

Chehalis Basin Strategy

Draft Economics Study Update



Reducing Flood Damage and
Restoring Aquatic Species Habitat

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Cover: *The Chronicle*, Centralia, Washington (left); Caitlin McIntyre, Lacey, Washington (center right and bottom right)

EXECUTIVE SUMMARY

This economic study is a technical analysis to be used in the process to develop the Chehalis Basin Strategy for reducing flood damage and restoring aquatic species habitat. The study was developed for the Washington State Department of Ecology (Ecology) in support of the State Environmental Policy Act Programmatic Environmental Impact Statement (EIS). This study updates the economic analysis completed in 2014 (EES and HDR 2014). The study analyzes the potential effect to the Chehalis Basin of alternative flood damage reduction and aquatic species habitat restoration actions. The economic study is a risk assessment of the expected impacts of different action alternatives on the costs of flooding and effects on aquatic species. The findings in this study will aid decision makers in determining next steps to reduce flood damage and restore aquatic species habitat in the Chehalis Basin.

Alternatives

There are five alternatives evaluated in the EIS and in this study. Each alternative, except for the No Action Alternative, has a combination of elements to reduce flood damage and restore aquatic species habitat.

No Action

The No Action Alternative is intended to represent the most likely future expected in the absence of implementing an action alternative. For the purposes of the EIS, Ecology considers the No Action Alternative to include:

- Projects and programs that have been planned and designed to address flood damage and/or aquatic species habitat
- Projects that are currently underway or being constructed
- Projects that have funding for implementation and are scheduled for implementation this biennium.

Under the No Action Alternative, existing activities, programs, and trends in the Chehalis Basin would continue, including compliance with State Forest Practice rules which will result in the maturation of riparian areas in commercial and state owned timberlands (Managed Forests).

Alternative 1: 2014 Governor's Workgroup Recommendation

The Governor's Chehalis Basin Work Group (Work Group) published its 2014 Recommendation Report, outlining a program of integrated, long-term, flood damage reduction and aquatic species habitat restoration actions for further study in the 2015 – 2017 state biennium budget. Since then, the Work Group membership has changed, and they are evaluating the alternatives in this EIS and public

comments in crafting their recommendation to the Governor later in 2016. Alternative 1 would achieve flood damage reduction through implementation of a comprehensive package of actions to: provide Large-scale Flood Damage Reduction Actions (including the Flood Retention Facility) that target a broad geographic area, provide Local-scale Flood Damage Reduction Actions with more localized benefits, and restore aquatic species habitat. Action elements included in Alternative 1 are as follows:

- **Large-scale Flood Damage Reduction Actions** – Flood Retention Facility (flood retention only [FRO] or flood retention flow augmentation [FRFA]), Airport Levee Improvements, and Aberdeen/Hoquiam North Shore Levee
- **Local-scale Flood Damage Reduction Actions** – Floodproofing, Local Projects, Land Use Management, and Flood Warning System Improvements
- **Aquatic Species Habitat Actions** – Low- or high-scenario restoration actions that include restoring riparian habitat, removing fish passage barriers, restoring off-channel habitat, adding wood, restoring bank erosion to naturally occurring rates, reconnecting the floodplain, and creating/restoring/enhancing wetlands

For the purposes of the economic study, the benefits and costs of Alternative 1 do not include the Aberdeen/Hoquiam North Shore Levee, Local Projects, Land Use Management, and Flood Warning System Improvements. Information on the costs and impacts for these action elements were not available at the time of this study as these action elements are in the early stage of the planning process.

Alternative 2: Structural Flood Protection Without a Flood Retention Facility

Alternative 2 evaluates a scenario in which Large-scale Flood Damage Reduction Actions in the upper Chehalis Basin would be focused primarily on Interstate 5 (I-5) and the Chehalis-Centralia Airport. This alternative includes the Airport Levee Improvements, I-5 Projects, and Aberdeen/Hoquiam North Shore Levee. The rest of the action elements (the Local-scale Flood Damage Reduction Actions for more localized benefit and Aquatic Species Habitat Actions) are also included in Alternative 2. Action elements included in Alternative 2 are as follows:

- **Large-scale Flood Damage Reduction Actions** – I-5 Projects, Airport Levee Improvements, and Aberdeen/Hoquiam North Shore Levee
- **Local-scale Flood Damage Reduction Actions** – Floodproofing, Local Projects, Land Use Management, and Flood Warning System Improvements
- **Aquatic Species Habitat Actions** – Low- or high-scenario restoration actions that include restoring riparian habitat, removing fish passage barriers, restoring off-channel habitat, adding wood, restoring bank erosion to naturally occurring rates, reconnecting the floodplain, and creating, restoring, and enhancing wetlands

For the purposes of the economic study, the benefits and costs of Alternative 2 do not include the Aberdeen/Hoquiam North Shore Levee, Local Projects, Land Use Management, and Flood Warning System Improvements. Information on the costs and impacts for these action elements were not available at the time of this study as these action elements are in the early stage of the planning process.

Alternative 3: Nonstructural Flood Protection

Alternative 3 represents a “nonstructural” approach to reducing flood damage and restoring aquatic species habitat. In contrast to implementing Large-scale Flood Damage Reduction Actions, flood damage would be reduced through a programmatic effort to floodproof or remove existing structures. These structures and their contents would be protected from significant damage during floods through elevation and other measures. In limited situations where structures cannot be elevated or floodproofed, the most feasible action would be removal of structures. Though flooding would continue to occur, the damage from and cost of recovering from such floods would be reduced. This alternative includes the implementation of all of the Local-scale Flood Damage Reduction Actions and Aquatic Species Habitat Actions without any Large-scale Flood Damage Reduction Actions (Flood Retention Facility, Airport Levee Improvements, I-5 Projects, Aberdeen/Hoquiam North Shore Levee, or Restorative Flood Protection). Action elements included in Alternative 3 are as follows:

- **Local-scale Flood Damage Reduction Actions** – Floodproofing, Local Projects, Land Use Management, and Flood Warning System Improvements
- **Aquatic Species Habitat Actions** – Low- or high-scenario restoration actions that include restoring riparian habitat, removing fish passage barriers, restoring off-channel habitat, adding wood, restoring bank erosion to naturally occurring rates, reconnecting the floodplain, and creating/restoring/enhancing wetlands

For the purposes of this economic study, the benefits and costs of Alternative 3 do not include the Local Projects, Land Use Management, and Flood Warning System Improvements. Information on the costs and impacts for these action elements were not available at the time of this study as these action elements are in the early stage of the planning process.

Alternative 4: Restorative Flood Protection

The proposed actions under Alternative 4 include increasing the flood storage capacity of the Chehalis Basin watershed by adding roughness to the river and stream channels and floodplain, and by reconnecting floodplain storage to the river. It would reduce flood damage upstream of the confluence by relocating existing land uses out of the floodplain. This alternative focuses on reducing flood peaks downstream of the Newaukum River confluence on the mainstem Chehalis River, and would be accomplished through implementation of the Restorative Flood Protection action element. This alternative also includes implementation of all of the Local-scale Flood Damage Reduction Actions and

Aquatic Species Habitat Actions. The Restorative Flood Protection action element would be coordinated with and complement the Aquatic Species Habitat Actions within the treatment areas.

- **Large-scale Flood Damage Reduction Actions** – Restorative Flood Protection
- **Local-scale Flood Damage Reduction Actions** – Floodproofing, Local Projects, Land Use Management, and Flood Warning System Improvements
- **Aquatic Species Habitat Actions** – Low- or high-scenario restoration actions that include restoring riparian habitat, removing fish passage barriers, restoring off-channel habitat, adding wood, restoring bank erosion to naturally occurring rates, reconnecting the floodplain, and creating/restoring/enhancing wetlands

For the purposes of the economic study, the benefits and costs of Alternative 4 do not include the Local Projects, Land Use Management, and Flood Warning System Improvements. Information on the costs and impacts for these action elements were not available at the time of this study as these action elements are in the early stage of the planning process.

Methodology

Action alternatives are evaluated based on their costs and impacts relative to the No Action Alternative. Except with regard to fish populations, the No Action Alternative is modeled based on current conditions and does not consider population growth and development within the floodplain. Future growth within the floodplain is excluded to eliminate bias from forecasting future conditions, which could result in the inflation of benefits.

For the purposes of this study, the No Action Alternative includes Managed Forests. The inclusion of Managed Forests results in the action alternative impacts being compared with a fishery that is forecast to experience growth over the study period. In addition, the No Action Alternative does not include any flood damage reduction projects (other than those currently underway or being constructed, or scheduled for implementation this biennium). Costs for each action alternative are defined as the financial costs required to implement and operate each action alternative. Action alternative impacts are defined as the measurable change in flood damages and estimated fishery. Impacts may be either positive or negative.

Project implementation costs are compared with project impacts resulting in net benefits over the study period. Benefit-cost ratios are also reported for informational purposes. An uncertainty analysis is provided to demonstrate a range of project costs and impacts. The uncertainty analysis is based on available information and is not meant to show the full range of possible values.

Business losses incurred within the basin during floods are felt locally but no loss is realized from a State or Federal Perspective.

Study Assumptions

Perspective

The economic study evaluates action alternatives from three perspectives:

- State – State of Washington
- Basin-wide – Lewis, Thurston, Grays Harbor, and Pacific counties
- Federal – National Economic Development account

The costs and impacts of action alternatives vary according to perspective.

General Assumptions

A 100-year study period was selected for the purposes of comparing action alternative implementation costs and estimated impacts. In using a 100-year study period, the full effect, positive or negative, from an action is assumed to be fully in place in year one of the 100-year period. All dollars are in real 2016 terms, thus inflation is excluded in the cost and impact estimates. Real interest rates are used for net present value (NPV) calculations and these discount rates may vary across perspectives. A discount rate of 1.5% was used to discount costs and impacts for the State and Basin-wide Perspectives. The Federal Perspective applied a 3.125% discount rate to the analysis based on federal requirements.

Action Alternative Costs

Action alternative costs include the capital costs needed to implement the project, annual operation and maintenance (O&M) costs needed to operate and maintain the project over the entire 100-year study period, and interest costs during the project construction phase. Interest during construction is calculated for structural action elements based on project construction schedules and a borrowing rate of 3.5%. Capital costs are provided in current 2016 dollars. Table ES-1 provides the initial capital costs and estimated present value (PV) of annual operating costs. Figures ES-1 and ES-2 summarize action alternative costs for the State Perspective.

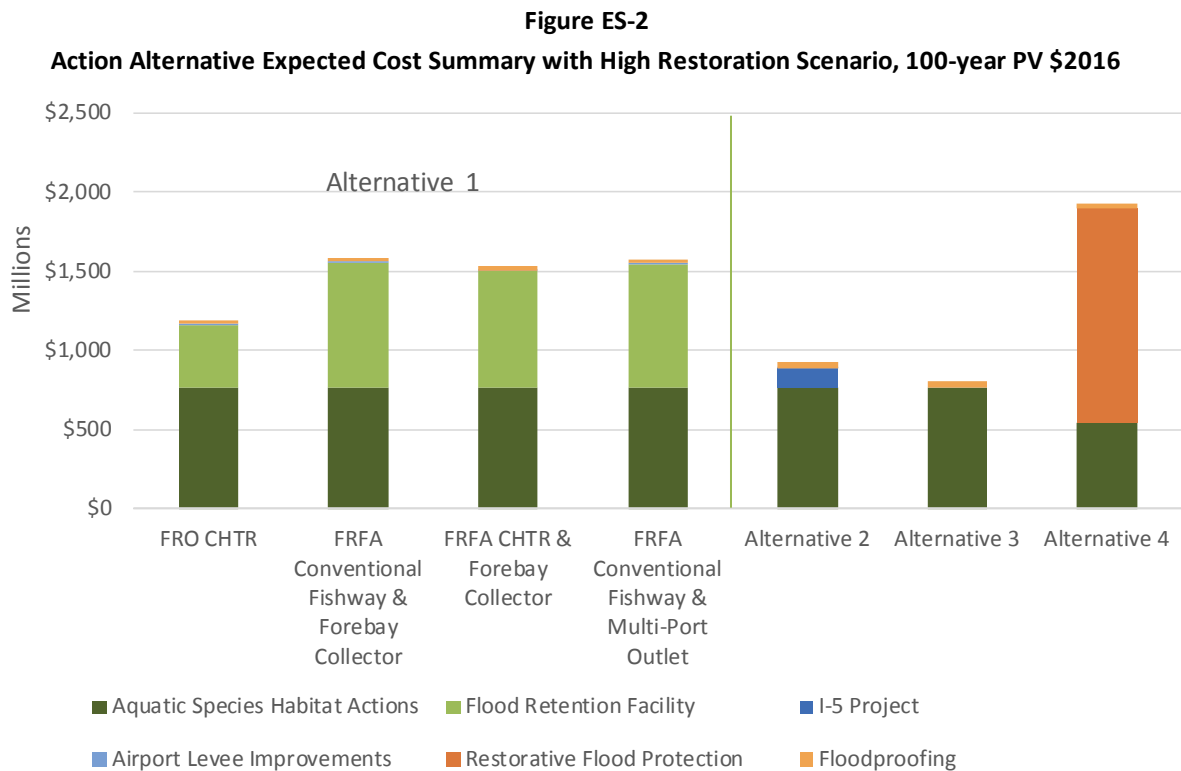
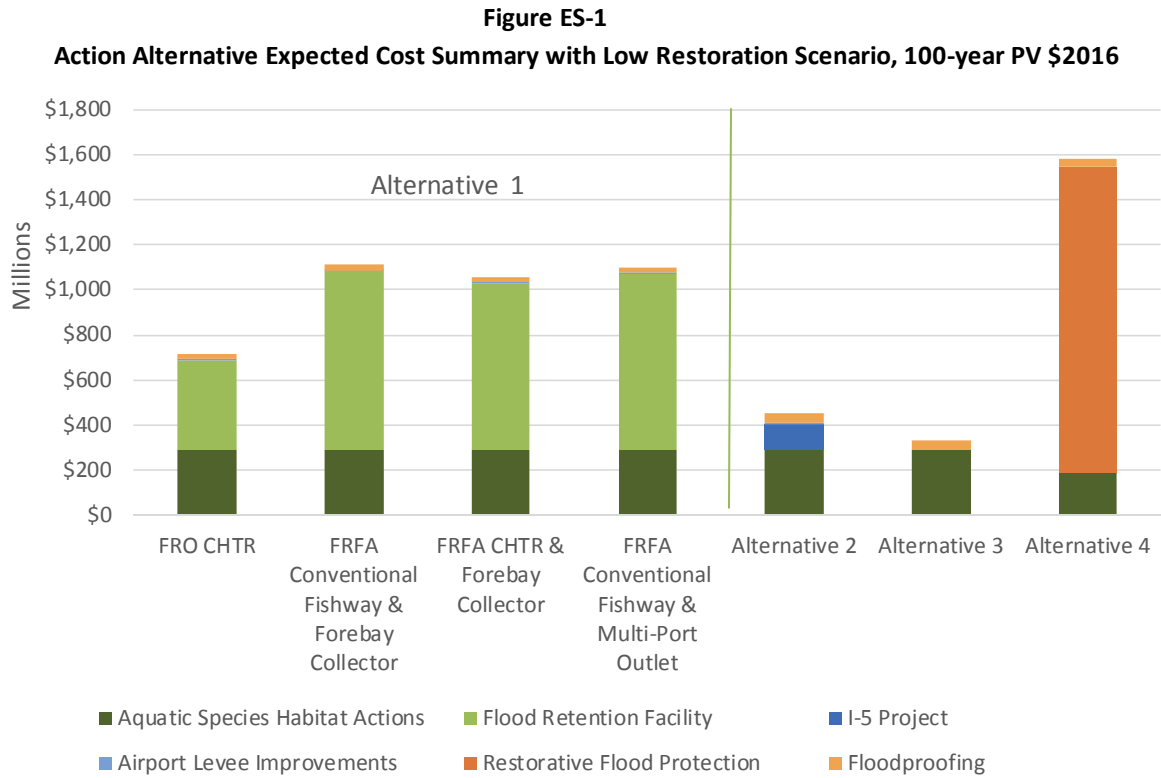
Table ES-1
PV Capital and Operation and Maintenance (\$2016), Millions

	CAPITAL	O&M
LOW RESTORATION SCENARIO		
Alternative 1		
FRO with CHTR Fish Passage	\$548.0	\$32.7
FRFA with Conventional Fishway and Forebay Collector	\$793.7	\$104.0
FRFA with CHTR and Forebay Collector	\$747.5	\$112.7
FRFA with Conventional Fishway and Fixed Multi-port Outlet	\$812.0	\$71.1
Alternative 2	\$405.7	\$0.5
Alternative 3 ¹	\$297.9	\$0.0
Alternative 4	\$1,554.3	\$12.2
HIGH RESTORATION SCENARIO		
Alternative 1		
FRO with CHTR Fish Passage	\$875.4	\$32.7
FRFA with Conventional Fishway and Forebay Collector	\$1,121.1	\$104.0
FRFA with CHTR and Forebay Collector	\$1,074.9	\$112.7
FRFA with Conventional Fishway and Fixed Multi-port Outlet	\$1,139.4	\$71.1
Alternative 2	\$733.1	\$0.5
Alternative 3	\$625.4	\$0.0
Alternative 4	\$1,797.8	\$12.2

Notes:

1. Only floodproofing is included in the cost of Alternative 3. For this study it was assumed that floodproofing would not require annual O&M.

CHTR = controlled handling, transport, and release



Action Alternative Impacts

If implemented, action alternatives may have both positive and negative impacts. The following impacts are quantified in this study:

- Flood damage to structures, content, and inventory
- Cleanup costs for buildings and agricultural acreage
- Vehicle damages
- Loss of agriculture crops due to flooding
- Transportation delays on I-5
- Temporary relocation costs for evacuated residents during flood events
- Public assistance during floods, including emergency protective measures for bridges, utilities, water control facilities, or debris removal
- Business interruption
- Commercial fishing
- Sport fishing
- Economic development

In addition, environmental non-use values are quantified and provided for informational purposes (but not included in the study net benefit results).

Results

This executive summary provides results for the State Perspective only. The main report includes results from the Basin-wide and Federal Perspectives.

Flood Damage Reduction

Flood damage reduction impacts were estimated for five flood events (2-, 10-, 20-, 100-, and 500-year). Based on the avoided damages, and probability of each flood event, expected annual impacts were calculated for each action alternative. Figure ES-3 demonstrates the breakdown of action alternative-expected annual flood reduction impacts in 100-year NPV from the State Perspective. Note that in Alternative 1, the flood damage reduction impacts are the same regardless of storage facility configuration (flood retention only versus flood control and flow augmentation). Aquatic Species Habitat Actions are excluded from the figure as they do not result in flood damage reduction impacts.

The most significant flood damage reduction impacts for action alternatives with storage options are due to avoided structure, content, and inventory damages. Second to structure, content, and inventory benefits, the Restorative Flood Protection greatly reduces damage to agricultural lands since under this alternative they are relocated out of the floodplain (avoided cleanup and crop damages). However, neither Alternative 3 nor Alternative 4 provide benefit by reducing I-5 transportation delays. The

I-5 Projects action element in Alternative 2 reduces some damages to property; however, the primary benefit is avoided I-5 closure costs. Floodproofing benefits are tied to floodproofing costs under each action alternative, as a larger number of buildings requiring floodproofing comes with both costs and benefits.

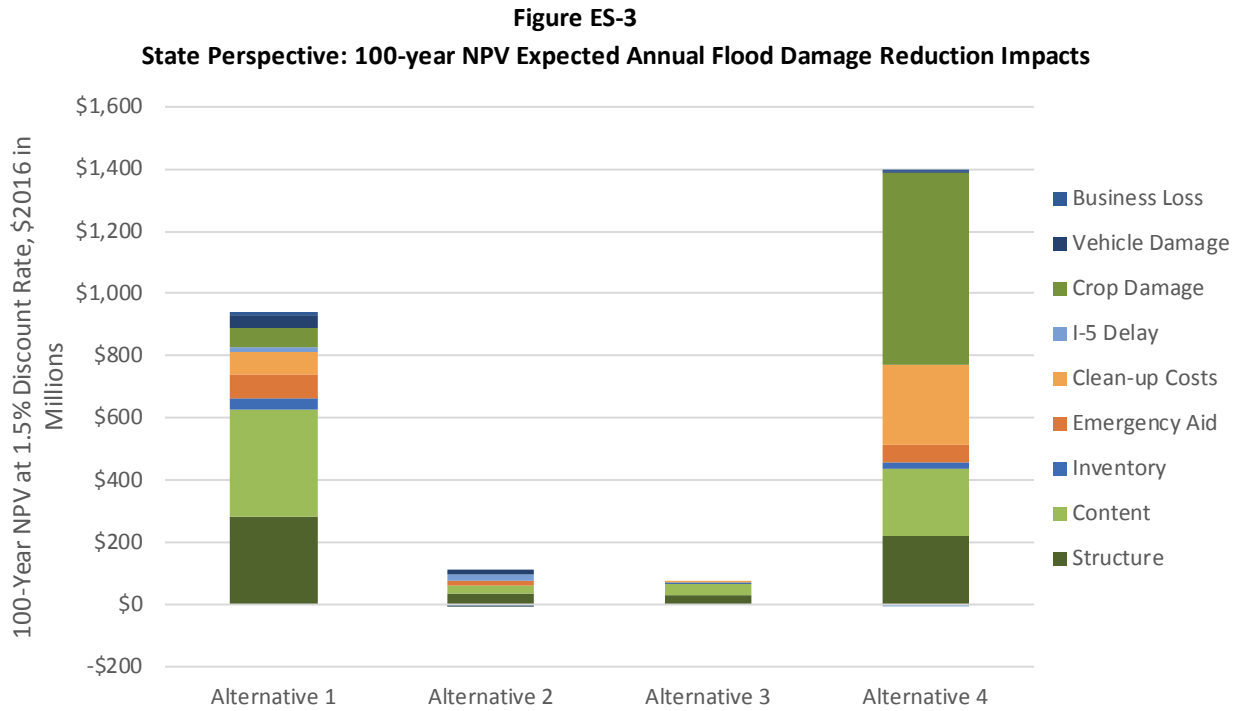


Table ES-2 summarizes the data provided in Figure ES-3.

Table ES-2
State Perspective: Flood Damage Reduction Impacts

100-YEAR NPV, MILLIONS (\$2016)				
FLOOD DAMAGE REDUCTION	ALTERNATIVE 1	ALTERNATIVE 2	ALTERNATIVE 3	ALTERNATIVE 4
Structure	\$283.4	\$33.7	\$29.4	\$220.6
Content	\$345.3	\$26.2	\$35.8	\$215.0
Inventory	\$33.0	-\$0.4	\$3.4	\$21.4
Floodproofing	\$69.3	\$15.9	\$0.0	\$49.2
Public Assistance	\$10.3	\$2.4	\$0.0	\$7.3
Temporary Relocation Assistance	\$8.9	\$0.7	\$0.0	\$7.0
Clean-up Costs: Debris	\$36.4	\$0.1	\$3.1	\$26.9
Clean-up Costs: Structures	\$18.2	-\$1.1	\$0.0	\$162.4
Clean-up Costs: Agriculture Fields	\$6.6	-\$0.4	\$0.0	\$58.5
Clean-up Costs: Agriculture Re-seeding	\$17.4	\$16.3	\$0.0	-\$0.3
I-5 Transportation Delay	\$58.7	-\$1.0	\$0.0	\$617.6
Agriculture: Crop Damage	\$41.4	\$16.5	\$0.0	\$4.7
Vehicle Damage	\$929.0	\$108.9	\$71.8	\$1,390.3
Total	\$283.4	\$33.7	\$29.4	\$220.6

Fishery

Impacts to commercial, tribal, and sport fisheries (salmonid species) were estimated for each of the action alternatives based on:

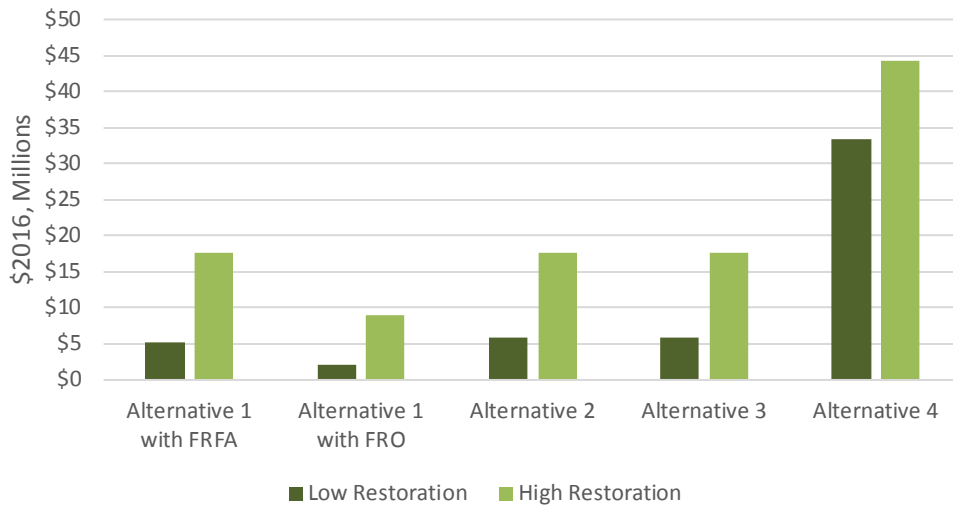
- Estimated changes in fish populations compared with the No Action Alternative ¹
- Commercial or sport value per fish.

Benefits due to Managed Forest Practices are not included in action alternative benefits.

Although the flood retention facilities have fish passage structures included, these facilities have negative impacts on salmonid populations. When paired with Aquatic Species Habitat Actions, Alternative 1 impacts to fisheries are positive. Figure ES-4 illustrates the environmental impacts monetized in this study (use values only).

¹ The No Action with Managed Forest is estimated equal to the average of predicted populations resulting from 20% and 60% managed forest riparian buffer maturation. Since the No Action Alternative includes Managed Forest riparian maturation, the benefit of these practices is excluded from the action alternatives.

Figure ES-4
State Perspective: 100-year NPV Fishery Impacts



Net Benefits

Table ES-2 compares the action alternative implementation costs with the action alternative impacts for the State Perspective. Flood damage reduction impacts are reported separately from the environmental (fishery) impacts. All dollars are shown in 100-year NPV. The Net Benefit column shows the expected total net benefit for the full 100-year period of each element being fully implemented in year one. The costs and impacts shown in Table ES-2 are a result of the best available information and subsequent model output available at the time of this study’s publication. The estimates in Table ES-3 represent the expected impacts and costs. Expected case results are calculated based on either an average or expected value from a range of input assumptions. For more discussion on action alternative non-quantifiable impacts please refer to the EIS.

Table ES-3
State Perspective: Net Benefits

EXPECTED, DEPRECIATED VALUES 100-YEAR NPV 1.5% DISCOUNT RATE (\$2016), MILLIONS					
	IMPACTS		PROJECT COSTS	NET BENEFIT	BENEFIT/COST
	FLOOD DAMAGE REDUCTION	FISHERY USE VALUES (SALMON)			
ALTERNATIVE 1					
Low Restoration Scenario					
FRO with CHTR Fish Passage	\$929	\$15	\$601	\$342	1.6
FRFA with Conventional Fishway and Forebay Collector	\$929	\$7	\$932	\$4	1.0
FRFA with CHTR and Forebay Collector	\$929	\$7	\$892	\$45	1.0
FRFA with Conventional Fishway and Fixed Multi-port Outlet	\$929	\$7	\$916	\$21	1.0
High Restoration Scenario					
FRO with CHTR Fish Passage	\$929	\$46	\$929	\$47	1.1
FRFA with Conventional Fishway and Forebay Collector	\$929	\$27	\$1,260	-\$304	0.8
FRFA with CHTR and Forebay Collector	\$929	\$27	\$1,219	-\$263	0.8
FRFA with Conventional Fishway and Fixed Multi-port Outlet	\$929	\$27	\$1,243	-\$287	0.8
ALTERNATIVE 2					
Low Restoration Scenario	\$109	\$16	\$408	-\$283	0.3
High Restoration Scenario	\$109	\$47	\$735	-\$579	0.2
ALTERNATIVE 3					
Low Restoration Scenario	\$72	\$16	\$298	-\$210	0.3
High Restoration Scenario	\$72	\$47	\$625	-\$507	0.2
ALTERNATIVE 4					
Low Restoration Scenario	\$1,390	\$55	\$1,450	-\$5	1.0
High Restoration Scenario	\$1,390	\$82	\$1,694	-\$221	0.9

Uncertainty Analysis

The results in Table ES-2 are based on the best information available; however, there are many uncertainties related to this information. These uncertainties may include the following: uncertainty inherent in modeling, such as the hydraulic modeling and assumptions or flood damage modeling (HAZUS, a natural disaster model by the Federal Emergency Management Agency); uncertainty related to values or prices, i.e., the value of fish or the cost for cleanup of a residential building; uncertainty to land use for agricultural acreage, or uncertainty related to number estimates such as the number of

people relocated during a flood or the change in fish populations. The uncertainty analysis evaluated low and high values for many of the study inputs and assumptions. These low and high values are not inclusive of the full possible range of outcomes; rather, they are based on available information via surveys, literature research, and conversations with local residents and business owners. Figures ES-5 and ES-6 demonstrate the results of the uncertainty analysis from the State Perspective. Alternative 4 has the greatest uncertainty due to the modeling of low impacts in agriculture. In the low impact scenario, crop damage is assumed to be zero for all action alternatives. This assumption is based on the timing of flood events during winter months during a time when crops may not be grown. Alternative 4 has the greatest impact to agriculture due to the relocation of acreage; therefore, the low impact scenario is significantly lower compared with the other action alternatives.

Figure ES-5
State Perspective: Uncertainty Summary with Low Restoration Scenario Actions

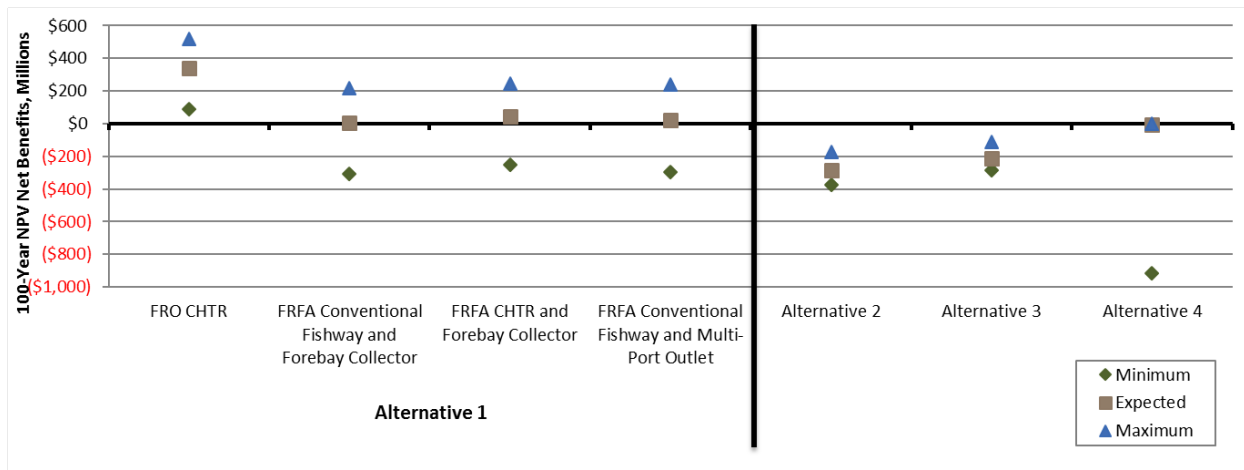
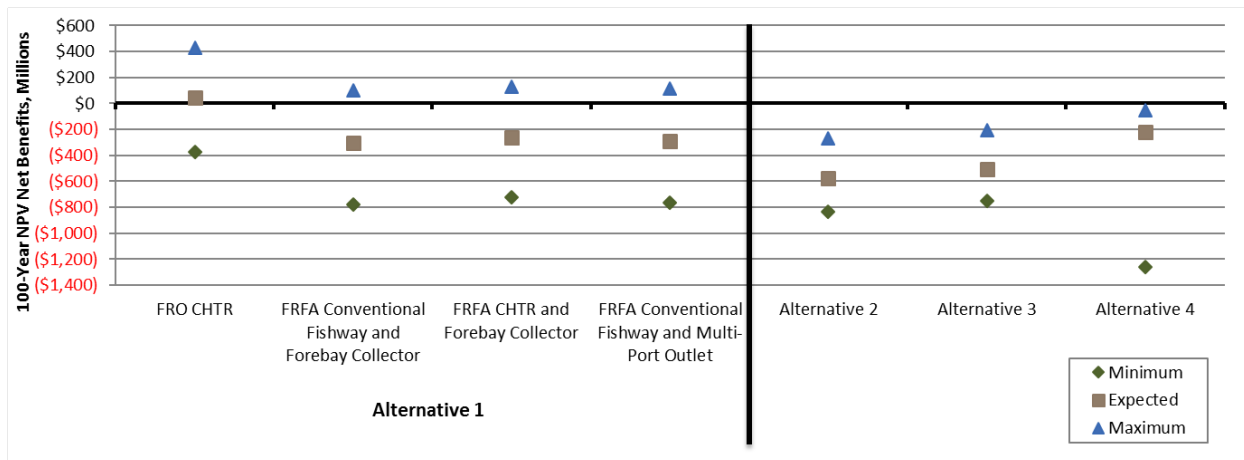


Figure ES-6
State Perspective: Uncertainty Summary with High Restoration Scenario Actions



Key Findings

This economic analysis indicates the following:

- The greatest flood damage reduction benefit from most action alternatives comes from eliminating damage to structures and their contents.
- More than 60% of the flood damage reduction benefit for Alternative 4 is due to the relocation of 10,300 acres of agriculture from the treatment area (average between 8,500 acres and 12,100 acres of relocated agricultural uses). However, acreage is based on land use zones and actual crop production may be less. Additionally, the value of the crops produced may vary depending on land location.
- Floodproofing is cost-effective when analyzed over 100 years for avoided damages.
- Alternative 4 provides the greatest benefit to fish populations.
- Any of the proposed flood retention facilities would reduce fish populations in the Chehalis Basin compared with the No Action Alternative; however, when paired with Aquatic Species Habitat Actions, the Chehalis Basin is estimated to realize greater fish population growth compared to the No Action Alternative.
- Avoided transportation delay benefits are greatest for Alternative 1 (flood retention).
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- The uncertainty modeling shows that Alternative 4 net benefits have the widest range. Alternative 1 net benefits are sometimes positive, and Alternative 2 and 3 net benefits are always negative.