06 July 06 July 07 July 07 July 08 July 08 July 08
Approve Contractors Plans (Safety, Health and Environmental Protection) for Phase 1. I-5 levees from Mellon St. to Salzer Creek Airport levee from Salzer Creek to SR-6 Phase 2. Skookumchuck Dam Salzer Creek levees east of I-5 Dillenbaugh Creek levees Phase 3. Ford's Prairie levees Skookumchuck River levees Project Mitigation Elements including SR-6 Bypass	Aug 06 Aug 06 Aug 06 Aug 07 Aug 07 Aug 08 Aug 08 Aug 08
Construction Contract Complete Phase 1. I-5 levees from Mellon St. to Salzer Creek Airport levee from Salzer Creek to SR-6 Phase 2. Skookumchuck Dam Salzer Creek levees east of I-5 Dillenbaugh Creek levees (WA-DOT) Phase 3. Ford's Prairie levees Skookumchuck River levees Project Mitigation Elements including SR-6 Bypass	Oct 07 Oct 07 July 08 Oct 08 Oct 08 Oct 09 Oct 09 Oct 09
Project Construction Physically Complete	Jan 2010
Project Fiscally Complete	Apr 2010
Final Acceptance & Transfer to Local Sponsor	April 2010

6.4 Operation and Maintenance

The local sponsor is responsible for all future operation and maintenance activities. An Operation and Maintenance Manual will be developed during construction and provided to the county for implementation. The estimated total cost of O&M is \$10,471,600 with an average annual equivalent value of \$652,800. See Section 5.9 for further discussion of operation and maintenance.

6.5 Cost Allocation

Cost allocation is the practice of allocating the separable costs of a project to the various project purposes they serve. Because all features of the recommended plan were formulated to address flood damage reduction objectives (or to mitigate for adverse environmental impacts) all costs are allocated to the authorized project purpose of Flood Damage Reduction. NED costs (economic costs that include opportunity costs) are used for cost allocation.

6.6 Cost Apportionment

Cost apportionment is the practice of dividing the responsibility for paying the costs of a project between the Federal government and the local sponsor (or appropriate non-Federal interests). Project financial costs are the costs that are shared by the planning partners. Cost sharing for construction of this project will be in keeping with current Corps of Engineers policy whereby, for flood damage reduction projects, the non-Federal share will be 35 percent of the project implementation costs (PED, construction, construction management, Federal supervision and administration, and monitoring). The local sponsor will provide 100 percent of the necessary lands, easements, rights-of-way, relocations and disposal areas (LERRDs), and conduct all future operation, maintenance, repair, rehabilitation and replacement (OMRR&R) activities. If the LERRD value exceeds the maximum share, the sponsor will be reimbursed for the value of the LERRD that exceeds the 50 percent. If the LERRD value is less than the required 35 percent non-Federal share, the sponsor will pay the difference in cash. In addition, the sponsor is also required to pay a minimum of 5 percent in cash. If this situation is estimated prior to executing the PCA, no additional credit will be given to the sponsor for in-kind services.

PED originally began prior to the policy change that required sponsors to provide 25% of PED costs; therefore the work performed during PED has been and will continue to be funded at a 100% Federal expense. The non-Federal cost share will include the cost allocation of the flood control cost shared elements and the betterments which will be 100% non-Federal.

Table 6-3 provides a summary of the estimated cost apportionment between the Federal and non-Federal interests for the recommended plan. The table shows the total first cost of the recommended project as \$94,355,000 of which \$56,466,800 is Federal cost and \$37,888,200 is non-Federal cost. The non-Federal cost includes the sponsor's cash contribution of \$23,078,200 and the LERRD value of \$14,810,000.

TABLE 6-3 CHEHALIS RIVER FLOOD DAMAGE REDUCTION COST APPORTIONMENT (\$)

	Federal Cost*	Non-Federal Cost*	Total*
NED Flood Damage Reduction and Mitigation	56,466,800	30,405,200	86,872,000
Plus Increment Flood damage Reduction and Buy-up to Locally Preferred Plan		7,483,000	7,483,000
Less LERRD Value		14,810,000	14,810,000
LP Plan Cash Contribution	56,466,800	23,078,200	79,545,000
Recommended Project (Locally Preferred Plan)	56,466,800	37,888,200	94,355,000

Apportionment of financial costs

**October FY03 price level (rounded)-Cost is project costs less OMRR&R*

6.7 Institutional Requirements

Before the PCA can be executed, the local sponsor will prepare the following financial analysis:

- the local sponsor's project-related yearly cash flows (both expenditures and receipts where cost recovery is proposed), including provisions for anticipated operation and maintenance requirements and contingencies for uncertain damages from natural events;
- the local sponsor's current and projected ability to finance its share of the project cost and to carry out project implementation and OMRR&R responsibilities;
- the means and certainty for raising additional non-Federal financial resources including but not limited to special assessment districts and state grants; and
- the steps that the local sponsor would take to ensure it would be prepared to execute its project-related responsibilities at the time of project implementation.

In addition, as part of any PCA, the local sponsor would be required to undertake to save and hold harmless the Federal government against all claims related to other activities associated with this project.

6.8 Environmental Requirements

There are many Federal, state, tribal and local laws, regulations and treaties applicable to the recommended plan. The EIS, including a Fish and Wildlife Coordination Act Report, programmatically satisfies NEPA requirements when a Record of Decision (ROD) is signed. In addition, a 404(b)(1) is also included in the EIS. As the design is finalized, the 404(b)(1) will be updated as needed on a site-specific basis prior to construction. The Corps will continue to coordinate with the state Department of Ecology and the Chehalis Tribe to obtain Section 401 state water quality certification prior to construction. Certification is usually done during PED (about 90 percent design level) when all necessary information is completed. Table 6-4 below shows the status and responsibility for compliance with the applicable laws, regulations and treaties.

TABLE 6-4 STATUS OF COMPLIANCE WITH ENVIRONMENTAL LAWS/REGULATIONS/TREATIES

Law/Regulation/Treaty	Status of Compliance
National Environmental Policy Act (NEPA)	In compliance for Final EIS/ROD
Endangered Species Act	In compliance.
National Historic Preservation Act	In compliance for this phase, ongoing coordination in next phase.
Clean Water Act	In compliance for this phase.
Clean Air Act	In compliance
Fish and Wildlife Coordination Act	In compliance
Natural Resource Conservation Service	In compliance
Migratory Bird Treaty Act	In compliance
Executive Order 12898, Environmental Justice	In compliance
Executive Order 11990, Protection of Wetlands	In compliance
Executive Order 11988, Floodplain Management	In compliance for this phase, floodplain management plan to be completed prior to PCA
Indian Treaty Rights	In compliance through public review process.
State Environmental Policy Act	In compliance for this phase. Lewis County will adopt Final EIS
Washington Hydraulic Code	In compliance for this phase, Lewis County will obtain permits before construction.
Water Quality Certification	In compliance for this phase.

Law/Regulation/Treaty	Status of Compliance
Growth Management Act	In compliance for this phase.
Model Toxics Control Act	In compliance for this phase. Lewis County will obtain any necessary approvals
State Aquatic Lands Management Laws	In compliance for this phase.
Thurston County Regulations	In compliance for this phase. Lewis County will obtain all required permits
Lewis County Regulations	In compliance for this phase. Lewis County will obtain all required permits
City Regulations and Ordinances	In compliance for this phase. Lewis County will obtain all required permits

6.9 Sponsorship Agreements

The local sponsor (Lewis County) has provided a letter of intent acknowledging sponsorship requirements of the project. Prior to the award of construction contracts, the sponsor will be required to execute the Project Cooperation Agreement and provide required funds.

6.10 Sponsor's Financial Plan and Capability Assessment

In accordance with ER 1005-2-100, paragraph 6-184.b, a preliminary financing plan and statement of financial capability was prepared by the local sponsor. The Corps' Seattle District office has reviewed the plan and assessed the sponsor's understanding of the budgetary issues related to financing the proposed project. The Corps has determined that the local sponsor has the capability to fund their portion of implementation responsibilities.

6.10.1 Financial Analysis

Local sponsor Lewis County is willing and able to share the costs of project implementation. As shown in Table 6-3, the cost estimate for the NED Plan is \$86,872,000. The sponsor is responsible for 35 percent of the implementation cost, an estimated \$30,405,200. Assuming that the real estate value for which the sponsor will get credit is \$14,810,000, and the sponsor will get credit for the \$3,000,000 already contributed in in-kind services, Lewis County would be responsible to provide the Corps of Engineers an additional \$12,595,200 in cash over the construction period for the NED Project. The sponsor, however, has expressed an interest to upgrade portions of the NED Plan to provide additional levels of flood protection. These upgrades (buy-ups) are a 100 percent local responsibility, and are estimated to add \$7,483,000 in costs to the NED Plan. Therefore, the total cash responsibility of the sponsor, if they continue to support the betterments and after crediting of LERRD and already contributed funds, may be as

much as \$20,078,200. Cost estimates change over time, and the final cost sharing numbers would be determined at the end of construction.

Despite the fact that Lewis County is the official sponsor and will be signing the Project Cooperation Agreement (PCA) with the Corps of Engineers, the county is expecting to receive the majority of its required project funds from the Washington State Department of Transportation (WSDOT). This source of funding, as well as other sources of non-Federal project matching funds are discussed in the county's Financing Plan and Statement of Financial Capability, provided by letter to Seattle District, dated 13 August 2002.

6.10.2 Assessment of Financial Capability

The Corps' assessment of the local sponsor's financial capability is required to verify that sufficient funds will be available to the sponsor to satisfy the financial obligations for the project. The financing plan submitted by Lewis County is satisfactory and sufficient.

The county intends to fund its land acquisition expenses, cash contribution requirements, and annual operation and maintenance costs from the following sources:

1. Washington State Department of Transportation funding.
2. creation of a flood control district (or similar local service district with taxing authority), or in the event sufficient funds are not available through these sources;
3. enter into an inter-local agreement with the cities of Centralia and Chehalis to assist in funding;
4. issue general obligation bonds.

An allocation of funds table will be included prior to the signing of the PCA.

7. LEGAL AND TECHNICAL REVIEW

The study's Quality Control (QC) Plan defined the process by which to assure quality products for the General Reevaluation Study. This QC Plan defined the responsibilities and roles of each member of the study team, along with a legal sufficiency and policy compliance review

The project team is comprised of qualified staff from within the Corps' Seattle District, Northwestern Division, the local sponsor, Lewis County, USFWS, and their consultants and contractors.

An Independent Technical Review (ITR) team was established whose members were selected on the basis of their lack of direct affiliation with the development of the GRR/EIS. ITR is currently a Corps district function. The objective of ITR was to ensure and confirm that:

- the documents are consistent with established criteria, procedures and policy;
- assumptions that are clearly justified have been utilized in accordance with established guidance and policy, with any deviations clearly identified and properly approved;
- the concepts, features, analytical methods, analyses, and details are appropriate, fully coordinated, and correct;
- the problems/issues are properly defined and scoped; and
- the conclusions and recommendations are reasonable.

ITR was conducted for all decision documents and was independent of the technical production of the product/project. The ITR included periodic technical review team meetings to discuss critical plan formulation or other project decisions, and coordinate the review of the written GRR, EIS, appendices, report documentation and files.

The ITR was divided into two major segments. The first part of the ITR took place in July 2001 and covered the basic hydrology, hydraulics, and economic analysis involved in developing the existing condition analyses and determining the appropriate "without-project" analysis. In addition, an ITR of Skookumchuck Dam liquefaction and stability analysis was also conducted to ensure that Corps dam stability criteria would be met. The second part of the ITR concentrated on review of the draft technical reports and covered all other aspects of project planning and design.

A Certification of Technical and Legal Review memorandum is included with the submittal of this report. This memorandum includes:

- a Statement of Technical and Legal Review that discusses the general scope of the review and lists the TTR team members;
- a Certification of TTR that identifies the significant technical concerns raised during the review and the resolution of those concerns, and is signed by the District Chiefs of Planning, Engineering, Operations, and Real Estate;
- a Certification of Legal Review of all documents and their legal sufficiency, signed by a District Office of Counsel attorney.

8. DISTRICT COMMANDER'S RECOMMENDATION

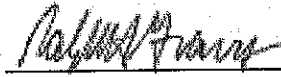
The cities of Chehalis, Centralia, and surrounding communities in Lewis and Thurston Counties, Washington, have a long history of flooding and flood damages. These problems have been acknowledged and studied for many years. More recently, heightened environmental awareness and the potential listing of area aquatic species as threatened and endangered have resulted in a need for increased focus on the development of flood control alternatives that minimize environmental impacts and that incorporate environmental features to mitigate any adverse impacts to fish and wildlife habitats.

The recommended project is the Locally Preferred Plan as described in this report. It would provide 100-year flood protection for the cities of Centralia and Chehalis, Washington. The project would provide estimated annual benefits of \$8,949,000, including \$6.7 million in flood related damages to structures and their contents, \$2.1 million in annual avoided costs associated with the need to elevate Interstate Highway 5 without the project, and an annual reduction of \$131,000 in traffic delays related to flooding. Annual economic costs are estimated at \$7,063,000, resulting in annual net benefits of \$1,886,000 and a positive benefit-to-cost ratio of 1.27 to 1. The NED Plan would have annual costs of \$6,496,000, providing net benefits of \$2,210,000 at a benefit-to-cost ratio of 1.34 to 1. The recommended project is supported by the local sponsor, Lewis County, Washington, who will assume all costs over those of the NED Plan as identified in this report.

I recommend that the selected plan described herein for flood damage reduction purposes be authorized for implementation as a Federal project. The implementation cost of the project is currently estimated at \$94,355,000. The Federal share is currently estimated at \$56,466,800 and the non-Federal share is \$37,888,200.

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 a national Civil Works construction program nor the perspective of higher review levels within the Executive Branch. Consequently,

the recommendations may be modified before they are transmitted to the Congress as proposals for authorization and implementation funding. However, prior to transmittal to the Congress, the sponsor, the states, interested Federal agencies, and other parties will be advised of any modifications and will be afforded an opportunity to comment further.



Colonel Ralph H. Graves
U.S. Army Corps of Engineers
District Engineer