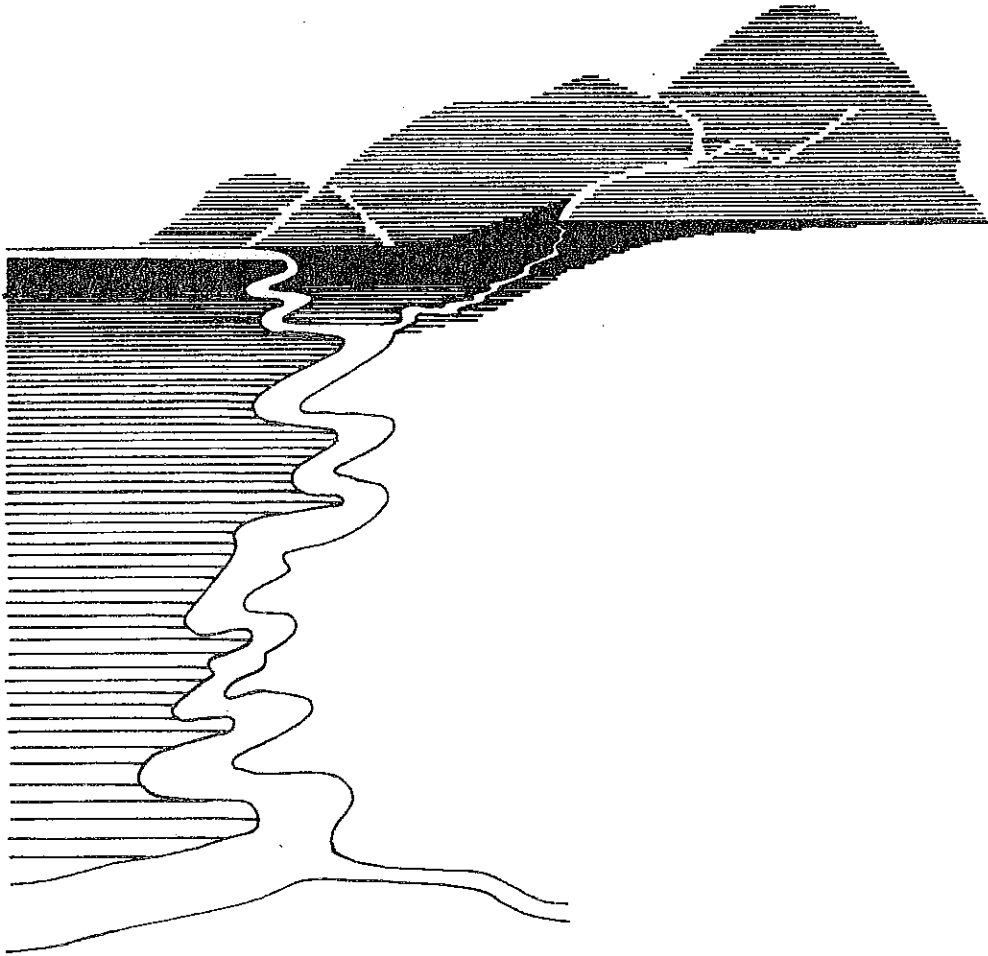


**CENTRALIA  
FLOOD DAMAGE REDUCTION**

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**APPENDIX D - PLAN FORMULATION**





APPENDIX D

PLAN FORMULATION

TABLE OF CONTENTS

<u>Paragraph</u>		<u>Page</u>
<b>SECTION 1. BACKGROUND</b>		
1.01	Study Authorization	D-1
1.02	Prior Corps Studies	D-1
1.03	Land Use Planning	D-1
1.04	Local Land Use Planning and Regulations	D-3
	a. Centralia	D-3
	b. Chehalis	D-3
	c. Lewis County	D-3
	d. Thurston County and Bucoda	D-5
1.05	Washington State Land Use Planning	D-5
	a. Department of Ecology	D-5
	b. Department of Natural Resources	D-6
	c. Departments of Fisheries and Game	D-6
1.06	Federal Policies, Regulations, and Programs	D-6
	a. Executive Order 11988	D-6
	b. Executive Order 11990	D-7
	c. Clean Water Act of 1977	D-7
	d. Flood Insurance Program	D-7
<b>SECTION 2. FORMULATION AND EVALUATION OF PRELIMINARY ALTERNATIVES</b>		
2.01	Description of Alternatives	D-8
2.02	Alternative 1 - No Action	D-8
2.03	Alternative 2 - Floodproof Structures	D-8
2.04	Alternative 3 - Multipurpose Storage	D-8
2.05	Alternative 4 - Small Headwater Dams	D-10
2.06	Alternative 5 - Watershed Management	D-10
2.07	Alternative 6 - Channel Clearing	D-11
2.08	Alternative 7 - Channel Excavation	D-11
	a. Alternative 7A	D-11
	b. Alternative 7B	D-11
	c. Alternative 7C	D-11
	d. Alternative 7D	D-11
2.09	Alternative 8 - Channel Excavation with Levees	D-11
2.10	Alternative 9 - Urban Area Levees	D-13
2.11	Alternative 10 - Levees with River Modification	D-13

TABLE OF CONTENTS (con.)

<u>Paragraph</u>		<u>Page</u>
2.12	Other Nonstructural Measures	D-13
	a. General	D-13
	b. Land Use Regulations	D-13
	c. Flood Insurance	D-17
	d. Evacuation and Relocation	D-17
	e. Purchase of Development Rights	D-17
	f. Summary	D-17
2.13	Preliminary Assessment and Evaluation of Alternatives	D-18
SECTION 3. FORMULATION, ASSESSMENT, AND EVALUATION OF FINAL ALTERNATIVES		
3.01	Description of Final Alternatives	D-21
	a. Alternative 1 - No Action	D-21
	b. Alternative 2 - Skookumchuck Dam Modification	D-21
3.02	Comparative Evaluation of Final Alternatives	D-24
	a. General	D-24
	b. National Economic Development	D-24
	c. Environmental Quality	D-24
	d. Regional Development	D-29
	e. Other Social Effects	D-29
3.03	Designation of Selection of Plans	D-30
	a. National Economic Development	D-30
	b. Least Environmentally Damaging Plan	D-30
	c. Tentatively Recommended Plan	D-30

TABLES

<u>Number</u>		<u>Page</u>
D1-1	Corps of Engineers Flood Control Studies for Centralia/Chehalis	D-2
D2-1	Evaluation of Nonstructural Measures	D-16
D2-2	Comparison of Preliminary Alternatives	D-19
D3-1	System of Accounts	D-25

FIGURES

D1-1	Existing Land Use Map	D-4
D2-1	Upper Chehalis River Basin Dam Sites	D-9
D2-2	Flood Damage Reduction Alternatives	D-12
D2-3	Levee Segments Analyzed	D-14
D2-4	200-Year Levee System	D-15
D3-1	Skookumchuck Dam Modifications	D-22

## SECTION 1. BACKGROUND

1.01 Study Authorization. The Centralia-Chehalis Flood Damage Reduction Study was authorized by a resolution adopted 19 April 1946 by the Committee on Flood Control of the U.S. House of Representatives. The complete text of the resolution is as follows:

"Resolved by the Committee on Flood Control, House of Representatives, that the Board of Engineers for Rivers and Harbors, created under section 3 of the River and Harbor Act approved 13 June 1902, be and is hereby requested to review the report on the Chehalis River and Tributaries, Washington, submitted in House Document numbered 494, 78th Congress, second session, with a view to determining whether any modification of the recommendations contained therein should be made at this time."

1.02 Prior Corps Studies. Prior Corps of Engineers studies involving flood control in the Centralia-Chehalis area are listed in table D1-1. In addition to these studies, the Corps of Engineers participated in a comprehensive framework study of water and related lands for the Columbia-North Pacific Region. The study was accomplished under the direction of the Pacific Northwest River Basins Commission. It was completed in 1972 and transmitted to Congress in 1974. The framework study identified and addressed the problem of flood damages in the flood plains of the Chehalis, Newaukum, and Skookumchuck Rivers and concluded that flood-plain regulation was needed throughout the basin. The study also indicated that flood control storage did not appear economically feasible and levees would be feasible only in areas of major development. The Centralia-Chehalis area was identified as an area where levees should be constructed, and the study recommended 9.5 miles of levee in the Centralia-Chehalis area as part of its recommended short-range (1970 to 1980) program. The National Hydropower Study has identified only two potential hydropower sites in the Chehalis basin, both of which are located on the Wynoochee River. No sites were listed on the Chehalis, Newaukum, or Skookumchuck Rivers. Hydropower in the Chehalis basin is being addressed under a separate interim report, Wynoochee Hydropower/Fish Hatchery.

1.03 Land Use Planning. Current land use within the flood problem area is mixed. Land use on the right bank of the Newaukum and Chehalis Rivers and on both banks of the Skookumchuck River within the cities of Centralia and Chehalis and surrounding developed areas is primarily residential and commercial. Some areas on the right bank of the Skookumchuck River remain in agricultural use primarily for pasture. Substantial areas between Interstate 5 (I-5) and the Newaukum and Chehalis Rivers remain in agricultural use. The left bank of the Chehalis and Newaukum Rivers is primarily in agricultural use except for a limited area within the city limits of Centralia and the community of Galvin. Several local, county, state, and Federal plans and programs

TABLE D1-1

CORPS OF ENGINEERS FLOOD CONTROL STUDIES  
FOR CENTRALIA/CHEHALIS

<u>Report</u>	<u>Date</u>	<u>Content</u>
House Document 148 72nd Congress 1st Session	1931	Investigated improvements on the Chehalis River for navigation, flood control, power 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 78th Congress 2nd 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	October 1965	Examined floodway problem along Lum Road in Centralia and recommended clearing and snagging on 1,660 feet of Coffee Creek (completed March 1966).
Flood Plain Information, Skookumchuck River Bucoda, Washington	February 1968	Delineated the flood plain along the Skookumchuck River from the Lewis/Thurston County line to about 1 mile upstream of Bucoda.
Flood Plain Information, Chehalis and Skookumchuck Rivers, Centralia-Chehalis, Washington	June 1968	Delineated the flood plain 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	August 1974	Delineated the suggested hydraulic floodway for the area covered by the June 1968 flood plain information report.
Special Study, Suggested Hydraulic Floodway Chehalis and Newaukum Rivers	March 1976	Delineated the flood plain and suggested hydraulic floodway for Chehalis River from Chehalis to Adna and the Newaukum River from its mouth to the I-5 bridge.

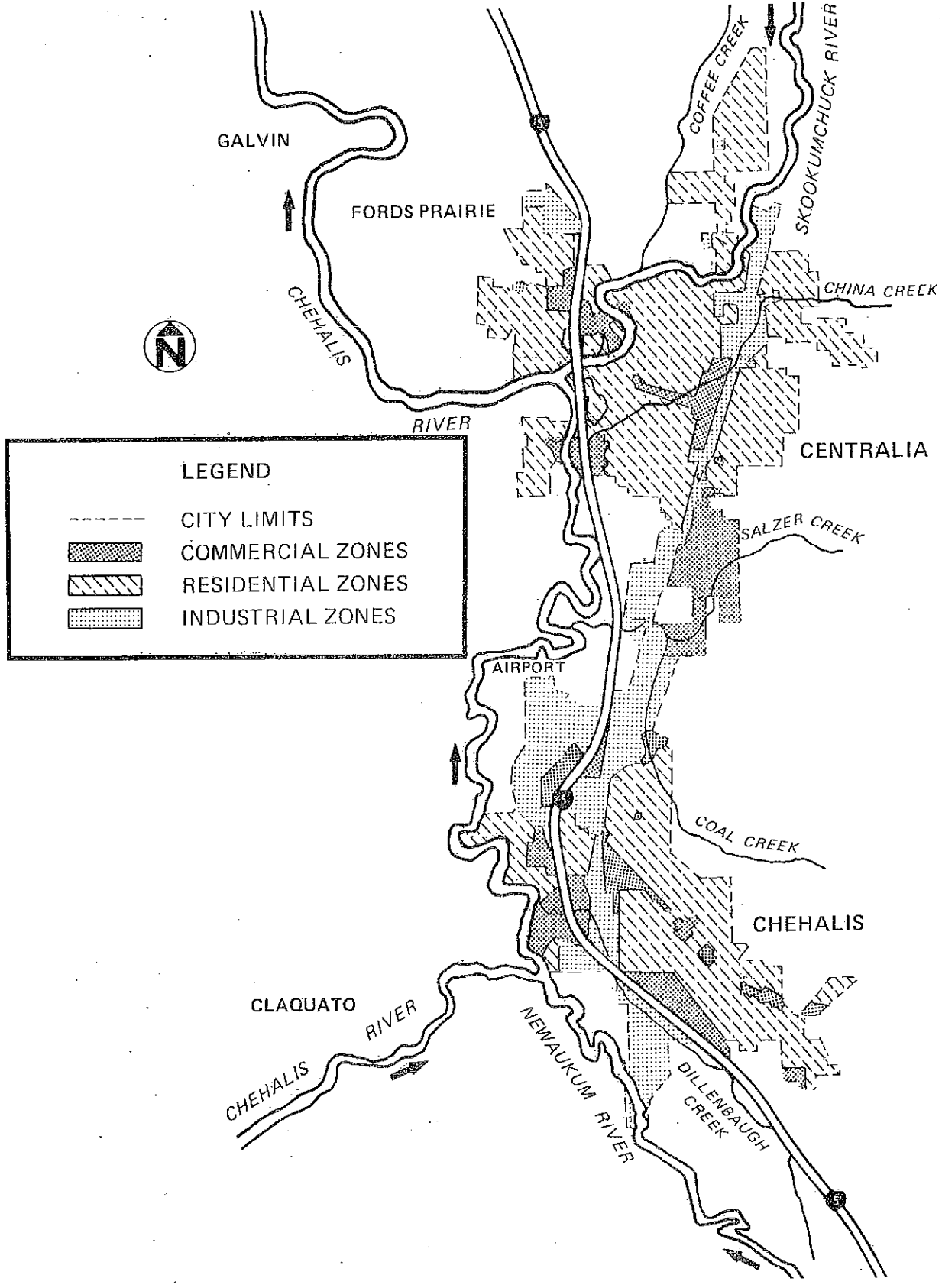
directly or indirectly influence and control the land use within the area and would have an impact on any proposed flood damage reduction plan. These plans and programs are described in the following paragraphs.

1.04 Local Land Use Planning and Regulations. Land use within the area is primarily governed by zoning ordinances of the cities of Centralia and Chehalis and the Lewis County Shoreline Master Program. Land use along the Skookumchuck River is largely governed by the Thurston County Shoreline Master Program. Figure D1-1 shows the land use classifications as defined by the zoning ordinances of Centralia and Chehalis. A simplified classification system has been shown for the areas within Centralia and Chehalis which divides the land into residential, commercial, and industrial land use categories. The actual zoning ordinances of the cities subdivide these broad categories into more detailed classifications. There is no Lewis County zoning ordinance or comprehensive plan so no classification is shown for areas outside the incorporated areas except for the shoreline classifications which are explained in more detail in paragraph 1.04c. The following paragraphs describe the land use planning for Centralia, Chehalis, Lewis County, Thurston County, and Bucoda.

a. Centralia. Centralia completed its first comprehensive land use plan in 1960 and established a zoning ordinance in 1962. Several planning studies have been prepared for the city, including a Central Business District Study prepared in 1963 and updated in 1969, a Centralia Freeway Interchange Study dated 1969, and a Centralia Comprehensive Plan Refinement and Update dated 1970. One of the criteria used in developing the 1970 comprehensive plan update was to encourage agricultural and other open uses in flood plain and poorly drained, low-lying areas.

b. Chehalis. The zoning ordinance for the city of Chehalis was adopted 6 November 1978. A general goal of the ordinance was to generally strike an appropriate balance between maximum flexibility in land use and the need for high-quality development for the overall community good. The zoning ordinance establishes a flood-plain overlay to assure land uses compatible with the flood plain. It provides that no building may be erected except on compacted fill, piling, or other hazard-protecting method. It also prohibits filling or any other use which would significantly obstruct the movement of floodwater or reduce the floodwater capacity of the flood plain. It restricts the storage of buoyant materials, camping, or any other activity posing a potential problem to the intent of the flood plain.

c. Lewis County. The Shoreline Management Program is the primary land use control exercised by the county in the study area. The Washington State Shoreline Management Act enacted in 1971 requires local governments to prepare guidelines for shoreline development. Substantial work or development within 200 feet of the natural shoreline requires a Shoreline Management Permit. Administration of the program



# EXISTING LAND USE MAP

FIGURE D1-1



within Lewis County has been vested with the Lewis County Planning Department. The county has prepared a Shoreline Master Program to guide the administration of the program and outline its goals. The plan classifies shorelines that fall within the jurisdiction of the act into four environments: (1) the natural environment which includes those resource systems and features that are necessary for maintaining natural, physical, and biological processes; (2) the conservancy environment which provides for multiple-use activities, although the intensity of uses is limited by extensive commercial forest areas, steep slopes, flooding, desirability for low-intensity recreational use, and wildlife habitat values; (3) the rural environment which includes agricultural and low-density residential development areas which do not anticipate immediate expansion; and (4) the urban environment which includes areas of intensive residential, commercial, or industrial use, or areas which anticipate intensive development in the near future. The land use restrictions are most severe for designated natural environment areas and least severe for urban environments. Within the area the Chehalis, Skookumchuck, and Newaukum Rivers and Salzer and Dillenbaugh Creeks are under the jurisdiction of the Shoreline Management Program. Shorelines within the area are either in an urban or rural classification with only a limited area in the conservancy category.

d. Thurston County and Bucoda. Thurston County has prepared a countywide shoreline master program similar to that in Lewis County. Much of the Skookumchuck River valley is under its jurisdiction and the shorelines are generally classified conservancy except for the limited urban area around Bucoda. The modification of Skookumchuck Dam is compatible with the program.

1.05 Washington State Land Use Planning. The State of Washington exercises regulatory responsibilities for land use planning in the study area through the Department of Ecology (WDE) in the Shoreline Management and Flood Control Zone Programs, the Department of Natural Resources (DNR) through the River Management Policy Plan Program, and the Washington Department of Game (WDG) and Washington Department of Fisheries (WDF) through their hydraulics permits programs. More details on these programs are presented in the following paragraphs. In addition, the state exercises management of certain land and water resources through the normal operations of the WDG and WDF, the Parks and Recreation Commission, and the Interagency Committee for Outdoor Recreation.

a. Department of Ecology. The WDE reviews all projects which require local shoreline management permits and, therefore, would review any permits granted by the counties. The WDE also issues permits for all work in designated flood control zones. Under this program, state permits are required for construction, reconstruction or modification of structures within any flood control zone. In general, the program requires that all structures within the 100-year flood plain be elevated above the 100-year flood elevation or be floodproofed. It generally prohibits development in the hydraulic floodway. The program does not

apply to any property within any plat filed or recorded prior to 1966 and therefore does not include much of the area.

b. Department of Natural Resources. The DNR owns the beds and shores of all navigable waters to the ordinary high-water line. The Chehalis River is considered navigable through the study area. In early 1979, the DNR initiated action to develop a River Management Policy Plan for the Chehalis River. A draft of the plan completed in January 1980 proposed that riverbeds within the study area be classified for unobstructed multiple use. The majority of the shorelines along the Chehalis and Skookumchuck Rivers in the study area below ordinary high water are classified for general access, which allows for open and unobstructed multiple use. The portion of the Chehalis River below the mouth of the Skookumchuck River is classified as specific undeveloped access and is reserved for public use. A portion of the Chehalis River shoreline between Centralia and the airport is designated as an enhancement area allowing for plantings, site improvements for public benefit, and removal of objects and hazards.

c. Departments of Fisheries and Game. The WDF and WDG require a hydraulics permit for excavation or placement of dredged or fill material within the waters of the State of Washington.

1.06 Federal Policies, Regulations, and Programs. Principal Federal regulations and programs that govern land and water use in the study area and would be applicable to any flood damage reduction plan are presented in the following paragraphs.

a. Executive Order 11988. Executive Order 11988 requires that Federal agencies recognize the significant values of flood plains and consider the public benefits that would be realized from restoring and preserving flood plains. The main objective of the Executive Order is to "avoid short-term adverse impacts associated with occupancy and modification of flood plains and to avoid direct and indirect support of flood-plain development" whenever there is a practical alternative. The Corps of Engineers is required to evaluate all its actions under the following general procedures:

- Determine if the proposed action is in the base flood plain.
- Identify and evaluate practical alternatives to the action if it is in the base flood plain.
- Identify beneficial and adverse impacts due to the action and any expected loss of natural and beneficial flood plain values.
- Determine if the action will induce flood-plain development and if there is any practical nonflood-plain alternative to the development.

- Determine methods to minimize any adverse impacts of the action and restore and preserve the natural and beneficial flood-plain values.

- Advise the general public of the action in the flood plain and obtain their views and comments.

- Recommend the plan most responsive to the objectives of the study and consistent with the requirements of the Executive Order.

An evaluation of the plan under Executive Order 11988 is presented in paragraph 4.02c of the environmental impact statement.

b. Executive Order 11990. Executive Order 11990 requires that Federal agencies take action to minimize the destruction, loss, or degradation of wetlands, and to preserve and enhance the natural and beneficial values of wetlands in carrying out the agency's responsibilities. The Executive Order requires that before new construction can be located on wetlands, there must be a determination that there is no practicable alternative to such construction and the proposed action includes all practicable measures to minimize harm to the wetlands.

c. Clean Water Act of 1977. Section 404 of the Clean Water Act of 1977 authorizes the Corps of Engineers to issue permits for the discharge of dredged or fill material into the navigable waters of the United States. Any flood damage reduction plan that involves discharge of dredged or fill material would require an evaluation of the impacts of that discharge. An evaluation of proposed fill actions is presented in appendix A.

d. Flood Insurance Program. The Federal Emergency Management Agency administers the National Flood Insurance Program. In general, the program provides Federal flood insurance to flood-prone communities that adopt regulations restricting construction in flood hazard areas. The cities of Centralia, Chehalis, and Bucoda and Thurston and Lewis Counties participate in the program. Preliminary or final rate maps and flood hazard boundary/floodway maps have been published for all the areas. Results of these studies will be used as a major criteria for applying land use regulations as well as for establishing the area's insurance rates. The minimum regulations require that all new construction and substantial improvements in special flood hazard areas be elevated or floodproofed to the 100-year flood elevation with additional standards for construction within any designated floodway.

## SECTION 2. FORMULATION AND EVALUATION OF PRELIMINARY ALTERNATIVES

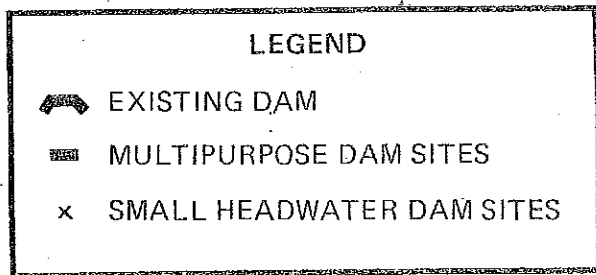
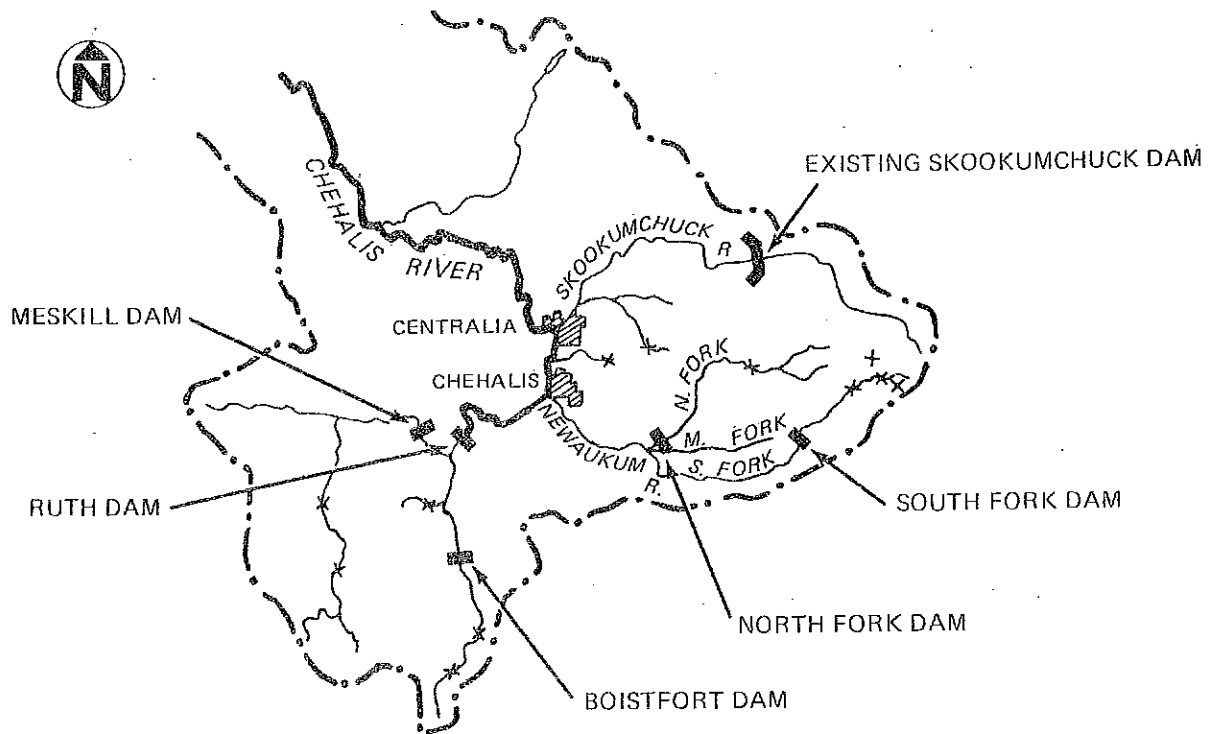
2.01 Description of Alternatives. Preliminary alternatives which address the flood damage reduction objective and the planning criteria are described in the following paragraphs.

2.02 Alternative 1 - No Action. No new action would be taken for flood damage reduction through either structural or nonstructural means. The existing 100-year, 200-year, and standard project flood plains are identified on plate 1 of the feasibility report. Development of the flood plain would be restricted through existing zoning, State of Washington Flood Control Zone Program, the Shoreline Management Program, and any new ordinances that would be required for continued community participation in the Flood Insurance Program. These regulations would generally prohibit most development within the hydraulic floodway and require floodproofing of structures within the flood plain. The Flood Insurance Program would indemnify insured property owners against losses. Undeveloped lands in the flood plain could be set aside for uses compatible with occasional inundation, such as recreation, fish and wildlife enhancement, open space, or certain agricultural activities. Existing average annual damages of \$2,998,000 in the Skookumchuck Valley would continue and increase gradually.

2.03 Alternative 2 - Floodproof Structures. About 1,300 residential and 130 commercial or industrial structures would be floodproofed in Centralia. Residential buildings would be raised so that the first floor level would be above the 100-year flood. Commercial and industrial buildings would be modified so that all openings below the flood-water surface would be watertight. Existing flood-plain zoning would be continued with no new buildings permitted within the floodway. Flood insurance would continue to be available. Flood damages to residential and commercial structures and contents would be largely eliminated. However, other adverse impacts from flooding would continue, including damages to public streets and utilities; cutoff of road and road access; disruption in police, fire, and ambulance service; and deposition of silt and debris.

2.04 Alternative 3 - Multipurpose Storage. Upstream multipurpose storage projects, shown in figure D2-1, would be constructed to provide flood control, irrigation, recreation, and low streamflow augmentation. Five new damsites were considered along with modification of the Skookumchuck Dam, owned by Pacific Power and Light (PP&L), to provide flood control storage. Construction of one or more of these dams would reduce the frequency of overbank flooding and reduce average annual damages and hazards to life and property.

• Ruth, located 8 miles west of Chehalis on the Chehalis River and providing 108,000 acre-feet of flood storage.



# UPPER CHEHALIS RIVER BASIN DAM SITES

FIGURE D2-1

- North Fork Newaukum, located 9 miles east of Chehalis on the North Fork Newaukum River and providing 9,000 acre-feet of flood storage.

- South Fork Newaukum, located 4 miles northeast of Onalaska on the South Fork Newaukum River and providing 15,000 acre-feet of storage.

- Boistfort, located 16 miles southwest of Chehalis on the South Fork Chehalis River and providing 16,000 acre-feet of flood storage.

- Meskill, located 10 miles west of Chehalis on the Chehalis River and providing 54,000 acre-feet of flood storage.

- Skookumchuck, located 14 miles northeast of Centralia on the Skookumchuck River and providing up to 35,000 acre-feet of storage. Prior to construction of the dam in 1968, the Corps of Engineers analyzed raising the dam to provide flood control storage above the water supply pool. This concept was not economically justified with a benefit/cost ratio of 0.3 to 1 (1976 price levels and interest rates).

However, in August, 1980 the city of Centralia requested a reanalysis of the dam's potential for flood control. Subsequent coordination with PP&L indicated that because of the experience they had gained in a decade of dam operation, they believed that use of part of their existing water supply storage during winter months for flood control storage would be possible. Hydrologic studies by the Corps indicated that 17,000 acre-feet of flood control storage could be provided at the dam and would reduce the 200-year flood on the Skookumchuck River in Centralia from 13,300 to 6,700 cubic feet per second (c.f.s.); a reduction of 2 to 5 feet in flood height. The reliability of the existing and future water supply requirements would also be maintained.

2.05 Alternative 4 - Small Headwater Dams. Twelve small headwater dams, located on figure D2-1, would be sited on tributaries to the Chehalis River above Centralia-Chehalis. The dams would have uncontrolled outlets to pass normal streamflows but would temporarily restrain portions of larger flows in lakes behind the dams. Total storage capacity of the system upstream of Centralia-Chehalis would be 14,500 acre-feet. The system would reduce the 100-year discharge at Grand Mound by about 3,000 c.f.s., representing less than a 1/2-foot reduction in flood crest at Centralia. Flood damage reduction would be minimal.

2.06 Alternative 5 - Watershed Management. Management measures, including reforestation, timber harvest control, and development control, would be undertaken to reduce stream erosion and silting and to decrease the magnitude of peak runoff associated with basin flooding. Due to the nature of major floods in the Chehalis River basin, watershed management in the upper Chehalis River basin would have little effect on major floods that occur when intense rain falls on saturated soils and melts the snow cover. Also, watershed management measures are already being undertaken in the basin under the direction of the Soil Conservation Service (SCS) and the State of Washington.

2.07 Alternative 6 - Channel Clearing. Vegetation and debris would be cleared from the banks and channel of the Chehalis River (shown on figure D2-2) between river mile (R.M.) 63, near Galvin, and R.M. 75, confluence with Newaukum. About 73 acres of clearing would be involved. Annual maintenance would be required to assure the continued effectiveness of this alternative. Removal of vegetation would decrease the flow resistance and provide a small increase in the capacity of the existing channel. Flood damage reduction would be minimal because the increase in channel capacity would be not significant when compared to the flood discharge. Uncontrolled flooding would continue.

2.08 Alternative 7 - Channel Excavation. Selected reaches (shown on figure D2-2) of the Chehalis, Skookumchuck, and Newaukum Rivers in the study area would be excavated to increase their flood carrying capacity and lower their flood crests. Four plans were examined but none were economically justified with benefit-to-cost ratios ranging from 0.7 to 1 to 0.3 to 1.

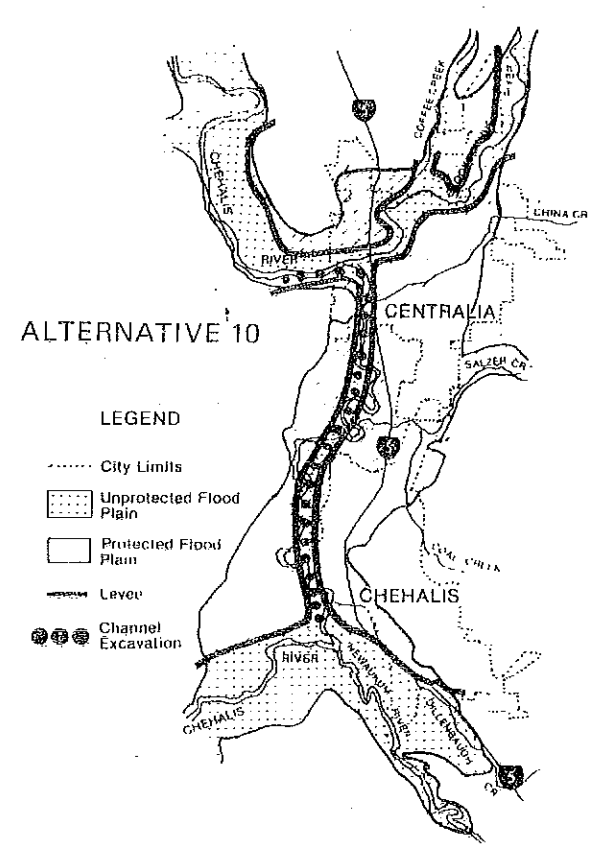
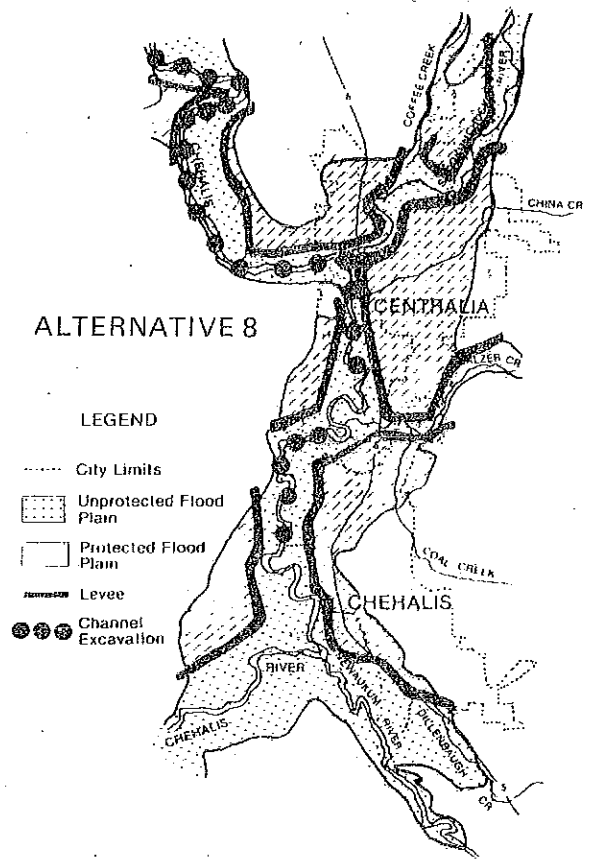
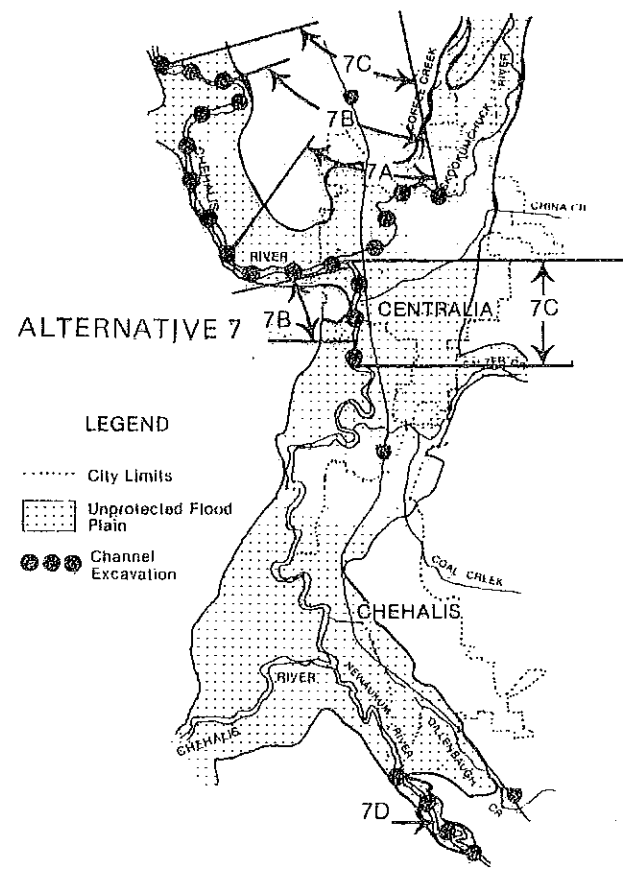
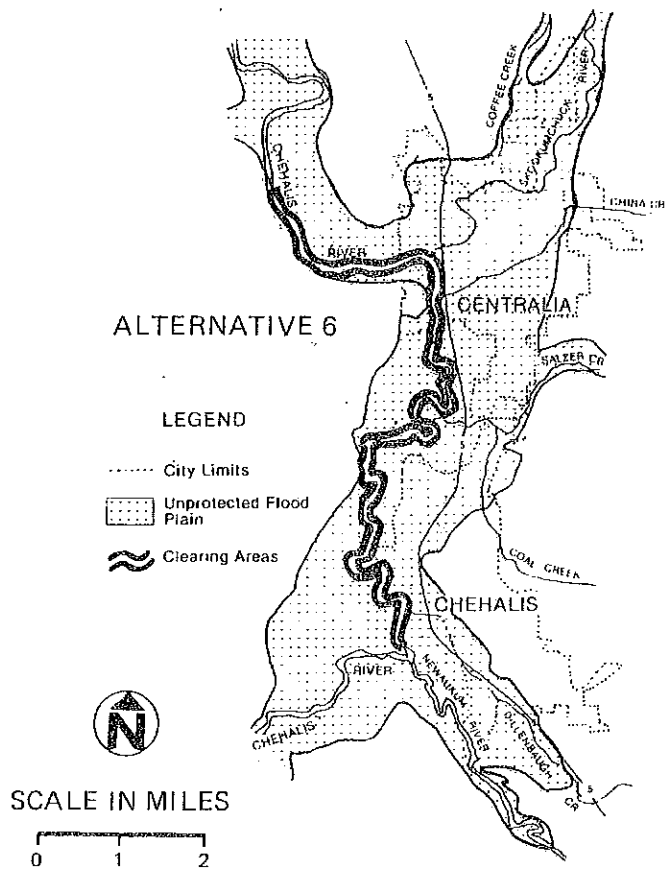
a. Alternative 7A. The Chehalis River would be excavated from the mouth of the Skookumchuck River downstream for about 8,000 feet, and the Skookumchuck River would be excavated from its mouth upstream 12,000 feet. About 289,000 cubic yards (c.y.) of material would be removed from the Chehalis River with excavation averaging 2 feet. The Skookumchuck River would be excavated an average of 3 feet with 191,000 c.y. of material removed. The plan would lower the 100-year Chehalis River flood crest about 1-1/2 feet at Centralia.

b. Alternative 7B. The Chehalis River would be excavated from 1/2-half mile upstream of the mouth of the Skookumchuck River downstream for about 32,000 feet. The maximum excavation depth would average 12 feet with 1,755,000 c.y. of material removed. Skookumchuck River excavation would be the same as alternative 7A. The plan would lower the 100-year Chehalis River flood crests about 4 feet at Centralia and about 1 foot at Chehalis.

c. Alternative 7C. The Chehalis River would be excavated from 1 mile upstream of the mouth of the Skookumchuck River downstream for about 37,000 feet. Skookumchuck River excavation would be the same as alternative 7A. The plan would lower the 100-year Chehalis River flood crest about 5 feet at Centralia and about 1 foot at Chehalis.

d. Alternative 7D. The Newaukum River would be excavated from 2 miles above the mouth upstream for about 33,000 feet. Excavation would average 5 feet in depth with 1,026,000 c.y. of material removed. The plan would lower the 100-year flood crest by about 2 feet at the Larabee Road Bridge upstream of Chehalis.

2.09 Alternative 8 - Channel Excavation with Levees. The Chehalis River channel (shown on figure D2-2) would be excavated from Centralia downstream for about 7 miles and for 2 miles in the vicinity of the



**PRELIMINARY ALTERNATIVES**  
**FIGURE D2-2**



airport. About 3,000,000 c.y. of material would be excavated. Part of the excavated material would be used to construct about 20 miles of levees on both banks of the Chehalis and Skookumchuck Rivers and Salzer Creek and to provide protection for about 5,800 acres of land.

2.10 Alternative 9 - Urban Area Levees. A number of alternative levee segments (shown in figure D2-3) providing flood protection for the cities of Centralia and Chehalis and the unincorporated areas of Galvin and Fords Prairie were analyzed. Only those segments within or adjacent to the city of Centralia and protecting from the Chehalis and Skookumchuck Rivers and Salzer and Coffee Creeks were found to be economically justified. A levee system (shown on figure D2-4) about 12.3 miles long could protect 1,980 acres from a 200-year flood. Two road bridges and three railroad bridges would have to be raised. Interior drainage facilities would include 63 acres of ponding areas, 1 permanent pumping station, and 11 temporary pumps. Fish and wildlife mitigation measures would be required.

2.11 Alternative 10 - Levees with River Modification. The Chehalis River channel would be straightened and enlarged from the Main Street Bridge to the Mellen Street Bridge. Levees providing 100-year flood protection would be constructed on both banks of the modified Chehalis River channel and also on both banks of the Skookumchuck River. Pumping plants would be required at Salzer and China Creeks. About 20,000 feet of channelization and 120,000 feet of levee would be required.

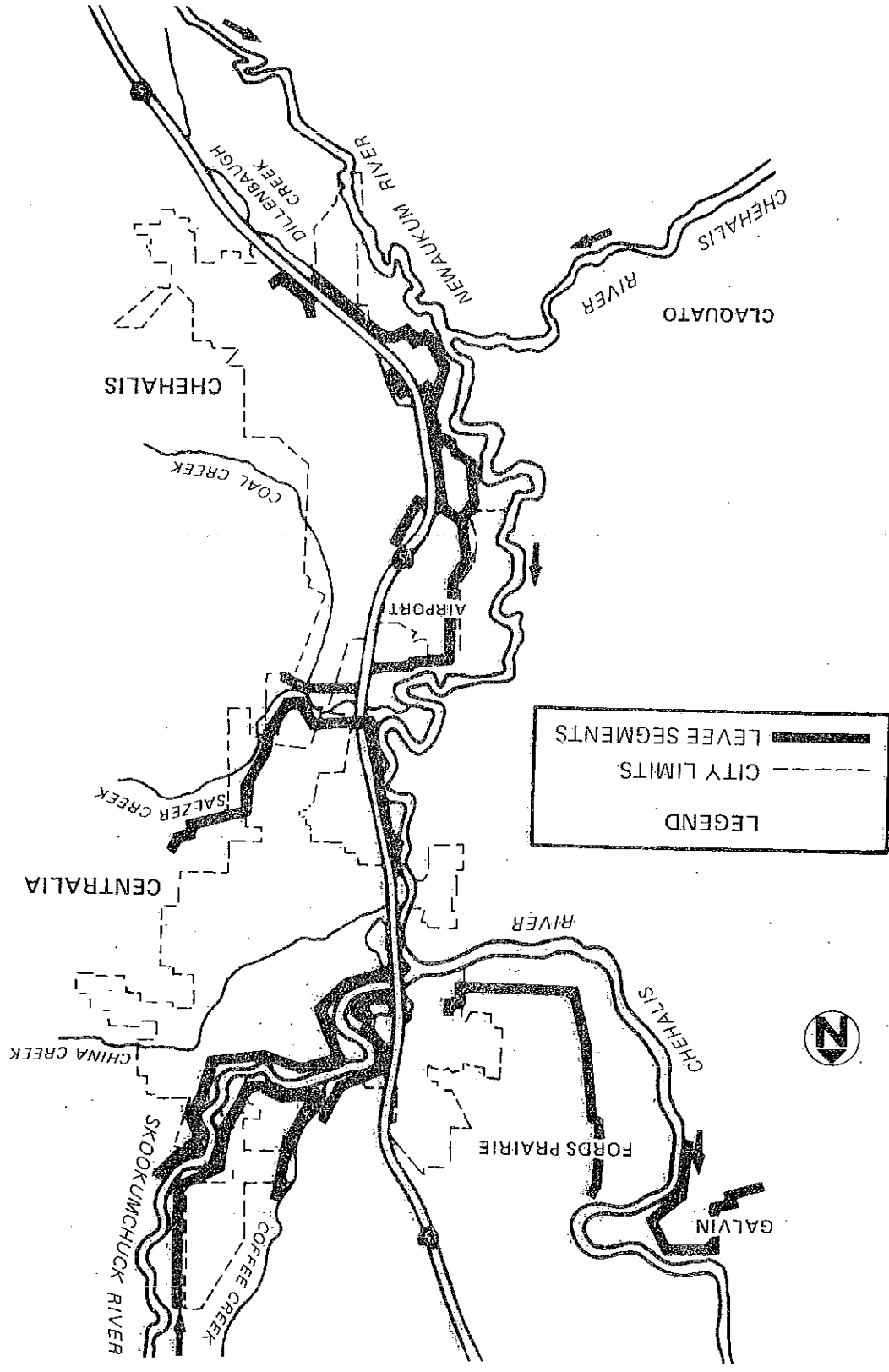
#### 2.12 Other Nonstructural Measures.

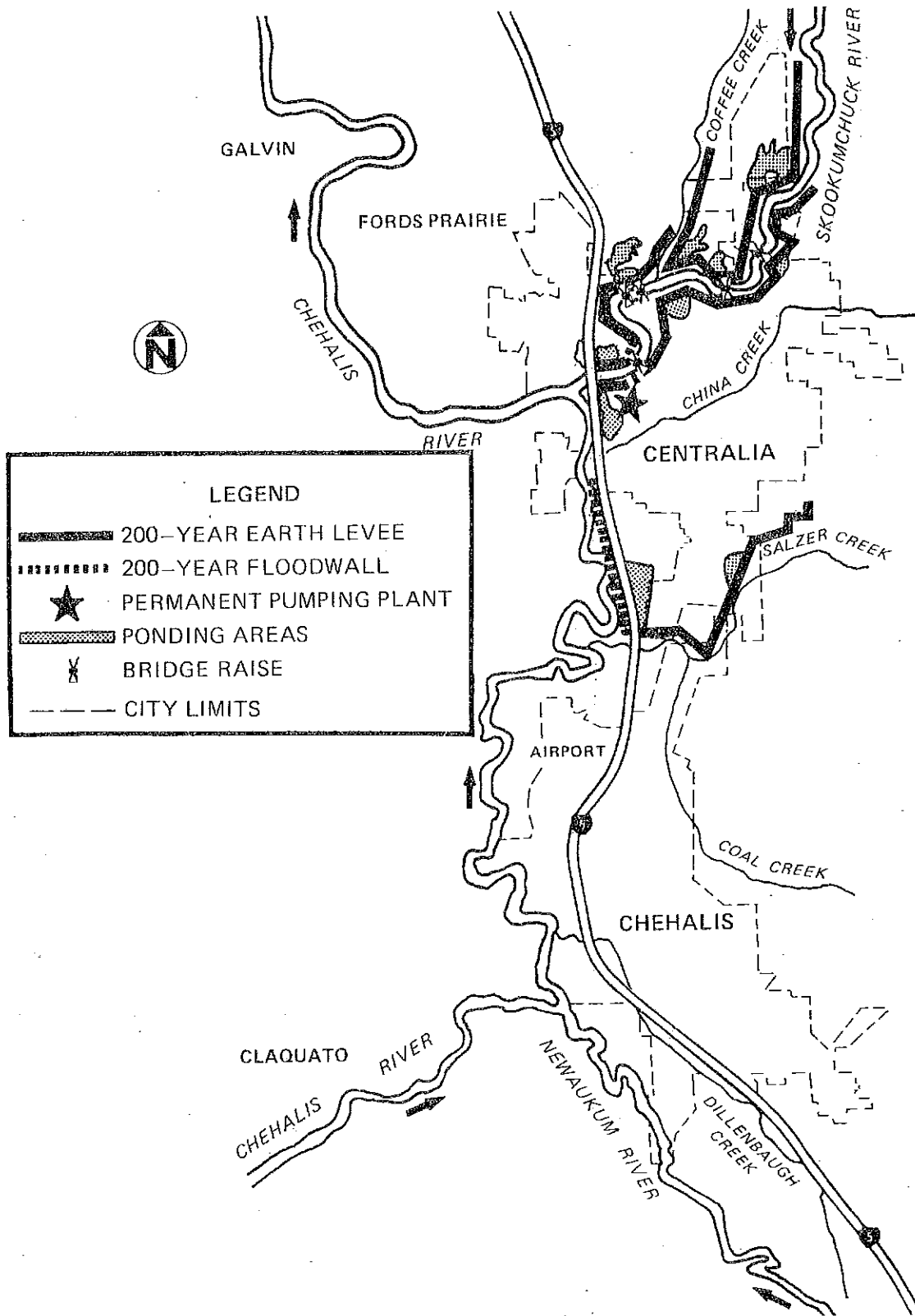
a. General. Nonstructural solutions to the flood problem were considered in accordance with Section 73 of the Water Resources Development Act of 1974 (Public Law 93-251), which directs that consideration be given to nonstructural alternatives in flood control planning, and to the Water Resources Council's Principles and Standards for Planning Water and Related Land Resources (14 December 1979), which directs that a primarily nonstructural plan shall be prepared and included whenever structural project or program alternatives are considered. The requirements of Executive Order 11988, which directs that a Federal agency must show that no practicable alternative exists before it proposes construction or directly or indirectly supports or induces development on the flood plain, were also recognized. In addition to the preliminary evaluation of floodproofing residential and commercial structures, other major categories of nonstructural measures were evaluated with respect to their feasibility in reducing flood damage within the study area. The evaluation of these measures is presented in the following paragraphs and summarized in table D2-1.

b. Land Use Regulations. These include such measures as zoning ordinances, subdivision regulations, and building and housing codes. The entire Chehalis/Skookumchuck River system is under the statewide Shoreline Management Program which was discussed in paragraph 1.04.

FIGURE D2-3

# LEEVE SEGMENTS CONSIDERED





# 200-YEAR URBAN LEVEES

FIGURE D2-4

TABLE D2-1

EVALUATION OF NONSTRUCTURAL MEASURES

Criteria	Land Use Regulations	Floodproofing	Flood Insurance	Evacuation and Relocation	Purchase of Development Rights
Response to Planning Objectives	Limits increase in flood damages to future development. No impact on existing development.	Eliminates flood damages to residential and commercial structures. Damage to streets, utilities and disruption in service would continue.	No reduction in flood damages to either existing or future development.	Flood damages reduced through elimination of uses of flood plain subject to damages.	Limits increase in flood damages to future development. No impact on existing development.
Economic Justification	No benefit-to-cost ratio calculated.	Benefit-to-cost of .4 for entire 100-year flood plain.	No benefit-to-cost ratio calculated.	No benefit-to-cost ratio calculated. However, economic justification doubtful.	No benefit-to-cost ratio calculated.
Implementation	Being implemented by local, county and state governments through zoning regulations resulting from Flood Insurance Program and Shoreline Management Program. Cooperation required for Federal Project.	Being implemented by local governments for all future development. No Corps implementation for existing development due to lack of economic justification. No local government interest in implementation for existing development.	Centralia and Chehalis participating in program.	No local government interest in participating in any relocation program.	No local government interest in participating in a program.
Public Acceptability	Generally acceptable to most groups.	Generally acceptable for future development. Mixed acceptability for existing development.	Generally acceptable to most groups.	Mixed acceptability. Acceptable to resource agencies. Not acceptable to local governments.	Supported by some environmental groups. Not acceptable to local governments.

Portions of the study area outside the cities of Centralia, Chehalis, and Bucoda are also covered by the Washington Flood Control Zone Program, which controls and regulates flood-plain development. The cities of Centralia and Chehalis have existing zoning ordinances which, to some extent, regulate future development in the flood plain. Existing city of Chehalis zoning is particularly explicit in controlling flood-plain development. In addition, both cities are participating in the Federal Flood Insurance Program and, as part of that program, adopt flood-plain regulations meeting Federal Insurance Administration standards. Chehalis has drafted new regulations and Centralia will be adopting new regulations in the future. Although these existing and proposed regulations will limit the increase in flood damage to future development within the 100-year flood plain, they will not impact the high level of flood damages to existing flood-plain development or address potential future damages from floods exceeding a 100-year frequency.

c. Flood Insurance. Flood insurance indemnifies a policyholder for financial losses suffered during a flood. As noted previously, the local jurisdictions are participating in the Federal Flood Insurance Program and land use regulations required as part of the program will limit the increase in flood damage. The insurance itself, however, can only indemnify for financial losses suffered during a flood and will not reduce flood damages to either existing or future development.

d. Evacuation and Relocation. This consists of removing residential and commercial structures from the flood plain and relocating these activities to a flood-free site. The 100-year flood plain in Centralia contains about 2,390 residences and about 315 commercial, industrial, or public structures, including much of Centralia's central business district. Because of this large investment in the flood plain, consideration of evacuation and relocation for the entire flood-plain area is neither economically nor politically feasible. The relocation of smaller areas of the flood plain was not publically acceptable.

e. Purchase of Development Rights. This would consist of the purchase of the rights to develop the presently undeveloped flood-plain areas. This measure would not address the high level of flood damages to existing development in the flood plain but could be effective in preserving the capacity of the hydraulic floodway and limiting the increase in flood damages to future development. However, these objectives would be accomplished under the regulations resulting from the Flood Insurance Program, the Washington Flood Control Zone Program and the Shoreline Management Program. Local governments consider these regulations adequate and are not interested in purchasing development rights.

f. Summary. The existing and developing city land use regulations will be an effective tool in limiting future increases in flood damages and could potentially be expanded. They will not, however, reduce the substantial flood damages that are occurring to existing

development, particularly within the most intensively developed floodplain areas in the city of Centralia. The only practical (but not economically justified) nonstructural alternative for reducing the existing hazard and risk of flood loss and for minimizing the impact of floods on human safety, health, and welfare within the study area would be the existing land use regulations coupled with floodproofing structural improvements.

2.13 Preliminary Assessment and Evaluation of Alternatives. A comparison of the preliminary alternatives is presented in table D2-2. The table assesses the implementation costs of the preliminary alternatives against key planning criteria. The National Economic Development (NED) planning criteria include average annual costs, average annual benefits, net benefits, and benefit-to-cost ratios. Under the Environmental Quality (EQ) criteria, the preliminary alternatives are evaluated against three of the most critical natural resources concerns. For the Regional Development (RD) and Other Social Effects (OSE) criteria, a general summary of the contributions of the alternatives to these accounts is presented. Each alternative was also evaluated with respect to its public acceptability based on the results of the public involvement program and coordination with Federal, state, and local agencies. The preliminary screening of alternatives was accomplished at the end of stage 2 studies, the costs are at 1976 price level, and annual costs and benefits are calculated at a 6-1/8 percent interest rate, unless otherwise indicated. Comparison of the alternatives at current price levels and interest rates would not affect the conclusion of the screening analysis because costs would increase proportionately with benefits.

TABLE D2-2 COMPARISON OF PRELIMINARY ALTERNATIVES

	ALTERNATIVE 1	ALTERNATIVE 2	ALTERNATIVE 3 MULTIPURPOSE STORAGE				ALTERNATIVE 4		
	NO ACTION	FLOODPROOF STRUCTURES	RUTH DAM SITE	NORTH FORK NEWAUKUM DAM SITE	SOUTH FORK NEWAUKUM DAM SITE	BOISTFORD DAM SITE	MESKILL DAM SITE	SKOOKUMCHUCK DAM MODIFICATION	SMALL HEADWATER DAMS
IMPLEMENTATION COSTS (1976 PRICE LEVEL)								(1980 PRICE LEVEL)	
FEDERAL	Costs for floodplain information and flood insurance studies.	\$18,100,000	\$107,000,000	\$22,600,000	\$30,900,000	\$29,700,000	\$57,000,000	\$10,200,000	\$27,900,000
NON-FEDERAL	Costs for zoning and flood proofing	\$4,500,000	none	none	none	none	none	none	none
TOTAL		\$22,600,000	\$107,000,000	\$22,600,000	\$30,900,000	\$29,700,000	\$57,000,000	\$10,200,000	\$27,900,000
(BASED ON TRADITIONAL COST SHARING)									
CONTRIBUTION TO PLANNING OBJECTIVE									
REDUCTION OF FLOOD DAMAGES WITHIN THE CITIES OF CENTRALIA AND CHEHALIS AND VICINITY.	No reduction for existing development. Growth in flood damages reduced by floodplain development regulation.	Damages to structures and contents reduced. Public utilities, some personal property and lands would continue to be damaged.	Significant reduction in the frequency of overbank flooding. About a 24,000 c.f.s. reduction in the 100-year flood discharge in study area.	Limited reduction in the frequency of overbank flooding. About a 2,000 c.f.s. reduction in the 100-year flood discharge in study area.	Limited reduction in the frequency of overbank flooding. About a 1,000 c.f.s. reduction in the 100-year discharge in study area.	Limited reduction in the frequency of overbank flooding. About a 5,000 c.f.s. reduction in the 100-year discharge in the study area.	Significant reduction in the frequency of overbank flooding. About a 16,000 c.f.s. reduction in the 100-year discharge in the study area.	Significant reduction in frequency of overbank flooding. A 5,900 c.f.s. reduction in the 100-year discharge on the Skookumchuck River.	Small reduction in flood damages. About a 3,000 c.f.s. reduction in the 100-year discharge in the study area.
RESPONSE TO PLANNING CRITERIA NATIONAL ECONOMIC DEVELOPMENT CRITERIA (NED) (6 1/2 PERCENT INTEREST RATE)								(7 3/8 PERCENT INTEREST RATE)	
A. AVERAGE ANNUAL COSTS	\$ 0	\$1,386,000	\$7,671,000	\$1,378,000	\$2,160,000	\$2,070,000	\$3,980,000	\$ 840,000	\$1,947,000
B. AVERAGE ANNUAL BENEFITS	\$ 0	\$ 590,000	\$2,823,000	\$ 449,000	\$ 627,000	702,000	\$1,655,000	\$1,510,000	\$ 523,000
C. BENEFITS MINUS COSTS	\$ 0	\$ -796,000	-4,848,000	-1,129,000	-1,533,000	\$-1,368,000	\$-2,325,000	\$ 670,000	-\$1,424,000
D. BENEFIT-TO-COST RATIO	\$ 0	0.4	0.4	0.3	0.3	0.3	0.4	1.8	0.3
ENVIRONMENTAL QUALITY CRITERIA (EQ)									
A. PRESERVE THE NATURAL AND BENEFICIAL VALUES OF THE UNDEVELOPED PORTIONS OF THE FLOOD PLAIN IN CONFORMANCE WITH EXECUTIVE ORDER 11988.	Development on the floodplain could continue but would be restricted by zoning, land use ordinances and building codes. Floodproofing would be required for new development.	Future floodplain development restricted by zoning, land use ordinances and building codes.	Increased flood protection for both developed and undeveloped floodplain areas. Development pressures would increase in areas provided increased protection.	Similar to Ruth site but on a more limited scale.	Similar to Ruth site but on a more limited scale.	Similar to Ruth site but on a more limited scale.	Similar to Ruth site but on a more limited scale.	Similar to Ruth site but on a more limited scale.	Increased flood protection for both developed and undeveloped areas. Degree of flood protection is so limited that it would not significantly effect land use regulations or stimulate development.
B. MAINTENANCE OF ANADROMOUS FISH PASSAGE IN THE CHEHALIS, NEWAUKUM AND SKOOKUMCHUCK RIVERS AND TRIBUTARY STREAMS.	No impediment to fish passage. Existing trends would continue.	No impediment to fish passage. Existing trends would continue.	Detrimental to upstream and downstream fish passage on the upper Chehalis River. Possible augmented stream flows to benefit spawning and rearing habitat.	Similar to Ruth site. Adverse impacts would occur on the South Fork Newaukum.	Similar to Ruth site. Adverse impacts would occur on the South Fork Newaukum.	Similar to Ruth site. Adverse impacts would occur on the South Fork Chehalis.	Similar to Ruth site.	No change to fish passage facilities provided at existing dam.	Detrimental to fish passage on upper tributaries of Chehalis, Newaukum and Skookumchuck Rivers. Inundation of spawning and rearing habitat.
C. PRESERVATION OF SHORE/ZONE HABITAT ALONG THE CHEHALIS, NEWAUKUM AND SKOOKUMCHUCK RIVERS.	No new threat to habitat. Existing trends would continue.	No new threat to habitat. Existing trends would continue.	Loss of fish and wildlife habitat within the reservoir area.	Similar to Ruth site but on a more limited scale.	Similar to the Ruth site but on a more limited scale.	Similar to the Ruth site but on a more limited scale.	Similar to Ruth site.	Minimal change from existing habitat. Existing trends would continue.	Temporary inundation of wildlife habitat. Some permanent losses due to dam construction.
REGIONAL DEVELOPMENT CRITERIA (RD)									
	No contribution to regional development.	Limited contribution to the RD account due to reduction of flood damages. Net contribution to account would be low because of high costs versus limited benefits.	Net contributions to the RD account due to reduction of flood damages and economic stimulations due to dam construction.	Similar to the Ruth site but on a more limited scale.	Similar to the Ruth site but on a more limited scale.	Similar to Ruth site.	Similar to the Ruth site.	Similar to Ruth site but on a more limited scale.	Net contribution to the RD account due to reduction of flood damages and economic stimulation due to dam construction.
OTHER SOCIAL EFFECTS CRITERIA (OSE)									
	No contribution to social well being.	Some increase in health and safety resulting to residences. Continued community disruption due to flooding of public transportation facilities and other public activities.	Increase in health and safety resulting from reduction of flood damages.	Similar to the Ruth site but on a more limited scale.	Similar to the Ruth site but on a more limited scale.	Similar to the Ruth site but on a more limited scale.	Similar to the Ruth site.	Similar to Ruth site but on a more limited scale.	Some increases in health and safety resulting from reductions in flood damages. Continued community disruption due to continued uncontrolled flooding.
PUBLIC ACCEPTABILITY									
	Not applicable.	Mixed acceptability. Generally most acceptable alternative to natural resources agencies and environmental groups. Some concern expressed about continued flood damages and restrictions of future development.	Generally not acceptable to resource agencies and environmental groups. Supported by some local government agencies.	Similar to the Ruth site.	Similar to the Ruth site.	Similar to the Ruth site.	Similar to the Ruth site.	Acceptable to agencies, groups, and individuals. Supported by Centralia.	Generally not acceptable. No group could be identified which supported this plan over other alternatives.

TABLE D2-2 COMPARISON OF PRELIMINARY ALTERNATIVES (CON.)

	ALTERNATIVE 5	ALTERNATIVE 6	ALTERNATIVE 7 CHANNEL EXCAVATION				ALTERNATIVE 8	ALTERNATIVE 9	ALTERNATIVE 10
	WATERSHED MANAGEMENT	CHANNEL CLEARING	PLAN 7A	PLAN 7B	PLAN 7C	PLAN 7D	CHANNEL EXCAVATION WITH LEVEES	URBAN AREA LEVEES	URBAN AREA LEVEES WITH RIVER MODIFICATION
IMPLEMENTATION COSTS (1978 PRICE LEVEL)								(1981 PRICE LEVEL)	
FEDERAL	Not quantified	\$350,000	\$6,100,000	\$16,400,000	\$21,650,000	\$9,800,000	\$32,100,000	\$20,286,000	\$53,550,000
NON-FEDERAL	Not quantified	none	\$ 690,000	\$ 1,000,000	\$ 1,050,000	\$ 700,000	\$ 3,200,000	\$ 3,484,000	\$ 2,950,000
TOTAL	Not quantified	\$350,000	\$6,790,000	\$17,400,000	\$22,700,000	\$10,500,000	\$35,300,000	\$23,770,000	\$56,500,000
(BASED ON TRADITIONAL COST SHARING)									
CONTRIBUTION TO PLANNING OBJECTIVE									
REDUCTION OF FLOOD DAMAGES WITHIN THE CITIES OF CENTRALIA AND CHEHALIS AND VICINITY.	Little effect on reducing major floods in the Centralia-Chehalis urban area that result from intense rain falling on saturated soil and snow.	Small reduction in flood damages. Uncontrolled flooding would continue in the study area.	A 1/2 foot reduction in the 100-year flood at Mellen Street. Uncontrolled flooding would be reduced.	A foot reduction in the 100-year flood at Mellen Street. Some residual flooding but flood damages would be significantly reduced.	A 5 foot reduction in the 100-year flood at Mellen Street. Some residual flooding but flood damages would be significantly reduced.	A 2 foot reduction in the 100-year flood at Mellen Street. Some residual flooding but flood damages would be significantly reduced.	Approximately 100-year flood protection for the floodplain between Grand Mound and the mouth of the Newaukum River.	200-year flood protection provided to 1980 acres of floodplain in and adjacent to Centralia.	Approximately 100-year protection for much of the floodplain. Significant reductions in annual flood damages and reduced hazards to life and property.
RESPONSE TO PLANNING CRITERIA NATIONAL ECONOMIC DEVELOPMENT CRITERIA (NED) (6 1/2 PERCENT INTEREST RATE)								(7 5/8 PERCENT INTEREST RATE)	
A. AVERAGE ANNUAL COSTS	Not quantified	\$33,600	\$454,000	\$1,181,000	\$1,506,000	\$752,000	\$2,301,000	\$1,878,000	\$3,658,000
B. AVERAGE ANNUAL BENEFITS	Not quantified	\$10,000	\$300,000	\$ 635,000	\$ 810,000	\$200,000	\$1,052,000	\$2,475,000	\$1,519,000
C. BENEFITS MINUS COSTS	Not quantified	-\$23,600	-\$154,000	-\$ 546,000	-\$ 696,000	-\$552,000	-\$1,249,000	\$ 597,000	-\$2,139,000
D. BENEFIT-TO-COST RATIO	Not quantified	0.4	0.7	0.5	0.5	0.3	0.5	1.3	0.4
ENVIRONMENTAL QUALITY CRITERIA (EQ)									
A. PRESERVE THE NATURAL AND BENEFICIAL VALUES OF THE UNDEVELOPED PORTIONS OF THE FLOOD PLAIN IN CONFORMANCE WITH EXECUTIVE ORDER 11988.	Watershed management would result in no increased development pressure. Existing flood plain regulations would continue.	Channel clearing would result in no significant increase in development pressure. Existing flood plain regulations would continue.	Increased flood protection and slight reduction in the size of the flooded areas, resulting in some increase in development pressure.	Increased flood protection and significant reduction in the size of the flooded area resulting in increase in development pressure.	Similar to 7B	Similar to 7A	Increased development pressure in areas provided 100-year protection including some undeveloped areas.	Increased development pressure in areas provided 200 year protection.	Increased development in areas provided 100-year protection including some undeveloped areas.
B. MAINTENANCE OF ANADROMOUS FISH PASSAGE IN THE CHEHALIS, NEWAUKUM AND SKOOKUMCHUCK RIVERS AND TRIBUTARY STREAMS.	Could improve fishery habitat through reduction in stream carried sediment.	Would adversely impact fish rearing habitat in the Chehalis River.	Would adversely impact fish rearing and spawning habitat in the Chehalis and Skookumchuck Rivers.	Similar to 7A but on a greater scale.	Similar to 7A but on a greater scale.	Would adversely impact fish rearing and spawning in the Newaukum River.	Would adversely impact fish rearing habitat in the Chehalis River.	Would adversely impact fish rearing habitat in the Skookumchuck River.	Would adversely impact fish rearing and spawning habitat on Chehalis and Skookumchuck Rivers. Could impact fish passage on tributary streams.
C. PRESERVATION OF SHORE ZONE HABITAT ALONG THE CHEHALIS, NEWAUKUM AND SKOOKUMCHUCK RIVERS.	Would tend to improve wildlife habitat.	Would destroy shore zone habitat along the Chehalis River.	Would reduce shore zone habitat on the Chehalis and Skookumchuck Rivers.	Similar to 7A but on a greater scale.	Similar to 7A but on a greater scale.	Would reduce shore zone habitat on the Newaukum River.	Would reduce shore zone habitat on the Chehalis, Skookumchuck and Newaukum Rivers through channel excavation, levee construction and induced development.	Would reduce shore zone habitat on the Skookumchuck River.	Would destroy shore zone habitat on the Chehalis and Skookumchuck Rivers.
REGIONAL DEVELOPMENT CRITERIA (RD)									
	Some limited contribution to the RD account due to reduction in erosion damage and limited flood damage reduction.	Some limited contribution to the RD account due to reduction in flood damages.	Net contribution to the RD account due to the reduction of flood damages and economic stimulation due to construction.	Similar to 7A but on a greater scale.	Similar to 7A but on a greater scale.	Similar to 7A	Net contribution to the RD account due to the reduction of flood damages and economic stimulation due to construction.	Net contribution to the RD account due to the reduction of flood damages and economic stimulation.	Net contribution to the RD account due to reduction of flood damages and economic stimulation due to construction.
OTHER SOCIAL EFFECTS CRITERIA (OSE)									
	Some limited increase in health and safety resulting from reduction in flood damages and erosion. Continued community disruption due to continued uncontrolled flooding.	Some limited increase in health and safety resulting from reduction in flood damages. Continued community disruption due to continued uncontrolled flooding.	Some increase in health and safety from reduction in flood damages. Some continued disruption due to continued uncontrolled flooding.	Significant increase in health and safety from reduction in flood damages. Some continued community disruption due to residual flood damages.	Similar to 7A	Similar to 7A	Significant increase in health and safety from reduction in flood damages. Community disruption eliminated up to 100-year flood.	Significant increase in health and safety from reduction in flood damages. Community disruption eliminated up to 200 year flood.	Significant increase in health and safety from reduction in flood damages. Community disruption eliminated in protected areas up to 100-year flood.
PUBLIC ACCEPTABILITY									
	Supported by resource agencies. Acceptable to local governments only if combined with more effective flood control measures.	Mixed acceptability. Not acceptable to resource agencies. Supported by Lewis County.	Mixed acceptability. Generally not acceptable to resource agencies and environmental groups. Supported by many local government agencies.	Similar to 7A	Similar to 7A	Similar to 7A	Mixed acceptability. Generally not acceptable to resource agencies and environmental groups. Generally more acceptable alternative to local governments and floodplain residents.	Residents living near levee alignment consider levees not acceptable because of adverse environmental (aesthetic and ecological) impacts and high local costs. Centralia does not support.	Generally not acceptable. No group could be identified which supported this alternative.

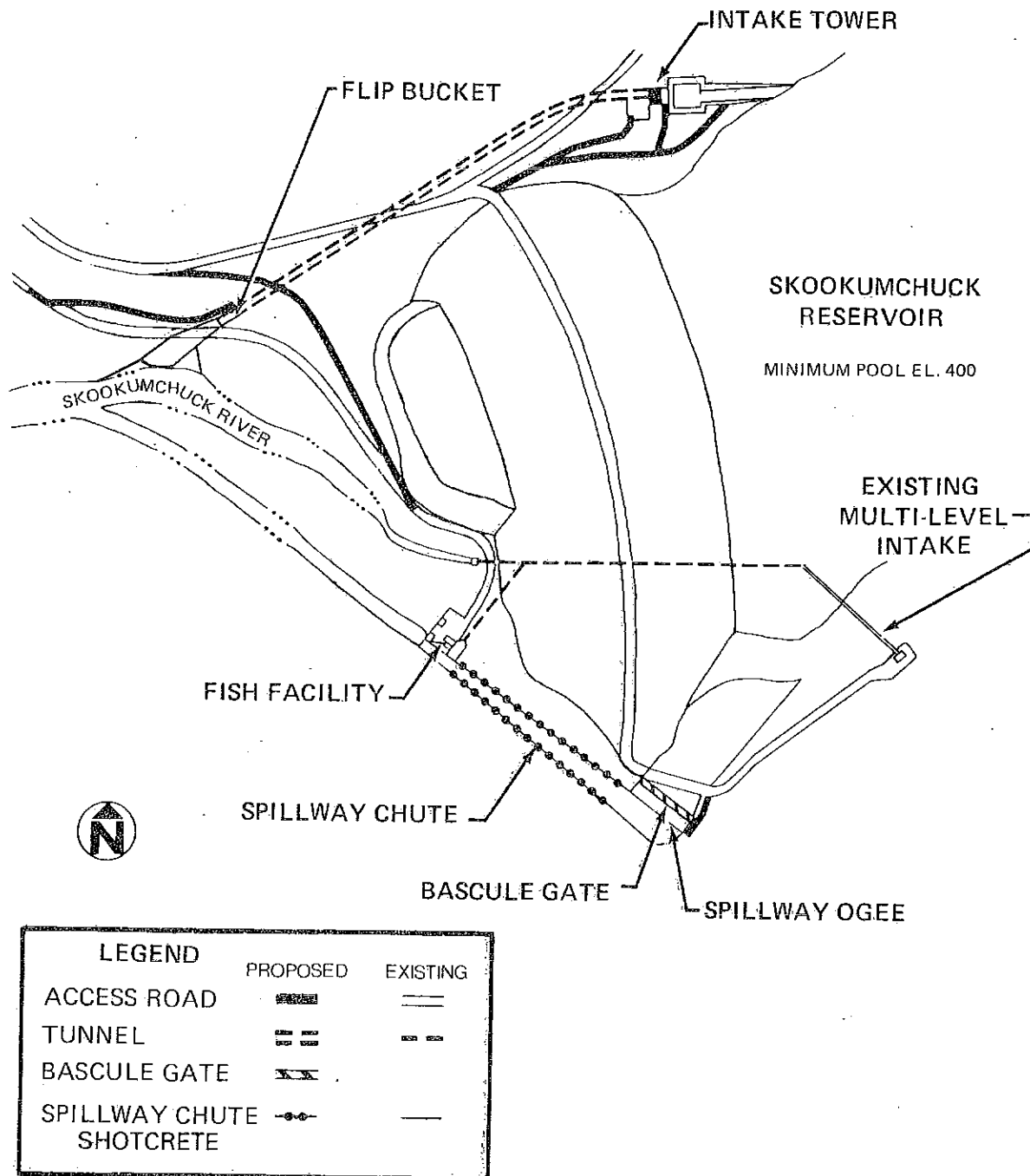


### SECTION 3. FORMULATION, ASSESSMENT, AND EVALUATION OF FINAL ALTERNATIVES

3.01 Description of Final Alternatives. The results of preliminary planning completed in 1980 indicated that two alternatives met the requirements of economic justification while responding to planning criteria. These included Skookumchuck Dam Modification and Urban Area Levees. The levee alternative was extensively discussed at the July 1980 public workshop in Centralia. Significant concerns were raised by the workshop participants and others following the workshop on significant adverse effects construction of levees would have on private property adjacent to the alignment. Considerable public opposition to any levee developed. Persons were concerned not only with construction impacts but with the potential problems associated with public use of the levee which included littering, vandalism, and trespass. Concerns were also expressed over the environmental impacts any levee could have, including a degradation of esthetic values (since views of the river would be blocked) and ecological impacts, including loss of riparian and instream habitat which could adversely affect spawning and rearing areas for anadromous fish, water quality, and wildlife resources. Subsequently, the city of Centralia requested a further analysis of Skookumchuck Dam modification. This analysis, completed in 1982, showed that dam modification for flood damage reduction was economically justified and would involve significantly fewer environmental impacts than a levee system. The city of Centralia has indicated strong support for dam modification. PP&L has indicated general agreement with the proposed dam modification. Therefore, the final alternatives under consideration in this study included: No Action and Skookumchuck Dam Modification.

a. Alternative 1 - No Action. This alternative would involve no new action for flood damage reduction through either structural or non-structural means. Consequently, this alternative is also representative of the without condition. This alternative was previously discussed in paragraph 2.02.

b. Alternative 2 - Skookumchuck Dam Modification. This alternative (see figure D3-1) would involve the use of 17,000 acre-feet (28,500 acre-feet in November and December) of the water supply storage in the existing Skookumchuck Dam for flood damage reduction during winter months. Structural modifications of the dam would be necessary to permit such a change in dam operation. A 12-foot-diameter flood control outlet works and tunnel would be built in rock on the north (right bank) dam abutment. The tunnel would be concrete lined, about 1,200 feet long, and have a capacity of 3,000 c.f.s. at the minimum flood control pool (elevation 435 feet) and 5,000 c.f.s. at maximum design pool (elevation 492 feet). In order to control the 15 feet of flood control storage above the spillway crest, a bascule gate 17 feet high by 136 feet wide would be added to the currently ungated spillway cut in rock in the south (left bank) dam abutment.



# SKOOKUMCHUCK DAM MODIFICATIONS

FIGURE D3-1

The flood storage at the dam would provide 200-year protection immediately downstream of the dam and significant reductions in flooding throughout the Skookumchuck River valley downstream of the dam. The 200-year Skookumchuck River flood at Centralia would be reduced from 13,300 c.f.s. to 6,700 c.f.s., a height reduction of 2 to 5 feet depending on location. In the immediate Centralia area about 575 acres would be removed from the 200-year flood plain with significantly reduced flood damages on the remaining flood plain. The Chehalis River Valley downstream of Centralia would also experience a reduction in flooding. The 200-year Chehalis River flow at Grand Mound would be reduced about 5,000 c.f.s., a height reduction of about 1/2 foot. This effect would continue downstream for about 30 miles.

With planned mitigation features, adverse environmental impacts would not be significant and the potential exists for some improvement of fishery flows over those currently provided. The total cost of alternative 2 is estimated at \$18,200,000, including engineering and design and supervision and administration.

An incremental analysis of the separable elements of the dam modification was performed. A change in dam operation by itself, without structural modifications, would not provide assured flood storage because the capacity of the existing low level outlet is too small to lower the flood pool following a storm and restore flood storage capability within a reasonable time period. The flood control tunnel and the spillway gate were analyzed individually and in combination. The maximum net benefits would be realized by the combination plan.

Consideration was given to measures that could reduce residual flood damages. Levee segments were analyzed along the Skookumchuck and Chehalis Rivers and Coffee and Salzer Creeks. These local protection measures were not incrementally justified when added to dam modification and probably would not be publically acceptable.

During July 1982, PP&L received FERC approval for their proposed 980-kW hydropower unit to be added to the existing low-level outlet. An analysis was made of the effect flood control operation would have on the small unit and determined that effects would be limited to reduced head during the flood control season (with potential for increased head during high runoff periods). The average annual value of power loss was estimated at \$4,000. In addition, the remaining hydropower potential of the site was analyzed (assuming the PP&L unit is installed). Minimum provisions for hydropower would require changing from the proposed 12-foot-diameter unlined tunnel with intake control to a 10-foot-diameter steel-lined tunnel with outlet control and a 7-foot-diameter spur tunnel to the potential powerhouse site. Net increase in cost for minimum provisions would be about \$2.1 million. The powerhouse would contain two 3-MW units but have a plant factor of only 11.3 percent (the proposed

PP&L unit develops a substantial portion of the available hydropower potential). Total powerhouse costs, including fish and wildlife mitigation, would total about \$8 million. The average annual costs would exceed the benefits by about \$500,000 with a benefit-to-cost ratio of about 0.4 to 1.0. Thus, there is no current justification for additional hydropower facilities and no justification for including minimum provisions for hydropower.

### 3.02 Comparative Evaluation of Final Alternatives.

a. General. Final alternatives 1 and 2 were analyzed to measure their responses to the planning objective and planning criteria. The impacts and outputs of the alternatives have been categorized into the four accounts of the Water Resources Council's Principles and Standards: NED, EQ, RD, and OSE. The results of the analysis are presented in table D3-1 and summarized below.

b. National Economic Development. Flood damage reduction was identified as the planning objective and was the primary economic output assessed. Alternative 2 would reduce the 200-year flood depths by 2 to 5 feet in the valley from the dam to Centralia and reduce the Skookumchuck River 200-year flood plain by 1,500 acres (770 acres near Centralia alone). Floodproofing required for future residential and commercial development would be reduced. The adverse economic outputs for alternative 2 include the annual interest and amortization of the investment and the annual operation and maintenance costs.

A high level (\$2,450,000) of benefits for flood damage reduction is provided by alternative 2. The 17,000 acre-feet of flood storage (28,500 acre-feet in November and December) is the maximum to which the dam owner would agree at this time. The owner believed a larger volume of flood storage would adversely affect the water supply function of the dam and thus was absolutely unacceptable. The addition of segments of levee to a dam project would not be economically justified incrementally and would be unacceptable to the local sponsor.

c. Environmental Quality. Table D3-1 lists the environmental criteria that were considered in the formulation of the alternatives. Major concerns in formulating the alternatives were the preservation of the shore zone habitat; preservation of fish spawning areas; maintenance of passage of anadromous fish, particularly in the tributary streams; and preservation of the natural and beneficial values in the flood plain. A significant portion of these concerns were satisfied through the incremental economic evaluation of alternatives prior to the formulation of the final alternatives. This screening analysis eliminated all levee alternatives and any project impacts on the Newaukum River and the tributaries of Coal and Dillenbaugh Creeks. It would not affect the current rural characters of the Skookumchuck valley. It also eliminated impacts to two major wetlands located adjacent to Coal and Dillenbaugh Creeks. The primary environmental effects of the dam modification, aside from the short-term construction impacts at the side,

TABLE D3-1

SYSTEM OF ACCOUNTS

	<u>Alternative 1 - No Action (without condition)</u>	<u>Alternative 2 - Skookumchuck Dam Modification</u>
<u>PLAN DESCRIPTION</u>		
STRUCTURAL MEASURES	None	<ul style="list-style-type: none"> <li>o Flood control outlet works with concrete lined, 12-foot-diameter, 1,200-foot-long tunnel and plunge pool outlet.</li> <li>o 17-foot by 136-foot bascule gate on spillway.</li> <li>o Additional shotcrete on spillway chute.</li> <li>o Operating agreement with PP&amp;L required.</li> </ul>
NONSTRUCTURAL MEASURES	Development of the flood plain would be restricted through existing zoning, State of Washington Flood Control Zone Program, Shoreline Management Program and ordinances required by Flood Insurance Program.	Same as Alternative 1.
FLOOD REDUCTION AT CENTRALIA (200-Year Flood)	None	<p>Skookumchuck River flow reduced from 13,300 c.f.s to 6,700 c.f.s.</p> <p>Flood depth reduced 2 to 5 feet.</p>
FISH AND WILDLIFE MITIGATION	None	<ul style="list-style-type: none"> <li>o Purchase 50 acres of land for management by WDG.</li> <li>o Install wood duck nesting boxes.</li> </ul>
<u>CONSTRUCTION/IMPLEMENTATION COST</u>		
Under Existing Law		
Federal		\$18,200,000
Non-Federal		0
TOTAL CONSTRUCTION COST	None	\$18,200,000
Interest During Construction		\$1,467,000
TOTAL IMPLEMENTATION COST		\$19,667,000

TABLE D3-1 (con.)

	Alternative 1 - No Action (without condition)	Alternative 2 - Skookumchuck Dam Modification
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ACCOUNTS

1. NATIONAL ECONOMIC DEVELOPMENT (NED)		
A. BENEFITS (Average Annual)		
1. Flood damage reduction		
a. Existing conditions		
Flood damages	\$2,998,000	\$2,998,000
Damages prevented	0	2,002,000
Residual flood damages	2,998,000	996,000
b. With future development		
Flood damages		\$2,998,000
Damages prevented	0	2,450,000
Residual flood damages		448,000
2. Elimination of future flood-proofing cost	0	\$27,000
TOTAL BENEFITS		
1. Existing conditions	0	\$2,132,000
2. With future development		2,506,000
B. COSTS (Average Annual)		
1. Interest and amortization of investment costs	0	\$1,550,000
2. Operation and maintenance	0	100,000
3. Potential power loss	0	4,000
TOTAL COSTS	0	\$1,654,000
C. BENEFITS MINUS COSTS (Average Annual)		
1. Existing conditions	0	\$478,000
2. With future development	0	852,000
D. BENEFIT-TO-COST RATIO		
1. Existing conditions	None	1.3
2. With future development	None	1.5

## 2. ENVIRONMENTAL QUALITY (EQ) CRITERIA

1. Preserve the natural and beneficial values of the undeveloped portions of the flood plain in the study area in conformance with Executive Order 11988.	Flood-plain development controlled by existing and future state and local land use regulations.	200-year flood plain reduced in area. Some potential for accelerated pressure for development on remaining flood prone land.
2. Preserve the wetlands in the study area in conformance with Executive Order 11990.	Continue existing trends.	Impacts to wetlands due to less frequent inundation. Mitigation includes purchase of 50 acres of land.
3. Maintain the passage of anadromous fish in the Chehalis, Newaukum, and Skookumchuck Rivers and tributary streams including China, Salzer, Coal, and Dillenbaugh Creeks.	No impact on fish passage.	No significant adverse impact on fish passage in the Chehalis or Skookumchuck or other tributaries supporting runs. Potential improvement in rearing flows in Skookumchuck River.
4. Preserve anadromous fish spawning areas in the study area.	Continue existing trends.	Reduction in loss of eggs due to scouring during peak floods.
5. Preserve the shore zone habitat along the Chehalis, Newaukum, and Skookumchuck Rivers and tributaries.	Continue existing trends.	Continue existing trends.
*6. Preserve or salvage significant historic and prehistoric cultural resources sites affected by potential project construction or effects.	Continue existing trends.	A cultural resources reconnaissance did not identify any cultural resource sites which would be affected by project construction.
7. Comply with the State of Washington Shoreline Management Program.	Flood-plain development subject to Shoreline Management Program.	Flood-plain development subject to Shoreline Management Program.
8. Comply with the State of Washington Flood Control Zone Program.	Portions of the flood plain subject to regulation under this program.	Project compatible with program.
9. Comply with local land use plans.	Flood plain within city limits subject to regulation.	Compatible with Thurston County plans.
10. Protect any endangered species in the study area and their critical habitat.	No impact on endangered species.	No endangered species identified in project area.
*11. Preserve water quality in the study area in conformance with Section 404 of the Clean Water Act of 1977.	Continue existing trends.	Localized temporary increases in turbidity during project construction. Minor increases in reservoir temperature may occur.
*12. Maintain existing air quality in the study area.	Continue existing trends.	Short-term reduction in air quality during construction due to increases in dust and exhaust emissions from the operation of construction equipment.
*13. Preserve the esthetic values along the Chehalis, Skookumchuck, and Newaukum Rivers and tributary streams.	Continue existing trend.	Continue existing trend.

\*Effect assessment item listed under Section 122 of Public Law 91-611.

### 3. REGIONAL DEVELOPMENT (RD) CRITERIA

*1. Increase employment in Lewis and Thurston Counties during plan implementation.	Continue existing trends.	Increased employment during project construction.
*2. Contribute to community development and growth by reduction of the depressing economic effects of flood damages within the cities of Centralia, Chehalis, and Bucoda.	Flood-plain management would control future development and reduce the growth of flood damages.	Yes, for areas provided reduced flooding. Economic impacts would continue in other areas. Growth controlled by flood plain regulation in flood prone areas.
*3. Increase net income to businesses in Thurston and Lewis Counties during plan implementation.	No Change	Yes, during project construction.
*4. Encourage local expenditures for improvement of community facilities (streets, sidewalks, utilities, parks).	No change	Yes, for areas with reduced flooding.
5. Increase property values within the study area.	No change	Yes, potential increase for property with reduced flooding.
6. Increase tax revenues within the study area.	No change	Yes, potential increase due to increased property value.

### 4. OTHER SOCIAL EFFECTS (OSE) CRITERIA

1. Limit flooding in unprotected areas in the study area to without project conditions.	No change	Skookumchuck River valley downstream from dam receives 2 to 5 feet reduction in flood heights.
2. Increase level of flood protection for residences and public facilities and properties within the study area to increase health, safety, and community well-being.	No change	Yes, existing 200-year flood reduced to volume of about a current 3-year flood.
*3. Increase community cohesion within the cities of Centralia and Chehalis.	No change	Would promote cohesion in flood reduction areas. May create community divisions since not all of Centralia and Chehalis is provided with flood reduction.
*4. Avoid the relocation of residential properties.	No residential properties relocated.	No residential properties relocated.
5. Avoid the relocation of public facilities and properties and the resulting inconvenience to residents during construction.	No public facilities relocated.	No public facilities relocated.
*6. Avoid increased noise levels in the study area.	No change	Short-term localized increase in noise during construction period.
7. Maintain recreation access to Chehalis, Skookumchuck, and Newaukum Rivers and tributary streams.	Continue existing trend.	Continue existing trend.

\*Effect assessment item listed under Section 122 of Public Law 91-611.



involve the change in reservoir and river fluctuations during the winter flood control season. The fluctuating reservoir elevation during winter months would adversely impact waterfowl and small fur bearing mammals. The impoundment of water during floods and subsequent bank full release will alter the hydraulic regime of the Skookumchuck River and its associated wetlands. Beneficial impacts include reduced scouring and destruction of fish eggs by peak flows and some improvement of fish flows. The spawning (145 c.f.s.) and incubation/rearing (110 c.f.s.) flows provided after the modification would improve fish flows over those currently provided by PP&L under an agreement with the WDF. Some adverse impacts to the wetlands due to change in inundation frequency could result. Mitigation measures would include purchase of 50 acres of wetland for management by the WDG and installation of wood duck nesting boxes along the river. Alternatives 1 and 2 are compatible with the land use regulations of the city of Centralia and would be compatible with the more restrictive regulations that would be required for continued participation in the Flood Insurance Program. The Skookumchuck valley is within urban, rural, or conservancy category on lands covered by the Shoreline Management Program administered by Lewis and Thurston Counties. Dam modification is compatible with the program. Construction is also permissible under the Washington Flood Control Zone Program. Implementation of alternative 2 would also require a hydraulics permit from the WDF and WDG since the alternative involves placement of a minor amount of riprap (600 c.y.) along the Skookumchuck River. Coordination has been maintained with WDF and WDG throughout the study. As noted in section 1 of this appendix, the DNR has prepared a draft Chehalis River Management Plan to guide use of lands within state ownership on the Chehalis River. The plan does not cover the Skookumchuck River upstream from Centralia.

d. Regional Development. In the RD account the major beneficial contributions of alternative 2, which are not fully monetized in the NED account, would be increased employment in Lewis and Thurston Counties during plan implementation and increased business activity and resulting increases in business income as a result of construction of a project. The construction related employment and business impact would be related to the project costs, and some employment of unemployed or underemployed persons would be expected. Alternative 2 would also increase property values due to the elimination of floodproofing requirements and the reduction of flood risks with possible resulting increases in tax revenues. Alternative 2 could also have a secondary effect of encouraging local expenditures for improvement in community facilities within the existing flood plain.

e. Other Social Effects. Three major criteria of the OSE account were limitation of flooding in unprotected areas to without project conditions and avoidance of the relocation of properties. The change in dam operation would decrease the flood heights from 2 to 5 feet throughout the entire Skookumchuck valley below the dam. Relocation of residential, commercial, or industrial property would not be necessary

except for access roads and some utilities at the damsite. Other OSE contributions of alternative 2 would be increased health and safety resulting from increased flood protection. Alternative 2 would impact community cohesion in a positive way due to reduced flooding over a large area. However, community divisions could arise because of continued flooding caused by the Chehalis River and the smaller tributary creeks.

### 3.03 Designation of Selection of Plans.

a. National Economic Development. The NED plan is defined as the plan that results in the maximum net economic return. Since the NED benefits have been monetized in the form of flood damages prevented and elimination of floodproofing costs, it is possible to compare the economic return of each alternative. This comparison is presented in table D3-1. The alternative with the highest net economic benefits after the economic costs are subtracted would be the plan that maximizes the economic return. Using this criterion, alternative 2, Skookumchuck Dam modification, is the NED plan.

b. Least Environmentally Damaging Plan. To be designated a LED plan, an alternative, as a minimum, must have the least negative effects on the EQ account. Alternative 2 was selected as the LED plan because with planned mitigation measures it would have no significant adverse impact on essential fish and wildlife habitat when compared to the without plan condition. This plan may provide some slight enhancement due to improved fishery flows, but quantification of this benefit was not done.

c. Tentatively Recommended Plan. The tentatively recommended plan is alternative 2. It emerges as the most effective plan when all responses to the planning objective and planning criteria are considered. It provides the highest level of flood damage reduction within the limitation imposed by the criterion of maintaining a positive benefit-to-cost ratio. It preserves the natural values of the flood plain by limiting construction to an existing damsite. Since alternative 2 makes maximum use of an existing dam and does not involve construction of structural measures in the flood plain being studied, it is also considered to be a nonstructural plan for the area. The plan preserves the current rural character of the Skookumchuck River valley. Adverse environmental impacts of the plan are minimal and some minor fishery improvement may result. The plan has the highest contribution to the OSE account through provision of increased health and safety resulting from reduced flood levels. The recommended plan also requires that the local sponsor continue to participate in the Flood Insurance Program, control development in the project area to prevent undue increases in the flood damage potential, publicize flood-plain information, adopt regulations necessary to insure compatibility between future development and protection levels provided by the project, and at least annually inform affected interests of the limitations of project protection.