5 COMBINED ALTERNATIVES: IMPACTS AND MITIGATION

5.1 Introduction

This chapter describes the potential long-term impacts of the combined alternatives as compared to the No Action Alternative, as well as potential compensatory mitigation measures for unavoidable significant adverse impacts. Specific short- and long-term impacts and mitigation associated with each action element, which are combined into the alternatives described in this chapter, are provided in Chapter 4. Because Chapter 4 provides a more detailed analysis for each action element, Chapter 5 focuses on those adverse impacts that are likely to be significant for each combined alternative. Cumulative impacts of the combined alternatives are described at the end of this chapter.

The extent to which the No Action Alternative and action alternatives meet the Chehalis Basin Strategy objectives is also described in Chapter 5. This strategy is intended to maximize the benefits of flood damage reduction and aquatic species habitat actions over the short and long term, while avoiding and minimizing environmental, social, cultural, agricultural, and economic impacts. Because each of the action alternatives would be implemented as part of a comprehensive package, a climate change analysis that considers the combined impacts of flood damage reduction and aquatic species habitat actions under each alternative is also included in this chapter.

Chehalis Basin Strategy Objectives

Reduce the following conditions caused by a major flood:

- Threats to human health and safety, including access to critical medical facilities
- Flood damage to commercial and residential properties
- Flood damage to agricultural properties, livestock, and crops
- Disruption in transportation systems, including closures of I-5 and local and regional transportation systems
- Disruption to industry, commercial businesses, and public services

Protect and restore aquatic species habitat function to:

- Improve resiliency of natural floodplain processes and ecosystems from the effects of climate change, including warming stream temperatures, low flows, and other effects
- Increase abundance of native aquatic species, including increased populations of healthy and harvestable salmon and steelhead
- Reduce the potential for future ESA listings
- Enhance tribal and non-tribal fisheries

The Chehalis Basin Strategy is intended to be implemented as a coordinated plan and phased over time. If a combined alternative identified in this EIS moves forward, the resulting actions would be subject to project-level environmental review before being approved for implementation. The process for this environmental review is described in Section 1.5. For actions included in the No Action Alternative, the lead agencies would also conduct appropriate environmental review.

The focus of the impacts analysis for the No Action Alternative is on the potential long-term impacts of ongoing flood damage reduction actions and habitat improvements at historical funding levels (excluding recent legislative funding related to the Chehalis Basin Strategy). Under the No Action Alternative, actions to reduce flood damage and improve aquatic species habitat conditions would continue to a lesser extent than with the action alternatives, and in a piecemeal fashion.

Each action alternative includes a distinct combination of Large-scale Flood Damage Reduction Actions (i.e., Flood Retention Facility, Restorative Flood Protection, Airport Levee Improvements, I-5 Projects, and Aberdeen/Hoquiam North Shore Levee). All action alternatives include the same Local-scale Flood Damage Reduction Actions (Floodproofing, Local Projects, Land Use Management, and Flood Warning System Improvements) and Aquatic Species Habitat Actions (low and high scenarios).

Impacts related to changes in flooding extents and depths in this chapter were analyzed using hydrologic modeling. Results are given in the context of the 100-year floodplain of the Chehalis River, referred to as the Chehalis River floodplain and the floodplain affected by the Restorative Flood Protection action element (Alternative 4).

No long-term impacts on air quality or noise are anticipated to occur as a result of the No Action Alternative or any of the action alternatives. Furthermore, visual quality conditions would result in site-specific, rather than Basin-wide, significant impacts with the Flood Retention Facility and Restorative Flood Protection. Therefore, potential impacts on these resources are not further evaluated in Chapter 5.

Table 5.1-1 provides a summary of the action elements evaluated in this EIS, and illustrates how the action elements are combined into the considered alternatives. Under the No Action Alternative, actions to reduce flood damage and improve habitat conditions would continue to a lesser extent than under the action alternatives (open circles designate less intense actions as part of this alternative).

Table 5.1-1

Action Elements and Combined Alternatives for Evaluation in the Draft EIS

ACTION ELEMENT	PROPOSED ALTERNATIVES				
	NO ACTION ALTERNATIVE	ALTERNATIVE 1: 2014 GOVERNOR'S WORK GROUP RECOMMENDATION	ALTERNATIVE 2: STRUCTURAL FLOOD PROTECTION WITHOUT FLOOD RETENTION FACILITY	ALTERNATIVE 3: NONSTRUCTURAL FLOOD PROTECTION	ALTERNATIVE 4: RESTORATIVE FLOOD PROTECTION
LARGE-SCALE FLOOD DAMAGE REDUCTION ACTIONS					
Flood Retention Facility (dam and associated reservoir)		●			
Airport Levee Improvements		●	●		
I-5 Projects		●	●		
Aberdeen/Hoquiam North Shore Levee		●	●		
Restorative Flood Protection					●
LOCAL-SCALE FLOOD DAMAGE REDUCTION ACTIONS					
Floodproofing		●	●	●	●
Local Projects	○	●	●	●	●
Land Use Management	○	●	●	●	●
Flood Warning System Improvements	○	●	●	●	●
AQUATIC SPECIES HABITAT ACTIONS					
Restore riparian habitat	○	●	●	●	●
Remove fish passage barriers	○	●	●	●	●
Restore off channel habitat	○	●	●	●	●
Add wood to streams for habitat	○	●	●	●	●
Reduce bank erosion to naturally occurring rates	○	●	●	●	●
Reconnect the floodplain	○	●	●	●	●
Create, restore, enhance wetlands	○	●	●	●	●

5.2 No Action Alternative

5.2.1 Overview

The No Action Alternative is intended to represent the most likely future expected in the absence of implementing an action alternative. Under the No Action Alternative, actions to address flood damage and aquatic species habitat improvements in the Chehalis Basin would continue at reduced levels as compared to the action alternatives. As such, the No Action Alternative would result in the least reduction in flood damage during major floods, and least benefit to aquatic species habitat function.

Under the No Action Alternative, existing activities, programs, and trends in the Chehalis Basin would continue. Because the No Action Alternative does not involve a coordinated and integrated approach, benefits are likely to be localized and minimal throughout the Chehalis Basin.

5.2.2 Long-term Impacts

For the purposes of this EIS, a summary description of long-term minor adverse impacts or benefits resulting from No Action Alternative is provided relative to the following elements of the environment: water resources, geology and geomorphology, wetlands and vegetation, and fish and wildlife. Those actions anticipated to result in moderate to significant adverse impacts are described in more detail in the sections that follow.

5.2.2.1 Environmental Elements with Minor Adverse Impacts or Benefits

While there could be incremental benefits from implementation of the No Action Alternative, these benefits would likely be outweighed at a Basin-wide scale by the adverse impacts that occur during the next major flood and continued degradation of aquatic species habitat.

For example, surface water quality could be improved under existing programs like Ecology's Water Quality Program and by ongoing localized flood damage reduction and aquatic species habitat restoration projects that are currently underway. These projects could affect water quality through funding projects that improve it, and through protecting properties where there is a risk of pollutants entering nearby waterbodies (e.g., WWTPs) during a flood. However, flood-related spills or leaks of toxic or hazardous materials and pollutants from developed areas would continue during major floods. Major floods would also continue to create instability on steep slopes and potentially trigger localized landslides, resulting in minor adverse impacts on geology. There could be limited reductions in flood extents, floodwater depths, and floodwater velocities due to smaller-scale shoreline stabilization, levee placement, and bridge and culvert replacements projects; however, minor adverse impacts on geomorphology and fish and wildlife could occur if these activities reduce channel migration, deflect flow energy, and impair riparian habitat.

With regard to fish, flooding is part of a natural flow regime and native fish have adapted to these conditions. Flooding provides access to temporary foraging habitats in the floodplain and supplies

nutrients to riparian vegetation that in turn provides shade, cover, and additional food sources to fish. However, major floods, especially repeated major floods, can contribute to impairment of habitats due to large-scale erosion and deposition of fine sediment in spawning and rearing areas, including scouring of recently laid redds or scouring of features that provide habitat complexity—both of which would be detrimental to fish.

Wildlife in the Chehalis Basin also likely exhibit some degree of adaptation to flooding. Although floods can benefit wildlife over the long term by creating new habitat conditions and modifying vegetation communities, repeated major floods, such as those experienced in the Chehalis Basin in recent years, can result in detrimental effects to wildlife. Potential adverse impacts include direct mortality of species unable to flee floodwaters such as small, less-mobile animals, young animals, and ground-nesting birds; destruction of nests and dens; displacement of wildlife to upland habitats where they may face increased competition for basic resources from both other animals and humans, increased mortality, or reduced reproductive success; and the destruction or alteration of wildlife habitat by scouring, prolonged inundation, sediment and woody material deposition, and large-scale erosion.

The potential adverse impacts on wetlands and vegetation from ongoing flood damage reduction actions are primarily related to direct impacts from the construction of new facilities or infrastructure. Adverse impacts could include permanent loss of wetlands and vegetation, modification of wetland hydrology, and potential disconnection of the floodplain. Overall, due to the limited scope of these actions and the likely location around developed areas, such impacts on wetland and vegetation would likely result in minor adverse impacts at a Basin-wide scale.

Ongoing habitat restoration actions would provide some benefits to water resources, geomorphology, and fish and wildlife by protecting and restoring riparian areas and floodplain habitat in certain areas, but benefits would be localized and provide minor overall benefits at a Basin-wide scale. Continued implementation of No Action Alternative measures (e.g., near-term habitat restoration projects; SRFB projects; and CREP, CFRP, FFFPP, and WSDOT fish passage programs) would provide some benefits to fish; however, these benefits are also anticipated to be localized and minor in a Basin-wide context. These benefits include the following:

- Reductions in water temperatures with the creation of cool-water habitats (i.e., deep pools) and restoration of riparian habitat
- Localized reductions in turbidity and sediment delivered to stream channels resulting from restoring natural erosion rates to reduce bank erosion
- Improvements in channel complexity and improved geomorphic function with the addition of restoration features such as large wood that affects transport and distribution of coarse substrate
- Beneficial increase in nutrient concentrations in streams that are restored with improved fish habitats

- Restoration of flow conditions and improved fish passage as a result of culvert removal or replacement activities
- Enhanced wetland habitats, and increased wetland function

The No Action Alternative includes salmon habitat potential benefits from the maturation of riparian areas in managed forestland compared to current conditions. In contrast, the action alternatives include benefits from managed forestland, as well as active restoration in the lowlands (included within the Aquatic Species Habitat Action), compared to current conditions. Modeled results of salmon habitat potential for Alternatives 1 and 4 are provided in Sections 5.3.2 and 5.3.3 (Alternative 1) and Section 5.6.2 and 5.6.3 (Alternative 4).

Adverse impacts on fish under the No Action Alternative would result from continued impairment to fish habitat and habitat requirements, as described in Section 3.4 (see Bjornn and Reiser 1991; Wampler et al. 1993; Envirovision 2000; Smith and Wenger 2001; GHLE 2011; and ASEPTC 2014a for suites of habitat impairments by sub-basin). Compared to its historical potential before European settlement, the current habitat is estimated to be 54% impaired for fall-run Chinook salmon, 56% impaired for winter-run steelhead, 72% impaired for coho salmon, and 87% impaired for spring-run Chinook salmon (ASEPTC 2014a). The scope of restoration planned under the No Action Alternative would be limited and result in minor, with generally localized benefits; however, the changes would likely not be sufficient to restore reaches of Chehalis Basin rivers and streams in a way that substantially improves salmon abundance. These changes would also provide minor benefits to wildlife species that breed, forage, rest, and overwinter in these habitat conditions, particularly semi-aquatic species such as amphibians. These minor benefits are not likely to be adequate to overcome the significant adverse impacts resulting from projected climate change (see Section 5.2.2.3).

Forest practices would continue to affect streamflow and landslides within the Chehalis Basin, as described in Section 3.1.2. Any changes to forest management practices are not anticipated to reduce the frequency of extreme flooding in a watershed the size of the Chehalis Basin (Perry et al. 2016).

5.2.2.2 Tribal Resources

Under the No Action Alternative, Aquatic Species Habitat Actions could provide minor beneficial effects on tribal resources, as described in Section 5.2.2.1. However, localized flood damage reduction actions could result in adverse impacts on treaty rights, primarily related to fish. The nature of potential impacts on tribal resources is pending additional coordination with tribes and continued government-to-government consultations.

Activities that impede the ability to exercise treaty rights (e.g., impaired access to resources or actions that harm resources or the habitat on which they are dependent) constitutes taking a property right that has been guaranteed to treaty tribes. Impairment or elimination of fish habitat used by fish (eggs, juveniles, and adults) could affect their survival. These activities could also affect behavior of adult or

juvenile fish such that some are unable to successfully complete their life cycle and contribute to spawning for the next generation.

Tribal fishers could be temporarily delayed or restricted from accessing the Chehalis River and its tributaries during some construction activities. Access to traditional plants and hunting of wildlife could also be affected by construction activities. Based on feedback from the Quinault Indian Nation, impacts on tribal resources could occur from disturbance resulting from flood damage reduction actions that include installation of hard banks (e.g., riprap and sheetpile). The excavation, channel re-routing, and other activities related to installation of levees and other hard bank proposals could result in short- and long-term losses to fish production (Sharp 2016a, 2016b).

Temperature and habitat constraints, which are of particular concern for spring-run Chinook salmon, would continue in the long term. It is likely tribal fisheries would continue to be focused on fall-run salmon entering the Chehalis River (coho, fall-run Chinook, and chum) and on winter steelhead. It is anticipated that spring and early summer harvests by Quinault Indian Nation and Chehalis Tribe fishers on Chinook salmon would be limited, consistent with trends in recent years. Spring and summer harvests of sturgeon by tribal fishers would continue to be managed to avoid impacts on a low abundance of spring- and summer-run Chinook salmon returning to the Chehalis Basin. The significant adverse impacts of climate change (see Section 5.2.2.3) would result in decreased salmonid abundance, and could result in further impacts on tribal resources.

5.2.2.3 Climate Change

Without an integrated strategy, actions under the No Action Alternative would be implemented in a piecemeal fashion. An uncoordinated approach could reduce the potential to formulate and adapt flood damage reduction and aquatic species habitat restoration strategies that are capable of adjusting to changing climatic conditions.

As discussed in Section 3.7, the effects of climate change would alter temperatures, precipitation, wind, sea levels, streamflow, water temperatures, and forest compositions. By mid-century, rainfall events are projected to become more severe, summer streamflows are projected to decrease, and annual variability would continue to cause some periods that are abnormally wet and others that are abnormally dry (ASEPTC 2014c; Mauger et al. 2016). Anticipated effects of climate change on the No Action Alternative are described as follows and, collectively, are expected to result in significant adverse impacts.

Geology and Geomorphology

Under the No Action Alternative and when considering climate change, potential increases in channel erosion and incision, bank instability and erosion, and lateral bank migration could result from the projected increase in the number and severity of high-flow events. Increases in winter precipitation would likely contribute to landslides on slopes saturated by rainfall or runoff (Mauger et al. 2016).

Water Resources

Under the No Action Alternative and when considering climate change, projected increases in temperatures and decreases in summer precipitation would likely result in increased temperatures in rivers and streams. With increased temperatures in rivers and streams, there would likely be increased algal production and decreased DO levels. Projected increases in temperature, decreases in summer precipitation, more intense winter rain, and reduced snow retention would likely result in decreased rates of summer instream flow (Mauger et al. 2016). With the reduced availability of water and inability to meet minimum instream flow requirements, there would be an increased frequency of interruptions in diversions and effects to water rights. There could also be potential changes in alluvial aquifer levels.

Increased peak flows and frequency of winter storms would result in more frequent and greater flood damage. Additionally, sea level rise would increase flooding in areas adjacent to Grays Harbor (e.g., Aberdeen, South Aberdeen, Hoquiam, Westport; Mauger et al. 2016).

Wetlands and Vegetation

Sea level rise would likely result in a shift from tidal swamps supporting woody vegetation to irregularly flooded marshes consisting of non-woody vegetation. There would be a loss of trees from saltwater intrusion into the lower Chehalis River, and a loss of low-elevation tidal mud and sand flats.

Warmer and drier summers would likely result in a shift in forest composition to increased hardwoods and fewer Douglas firs, and increased numbers and extent of wild fires. With longer-term shifts in forest types and species, there could be increased insect and tree disease outbreaks.

Fish and Wildlife

Projected increases in temperature in rivers and streams as well as a decrease in summer precipitation would likely result in decreased abundance of cold water-associated fish, such as salmon and steelhead. As shown in Table 5.2-1, future conditions as a result of climate change under the No Action Alternative would have the greatest impact on spring-run Chinook salmon and the least impact on winter- and fall-run chum salmon. Chum salmon would be least affected by climate change because of their late-season entry into freshwater in the fall after water has cooled and precipitation has increased (ICF 2016).

Table 5.2-1
Potential Response in Salmon Abundance in the Chehalis Basin to Climate Change

SPECIES (CURRENT HABITAT POTENTIAL)	CHANGE FROM CURRENT CONDITION IN NUMBER OF FISH (%)
Coho salmon (40,642)	-22,390 (-55%)
Fall-run Chinook salmon (25,844)	-6,969 (-27%)
Winter/fall-run chum salmon (190,550)	-8,270 (-4%)
Spring-run Chinook salmon (2,146)	-1,869 (-87%)
Winter-run steelhead (6,800)	-3,741 (-55%)

Depending on projected changes in climate, spring-run Chinook salmon could be nearly extirpated from the Chehalis Basin, or have substantially reduced populations, primarily as a result of assumed increases in summer water temperature (ICF 2016). Analysis also showed five subpopulations of spring-run Chinook salmon and one subpopulation of winter-run steelhead could be extirpated from the Chehalis Basin as a result of climate change under the No Action Alternative. NMFS and USFWS are responsible for assessing the possible listing of salmonids under Section 4 of the ESA and would initiate an ESA-listing proposal for endangered or threatened species. The analysis of climate change impacts on fish and wildlife under the No Action Alternative does not include future actions that could occur as a result of ESA listings.

Negative impacts on spawning and rearing habitat for other cold-adapted fish, such as mountain whitefish, and non-fish aquatic species could occur due to increases in summer water temperature (ASEPTC 2014c). Beneficial effects on spawning and rearing habitat for warm-adapted fish and non-fish aquatic species, such as Pacific lamprey, largemouth bass, smallmouth bass, speckled dace, largescale sucker, and western toad, could occur due to increases in summer water temperature (ASEPTC 2014c). The adverse impacts of sea level rise would shift fish species composition in the lower Chehalis River as saltwater extends farther upstream.

In addition to affecting fish, projected increases in water temperature, changes in seasonal flows, and the upstream extension of saltwater in the Chehalis Basin would adversely affect stream- and stillwater-breeding amphibians, including western toad, by constraining or potentially eliminating suitable breeding and foraging habitat for these species. Terrestrial amphibians including Dunn's salamander and Van Dyke's salamander could also be affected by increased summer air temperatures and changes in precipitation patterns. Other wildlife including mammals, reptiles, and birds could also be affected by climactic changes and would be subjected to the loss of breeding and foraging habitat due to changes in seasonal flooding, sea level rise, wetland and mudflat/sandflat conversion, tree loss, and vegetation community changes. Reduction in food sources, especially for those wildlife that rely on salmon carcasses for a part of their diet, could also occur—as could increased competition for other basic life resources as species relocated to find more suitable habitats.

Air Quality

Decreased summer precipitation and increased wild fires with climate change are likely to adversely affect air quality under the No Action Alternative.

Built Environment

Continued rise in sea level, more intense heavy winter rains, decreased summer precipitation, and increased wildfire activity as a result of climate change could result in the following effects to the built environment under the No Action Alternative:

- **Land Use –** Increased impacts on structures and agriculture due to increased flooding and shoreline inundation
- **Transportation –** Increased flooding and shoreline inundation, which would result in increased transportation closures, delays, or detours for facilities and transportation lines located in or near coastal and low-lying areas, as well as facilities located in or near current floodplains
- **Recreation –** Increased flooding impacts on park facilities located within the floodplain and low-lying areas
- **Historical and Cultural Preservation –** Potential increased impacts on cultural resources from increased flooding and inundation
- **Public Services and Utilities –** Increased flooding impacts on public service and utility facilities located within the floodplain due to increased peak flow and frequency of winter storms, resulting in more frequent and greater flood damage
- **Environmental Health and Safety –** Impacts on emergency response services would continue during floods due to closures of I-5 and local roads that are impassible during major floods
  - Flood conditions would increase and more frequent major floods would increase the potential for contamination of wells and surface water

5.2.2.4 Land Use

Landowners could choose to relocate homes and businesses outside of the floodplain to avoid damages. More than 1,360 high-value structures susceptible to flooding within the Chehalis River floodplain—approximately 56% residential, 26% commercial, and 18% agricultural—would remain vulnerable under the No Action Alternative and could incur flood damages (see Appendix L), resulting in a significant adverse impact. Agricultural losses to crops and livestock from flooding would continue, although livestock losses would be lessened by farm pads that have already been constructed. Under the No Action Alternative, it is anticipated that development would progress in much in the same way as it has in the past (see Appendix L).

During the next 100 years, population growth in the Chehalis River floodplain could result in the development of 407 to 914 new residential and commercial/industrial structures (approximately 4 to 9 structures per year). These structures would be distributed throughout all three counties in the

Chehalis River floodplain, with the highest portion of this development expected in Lewis County because that is where the most vacant or subdividable parcels in the floodplain exist. Most of the potential development associated with the No Action Alternative would occur as residential structures in Lewis County, likely in incorporated and Urban Growth Areas (UGAs) in Chehalis and Centralia (see Appendix L).

The cities of Aberdeen and Hoquiam recently joined together to create a Coastal Resiliency Master Plan—the Timberworks Master Plan—which would identify multiple-benefit projects that can reduce flood risk, improve fish habitat, and increase public open space and recreation opportunities. Initiation of this project occurred in November 2015 and the long-term effect on land use is undetermined.

Agricultural losses to crops and livestock from flooding would continue, although livestock losses would lessen to some degree by farm pads that have been constructed since the 2007 flood. Farm pads and excavation routes that are currently funded, or are completed through 2017, would likely reduce the risk of adverse impacts on livestock from flooding. Funding for farm pads and excavation routes after 2017 is uncertain under the No Action Alternative. Ultimately, flooding would continue to cause significant adverse impacts on agricultural lands and infrastructure in the floodplain.

5.2.2.5 Recreation

The habitat restoration actions included in the No Action Alternative would not substantially improve fish abundance (see Section 5.2.2.1) and recreational fishing opportunities would continue to decline. Flooding at parks and other recreational facilities throughout the Chehalis Basin would not be substantially reduced through implementation of flood damage reduction actions included in the No Action Alternative. Floods would continue to affect structures and facilities within recreation areas, and access roads and bridges to recreational facilities (such as Rainbow Falls State Park and the Willapa Hills Trail) would remain at risk of being damaged by floodwaters. This would cause moderate adverse impacts because floods would continue to displace recreational uses until floodwaters recede and could cause long-term loss of access.

If farm pads provide high ground to protect livestock and equipment at agricultural operations used for agritourism, this would provide beneficial effects. As stated in Section 5.2.2.4, major floods would continue to have significant adverse impacts on agricultural lands and infrastructure in the floodplain.

5.2.2.6 Historic and Cultural Preservation

Potential short- and long-term impacts on historic and cultural resources include the following:

- Destruction, damage to, or alteration of a cultural resource
- Necessary removal of a cultural resource from its original location
- Changes to the use or physical features of a cultural resource

- Introduction of visual, atmospheric, or audible elements that diminish the integrity of the significant features of a cultural resource

Although few large-scale projects are likely to be constructed under the No Action Alternative, WSAPM identifies the Chehalis River and watershed as primarily at a moderate to very high risk, with completion of an archaeological survey highly advised or recommended.

Although the degree or severity of the impact would depend on the nature of cultural resources that would be disturbed, moderate to significant adverse impacts on cultural resources could occur due to the predicted archaeological potential. Impacts on cultural resources associated with the No Action Alternative are related to the following:

- Required ground disturbance related to construction and implementation of actions under the No Action Alternative
- Increased channel mobility and resulting stream channel changes and subsequent erosion
- Additional, increased, or changed vehicular and foot traffic patterns
- Different flood patterns or increased peak flows under climate change, which could cause flooding and sedimentation of submerged resources in other areas, change stream channels and cause erosion, and change the streambank locations and result in bank erosion

Potential impacts on tribal cultural resources or graves, Indian human remains, or traditional cultural properties may also occur, and would be determined in coordination with tribes, and continued government-to-government consultations.

5.2.2.7 Transportation

Significant adverse impacts on transportation would occur due to the continuation of the following conditions during major floods:

- Closures of I-5 (currently 4 days during 100-year floods) requiring use of WSDOT's detour route (see Section 3.13; WSDOT 2014)
- Closures of SR 6, US 101, and US 12, and flooding of local roadways would continue
- Flooding within the Chehalis-Centralia Airport, which would restrict flights and use of the airport for emergency response
- Flooded rail lines, including BNSF, Union Pacific, and the Curtis Industrial Park line

5.2.2.8 Public Services and Utilities

Projects included in the No Action Alternative would not significantly reduce flooding, and public service facilities and utilities located within the floodplain would continue to be adversely affected by floods. Significant adverse impacts could continue to occur under the No Action Alternative due to damaged

utility infrastructure, interrupted utility services, and temporary service outages while providers work to repair damage and restore service.

5.2.2.9 Environmental Health and Safety

Significant adverse impacts on environmental health and safety could continue to occur due to the continuation of the following conditions during major floods:

- Closures of I-5, SR 6, US 12, US 101, and local roads during major floods, reducing emergency response time
- Siting of critical facilities in the floodplain as part of future development, which could also adversely affect emergency response
- Contamination of wells and surface water

5.2.3 Mitigation

Mitigation for unavoidable adverse impacts that occur as a result of projects implemented under the No Action Alternative would be project-specific, and therefore must be identified on a project-level basis. Compensatory mitigation for impacts on wetlands, vegetation, fish, and wildlife that occur as a result of project-related actions would be similar to mitigation described in Chapter 4 for smaller-scale elements such as levees and Local-scale Flood Damage Reduction Actions, as well as for the Aquatic Species Habitat Actions.

Acquisition and restoration of floodplain areas or streambanks of equivalent size or habitat function for fish could be implemented if a project is found to impair habitat for sensitive species.

The potential mitigation associated with project-related impacts on tribal resources would be addressed directly with tribal leadership during project-level environmental review and consultations, as described in Section 4.2.5. Mitigation of impacts on treaty rights is subject to consideration and agreement by the Quinault Indian Nation.

Mitigation measures for project-related adverse impacts on historic and cultural resources would be determined during project-specific evaluations of activities implemented under the No Action Alternative, as described in Section 5.2.2.6.

Significant unavoidable impacts are identified under the No Action Alternative that are not project-related; rather, these impacts are due to the ongoing and increasing effects of climate change and associated flood damage, as well as habitat degradation. These impacts are not triggered by a specific project and without a comprehensive program, such as the Chehalis Basin Strategy, would be less likely to be addressed in a coordinated manner in the future.

5.3 Alternative 1: 2014 Governor's Work Group Recommendation

As described in Chapters 1 and 2 of the EIS, the 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 2015-17 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. This recommendation, the 2014 Governor's Work Group Recommendation (Alternative 1), would achieve flood damage reduction through implementation of a dam with a temporary (FRO) or permanent (FRFA) reservoir, Airport Levee Improvements, the Aberdeen/Hoquiam North Shore Levee, and Local-scale Flood Damage Reduction Actions. The Aquatic Species Habitat Actions would be implemented to accomplish the restoration objectives outlined in this recommendation.

Alternative 1 would result in the greatest reduction in overall flood extents and depths within the Chehalis Basin during a major flood or greater when compared to the No Action Alternative, as well as to the other action alternatives. Most of the flood damage reduction from Alternative 1 would be realized in the Chehalis River floodplain.

In the long term, Alternative 1 would provide an increased benefit to aquatic species habitat function as compared to the No Action Alternative through implementation of Aquatic Species Habitat Actions. However, as compared to the other action alternatives, Alternative 1 would result in more impacts on native salmon and aquatic species as a result of permanent and large-scale changes to the Chehalis River and floodplain caused by a Flood Retention Facility.

5.3.1 Flood Damage Reduction

5.3.1.1 Benefits from Implementing Flood Damage Reduction Actions

Alternative 1 could help to moderate the extent and depth of flooding in downstream areas from more intense winter rains anticipated with climate change, and therefore broadly help to avoid future flood damage resulting from extreme floods in these areas. The No Action Alternative would not include actions that would address this possibility on a broad geographic scale. Alternatives 2 and 3 include elements that would help avoid future flood damage resulting from more intense winter storms if constructed properly (Airport Levee Improvements and Floodproofing); however, these would not affect as broad a geographic area as Alternative 1. Alternative 4 would increase the areal extent and depth of 100-year floods upstream of Newaukum River confluence. Downstream of the Newaukum River confluence, including in the Chehalis-Centralia area, Alternative 4 would reduce flood extents and depths but to a lesser degree than Alternative 1.

Alternative 1 would eliminate inundation in portions of the upper Chehalis Basin from Doty to the confluence with the South Fork Chehalis River, and reduce inundation by 1 to 10 feet in other portions of this area during a 100-year flood (see Figure 5.3-1). Downstream of the South Fork Chehalis River confluence to Centralia, inundation would be reduced by 1 to 5 feet in most locations, with portions of Chehalis behind the airport levee predicted to experience reductions of inundation up to 10 feet, or to be no longer inundated. Downstream of Centralia to approximately Elma, inundation is predicted to decrease by between 0.1 and 5 feet in the Chehalis River floodplain during a 100-year flood, depending on location. Downstream of Elma, inundation is predicted to decrease by between 0.1 and 1 foot (see Figures 5.3-1 through 5.3-3). Alternative 1 would not reduce flood inundation or flood damage in the South Fork Chehalis River floodplain upstream of approximately King Road, or in the Newaukum River floodplain upstream of approximately Stan Hedwall Park in Chehalis. It is anticipated that the Aberdeen/Hoquiam North Shore Levee would protect the areas behind the levee in Aberdeen and Hoquiam from coastal flooding (not shown in the figures), which would also be the case for Alternative 2.

Within the Chehalis River floodplain, the number of high-value residential, commercial, and agricultural structures flooded could be reduced from approximately 1,379 to 820 during a 100-year flood as result of the Flood Retention Facility and Airport Levee Improvements (protection of 559 structures). For the 2007 flood, the number of valuable residential and commercial structures flooded would have been reduced from 2,026 to 736 (WSE 2014c, 2014d; Karpack 2016c). The Aberdeen/Hoquiam North Shore Levee could prevent coastal flooding behind the levee, where up to 2,715 structures could potentially be protected (Franklin 2016); these structures have not been determined to be of high or limited value at this time. However, the Large-scale Flood Damage Reduction Actions in Alternative 1 would not eliminate flood damage to many residential, commercial, and industrial structures in the Chehalis River floodplain, nor in many Chehalis River tributaries. In locations where structures would remain inundated after implementation of Large-scale Flood Damage Reduction Actions, Floodproofing would still be necessary to protect structures and their contents from flood damage. The exact number of structures protected from flood damage as part of all of the action alternatives would be determined during project-level design and environmental review. Based on communication with cities, counties, and business owners in the Chehalis Basin, 75% of the residential structures and 25% of the commercial, industrial, and other non-residential structures in the Chehalis River floodplain could be protected through elevation, other floodproofing measures, and buy-outs.

Figure 5.3-1

Alternative 1 Changes in Downstream Inundation During 100-year Flood – Upper Chehalis Basin

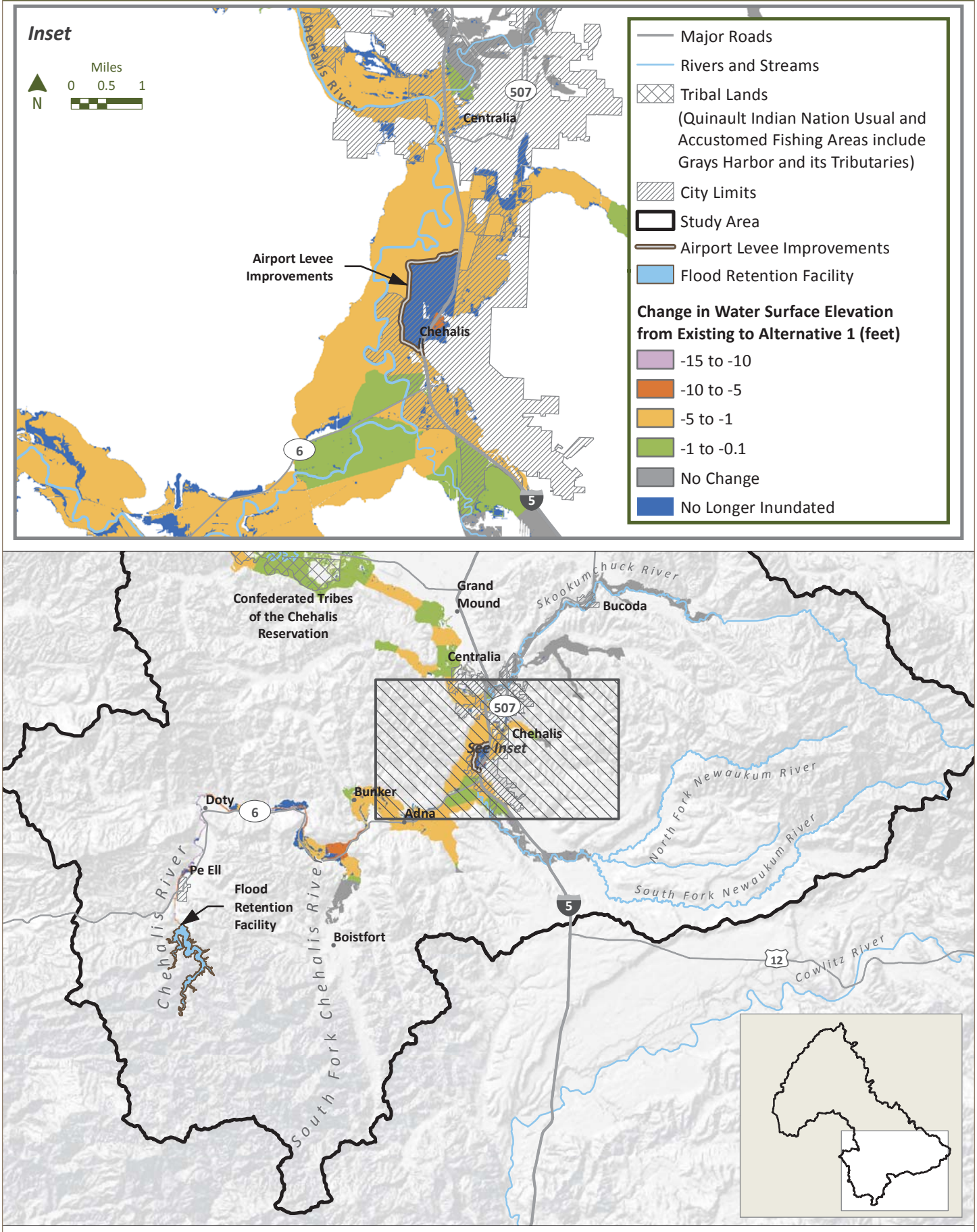


Figure 5.3-2

Alternative 1 Changes in Downstream Inundation During 100-year Flood – Middle Chehalis Basin

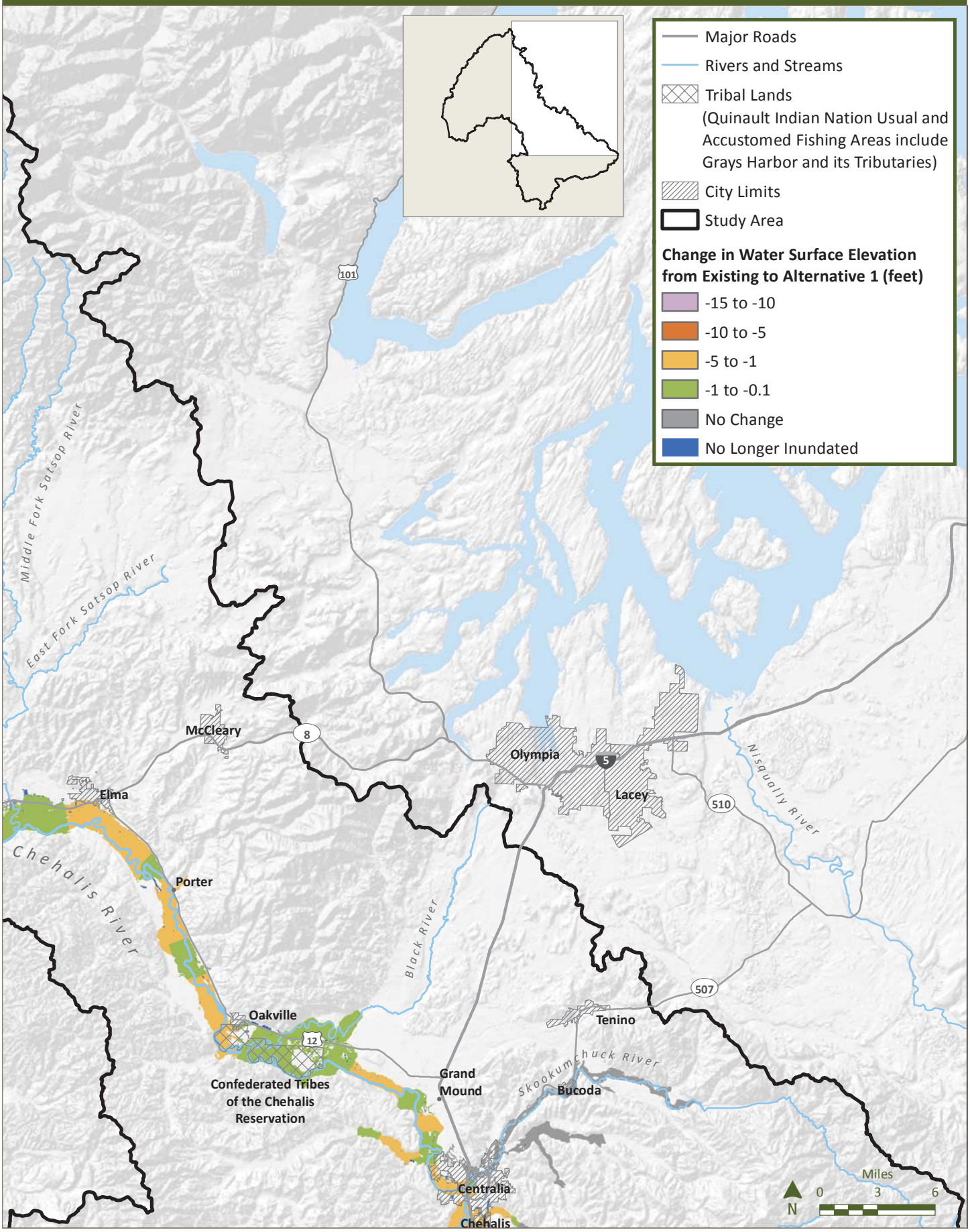
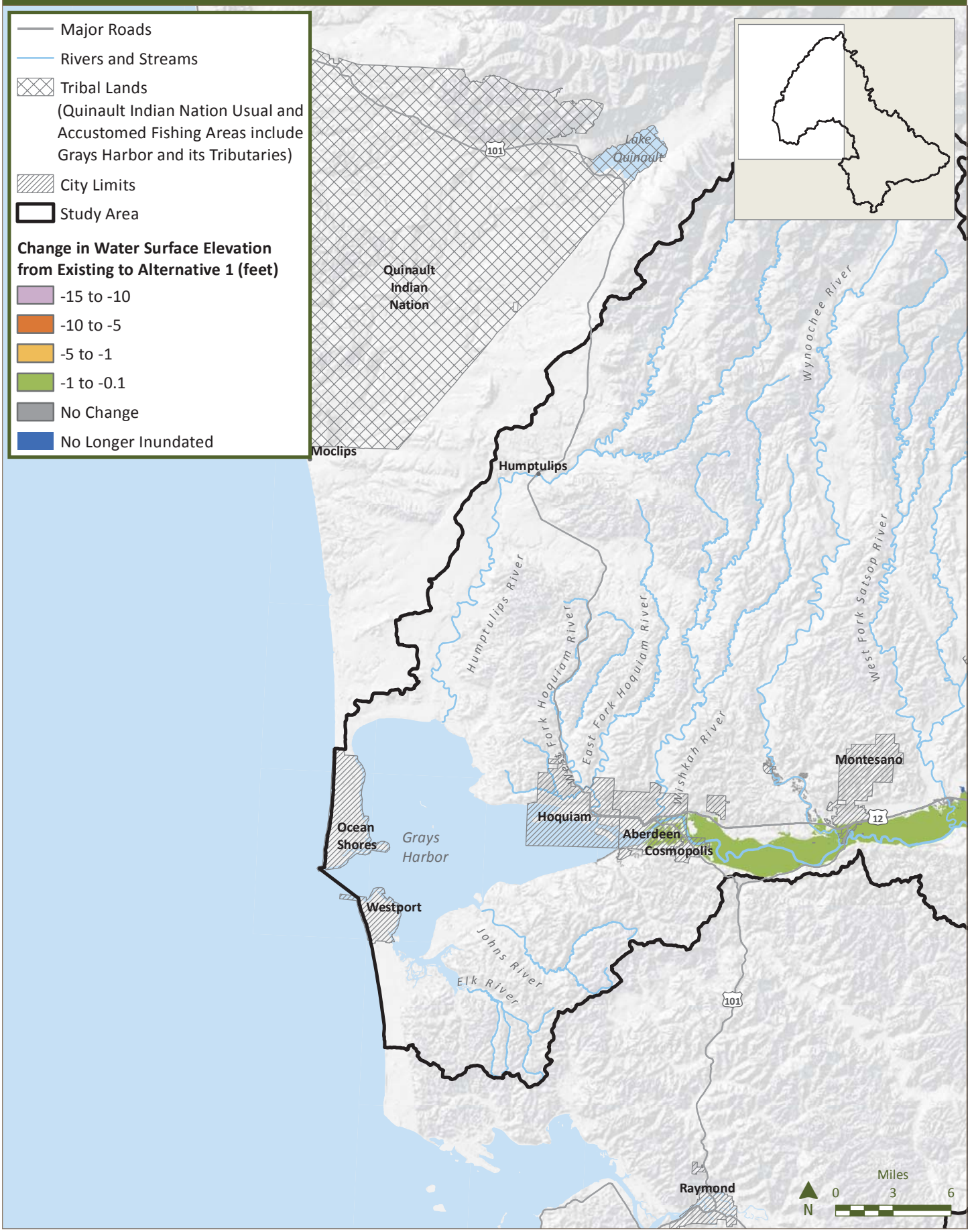


Figure 5.3-3

Alternative 1 Changes in Downstream Inundation During 100-year Flood – Lower Chehalis Basin



Implementation of the Flood Retention Facility and Airport Levee Improvements could reduce flooding in the Chehalis River floodplain during major floods on 4,481 acres, mostly located within Lewis County (see Tables 5.3-1 and 5.3-2). This includes 90 acres on Chehalis Tribe reservation, which is not shown in Table 5.3-1. Most of the reduction would be on agricultural/forestlands and residential land. In some portions of the Chehalis River floodplain, this land would no longer be inundated; in some locations, inundation would simply be reduced.

Table 5.3-1
Change in Acres Flooded by County and Land Use Zone for Alternative 1

GENERAL ZONE	LEWIS COUNTY	GRAYS HARBOR COUNTY	THURSTON COUNTY[1]
Agricultural/forestland	-1,351	-432	-173
Commercial/industrial	-551	-284	0
Parks	-40	0	0
Public land	-256	0	0
Residential	-1,134	-74	-94
Total	**-3,334**	**-790**	**-267**

Note:
1. Does not include Chehalis Tribe reservation

The implementation of Alternative 1 could reduce flood damage and result in beneficial effects on I-5, as well as other local and regional transportation systems. Installation of the Flood Retention Facility and Airport Levee Improvements could reduce the duration of closures of I-5 during a 100-year flood from the current 4 days to 1 day (WSDOT 2014). This includes reduced flooding depths of roadways near Chehalis and Centralia during a 100-year flood by up to 5 feet. Flood depths along SR 6 could also be reduced up to 5 feet in most areas, and up to 10 feet in areas east of Doty. Some areas east of Doty would no longer be inundated. Downstream, flood depths along US 12 could be reduced by 0.01 to 1 foot in most areas, and up to 5 feet near Oakville, Porter, and Elma. Flooding of roadways on the Chehalis Tribe reservation could be reduced by up to 1 foot. The Chehalis-Centralia Airport would be protected by the Airport Levee Improvements during a 100-year flood, and the Aberdeen/Hoquiam North Shore Levee would protect local roadways behind the levee during coastal floods. Flooding of rail lines, including BNSF, Union Pacific, and the Curtis Industrial Park line would also be reduced.

The decreased severity of flooding could reduce the need for emergency response, increase public safety, and reduce adverse impacts on public services and utilities. For example, the airport would remain functional and be able to provide a base for emergency response during floods, and the radio tower located on the airport property would be protected during 100-year floods. Reduction of the period of closure of I-5 would make it available as an emergency response route for a longer time during floods. The Aberdeen/Hoquiam North Shore Levee could protect public services and utilities in

Aberdeen and Hoquiam from coastal flooding. Local Projects, such as flood protection of WWTPs, could reduce the potential for floodwater contamination by keeping the WWTPs operable during floods. Land Use Management actions would require a higher level of protection for new critical facilities (facilities that are vital to flood response activities and public health and safety or could release hazardous waste during floods). Flood Warning System Improvements, such as improvements to flood forecasting and flood inundation maps, would improve predictions and increase the lead time for flood warning, improving public safety.

5.3.1.2 Impacts of Implementing Flood Damage Reduction Actions

While there would be beneficial effects as a result of implementing Alternative 1, unavoidable significant adverse impacts on water resources, geology, geomorphology, wetlands and vegetation, fish and wildlife, tribal resources, and cultural resources would occur—primarily as a result of implementing the Flood Retention Facility as described in more detail in Chapter 4.

As compared to natural conditions, higher levels of sediment could be delivered to the temporary or permanent reservoir area from landslides that could potentially be triggered by fluctuating water levels, resulting in highly turbid conditions in the reservoir (also see Section 4.2.2.2.1). The effects of these erosion processes have the potential to cause a significant adverse impact on water quality within the reservoir with respect to suspended sediment and turbidity conditions by violating the state water quality criterion for turbidity (5 NTU over background).

For both the FRO and FRFA facility types, the potential for prolonged, controlled releases of turbid water exists as the reservoir draws down after a major flood (occurrence once every 7 years on average). Reduction in sediment quantity when the reservoir pool is in operation (for both the FRO and FRFA facilities), or the release of higher rates of suspended sediment outside of flood retention periods (for the FRO facility), have the potential to result in a significant adverse impact on downstream water quality with regard to suspended sediment and turbidity conditions. The FRFA facility would also alter approximately 6.3 miles of the Chehalis River upstream of the dam from a free-flowing river to a reservoir, resulting in a significant adverse impact on water quality.

In the FRO reservoir, increased solar heating of the Chehalis River in the reservoir inundation area would occur due to a reduction in riparian vegetation. Predictions of a water quality model that simulated the anticipated changes to vegetation indicated that nearly a 4˚C increase in summer water temperatures (over existing conditions) could occur within the reservoir footprint (PSU 2016). In the Crim Creek tributary upstream of the dam, up to a 5˚C increase was predicted. Modeling predicts this temperature effect to diminish upstream along the mainstem Chehalis River, where at RM 114 the predicted increase is 2˚C. Because warmer waters hold less DO, and can also stimulate biological activity creating a greater demand for DO, lower DO in the reservoir area is expected. With the increase in temperature by up to 4˚C and decrease in DO, there would be a significant adverse impact on water quality.

Compared to the No Action Alternative and other action alternatives, the occurrence of landslides along the perimeter of the reservoir has the potential to increase as a result of fluctuating water levels with the Flood Retention Facility. Over the life of the Flood Retention Facility, an earthquake on the CSZ to the west or Doty Fault Zone to the north could occur, and cause damage to the dam due to strong shaking. This would result in a significant adverse impact, if it were to occur. However, the dam and appurtenant structures could be designed to withstand this potential situation. Alternative 1 would have significant adverse impacts on geomorphology, primarily as a result of the dam disrupting sediment and wood transport downstream during dam operations. Compared to the No Action Alternative and other action alternatives, impacts on geomorphic functions would be greater.

Alternative 1 would have a much greater degree of unavoidable adverse impacts on wetlands and vegetation than the No Action Alternative and other action alternatives. This is primarily due to the permanent loss of approximately 68 acres (FRO facility) to 98 acres (FRFA facility) of wetlands and approximately 6 acres (FRO facility) to 720 acres (FRFA facility) of forested vegetation that would be required to construct and operate the Flood Retention Facility, which is unique to this alternative. Permanent loss or conversion of wetlands and vegetation associated with the Airport Levee Improvements, Aberdeen/Hoquiam North Shore Levee, and Local-Scale Flood Damage Reduction Actions are expected to be limited to within the footprint of the actions, which are largely located in areas that are currently developed or have been previously disturbed by past industrial, commercial, and residential activities.

Implementing Alternative 1 could also result in changes in wetland water regimes, vegetation, nutrient cycling, functions, and hydrologic sources of downstream floodplain wetlands. Table 5.3-3 provides a comparison of the approximate area of wetlands in the Chehalis River floodplain under the No Action Alternative with those in the Chehalis River floodplain with the Alternative 1 action elements in place. As indicated, Alternative 1 would reduce the extent of floodplain wetlands that would receive flood flows from 100-year floods. In addition to the No Action Alternative, this reduction in flooding as a source of hydrology for floodplain wetlands would be greater under Alternative 1 than that for any of the other action alternatives.

Table 5.3-3
Wetlands Located in Future 100-year Floodplain for the No Action Alternative and Alternative 1

WETLAND TYPE	AREA (ACRES)	
	NO ACTION ALTERNATIVE	ALTERNATIVE 1
Potentially (previously) disturbed wetlands	4,276	3,902
Palustrine forested wetland	4,789	4,492
Palustrine scrub-shrub wetland	4,476	4,228
Palustrine emergent wetland	6,291	5,949
Estuarine emergent wetland	50	47
Unconsolidated shore	339	335
Open water	3,877	3,817
Palustrine aquatic bed wetland	71	71
Estuarine aquatic bed wetland	0	0
Total	**24,169**	**22,841**

Source: Ecology 2011b; modeled inundation extent (WSE 2014c)

Alternative 1 would result in the most adverse impacts on fish as compared to the No Action Alternative and other action alternatives because of permanent and large-scale changes to the Chehalis River and its floodplain caused by the Flood Retention Facility, as further described in Chapter 4. Permanent changes to water quality (turbidity, temperature, and DO), temporary or permanent inundation of what is currently stream habitat above the dam, and reductions in forces that shape habitat downstream (delivery of coarse sediment used for refuge and spawning or large wood that creates habitat structure) would occur. These impacts could be avoided and minimized through such measures as fish passage facilities, reduced drawdown rates to avoid or minimize landslide occurrences, release of cooler waters in late spring to early fall (FRFA facility only), gravel augmentation, and large wood relocation. However, there would be significant adverse impacts resulting in the potential decline of salmonids as further described in Chapter 4. These declines would be greater when factoring in climate change predictions during the next 100 years (see Section 5.3.3 for an analysis of climate change impacts for Alternative 1). Impacts from the combination of the Flood Retention Facility and Aquatic Species Habitat Actions on fish were modeled, and are included in the Aquatic Species Habitat Actions evaluation in Section 5.3.2. Impacts from the combinations of the Flood Retention Facility and Aquatic Species Habitat Actions with climate change on fish have also been modeled and are included in Section 5.3.3.2.

Alternative 1 would temporarily or permanently inundate habitat above a dam, and constrain or eliminate instream breeding and foraging habitat for stream- and stillwater-breeding amphibians. Over time, potential changes to wildlife habitat could change the composition of wildlife species currently occurring within habitats by creating habitat conditions more favorable to some wildlife species, while eliminating characteristics favorable to other wildlife species as described in Section 4.2.4. Disturbed areas could be repopulated with non-native, invasive species that compete with native wildlife for

resources. The long-term adverse impacts range from minor to significant because different classes of wildlife species (e.g., amphibians, reptiles, categories of mammal and bird species) have a variety of habitat needs and home ranges with different vulnerabilities and potential responses to the disturbance and conversion of habitat features.

Impacts on tribal resources would occur with implementation of Alternative 1, primarily related to impacts on fish resources, although disruption to plant, wildlife, and traditional cultural practices could also occur. The extent of potential impacts on tribal resources is pending additional coordination with tribes and continued government-to-government consultations.

Impacts on cultural resources that could occur following construction of elements of Alternative 1 include potential sedimentation of any submerged resources; changes in stream channels and streambanks, resulting in erosion and potential exposure of resources; and increased or changed vehicular and foot traffic patterns that could affect resources. These changes could expose, damage, destroy, and/or alter cultural resources within construction footprints, as well as within the footprints of reservoirs or areas of changed river or tributary flows. In addition, erosion and other changes to stream channels and banks could require the removal of a cultural resource from its original location, or change the use or physical features of a cultural resource. Moderate to significant adverse impacts on cultural resources could occur due to the predicted archaeological potential in several areas of proposed construction.

Installation of the Flood Retention Facility and Airport Levee Improvements could result in increased development pressure in the Chehalis River floodplain due to a reduction of flooded area on developable parcels. In Lewis County, this could result in approximately 649 parcels, mostly located in residential incorporated and UGA areas of Lewis County, experiencing increased development pressure. Commercial/industrial parcels that have a lower risk of being flooded, and could be subject to greater development pressure, are mainly located in incorporated areas of Lewis County. Agricultural parcels that would contain area no longer inundated under Alternative 1 are located in unincorporated Lewis County.

During the next 100 years, population growth in the Chehalis River floodplain could result in development similar to that expected for the No Action Alternative, approximately 4 to 9 structures per year (total of 407 to 914 structures during the next 100 years). As a result of decreased flooding extents and the corresponding increase in development pressure on those parcels, future Chehalis River floodplain development rates under this alternative may tend toward the high end of the range in Lewis County, where flood extents would be most substantially reduced. Further analysis related to future development in the Chehalis River floodplain is included in Appendix L.

5.3.2 Aquatic Species Habitat Actions Evaluation

Alternative 1, when implemented as a comprehensive strategy, could substantially increase abundance of native aquatic species, reduce the potential for future ESA listings, and enhance tribal and non-tribal

fisheries as compared to the No Action Alternative. As described in the introduction to Section 5.3, Alternative 1 would result would result in more impacts on native salmon and aquatic species as compared to the other action alternatives because of permanent and large-scale changes to the Chehalis River and its floodplain caused by the Flood Retention Facility.

Implementation of Aquatic Species Habitat Actions would result in beneficial effects to native aquatic and semi-aquatic species and salmonids at a Basin-wide scale, due to the following:

- Restoring and protecting riparian habitat throughout the Chehalis Basin
- Opening up more than 295 miles of streams for migrating fish by removing partially or totally blocked fish passage barriers
- Restoring off-channel habitat on the mainstem Chehalis River and its tributaries, reconnecting the floodplain, adding wood, and reducing bank erosion to naturally occurring rates
- Creating, restoring, or enhancing wetlands for use by semi-aquatic species

As described in Chapter 2, the low restoration scenario focuses on reaches in the middle and upper Chehalis Basin that improve habitat for spring-run Chinook salmon, whereas the high restoration scenario occurs across a greater geographic area with improvements to habitat focused on areas with the highest restoration potential for all salmonid species. While these scenarios were developed based on habitat potential for salmonid species, the restoration actions will have benefits for other fish and amphibians as well.

Changes to the potential of the habitat in modeled tributaries in the Chehalis Basin to support salmon and steelhead in response to the combined actions in Alternative 1 was modeled for the different salmonid species that occur in WRIAs 22 and 23. The resulting changes in Chehalis Basin salmon populations are depicted for a range of dam and restoration scenarios (see Table 5.3-4). Modeled results of salmon habitat potential for Alternative 1 include the maturation of riparian areas in managed forestlands and active restoration from the Aquatic Species Habitat Actions compared to current conditions. The contribution of managed forestlands to total salmonid abundance would, on average, contribute 59% of the restoration benefit under the low scenario and 27% under the high scenario. Most of the benefit of riparian and fish passage improvements in managed forestlands would accrue to coho and steelhead because a larger portion of their habitat is located in the Satsop, Humptulips, and Wynoochee basins that are largely managed forestland[3].

Without Aquatic Species Habitat Actions, the Flood Retention Facility type that would have the most adverse impact on salmon populations would depend on the species. The FRFA facility would have a greater adverse impact for coho salmon and fall-run Chinook salmon, whereas the FRO facility would have a greater adverse impact for winter/fall-run chum salmon, spring-run Chinook salmon, and winter-

[3] Refer to Draft EIS Addendum dated October 17, 2016.

run steelhead. Under low and high restoration scenarios, impacts of the FRFA facility would be greater than the FRO facility, largely because restoration of riparian areas upstream of the dam and inundation footprint would reduce water temperatures. Elevated water temperature is an adverse impact of the FRO facility that has a strong effect on salmon productivity in areas of the inundation footprint and extending downstream of the FRO facility. Although the FRFA facility would be designed to provide cool water downstream to benefit salmon, it would generally result in a greater magnitude of adverse impacts than an FRO facility, primarily due to loss of stream habitat and salmon spawning and rearing habitat in the permanent conservation pool. The predicted impacts of the facilities to salmonid abundance are shown in combination with the beneficial effects of the low and high restoration scenarios in Table 5.3-4 and Figure 5.3-4.

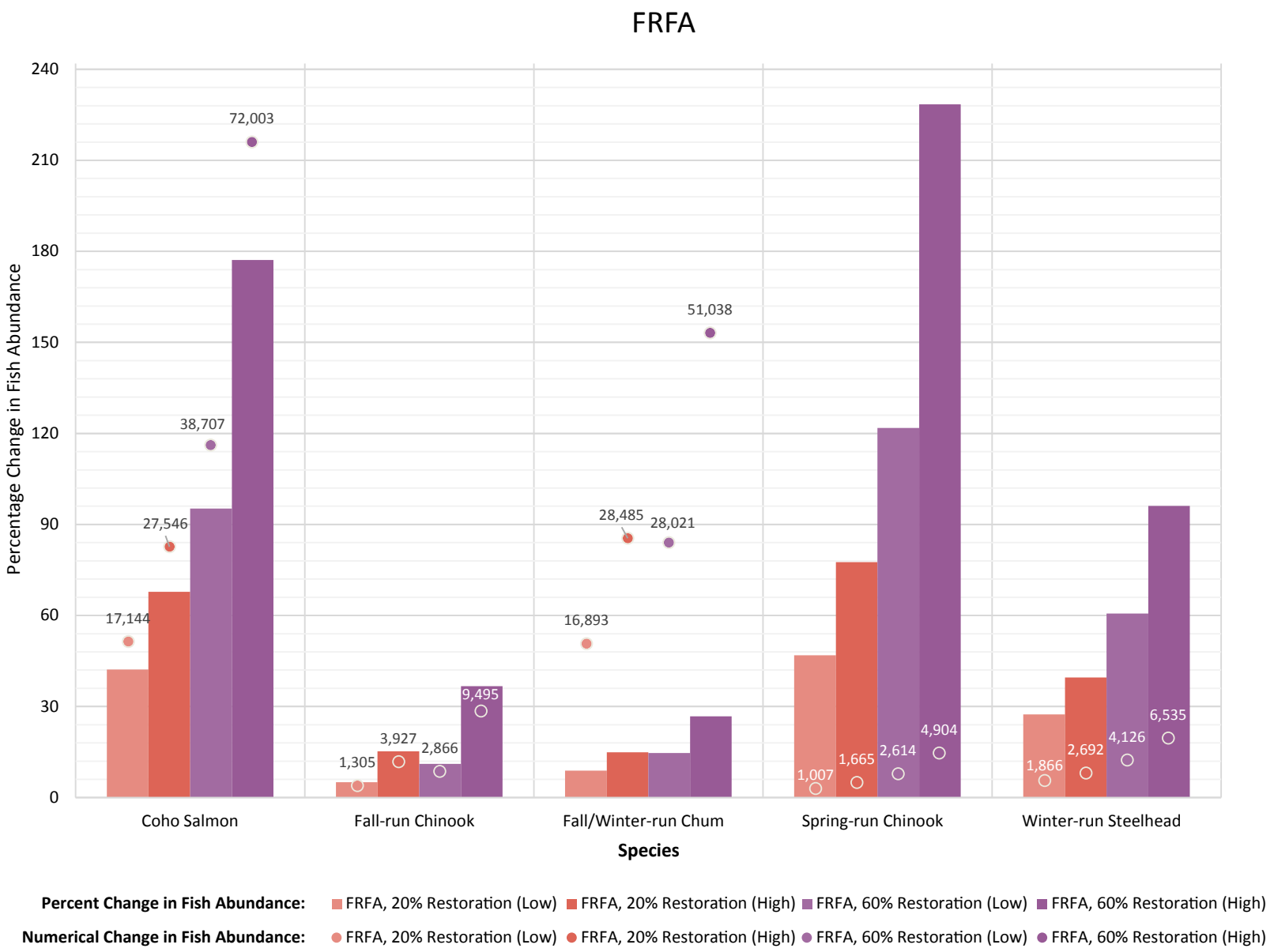
Table 5.3-4
Potential Response in Salmonid Abundance for the Chehalis Basin with Alternative 1

SPECIES (CURRENT HABITAT POTENTIAL)	FLOOD RETENTION FACILITY SCENARIO	CHANGE IN ABUNDANCE IN NUMBER OF FISH (%)				
		NO RESTORATION	WITH LOW RESTORATION; 20% OF REACHES	WITH HIGH RESTORATION; 20% OF REACHES	WITH LOW RESTORATION; 60% OF REACHES	WITH HIGH RESTORATION; 60% OF REACHES
Coho salmon (40,642)	FRO 100	-325 (-1%)	21,167 (52%)	38,831 (96%)	50,560 (124%)	94,930 (234%)
	FRO 50	-308 (-1%)	21,200 (52%)	38,866 (96%)	50,623 (125%)	94,998 (234%)
	FRFA	-622 (-2%)	17,144 (42%)	27,546 (68%)	38,707 (95%)	72,003 (177%)
Fall-run Chinook salmon (25,844)	FRO 100	-82 (<-1%)	2,860 (11%)	9,078 (35%)	4,366 (17%)	19,282 (75%)
	FRO 50	-80 (<-1%)	2,876 (11%)	9,100 (35%)	4,384 (17%)	19,311 (75%)
	FRFA	-150 (-1%)	1,305 (5%)	3,927 (15%)	2,866 (11%)	9,495 (37%)
Fall/winter-run chum salmon (190,550)	FRO 100	-1,837 (-1%)	18,589 (10%)	29,068 (16%)	30,641 (17%)	55,747 (30%)
	FRO 50	-1,837 (-1%)	18,589 (10%)	29,068 (16%)	30,641 (17%)	55,747 (30%)
	FRFA	-1,548 (-1%)	16,893 (10%)	28,485 (16%)	28,021 (15%)	51,038 (28%)
Spring-run Chinook salmon (2,146)	FRO 100	-82 (-4%)	1,990 (93%)	4,520 (211%)	5,448 (254%)	15,175 (707%)
	FRO 50	-75 (-3%)	2,013 (94%)	4,555 (212%)	5,506 (257%)	15,265 (711%)
	FRFA	-56 (-3%)	1,007 (47%)	1,665 (78%)	2,614 (122%)	4,904 (228%)
Winter-run steelhead (6,800)	FRO 100	-117 (-2%)	1,996 (29%)	2,963 (44%)	4,488 (66%)	7,426 (109%)
	FRO 50	-103 (-2%)	2,078 (31%)	3,056 (45%)	4,662 (69%)	7,655 (113%)
	FRFA	-95 (-1%)	1,866 (27%)	2,692 (40%)	4,126 (61%)	6,535 (96%)

Source: ICF 2016

Figure 5.3-4a

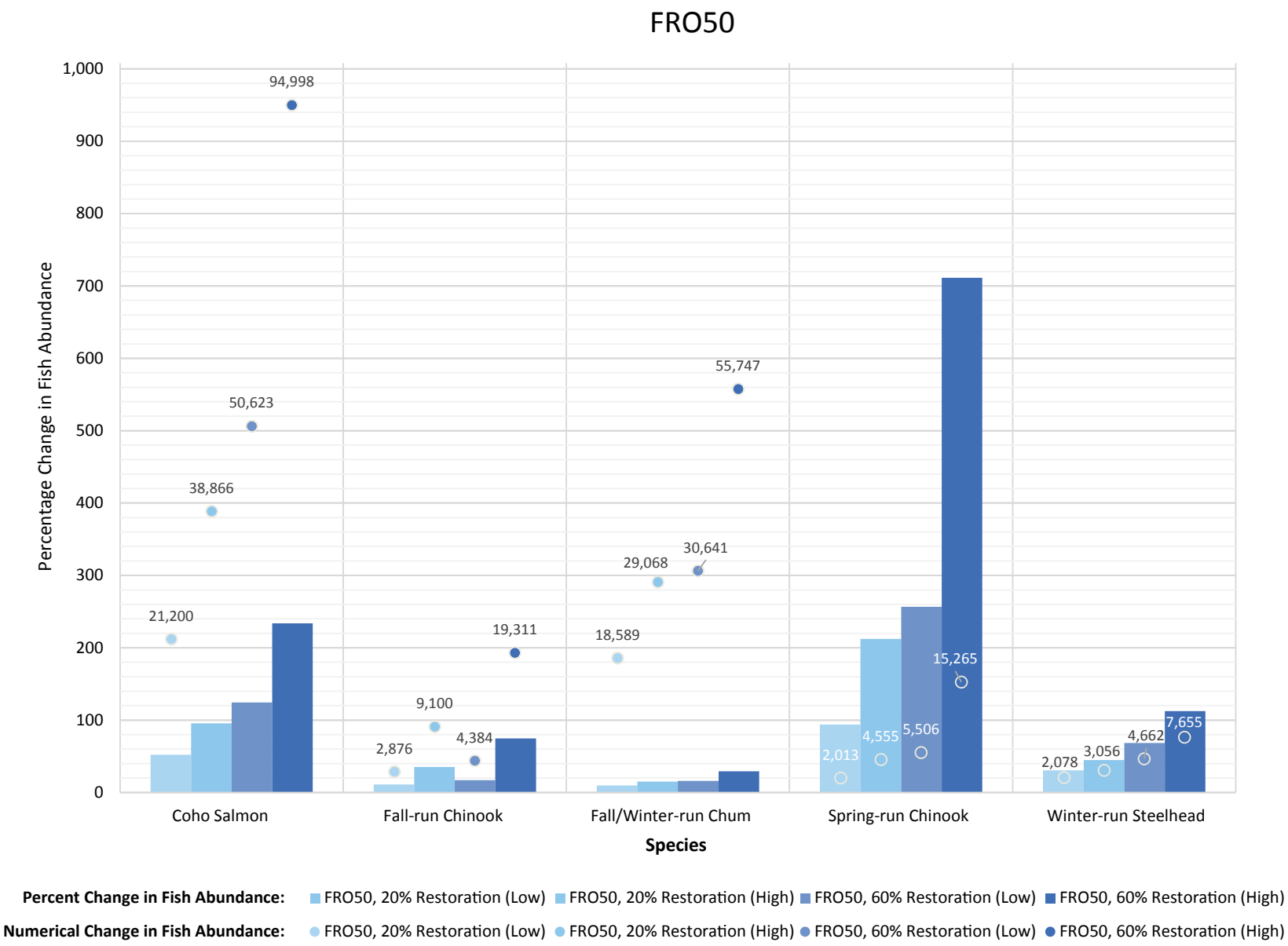
Potential Response in Salmonid Abundance to Habitat Change in the Chehalis Basin with Alternative 1



Source: ICF 2016

Figure 5.3-4b

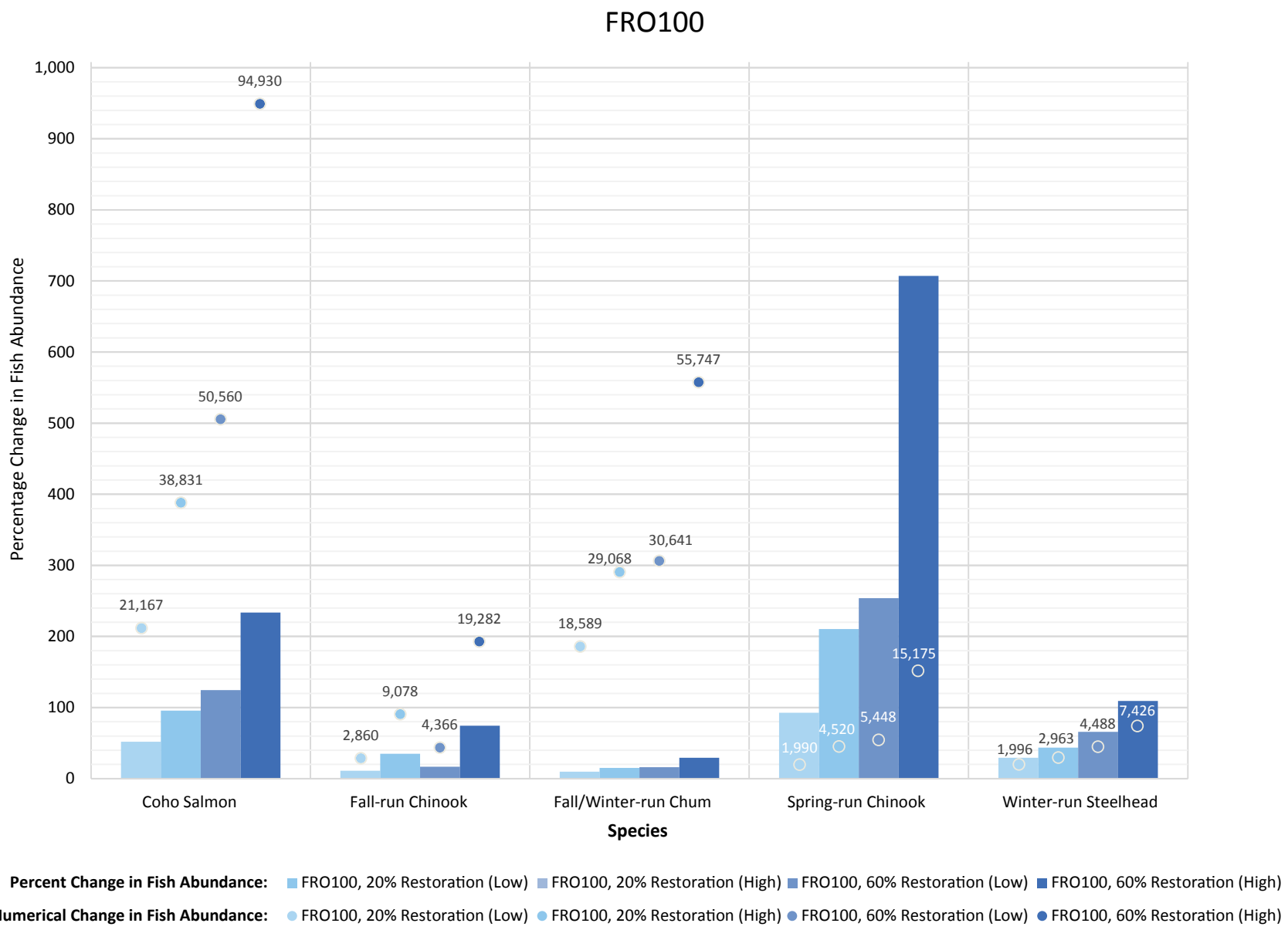
Potential Response in Salmonid Abundance to Habitat Change in the Chehalis Basin with Alternative 1



Source: ICF 2016

Figure 5.3-4c

Potential Response in Salmonid Abundance to Habitat Change in the Chehalis Basin with Alternative 1



Source: ICF 2016

As described in Chapter 4, with the exception of potential significant adverse impacts on cultural resources, implementation of the Aquatic Species Habitat Actions would result in beneficial effects, no impact, or minor to moderate adverse impacts on most elements of the environment. For cultural resources, the degree or severity of the impact would depend on the nature of cultural resources that would be disturbed as determined during a project-level environmental review, and could range from minor to significant adverse impacts depending on the location. The extent of potential impacts on tribal resources from Aquatic Species Habitat Actions is pending additional coordination with tribes and continued government-to-government consultations. Climate change would reduce the effectiveness of restoration for salmonid populations and other aquatic species (see Section 5.3.3.2).

5.3.3 Climate Change Analysis

Alternative 1 is anticipated to provide substantial beneficial effects in response to the effects of climate change when considering the combined action elements. However, Alternative 1 also results in generation of the most GHG of all alternatives as a result of construction of the Flood Retention Facility, which adversely affects climate conditions. The Flood Retention Facility is not part of the other action alternatives.

Adverse impacts from climate change on Alternative 1 are anticipated to be minor when combining all of the action elements. Alternative 1 would temper the effects of a changing climate in the Chehalis Basin more than the No Action Alternative, as the elements within Alternative 1 are designed to moderate those effects in a large-scale fashion.

5.3.3.1 Adverse Effects Contributing to Climate Change

The minor adverse impacts anticipated under Alternative 1 that would contribute to climate change would occur as the result of permanent loss of vegetation with the Flood Retention Facility, which reduces carbon sequestration (i.e., carbon storage). Construction of the FRFA facility would generate moderately greater GHG emissions equivalent than construction of the FRO facility—889 acres and 107,569 MT CO_2e versus 411 acres and 49,731 MT CO_2e. However, the vegetation losses associated with construction represent less than one-fifth of 1% of the existing forestland within the Chehalis Basin.

Aquatic Species Habitat Actions would result in a benefit to the resiliency of natural systems in the Chehalis Basin in the face of climate change under Alternative 1. This action element would increase or protect vegetation across floodplains in the Chehalis Basin, and result in an increase in carbon storage ranging from 900,000 to 1.93 million MT CO_2 (Ecology 2011c). These benefits exceed the potential adverse impacts contributing to climate change described previously.

5.3.3.2 Effects of Climate Change on Alternative 1

Alternative 1 would moderate the extent of flooding in downstream areas from the more intense winter rains anticipated with climate change, reduce the frequency of major floods originating in the Chehalis River headwaters, and reduce flood damage to land and to structures in the Chehalis River floodplain

more than the No Action Alternative and other action alternatives. Hydraulic modeling of peak flows under climate change conditions indicate that a FRO or FRFA dam would reduce peak flows to a greater degree in a 100-year flood in the future than under existing conditions, indicating Alternative 1 could help reduce flooding impacts from climate change (Karpack 2016a). In addition, the FRFA facility could moderate increases in summer instream temperature resulting from climate change by releasing cool water into the Chehalis River during late spring through early fall, although it could increase river temperatures at other times.

The design of facilities included in this alternative is expected to anticipate changes in precipitation, increased flooding, and drought conditions that are predicted with climate change forecasts.

Impacts of the Flood Retention Facility coupled with the Aquatic Species Habitat Actions on fish abundance were modeled using EDT. The results indicate that when combined with a dam, both the low and high scenarios for Aquatic Species Habitat Actions would be effective in overcoming the modeled effects of climate change on salmon population abundance in the Chehalis Basin (ICF 2016). See Table 5.3-5 and Figure 5.3-5 for a summary of modeled results. Modeling related to salmon abundance and climate change for the other action elements that are included in Alternative 1 has not been conducted.

The combination of the FRFA facility and high restoration would result in the greatest benefits to the modeled fish species under climate change, notably spring-run Chinook salmon. Model results indicate this combination would not only lessen the predicted decline in abundance, but is predicted to result in increased populations across all species.

Table 5.3-5

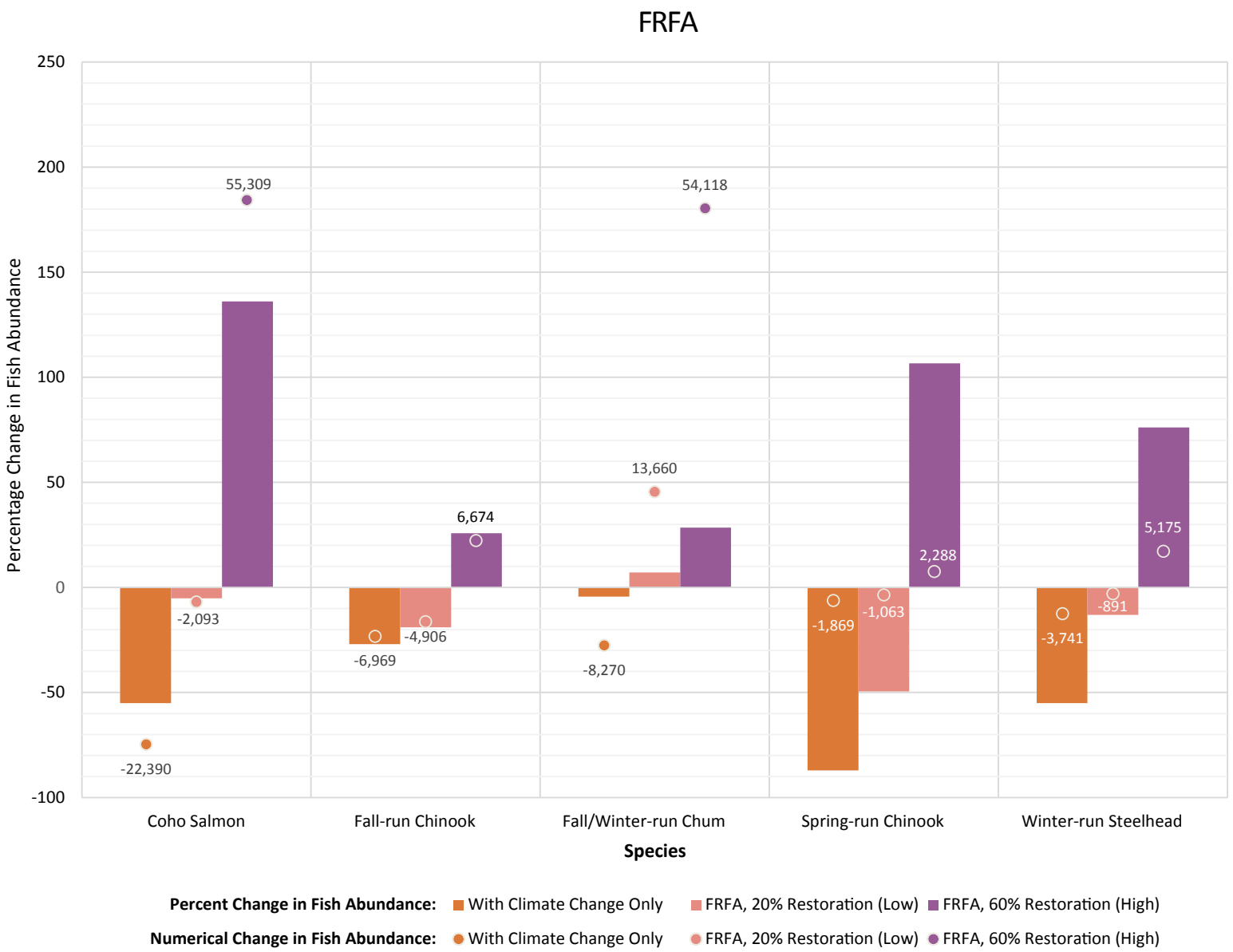
Potential Response in Salmonid Abundance for the Chehalis Basin with Alternative 1 and Climate Change

SPECIES (CURRENT HABITAT POTENTIAL)	FUTURE HABITAT POTENTIAL WITH CLIMATE CHANGE	FLOOD RETENTION FACILITY SCENARIO	CHANGE IN ABUNDANCE IN NUMBER OF FISH (%)	
			WITH FLOOD RETENTION AND LOW RESTORATION; 20% OF REACHES AND CLIMATE CHANGE	WITH FLOOD RETENTION AND HIGH RESTORATION; 60% OF REACHES AND CLIMATE CHANGE
Coho salmon (40,642)	-22,390 (-55%)	FRO 100	-2,115 (-5%)	49,030 (121%)
		FRO 50	-2,104 (-5%)	49,065 (121%)
		FRFA	-2,093 (-5%)	55,309 (136%)
Fall-run Chinook salmon (25,844)	-6,969 (-27%)	FRO 100	-4,785 (-19%)	6,935 (27%)
		FRO 50	-4,780 (-18%)	6,945 (27%)
		FRFA	-4,906 (-19%)	6,674 (26%)
Fall/winter-run chum salmon (190,550)	-8,270 (-4%)	FRO 100	16,899 (9%)	63,264 (33%)
		FRO 50	16,899 (9%)	63,264 (33%)
		FRFA	13,660 (7%)	54,118 (28%)
Spring-run Chinook salmon (2,146)	-1,869 (-87%)	FRO 100	-1,138 (-53%)	2,151 (100%)
		FRO 50	-1,138 (-52%)	2,151 (100%)
		FRFA	-1,063 (-50%)	2,288 (107%)
Winter-run steelhead (6,800)	-3,741 (-50%)	FRO 100	-936 (-14%)	6,468 (95%)
		FRO 50	-963 (-14%)	6,521 (96%)
		FRFA	-891 (-13%)	5,175 (76%)

Source: ICF 2016

Figure 5.3-5a

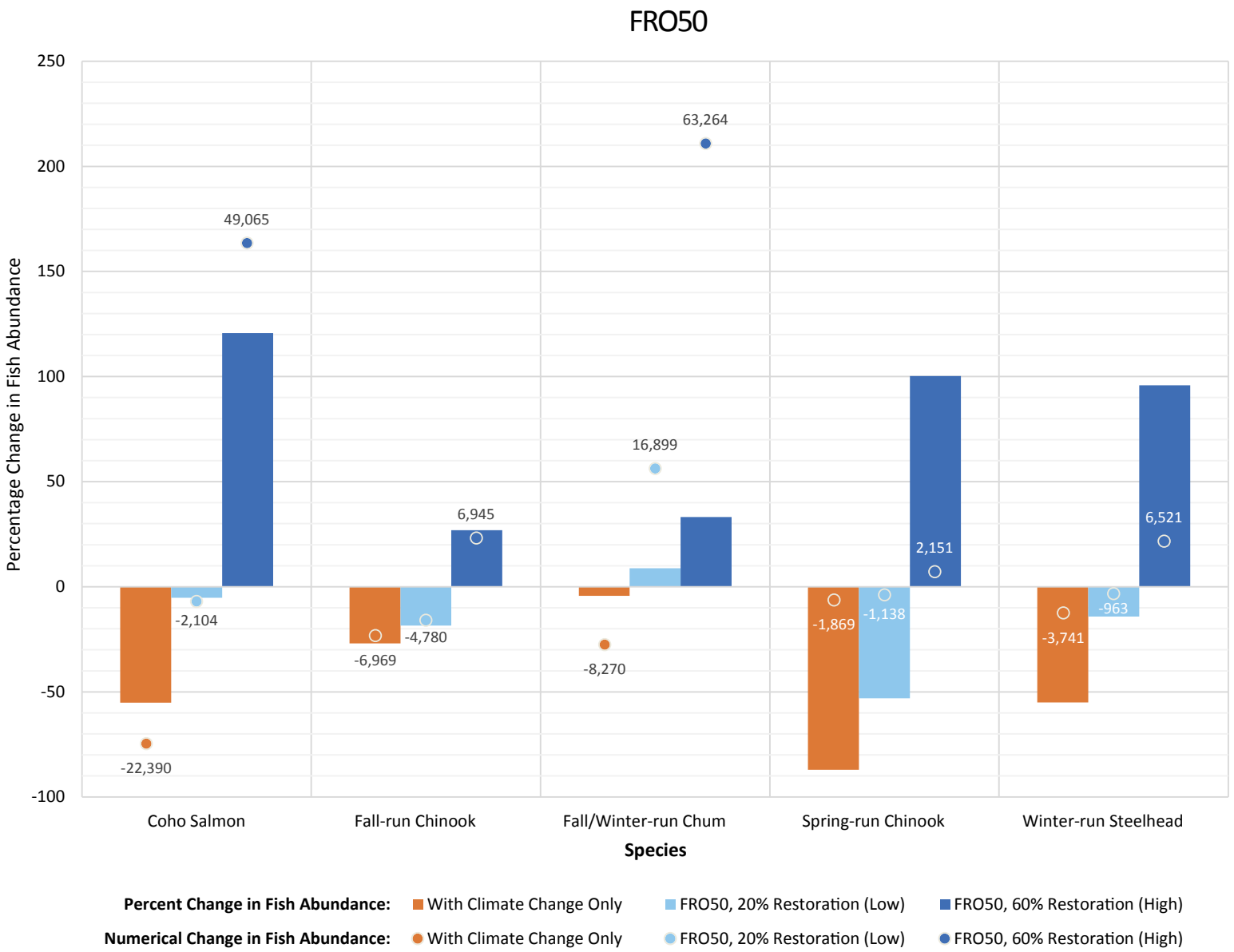
Potential Response in Salmonid Abundance to Habitat Change in the Chehalis Basin with Climate Change and Alternative 1



Source: ICF 2016

Figure 5.3-5b

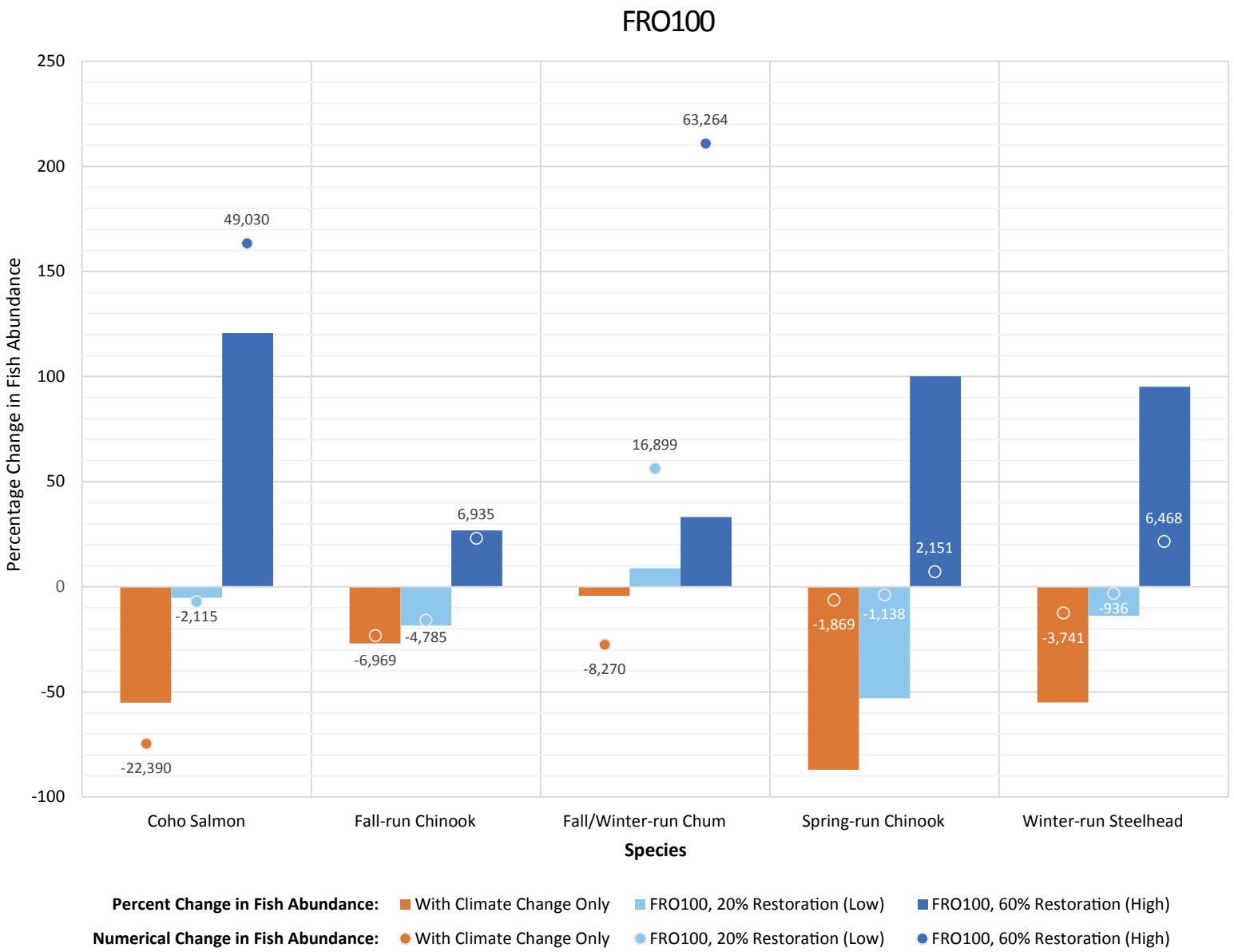
Potential Response in Salmonid Abundance to Habitat Change in the Chehalis Basin with Climate Change and Alternative 1



Source: ICF 2016

Figure 5.3-5c

Potential Response in Salmonid Abundance to Habitat Change in the Chehalis Basin with Climate Change and Alternative 1



Source: ICF 2016

5.3.4 Mitigation

Specific mitigation measures to address potential unavoidable adverse impacts resulting from the implementation of Alternative 1 would be identified during project-level design and environmental review.

Some unavoidable, adverse impacts could be minimized through such measures as designing the dam to withstand the effects of earthquakes and shaking on the CSZ and other nearby faults (including the Doty Fault). Other mitigation measures for unavoidable adverse impacts could include incorporating fish passage into the dam, reducing reservoir drawdown rates to minimize landslide potential, and releasing cooler waters in spring to early fall (FRFA facility only). A Reservoir Operations and Management Plan would be developed and incorporated into the design to minimize impacts on water resources, geology and geomorphology, vegetation, and fish and wildlife to the extent feasible. The Reservoir Operations and Management Plan would be developed to minimize adverse impacts on flow from maintaining water in a reservoir, water quality (including turbidity, temperature, and DO), wood and sediment management, and landslides resulting from a dam and reservoir. Additionally, a Post-construction Vegetation Management Plan and Fisheries Management Plan (to evaluate fish passage performance) would be prepared and include monitoring and adaptive management requirements. Project-specific mitigation plans, such as downstream sediment and wood supplementation, could also be prepared to address unavoidable impacts on geomorphology.

For project elements that are anticipated to have long-term, significant, or unavoidable impacts on wetlands, compensatory mitigation measures would be required during project-level design and environmental review to ensure no net loss of ecological function. To achieve this, the goals of the mitigation would be based on the following guidelines from the joint Ecology, USACE, and EPA document *Wetland Mitigation in Washington State – Part 1*:

- Replace impacted wetland with the same or higher category of wetland
- Provide equal or greater area of wetlands through re-establishment or creation
- Locate mitigation in areas where compensation could contribute to ecosystem functioning
- Clearly identify how the compensation actions would replace the functions lost or provide measureable gains in other functions that are important in the area

Potential compensatory mitigation for long-term impacts on vegetation could include purchasing and preserving adjacent and off-site areas of forestlands within the same watershed, which could mitigate unavoidable adverse climate change impacts.

Compensatory mitigation would be required for loss of fish habitat and fish habitat function, and reduced fish population performance above and below the dam. Examples of compensatory mitigation include fish habitat restoration, protection, or acquisition of land that presents an opportunity for in-kind compensation for fish habitat lost. Mitigation actions associated with wetlands, vegetation, and fish would also benefit wildlife.

Potential compensatory mitigation measures for potential impacts on tribal resources and cultural resources would be the same as those described in Sections 4.2.5 and 4.2.12, respectively. Mitigation of impacts on treaty rights is subject to consideration and agreement by the Quinault Indian Nation.

As noted in Section 4.1.3, identified compensatory mitigation measures may not completely reduce or eliminate potential adverse impacts; significant unavoidable impacts for which effective mitigation measures have not been identified may remain.

5.4 Alternative 2: Structural Flood Protection Without Flood Retention Facility

Structural Flood Protection Without Flood Retention Facility (Alternative 2) would reduce flood damage during a major flood or greater when compared to the No Action Alternative. As compared to the other action alternatives, Alternative 2 would reduce flood damage in a much smaller geographic area than Alternatives 1 and 4, but in a greater geographic area than Alternative 3. Flood damage reduction in Alternative 2 would be achieved through installation of the Airport Levee Improvements, I-5 Projects, Aberdeen/Hoquiam North Shore Levee, and Local-scale Flood Damage Reduction Actions.

Alternative 2 would have an increased benefit to aquatic species habitat function when compared to the No Action Alternative as a result of implementation of Aquatic Species Habitat Actions. As compared to the other action alternatives, Alternative 2 would result in greater benefits to aquatic species habitat function than Alternative 1, similar benefits as Alternative 3, and less benefit than Alternative 4.

5.4.1 Flood Damage Reduction

5.4.1.1 Benefits from Implementing Flood Damage Reduction Actions

Installation of the Airport Levee Improvements and I-5 Projects would result in areas behind (east of) the levee being no longer inundated during a 100-year flood (see Figure 5.4-1). In other portions of the Chehalis-Centralia area, there would be a reduction of 0.1 to 1 foot, depending on the location. On the west side of the Chehalis River, there would be a 0.1 to 0.9-foot increase in inundation, affecting 14 acres, due to the walls and levees shifting water upstream during a flood. Reductions in flood levels would not occur in the upper, remainder of the middle, or lower Chehalis Basin (see Figures 5.4-2 and 5.4-3); therefore, these Large-scale Flood Damage Reduction Actions would not reduce flood damage in those areas. Similar to Alternative 1, it is anticipated that the Aberdeen/Hoquiam North Shore Levee would prevent coastal flooding to the areas behind the levee in Aberdeen and Hoquiam (not shown on the figures).

Implementation of the Airport Levee Improvements and I-5 Projects would reduce flooding (and therefore flood damage) to approximately 88 high-value residential and commercial structures in the Chehalis River floodplain during a 100-year flood when compared to the No Action Alternative (WSE 2014d; Karpack 2016c). This is fewer than Alternatives 1 and 4, but more than Alternative 3.

Figure 5.4-1

Alternative 2 Changes in Downstream Inundation During 100-year Flood – Upper Chehalis Basin

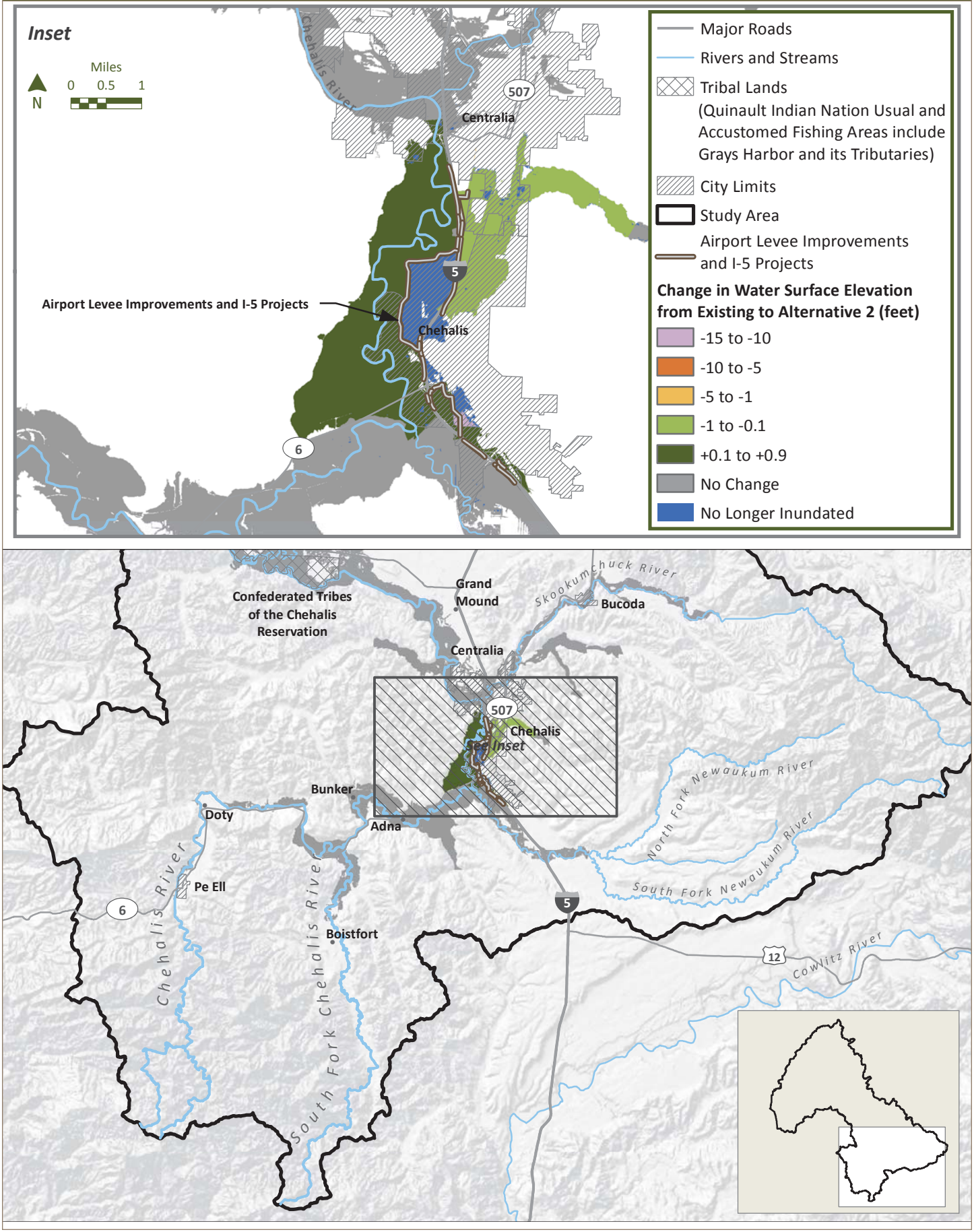


Figure 5.4-2

Alternative 2 Changes in Downstream Inundation During 100-year Flood – Middle Chehalis Basin

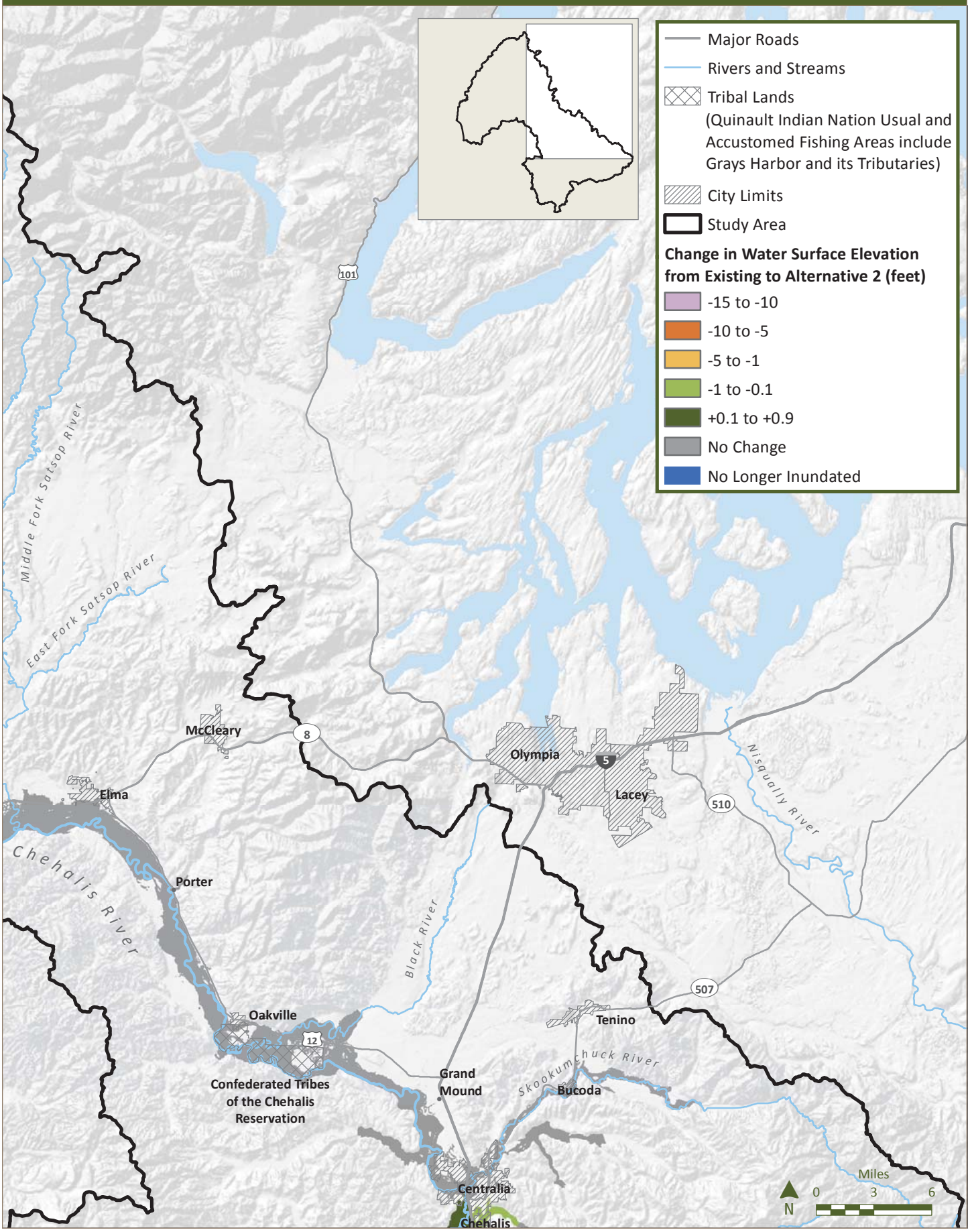
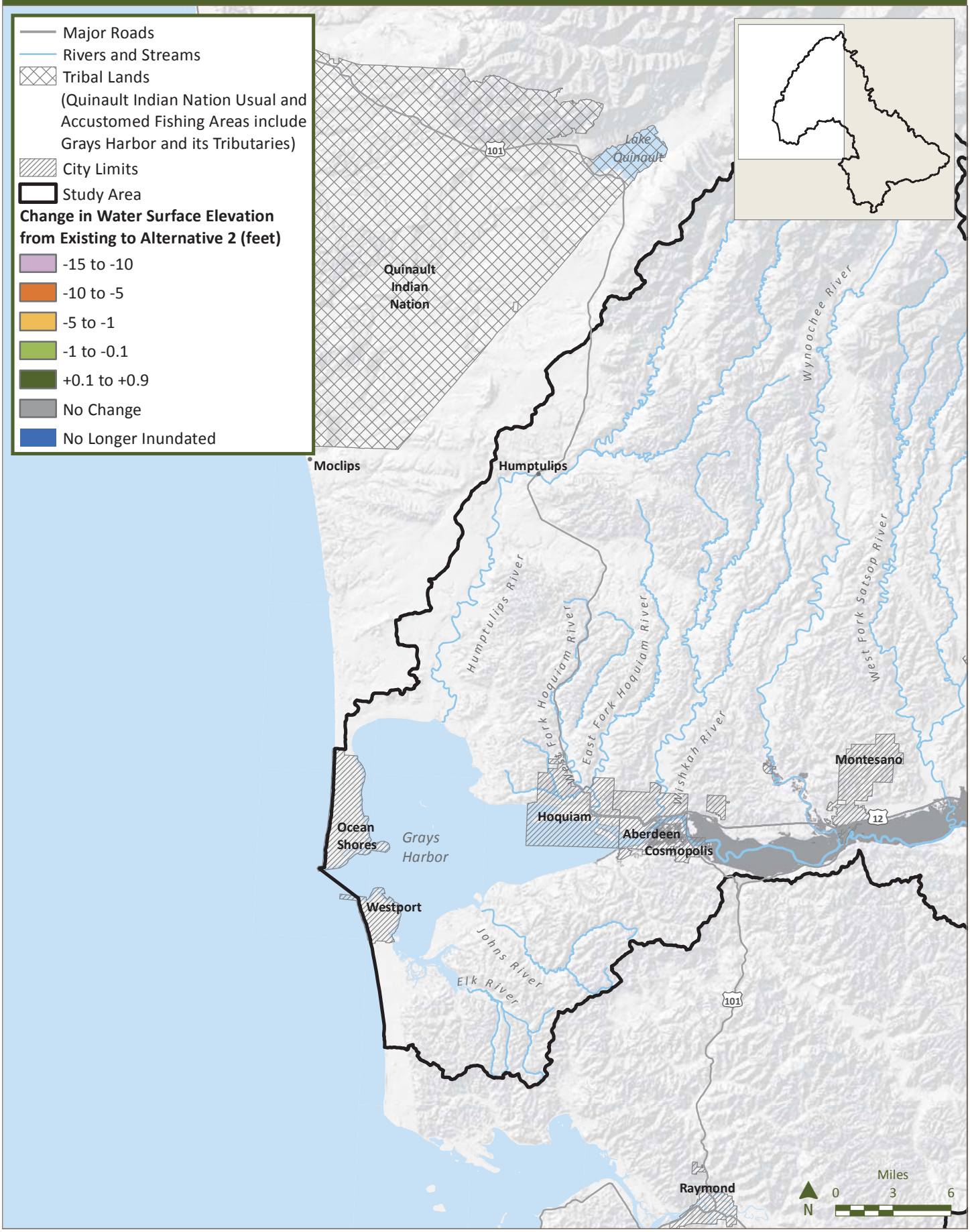


Figure 5.4-3

Alternative 2 Changes in Downstream Inundation During 100-year Flood – Lower Chehalis Basin



The Airport Levee Improvements and I-5 Projects would primarily protect structures in the Chehalis-Centralia area near the airport and I-5, and would not reduce flood damage in communities within Thurston and Grays Harbor counties. Similar to Alternative 1, the Aberdeen/Hoquiam North Shore Levee would prevent coastal flooding behind the levee, where up to 2,715 structures could potentially be protected (Franklin 2016). These structures have not been determined to be of high or limited value at this time. Similar to the other action alternatives, remaining residential, commercial, and industrial structures would have to be floodproofed to experience a reduction in flood damage.

Implementation of the Airport Levee Improvements and I-5 Projects would reduce inundated area during major floods by approximately 565 acres, all located within Lewis County (see Table 5.4-1 and Figure 5.4-1). Most of this would be on commercial land (333 acres) and public land or parks (210 acres), with some on residential land (36 acres). Raising the airport levee and constructing the I-5 Projects has the potential to increase flood extents and depths on approximately 14 acres of agricultural/forestlands to the west of (and upstream and downstream) these actions. Changes would be localized in nature, occurring upstream to north of SR 6 and downstream to just north of Mellen Street. Increased flood extents would occur around the edges of the Chehalis River floodplain; and increases in flood depths are not anticipated to exceed 1 foot (WSE 2014c).

Table 5.4-1
Change in Flooded Area Under Alternative 2

GENERAL ZONE	LEWIS COUNTY	GRAYS HARBOR COUNTY	THURSTON COUNTY[1]
Agricultural/forestland	14	0	0
Commercial/industrial	-333	0	0
Parks	0	0	0
Public land	-210	0	0
Residential	-36	0	0
Total	**-565**		

Note:
1. Does not include the Chehalis Tribe reservation

The Airport Levee Improvements combined with the I-5 Projects would reduce the duration of closures of I-5 during major floods up to 3 days, which is a lesser extent than Alternative 1 but greater than the other action alternatives. The Airport Levee Improvements and I-5 Projects would decrease flood elevations east of I-5, and some areas south of Chehalis would no longer be inundated (generally behind the airport levee but in localized areas as well). However, the projects would increase flood levels on the west side of I-5, which could increase flooding of SR 6 and local roadways. Rail lines, including BNSF, Union Pacific, and the Curtis Industrial Park line, would continue to be flooded during major floods.

As described in Alternative 1, decreased flooding extents would reduce the need for emergency response, increase public safety, reduce impacts on access to critical medical facilities, and would affect public services and utilities to a lesser degree.

5.4.1.2 Impacts of Implementing Flood Damage Reduction Actions

While implementing Alternative 2 would be beneficial with regard to reducing flood damage, unavoidable significant adverse impacts would occur—primarily as a result of implementing the Large-scale Flood Damage Reduction Actions, as described in more detail in Chapter 4. As described in this section, impacts on water resources, geology, wetlands and vegetation, fish and wildlife, tribal resources, and cultural resources would occur to a lesser degree than Alternative 1. Adverse impacts on wetlands, tribal resources, and cultural resources could be undetermined or significant, depending on the resource.

Minor adverse impacts on water resources could occur in limited areas through the implementation of Alternative 2. The adverse impacts are primarily related to an increase in water depths in areas immediately upstream and downstream of the levee (WSE 2014d). Approximately 29 high-value structures would experience new inundation, only 7 of which would experience an increase of more than 1 inch. Most of these structures are residential, while some are commercial and agricultural.

For Alternative 2, the potential exists for minor adverse impacts on geology due to increased land settlement from construction of the Airport Levee Improvements and the Aberdeen/Hoquiam North Shore Levee as compared to the No Action Alternative, Alternative 3, and Alternative 4. This could cause long-term settlement of surrounding land and adjacent buildings. The occurrence of landslides and induced seismicity in the upper watershed would be less than Alternative 1 because the Flood Retention Facility would not be built. For geomorphology, the potential exists for moderate adverse impacts as a result of altering the geomorphic characteristics (i.e., channel migration potential) of the Chehalis River in the vicinity of the Aberdeen/Hoquiam North Shore Levee. With bank-hardening measures or levee placement, there is the potential to increase the velocity in the Chehalis River as well as redirect high-velocity flows downstream or to an adjacent or opposite bank, increasing erosion.

Alternative 2 would have significant adverse impacts on wetlands, primarily due to the permanent loss of wetlands that would be required to construct the Large-scale Flood Damage Reduction Actions. Alternative 2 would result in greater impacts on wetlands when compared to the No Action Alternative. In comparison to the other action alternatives, Alternative 2 would have fewer unavoidable significant adverse impacts on wetlands than Alternative 1 (see Table 5.4-2), but greater adverse impacts than Alternatives 3 and 4 due to the potential construction-related impacts and floodplain habitat connectivity constraints associated with the levee actions.

Table 5.4-2 provides a comparison of the approximate area of wetlands in the Chehalis River floodplain under the No Action Alternative with the approximate area of wetlands in the Chehalis River floodplain

under Alternatives 1 and 2—both of which include structural flood protection actions. As indicated, the area of floodplain wetlands subject to 100-year floods under Alternative 2 would be less than the No Action Alternative, but greater than Alternative 1. This indicates that Alternative 1 would result in a greater reduction in area of downstream wetlands subject to flooding than Alternative 2. The potential change in downstream wetlands flooded by a 100-year flood was not modeled for Alternatives 3 and 4, but would be less than Alternative 2 due to the lack of large-scale structural flood actions under Alternative 3, and the fact that one of the primary goals of Alternative 4 is to increase flood storage within the floodplain.

Table 5.4-2
Wetlands Located Inside of 100-year Inundation Event Boundary for the No Action Alternative and Alternatives 1 and 2

WETLAND TYPE	AREA (ACRES)		
	NO ACTION ALTERNATIVE	ALTERNATIVE 1	ALTERNATIVE 2
Potentially (previously) disturbed wetlands	4,276	3,902	4,154
Palustrine forested wetland	4,789	4,492	4,705
Palustrine scrub-shrub wetland	4,476	4,228	4,407
Palustrine emergent wetland	6,291	5,949	6,196
Estuarine emergent wetland	50	47	49
Unconsolidated shore	339	335	337
Open water	3,877	3,817	3,859
Palustrine aquatic bed wetland	71	71	71
Estuarine aquatic bed wetland	0	0	0
Total	**24,169**	**22,841**	**23,778**

Source: Ecology 2011b; modeled inundation extent (WSE 2014c)

Under Alternative 2, impacts on vegetation would be much less than those anticipated under Alternatives 1 and 4, and slightly more than those anticipated under the No Action Alternative and Alternative 3. Similar to the No Action Alternative and Alternative 3, adverse impacts on vegetation under Alternative 2 would be primarily from the localized clearing of vegetation and its replacement with flood control structures and components. Neither the large-scale vegetation clearing proposed for the dam under Alternative 1, nor the large-scale conversion of existing upland forestland proposed under Alternative 4 would occur under Alternative 2.

Minor adverse impacts could occur to fish and wildlife as a result of changing flood extents and elevations upstream and downstream of the Airport Levee Improvements and I-5 Projects (depending on the location), and Local Projects during 100-year floods. These adverse impacts are described in more detail in Chapter 4, and would be more than those described for the No Action Alternative due to the implementation of Airport Levee Improvements and I-5 Projects. As compared to Alternative 1,

Alternative 2 would have a much lesser degree of long-term impacts on fish and wildlife because it would exclude the permanent and large-scale changes to the Chehalis River and its floodplain resulting from the Flood Retention Facility. In comparison to Alternatives 3 and 4, the structural elements associated with Alternative 2 (floodwalls and levees) would result in a greater adverse impact on fish and wildlife.

Impacts on tribal resources would occur with the implementation of Alternative 2, primarily related to impacts on fish resources, although disruption to plant, wildlife, and traditional cultural practices could also occur. The extent of potential impacts on tribal resources is pending additional coordination with tribes and continued government-to-government consultations. In comparison to the No Action Alternative, Alternative 2 would have a greater potential for unavoidable adverse impacts on tribal resources due to the Large-scale Flood Damage Reduction Actions. As compared to other action alternatives, Alternative 2 would likely result in less impact on tribal resources than Alternative 1, and greater adverse impacts than Alternative 3 and Alternative 4.

Moderate to significant adverse impacts on cultural resources could occur due to the predicted archaeological potential in proposed areas of construction, although the degree or severity of the impact would depend on the nature of cultural resources that would be disturbed. As compared to the No Action Alternative, potential long-term impacts from Alternative 2 would be greater due to the additional disturbance activities during construction and operation within areas that have cultural resources potential. As compared to the other action alternatives, Alternative 2 would have less impact than Alternatives 1 and 4, and slightly more than Alternative 3 due to the additional excavation in areas with a high probability for archaeological material.

Development pressure could increase as a result of implementing the Airport Levee Improvements and I-5 Projects in areas where inundation is decreased. This would only affect residential (104 parcels) and commercial/industrial (68 parcels) in the incorporated areas of Chehalis and Centralia, and 1 parcel in Lewis County (in the UGA). In total, Alternative 2 could increase development pressure on up to 173 parcels in Lewis County. No agricultural parcels that could be further developed would be affected.

During the next 100 years, population growth in the floodplain could result in development similar to that expected for the No Action Alternative, approximately 4 to 9 structures per year (total of 407 to 914 structures during the next 100 years). As a result of decreased flooding extents and the corresponding increase in development pressure on those parcels, future Chehalis River floodplain development rates under this alternative may tend toward the middle of the range. It is assumed that development pressure in Thurston and Grays Harbor counties would not be influenced by this alternative because flood extents and depths in those locations would not be reduced as a result of implementing the Airport Levee Improvements and I-5 Projects. Floodplain growth in those areas would occur consistent with the No Action Alternative. More analysis related to potential future development in the Chehalis River floodplain is included in Appendix L.

5.4.2 Aquatic Species Habitat Actions Evaluation

Implementation of the Aquatic Species Habitat Actions of Alternative 2 would substantially increase the abundance of native aquatic species, reduce the potential for future ESA listings, and substantially enhance tribal and non-tribal fisheries as compared to the No Action Alternative (before factoring in climate change; see Section 5.4.3). The benefits of combined actions within Alternative 2 to fish, wildlife, and non-salmonid fish have not been modeled but are anticipated to be similar to the Aquatic Species Habitat Action.

As described in the introduction to Section 5.4, the long-term impacts of Alternative 2 would likely result in an increased benefit to aquatic species habitat function when compared to the No Action Alternative. As compared to the other action alternatives, Alternative 2 could result in greater benefits to aquatic species habitat function than Alternative 1, because it would exclude the permanent and large-scale changes to the Chehalis River and its floodplain resulting from the Flood Retention Facility. Alternative 2 is anticipated to result in less benefit to aquatic species compared to Alternatives 3 and 4, when considering the structural components associated with Alternative 2 versus the other action alternatives. Potential impacts on cultural resources and tribal resources from implementation of Aquatic Species Habitat Actions in Alternative 2 would be the same as those described under Alternative 1, though likely in less magnitude due to the relatively smaller construction and operational footprint of Alternative 2.

5.4.3 Climate Change Analysis

Alternative 2 is anticipated to provide beneficial effects with regard to reducing flood damage and restoring habitat for aquatic species in response to the effects of climate change. These beneficial effects would be greater than under the No Action Alternative, due to structural flood protection measures that would be designed to provide resiliency with the potential for more frequent and intense floods resulting from climate change, and due to Aquatic Species Habitat Actions associated with this alternative. In comparison to other action alternatives, the long-term adverse impacts contributing to climate change from implementation of this alternative are similar to all other action alternatives, except for Alternative 1, which has additional adverse impacts related to the additional vegetation loss and resulting equivalent GHG emissions associated with construction and operation of the Flood Retention Facility.

Climate change has the potential to reduce the effectiveness of flood protection provided by levees and floodwalls (i.e., Airport Levee Improvements, I-5 Projects, and Aberdeen/Hoquiam North Shore Levee elements). Flood elevations could increase as a result of climate change, which could require additional freeboard in levee designs. Impacts of flood elevations that are increased upstream and downstream as a result of levees and walls are likely to be magnified with climate change, as floods occur more frequently and are more intense. Adverse impacts from the effects of climate change on Alternative 2 are anticipated to reduce the effectiveness of restoration for salmonid populations under both the low

and high restoration scenarios due to increased river temperatures and drier summers, although this effect has not been modeled.

5.4.4 Mitigation

Unavoidable adverse impacts that cannot be mitigated without substantial intervention include those associated with the permanent loss of wetlands. Impacts on fish and wildlife are expected to be minor for Alternative 2, but could result in undetermined adverse impacts on tribal resources. Impacts on cultural resources would depend on the nature of cultural resources that would be disturbed. Specific measures would be identified and implemented during project-level design and environmental review. Potential compensatory mitigation measures for potential impacts on wetlands, tribal resources, and cultural resources would be the same as those described under Alternative 1.

5.5 Alternative 3: Nonstructural Flood Protection

Nonstructural Flood Protection (Alternative 3) would not result in geographically broad-scale flood damage reduction during a major flood or greater when compared to the other action alternatives. The implementation of Local-scale Flood Damage Reduction Actions would protect key properties and infrastructure from flood damage, and would protect a substantial portion of the residential structures—as well as some commercial and other structures—in the Chehalis River floodplain through elevation, other floodproofing measures, and buy-outs. This alternative would reduce the pattern of damage and recovery to structures and their contents associated with major floods or greater, but would not reduce flood damage to transportation systems and agricultural properties or crops at a Basin-wide scale.

Alternative 3, as compared to the No Action Alternative, would result in an increased benefit to aquatic species habitat function through implementation of Aquatic Species Habitat Actions. As compared to Alternatives 1 and 2, Alternative 3 would result in greater benefits to aquatic species habitat function because there would be none of the adverse effects associated with Large-scale Flood Damage Reduction Actions structural components. As compared to Alternative 4, Alternative 3 would result in less benefit to habitat function because the treatments associated with Alternative 4 would result in increased habitat function.

5.5.1 Flood Damage Reduction

5.5.1.1 Benefits from Implementing Flood Damage Reduction Actions

Geographically broad-scale reductions to flood depths and extents would not result from the implementation of Alternative 3 (see Figures 5.5-1 through 5.5-3). However, the implementation of Local-scale Flood Damage Reduction Actions would protect key properties and infrastructure from flood damage, and would protect up to 75% of the residential and 25% of the commercial, industrial, or other non-residential structures in the Chehalis River floodplain through elevation, other floodproofing measures, and buy-outs. Alternative 3 would reduce flood damage to structures in the Chehalis River floodplain by implementing a single action.

5.5.1.2 Impacts of Implementing Flood Damage Reduction Actions

The benefits of Alternative 3 would be localized to structures that are floodproofed, and properties and infrastructure protected by Local Projects. Closures of I-5 (up to 4 days) would continue during major floods. WSDOT would continue to use its detour route when I-5 is closed for more than 24 hours. Local roadways that currently flood during major floods would continue to do so, except where smaller-scale flood damage reduction projects reduce flooding of local roadways. The Chehalis-Centralia Airport would continue to flood during major floods, restricting flights and use of the airport for emergency response. Rail lines, including BNSF, Union Pacific, and the Curtis Industrial Park line, would continue to be flooded during major floods.

Alternative 3 has the potential to reduce threats to human health and safety when compared to the No Action Alternative, because Alternative 3 would protect structures in the floodplain and allow people the option of safely waiting out many floods in their homes. However, Alternative 3 would not improve the ability to access critical medical facilities as compared to the No Action Alternative, and would not reduce disruption to industry, commercial businesses, and public services—with the exception of protecting the structures that house them in the event those structures have been floodproofed. Similar to the No Action Alternative, but on an accelerated scale, minor localized adverse impacts on the built and natural environment would occur as a result of the implementation of Alternative 3, which are described in detail in Chapter 4.

Potential impacts on cultural resources and tribal resources would be less in magnitude than the rest of the action alternatives due to the reduced level of excavation and structural components, but could still result in moderate to significant adverse impacts on cultural resources due to the predicted archaeological potential. The extent of potential impacts on tribal resources would be determined pending additional coordination with tribes and continued government-to-government consultations.

Alternative 3 would not result in significant adverse impacts on any elements of the built or natural environment, as described in more detail in Chapter 4. Noted impacts resulting from Alternative 3 are minor or moderate; however, bank stabilization impacts on fish habitat cumulatively could be significant, depending on the project setting.

Figure 5.5-1

Alternative 3 Changes in Downstream Inundation During 100-year Flood – Upper Chehalis Basin

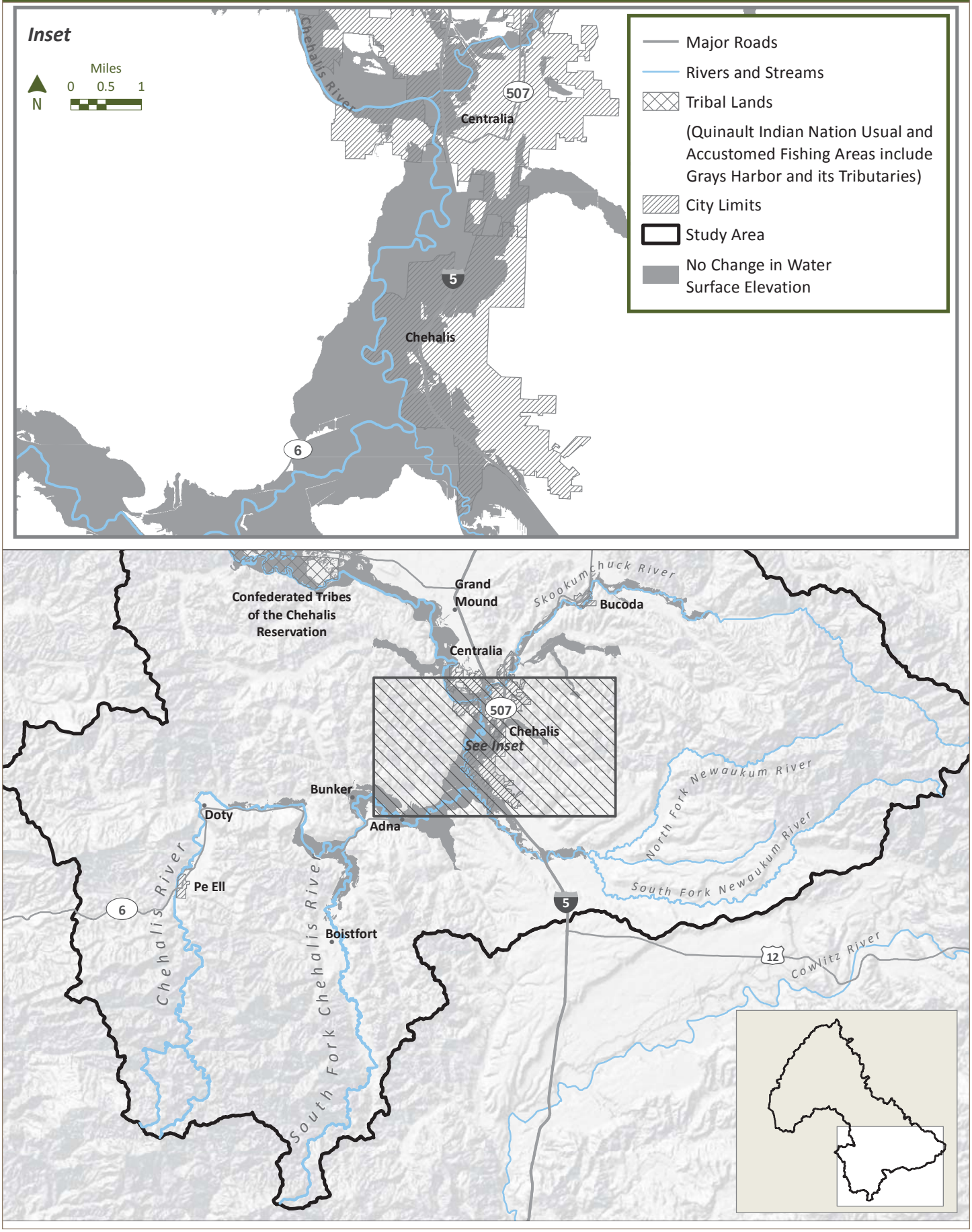


Figure 5.5-2

Alternative 3 Changes in Downstream Inundation During 100-year Flood – Middle Chehalis Basin

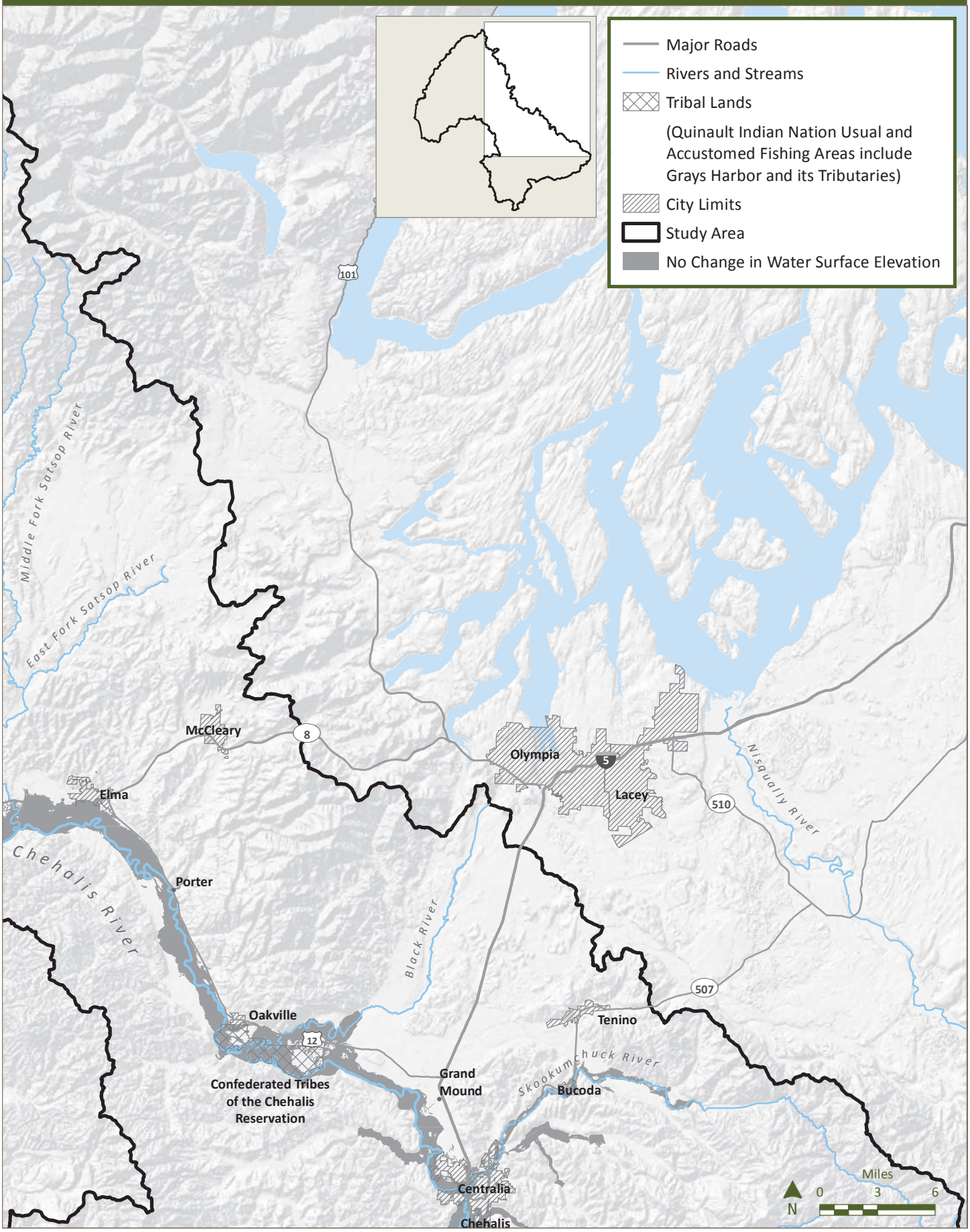
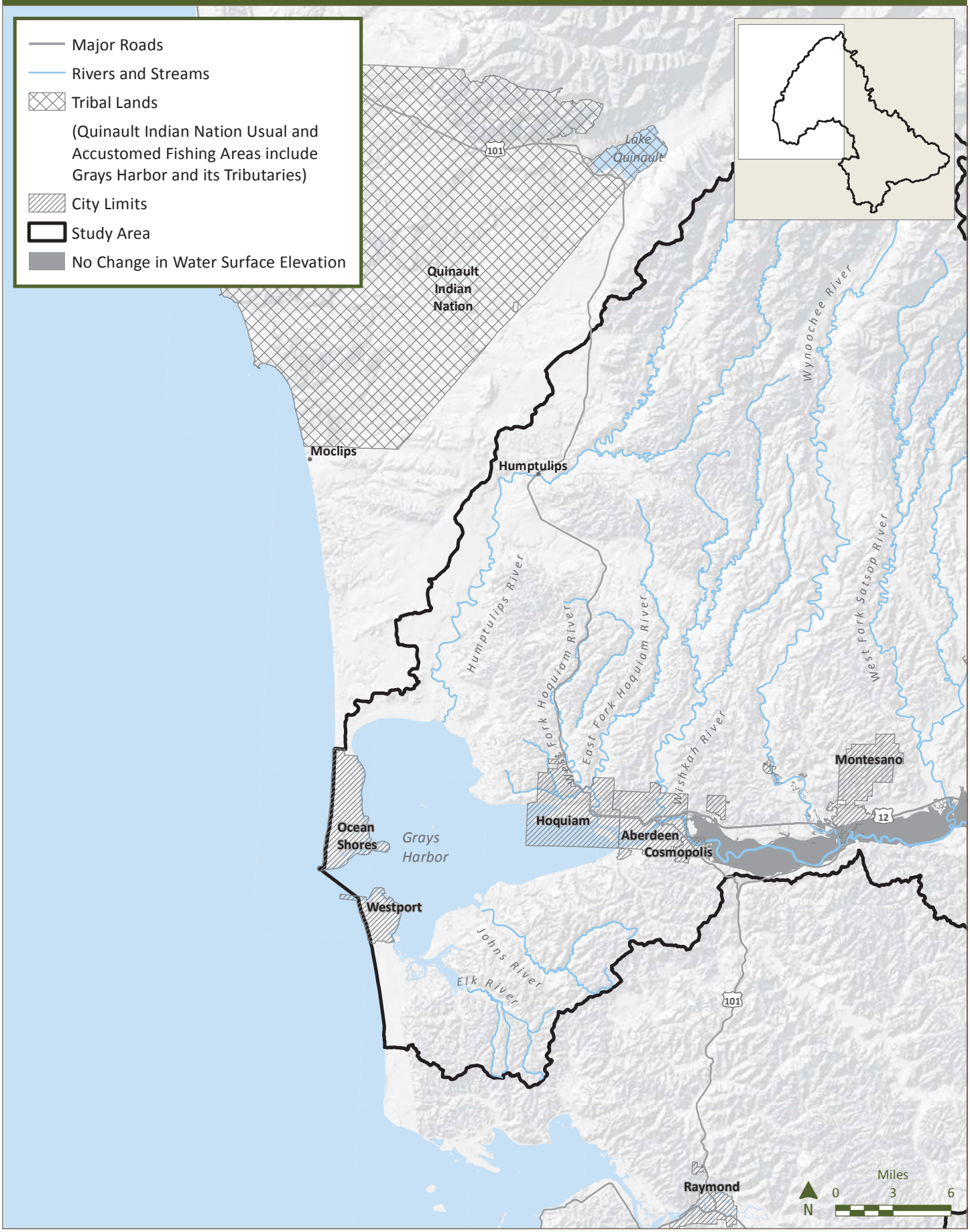


Figure 5.5-3

Alternative 3 Changes in Downstream Inundation During 100-year Flood – Lower Chehalis Basin



5.5.2 Aquatic Species Habitat Actions Evaluation

Alternative 3, when implemented as a comprehensive strategy, would substantially increase abundance of native aquatic species, reduce the potential for future ESA listings, and substantially enhance tribal and non-tribal fisheries as compared to the No Action Alternative. As described in the introduction to Section 5.5, Alternative 3 would have an increased benefit to aquatic species habitat function over the long term as compared to the No Action Alternative, through implementation of Aquatic Species Habitat Actions. As compared to Alternatives 1 and 2, Alternative 3 would result in greater benefits and fewer impacts on aquatic species habitat function due to the lack of large-scale structural flood damage components. Alternative 3 would have fewer benefits to habitat function as compared to Alternative 4, because the treatments associated with Alternative 4 would result in increased habitat function.

5.5.3 Climate Change Analysis

This section provides an analysis of the adverse effects of Alternative 3 that contribute to climate change, as well as the effects of climate change on Alternative 3.

5.5.3.1 Adverse Effects Contributing to Climate Change

Overall, Alternative 3 is not anticipated to result in impacts that contribute to climate change. Alternative 3 is anticipated to result in beneficial effects with regard to climate change due to the wetland and riparian restoration activities and associated carbon sequestration that would occur with the Aquatic Species Habitat Actions associated with this alternative. These benefits would far exceed those expected to occur to the same resources under the No Action Alternative. In comparison to the other action alternatives, Alternative 3 would have fewer adverse impacts contributing to climate change than Alternatives 1 and 2, but would not offset the impacts of climate change (a beneficial result) as much as Alternative 4, due to the degree of wetland and riparian restoration activities and associated carbon sequestration associated with actions under that alternative.

5.5.3.2 Effects of Climate Change on the Proposed Alternative

It is assumed that actions such as Floodproofing and Local Projects associated with Alternative 3 would be designed in anticipation of projected future changes in precipitation, increased flooding, and drought conditions predicted with climate change forecasts. As a result, adverse impacts from climate change on the elements of this alternative are not anticipated, except for the reduced effectiveness of the Aquatic Species Habitat Actions low and high scenarios (see Section 4.8.7).

5.5.4 Mitigation

Significant, adverse impacts are not anticipated from implementation of Alternative 3, and therefore, compensatory mitigation measures are not expected to be necessary.

5.6 Alternative 4: Restorative Flood Protection

Restorative Flood Protection (Alternative 4) would address flooding in the Chehalis River floodplain as well as in tributary areas of the Chehalis River—the North and South Fork Newaukum rivers, South Fork Chehalis River, Stearns Creek, Bunker Creek, Deep Creek, Lake Creek, Stillman Creek, and Elk Creek—largely through supporting relocation and adaptation of at-risk land uses under existing conditions. Alternative 4 would increase the areal extent and depth of 100-year floods upstream of Newaukum River confluence. Downstream of the Newaukum River confluence, including in the Chehalis-Centralia area, Alternative 4 would reduce flood extents and depths, but to a lesser degree than Alternative 1. As compared to the No Action Alternative and Alternatives 2 and 3, Alternative 4 would decrease flood extents and depths to a greater extent in the Chehalis River floodplain. Because Alternative 4 would relocate 16,000 acres of land uses, including 8,500 acres of agriculture, upstream of the Newaukum confluence, it would result in greater flood damage reduction compared to the No Action Alternative and other action alternatives (see Appendix C).

Over the long term, Alternative 4 would benefit aquatic species habitat function to a much greater degree compared to the No Action Alternative and other action alternatives; this would be achieved through implementation of the Aquatic Species Habitat Actions and Restorative Flood Protection treatments proposed under Alternative 4. Restorative measures, including placement of engineered wood structures, associated with implementation of this alternative are intended to reduce flood damage by slowing and storing the flow of floodwaters in the floodplain, and would be coordinated with Aquatic Species Habitat Actions. These actions would complement, rather than replace, the actions associated with Aquatic Species Habitat Actions.

5.6.1 Flood Damage Reduction

5.6.1.1 Benefits from Implementing Flood Damage Reduction Actions

Downstream of the Newaukum River confluence, Alternative 4 would reduce flooding on approximately 815 acres through a reduction of peak flood flows entering the mainstem Chehalis River. Compared to Alternatives 1 and 2, there would be less reduction in water surface elevation during a 100-year flood along the Chehalis River in the Chehalis-Centralia area than Alternative 1, and similar reductions in specific locations to Alternative 2. The reduction in inundation for Alternative 4 during a 100-year flood is shown in Figure 5.6-1.

Downstream of Restorative Flood Protection treatment areas, within the Chehalis-Centralia city limits, 136 high-value structures would experience reduced inundation. Within river management areas or greenways in the Restorative Flood Protection treatment areas, flood inundation would be increased on approximately 16,000 acres, affecting approximately 280 high-value structures that are not anticipated to flood under current conditions. Flood depths and frequencies would increase and further affect 182 high-value structures within the treatment areas that do flood under current conditions during a 100-year flood. Alternative 4 would permanently address flood damage to these 462 structures by

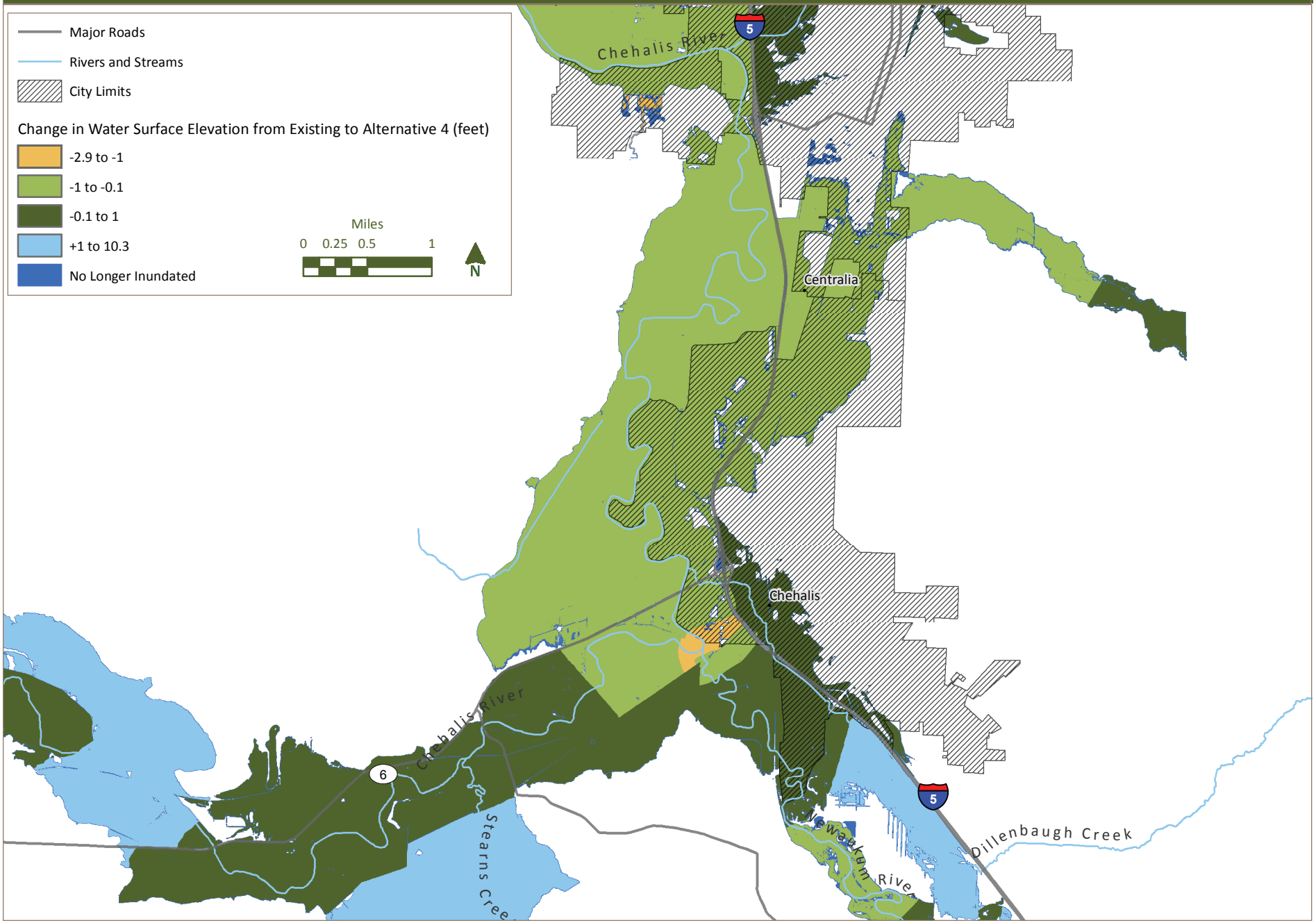
removing them, and providing compensation, relocation, or adaptation assistance to landowners. If all landowners with structures that currently experience flooding, and where flooding would increase, participated, 182 fewer structures within treatment areas would be flooded than under current conditions, and approximately 16,000 acres would no longer experience flood damage because these land uses would be relocated.

Similar to the other action alternatives, remaining residential, commercial, and industrial structures—in this case, outside of river management corridors, but within the future Restorative Flood Protection 100-year floodplain, as well as in the remainder of the Chehalis River floodplain—would have to be floodproofed to experience a reduction in flood damage.

In the Chehalis-Centralia area, Alternative 4 would reduce flood durations on local roads. Restorative Flood Protection would protect the Chehalis-Centralia Airport during smaller floods, allowing flights to continue, but the airport would continue to flood during 100-year floods. Restorative Flood Protection would likely decrease the frequency of rail closures downstream of the Newaukum confluence.

Figure 5.6-1

Alternative 4 Changes in Inundation During 100-year Flood – Upper Chehalis Basin



Note: Difference in water surface elevation (feet) of a 100-year storm event between existing conditions and with the Restorative Flood Protection Alternative

In addition to flood damage reduction benefits within and downstream of Restorative Flood Protection treatment areas, Alternative 4 would benefit wetlands and improve riparian vegetation communities, and improve connectivity to floodplain habitat. These treatment actions would create conditions that are beneficial to fish and wildlife, both in the channels and within connected floodplain habitats. Potential long-term impacts on tribal resources consider impacts following construction on fishing, hunting, gathering, and other traditional cultural activities and treaty-reserved resources. Restorative Flood Protection actions taken to reduce flood damage as part of Alternative 4 are expected to have beneficial outcomes for tribal resources, primarily because of the significant improvement in self-sustaining habitat conditions that would benefit fisheries.

5.6.1.2 Impacts of Implementing Flood Damage Reduction Actions

As described in this section, impacts on land use, transportation, public services and utilities, and, potentially, cultural resources could be significant. While there would be a localized significant impact on vegetation as a result of relocating approximately 16,000 acres of floodplain land uses to converted uplands (currently managed forestland), this impact may be moderated through restorative actions. This would include measures such as planting native vegetation across equal valley bottom areas; the impact would also be reduced when considering benefits to vegetation that result from the implementation of Aquatic Species Habitat Actions.

Restorative Flood Protection treatment areas would occupy much of the channels and floodplains of the Newaukum, South Fork Chehalis, and mainstem Chehalis rivers; and Stearns, Stillman, Elk, Bunker, Deep, and Lake creeks. Based on screening-level analysis, this could result in new or increased flooding to an area potentially reaching 21,000 acres in size, which is considered a moderate impact on surface water quantity. This includes approximately 12,100 acres of active farmland, where approximately 8,500 acres of agricultural land would be converted to floodplain forest.

The treatments required, and resultant changes to the river system in those areas, would likely displace many rural residential homes and farms; some public and commercial land uses could also be displaced or affected. Approximately 462 high-value structures would be relocated or experience more flooding. Although this action includes compensating willing landowners for property or structures that would become inundated (or experience more inundation), and assistance for interested landowners to relocate to areas of the Chehalis Basin that do not flood, the potential adverse impacts are still considered significant. Permanently relocating or moving these structures out of flood-prone areas can, however, also be considered a long-term benefit.

Upstream of the Newaukum River confluence, Alternative 4 would increase the duration of closure of SR 6 by approximately 4 days, SR 506 by approximately 1 to 2 days, and SR 508 by approximately 2 days during a 100-year flood. Compared to the No Action Alternative and other action alternatives, this could increase disruptions to industry, commercial businesses, and public services. Downstream of the Newaukum confluence with the Chehalis River, I-5 closures would continue during major floods (up to

4 days), requiring the use of WSDOT's detour route. Under Alternative 4, local roadways that currently flood during major floods would continue to do so, even though smaller-scale flood damage reduction projects could reduce flooding of local roadways in some places. The Chehalis-Centralia Airport would continue to flood during 100-year floods, restricting flights and use of the airport for emergency response.

Compared to the No Action Alternative and Alternatives 1 and 2, Alternative 4 does not improve access to critical medical facilities because flooding of local and regional roads would continue, and in some locations would be expanded. Higher flood levels and increased duration of flooding of SR 6 and local roadways could prevent or delay emergency service access. Restorative Flood Protection includes relocation of residential, agricultural, commercial, and public service land uses out of the 10-year floodplain, which would reduce the demand for emergency services during floods as part of Alternative 4, but access to areas outside the 10-year floodplain within treatment areas may still be required.

Alternative 4 includes relocation of agricultural, residential, and commercial land uses. New public services and utilities would need to be provided to the upland areas where the displaced land uses would be relocated. This would not directly increase the demand for public services and utilities, but relocation of land uses would require removal and relocation of public services and utilities throughout the 10-year floodplain, which would be a significant adverse impact.

Although the degree or severity of impact on cultural resources would depend on the nature of the disturbance, moderate to significant adverse impacts on cultural resources could occur due to the predicted archaeological potential. Potential impacts on tribal cultural resources or graves, Indian human remains, or traditional cultural properties would be determined in coordination with tribes and government-to-government consultations.

5.6.2 Aquatic Species Habitat Action Evaluation

Alternative 4, when implemented as a comprehensive strategy, would substantially increase abundance of native aquatic species, reduce the potential for future ESA listings, and substantially enhance tribal and non-tribal fisheries as compared to the No Action Alternative. As described in the introduction to Section 5.6, the long-term impacts of Alternative 4 would have an increased benefit to aquatic species habitat function as compared to the No Action Alternative and other action alternatives through implementation of the Aquatic Species Habitat Actions and Restorative Flood Protection treatments. The predicted impacts on salmon and steelhead abundance are shown in combination with the beneficial effects of the low and high restoration scenarios in Table 5.6-1 and Figure 5.6-2.

Similar to the No Action Alternative and Alternative 1, modeled results of salmon habitat potential for Alternative 4 include the maturation of riparian areas in managed forestlands and active restoration from the Aquatic Species Habitat Actions compared to current conditions. The contribution of managed forestlands to total salmonid abundance would, on average, contribute 59% of the restoration benefit under the low scenario and 27% under the high scenario. Most of the benefit of riparian and fish

passage improvements in managed forestlands would accrue to coho and steelhead because a larger portion of their habitat is located in the Satsop, Humptulips, and Wynoochee basins that are largely managed forestland[4].

Table 5.6-1
Potential Response in Salmonid Abundance for the Chehalis Basin with Alternative 4

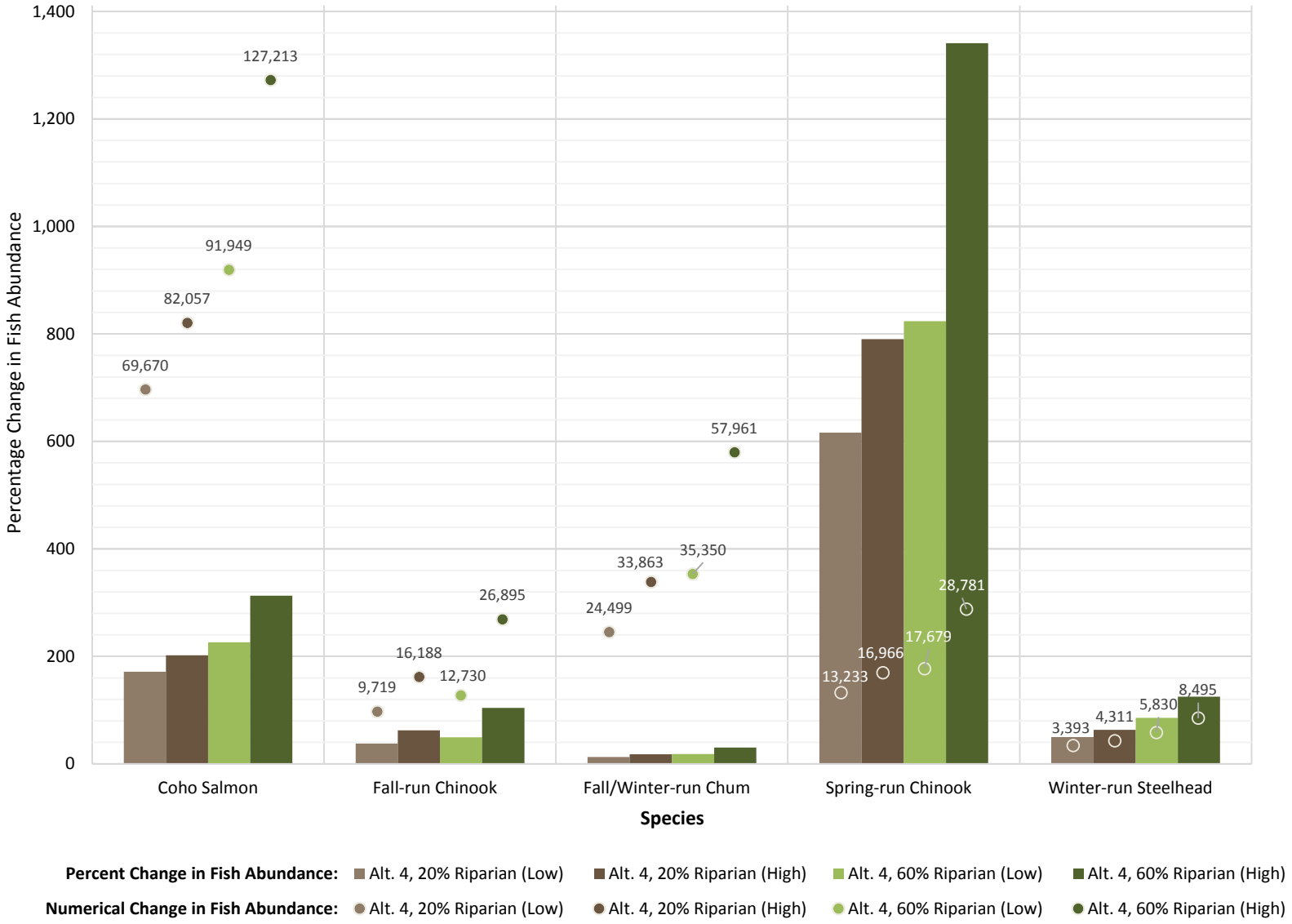
SPECIES (CURRENT HABITAT POTENTIAL)	CHANGE IN ABUNDANCE IN NUMBER OF FISH (%)				
	NO RESTORATION	WITH LOW RESTORATION; 20% OF REACHES	WITH HIGH RESTORATION; 20% OF REACHES	WITH LOW RESTORATION; 60% OF REACHES	WITH HIGH RESTORATION; 60% OF REACHES
Coho salmon (40,642)	46,471 (114%)	69,670 (171%)	82,057 (202%)	91,949 (226%)	127,213 (313%)
Fall-run Chinook salmon (25,844)	6,782 (26%)	9,719 (38%)	16,188 (63%)	12,730 (49%)	26,895 (104%)
Fall/Winter-run chum salmon (190,550)	5,573 (3%)	24,499 (13%)	33,863 (18%)	35,350 (19%)	57,961 (30%)
Spring-run Chinook salmon (2,146)	10,153 (473%)	13,233 (616%)	16,966 (790%)	17,679 (824%)	28,781 (1,341%)
Winter-run steelhead (6,800)	1,306 (19%)	3,393 (50%)	4,311 (63%)	5,830 (86%)	8,495 (125%)

Source: ICF 2016

[4] Refer to Draft EIS Addendum dated October 17, 2016.

Figure 5.6-2

Potential Response in Salmonid Abundance to Habitat Change in the Chehalis Basin with Alternative 4



Source: ICF 2016

5.6.3 Climate Change Analysis

This section provides an analysis of the adverse effects of Alternative 4 contributing to climate change, as well as the effects of climate change on Alternative 4.

5.6.3.1 Adverse Effects Contributing to Climate Change

No long-term adverse impacts that contribute to the effects of climate change are anticipated from the implementation of Alternative 4. Benefits to offset the adverse impacts of climate change that would occur with Restorative Flood Protection and Aquatic Species Habitat Actions are greater than those described under the other action alternatives, because these actions would increase the amount of forestland in the Chehalis Basin and offset forestland impacts that may occur from relocating floodplain land uses to converted uplands.

5.6.3.2 Effects of Climate Change on the Proposed Alternative

Actions taken under Alternative 4 would anticipate the changes in precipitation, increased flooding, and drought conditions that are predicted with climate change forecasts. Similar to Alternatives 1 and 2, the extent of flooding in downstream areas from more intense heavy winter rains anticipated with climate change could be moderated, to some degree, in a broad geographic area through the implementation of Alternative 4.

Restorative Flood Protection actions in Alternative 4 include restoring floodplain connectivity, restoring streamflow regimes, and re-aggrading incised channels. These actions, along with Aquatic Species Habitat Actions, are likely to ameliorate streamflow and temperature changes and increase habitat resilience in the face of climate change. Protection and restoration of natural watershed processes is also anticipated to mitigate climate change through carbon sequestration. Distributing flood damage reduction actions in all three of the upper sub-basins in the Chehalis Basin may further buffer against future variability in the magnitude and spatial distribution of precipitation patterns that could result from climate change.

The impacts of Alternative 4 on fish abundance under climate change conditions were modeled using EDT. The results indicate that Alternative 4 would increase salmon population abundance in the Chehalis Basin, with the most notable increase in abundance in spring-run Chinook salmon (ICF 2016). See Table 5.6-2 and Figure 5.6-3 for a summary of the modeled results.

Table 5.6-2

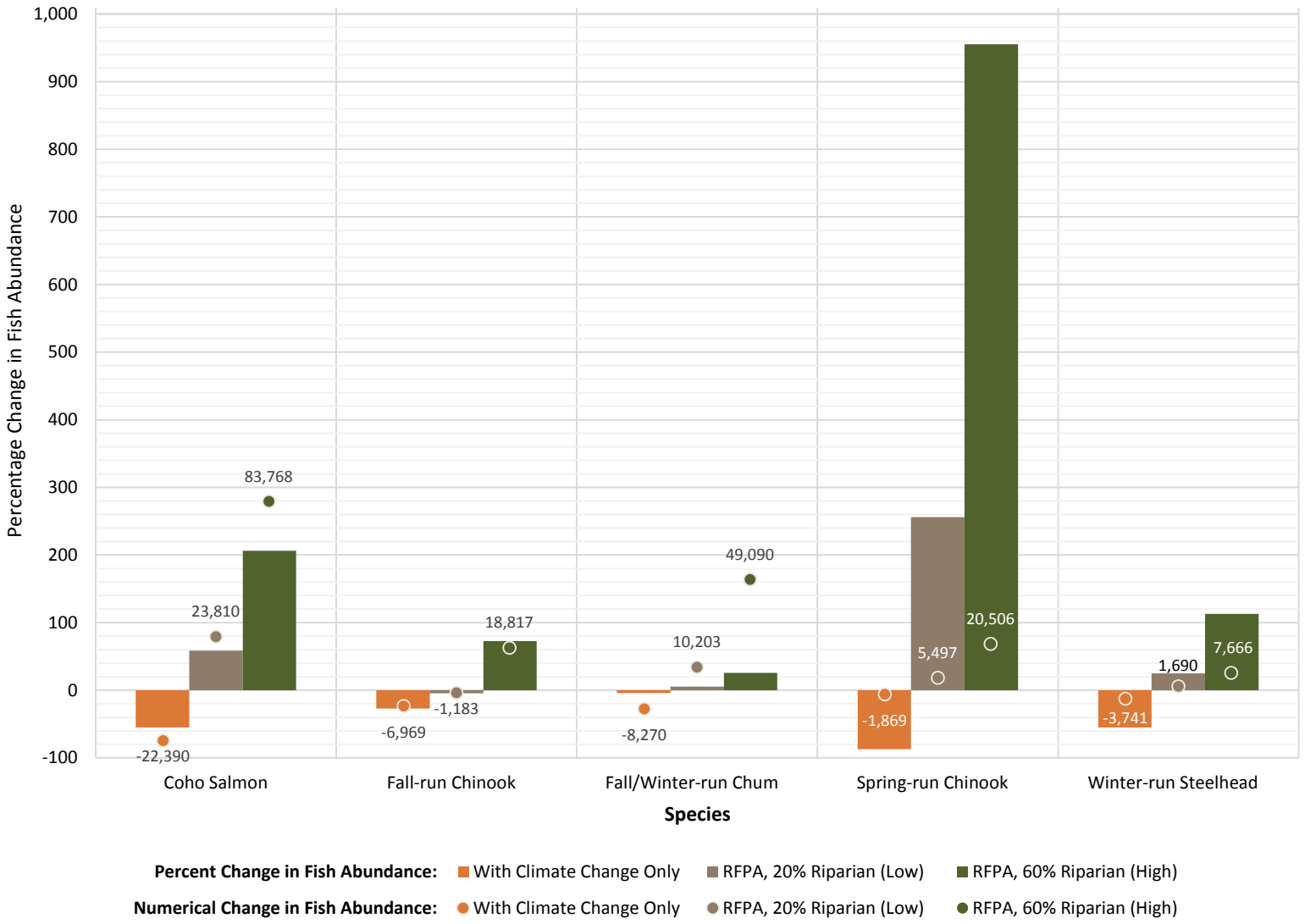
Potential Response in Salmonid Abundance for the Chehalis Basin with Alternative 4 and Climate Change

SPECIES (CURRENT HABITAT POTENTIAL)	FUTURE HABITAT POTENTIAL WITH CLIMATE CHANGE	CHANGE IN ABUNDANCE IN NUMBER OF FISH (%)	
		WITH ALTERNATIVE 4 AND LOW RESTORATION; 20% OF REACHES AND CLIMATE CHANGE	WITH ALTERNATIVE 4 AND HIGH RESTORATION; 60% OF REACHES AND CLIMATE CHANGE
Coho salmon (40,642)	-22,390 (-55%)	23,810 (59%)	83,768 (206%)
Fall-run Chinook salmon (25,844)	-6,969 (-27%)	-1,183 (-5%)	18,817 (73%)
Fall/Winter-run chum salmon (190,550)	-8,270 (-4%)	10,203 (5%)	49,090 (26%)
Spring-run Chinook salmon (2,146)	-1,869 (-87%)	5,497 (256%)	20,506 (955%)
Winter-run steelhead (6,800)	-3,741 (-50%)	1,690 (25%)	7,666 (113%)

Source: ICF 2016

Figure 5.6-3

Potential Response in Salmonid Abundance to Habitat Change in the Chehalis Basin with Climate Change and Alternative 4



Source: ICF 2016

5.6.4 Mitigation

The most significant impact associated with Alternative 4 is to existing land uses, transportation, and public services. Because Restorative Flood Protection has only been evaluated at a concept or screening level, land use, transportation, and public service impacts at specific locations have not yet been determined. Potential avoidance and minimization measures could include treatment area design that avoids construction of Restorative Flood Protection treatments in areas where the most or highest magnitude of impacts would occur, and where treatments would not significantly reduce downstream flood elevations.

An integral part of Alternative 4 is providing assistance to help willing property owners and residents adapt. Mitigation strategies could include the following:

- **Stay-in-place adaptation assistance –** This could include floodproofing, elevation of structures, farm pads, drainage improvements, or relocation of homes and structures to more upland portions of the same parcel
- **Buy-outs –** Property owners may prefer a buy-out option for their property
- **Conservation easements –** Permanent conservation easements could be used to compensate property owners for lost use of land
  - This could be combined with stay-in-place assistance where life and property would not be at risk, or be a strategy for parcels without structures
- **Relocation support to upland areas –** Relocation of some land uses to upland areas could be a viable option in portions of the watershed
  - The feasibility of this concept is very preliminary and could continue to be explored

Mitigation for potential long-term impacts on public services and utilities could include removal and decommissioning of utilities in the treatment areas, and areas where flood levels are anticipated to increase. Wastewater treatment systems, propane tanks, and underground fuel supplies would be decommissioned according to local and state guidelines to avoid potential contamination.

Mitigation for impacts on public services and utilities in areas that would experience increased flooding could include measures to floodproof or protect the affected utilities and services, or relocating them out of the flooded area.

Impacts on cultural resources would depend on the nature of cultural resources that would be disturbed. Specific measures would be identified and implemented during project-level design and environmental review. Potential compensatory mitigation measures for potential impacts on cultural resources and tribal resources would be the same as those described under Alternative 1.

5.7 Comparison of Alternatives

The objectives of the Chehalis Basin Strategy, as described in Section 5.1, are used as the basis for evaluating the alternatives and their ability to meet the dual purpose and need of reducing flood damage and restoring aquatic species habitat. Sections 5.2 through 5.6 include information regarding the extent to which the No Action Alternative and action alternatives meet the objectives. This section provides a comparison between all of the alternatives.

5.7.1 Reduction in Flood Damage

In preparation of the EIS, a number of modeling studies were completed to understand which alternative would result in the greatest reduction in flood extents and depths, as well as the greatest reduction in flood damage. This section compares the following quantitative and qualitative differences among the alternatives: change in extent and depth of flood damage reduction, effects to agricultural land use, reduction in structure damage, and effects to transportation systems. Based on available data, Alternative 1 would reduce the areal extent and depth of 100-year floods to a greater extent than the No Action Alternative, as well as the other action alternatives. Alternative 4 would increase the areal extent and depth of 100-year floods upstream of Newaukum River confluence. Downstream of the Newaukum River confluence, including in the Chehalis-Centralia area, Alternative 4 would reduce flood extents and depths but to a lesser degree than Alternative 1. However, because Alternative 4 would relocate 16,000 acres of land uses, including 8,500 acres of agriculture, upstream of the Newaukum confluence, it would result in greater flood damage reduction compared to the No Action Alternative and other action alternatives (see Appendix C).

During 100-year floods, Alternative 1 would result in the greatest reduction in flood extents as compared to the No Action Alternative and other action alternatives. The No Action Alternative and Alternative 3 would not reduce flood extents. Alternative 1 would reduce flooding on approximately 4,481 acres throughout Lewis, Thurston, and Grays Harbor counties, with the most benefits realized in the Chehalis-Centralia area (see Figure 5.3-1). Alternative 2 would primarily reduce flooding in the Chehalis-Centralia area near the airport and I-5. However, raising the airport levee and constructing the I-5 Projects as part of Alternative 2 have the potential to increase flood extent and depth on approximately 14 acres of agricultural/forestland to the west (and upstream and downstream) of these actions (see Figure 5.4-1). While Alternative 4 would increase flooding by 4,590 acres in many valley bottom areas upstream of the Chehalis River confluence with the Newaukum River, it would result in a reduction of approximately 815 acres of flooded area downstream of the Newaukum River confluence (see Figure 5.6-1).

The increase or decrease in flood extents and depths would have an impact on land use. Alternative 1 would reduce flooding to a greater extent than the No Action Alternative and other action alternatives due to the reduction in flooding to 1,956 acres of agricultural/forestland (see Table 5.3-1). Alternative 4 would have the greatest impact on agriculture because implementation of the Restorative Flood

Protection action element could result in new or increased flooding to an area potentially reaching 21,000 acres in size in the future 100-year floodplain, including approximately 12,100 acres of active farmland, and would require relocation of 8,500 acres of farmland. The location, magnitude, and concentration of this potential impact from Alternative 4 has not been identified at this time.

Table 5.7-1 provides a comparison of the total number of structures flooded, relocated, or floodproofed during a 100-year flood by alternative. The Aberdeen/Hoquiam North Shore Levee action element is included in Alternatives 1 and 2, and would result in the additional protection of 2,715 structures. Alternative 4 would result in the greatest reduction in flood damage to high-value structures, primarily due to relocating up to 462 structures out of the proposed greenway to upland areas. Because of the land use impacts associated with construction and operation of the Restorative Flood Protection action element, Alternative 4 includes landowner compensation, relocation, or adaptation assistance for landowners willing to participate. Alternative 1 would result in the greatest reduction in remaining structures flooded after the actions have been implemented.

Table 5.7-1
Reduction in Flood Damage to High-value Structures Under Different Alternatives

	CHANGE FROM BASELINE 100-YEAR FLOOD				
ACTION	NO ACTION ALTERNATIVE	ALTERNATIVE 1	ALTERNATIVE 2	ALTERNATIVE 3	ALTERNATIVE 4
Structures that would no longer be flooded	0	559	88	0	136
Structures relocated	0	0	0	0	462
Structures floodproofed	0	500	812	802	645
Total damages reduced to structures	**0**	**1,059**	**900**	**802**	**1,243**
Remaining structures flooded	1,379	320	479	577	598[1]

Notes:
1. Structures relocated are not included in this total because it is currently unknown whether property owners would be willing to relocate.

The alternatives were also evaluated to determine their effectiveness in reducing disruption in transportation systems, including closures of I-5 and local and regional transportation systems. Under the No Action Alternative, I-5 would continue to be closed up to 4 days during a 100-year flood, requiring use of WSDOT's detour route. Closures of SR 6, US 101, and US 12, and flooding of local roadways would continue. Flooding of rail lines, including BNSF, Union Pacific, and the Curtis Industrial Park line, would also continue under the No Action Alternative. All of the action alternatives would reduce disruptions to transportation systems compared to the No Action Alternative.

Of the action alternatives, Alternative 1 would result in the least disruption to transportation systems, while Alternative 4 would result in the most disruption (see Table 5.7-2). Under Alternative 1, flooding

of roadways would be reduced in the upper Chehalis Basin near the Chehalis River due to implementation of the Flood Retention Facility and Airport Levee Improvements. Alternative 4 would increase flooding impacts on transportation systems in the Chehalis Basin upstream of the Newaukum confluence with the Chehalis River.

Table 5.7-2
Reduction in Transportation Impacts During a 100-year Flood Under Different Alternatives

NO ACTION ALTERNATIVE	ALTERNATIVE 1	ALTERNATIVE 2	ALTERNATIVE 3	ALTERNATIVE 4
I-5 CLOSURES (CLOSED 4 DAYS DURING 100-YEAR FLOOD)				
No reduction	Reduced by 3 days	Reduced up to 3 days	No reduction	No reduction
FLOODING OF SR 6, US 101, US 12, AND LOCAL ROADS				
No reduction	Reduced by 1 to 3 days	Reduced behind levee, increased on west side of I-5 (SR 6 and local roadways)	No reduction	Reduced in Chehalis-Centralia area by up to 1 day, could be increased on SR 6 (4 days), SR 506 (1 to 2 days), and SR 508 (2 days)

5.7.2 Restoration of Aquatic Species Habitat

Implementation of the Aquatic Species Habitat Actions low and high scenarios in all of the action alternatives would substantially increase riparian area and salmon abundance, resulting in a benefit to other aquatic species as well. With Aquatic Species Habitat Actions, riparian area would be increased between 21 river miles (1,150 acres) and 214 river miles (9,750 acres). Alternative 1 would decrease 241 acres of riparian area in the FRFA reservoir due to clear-cutting and permanent inundation. As a combined action alternative, Alternative 1 would result in a total of between 909 and 9,509 acres of increased riparian habitat. Alternative 4 would increase the riparian area by between 562 and 6,552 acres through adding large wood in the treatment areas, for a total of 1,712 to 16,302 acres of increased riparian habitat.

As shown in Table 5.7-3, Alternative 1 would result in the least increase in salmon abundance, while Alternative 4 would result in the greatest increase in salmon abundance. The increase in salmon abundance for Alternatives 2 and 3 would be very similar to the Aquatic Species Habitat Actions (see Section 4.8.4.2.1). Across all alternatives, climate change would reduce salmon abundance, and the low restoration scenario would generally maintain the status quo. Modeled results of salmon habitat potential include the maturation of riparian areas in managed forestlands and active restoration from the Aquatic Species Habitat Actions compared to current conditions.

A major difference between Alternative 1 and the other alternatives is the effect on salmon and other aquatic species that use the mainstem Chehalis River upstream and immediately downstream of the dams. The dams would have a significant adverse impact on the native species that use this area of the mainstem. Although, the FRO dam would allow passage of species, changes to habitat in the reservoir area would decrease the survival of salmon and other species. The FRFA dam would more severely reduce upstream and downstream passage of aquatic species resulting significant reductions of salmon, lamprey and other species in that portion of the Chehalis Basin.

The potential response of some specific species to Alternatives 1 and 4—accounting for climate change—are also compared in the previous sections (see Figures 5.3-4 and 5.3-5 [Alternative 1] and Figures 5.6-2 and 5.6-3 [Alternative 4]). The contribution of managed forestlands to salmon abundance would, on average, contribute 59% of restoration benefit for the low scenario and 27% for the high scenario[5].

Table 5.7-3
Potential Response in Salmon Abundance to Habitat Change in the Chehalis Basin Under Different Action Alternatives

ACTION	CHANGE IN ABUNDANCE FOR CHUM, SPRING-RUN AND FALL-RUN CHINOOK, COHO, AND WINTER-RUN STEELHEAD IN NUMBER OF FISH (%)			
	LOW RESTORATION 20% OF REACHES (CURRENT CONDITIONS)	LOW RESTORATION 20% OF REACHES (FUTURE CONDITIONS)	HIGH RESTORATION 60% OF REACHES (CURRENT CONDITIONS)	HIGH RESTORATION 60% OF REACHES (FUTURE CONDITIONS)
Aquatic Species Habitat Actions (Alternatives 2 and 3 would be similar)	48,843 **(18%)**	5,019 **(2%)**	194,383 **(73%)**	141,135 **(53%)**
Alternative 1 (FRFA and Aquatic Species Habitat Actions)	38,215 **(14%)**	4,707 **(2%)**	143,975 **(54%)**	123,564 **(46%)**
Alternative 1 (FRO 50 and Aquatic Species Habitat Actions)	46,756 **(18%)**	8,781 **(3%)**	192,986 **(73%)**	127,946 **(48%)**
Alternative 1 (FRO 100 Aquatic Species Habitat Actions)	46,602 **(18%)**	7,925 **(3%)**	192,560 **(72%)**	127,848 **(48%)**
Alternative 4 (Restorative Flood Protection and Aquatic Species Habitat Actions)	120,514 **(45%)**	40,017 **(15%)**	249,345 **(94%)**	179,847 **(68%)**

Based on the increased riparian area and salmon abundance, Alternative 4 would result in the greatest benefit to aquatic species compared to the No Action Alternative and other action alternatives. Alternative 1 would substantially restore habitat for aquatic species, but would result in the least benefit

[5] Refer to Draft EIS Addendum dated October 17, 2016.

as a result of permanent and large-scale changes to the Chehalis River and floodplain caused by a Flood Retention Facility.

5.8 Cumulative Impacts

This cumulative impacts analysis is prepared in accordance with SEPA (Chapter 43.21C RCW), the SEPA Rules (WAC 197-11-060), and the SEPA Handbook. Additional guidance developed by the Council on Environmental Quality in the handbook entitled *Considering Cumulative Effects under NEPA* (1997) was also considered where SEPA requirements are consistent with requirements of NEPA.

Cumulative impacts are the effects that may result from the incremental impact of an action when added to other past, present, and reasonably foreseeable future actions (40 Code of Federal Regulations [CFR] 1508.7). "Cumulative impacts can result from individually minor but collectively significant actions taking place over a period of time" (40 CFR 1508.7). Generally, an impact can be considered cumulative if: (a) effects of several actions occur in the same locale; (b) effects on a particular resource are similar in nature; and (c) effects are long term in nature.

5.8.1 Past Actions

Beginning in the mid-1850s, various activities, including agriculture, ranching, logging, gravel mining, dredging, and the installation of dams and diversions, have exacerbated flooding, caused channel incision, and degraded aquatic species habitat in the Chehalis Basin.

One of earliest documented floods, occurring in 1887, inundated most of the area between Centralia and Chehalis (*The Chronicle* staff 2007). In the past 60 years, major floods have occurred in eight separate events, with flood levels rising and flood damage in the Chehalis Basin increasing. The 1996, 2007, and 2009 floods are the three largest floods on record and resulted in widespread environmental damage, including threats to public health and safety; losses to homeowners, agriculture, and commercial businesses; damage to public infrastructure; and emotional and psychological costs. The primary cause of flooding in Western Washington has been found to be atmospheric rivers which funnel large quantities of precipitation in a short time span, typically during a period of a few hours to a few days (Neiman et al. 2011). Winter storms associated with atmospheric rivers produce twice the amount of precipitation as storms not associated with atmospheric rivers (Ralph et al. 2008). The influence of urbanization on flooding has generally been muted; overall, residential, commercial, and industrial land use collectively comprise a small portion (7%) of the overall land cover in the Chehalis Basin, and impervious surfaces are less than 2%.

In preparation of one of the actions evaluated in the EIS (Restorative Flood Protection action element), research determined that significant areas of channel incision (down-cutting of the river) and loss of floodplain storage have also occurred in portions of the Chehalis Basin. Channel incision and floodplain forest clearing can reduce floodplain connectivity and capacity for flood storage, as well as influence flood timing and extents (Dixon et al. 2016; Watson et al. 2016). This can result in more rapid downstream conveyance of high flows, which directly affects the magnitude and timing of downstream flooding. In the Chehalis Basin, one of the historical practices contributing to channel incision was the

use of splash dams to transport logs (see Section 3.2.4). Current land use also contributes to continued down-cutting of the river channels in some locations. Legacy agricultural practices of removing wetlands, straightening and armoring riverbanks, and removing floodplain forests increase flooding downstream (see Section 1.2).

Much research has been conducted to understand how forest management practices influence the extent of flooding in the Chehalis Basin. In general, there is consensus that timber harvesting results in an increase in rain-induced, channel-forming flows up to 20 or more years post-harvest (Perry et al. 2016). However, as stated previously under the No Action Alternative, the balance of evidence suggests changes to forest management practices would not reduce the frequency of extreme flooding in a watershed the size of the Chehalis Basin (Perry et al. 2016). Many studies have also documented increases in landslides and surface erosion resulting from timber-harvesting and road-building practices (Dragovich et al. 1993; Dyrness 1967; Guthrie and Evans 2004; Jakob 2000; Ketcheson 1977; Montgomery et al. 2000; Robison et al. 1999; Swanson and Dyrness 1975; Swanson et al. 1987; Swanston 1974). New Forest Practices Rules have been implemented through the Adaptive Management Program; however, there are conflicting conclusions on how effective the current rules are during an extreme storm event, such as the 2007 flood (see Appendix E).

Overall, agricultural and residential uses in the Chehalis Basin have also led to reduced habitat complexity and function over baseline pre-European settlement conditions (Mobrand 2003). Beginning in the mid-1850s, agriculture and ranching, followed by logging in the 1880s, have shaped habitat in a number of ways. These include loss of riparian vegetation, increased erosion, reduced water quality, increased stream temperature, and overall reduced aquatic habitat function. Gravel mining and dredging activities have also led to the loss of wetlands and tidelands that are important rearing habitats for aquatic and semi-aquatic species. Dams and diversions constructed for agricultural and municipal water uses have also adversely affected habitat conditions, including reduced flows, increased stream temperatures, and barriers to fish passage. Farming, forestry, harvesting of shellfish, and fishing continue to be central to the Chehalis Basin economy, and the loss and degradation of habitat, estimated to be between 54% and 87% (ASEPTC 2014a), has resulted in declines in salmon, steelhead, and other fish, affecting both tribal and non-tribal people of the Chehalis Basin.

5.8.2 Present and Reasonably Foreseeable Future Actions

Present and reasonably foreseeable future actions that are anticipated in the Chehalis Basin that are relevant to the Chehalis Basin Strategy include the following:

- New residential and commercial development
- Expansion of agricultural uses
- Local programs and activities (many of which are described under the No Action Alternative and Local Projects action element in Sections 2.3.4.1 and 2.3.3.2)

- Predicted increases in heavy precipitation and storms as a result of climate change

While many Chehalis Basin communities have regulations that prohibit development in the floodplain, current regulations in both Lewis and Grays Harbor counties allow for continued subdivision and development in the floodplain, although additional development standards apply. Under current floodplain land use management regulations, future growth potential is primarily centered around opportunities for residential development in incorporated and UGA areas in Lewis County—many of which are in Chehalis and Centralia—followed by residential development in unincorporated areas of all three counties (Lewis, Grays Harbor, and Thurston). Residential opportunities are followed by opportunities for growth on agricultural parcels (21% of the overall development potential), and much more limited commercial and industrial development (11%; see Appendix L). Future growth would be constrained to an extent by water availability because issuance of new water rights within the basin are limited in part to maintain minimum instream flows for fish and to minimize potential impacts on groundwater. However, agricultural expansion is anticipated to continue, supported in part by the continued work of the Chehalis Basin Partnership to improve water use and irrigation efficiency and to develop partnerships for shared water rights and more localized systems for food processing, storage, transport, and sales.

A number of specific present and future actions have been identified that are relevant to reducing flood damage or restoring habitat for aquatic species, many of which are included in the No Action Alternative. For example, by 2030, WSDOT is required to correct 818 WSDOT-owned culverts in the western Washington (WSDOT 2016). Individual culvert corrections would be prioritized to provide the highest benefits to fish, including improving fish passage and stream function. Near-term aquatic species habitat restoration projects have been funded and will be implemented in the Chehalis Basin by 2017. Other present and future actions that will are relevant to the Chehalis Basin Strategy include continuation of SRFB-funded habitat projects, the CREP, USFWS' CFRP, and DNR's FFFPP.

With regard to reducing flood damage, local projects that protect structures by elevating and floodproofing them, protect critical properties and infrastructure like WWTPs and roads from flood damage, provide safe harbor for farm animals and equipment, or improve floodplain storage, are anticipated to continue in the Chehalis Basin under the No Action Alternative, though at levels of historic (pre-2011) funding. Additionally, various projects are also planned along the I-5 corridor to retrofit stormwater runoff facilities to minimize potential adverse impacts on water quality.

With respect to Forest Practices, although it is not clear how effective current Forest Practices rules are at reducing landslides and erosion during extreme storm events, it is clear that practices have improved the management of areas to reduce the potential for landslides during less severe floods (see Appendix L).

With respect to climate change, research has shown that although the mechanisms driving heavy rain events within the Chehalis Basin are not expected to change substantially in the future, atmospheric rivers are projected to increase across the region, resulting in higher moisture transport and rainfall associated with these storms. The risk of winter flooding is also anticipated to increase, and summer low flows are anticipated to further decrease (Mauger et al 2016).

5.8.3 Cumulative Effects of the Alternatives

To some degree, identifying the cumulative effects of the action alternatives is inherent in the analyses described in this chapter, because many local programs and initiatives anticipated to continue in the future are part of the impact evaluation (e.g., the Local Projects action element). More localized differences in cumulative effects could occur where other developments and actions would be in close proximity to elements of the alternatives. However, these differences would generally be further identified at the project-level environmental review as compared to the programmatic-level analysis conducted in this EIS.

The cumulative effects of the Chehalis Basin Strategy are expected to be beneficial, although some cumulative adverse impacts could occur as a result of individual actions.

The action elements comprising the Chehalis Basin Strategy are intended to substantially contribute to reducing flooding damage and improving aquatic species habitat in the Chehalis Basin. While the action alternatives all include Local-scale Flood Damage Reduction Actions and Aquatic Species Habitat Actions, they differ in the incorporation of Large-scale Flood Damage Reduction Actions and the degree to which they would contribute to cumulative impacts on water resources and aquatic habitat in the Chehalis Basin.

Of the action alternatives, Alternative 1 would result in the broadest flood damage reduction benefits, associated primarily with the construction of the Flood Retention Facility, which is unique to this alternative. Construction of the Flood Retention Facility would cumulatively add to existing impacts on fisheries in a river basin that has already been extensively dammed and where habitat has been adversely affected by development, climate change, and other modifications to the system. Construction of the Flood Retention Facility could also contribute to existing and ongoing water quality problems in the Chehalis River, including elevated temperatures and low DO. Aquatic Species Habitat Actions under Alternative 1, while not intended to mitigate for the effects of the Flood Retention Facility, would build on other habitat restoration efforts currently occurring in the Chehalis Basin. These efforts may decrease the potential for adverse impacts from the Flood Retention Facility to accumulate and contribute to conditions that have negatively affected water resources and fish in the Chehalis Basin. Local Projects that include bank stabilization could cumulatively adversely affect flood flows and velocity in armored reaches, and therefore affect habitat and aquatic conditions for fish, depending on site-specific conditions. If land use management recommendations do not limit future floodplain development and a dam increases development pressure in the floodplain, continued floodplain

development could cumulatively affect water resources, fish and wildlife habitat, and increase the future risk of flood damage.

Alternative 2 would also result in the potential for cumulative impacts due to Aquatic Species Habitat Actions and Local-scale Flood Damage Reduction Actions, such as Local Projects including bank stabilization. Large-scale Flood Damage Reduction Actions would cumulatively result in reductions to flood damage in the Chehalis River floodplain, which is a beneficial cumulative impact, particularly when combined with Aquatic Species Habitat Actions and the other ongoing habitat restoration efforts in the Chehalis Basin.

Compared to Alternatives 1 and 2, Alternative 3 is most likely to result in cumulative beneficial contributions to aquatic species habitat function due to the lack of structural components; and is least likely to contribute to cumulative adverse impacts on water resources, fish and wetlands for the sake of reducing flood damage. Alternative 3 would result in the same potential for cumulative impacts due to Aquatic Species Habitat Actions and Local-scale Flood Damage Reduction Actions (Local Projects including bank stabilization) as Alternatives 1 and 2, and continued floodplain development could cumulatively affect water resources, fish and wildlife habitat, and increase the future risk of flood damage.

Alternative 4 would reduce flood damage more broadly than Alternatives 2 and 3, and in different locations than Alternative 1. Of the action alternatives, Alternative 4 would result in the least potential for cumulative adverse impacts on aquatic species habitat due to the lack of structural elements and the inclusion of Restorative Flood Protection treatments. Alternative 4 would cumulatively help to improve aquatic species habitat functions in a basin that as noted above, has been adversely affected by dams, development, climate change, and other modifications to the system. In locations where both Alternatives 1 and 4 reduce flood damage, Alternative 4 does not reduce flood extents or depths, and therefore flood damage, as much as Alternative 1. However, Alternative 4 increases flooding in tributary areas of the Chehalis River—the North and South Fork Newaukum rivers; South Fork Chehalis River; and Stearns, Bunker, Deep, Lake, Stillman, and Elk creeks. Cumulatively, increased flooding has an adverse impact on land uses in the floodplain. The potential for cumulative impacts on land uses and structures in the floodplain resulting from increased flooding under Alternative 4 is likely to be minimized through supporting relocation and adaptation of at-risk land uses under existing conditions. Alternative 4 would result in the same potential for cumulative impacts due to Aquatic Species Habitat Actions and Local-scale Flood Damage Reduction Actions (Local Projects including bank stabilization) as the other action alternatives, except it would reduce the potential for cumulative impacts on aquatic species habitat as a result because of the inclusion of Restorative Flood Protection actions

Implementation of actions that disrupt access to tribal resources associated with a tribe's sovereignty or formal treaty rights, or reduce or limit access to plants, fish, or wildlife used for commercial, subsistence, and ceremonial purposes, have the potential to cumulatively affect tribal resources. Potential impacts could also include direct impacts on or loss of natural resources protected by tribal treaties for fishing,

hunting, or gathering during construction or implementation of the action elements or combined alternatives considered in this EIS.

While reduced flooding potential could result in increased population growth and land use development within the Chehalis Basin, flood damage reduction would also result in cumulatively significant improvements related to public health and safety and reduced disruptions to industry, commercial businesses, and public services.