4 ACTION ELEMENTS: IMPACTS AND MITIGATION

4.1 Introduction

This chapter describes the potential short- and long-term impacts of the action elements on the affected environment (described in Chapter 3), as well as possible mitigation measures. Action elements are described in this chapter in order from the largest to smallest magnitude flood damage reduction actions, followed by aquatic species habitat actions. Therefore, this chapter begins with a discussion of the Large-scale Flood Damage Reduction Actions in Sections 4.2 through 4.6, followed by Local-scale Flood Damage Reduction Actions (Section 4.7), and Aquatic Species Habitat Actions (Section 4.8). Section 4.2 includes a summary assessment of the key adverse impacts and beneficial effects associated with the Flood Retention Facility; additional detailed information is provided in Appendix H.

Because the analysis of impacts in this EIS is programmatic, specific design and construction details for the implementation of many of the action elements have not been determined. Thus, short- and long-term impacts are discussed commensurate with the level of detail used to describe the action element. Chapter 5 evaluates the potential impacts of groupings of action elements when combined together into alternatives.

4.1.1 Impact Evaluation Considerations

Short-term impacts refer to temporary impacts that would occur during construction, typically localized to the construction footprint, with conditions returning to pre-construction status or function following completion of construction. Long-term impacts are those that would occur following implementation of an action element, and include permanent impacts resulting from construction and operation.

> **Action Elements**
>
> **Large-scale Flood Damage Reduction Actions** include the Flood Retention Facility (FRO or FRFA dam and associated reservoir), Restorative Flood Protection, Airport Levee Improvements, I-5 Projects, and Aberdeen/Hoquiam North Shore Levee.
>
> **Local-scale Flood Damage Reduction Actions** include Floodproofing, Local Projects (including protection of roads and infrastructure), Land Use Management, and Flood Warning System Improvements.
>
> **Aquatic Species Habitat Actions** includes a number of measures to restore aquatic habitat such as riparian habitat restoration, fish passage barrier removal, off-channel habitat restoration, wood installation, bank erosion reduction to naturally occurring rates, floodplain reconnection, and wetland creation, restoration, and enhancement.

Degree of Adverse Impacts

Minor = Minimal and/or easily mitigated

Moderate = Adverse but limited in scope and effect; limited in extent on a Basin-wide scale (smaller footprint and would result in limited changes); potentially consistent with regulatory standards; mitigation requirements would be straightforward and reasonably achievable

Significant = Adverse and larger in scope; greater magnitude and extent of impact across the Chehalis Basin (larger footprint and would result in greater changes); potentially inconsistent with regulatory standards; mitigation requirements would be extensive

Adverse impacts, if any, would be considered minor, moderate, or significant depending on their magnitude. The discussion of impacts and mitigation is focused on probable significant adverse impacts, and beneficial effects are described where applicable. The summary of impacts in this section is provided at a Basin-wide scale for the purposes of conducting a programmatic-level evaluation. Although an impact could be considered minor or moderate at the Basin-wide scale, it could be a significant impact locally, or for cultural or tribal resources. Ecology expects that a more detailed evaluation of project impacts would be required during project-level environmental review. The factors (or indicators) that were used to evaluate the degree of adverse impact for each element of the environment are described in Appendix I.

4.1.2 Short-term Impacts and Mitigation Common to Many Action Elements

To assist in the programmatic-level evaluation of short-term impacts, some basic assumptions regarding construction have been made for the purposes of this EIS. Potential construction-related activities, associated impacts, and possible mitigation that are similar across many action elements are listed in Table 4.1-1. The abbreviations in the short-term impacts column refer to the element(s) of the environment that would be affected. In addition to the measures outlined in Table 4.1-1, compliance with permit conditions and application of best management practices as part of future, project-specific permits and authorizations would avoid and minimize some of the short-term adverse impacts commonly associated with construction. Other short-term impacts and mitigation measures unique to specific action elements are described in the applicable sections of this chapter.

Mitigation Considerations

When considering mitigation, the first step would be to avoid or minimize impacts through design or siting (such as avoiding impacts on wetlands and vegetation communities). The next step would be to rectify the impact by repairing the affected environment. For impacts that cannot be avoided or minimized, compensatory mitigation could include restoration or rehabilitation, preservation, or monitoring the impact and taking appropriate corrective measures.

Table 4.1-1
Summary of Short-term Impacts and Possible Mitigation for Action Elements

CONSTRUCTION ACTIVITY	SHORT-TERM IMPACTS	AVOIDANCE AND MINIMIZATION	COMPENSATORY MITIGATION
Water diversions for activities involving in-channel construction, placement of cofferdams to isolate the work area and/or construction of a bypass channel to reroute the river; temporary dewatering could also be required depending on the construction activity	• Increased turbidity and sedimentation (WR, GG, FW, VQ) • Localized hyporheic exchange alterations (the zone of interaction between the shallow groundwater and surface water of the river; WR, WV, FW) • Localized shallow groundwater aquifer recharge effects (WR, WV, FW) • Fish stranding, gill and skin injuries, impaired foraging or predator avoidance, obstruction of passage (FW, R) • Impacts on wildlife species that breed, forage, or overwinter in stream habitats affected by dewatering (FW, R) • Modification of wetland hydrology (WV, FW)	• Implement an approved Erosion Control Plan to control and prevent sediment inputs to receiving waters, including use of silt fences and turbidity curtains • Pump and infiltrate groundwater from excavation pits • Limit in-water and near-water work to periods where sensitive aquatic species are not present and to periods of low flow • Install fish barrier • Remove and relocate aquatic species from dewatered area • Design bypass channel with hydraulic conditions to ensure upstream and downstream fish passage during its use, including avoiding delay through adequate attraction to the bypass channel; monitor passage through the bypass channel for effectiveness	• Restore and/or compensate for temporary impacts on fish and wildlife • Restore and/or compensate for temporary impacts on natural resources, such as wetlands or vegetation, to maintain ecological function

CONSTRUCTION ACTIVITY	SHORT-TERM IMPACTS	AVOIDANCE AND MINIMIZATION	COMPENSATORY MITIGATION
Upland excavation and clearing activities, as well as fill placement, associated with project construction	• Increased turbidity and sedimentation (WR, GG, FW, VQ) • Temporary fill in wetlands, wetland buffers, and riparian habitat (WV, FW) • Reduced habitat function through temporary loss of potential priority habitat	• Implement an approved Erosion Control Plan to control and prevent sediment inputs to receiving waters, including use of silt fences and other erosion control measures • Implement seasonal restrictions for protection of wildlife using upland habitats	• Acquire in-kind habitat, or create wetland mitigation sites that would create or improve wetlands and wetland buffers • Create, restore, and/or protect in-kind riparian habitat, such as riparian vegetation for shading and nutrient inputs or priority habitats that support a variety of native fish and wildlife species
Temporary road construction and use, as well as transport and placement or stockpiling of excavation material	• Increased pollutant-laden stormwater runoff (WR, FW, VQ) • Increased truck traffic on roadways with associated vehicle emissions and potential damage to local roadways (AQ, VQ, T, EHS) • Increased particulate matter (e.g., dust; AQ, VQ) • Increased turbidity and sedimentation from handling of excavated materials and construction and operation of the temporary roads (WR, GG, FW, VQ, T) • Removal of vegetation and/or priority habitat for construction of the temporary roads or stockpile areas (WV, FW, VQ)	• Minimize number and length of construction roads to limit surface area subject to sediment production • Meet applicable stormwater manual requirements (i.e., the most recent version of Ecology's *Stormwater Management Manual for Western Washington*) • Develop a Traffic Control Plan • Maintain access to properties to the extent possible by installing signs, marking detour routes, flagging, and providing information to the public, including notifications in advance of construction activities • Comply with applicable dust control policies and plans • Implement an approved Erosion Control Plan to control and prevent sediment inputs to receiving waters, including use of silt fences and other erosion control measures • Locate temporary roads and stockpiling areas to limit disturbance of vegetation communities	• Decommission construction roads that are not necessary for long-term maintenance of the action element • Revegetate, maintain, and monitor decommissioned road or stockpile areas • Create, restore, and/or protect priority habitats that support a variety of native fish and wildlife species

CONSTRUCTION ACTIVITY	SHORT-TERM IMPACTS	AVOIDANCE AND MINIMIZATION	COMPENSATORY MITIGATION
Borrow pit and quarry pit development	• Increased pollutant-laden stormwater runoff (WR, FW, VQ) • Increased truck traffic on roadways with associated vehicle emissions and potential damage to local roadways (AQ, VQ, T, EHS) • Increased dust (AQ, VQ) • Increased turbidity and sedimentation from handling of excavated materials and construction and operation of the temporary roads (WR, GG, FW, VQ, T) • Removal of vegetation and/or priority habitat for construction of temporary roads or pits (WV, FW, VQ) • Temporary fill in wetlands, wetland buffers, and riparian habitat (WV, FW)	• In addition to measures outlined for "temporary road construction and use" and "upland excavation and clearing activities," minimize the number of borrow (rock and soil) sites, and locate them as close to the dam site as possible to limit the need for long transportation routes and the production of sediment on roads	• Reclaim pit areas that are not necessary for long-term maintenance of the action element • Create, restore, and/or protect priority habitats that support a variety of native fish and wildlife species
Concrete production and use	• Increased potential for high pH releases to nearby waterbodies and wetlands, with resulting impacts on fish and aquatic species (WR, FW)	• Install work area isolation measures and rigorous wastewater management procedures	• Restore temporary impacts on natural resources, such as wetlands and riparian areas, to maintain ecological function
Construction of staging areas to accommodate storage of equipment and stockpiling of material	• Increased pollutant-laden stormwater runoff (WR, FW, VQ) • Increased dust (AQ, VQ) • Removal of vegetation for construction of staging or stockpiling areas (WV, FW, VQ)	• Meet applicable stormwater manual requirements (i.e., the most recent version of Ecology's *Stormwater Management Manual for Western Washington*) • Comply with applicable dust control policies and plans • Limit disturbance of vegetation communities	• Revegetate staging and stockpiling areas post-construction

CONSTRUCTION ACTIVITY	SHORT-TERM IMPACTS	AVOIDANCE AND MINIMIZATION	COMPENSATORY MITIGATION
Equipment use such as compactors, pile drivers, jackhammers, rock drills, cranes, and generators	• Increased noise and vibration levels that are injurious or inhibit normal behavior, resulting in temporary hearing impairments or displacement of humans, fish, and wildlife (FW, N, R) • Increased potential for accidental spills of fuel or oil (WR, FW, VQ) • Increased vehicle emissions from mechanized construction equipment (AQ)	• Limit noise-generating work such as blasting to time periods when sensitive species are not breeding or nesting • Construction equipment would be required to comply with WAC 173-60 – Maximum Environmental Noise Levels • Implement a Blasting Noise Mitigation Plan • Develop project-specific Spill Prevention and Response Plan that outlines provisions for storing fuels, refueling locations, spill control measures, and necessary containment equipment and materials • Avoid idling of equipment	None proposed
Temporary removal or disturbance of upland, riparian, and wetland vegetation communities, as well as disturbance of mixed coniferous/deciduous upland forest vegetation	• Increased turbidity and sedimentation from ground disturbance (WR, GG, FW, VQ) • Change in composition of wildlife species that occupy the existing habitat types (FW, R) • Increased dust (AQ, VQ)	• Limit disturbance of vegetation communities • Implement an approved Erosion Control Plan to control and prevent sediment inputs to receiving waters, including use of silt fences and other erosion control measures • Implement wildlife seasonal restrictions • Comply with applicable dust control policies and plans	• Revegetate cleared areas with native species • Monitor and maintain planted areas to ensure the success of mitigation plantings

Notes:
AQ = Air Quality
EHS = Environmental Health and Safety
FW = Fish and Wildlife
GG = Geology and Geomorphology
N = Noise
R = Recreation
T = Transportation
VQ = Visual Quality
WR = Water Resources
WV = Wetlands and Vegetation

4.1.3 Long-term Impacts

Long-term impacts are characterized as those projected to occur within a 100-year timeframe for each action element. The impact evaluation considers the net effect of the action following implementation of avoidance and minimization measures (e.g., the creation of fish passage facilities for the dam). The long-term impacts associated with the implementation of the action elements are variable and discussed in more detail in Sections 4.2 through 4.8.

Potential compensatory mitigation measures have also been identified for long-term impacts that cannot be avoided or minimized during design, construction, and implementation of the action elements. It is important to note that 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 are noted.

Forecasting Climate Change

This EIS identifies and evaluates impacts related to climate change based on predicted future streamflows and temperature conditions. The process for anticipating future streamflows was led by CIG at the University of Washington and involved assimilating and scaling data from existing forecasting models. These models included several hydrologic models and 12 different Global Climate Models (GCMs), which were modified and applied to numerous sites in the Chehalis Basin, several different future timeframes, and three different GHG emission scenarios. Model data was used for the period 1951 to 2005 to define historical conditions, and 2040 to 2099 to define future conditions. Average percentage changes by month were applied to the historical daily flow time series to develop future (non-peak) flows. Average percentage changes to modeled peak flows were applied to the historical peaks to develop future peak flows.

The GCMs also provide projected future meteorological conditions, including air temperature and relative humidity, which are key factors in determining stream and reservoir temperatures. In conjunction with the projected changes to streamflow under climate change, the projected air temperature increases and relative humidity changes were applied to the suite of water quality models. The changes in simulated water temperatures under future conditions without a reservoir were compared to the simulated water temperatures under future conditions with the proposed reservoir. These predicted streamflows and water quality conditions are incorporated into the impact analyses for several elements of the environment and EIS action alternatives.

4.1.4 Comparison of Long-term Impacts

For all action elements, several potential impacts on tribal resources have been identified, with the extent of impacts pending additional coordination with tribes and continued government-to-government consultations. In addition, the action elements could result in moderate to significant adverse impacts on cultural resources due to the proposed actions and predicted archaeological potential based on

WSAPM. The degree or severity of the impact would depend on the nature of the cultural resources that would potentially be disturbed.

Long-term significant adverse impacts of the Flood Retention Facility would be greater than the rest of the action elements, and include the following:

- Increase in turbidity and temperature and decrease in DO
- Conversion of a reach of the upper Chehalis River from a free-flowing river to a permanent reservoir impoundment (FRFA facility only)
- Landslide potential around the reservoir footprint (FRFA facility only)
- Damage to the dam if an earthquake were to occur on the CSZ to the west of the Flood Retention Facility or Doty Fault Zone to the north, which would also effect environmental health and safety
- Geomorphic impacts on the Chehalis River and its floodplain downstream of the dam due to changes in sediment and wood transport processes
- Permanent loss of approximately 68 acres (FRO facility) and 98 acres (FRFA facility) of wetlands
- Permanent loss of vegetation: 6 acres for the FRO facility (in the dam footprint) and 720 acres for the FRFA facility (9 acres in the dam footprint, 711 acres in the reservoir area)
- Reduced fish passage for adult and juvenile salmonids and Pacific lamprey
- Reduced habitat for fish and wildlife species, including instream and off-channel habitat in the reservoir area
- Change in visual quality of the area due to clearing of vegetation

The long-term beneficial effects of the Flood Retention Facility include substantial reduction in the extent and depths of 100-year floods in downstream areas, including partially offsetting the anticipated effects of climate change on peak floods. Along the Chehalis River in the Chehalis-Centralia area, the flood level could be reduced up to 1.8 feet during a 100-year flood (WSE 2014d). The number of high-value structures inundated would also be reduced substantially (see Section 5.2.2.4 for more information on structures). These reduced flood elevations have corresponding beneficial effects to land use, recreation, transportation, public services and utilities, and environmental health and safety. In the case of the FRFA facility, temperature reduction in the Chehalis River downstream of the dam to approximately the confluence of the Skookumchuck River would result in beneficial effects to water quality and fish as described in Section 4.2.

Restorative Flood Protection would also include significant adverse impacts due to land use impacts within the

Structure Value

Structures were delineated as either "high value" (e.g., schools, residences, businesses) or "limited value" (e.g., sheds, park shelters, carports; WSE 2014d). This EIS uses high-value structures to evaluate impacts.

treatment areas. Based on screening-level analysis, these impacts could cause new or increased flooding to an area, potentially reaching 21,000 acres in size, which includes approximately 12,100 acres of active farmland. The potentially affected area includes floodplains in the North Fork and South Fork Newaukum River, mainstem Chehalis River above the Newaukum River confluence, and the South Fork Chehalis River. The tributaries of Stearns, Stillman, Lake, Elk, and Bunker creeks are also included. The treatments required, and the 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 providing assistance to interested landowners to relocate to areas of the Chehalis Basin that do not flood, the potential adverse impacts are still considered significant. Significant adverse impacts on visual quality would also occur due to the construction of engineered-floodplain structures over an area up to 21,000 acres within the treatment areas.

Restorative Flood Protection would result in a reduction in flood elevations of 0.4 foot for the 100-year floodplain along the Chehalis River in the Chehalis-Centralia area, and 1.1 foot at the Newaukum River confluence. In addition to flood damage reduction benefits, Restorative Flood Protection would increase wetland areas, improve riparian vegetation communities, and improve connectivity to floodplain habitat. These treatment actions would provide conditions that are beneficial to fish and wildlife, both in the channels and within connected floodplain habitats. Eventually, this action element would be self-sustaining and would not require routine maintenance or upkeep.

The Airport Levee Improvements, I-5 Projects, and Aberdeen/Hoquiam North Shore Levee are not likely to result in long-term significant adverse impacts with regard to a majority of the elements of the environment. Adverse impacts are primarily minor in nature, except for the potential loss of fewer than 5 acres of wetlands as a result of the Airport Levee Improvements and I-5 Projects. For the Airport Levee Improvements and Aberdeen/Hoquiam North Shore Levee, there would also be moderate impacts due to increases in flood depths or extents upstream and downstream of the levee, and disruption of the groundwater flow regime within the footprint of the levee. These action elements would reduce damages during a 100-year flood, resulting in beneficial effects with regard to water resources, transportation, public services and utilities, and environmental health and safety.

Local-scale Flood Damage Reduction Actions, such as Floodproofing and Local Projects, are not likely to result in any long-term significant adverse impacts. These action elements would primarily result in benefits by reducing flood damage to structures, infrastructure and roads, and agricultural land, including the protection of livestock and farm equipment. Land Use Management actions would not result in long-term significant adverse impacts, and—in terms of benefits—could reduce future development in the Chehalis River floodplain, which would avoid repeated cycles of future flood damage and recovery. Flood Warning System Improvements would not result in long-term significant adverse impacts, and would benefit public safety.

Aquatic Species Habitat Actions would primarily result in beneficial effects, with adverse impacts identified for a few resources as described in Section 4.8. Actions would be designed to protect, improve, and create sustainable ecosystem processes and functions that support the long-term productivity of native aquatic and semi-aquatic species, and at much higher levels of abundance than current habitat conditions support. It is assumed that in the future, the selected restoration actions would fall between the low and high scenarios described in Section 2.3.3.3. With regard to impacts, the main difference between the high and low restoration scenarios is the magnitude of short- and long-term impacts. In other words, the low restoration scenario would result in similar benefits and impacts as the high scenario, but each to a lesser degree. All of the low and high restoration scenarios combined with the effects of climate change would result in an increased abundance of salmonids (or reduce the degree of predicted losses) compared to climate change conditions only. The high restoration scenarios with climate change would result in a significantly greater percentage increase in abundance (more than 75%) of coho salmon and spring-run Chinook salmon compared to the low restoration scenario when applied to either 20% or 60% of the reaches, as well as for winter-run steelhead when applied to 60% of the reaches. While the low restoration scenario would still result in reductions of spring-run Chinook salmon and coho salmon (when applied to 20% of the reaches), the abundance of fish under the high restoration scenario would exceed the habitat potential for these two species.

4.2 Flood Retention Facility (FRO and FRFA)

Short-term impacts from construction of the Flood Retention Facility would be more substantial than short-term impacts from construction of the rest of the action elements, due to the magnitude of excavation, clearing, water diversion, and temporary road construction, and because construction would occur over 2 to 3 years rather than months. This action element also includes concrete production and use, development of a borrow pit and quarry pit, and installation of a new power line for construction and operation of power pumps, gates, instruments, and other facilities.

This section provides a summary of the primary long-term adverse impacts and benefits resulting from implementation of the Flood Retention Facility. More detailed descriptions of operations and associated impacts to support this analysis are provided in Appendix H. Unless otherwise noted, the term Flood Retention Facility is used in reference to both types (FRO and FRFA) of dams and associated reservoirs. When impacts or mitigation are applicable to only one type of facility, the specific facility type is noted (FRO facility or FRFA facility).

4.2.1 Water Resources

4.2.1.1 Short-term Impacts

The temporary impacts described in Table 4.1-1, and their effects on water resources during construction of the Flood Retention Facility, would be relatively short in duration (2 to 3 years) and generally limited to the dam and reservoir footprint. Avoidance and minimization measures would be employed when designing, constructing, and permitting the facility. Permanent or long-term impacts resulting from construction are discussed below.

4.2.1.2 Long-term Impacts

Long-term impacts on water quality are based on water quality modeling analysis and results for both the FRFA and FRO facilities. The results and findings of this analysis are presented in the following studies, some of which are currently in development:

- *Draft Reservoir Water Quality Model* (Anchor QEA 2016b)
- *Draft Development and Calibration of the Chehalis River CE-QUAL-W2 Water Quality Model* (PSU 2016)

Surface water quantity and water rights impacts are based on professional judgment and studies developed by water resource engineers, including hydraulic and hydrologic modeling, reservoir simulations, and the results and findings from the following studies:

- *Re-evaluation of Statistical Hydrology and Design Storm Selection for the Chehalis River Basin* (WSE 2014a)
- *Peer Review of December 2007 Peak and Hydrograph at Doty Gaging Station* (WSE 2014b)

- *Development and Calibration of Hydraulic Model* (WSE 2014c)
- *Chehalis River Basin I-5 Flood Protection near Centralia and Chehalis* (WSDOT 2014)

Impacts on groundwater are based on professional judgment, including known information about the existing groundwater aquifer system and the expected changes in water quantity and quality that would occur as result of dam operations scenarios. Existing groundwater characterization of the Chehalis Basin is summarized in the following report:

- *Hydrogeologic Framework and Groundwater/Surface-Water Interactions of the Chehalis River Basin, Southwestern Washington* (Gendaszek 2011)

Floodwaters would be retained in the reservoir (see Figure 4.2-1) when flows are predicted to exceed a major flood. Floods of this magnitude occur, on average, once every 7 years (15% probability of occurring in any given year). The FRO dam would allow the Chehalis River to pass through unimpeded, except during a major flood. Flows would be retained in the FRO reservoir during a major flood, then emptied over a period of up to 32 days after the flood peaks. The FRFA dam would maintain a permanent pool in the reservoir with extra capacity for flood retention when a major flood occurs. The specific operational details that would affect water resources are described in the *Draft Operations Plan for Flood Retention Facilities* (Anchor QEA 2016c).

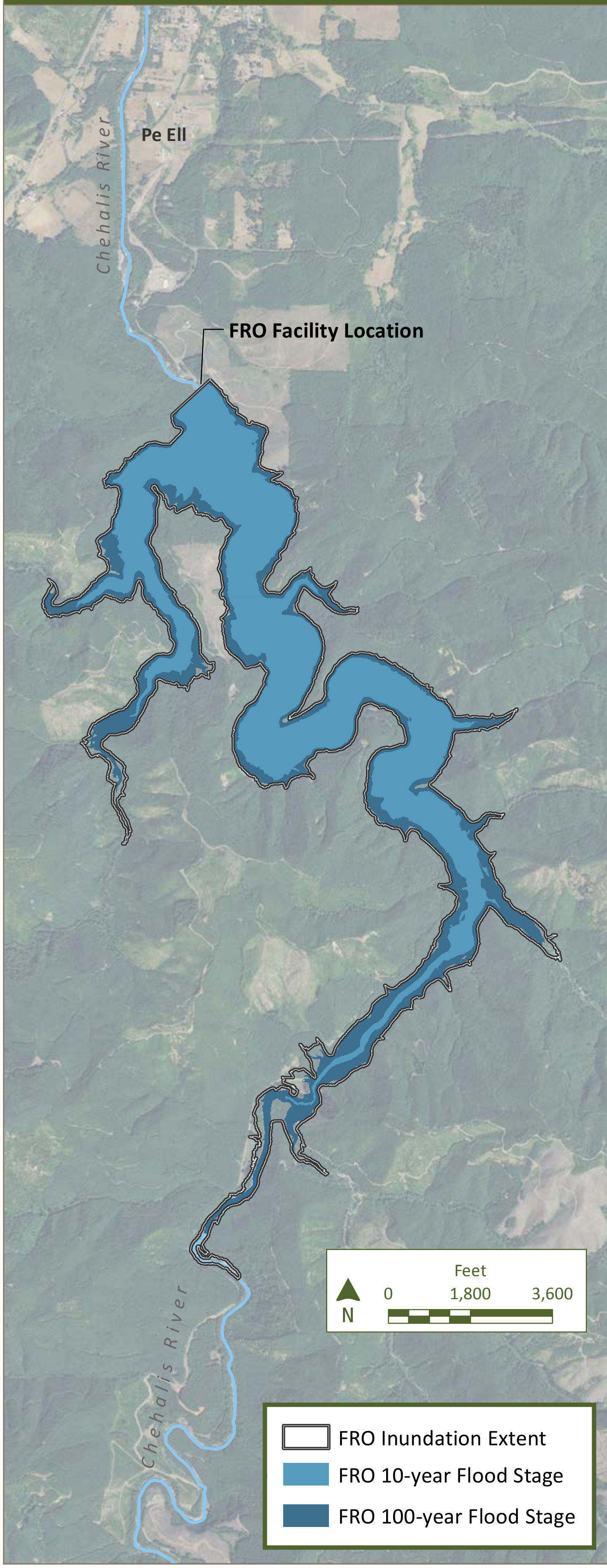
As part of the detailed water quality modeling completed to support this EIS, a preliminary optimization of reservoir flow and temperature releases was performed (Anchor QEA 2016b, 2016c). Different operating scenarios were reviewed and tested using the reservoir water quality model and the Chehalis River water quality model (PSU 2016). The optimized operating scenario is evaluated for this EIS.

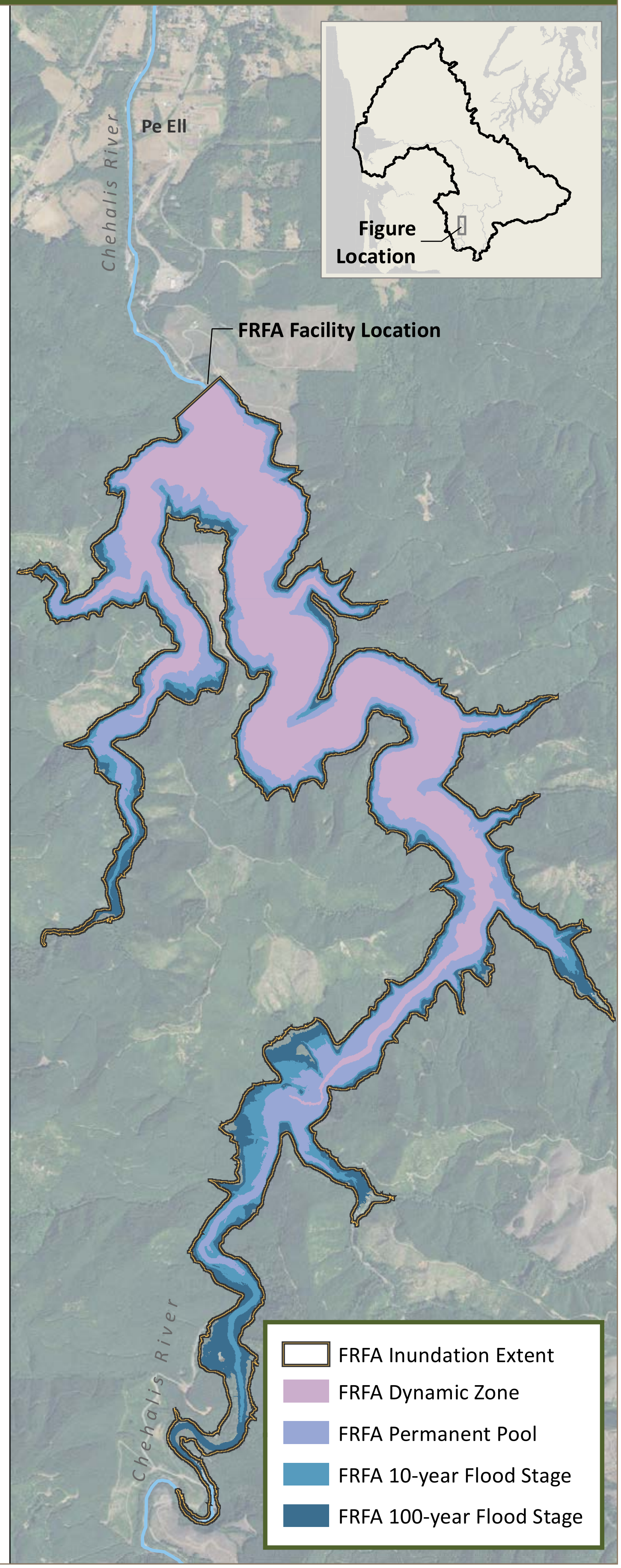
The operation of the Flood Retention Facility would have the potential to affect water resources through changes to surface water quality, surface water quantity, and groundwater through periodic or permanent inundation upstream of the dam, peak flow reduction, and low flow increases (for the FRFA facility) in the Chehalis River downstream of the dam.

No adverse impacts on water use and water rights downstream of the dam are anticipated because flow changes would not affect the ability of water users to divert their water right downstream of the dam during its operation. Water stored in the FRFA reservoir during the winter and released during low-flow periods would augment flows and improve temperature (for the benefit of aquatic species; other uses would be secondary). Because the proposed reservoir would impound more than 10 acre-feet of water, a reservoir permit, which is issued by Ecology, would be required per Chapter 90.03.370 RCW. To mitigate for adverse impacts on Pe Ell's water supply, the intake would be relocated or a new water source would be provided, requiring a change in the water right.

Figure 4.2-1

Reservoir Inundation Areas





4.2.1.2.1 Surface Water Quality

Adverse impacts on surface water quality are primarily related to the conversion of the upper Chehalis River to a temporary (FRO) or permanent (FRFA) reservoir, streamside and hillslope vegetation removal, peak flow reduction, and flow augmentation in the Chehalis River downstream of the dam. Adverse impacts on surface water quality are anticipated to include the following:

- Adverse impacts on water quality constituents, including violations of state water quality standards: sediment and turbidity; temperature, DO, and nutrients; and mercury (Hg)
- Potential pollutant loading at the Flood Retention Facility from operations, and reduction in downstream pollutant loading (heavy metals, hazardous materials) during peak floods

Flow augmentation and temperature reductions downstream of the dam in the mainstem Chehalis River (FRFA facility only) would result in a beneficial effect to surface water quality.

Water Quality Constituents

Suspended Sediment and Turbidity

FRO and FRFA facility operations have the potential to affect suspended sediment and turbidity in the reservoir footprint area, and downstream of the dam in the Chehalis River.

For both the FRO and FRFA facilities, sediment could be generated from surface runoff from exposed slopes along the reservoir footprint, and along shoreline areas from erosion (from wave action) at the reservoir water line. The area within the permanent pool of the FRFA reservoir would be cleared, and fluctuating reservoir levels would expose bare soils to erosion. Fine sediment previously deposited in the reservoir area could be re-suspended when reservoir water levels rise or fall, increasing suspended sediment and turbidity in the reservoir as the reservoir level fluctuates. The potential for increased turbidity and suspended sediments from slope erosion in the reservoir is greater for the FRFA facility than the FRO facility because of the bare slopes within the permanent pool of the FRFA reservoir. In addition, as compared to natural conditions, higher levels of sediment could be delivered to a temporary or permanent reservoir area from landslides that could potentially be triggered by fluctuating water levels, resulting in highly turbid conditions in the reservoir (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 with respect to suspended sediment and turbidity conditions by violating the state water quality criterion for turbidity (5 Nephelometric Turbidity Units [NTU] over background).

Downstream of the dam, changes in the suspended sediment and turbidity levels in the Chehalis River would occur due to the following:

- Capture of sediment in the reservoir
- Change in the rate and timing of suspended sediment transport out of the reservoir

- Reduction in bank erosion by reducing peak flows
- Potential reduction in the downstream floodplain area that could settle sediment out

For both the FRO and FRFA facilities, 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). Based on proposed facility operations, this drawdown period could last up to 32 days. For both configurations, some fine sediment would be trapped during the flood retention period, reducing the overall quantity of suspended sediment released during that time. For the FRO facility, high flows that occur outside of flood retention periods can erode previously deposited fine sediment in the reservoir, causing higher rates of suspended sediment to be released than under existing conditions. This would create more frequently occurring turbid conditions in the Chehalis River downstream of the dam. The effects of these processes have the potential to result in a moderate to significant adverse impact on downstream water quality relative to suspended sediment and turbidity conditions.

Temperature, Dissolved Oxygen, and Nutrients

Within the FRO and FRFA reservoir inundation areas, streamside vegetation, especially mature conifers, would be removed in areas along the Chehalis River and its tributaries. This can affect temperature in the reservoir footprint as well as the Chehalis River downstream as discussed in the following sections. Flood retention is anticipated to only occur in the FRO reservoir during October to March when air and water temperatures are cooler. When in operation, the FRO facility flood retention periods are shorter than in the FRFA facility, limiting the potential for temperature and DO impacts as compared to the FRFA facility.

Reservoir Footprint

In the FRO reservoir, increased solar heating of the Chehalis River in the reservoir inundation area would occur due to reduction of riparian vegetation. Predictions of a water quality model that simulated the anticipated changes to temperature indicated a nearly 4˚C increase in summer water temperatures (over existing conditions) could occur along the mainstem at the dam site (RM 108.6; 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 approximately 1˚C. Since warmer waters hold less DO, and can also stimulate biological activity that creates a greater demand for DO, lower DO concentrations in the reservoir area are expected. With the increase in temperature of nearly 4˚C along the mainstem at the dam site and a decrease in DO, there would be a significant adverse impact on water quality (temperature and DO).

Applicable Temperature Water Quality Criteria

The temperature surface water quality criteria for lakes and reservoirs states that "human actions may not exceed 0.3˚C (0.54˚F) above natural conditions" (WAC 173-201A). For this EIS evaluation, compliance with this standard cannot be determined because a reservoir is not currently established. Therefore, results of temperature modeling are compared to the core summer salmonid habitat temperature criterion of 16˚C (WAC 173-201A) and the supplemental spawning and incubation protection water temperature criterion (effective September 15 to July 1) of 13˚C, which supersedes the 16˚C criteria during this timeframe (Ecology 2011a). Some of the Chehalis River tributaries within the reservoir footprint also have the supplemental spawning and incubation temperature criteria applied from October 1 through May 15 (see Appendix D, Figure D-2 for the extent of these tributaries).

Model simulation of impacts during the wet period (late fall to early spring) for the FRO reservoir indicated that moderate impacts on water temperature could result if flood retention is necessary early in the wet period (October to November) when air temperatures are still warm relative to the peak wet period (December through March; PSU 2016). The associated water quality impacts (changes in DO and biological activity within the FRO reservoir) during the wet period are expected to be minor as a result of the minor predicted increases in temperature.

For the FRFA facility, the conservation pool would have varying water temperatures depending on the season and depth within the reservoir. Model predictions showed that the temperatures in the upper portions of the conservation pool would increase more rapidly than the lower layers due to surface heating from solar radiation, resulting in thermal stratification during the summer and fall months (see Figure 4.2-2). During July, the temperature differential between the conservation pool's surface layer and bottom layer can approach 18˚C, dependent on the year. Surface layer temperatures could reach approximately 20 to 25˚C depending on meteorological conditions, which is comparable to current conditions that exist in the summer in the Chehalis River without the reservoir (see Figure 4.2-2). The model predictions also show that algal activity (which produces oxygen) would be increased in the upper layers of the reservoir over late spring through mid-summer, resulting in a condition where DO exceeds 100% saturation (condition known as supersaturation). However, model simulations also showed that decomposition of the algae (that die and settle from the surface layers) and the organic matter (from the watershed that settles) in the reservoir sediments result in increased oxygen demand (i.e., consumption) in the lower layers, resulting in lower DO levels than at the surface. Since the reservoir is predicted to stratify, oxygen cannot mix from the surface layer to the lower layers to meet this oxygen demand, thereby resulting in lower oxygen concentrations (hypoxic conditions) in the bottom waters in late summer (see Figure 4.2-3).

Figure 4.2-2

Modeled Temperature Profile Within FRFA Reservoir Conservation Pool

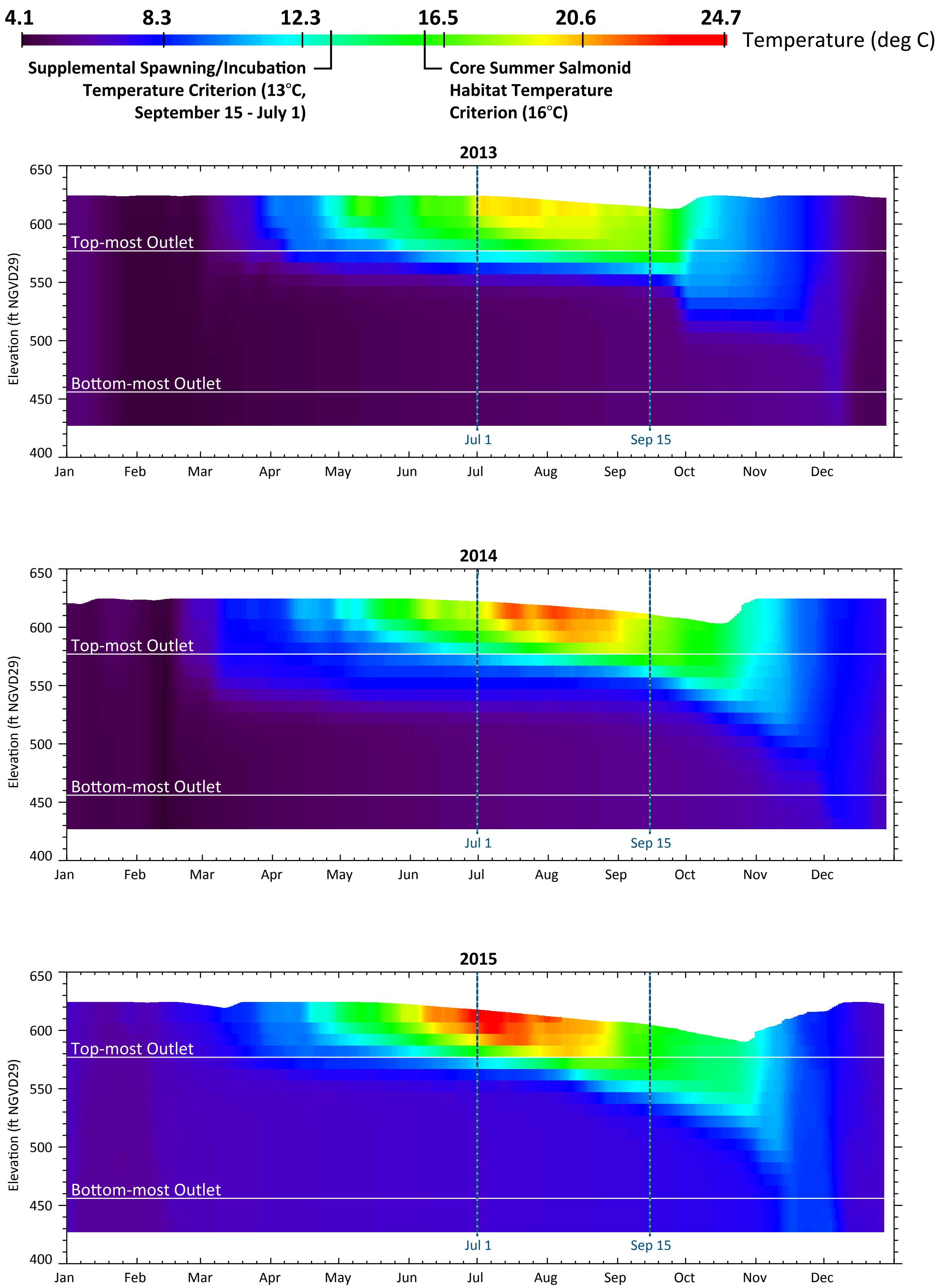


Figure 4.2-3

Modeled Dissolved Oxygen Profile Within FRFA Reservoir Conservation Pool

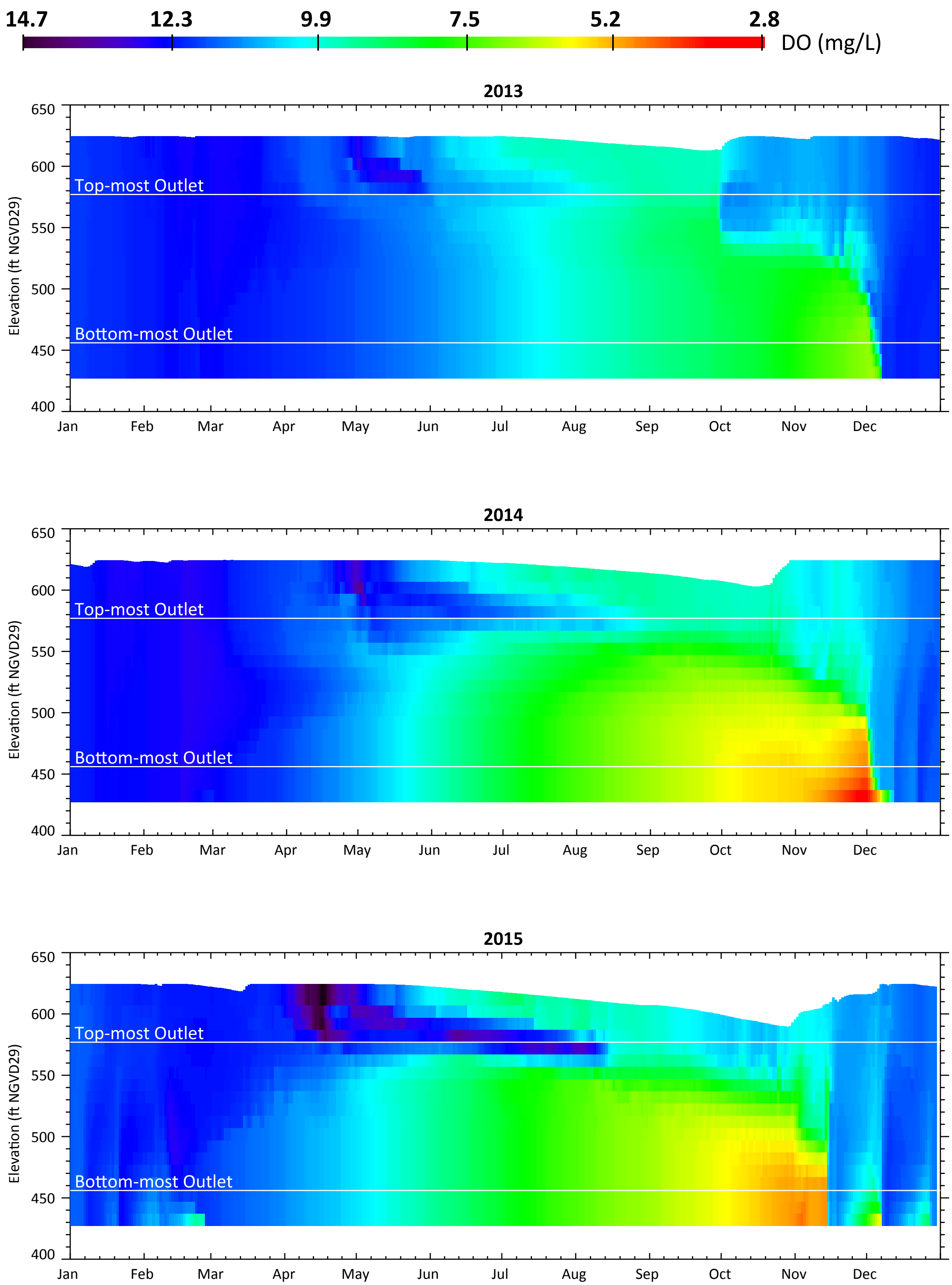


Figure 4.2-2 shows that upper portions of the conservation pool do not meet the core summer salmonid habitat criterion (of 16°C), whereas Figure 4.2-3 shows that portions of the lower waters do not meet the DO criterion (of 9.5 mg/L) in late summer. Model simulations showed that over certain depths in the reservoir (from an elevation of approximately 560 to 580 feet), both the temperature and DO criteria are met simultaneously over portions of the summer period, but there are other periods when at least one criterion is not met throughout the water column. However, there are also periods where neither criterion is met in the top portion of the conservation pool during summer. Therefore, a moderate adverse impact on water quality (temperature and DO) in the reservoir during late summer and early fall is anticipated because surface water quality criteria are not predicted to be met during water storage in the reservoir.

Water quality standards are based on the protection of existing and designated uses. As noted in the sidebar, the area that would be inundated by a permanent FRFA reservoir is protected by the designated use "Core Summer Salmon Habitat" (WAC 173-201A-200). The FRFA reservoir would permanently inundate existing spawning areas, and eliminate habitat features necessary for spawning and emergence of salmonids, as is required for this designated and existing use.

Waterbody Use Terms

- **Designated uses –**These are defined in the surface water quality standards, which specify the quality of aquatic life uses that must be protected in each waterbody. This designation applies regardless of whether the associated numeric criteria are fully attained.
- **Existing uses –** USEPA regulations define existing uses as "those uses actually attained in a water body on or after November 28, 1975 whether or not they are included in the water quality standards." A waterbody's existing uses serve as the baseline or 'floor' of the uses that must be maintained, including the habitat and water quality conditions necessary to protect them. Any change in the designated uses may not result in a lesser aquatic life use or numeric criteria than those that have been determined necessary to meet existing uses.

Downstream of Flood Retention Facility

Impacts on the water temperature in the Chehalis River downstream of the dam were evaluated with a temperature model that simulated both baseline and with a reservoir upstream for both the FRO and FRFA facilities (PSU 2016). The predicted changes in downstream temperatures relative to existing conditions for both the FRO and FRFA facilities in July (during a period of predicted high water temperatures) are shown in Figure 4.2-4.

For the FRO facility, Figure 4.2-4 shows that the greatest downstream impact is predicted immediately below the reservoir (approximately 2 to 3°C warmer than existing conditions) during summer (July 15) with negligible impacts below the confluence of the South Fork Chehalis River (RM 88). This would result in a moderate adverse downstream impact with regard to stream temperature during peak summer temperatures. Model simulations indicated that downstream impacts resulting from flood storage could result in minor changes in temperature (increase or decrease) relative to current conditions, depending on whether the flood occurs during the peak wet season (December to February) or during the early or later stages of the wet season (see Appendix H; PSU 2016). However, these changes were not predicted to result in a violation of temperature criteria beyond what would occur under current conditions. Therefore, the FRO reservoir release is expected to have a minor adverse impact on downstream temperature from late fall through early spring (see Appendix H; PSU 2016).

The potential also exists for reduced DO concentrations in floodwater discharged from the FRO reservoir as a result of any water temperature warming, decay of organic material, and periodic sediment inputs at and upstream of the dam. Based on water quality modeling for the FRFA reservoir (which would store nearly twice the volume proposed for the FRO reservoir), adverse impacts on DO were predicted within the reservoir over the wet season (October through March) near the bottom (see Figure 4.2-3). Moreover, the impacts predicted for the FRFA facility are the result of warmer conditions over the summer when productivity in the reservoir resulted in a higher oxygen demand at the bottom of the reservoir in the fall. For the FRO facility, the impact is likely to be minor because flood retention operations would occur in cool months and the retention time is short. In addition, the reservoir would be drained between flood retention operations and sediment and organic materials would be transported out of the reservoir by river flows. Therefore, it is estimated that there is potential for a minor adverse impact as a result of FRO dam operations, particularly if flood storage is required earlier in the wet season (for example during October and November). Dry season FRO facility scenarios are not presented or discussed because the FRO facility would not be operational.

For the FRFA facility, temperature modeling of the controlled releases of waters from different parts of the FRFA reservoir (flow augmentation) showed that downstream water temperatures in the Chehalis River can be improved during late spring through early fall. The predicted effects of flow augmentation on downstream river temperatures are shown in Figure 4.2-4. In particular, in the upper sections of the reaches designated as core summer salmonid habitat, improvements of up to 10°C were predicted, which would bring these reaches into compliance with the 16°C criterion during the summer immediately downstream of the dam. The model simulations also showed that the anticipated downstream benefits attenuate to existing background conditions to near the confluence of the Skookumchuck River (approximately RM 65; see Figure 4.2-4).

Modeling predicts that the release of cooler waters from the lower depths of the reservoir (see Figure 4.2-2) would also result in release of waters to the Chehalis River that are lower in DO and rich in nutrients and dissolved organic matter. Adverse impacts on DO near the bottom of the reservoir were predicted over the wet season (October through March; see Figure 4.2-3). Based on the conceptual design and operations plan for the FRFA facility, it is anticipated that DO levels would be enhanced in the outflow through engineered aeration. However, the nutrients in the reservoir outflow have a potential to cause an adverse impact on downstream water quality by stimulating algal growth in summer and fall (lowering DO concentrations). The extent of such impacts is presently being evaluated in the downstream water quality model. If adverse impacts are determined, then reservoir operations would be revised to reduce nutrient-rich waters from the bottom of the reservoir to minimize the downstream impacts, while still providing the downstream temperature-reduction benefit. The multi-outlet tower proposed in the operations plan would allow for such modifications.

Mercury

The potential exists in the FRFA reservoir for the conversion of atmospheric inorganic Hg to organic methylmercury (MeHg), a more toxic form that accumulates in the food web and in fish. The local atmospheric levels of Hg are not quantified at this time, but could be evaluated during project-level environmental review. The FRFA reservoir could provide an environment for the growth of the sulfite-reducing bacteria that convert Hg to MeHg. Non-salmonid species (e.g., mountain whitefish, rainbow trout, Northern pikeminnow) have the potential to spend extended periods of time in the reservoir, and salmonids have the potential to spend up to 1 year in the reservoir (see Section 4.2.4.2 for effects to fish). The local atmospheric source (the Chehalis Power Plant) would no longer exist after the year 2020, which is before a Flood Retention Facility would be constructed, thereby reducing a potential local source of atmospheric Hg. An additional source of Hg would be from the exposed sediment in the reservoir footprint and from sediment entering the reservoir from surface erosion and landslides. This would likely be a minor adverse impact due to the short reservoir residence times (less than 100 days) and lack of local atmospheric sources.

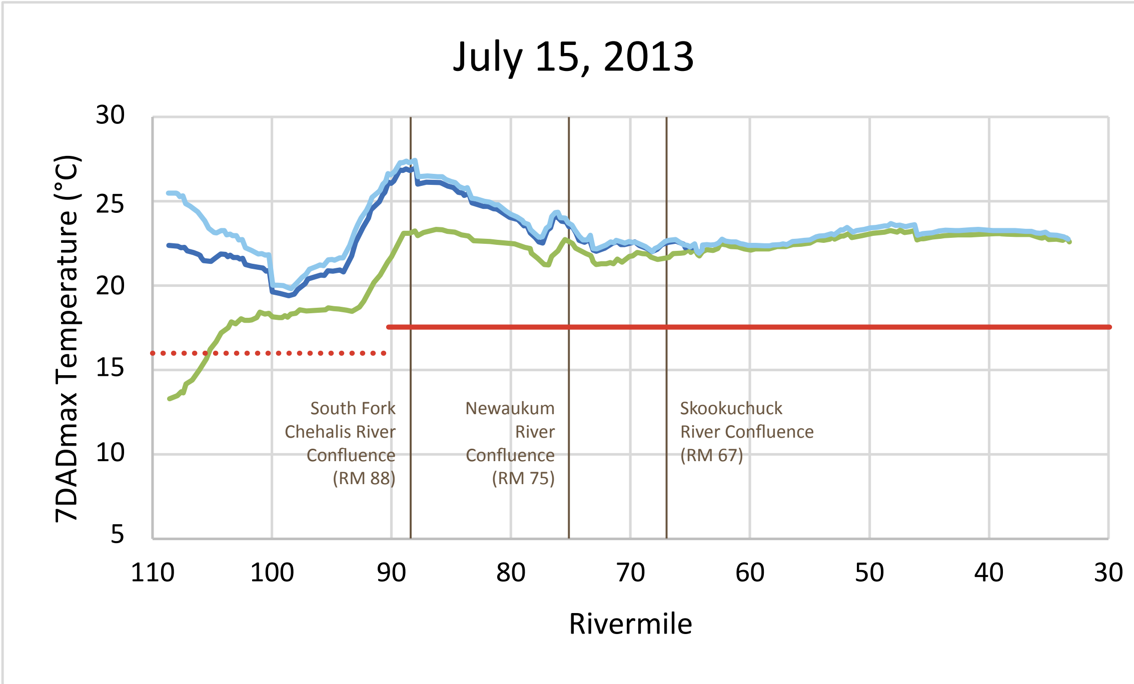
Pollutant Loading

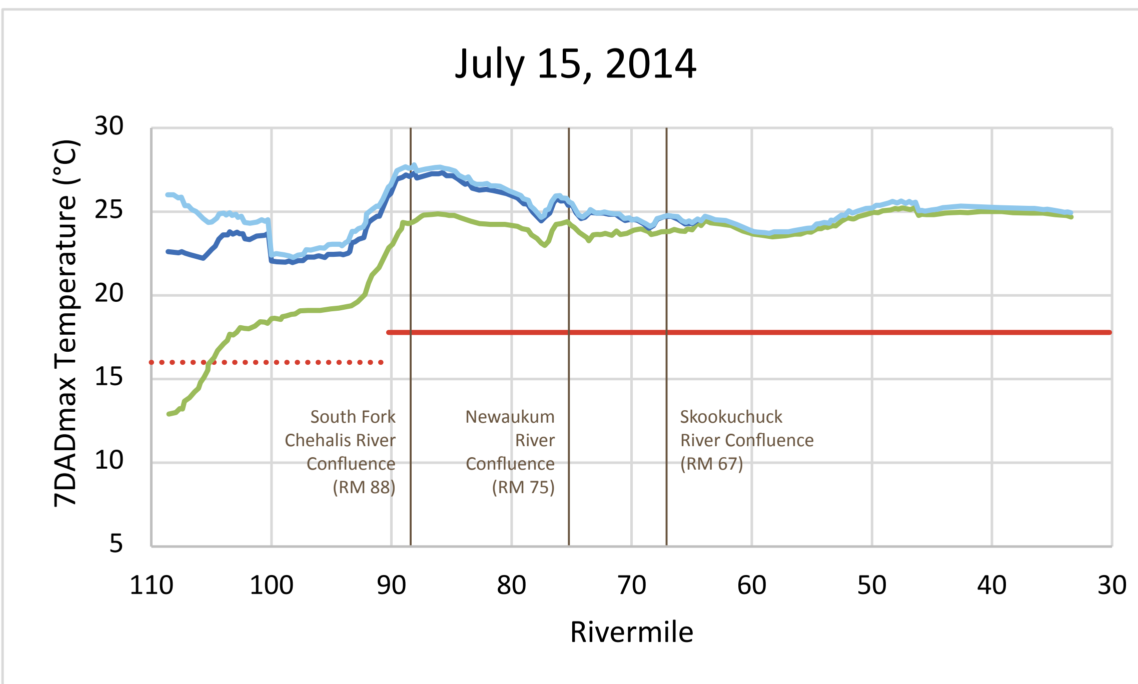
Operations and maintenance of the Flood Retention Facility has the potential to introduce pollutants by spills or contamination, use of hydraulic fluids, and other potential pollutants related to facility operations. This potential exists at and in the vicinity of the Flood Retention Facility. This potentially could be a minor to moderate adverse impact in the vicinity of the dam.

Flood retention operations would reduce downstream flooding, thereby reduces the area from which floodwaters have the potential to accumulate toxins and pollutants during a flood, which is a beneficial effect. A reduction in the area of the floodplain inundated by a major flood downstream of a dam could reduce the contamination of surface water, and the release of pollutants and hazardous materials from flooding urban areas and agricultural fields and facilities. Mobilization of pollutants to the Chehalis River would be reduced from sources such as livestock grazing (e.g., fecal coliform bacteria), atmospheric deposition of Hg (as dry fall-out and precipitation), and fuel and chemicals stored in the Chehalis River floodplain. Section 4.2.15.2 describes the improvements to environmental health and safety as a result of these effects.

Figure 4.2-4

Modeled Temperatures Downstream of Flood Retention Facility





Modeled Baseline Conditions
FRFA Modeled Temperature Scenario
FRO Modeled Temperature
Core Summer Salmonid Habitat Temperature Criterion (16°C)
Spawning, Rearing, and Migration Criterion (17.5°C)

Downstream Flow Augmentation

No flow augmentation would occur with FRO facility operations. Currently, the mainstem Chehalis River experiences high summer and early fall water temperatures that routinely exceed applicable criteria (WAC 173-201A; Ecology 2012). The FRFA facility operations would improve water quality in the Chehalis River downstream of the dam to approximately the confluence of the Skookumchuck River (RM 65) during the late summer and early fall due to cool-water flow augmentation from the reservoir pool (see Figure 4.2-4). From the late spring to early fall (mid-May to October), natural flows in the upper Chehalis River are low; median flows are currently from 20 to 160 cfs. The minimum discharge at the dam would range from 80 to 160 cfs during this timeframe. This flow augmentation would increase flows and reduce temperatures at and downstream of the proposed dam. The model predicted temperature improvements would be in the range of 10°C immediately downstream of the dam, with the proposed flow range (80 to 160 cfs) during the summer. In the fall, warmer water in the range of 1 to 2°C (higher than baseline condition) could potentially be discharged as a result of warming in the upstream reservoir. This flow would be cooler in temperature than existing flows in the mainstem Chehalis River during the late summer through early fall (see water quality benefits described for temperature and DO). This increase in cool-water flow could improve habitat conditions in the mainstem Chehalis River (downstream of the dam) for cool-water dependent aquatic species that use this area by lowering water temperatures and improving DO conditions (see Section 4.2.4 for effects to fish and wildlife).

4.2.1.2.2 Surface Water Quantity

The primary purpose of the Flood Retention Facility is to retain floodwater during a major flood. For FRO facility operations, river flows would be retained in a reservoir on the Chehalis River only during and after a major flood or greater. For the FRFA facility, the Chehalis River would be converted to a permanent reservoir for 6.3 miles upstream of the dam. Adverse impacts on surface water quantity are anticipated to be related to the following:

- Changes in flows and inundation of the mainstem Chehalis River at and upstream of the Flood Retention Facility
- Retention of a major flood and changes in downstream flow regimes

The dam would alter the Chehalis River from a free-flowing river to a reservoir. For the FRO facility, these changes would result in a moderate adverse impact on surface water quantity because the river within the reservoir footprint would be periodically inundated once every 7 years on average (or 15% probability of occurring in any given year) for a period of up to 32 days. When the FRO facility is not operational, the river would continue to be a free-flowing river. For the FRFA facility, these changes would result in a significant adverse impact because the Chehalis River would be changed from a free-flowing river to a permanent reservoir, affecting instream habitat conditions currently used by aquatic species in the system. Table 4.2-1 provides a summary of the potential changes to surface water quantity at and above the dam.

Table 4.2-1
Flood Retention Facility Reservoir Conditions for Surface Water Quantity

CONDITIONS	FRO FACILITY[1]	FRFA FACILITY[1]
Reservoir permanency	Reservoir inundation upstream of the FRO dam would be temporary (up to 32 days)	Permanent reservoir pool would be maintained with additional capacity to retain floods
Inundation extent	Temporary reservoir would extend 5.3 miles, on average, during a major flood	Permanent reservoir would extend 6.3 miles (at full conservation pool extent)
Maximum periodic inundation extent	6.2 miles to account for floods similar to the 2007 flood	7.6 miles to account for floods similar to the 2007 flood
Maximum inundated area	778 acres	1,264 acres
Median (mid-point) reservoir elevation during flood operations	513 feet	602 feet
Maximum reservoir elevation during flood operations	620 feet	683 feet
Median (mid-point) reservoir depth during flood operations	88 feet	177 feet
Maximum reservoir depth during flood operations	195 feet	258 feet
Capacity	65,000 acre-feet	Conservation pool: 65,000 acre-feet Flood storage pool: 65,000 acre-feet Total: 130,000 acre-feet

Note:
1. Elevation of the river bed at the proposed dam site is 420 feet

Outside of flood operations, the FRFA reservoir level would fluctuate in response to inflow and outflow. The proposed operations of the FRFA facility would limit the reservoir drawdown to provide flexibility for releasing cool water in the summer and better downstream passage conditions for juvenile fish. Anchor QEA (2016c) provides details of facility operations related to surface water quantity.

Downstream of the dam, discharge from the reservoir would be reduced during a major flood in order to decrease downstream flooding. Modeled flood flow reductions at Grand Mound are provided in Table 4.2-2.

Table 4.2-2
Peak Flow Comparison of Chehalis River at Grand Mound

FLOOD	EXISTING PEAK FLOW (cfs)	PEAK FLOW WITH FLOOD RETENTION (cfs)	DIFFERENCE IN PEAK FLOW (%)
100-year	70,600	58,400	-17.3%
10-year	43,800	37,500	-14.4%
1996	72,100	61,200	-8.5%
2007	71,100	52,100	-26.7%
2009	57,300	48,600	-15.2%

Downstream of the Flood Retention Facility, flood elevations would be reduced along the mainstem Chehalis River from the dam to the mouth of the river. The reduction in flood elevations would vary depending on the location and magnitude of the flood, with larger reductions generally closer to the dam and smaller reductions farther downstream. Modeled flood elevation reductions for a 100-year flood at various locations along the Chehalis River are provided in Table 4.2-3.

Table 4.2-3
Flood Retention Facility Flood Elevation Reductions along Chehalis River (100-year Flood)

LOCATION	EXISTING 100-YEAR FLOOD PEAK ELEVATION (FEET)	100-YEAR FLOOD PEAK ELEVATION WITH FLOOD RETENTION (FEET)	DIFFERENCE IN FLOOD ELEVATION (FEET)
Near Doty	319.2	308.1	-11.1
Downstream of South Fork	222.2	217.1	-5.1
Along airport levee	180.5	179.0	-1.5
Behind airport levee	180.3	173.3	-7.0
Mellen Street	177.7	176.0	-1.7
Galvin Road	168.2	166.5	-1.7
Grand Mound	147.5	146.6	-0.9
Near Rochester	124.4	123.4	-1.0
Black River confluence	93.5	92.5	-1.0
Satsop River confluence	33.9	33.3	-0.6
Montesano	18.6	17.9	-0.7

Source: WSE 2014d

The Flood Retention Facility would not reduce flood elevations or associated flood damage to structures along tributaries to the Chehalis River, except in the downstream-most areas of tributaries that are subject to flooding from high water levels in the Chehalis River. In those tributaries, such as the South Fork Chehalis River, Newaukum and Skookumchuck rivers, flood levels would be reduced indirectly as a result of a Flood Retention Facility reducing flood flows in the Chehalis River.

Modeled results related to structures that are no longer flooded have been developed for the combined Flood Retention Facility and Airport Levee Improvements and are described in more detail in Chapter 5.

4.2.1.2.3 Groundwater

Adverse impacts on groundwater could be related to the following:

- Changes to groundwater recharge in the reservoir footprint
- Changes to groundwater flow regime in downstream floodplain areas

Very little groundwater exists in the area where the reservoir would be located because it is situated in a narrow canyon, and a thin layer of alluvial material overlies bedrock throughout the length of the proposed reservoir site. Hillsides in and adjacent to the reservoir footprint also have limited groundwater storage capacity because of steep slopes and thin layers of soil over bedrock. During operation of either Flood Retention Facility (when the flood pool is filled), additional recharge could occur along hillsides and the reservoir bed would be saturated, slightly increasing groundwater storage. Groundwater conditions would return to existing when the flood pool is drawn down, and no adverse impacts on groundwater quantity are anticipated in the dam and reservoir footprint. When the FRO facility is not operational, groundwater recharge would be similar to existing conditions.

Downstream of the dam, a reduction in groundwater recharge could occur due to a reduction in the Chehalis River floodplain area that is inundated during floods with a greater than 7-year recurrence interval. The Chehalis River floodplain would be reduced by about 4,480 acres during a 100-year flood, which is about 10% of the existing floodplain area. This reduction in floodplain area would be realized along the entire mainstem Chehalis River; however, more reduction would occur throughout the upper mainstem. The extent of floodplain reduction would be less during smaller (less than 7-year recurrence) floods. The potential reduction in recharge could be partially offset by higher stages in the river for a longer duration than existing as the reservoir empties, but this has not been quantified to support this programmatic-level analysis. Localized modifications of the hyporheic zone could occur because of changes to flow and inundation areas. See Section 4.2.4 for a discussion of how changes to groundwater could affect aquatic species.

Summer flow augmentation with the FRFA facility could contribute to some groundwater recharge in losing reaches (i.e., reaches where flow is presently from river to groundwater) compared to existing conditions. Overall, significant adverse impacts on groundwater flow regimes are not expected downstream of the Flood Retention Facility. However, this has not been quantified to support the preliminary analysis for this programmatic EIS.

> **Hyporheic Zone**
>
> The hyporheic zone is a region beneath and alongside the river bed, where there is mixing of shallow groundwater and surface water. The flow dynamics and behavior in this zone is recognized to be important for surface water/groundwater interactions, as well as fish spawning, among other processes.

No adverse impacts on groundwater quality are anticipated from either FRO or FRFA reservoir operations either within the reservoir footprint or downstream of the dam.

4.2.1.3 Mitigation

Potential mitigation measures for short-term impacts on water resources are described in Table 4.1-1. Potential avoidance, minimization, and mitigation measures for long-term impacts on water resources are described in the following sections.

4.2.1.3.1 Surface Water Quality

Compensatory mitigation for actions that are anticipated to have long-term, significant, or unavoidable impacts on surface water quality is detailed in this section.

At this time, it is not known whether completely eliminating and indefinitely removing an existing and designated use within a broad geographic area, such as the FRFA reservoir, could be mitigated, and if this action would be allowable within the state's authority under CWA Section 401. The FRO reservoir could periodically affect or modify a portion of the waterbody's existing designated use, but the designated use as a whole could remain. If proposed mitigation for the FRO facility provides evidence that habitat features and types associated with the existing designated use would remain intact and water quality standards would be met, this type of Flood Retention Facility may not be subject to the same CWA Section 401 certification challenges as the FRFA facility with regard to meeting water quality standards.

Sediment and Turbidity

Avoidance and minimization measures to limit sediment and turbidity in the reservoir area could include the following:

- Revegetating cleared areas (for both FRO and FRFA reservoirs) with trees that could withstand periodic inundation (e.g., partially submerged in the reservoir pool)
- Keeping trees that could withstand inundation in areas requiring thinning
- Maintaining a reservoir drawdown rate that limits slope instability (10 to 20 feet per day; Shannon & Wilson 2014a)
- Maintaining a minimum pool of water in the FRFA reservoir to reduce potential mobilization of sediments and associated nutrients and contaminants from the reservoir
  - For example, the maximum drawdown would be 40 vertical feet (below the elevation of the conservation pool), minimizing the exposed area during operations

Compensatory mitigation for potential impacts from sediment and turbidity could include implementation of a Reservoir Operations and Management Plan that includes monitoring riparian vegetation and shoreline erosion, and treating erosion areas to reduce sediment impacts. The potential for soil erosion associated with periods of pool drawdown would also be monitored and evaluated within the plan, and would be used to adaptively manage dam operations and reservoir drawdown rates.

Temperature and Dissolved Oxygen

Avoidance and minimization measures to address water temperatures downstream of the dam could include managing FRFA facility operations to optimize cool temperatures and flow benefit for aquatic species (in the Chehalis River) and maintain DO conditions that are compliant with the state water quality criterion of greater than 9.5 mg/L.

Compensatory mitigation measures to address losses of riparian shade within the reservoir and downstream of the dam could include planting riparian vegetation that is more flood tolerant within the reservoir footprint (for either the FRO or FRFA facilities). This would likely not mitigate all of the riparian loss at the reservoir site, and additional downstream riparian planting could be required.

Mercury and Pollutants

Avoidance and minimization measures for potential spills or contamination, hydraulic fluids, and other potential pollutants related to Flood Retention Facility operations could include implementation of a project-specific Spill Prevention and Response Plan.

4.2.1.3.2 Surface Water Quantity

Avoidance and minimization measures for surface water quantity could include managed reservoir drawdown rates, release rates, debris management, and other factors. No long-term compensatory mitigation measures are proposed for water quantity impacts because the overall effect would be beneficial due to the reduction in flooding (FRO and FRFA facilities) and the improvement in instream flow (FRFA facility).

4.2.1.3.3 Groundwater

No long-term adverse impacts on groundwater quantity or quality are anticipated, so no mitigation is proposed.

4.2.2 Geology and Geomorphology

4.2.2.1 Short-term Impacts

4.2.2.1.1 Geology

The potential short-term impacts on geology that would occur during construction are described in Table 4.1-1. In addition, the construction of a temporary river bypass tunnel would require the permanent placement of tunnel muck outside of the dam and reservoir footprints. This impact would be confined to the immediate area around the waste sites where muck would be permanently placed. The conceptual design proposes using on-site quarries to provide aggregate for construction. If off-site quarries were also used, the local supply of these construction materials could be reduced, thereby driving up prices for the materials or limiting development that uses those materials.

4.2.2.1.2 Geomorphology

The potential short-term impacts on geomorphology are described in Table 4.1-1. Additional short-term impacts include the interruption of sediment and wood transport regimes throughout the construction work zone, and the loss of channel function for the river segment that is re-routed through the work zone.

4.2.2.2 Long-term Impacts

In addition to references by others, the impacts on geology are informed by field work and studies that have been completed by engineering geologists and geotechnical engineers for the Chehalis Basin Strategy since 2009. They include geologic mapping, landslide identification and analysis, rock quarry material identification and evaluation, seismicity analysis, seismic engineering studies, logging of deep drill holes, downhole and seismic refraction geophysical surveys, rock and soil laboratory testing, and preliminary geotechnical engineering analyses. The reference documents that present this work include the following (in chronological order):

- *Reconnaissance-Level Geotechnical Report, Proposed Chehalis River the South Fork Dam Sites, Lewis County, Washington (*Shannon & Wilson 2009)
- *Preliminary Desktop Landslide Evaluation* (Shannon & Wilson 2014b)
- *Quarry Rock Desktop Study* (*S*hannon & Wilson 2014c)
- *Landslide Reconnaissance Evaluation of the Chehalis Dam Reservoir* (Shannon & Wilson 2015)
- *Phase 1 Site Characterization Technical Memorandum* (HDR and Shannon & Wilson 2015)
- *Phase 2 Site Characterization Technical Memorandum* (HDR and Shannon & Wilson 2016)

Adverse impacts on geomorphology are based on field work by geologists and geomormorphologists, sediment transport modeling, analysis of existing and historical geomorphic conditions, and the results and findings from the following studies:

- *Geomorphology and Sediment Transport Draft Technical Memorandum* (Watershed GeoDynamics and Anchor QEA 2014)
- *Draft: Summary of the Effects on the Chehalis Flood Retention Only (FRO) Reservoir Operations on Aquatic Habitat in the Reservoir Area* (Dubé 2016)
- *Geomorphology, Sediment Transport, and Large Woody Debris* (Watershed GeoDynamics and Anchor QEA 2016)

4.2.2.2.1 Geology

The potential adverse impacts on geology are related to the following:

- Shallow rapid and deep-seated landslides triggered by fluctuating reservoir water levels and tree removal
- Erosion along the reservoir perimeter (from wave action and erosion of exposed slopes in areas of vegetation removal) increasing sedimentation and turbidity in the reservoir
- Increased low-level induced seismicity from the weight of water in the FRFA reservoir

In the reservoir area, fluctuating water levels and removal of trees could trigger shallow landslides and deep-seated landslides around the reservoir footprint (RM 108 to RM 114; see Figure 4.2-5). Because shallow landslides have the potential to occur around the reservoir perimeter with impacts isolated to the reservoir area, the adverse impact on geology would be moderate. For deep-seated landslides, there would be a minor to moderate adverse impact for the FRO facility due to the limited presence of a fluctuating reservoir (once every 7 years) and slightly smaller reservoir footprint, and a moderate adverse impact for the FRFA facility because the risk for slope instability could be higher and more widespread due to the larger reservoir footprint and increased saturation of the landslide masses.

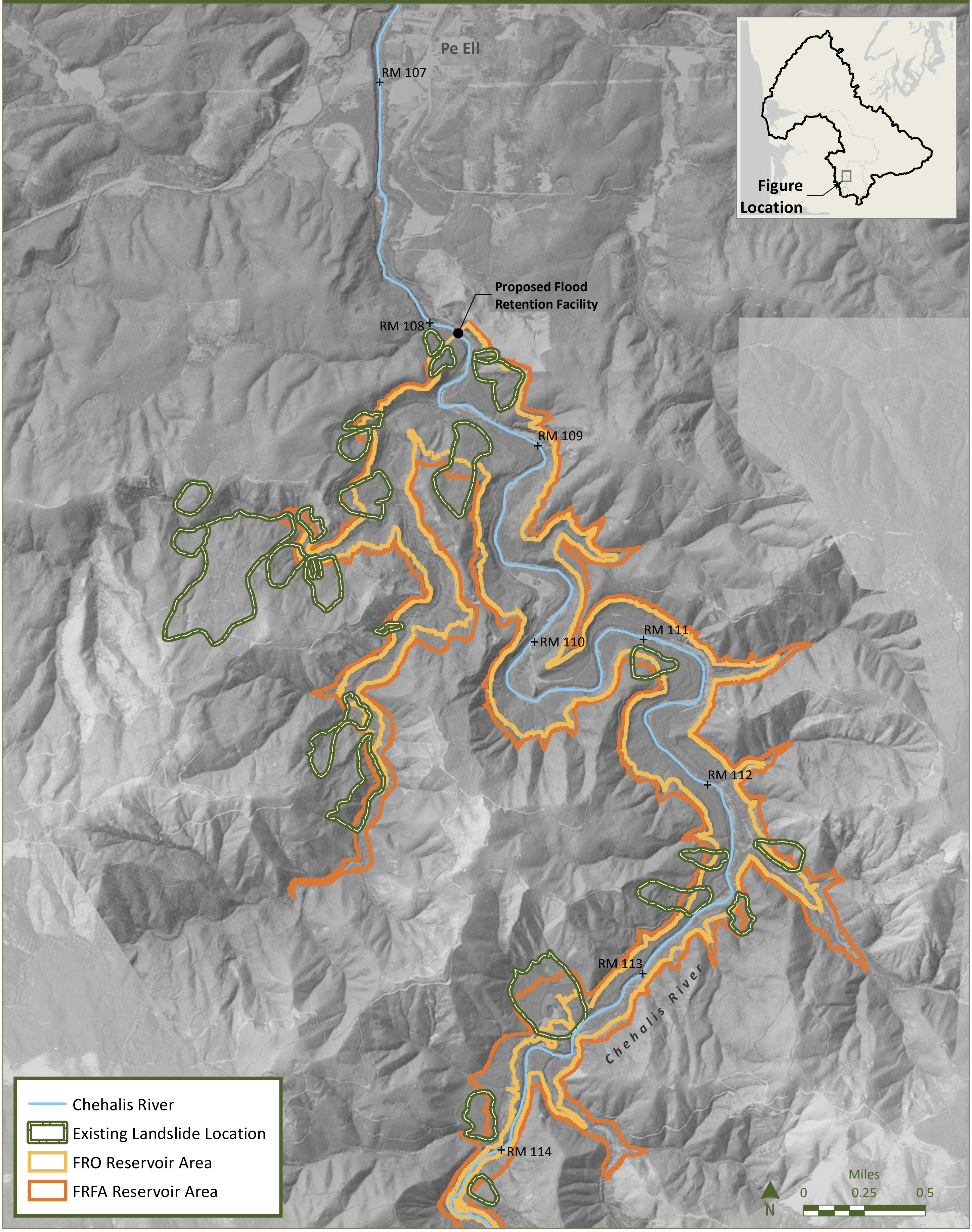
Over the long term, small-scale sloughing or slumping would periodically occur along the temporary FRO or permanent FRFA reservoir perimeter, especially in areas of dynamic water-level fluctuations, releasing fine-grained sediment and woody material into the reservoir. There would be a moderate adverse impact due to its limited geographic extent and periodic nature.

In the FRFA reservoir, a minor adverse impact could result from low-level seismicity induced by the weight of the water in the reservoir, potentially damaging the dam and appurtenant structures and causing concern among local residents. Because the water loading in the FRO reservoir will be short-lived, it is unlikely that a low-magnitude earthquake would be induced by the temporary FRO reservoir (Gupta 1992).

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. Damage to the dam would require repair and potentially cause a temporary shutdown. If an earthquake were to occur when the reservoir was full during flood operations, and the dam were damaged (despite being designed for this situation), it could have an adverse impact on downstream communities, as discussed in Section 4.2.15.2.

Figure 4.2-5

Landslides in Reservoir Areas



4.2.2.2.2 Geomorphology

The potential adverse impacts on geomorphology are related to the following:

- Changes in sediment load and sediment transport processes
- Changes in large wood load, transport, and recruitment
- Changes in geomorphic function and channel complexity

The potential changes in wood and sediment transport processes resulting from implementation of both the FRO and FRFA facilities would have a significant adverse impact on geomorphology due to the interruption of these processes upstream and downstream of the dam, as described here.

The Flood Retention Facility would disrupt both bedload and suspended load sediment transport processes (see Figure 4.2-6). The FRO facility would disrupt sediment transport continuity temporarily (when operational), whereas the FRFA facility would retain most sediment permanently. Sediment transport would be disrupted through the FRO dam during and after flood retention until the system reaches equilibrium. The potential adverse impacts on geomorphology include the following:

- Deposition and erosion of sediments in the zone of the reservoir that experiences water level fluctuations during flood retention operations (this zone could extend 3 to 5 miles for the FRO reservoir and 1.5 miles for the FRFA reservoir)
- Changes to sediment and large wood transport upstream and at the dam
- Changes to sediment and wood transport and deposition downstream of the dam to downstream of the Skookumchuck River confluence (approximately RM 62)

Changes to geomorphic processes (i.e., changes in sediment transport) are not anticipated to result in effects below RM 62. Reduced sediment transport could deplete substrates used for fish spawning and rearing downstream of the dam, in particular, spawning gravels for salmon, coarser substrate used as refuge by juvenile salmon and other fish, and fine substrate used by larval lamprey (Watershed GeoDynamics and Anchor QEA 2014). Potential effects to fish resulting from these geomorphic changes are discussed in Section 4.2.4.

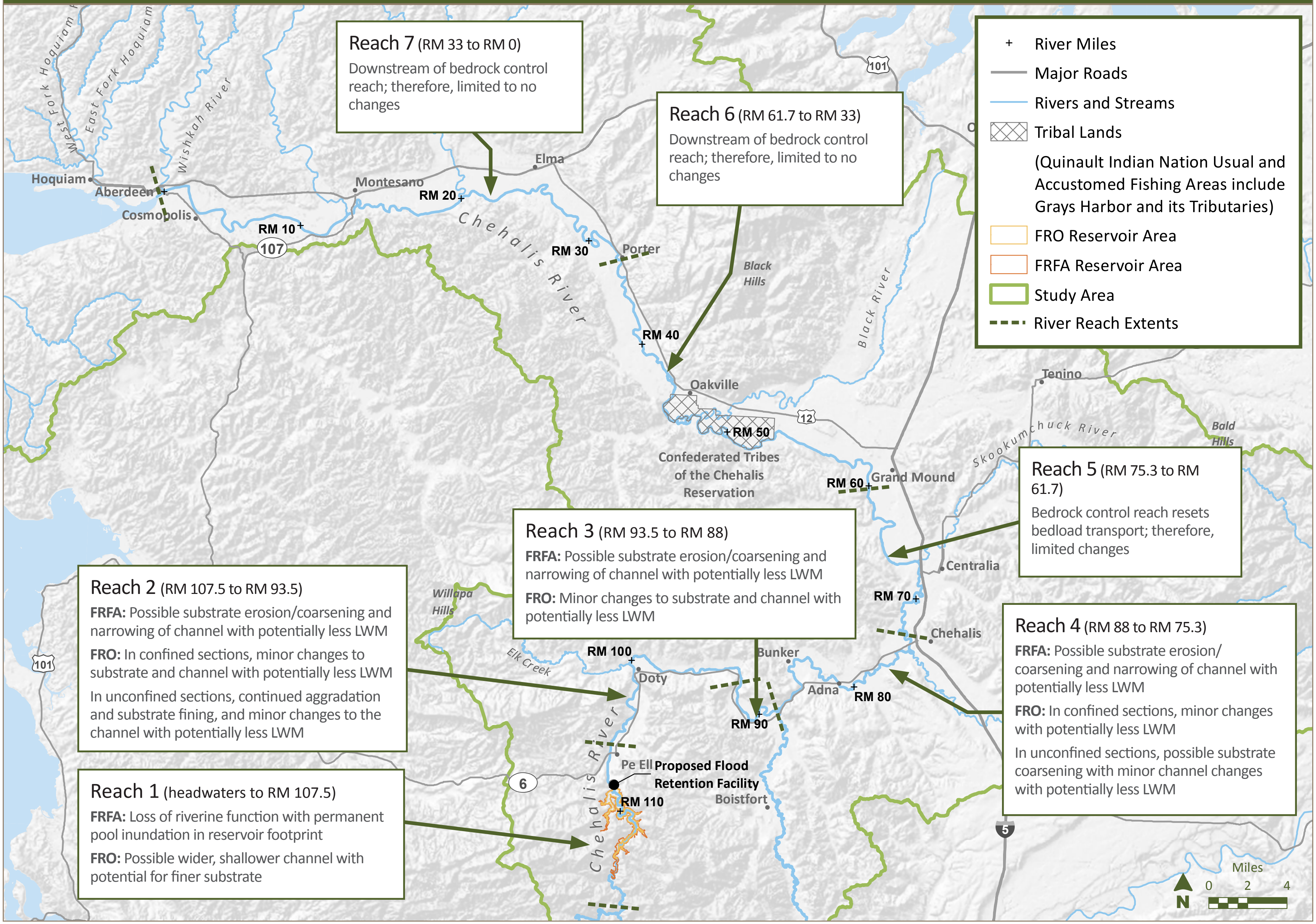
In the long term, 25% to 50% of the bedload would be retained by the FRO facility—amounting to approximately 9,000 to 17,500 tons per year on average (Watershed GeoDynamics and Anchor QEA 2014). Based on preliminary modeling results, sediment entrainment of up to 1 foot could occur upstream of the FRO dam throughout the reservoir footprint (based on modeling results for large floods; Dubé 2016). The FRFA facility would retain most sediment in the reservoir upstream of the FRFA dam (Watershed GeoDynamics and Anchor QEA 2014). For the FRFA facility, all bedload and 86% to 93% of the suspended load would be retained, which is equivalent to approximately 85,000 tons per year on average.

Large wood would also be trapped in either reservoir during flood operations. During non-flood operations, the FRFA facility would trap all large wood while the FRO facility would allow wood up to 15 feet in length and 3 feet in diameter to be transported through the dam with the flow. However, most wood is supplied during floods, and the FRO dam would trap it when retaining floods. Based on an aerial photograph interpretation of past floods, the estimated volume of wood that would be trapped during a 7-year flood is approximately 6,000 to 7,000 cy for both the FRO and FRFA facilities (Watershed GeoDynamics and Anchor QEA 2016). Wood recruitment occurs primarily from upstream mass wasting, with some wood input from entrainment of wood stored along the channel margins. Wood could be supplied from the Chehalis River upstream of the reservoir, from tributaries, from landslides in the reservoir area, or from trees in the reservoir area that are uprooted when inundated. Trapping of large wood at and upstream of the dam would reduce the potential wood load in the Chehalis River downstream, resulting in a direct impact on the downstream wood supply.

Changes to water flow and sediment transport would have adverse impacts on the channel geomorphology downstream of the dam. Operating the FRO facility would alter the timing and rate of sediment transport, and potentially the rate and occurrence of channel migration due to potential changes in channel conditions (e.g., an increase in channel bed elevation) and changes in flow. The change in the temporal discharge of sediment (bedload and suspended load) and the reduction in the quantity of sediment transported from the FRFA facility would affect the sediment transport continuity in the mainstem Chehalis River downstream of the dam. This change in sediment transport could potentially have a significant adverse impact on channel processes, channel migration, and channel structure downstream of the dam. The largest impact would occur immediately downstream of the dam, where the sediment supply would be most depleted.

Figure 4.2-6

Geomorphic Characteristics of the Chehalis River with Flood Retention Facility



4.2.2.3 Mitigation

4.2.2.3.1 Geology

In addition to the avoidance and minimization measures described in Table 4.1-1, the following measures could be employed to address short-term impacts on geology during construction:

- The tunnel muck waste area would be isolated from the temporary river bypass system and tunnel spoils would be compacted to reduce soil particle erosion outside of the reservoir footprint
- Rock quarries would be developed, or existing forestland quarries would be expanded, within a few miles of the dam and reservoir footprint, so there would be no strain on local commercial rock resources
  - The need for rounded gravel would be incidental, and it could be obtained from local commercial sources in the Centralia-Rochester area with little to no effect on local supply
  - The aggregate used would be crushed basalt that is local to the area and would not be sourced from local commercial quarry sites; therefore, local resources would not be depleted

Long-term landslide avoidance and minimization measures could consist of one or more stabilizing strategies at each landslide site, such as constructing surface and subsurface drainage to lower groundwater levels in the landslide hazard area(s), excavating landslide debris above the landslide plane, installing earth or rock buttresses, and controlling the drawdown rate of the reservoir (anticipated to be 10 to 20 feet per day). For potential low-level induced seismicity of the FRFA facility, the proposed reservoir depth would be designed to be shallower than reservoirs elsewhere that have incurred seismicity. Induced seismicity is associated with active faults, and no known active faults in the reservoir area exist.

To minimize the risk of earthquake-generated landslides to the dam, the following avoidance and minimization measures would be implemented:

- The dam and appurtenant structures would be designed to withstand the effects of shaking on the CSZ and other nearby faults (including the Doty Fault) considered to have the most effect
  - The dam would be designed accordingly, and instrumentation would be installed to measure motions in the structure in the event of a seismic event
- The design of the dam would include incorporation of local seismic criteria
  - The seismic design criteria would result in a dam designed to withstand a seismic event about four orders of magnitude greater than a seismic event that could be generated by reservoir conditions

For unavoidable adverse long-term impacts associated with shallow landslides that result in loss of nearshore riparian or aquatic habitats, compensatory mitigation could include improvements to or creation of other habitats within the Chehalis Basin to compensate for lost habitat functions or aquatic species impacts (see Section 4.2.3.3). A Post-construction Monitoring Plan would be developed as part of the Reservoir Operations and Management Plan and any monitoring of shoreline and reservoir footprint conditions for potential landslide impacts that could occur.

4.2.2.3.2 Geomorphology

Potential mitigation measures for short-term impacts on geomorphology are described in Table 4.1-1. To avoid and minimize short-term sediment transport disruption impacts through the construction zone, a temporary river bypass tunnel would be designed and constructed to pass all river flows, suspended sediment load, and bedload. Compensatory mitigation for the disruption of large wood transport would entail relocating large wood meeting the minimum criteria (12-inch-diameter breast height and 25-foot length) to a downstream channel location.

Long-term impacts on geomorphology include modifications of sediment transport quantities and timing, modifications of large wood recruitment and transport, and channel and bank erosion. To avoid and minimize these long-term impacts on geomorphology, the following measures would be implemented:

- The FRO dam would be designed to pass suspended sediment load, bedload, and most wood (up to 15 feet in length and 3 feet in diameter) at all times except during flood operations
- A Reservoir Operations and Management Plan would be developed to minimize impacts on geomorphology
  - This plan would include allowing moderate floods (less frequent than a 7-year flood) to pass the dam to maintain peak flows downstream, and to maintain sediment transport, erosion, and deposition processes, including flows necessary to maintain gravel-sorting and deposition in spawning areas
- Spawning gravel areas downstream of the dam would be monitored to determine whether gravel augmentation is necessary to preserve existing gravel bars used for spawning
  - The locations and quantities of this augmentation would be determined based on post-construction monitoring results (i.e., adaptive management would include developing a specific mitigation measure to address a specific impact)
  - This monitoring could include channel cross sections and substrate (bed material) sizes (i.e., pebble counts) to quantify and document changes

For project elements that are anticipated to have long-term, significant, or unavoidable impacts on geomorphology, compensatory mitigation to address modifications of sediment transport quantities and timing, modifications of large wood recruitment and transport, and channel and bank erosion could include the following:

- If monitoring of spawning gravel areas downstream indicates gravel bars are becoming too coarse or significantly reducing in size because of gravel retention in the reservoir, gravel augmentation within the Chehalis River channel could occur

- To mitigate for the potential interruption of wood transport through the dam, large wood captured in the reservoir could be collected and relocated to an appropriate location downstream of the dam (during both flood and non-flood dam operations)
  - Locations of wood placement and quantities would be determined at the time of placement based on channel and habitat conditions present.

A Flood Retention Facility may cause adverse impacts that cannot be fully mitigated by the compensatory actions described here.

4.2.3 Wetlands and Vegetation

4.2.3.1 Short-term Impacts

The potential short-term impacts on wetlands and vegetation from construction activities such as excavating, clearing, filling, and staging equipment and materials are described in Table 4.1-1. Short-term impacts include the temporary disturbance (ranging from 19 acres for the FRO facility to 21 acres for the FRFA facility) of mixed coniferous/deciduous upland forest vegetation of varying sizes and age classes, as well as some scattered wetland communities, from the construction of temporary access roads and construction equipment and material staging areas.

4.2.3.2 Long-term Impacts

The potential adverse impacts on wetlands and vegetation are similar for the FRO and FRFA facility types, but vary in magnitude due to the larger footprint of the FRFA facility and the fact that most of the area would be converted to open water with the conservation pool. Anticipated adverse impacts are related to the following:

- Permanent loss of wetlands and vegetation
- Conversion, disturbance, and reduction of existing wetland, riparian, and vegetation communities

These impacts include vegetated areas and wetlands that would be permanently replaced with facility structures (e.g., dam and spillway).

Over the long term, each of these impacts could in turn affect fish, amphibians, and wildlife currently using these areas; and change the types of available habitat through the modification of river flows, floodplain connectivity, habitat structure, and habitat-shaping processes. These potential adverse impacts on wetlands and vegetation are considered significant due to the substantial loss, disturbance, or conversion of existing habitat. When considered on a Basin-wide scale, the potential loss of vegetation and conversion of vegetated habitat is a small percentage of existing forest habitat.

4.2.3.2.1 Wetlands

Although a formal delineation has not been completed, the 2011 *Modeled Wetlands Inventory* (Ecology 2011b) provides a conservative estimate of total acreage for the wetland types present in the reservoir upstream of the dam (ranging from up to 68 acres for the FRO facility and up to 89 acres for the FRFA facility; see Table 4.2-4 and Figure 4.2-7).

Downstream of the Flood Retention Facility, wetlands in the Chehalis River floodplain could be affected by reduced water inputs from overbank flooding events. Since the FRO and FRFA facilities are designed to reduce flooding from a major flood, many floodplain wetlands would continue to receive floodwater inputs from smaller floods. Wetlands in the outer edges of the Chehalis River floodplain could experience a reduction in the frequency of floodwater inputs; however, as flooding there is already infrequent, these potential changes are unlikely to result in any major changes to the hydrology of these wetlands. Modeled results for the decreased area of floodplain inundation and its potential effect on wetlands have been developed for the combined Flood Retention Facility and Airport Levee Improvements (Alternative 1) and are described in more detail in Chapter 5.

Figure 4.2-7
Wetland Areas Mapped Within the Reservoir Footprint

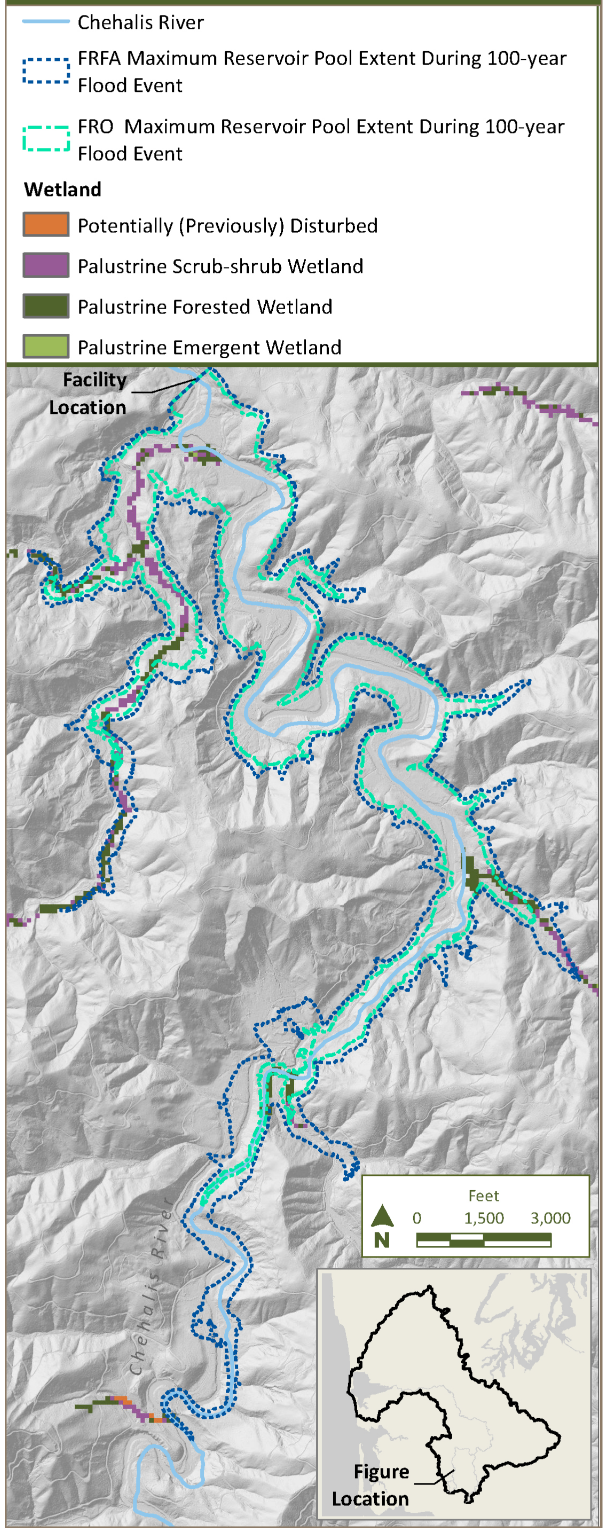


Table 4.2-4
Wetland Areas Mapped Within the Flood Retention Facility Reservoir Footprint

WETLAND TYPE	AREA (ACRES)			
	FRO FACILITY		FRFA FACILITY	
	FLOOD POOL TOTAL	CONSERVATION POOL	FLOOD POOL	TOTAL FOR FRFA RESERVOIR
Palustrine forested wetland	36	35	13	48
Palustrine scrub-shrub wetland	31	31	9	40
Palustrine emergent wetland	1	1	0	1
Total	**68**	**67**	**22**	**89**

Note: Several wetland seeps (springs, pools, or other wet places where groundwater naturally comes to the surface) could also be affected, including at least 10 seeps that are known to support amphibian species (e.g., Columbia torrent salamander, western red-back salamander, Dunn's salamander; Tyson and Hayes 2016). These seep areas are too small to be captured by the 2011 *Modeled Wetlands Inventory*, which does not capture wetlands that are less than 1 acre in size (Ecology 2016d).
Source: Ecology 2011b

4.2.3.2.2 Vegetation

Permanent impacts on vegetation include the removal of existing vegetation in the footprint of the dam, ranging in extent from 6 acres (FRO facility) to 9 acres (FRFA facility), for construction. This vegetation would not be expected to grow back or be replanted because these areas would be occupied by structures, access roads, and other features required for dam operations.

In addition to removal of vegetation for the dam, tree clearing and vegetation removal would occur within the reservoir area, with the details of the removal approach and mechanisms to reduce the extent of clearing provided in the Pre-construction Vegetation Management Plan (part of the Reservoir Operations and Management Plan). This plan would be designed to retain (and allow for the future establishment of) various vegetation community types in specific zones based on the expected duration of inundation during flood retention operations, while allowing some of the harvestable timber to be removed from the reservoir footprint.

The extent of vegetation removal completed prior to dam operation, and the expected post-construction vegetation community for each of these zones, is described in more detail in Appendix J.

The potential adverse impacts of the FRO reservoir area on vegetation include the following changes in vegetation communities:

- Selective harvesting of up to 405 acres of mixed coniferous/deciduous forested riparian areas, which would convert the area to forests dominated by deciduous riparian shrubland

- Periodic inundation of up to 306 acres of coniferous forest dominated by Douglas fir, which would transition to a mixed deciduous/coniferous forest dominated by such species as red alder, western red cedar, and big-leaf maple

The potential adverse impacts of the FRFA reservoir on vegetation include the following changes in vegetation communities:

- Permanent loss of 711 acres from forested upland, riparian, and wetland plant communities
- Selective harvesting of up to 178 acres of mixed coniferous/deciduous forested riparian areas, which would convert the area to forests dominated by deciduous riparian shrubland
- Periodic inundation of up to 262 acres of coniferous forest dominated by Douglas fir, which would transition over time to a mixed deciduous/coniferous forest dominated by such species as red alder, western red cedar, and big-leaf maple

Removal of vegetation from existing riparian areas along the Chehalis River channel and tributary streams in the reservoir footprint could alter or eliminate many of the important riparian functions (Knutson and Naef 1997) provided by these areas, including habitat corridors for wildlife, water and sediment filtration, shading and thermoregulation of instream water, and reduction in ecosystem complexity. These impacts could subsequently affect fish and wildlife, and change the types of habitat available in this area over the long term (see Section 4.2.4).

Both the FRO and FRFA facility types would modify seasonal peak flows in the Chehalis River and reduce the extent of major floods in areas downstream. These changes could reduce the transport of water and nutrients to the outer edges of the Chehalis River floodplain, which could in turn affect the growth and survivorship of vegetation in those areas. Potential results include a gradual change in vegetation composition in these locations. Such changes in plant community composition could modify the types of habitat available in these areas, and affect the fish and wildlife currently using them (see Section 4.2.4).

The reduction in flood extents downstream of the dam would also reduce the episodic disturbance of downstream riparian areas and wetlands by major or larger floods. This could result in a reduction in the occurrence of major channel avulsions and large-scale channel migrations, allowing the adjacent riparian forest to become more mature as the occurrence of periodic disturbance decreases. In addition to these changes, a reduction in the downstream flooding extents could also limit the establishment of invasive species that are spread by flood flows, as certain areas of the floodplain would receive floodwaters less frequently.

4.2.3.3 Mitigation

Some potential impacts on wetlands and vegetation could be addressed through avoidance and minimization measures, including avoiding wetlands during construction access and staging efforts, locating construction access and supporting infrastructure routes to avoid wetlands and minimize stream crossings, and restoring vegetation in temporarily disturbed areas.

The potential compensatory mitigation measures to address unavoidable significant adverse impacts on wetlands from the Flood Retention Facility would be designed to address loss of wetland habitat and ensure no net loss of ecological function. Potential compensatory mitigation for long-term impacts on wetlands could include the following:

- Creating wetlands around the perimeter of the FRO flood pool or FRFA conservation pool
- Restoring previously disturbed wetlands in the floodplain downstream of the dam
- Reconnecting off-channel wetlands to the Chehalis River and floodplain downstream of the dam
- Purchasing credits from an approved wetland mitigation bank in the same watershed

Potential compensatory mitigation measures to address unavoidable adverse impacts on vegetation from the Flood Retention Facility would be designed to address loss or conversion of riparian habitat and replace the functions and values lost from the removal and/or modification of vegetation. A Post-construction Vegetation Management Plan (part of the Reservoir Operations and Management Plan) would be developed and implemented to regularly inspect shoreline erosion, landslides, invasive species, and other conditions that could affect riparian functions along the perimeter of the FRFA conservation pool and tributaries that feed into the reservoir. Corrective measures such as replanting with native, flood-tolerant species could be implemented in problem areas.

Wetland Mitigation Guidance

For action elements that are anticipated to have long-term, significant, or unavoidable impacts on wetlands, compensatory mitigation measures would be developed 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 USEPA document *Wetland Mitigation in Washington State – Part 1*:

- Replace wetland impacts 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

Additional compensatory mitigation for long-term impacts on vegetation could include the following:

- Purchasing and preserving adjacent and off-site areas of forestlands within the same watershed
- Replanting harvested areas with native vegetation
- Restoring and enhancing downstream riparian areas by removing invasive species and replanting with native trees and shrubs
- Using flow controls or irrigation and strategic removal of non-native or invasive plant species to stimulate recruitment of valued pioneer riparian trees such as cottonwoods (Poff et al. 1997)

4.2.4 Fish and Wildlife

4.2.4.1 Short-term Impacts

4.2.4.1.1 Fish

Potential short-term impacts related to construction would primarily be from diversion of the Chehalis River around the construction site, and would include the risk of impaired water quality due to construction activities (including the risk of increased turbidity, hazardous materials spills, and low pH runoff), delays or blockages to upstream migrating adult salmon and steelhead with effects on population productivity and subsequent adult returns, and disturbance of habitat in the streambed and riparian areas.

Construction of the dam would require in-water work, diversion of the river, and construction of access roads. These short-term impacts would occur over 2 to 3 years. Direct impacts on fish would occur by injury, mortality, or inhibition of normal behavior like migration, spawning, foraging, and rearing in the same time and place as the construction activity. Effects from direct impacts are outlined in Table 4.1-1 and include gill and skin injuries, impaired foraging or predator avoidance, acutely toxic conditions due to concrete or hazardous spills, trauma from injurious noise levels, and stranding or obstruction of fish passage.

Construction of the Flood Retention Facility could temporarily cause the following indirect impacts on fish:

- Filling of course gravel with fine sediment, which would cause a temporary disruption to spawning and rearing
- Temporary, localized interruption of recharge or discharge of hyporheic zones that could provide cooler, more oxygenated water and food for fish
- Removal of upland and riparian vegetation that typically provides shade and food, and prevents erosion, from in and around the Flood Retention Facility footprint

4.2.4.1.2 Wildlife

Short-term impacts on wildlife would result from construction activities that are either site-specific (e.g., clearing of vegetation from construction access and staging areas) or transient (e.g., construction-and equipment-generated noise). Potential short-term impacts on wildlife related to construction activities are described in Table 4.1-1. Of the listed activities, the following are expected to have the greatest effects on wildlife:

- Removal and disturbance of upland, riparian, and wetland vegetation communities
- Diversion of the Chehalis River around the construction site and the dewatering of in-channel work areas
- Excavation and fill placement in upland work areas
- Disturbance to wildlife caused by construction noise, equipment and vehicle usage, and human presence

Construction of the Flood Retention Facility would require the disturbance of a variety of vegetation communities, including mixed upland forestland and riparian areas (see Section 4.2.3), which are currently providing habitat for native wildlife species that use these areas to breed, forage, rest, and overwinter. Activities required for selective tree removal in the reservoir footprint (e.g., access road construction, logging equipment usage) as part of the proposed Pre-construction Vegetation Management Plan (see Appendix J) could also affect wetlands and several seeps that are reported to support amphibians (Hayes et al. 2015c, 2015d).

Vegetation removal activities in construction areas would degrade or eliminate habitat and could directly injure or kill wildlife that are unable to relocate to avoid the disturbance (e.g., amphibians, reptiles, small mammals). If land clearing takes place during the spring and early summer when most birds nest, eggs and nestlings of tree- and ground-nesting birds could be lost or nests could be abandoned. More mobile species (e.g., young and adult birds, medium and large mammals) would be displaced to adjacent habitat during land-clearing activities. Wildlife displaced from construction sites would move to nearby habitats where they could be competing with resident wildlife, especially if nesting and food resources are already limited. The resulting changes in the local species composition would affect a variety of species in the food web that occupy these habitats, including species that prey on amphibians and other aquatic species. Since human disturbance from logging currently occurs in portions of the Flood Retention Facility site, some level of habituation by wildlife to noise and human activity has potentially occurred. Certain wildlife (e.g., various types of birds, raptors, coyote, raccoon) could adapt to and continue to use areas disturbed by construction activities.

Diversion of the Chehalis River through the temporary river bypass tunnel and dewatering of in-channel work areas would likely kill any aquatic species using those areas for breeding, foraging, or overwintering at the time of diversion and dewatering. Such impacts would primarily affect amphibians that use instream areas for these purposes (e.g., coastal giant salamander, coastal tailed frog, Columbia torrent salamander), as well as those amphibians that use the stream margin and associated stillwater areas (e.g., Pacific treefrog, northern red-legged frog, rough-skinned newt, and western toad; Hayes et al. 2015c, 2015d). Aquatic wildlife using areas upstream and downstream of the construction site could also be injured or killed by the increased water velocity and turbidity present in and around the temporary river bypass tunnel.

Excavation and fill placement in upland areas would adversely affect terrestrial wildlife with limited capacity to flee the disturbance area (e.g., terrestrial amphibians, reptiles, some small mammals), particularly burrowing mammals like moles, voles, and shrews. Such activities would likely cause direct mortality or injury to these species and temporarily or permanently eliminate their habitat.

In regard to more transient construction disturbances such as increased noise levels and vehicle usage, some wildlife species would adapt to these disruptions (e.g., birds and mammals that are habituated to human disturbance), and some species would successfully relocate to other suitable habitat (e.g., larger mammals, birds). Some less mobile wildlife species (e.g., small mammals, amphibians, reptiles) would be unsuccessful in adapting or relocating, and their ability to find adequate shelter and foraging and breeding habitat would be constrained.

Although many of these impacts would be of relatively short duration, and habitat for some types of wildlife would be re-established in many of these areas following construction, there would be temporal delays in restoring habitat function and quality to pre-action conditions.

4.2.4.2 Long-term Impacts

The potential adverse impacts on fish and wildlife were determined by evaluating how the physical changes in the environment described in the water resources, geology and geomorphology, and wetlands and vegetation sections (see Sections 4.2.1, 4.2.2, and 4.2.3) would affect the quality of habitat, behavior, and survival. Research was carried out in the Chehalis River from 2013 to 2016 to characterize existing distributions and behavior of fish and wildlife in the areas of the mainstem Chehalis River affected by the Flood Retention Facility, including the following studies:

- *Upper Chehalis Instream Fish Study 2015* (Winkowski 2015)
- *Riverscape Surveys of In-stream Fish Assemblages and Habitat in the Chehalis River* (Zimmerman and Winkowski 2016)
- *2016 Chehalis ASRP Egg Mass Surveys in Off-Channel Habitat: 3rd Progress Report for Post-Feasibility Efforts* (Hayes et al. 2016a)
- *2016 Chehalis ASRP Instream Amphibian Survey Report: 3rd Progress Report for Post-Feasibility Efforts* (Hayes et al. 2016b)
- *2016 Chehalis ASRP Stream-Associated Amphibian Survey: 3rd Progress Report* (Hayes et al. 2016c)
- *Waterfowl and Waterbird Abundance and Use of Aquatic Off-Channel Habitats in the Chehalis Floodplain: Preliminary Report* (Evenson et al. 2016)
- *Upper Chehalis Salmonid Spawner Abundance and Distribution, 2013-2015 Interim Report* (Ashcraft et al. 2016)

- *Summer habitat and movements of juvenile anadromous salmonids in a coastal river in Washington State* (Winkowski and Zimmerman, in prep)
- *Behavior and movements of adult spring Chinook salmon* (Oncorhynchus tshawytscha) *in the Chehalis River Basin, southwestern Washington, 2015* (Liedtke et al. 2016)

In order to estimate the change in fish populations with a dam, the potential changes in fish habitat quality were modeled using the EDT model (ICF 2016), and fish passage efficiency and survival through the dam were estimated for various fish passage scenarios (Garello 2016a).

4.2.4.2.1 Fish

The potential adverse impacts on fish are primarily related to the following changes in physical attributes of the environment created by the Flood Retention Facility:

- Periodic or permanent inundation of the area upstream of the dam
- Introduction of an obstacle or complete barrier to fish migration from dam infrastructure
- Reduction in the magnitude of high-flow events downstream of the dam, with a decrease in temperatures downstream for the FRFA facility only

Anticipated adverse impacts of the Flood Retention Facility on fish would be significant for fish populations in the Chehalis Basin. Adverse impacts would primarily affect fish in the mainstem Chehalis River above and immediately below the dam; however, the impact could cause changes to fish population levels that are observable at a Basin-wide scale, particularly for migratory fish such as salmon and steelhead. Adverse impacts would occur due to changes in habitat functions and reduced access to habitat from the following:

- Loss of habitat function within the reach of the Chehalis River inundated upstream of the dam for cool, swift-water associated fish species, including loss of spawning habitat and food supplied to the river from the riparian corridor and vegetation
- Partial reduction in fish survival and potential interruptions to migration due to passage impediments, including salmon and lamprey spawning migrations
- For the FRFA, exposure of juvenile salmonids that use the permanent reservoir for rearing to predators that may thrive in the reservoir
- Changes to fish habitat-forming processes and water quality downstream of the dam

The potential long-term benefits to some species of fish are primarily related to the following changes in physical attributes of the environment created by the FRFA facility:

- Creation of reservoir habitat that some species and life stages that currently exist in the area could utilize for rearing or foraging, such as coho salmon, steelhead, largescale sucker, mountain whitefish, or sculpin; however, uses in the summer may be limited due to high water temperatures

- Increased habitat area and capacity for native salmonid and non-salmonid species associated with flow augmentation and temperature reduction downstream of the FRFA facility

This section provides a summary of the effects to fish during operation of the Flood Retention Facility. Additional detailed information is provided in Appendix H.

The effects of dams on aquatic systems in the Pacific Northwest have been widely studied, with the literature generally showing far-reaching negative impacts for aquatic systems. These impacts are particularly notable for salmonids, affecting habitat quality, upstream and downstream survival, and migration. In addition, headwater areas like the upper Chehalis River are important holding and rearing areas for salmon across the Pacific Northwest, and the construction of dams in Puget Sound rivers has led to multiple extirpations of spring-run Chinook salmon populations (Beechie et al. 2006). The dams proposed for the upper Chehalis River are uniquely designed for the purpose of flood retention and fish passage, with added measures intended to reduce the adverse impacts on fish. It is important to evaluate the impacts of the proposed dams in context with historical impacts of existing dams throughout the Pacific Northwest; however, because of the unique design of the FRO and FRFA dams and flood control operations being proposed, it is equally important to evaluate the impacts of each dam type on fish independent from the known effects of other dams.

Construction of the Flood Retention Facility would occur over 2 to 3 years and would thus affect multiple year-classes of fish that spawn in the area of construction, potentially reducing survival of eggs and juveniles in the vicinity of the Flood Retention Facility site. Fish attempting to migrate upstream of the dam site to spawn could also be affected if adequate fish passage is not provided around the site during construction. Short-term impacts during the 2- to 3-year construction period could become a long-term impact as reduced egg and juvenile survival in a given year would lead to reduced abundance in subsequent generations. For instance, reduced salmon and steelhead egg survival in a given year could result in fewer adult salmon and steelhead returning to the upper Chehalis Basin 2 to 4 years later.

The construction of new roads to access the dam structure for maintenance activities has the potential to increase the amount of impervious surface adjacent to the Chehalis River and runoff carrying fine sediment. High levels of fine suspended sediment in the water could cause a direct impact on fish by causing gill abrasions, which is a hazard to fish health. In addition, there could be an indirect impact on fish because sedimentation slows the delivery of oxygenated water through spawning substrate to incubating eggs, and high turbidity interferes with vision, impairing foraging and predator avoidance behaviors.

Overall, both the FRO and FRFA facility types would create a significant adverse impact on fish survival, migration, and the area of habitat available for spawning and rearing, specifically for species that use the stream reaches just above and below the dam. The impact on fish resources would result from loss of habitat functions and reduced survival or access to spawning grounds in the vicinity of the Flood Retention Facility. The magnitude of the impact on the total Chehalis Basin population of a given species would vary depending on the abundance and distribution of each species in other tributaries to the Chehalis River, including those that would be largely unaffected by the dam.

The free-flowing reach of the Chehalis River upstream of the dam would be converted to a lake-type habitat—either temporarily in the case of the FRO facility (up to 32 days), or permanently in the case of the FRFA facility. Many species that migrate, spawn, and rear in the dam footprint and reservoir area have adapted to cool, fast-flowing stream conditions and would be adversely affected by inundation, whether temporary or permanent. With current conditions, major floods can adversely affect fish in these areas due to high-velocity flow that can displace fish and scour redds, causing impacts that can last several generations. Flood retention with a dam would cause inundation that would similarly displace fish from the stream channel and suffocate redds, but may additionally interrupt normal behaviors (e.g., foraging, migration, spawning), and could reduce survival of resident fish species and immobile life stages for longer periods of time than occurs during an uncontrolled flood under existing conditions. Changes to flow and inundation areas could cause localized modifications to hyporheic flows, a habitat feature that can supply cool groundwater in otherwise warm rivers, including the Chehalis River (Liedtke et al. 2016), as well as act as a site for nutrient cycling, a source of DO, and a source of food for fish (Boulton et al. 1998; Stanford and Ward 1988). Modifications to hyporheic flow could also affect critical spawning habitat for salmon that seek areas of hyporheic exchange for building redds (Geist et al. 2002).

Loss of habitat function would occur due to removal of trees with either the FRO or FRFA facility, as described in Section 4.2.3, which would permanently eliminate the riparian buffer zone and reduce food and nutrient inputs that directly and indirectly feed fish (Allan et al. 2003). With the FRO reservoir, shading by riparian trees would be reduced or eliminated around stream reaches that flow through the reservoir footprint, resulting in an increase of water temperatures in the summer of up to 5°C for some areas compared to current conditions (e.g., Crim Creek, an area with a narrow stream channel that is currently well shaded) that would persist to areas downstream of the FRO dam. Water temperatures in the reach immediately below the FRO dam—where summer water temperatures already exceed optimal limits for salmon and other cool-water fish species—are predicted to increase in summer by approximately 2 to 3°C (Beschta 1997). Impacts of the FRO facility on water temperature would be negligible below the confluence with the South Fork Chehalis River.

The supply of large wood to the river channel from the stretch of river that flows through the inundation footprint would be eliminated with an FRFA facility during both non-flood and flood operations. For the FRO facility, large wood would be trapped during flood operations (see Section 4.2.2.2.2). Large wood is necessary to maintain fish habitat-forming processes, such as the creation of pools and side-channel habitat. Some impacts on riparian zone function in the inundation footprint could be minimized with a Pre-construction Vegetation Management Plan that would prevent total loss of riparian vegetation and riparian area function for fish through selective clearing; however, adequate shading is not likely to minimize the impact on water temperature, and large wood would not be recruited to the stream channel.

Changes in water quality in the reservoir, as discussed in Section 4.2.1.2.1 (turbidity, temperature, and DO), would create a significant adverse impact on fish. A small risk exists for MeHg to accumulate in the food web due to the conversion of atmospheric Hg to its toxic form, MeHg, by bacteria that thrive in summer reservoir conditions. In the permanent FRFA reservoir, water would heat and stratify during the summer months, exceeding the core summer salmonid habitat criterion (of 16°C), and the temperature range for optimal growth of juvenile salmon (10 to 15°C; McCullough 1999) in the upper elevations (shallower depths) of the reservoir. Immediately upstream of the FRFA dam, water temperatures may reach approximately 20 to 25°C in July and August—depending on meteorological conditions—which would be stressful, increase risk of disease outbreak, and would be detrimental to growth of juvenile salmon because their ability to feed cannot meet their metabolic requirements at these temperatures. Warmer waters in the FRFA reservoir would also hold lower DO; however, reductions in DO are not expected to reach levels considered lethal for juvenile salmon near the surface. In addition, decaying vegetation and lack of mixing could contribute to low DO levels deep in the reservoir, causing fish to avoid seeking refuge at depth.

Reduced water quality in shallower layers of the reservoir could force juvenile salmon to seek thermal refugia in deeper water, limiting their foraging opportunities and reducing the effectiveness of juvenile fish collection facilities, or could cause them to emigrate from the reservoir early in the summer, eliminating any benefit of the reservoir for rearing. Warmer reservoir temperatures are also known to exacerbate predator feeding (e.g., northern pikeminnow that are currently found downstream of the proposed dam site) on juvenile salmonids (Peterson and Kitchell 2001). Invasive predators (e.g., smallmouth or largemouth bass) are not anticipated because these species are located farther downstream at this time.

Mobilization of fine sediment would occur in hydrologically dynamic areas of both the FRO and FRFA reservoir, causing increased turbidity in the reservoir and areas downstream of the dam. Turbidity could affect fish directly by causing gill abrasion and impairing vision. Frequent disturbance of the substrate would alter food webs that support fish by resetting the standing crop of algae and aquatic invertebrates that feed fish (Power 2006). Sediment deposition would create the greatest impact on benthic species and immobile life stages. Fine sediments could reduce incubation survival for fish that use the riverbed for spawning, and change habitat use for species that rely on larger bed materials. In particular, incubating salmon embryos in redds require a constant flow of oxygenated water through the gravel and would suffocate if inundated under still, deep water or if they become covered in newly deposited sediment.

The dam presents a barrier to upstream and downstream juvenile and adult fish movement, impairing the fish's ability to forage, find refuge, and, in some cases, complete its life cycle, presenting a significant adverse impact on fish. The potential impact of a barrier would be greatest for highly migratory species that migrate to the sea to complete their life cycles (e.g., salmon, steelhead, Pacific lamprey). Passage through tunnels with the FRO dam presents the least impact on migratory species because these would be designed to mimic the natural gradient of the river channel. Therefore, when water is not being impounded, the FRO dam may only present a minor adverse impact on passage for adult and juvenile fish migrating upstream and downstream. With the FRFA dam, and when tunnels in the FRO dam are closed for flood retention, engineered structures and mechanisms for the passage of juvenile and adult fish through or around either dam would be provided. Final fish passage designs have not been determined, and passage success would vary considerably depending on the method of passage. Fish passage facilities would be designed according to state and federal fish passage engineering criteria to allow fish to safely pass the dam and access spawning and rearing area above the dam.

Pacific lamprey are found in the mainstem Chehalis River below the proposed dam site (USFWS 2011) and occupied every sub-basin sampled in the Chehalis Basin in a recent study, including major tributaries of the Chehalis River that would not be affected by the proposed dam and reservoir, including the Newaukum, Skookumchuck, and Black rivers (Jolley et al. 2016). Considerations to accommodate adult lamprey passage through the outlet tunnels in the FRO dam and around the FRFA dam are being incorporated into the designs, because adult lamprey have difficulty ascending fish passageways designed strictly for salmon (Garello 2016b).

Overall, adult and juvenile lamprey passage through the FRO dam is expected to be high (from 95% to 96%), and higher than passage through the FRFA dam (adult passage estimates range from 40% to 60%; juvenile downstream passage estimates range from 0.3% to 0.6%). While upstream and downstream passage and survival rates for lamprey and salmonids would be reduced from current levels, there is uncertainty with how well the facilities would perform for lamprey, especially the facilities designed to pass fish around the FRFA dam. The fish passage facilities associated with the FRFA dam could nearly eliminate downstream passage for lamprey. Over the long term, the challenge of passing lamprey downstream around the FRFA dam could prevent lamprey from migrating to the ocean, leading to local reductions in the population, and possibly the elimination of lamprey upstream of the dam. Based on the available information, construction of the FRO dam would not significantly affect passage of lamprey, but it is unknown how changes in the reservoir area would affect lamprey. Construction of the FRFA dam would have a significant effect on the upper mainstem population of lamprey in the Chehalis Basin. Because lamprey abundance has not been as broadly quantified as salmon abundance, the magnitude of the impact that the loss of lamprey upstream of the FRFA dam presents to the whole Chehalis Basin population remains uncertain. However, the Basin-wide population is not expected to be eliminated with either dam type, based on the conclusion by Jolley et al. (2016) that a robust population of Pacific lamprey is currently present in the Chehalis Basin.

The anticipated total survival (a combination of fish performance and survival) through each type of fish passage facility for groups of species is summarized in Table 4.2-5. For the FRO dam, passage through the tunnel outlets is expected to be high for all species and life stages. When water is impounded behind the FRO dam, passage through the trap and transport facility is expected to be average or high, depending on the species and life stage. For the FRFA dam, passage facilities for fish migrating upstream are expected to perform well for adult salmonids and average for adult lamprey and juvenile salmonids. Passage of juvenile lamprey migrating downstream is expected to be extremely poor and could result in Pacific lamprey being eliminated from the upper Chehalis River.

Table 4.2-5
Anticipated Fish Passage Survival Through the Dam and Fish Passage Structures

		TYPE OF FACILITY AND PASSAGE STRUCTURE			
		FRO	FRFA		FRO OR FRFA
SPECIES		TUNNELS	LADDER	JUVENILE PASSAGE FACILITIES	TRAP AND TRANSPORT
Anadromous salmon and steelhead	Adult upstream	94% – 96%	79%		91%
	Juvenile upstream	59% – 79%			54%
	Juvenile downstream	85% – 95%		64%	
Lamprey	Adult upstream	96%	54%		54%
	Juvenile downstream	95%		<1%	

Note: Ranges are based on differing passage survival depending on species.

Though inundation or blockages to fish passage could be temporary, a loss of productivity for several weeks in a single year due to temporary inundation or blockage of fish passage would lead to reduced productivity in the subsequent generation. For salmon, the operation of the FRO facility could impair a single group of spawners, and reduce the productivity of their offspring 2 to 4 years later. In this way, the impact of a single flood could become protracted and cause fewer adult salmon and steelhead to return to the upper Chehalis Basin in future years.

There would be a reduction in fish habitat downstream of the dam to RM 62 (downstream of the Skookumchuck River confluence) during major floods due to impaired geomorphic processes, including reduced transport of coarse sediment (reduced by 25% to 50%) and wood transport (see Section 4.2.2). Mitigating effects of a Pre-construction Vegetation Management Plan, and the ability of the FRO dam to pass sediment and wood during most flows, would reduce the change to habitat function downstream of the FRO dam compared to the year-round change in flow and retention of sediment and wood with the FRFA dam (see Section 4.2.2.2.2). Changes to geomorphic processes downstream of the dam would result in a significant adverse impact on the formation of fish habitat.

Flood control operations would reduce floodplain inundation by 10% (4,480 acres), eliminating some connections between the Chehalis River and off-channel or floodplain areas during and after floods that are large enough to trigger flood retention. Floodplain areas that are ephemerally connected to the mainstem Chehalis River can be important rearing and holding habitat for fish, and a reduction in the floodplain's inundated area would be a minor impact on fish habitat function.

Flow augmentation and releases of cool water from the FRFA reservoir are anticipated to provide downstream benefits to native fish species including Pacific lamprey, mountain whitefish, largescale sucker, speckled dace (discussed later in this section) and adult spring-run Chinook salmon that require cool-water refugia during peak summer water temperatures. A positive response of spring-run Chinook salmon reflects the potential effect of cooler summer water on pre-spawning survival, improved juvenile rearing, and potential for earlier spawning. This assumes that spring-run Chinook salmon would respond by expanding their distribution into the reach of the mainstem Chehalis River between Elk Creek and the Flood Retention Facility site, as they have not been observed using this stretch of river previously in summer (Zimmerman and Winkowski 2016). Whether adult spring-run Chinook salmon would respond behaviorally to modulating temperature and flow from the FRFA facility is unknown and represents a key uncertainty (see Appendix K). In spring and summer months, water temperatures would be reduced by as much as 10°C in the reach immediately below the dam with effects diminishing farther downstream to RM 65 (approximately the confluence with the Skookumchuck River). Below RM 65, negligible differences in cool-water habitat from baseline conditions would occur, mainly due to the influence of large tributaries. The predicted impact of the FRO and FRFA facilities on salmon productivity was quantified using habitat modeling (EDT; ICF 2016). The modeled current habitat potential for the Chehalis Basin to support each salmon species is depicted as the number of potential spawners, alongside average estimated total run size and escapement since 1987 shown in Table 4.2-6 (further details on salmon run size can be found in Table 3.4-4 in Section 3.4.1.1.4).

Table 4.2-6
Baseline Potential Salmonid Abundance in the Chehalis Basin

SPECIES	EDT HABITAT POTENTIAL SPAWNERS	ESTIMATED TOTAL RUN ABUNDANCE	ESTIMATED ESCAPEMENT
Coho salmon	40,642	60,096	43,222
Fall-run Chinook salmon	25,844	25,500	12,100
Fall/winter-run chum salmon	190,550	36,300	21,900
Spring-run Chinook salmon	2,146	2,300	2,200
Winter-run steelhead	6,800	12,800	10,700

Source: ICF 2016

Three dam scenarios were modeled using EDT to account for the changes in habitat that could occur with inundation, barriers to fish passage, and reduction in downstream habitat-building processes: the FRFA, and two FRO scenarios. Two scenarios were modeled for the FRO dam to provide a range of results that reflects the uncertainty around the effects of habitat degradation upstream of the dam. The FRO 50 scenario predicts degradation in 50% of the spawning habitat in the inundation area, whereas the FRO 100 predicts degradation in 100% of spawning habitat in the inundation area, with no differences in all other habitat characteristics upstream and downstream of the dam for the FRO. The degradation is modeled by converting reaches from pool and riffle habitat with high value for salmon spawning to glide habitat which holds little spawning value. The effect of an FRO 50 scenario could represent a more likely scenario because habitat would be disturbed only when floods are retained, approximately once every 7 years on average, and a Pre-construction Vegetation Management Plan would prevent total loss of riparian vegetation and riparian area function for fish. Though inundation associated with an FRO facility is anticipated to occur infrequently, a precise projection of the highest extent of impacts on upstream habitat degradation is difficult to predict given uncertainties related to the extent of potential water temperature increases, reduction of food and nutrient inputs from riparian habitat loss and fine sediment deposition, spawning gravel changes in the reach between retention events, channel widening, mass wasting sediment input, and other factors. Therefore, it is appropriate to evaluate both 50% and 100% upstream habitat loss, to capture the range of potential outcomes. The modeled impact of each Flood Retention Facility type on the whole Chehalis Basin population of salmon and steelhead is summarized in Table 4.2-7 and Figure 4.2-8 (ICF 2016).

All of the three dam scenarios modeled would reduce the overall abundance of all salmon and steelhead populations in the Chehalis Basin from less than 1% to 4% depending on the species. An FRFA dam would have a larger adverse impact on coho and fall-run Chinook salmon, whereas the FRO dam would have a larger adverse impact on spring-run Chinook salmon, winter/fall-run chum salmon, and winter-run steelhead.

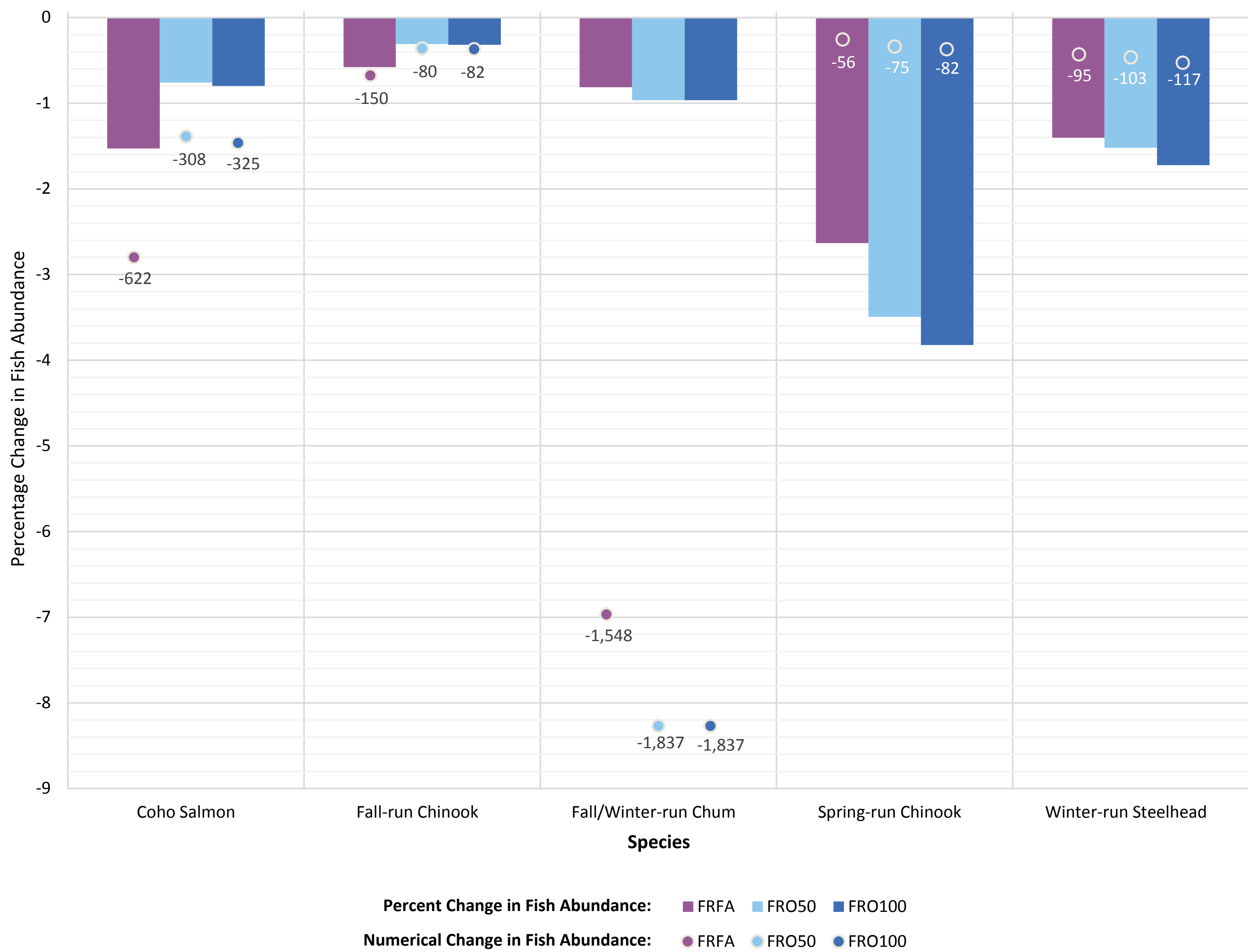
Table 4.2-7
Potential Response in Salmonid Abundance to Habitat Change in the Chehalis Basin from Flood Retention Facility Types

SPECIES (CURRENT HABITAT POTENTIAL)	CHANGE FROM CURRENT CONDITION IN NUMBER OF FISH (%)		
	FRFA	FRO 50	FRO 100
Coho salmon (40,642)	-622 (-2%)	-308 (-1%)	-325 (-1%)
Fall-run Chinook salmon (25,844)	-150 (-1%)	-80 (<-1%)	-82 (<-1%)
Winter/fall-run chum salmon (190,550)	-1,548 (-1%)	-1,837 (-1%)	-1,837 (-1%)
Spring-run Chinook salmon (2,146)	-56 (-3%)*	-75 (-3%)	-82 (-4%)
Winter-run steelhead (6,800)	-95 (-1%)	-103 (-2%)	-117 (-2%)

Note:
* = With response to flow augmentation and temperature reduction; without response to increased flow and cooler water, effect downstream of dam similar to FRO 100
The behavioral response of adult spring-run Chinook salmon in the Chehalis River to modulating temperature and flow from the FRFA facility is unknown and represents a key uncertainty described in more detail below and in Appendix K.
Source: ICF 2016

Figure 4.2-8

Potential Response in Salmonid Abundance to Habitat Change in the Chehalis Basin from Flood Retention Facility Types



Source: ICF 2016

The combination of adverse impacts upstream of the FRFA dam and beneficial effects of flow augmentation and temperature reduction downstream of the FRFA dam is expected to reduce the Chehalis Basin population abundance of salmon by 1% to 3%, depending on species (see Table 4.2-7 and Figure 4.2-8). The cumulative change to Chehalis Basin spring-run Chinook salmon populations is predicted to be negative; however, the abundance of spring-run Chinook salmon spawners using areas just below the dam is predicted to increase (impacts in the area just below the dam are discussed further below). The strong positive response of spring-run Chinook salmon modeled was due to the reduction in water temperature during the summer, and reflects the potential effect of cooler summer water on pre-spawning survival, improved juvenile rearing, and expansion of earlier spawning life histories. This assumes that spring-run Chinook salmon would hold over summer and spawn in the mainstem Chehalis River between Elk Creek and the Flood Retention Facility site prior to spawning in the fall in the same area. Whether adult spring-run Chinook salmon would respond behaviorally to modulating temperature and flow from the FRFA facility is unknown and represents a key uncertainty. An alternative view is that during summer, prior to spawning, adult spring-run Chinook salmon have adapted to the Chehalis River by holding in cool-water refugia—either in areas with cold groundwater inputs farther downstream than the area that would be most affected by an FRFA dam, or by moving upstream quickly to cool headwaters—and that the area modified by increased flow and decreased temperature with an FRFA dam would provide little habitat value for pre-spawn holding, spawning, or rearing. If this view is correct, the cool-water releases from an FRFA dam may have no effect on fish populations downstream of the dam. If the benefits of flow augmentation and temperature reduction do not accrue as anticipated, the total Chehalis Basin spring-run Chinook salmon population would experience reductions at least on the scale of the FRO 100 scenario, and perhaps greater due to the added loss of habitat upstream of the dam. More information is included in Appendix K.

At the Basin-wide scale, both FRO facility habitat scenarios considered would have negative effects on all salmonid species, resulting in population declines ranging from about <-1% for fall-run Chinook salmon under FRO 50 and FRO 100, to -4% for spring-run Chinook salmon under FRO 100, presenting a significant adverse impact on salmon (see Table 4.2-7 and Figure 4.2-8).

When considering impacts on salmonid species at a local scale within individual sub-basins, the impacts of both dam facilities attenuate moving downstream (see Figure 4.2-9). Changes in abundance would occur in other tributary sub-basin populations because those fish migrate through, and are affected by, changes occurring in the mainstem Chehalis River downstream of the FRO facility. This includes spawning populations in Elk Creek, the South Fork Chehalis, and the Newaukum, Skookumchuck, and Black rivers. Model results indicate impacts on subpopulations using the mainstem Chehalis River up to the confluence with the Skookumchuck River. Chum salmon would be affected in areas below the confluence with Elk Creek because chum are not present upstream of Elk Creek. Impacts on populations in the lowest reaches and tributaries of the Chehalis River were not detected.

Changes to habitat in the river segments upstream of the dam facilities and immediately downstream to the confluence of the mainstem Chehalis River with Elk Creek are shown in Table 4.2-8. The number of salmon spawning in the upper Chehalis River upstream of the FRO facility would be reduced by 18% to 49% under the FRO 50 scenario, and 29% to 55% under the FRO 100 scenario, depending on the species (see Table 4.2-8 and Figure 4.2-9). Changes in habitat between the FRO facility and the confluence of the mainstem Chehalis River with Elk Creek would result in declines in the subpopulations that use this reach to spawn, ranging from a loss of 17% of the fall-run Chinook salmon population to a loss of 58% of the spring-run Chinook salmon population (see Table 4.2-8 and Figure 4.2-9). Declines in subpopulations downstream of Elk Creek would be smaller (0% to 17%), except for spring-run Chinook salmon that could spawn in the mainstem from the confluence of the South Fork Chehalis River to the confluence with Elk Creek, which could see a decline of 36% (see Figure 4.2-9). With an FRFA facility, major declines in salmon subpopulations currently spawning above the dam site would occur due to the replacement of stream habitat with a reservoir (see Table 4.2-8 and Figure 4.2-9). The majority of fall-run Chinook salmon (98%), spring-run Chinook salmon (97%), and half the winter-run steelhead (50%) would be lost upstream of the dam. Coho salmon in this reach would experience a 23% loss. Immediately downstream of the FRFA facility to the confluence with Elk Creek, spring-run Chinook salmon abundance could increase (67%), but other species spawning in this reach would decline (losses of 28% to 62%, depending on species). Impacts in the lower portion of the Chehalis River were either not detected or were minor and positive for spring-run Chinook salmon (see Figure 4.2-9). If spring-run Chinook salmon do not respond as modeled to flow and temperature modulation, the change in abundance modeled for spring-run Chinook salmon would be similar to that predicted for the FRO facility, since adverse impacts of downstream changes to habitat-forming processes would be similar.

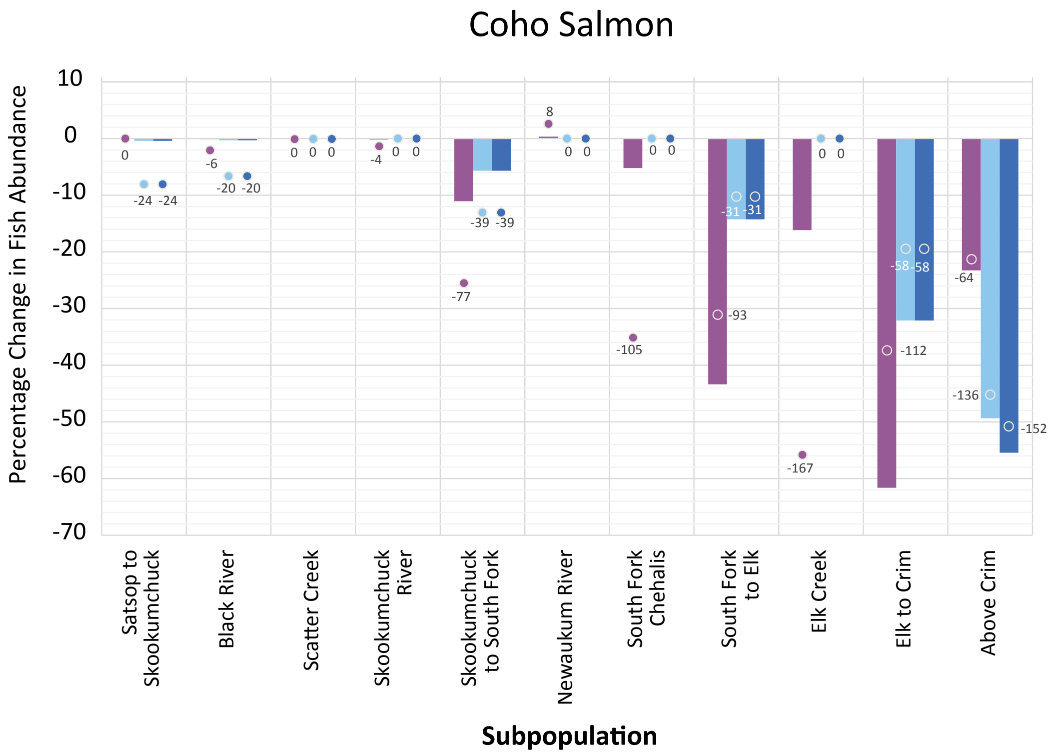
Table 4.2-8
Potential Response in Salmonid Abundance to Habitat Change in Upper Chehalis Sub-populations from Flood Retention Facility Types

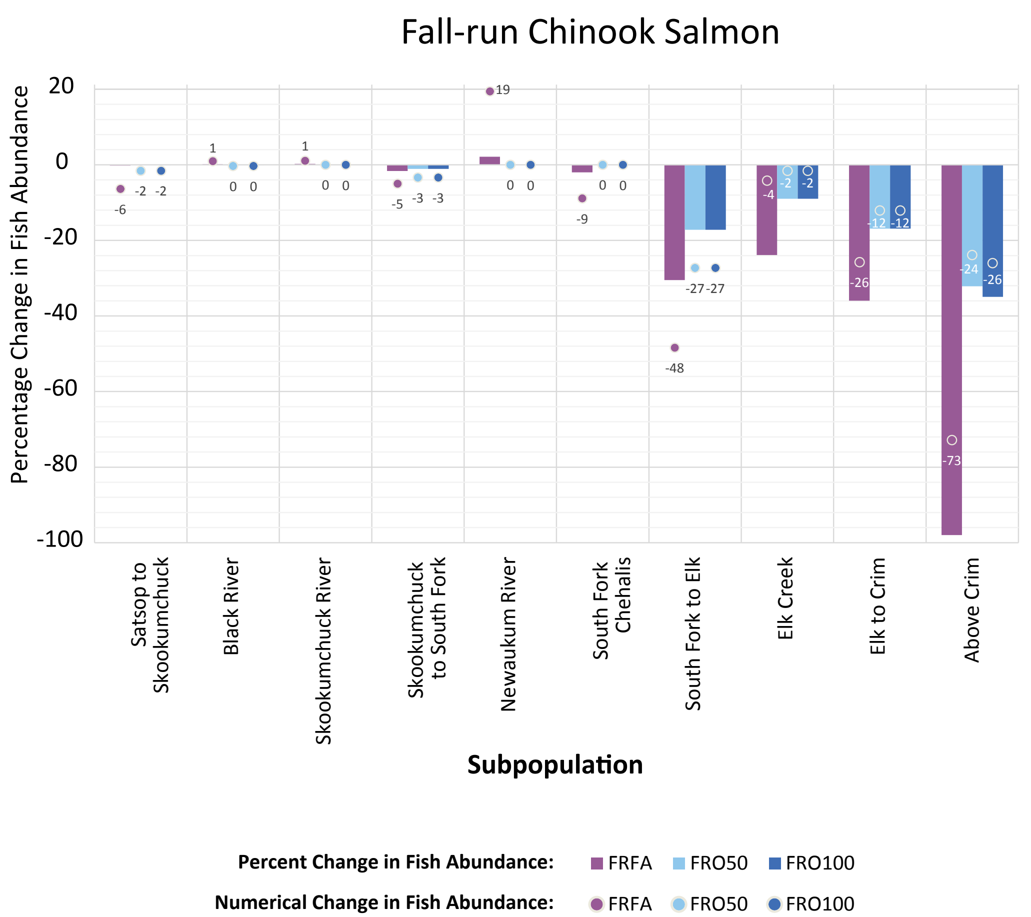
SPECIES	SUB-POPULATION (CURRENT HABITAT POTENTIAL)	CHANGE FROM CURRENT CONDITION IN NUMBER OF FISH (%)		
		FRFA	FRO 50	FRO 100
Coho salmon	Upstream of Crim Creek (dam site; 275)	-64 (-23%)	-136 (-49%)	-152 (-55%)
	Crim Creek to Elk Creek (182)	-112 (-62%)	-58 (-32%)	-58 (-32%)
Fall-run Chinook salmon	Upstream of Crim Creek (dam site; 74)	-73 (-98%)	-24; -32%	-26 (-35%)
	Crim Creek to Elk Creek (72)	-26 (-36%)	-12; -17%	-12 (-17%)
Fall/winter-run chum salmon	Upstream of Crim Creek (dam site; 0)	N/A	N/A	N/A
	Crim Creek to Elk Creek (0)	N/A	N/A	N/A
Spring-run Chinook salmon	Upstream of Crim Creek (dam site; 61)	-59 (-97%)	-11 (-18%)	-18 (-29%)
	Crim Creek to Elk Creek (56)	38 (67%)	-33 (-58%)	-33 (-58%)
Winter-run steelhead	Upstream of Crim Creek (dam site; 171)	-85 (-50%)	-74 (-44%)	-88 (-52%)
	Crim Creek to Elk Creek (18)	-5 (-28%)	-5 (-25%)	-5 (-25%)

Note: N/A is used where the percentage change cannot be calculated from an initial population of zero.
Source: ICF 2016

Figure 4.2-9a

Potential Response in Salmonid Abundance to Habitat Change in Upper Chehalis Sub-populations from Flood Retention Facility Types

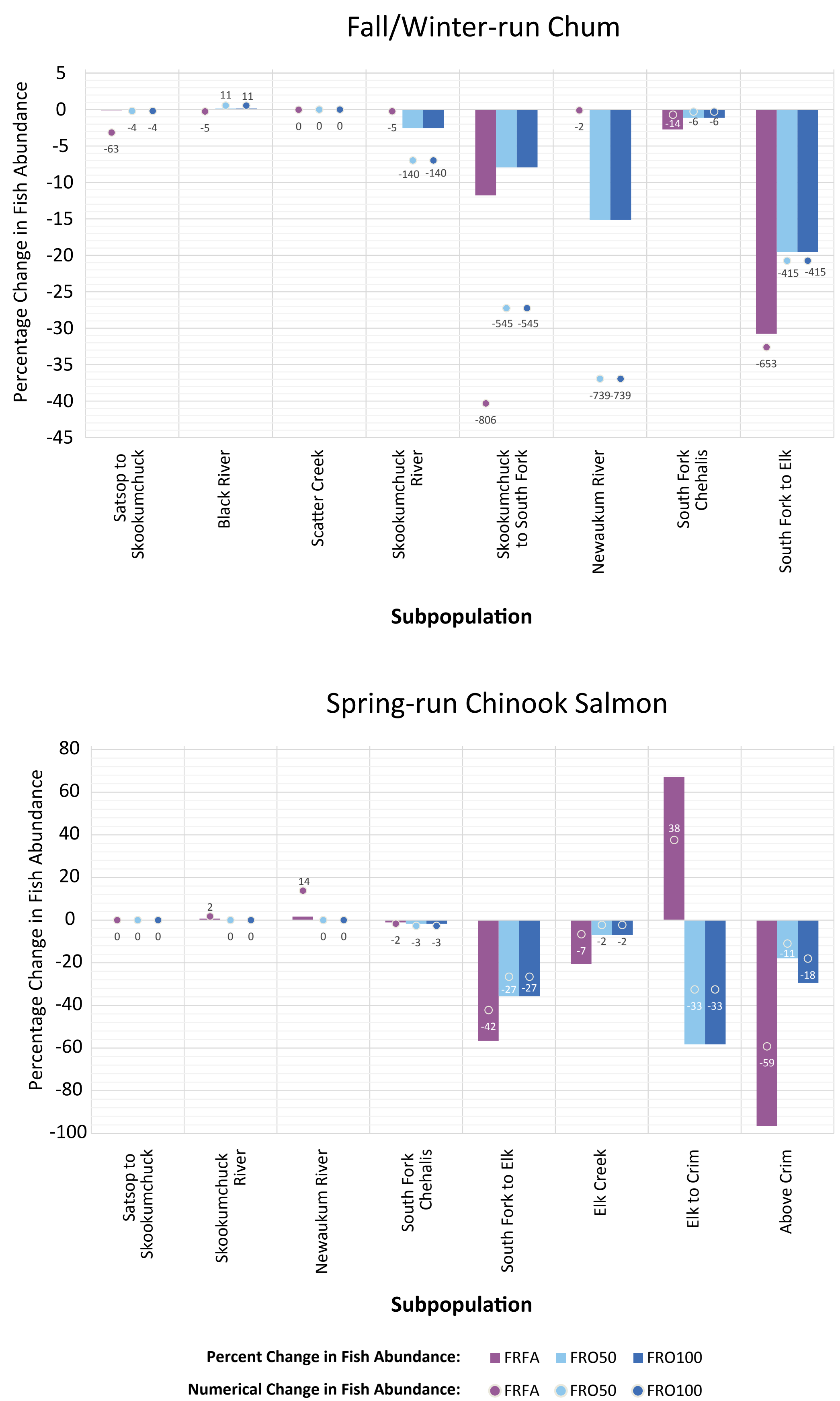




Source: ICF 2016

Figure 4.2-9b

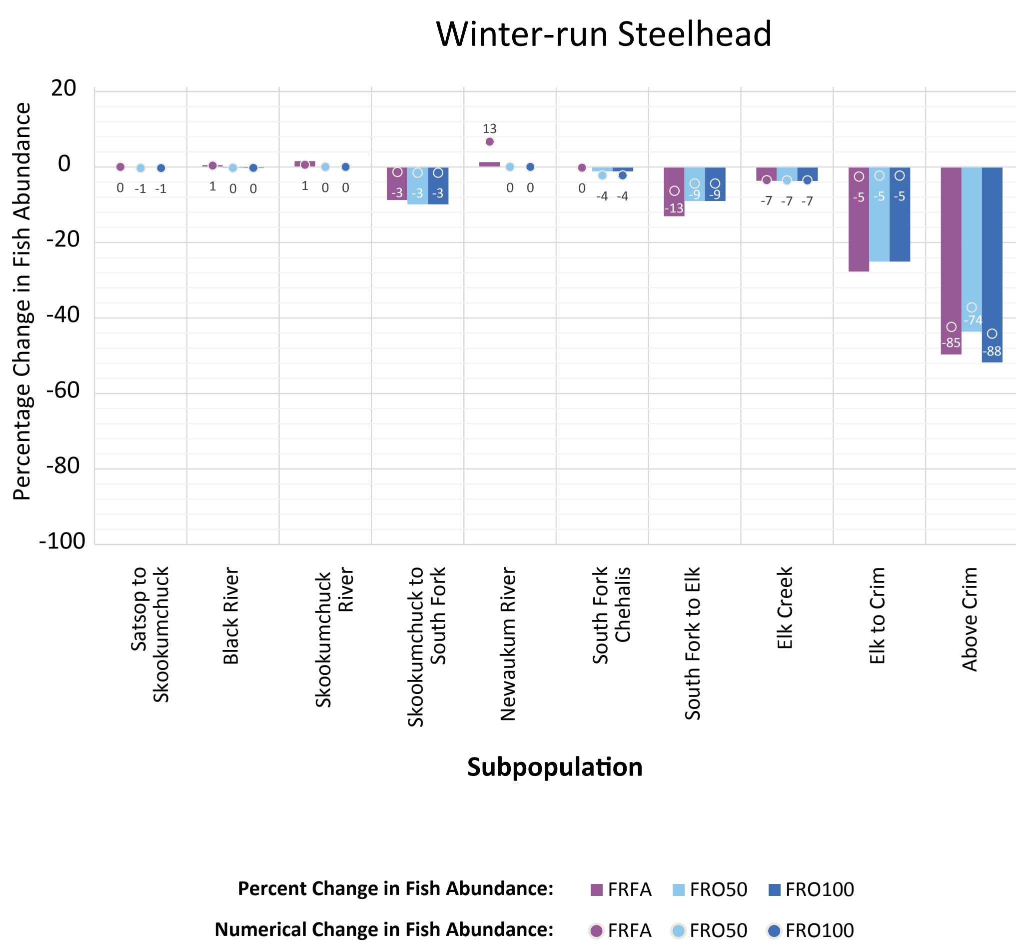
Potential Response in Salmonid Abundance to Habitat Change in Upper Chehalis Sub-populations from Flood Retention Facility Types



Source: ICF 2016

Figure 4.2-9c

Potential Response in Salmonid Abundance to Habitat Change in Upper Chehalis Sub-populations from Flood Retention Facility Types



Source: ICF 2016

The response of non-salmonid fishes to an FRFA facility was estimated by evaluating the change in usable instream habitat area available to different species based on changes in flow and temperature that would occur with an FRFA dam from May through September (Beecher 2015; PSU 2016). Habitat area for spawning and rearing life stages (where relevant and data is available) of four native fish species (Pacific lamprey, mountain whitefish, speckled dace, and largescale sucker) and two non-native predator species (largemouth bass and smallmouth bass) were evaluated. The monthly averages of change in Weighted Usable Area (WUA), a measure of habitat area, were summed to provide a single index of change in WUA for each species and life stage (see Table 4.2-9). In general, the native fish species evaluated would respond positively to summer water releases from an FRFA dam, which would increase flow and decrease summer water temperature. The responses could be greatest in the reach just downstream of the dam (Pe Ell to Elk Creek), with the responses attenuating downstream corresponding to attenuation of the change in flow and temperature resulting from the FRFA dam.

Table 4.2-9
Cumulative Monthly Change in Instream Habitat Area (Weighted Usable Area) in Summer with Augmented Flow and Reduced Temperature Water Released from the FRFA Facility

SPECIES	LIFE STAGE	PE ELL TO ELK CREEK	ELK CREEK TO SOUTH FORK	SOUTH FORK TO NEWAUKUM	NEWAUKUM TO SKOOKUM-CHUCK	SKOOKUM-CHUCK TO BLACK	BLACK TO PORTER
Pacific lamprey	Rearing	28%	-11%	4%	5%	2%	-1%
	Spawning	24%	18%	14%	2%	3%	5%
Mountain whitefish	Spawning	43%	26%	23%	7%	4%	6%
Speckled dace	Rearing	28%	8%	9%	7%	1%	-1%
Largescale sucker	Rearing	18%	8%	8%	4%	2%	0%
	Spawning	34%	27%	59%	9%	26%	29%
Largemouth bass	Rearing	N/A[2]	N/A[2]	-17%	-1%	-1%	-3%
	Spawning	N/A[2]	N/A[2]	-43%	-10%	-5%	-7%
Smallmouth bass	Rearing	N/A[2]	N/A[2]	-9%	-1%	-1%	-2%
	Spawning	N/A[2]	N/A[2]	0%	46%	0%	0%

Notes:
Data are the sum of the monthly averages of the change in WUA from May through September.
N/A indicates the species was not recorded in that reach at any life stage.
Source: Beecher 2015

The non-native predator species evaluated have only been observed as far upstream as the confluence with the South Fork Chehalis River (Hughes and Herlihy 2012; Zimmerman and Winkowski 2016). However, downstream of the South Fork Chehalis River, the habitat available for non-native species could be reduced in summer, with the effect attenuating farther downstream. One exception could occur with an increase in smallmouth bass spawning habitat in the reach between the confluences of the mainstem Chehalis River with the Newaukum and Skookumchuck rivers (see Table 4.2-9), influenced largely by changes to conditions in June (data by month not shown). It is important to note that other metrics such as substrate type or habitat structure that would be affected by an FRFA dam were not considered in this approach, and these other habitat metrics may have as much influence on species distributions as flow and temperature. Data are not available to construct a similar analysis of change in habitat during fall and winter months for these fish species when flow would be reduced by flood retention. Further evaluation would be necessary to accurately predict species responses to all of the changes in habitat that could accrue. Overall, these data suggest the FRFA dam would cause an increase in habitat for native fish species, with a reduction in habitat for non-native predators, representing a benefit to native fish downstream of the dam.

Reduction in instream habitat that would occur upstream of an FRFA facility has the potential to suppress populations of state or federally sensitive, candidate, or listed species. Pacific lamprey and Olympic mudminnow are species that could be affected by a Flood Retention Facility and are listed as state species of concern, priority species, and species of greatest conservation need. Additionally, riffle and reticulate sculpin are state species of concern. Pacific lamprey, riffle sculpin, and reticulate sculpin have been observed in the potential dam and reservoir footprint (Winkowski 2015), and like salmon, prefer fast-moving streams, with well-aerated gravel to spawn and rear as larvae. The installation of an FRFA facility would eliminate this type of habitat in the footprint of the conservation pool. Reticulate sculpin could inhabit the shallow areas of a permanent reservoir because they can tolerate warmer temperatures (greater than 20°C) and silty habitat. Pacific lamprey, riffle sculpin, and reticulate sculpin are likely widespread across the Chehalis Basin, though their distribution has not been extensively studied. Olympic mudminnow occur in slow-moving, off-channel habitat in floodplain areas in the middle and lower Chehalis River floodplain many river miles downstream of the potential dam and downstream of the area affected by flow and temperature modulation by the FRFA facility (Hayes et al. 2016a). The impact of a dam in the upper Chehalis Basin on Olympic mudminnow would be minor, as the majority of Olympic mudminnow habitat would not be affected, however flood retention could prevent inundation of relatively small areas of Olympic mudminnow off-channel habitat. No Chehalis River salmon or steelhead populations are currently listed as threatened or endangered under the ESA, and none have been designated as ESUs or main population groups under an ESU, as is commonly done for species in need of recovery. Nonetheless, any degradation in Chehalis River salmon population abundance, productivity, diversity, and spatial structure could lead to listing of the species if the population is no longer found to be viable (McElhany et al. 2000).

4.2.4.2.2 Wildlife

Anticipated adverse impacts on wildlife that would result from the construction and operation of the Flood Retention Facility are primarily related to the removal and disturbance of habitat and habitat functions over time, including potential loss of amphibian breeding habitat. The potential impacts on wildlife are similar for the FRO facility and FRFA facility, but vary in magnitude due to the larger footprint of the FRFA reservoir and the fact that a significant portion of the habitat would be converted to open water within the FRFA permanent reservoir pool. The adverse impacts described in this section range from minor to significant because different classes of wildlife species have a variety of habitat needs and home ranges, with different vulnerabilities and potential responses to the disturbance and conversion of habitat features.

Adverse impacts on wildlife would primarily be driven by the following changes in the physical environment created by the construction and operation of the Flood Retention Facility:

- Loss, conversion, and fragmentation of wetland and vegetation communities that function as wildlife habitat as a result of selective clearing and inundation in the dam and reservoir footprint
- Changes to wildlife habitat-forming processes downstream of the dam due to the streamflow management and vegetation community modification

Each of these changes would modify habitat that is currently used by a variety of wildlife to breed, forage, rest, and overwinter, including invertebrates, amphibians, reptiles, and multiple species of mammals and birds. Changing or eliminating existing habitat characteristics and functions would create conditions that reduce the quality of habitat available for existing species, thereby affecting the ability of wildlife to occupy the modified habitat. As a result, the diversity and composition of species that occupy affected habitats would change as some existing species adapt to and occupy the modified habitat, those that are unable to adapt or compete in the changed habitat perish or leave, and new species that were not there previously (e.g., invasive species) become established.

Potential adverse impacts on habitat conditions and functions in the Flood Retention Facility footprint include the loss, conversion, and fragmentation of wetland and vegetation communities that function as wildlife habitat (see Section 4.2.3). The loss, conversion, and fragmentation of such communities would occur during both construction and operation of the facility through selective clearing and periodic to permanent inundation, respectively.

Impacts on wetland and vegetation habitat would affect wildlife currently using these areas and change the types and functions of available habitat over the long term. Potential impacts on wildlife vary depending on the type of activity and the different classes of wildlife species that occupy these habitats. The clearing of vegetation to construct the dam structures and their supporting infrastructure (e.g., access roads, utility corridors) would cause a direct loss of wildlife habitat, and would cause varying degrees of habitat fragmentation based on the width and orientation of the clearing as well as the wildlife species affected.

Conversion of forested upland, riparian, and wetland habitats to those dominated by herbaceous and shrubby vegetation would result in the loss of habitats used by some wildlife species in the reservoir footprints, and could represent a gain of habitat for other wildlife species. For example, loss of riparian cover would impair habitat conditions for many amphibians, especially by reducing adequate surface moisture and appropriate temperature conditions for terrestrial stages of stream-associated amphibians, such as the state-candidate species Van Dyke's salamander (Hallock and McAllister 2005). Conversely, the more brushy vegetation that would likely replace several of the forested riparian zones in the reservoir footprint could provide additional foraging habitat for deer, elk, and birds of prey (Link 2004). In the FRFA reservoir area, the conversion from upland forest and wetlands to an inundated reservoir would remove and convert habitat used by terrestrial and semi-aquatic wildlife species; however, species that utilize open-water habitat (e.g., waterfowl and osprey) would benefit from the changes in habitat types. Disturbances to habitats of native species provide opportunities for the invasion of non-native wildlife species (e.g., European starling and American bullfrog) that could prey on or out-compete native wildlife species for resources (Knutson and Naef 1997).

The loss of trees from the riparian zone in the reservoir footprint by either selective removal under the proposed Pre-construction Vegetation Management Plan or by flood-induced mortality would directly remove nesting, denning, and feeding habitat used by wildlife including birds, mammals, amphibians, and other animals. Tree removal from these areas would also adversely affect many of the riparian functions being performed by these areas including water filtration and purification, stream channel stability, nutrient dynamics, stream shading (i.e., thermoregulation), and wood recruitment. Increased sediments entering the stream system from runoff and streambank erosion could lead to filling of interstitial spaces in stream substrates that are used by amphibians for breeding and foraging (Leonard et al. 1993). Reduction in the amount of leaf litter, organic material, and other nutrient inputs that support species at the base of the food chain would reduce foraging for aquatic and semi-aquatic wildlife species. Reduction in the amount and variety of woody material entering the system would also affect nutrient cycles and limit instream habitat-forming processes that support stream-associated amphibians. Riparian woody material is a habitat feature used by terrestrial amphibians, like the state-candidate species Van Dyke's salamander, for breeding and foraging. Instream woody material is used by stream-breeding amphibians like the Columbia torrent salamander for breeding and refuge. In addition to these impacts, conversion or removal of riparian areas would reduce, eliminate, or fragment habitat and travel corridors for wildlife including amphibians, reptiles, birds, and various mammals.

Generally, wildlife such as songbirds, raptors, and various classes of mammals are more adaptable to changes in habitat features. These wildlife groups are also able to disperse more easily to adjacent areas with suitable habitat conditions. Given that the proposed Flood Retention Facility would be located in a basin dominated by managed forestland, similar forest habitats are abundant and accessible in the area. Semi-aquatic wildlife species such as amphibians, North American beaver, and western pond turtle, however, rely on specific aquatic habitat features to breed, forage, and overwinter, and would be much more vulnerable to the localized impacts on wetlands and the conversion of riparian vegetation communities. Such species would not be able to adapt to significant changes in aquatic habitat and are unlikely to disperse successfully to other suitable habitats. Some amphibians could also face increased predation within modified habitats as a result of changes in the availability or quality of cover (e.g., vegetation, leaf litter, woody material), as well as a potential increase in the number of predators (e.g., fish, reptiles, small and medium-sized mammals, birds, other amphibians) in the area due to displacement from adjacent modified habitats.

In addition to vegetation removal and modification, inundation of the reservoir would cause adverse impacts on wildlife and wildlife habitat in the stream reach within the boundaries of the inundation area. Though flooding would be infrequent and temporary in both the FRO reservoir and flood storage portion of the FRFA reservoir that is located above the conservation pool, the flooded area would be relatively large (see Table 4.2-1 in Section 4.2.1.2.2). During floods, river flows would be retained in the reservoir, with filling and draining of the reservoir lasting up to 32 days. Inundation of riparian habitat used by amphibians and other wildlife species would directly displace animals or result in mortality for species unable to disperse or relocate to other suitable habitats (Knutson and Naef 1997). Increased deposition of sediment upstream of the dam would negatively affect water quality, as well as breeding and foraging habitat for stream invertebrates and stream-associated amphibians. Temporary inundation and sedimentation of the stream channel would alter its structure from pools and riffles to an eroded channel through sediment, and would replace stable aquatic habitat with dynamic habitat, removing instream habitat preferred by aquatic amphibians.

Permanent inundation of up to 1,264 acres for the FRFA reservoir would convert stream and riparian habitats to a pool (lacustrine) habitat for which many stream-dwelling wildlife species, especially native amphibians, are not well adapted, presenting a loss of functional habitat for these species and a substantial adverse impact on aquatic wildlife. Most wildlife species would not adapt to the changes from stream, riparian, and terrestrial habitats to a lacustrine habitat, forcing these species to attempt to relocate to other suitable habitat (Knutson and Naef 1997). Some species would successfully relocate to other suitable habitat and some species would be unsuccessful in relocating to other habitats and would perish (Knutson and Naef 1997).

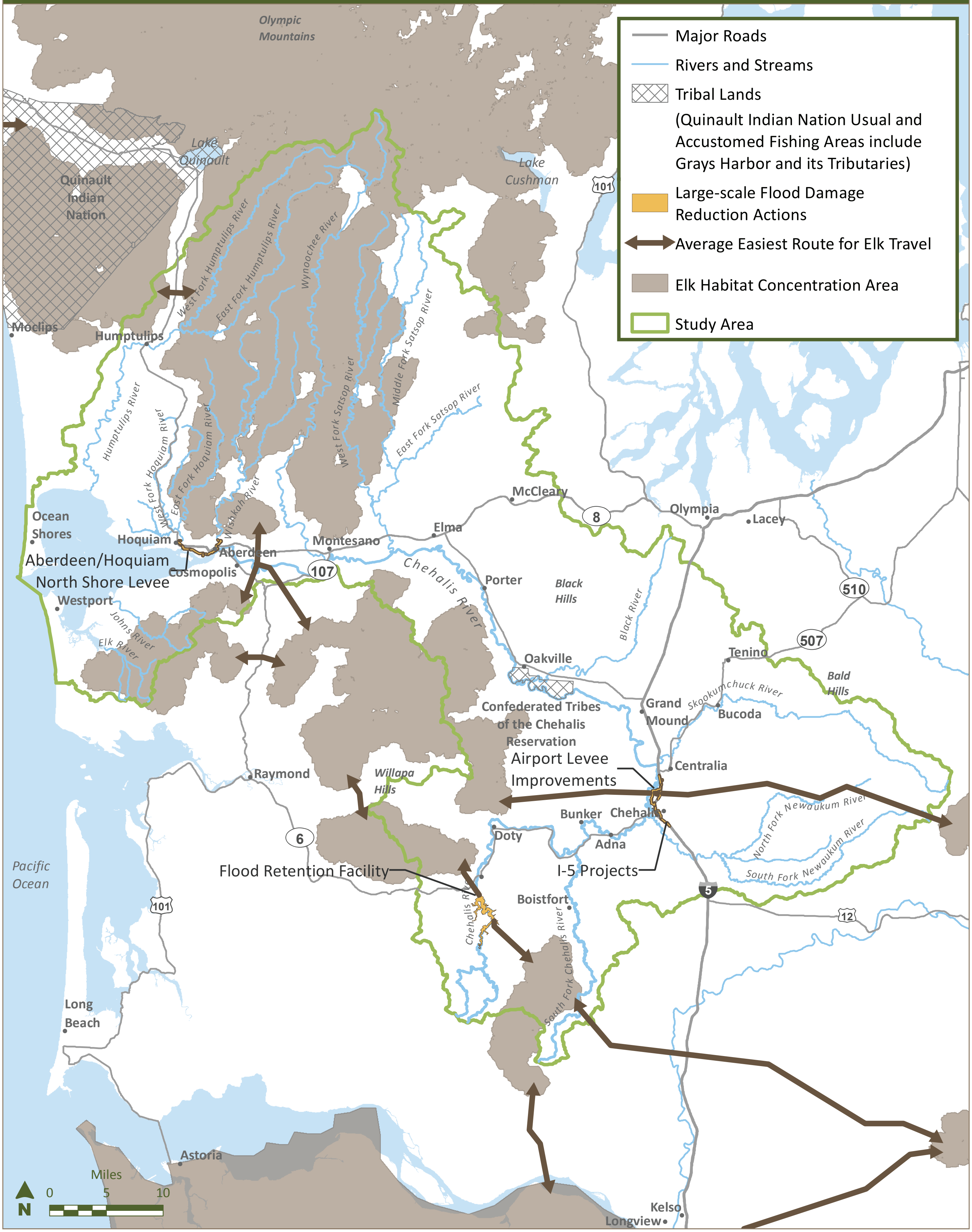
Specific species that would be adversely affected by temporary (FRO reservoir) and permanent (FRFA reservoir) water retention include western toad and western pond turtle. Breeding habitat for western toad in the Chehalis Basin is concentrated in the mainstem Chehalis River and larger tributaries within the proposed reservoir footprint (Hayes et al. 2016b). Temporary inundation of these areas by the FRO reservoir during flood retention and permanent inundation in the FRFA reservoir conservation pool would eliminate this habitat, potentially contributing to the extirpation of western toad from this portion of the Chehalis Basin. Although western toad are known to breed in stillwater reservoirs, the potential for this to occur in the FRFA conservation pool is uncertain due to the magnitude and timing of water fluctuations in the reservoir due to dam operations. Western pond turtle, a state-endangered species that is potentially present in the Chehalis Basin, would also be affected by the direct loss of potential breeding habitat from the conversion of stream habitat to reservoir habitat (ASEPTC 2014c). Such losses would contribute to the local extirpation of that species.

As discussed in Section 4.2.4.2.1, conversion of stream and riparian habitats to a pool habitat under the FRFA would also result in the loss of salmon spawning habitat within the reach of the Chehalis River upstream of the dam. Salmon provide nutrients to a wide range of wildlife species that directly prey on live spawners, scavenge the carcasses of dead fish, or prey upon salmon eggs and juveniles after spawning. The range of mammal species that feed on salmon includes bears, weasels, shrews, and potentially deer, squirrels, and mice. Avian predators and scavengers include eagles, hawks, gulls, crows, and some songbirds (Willson and Halupka 1995). The nutrients from spawners also benefit wildlife by fertilizing riparian and aquatic plant species which, in turn, provide food or cover for aquatic and terrestrial animal species (Schindler et al. 2003). Decreases in salmon abundance resulting from lost freshwater habitat will, therefore, have an adverse impact on wildlife species that either feed on or otherwise benefit from salmon-derived nutrients. The significance of the adverse impact on wildlife is proportional to the decrease in abundance and is also expected to be most intense in areas where salmon spawning is substantially reduced or prevented, such as the reservoir footprint.

Replacing vegetated habitat with reservoirs of standing water could alter or restrict the migratory routes of elk, deer, and other large, migratory, terrestrial species. Elk require large areas to meet migratory needs and often move long distances on a seasonal basis. Important habitat patches for elk known as HCAs exist within the Chehalis Basin and in the surrounding geographic area to the north and south of the proposed reservoir footprints (see Figure 4.2-10). Landscape connectivity between the HCAs—that is, migratory routes that are not significantly altered by human infrastructure—are necessary for migration of elk and other species. Migratory elk would seek paths between HCAs that require the least energy expenditure by the animals (i.e., least cost paths). The Flood Retention Facility would not directly affect acreage within an HCA; however, both footprints appear to overlap one of these paths of least energy expenditure and could force animals to travel around the area, expending more energy and presenting a moderate impact on the species (WHCWG 2010; see Figure 4.2-10).

Figure 4.2-10

Terrestrial Species Connectivity



Changes to the way floodwaters move through the system both upstream and downstream of the dam would also disrupt many of the existing physical, chemical, and biotic processes of riparian areas, reducing or eliminating many of the important functions provided by the riparian zone (Knutson and Naef 1997). Downstream of the dam, flood control would cause a reduction in the magnitude of peak floods, which would translate to reductions in habitat-forming processes, especially those that are driven by major floods. While flooding of the magnitude that would trigger flood retention would be infrequent, it is the largest floods that have the greatest ability to shape habitat for aquatic and semi-aquatic species and wildlife species that use the riparian areas and the floodplain. Habitat-building processes downstream would also be affected by the retention of much of the sediment and LWM load by the Flood Retention Facility.

Downstream of the dam, reduced flooding would reduce stream and riparian habitat-shaping processes. Wetlands and periodically inundated areas that serve as functional floodplain habitat for semi-aquatic species, such as amphibians and waterfowl, would also be reduced. These adverse impacts range from minor to moderate given the size of the entire Chehalis Basin relative to the change in the extent of flooding.

Flood control with the FRFA dam would allow for the modulation of flows downstream of the dam year-round, with the intention of providing higher base flows and cooler water during the summer months to improve downstream habitat. The potential effects of these higher flows and cooler water temperatures on stream breeding and stream-associated terrestrial amphibians is variable. An increase in low summer instream flows downstream of the FRFA dam could benefit certain amphibian species by providing sufficient water levels in off-channel habitats that dry up under existing conditions. Although many amphibian species could also benefit from cooler stream temperatures, such changes could interfere with the seasonal environmental cues (e.g., increased water temperature, decreased flow and water depth) used by these species to trigger the initiation of metamorphic processes. An increase in summer base flows and reduction in temperatures has the potential to delay or eliminate breeding habitat for the instream-breeding western toad, which appears to prefer warm, shallow, open water areas in the stream channel for breeding (Hayes et al. 2016b). To evaluate this potential, the change in usable downstream habitat for western toad based on the proposed changes in flow and temperature that would occur with an FRFA dam was modeled for the six consecutive river reaches below the proposed dam. The results of this modeling effort indicate that there would be no change in the area of usable habitat for western toad in the river reach immediately below the proposed dam, but a reduction in area of usable habitat for all subsequent reaches. Overall, although flows from the FRFA dam could be regulated to maximize available instream habitat for salmon below the dam, targeted flows could conflict with those that are optimal for amphibians (ASEPTC 2014c).

4.2.4.3 Mitigation

4.2.4.3.1 Fish

A range of possible mitigation measures for short-term impacts on fish are described in Table 4.1-1. However, instream work would be unavoidable and large in scale, and limiting work to times of the year when sensitive species are absent would not be possible. Year-round construction for 2 to 3 years would be required. Avoidance and minimization to reduce short-term direct impacts on fish could include construction of a temporary river bypass tunnel to pass water and fish downstream during the construction period. A trap-and-haul strategy would be implemented to provide upstream fish passage and maintain fish survival around the Flood Retention Facility construction site.

Some potential long-term impacts on fish would be addressed through avoidance and minimization measures, including provision of fish passage around the dam, minimum instream flows released from the dam during flood retention periods, and release of cool water from the FRFA facility during late spring to early fall. New infrastructure such as roads and power lines could be planned to minimize the number of stream crossings that require permanent removal of intact riparian habitat. 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 could include fish habitat restoration, protection, or acquisition of land that presents an opportunity for in-kind compensation for fish habitat lost.

Consistent with state mitigation policy (WDFW mitigation policy POL-M5002), mitigation for unavoidable adverse impacts on fish would include continued collection of baseline data and detailed implementation plans based on identified population performance standards or goals for fish populations, fish passage, and life history diversity, including maintenance of recreational and harvest opportunities. Compensatory mitigation would be described in the Reservoir Operations and Management Plan, including an adaptive management plan for fish species affected by the Flood Retention Facility that includes regular monitoring and evaluation of fish passage and population performance (e.g., monitoring fish abundance, habitat processes upstream and downstream of the dam site) to ensure population viability goals are met. Compensatory mitigation measures would be developed during project-level design and permitting to address the loss of fish habitat and function. Adaptive management plans would include corrective actions to be taken if mitigation developments do not meet goals and objectives. A Flood Retention Facility may cause adverse impacts that cannot be fully mitigated by the compensatory actions described here.

4.2.4.3.2 Wildlife

Potential mitigation measures to reduce short-term impacts on wildlife and wildlife habitat from construction of the Flood Retention Facility are described in Table 4.1-1.

Some potential long-term impacts on wildlife could be addressed through avoidance and minimization measures, including developing and implementing a Post-construction Vegetation Management Plan (see Section 4.2.3.3) to address the loss of loss of forestland upstream of the dam. Compensatory mitigation measures would be developed during project-level design and environmental review that would create or improve wetland, wetland buffer, and riparian habitat conditions that support a variety of native wildlife species.

4.2.5 Tribal Resources

The health and productivity of the entire Chehalis Basin affects the treaty fisheries and the non-treaty Chehalis Tribe fishery on the Chehalis Tribe reservation. The upper and middle Chehalis River and its tributaries contain valuable habitat for spawning and rearing salmonids.

Impacts on tribal resources could occur during or following construction, if tribal members could no longer access a resource or if the resource was diminished. The following potential impacts were considered:

- Access to treaty reserved usual and accustomed fishing areas, including Grays Harbor and the Chehalis River
- Access to treaty-reserved usual and accustomed areas for hunting and gathering on open and unclaimed lands
- Access to culturally significant areas for gathering of plant material or other related activities
- Injury and mortality of fish and wildlife and their habitats, and plants that are identified as a tribal resource; these impacts are detailed in Section 4.2.4 and are included in this section by reference

Indirect impacts on tribal resources could occur as a result of the impacts on water resources, geology and geomorphology, wetlands and vegetation, and fish and wildlife detailed in Sections 4.2.1 through 4.2.4.

> **Tribal Resources**
>
> Tribal resources refer to the rights and interests of Indian tribes within the Chehalis Basin to various natural resources, including those associated with a tribe's sovereignty and/or federally reserved treaty rights. These resources include plants, wildlife, fish, and shellfish. Tribal resources also include rights and interests in cultural, historic, spiritual, and archaeologic places and artifacts, including graves and Indian human remains. Impacts on treaty-reserved rights cannot be mitigated without consent of an affected treaty tribe. Discussion or consideration of mitigation for impacts on treaty rights resulting from any of the actions evaluated in this EIS would require consent by the Quinault Indian Nation. Additional information on tribal rights is found in Section 2.4.1

4.2.5.1 Short- and Long-term Impacts

The potential impacts on tribal resources that would occur during construction of the Flood Retention Facility are related to the temporary disruption of access to areas for gathering resources associated with a tribe's sovereignty or formal treaty rights. These construction-related impacts could occur near construction activities associated with the dam, reservoir area, haul roads, and other components of the Flood Retention Facility. Potential impacts could include reduced or limited access to plants, fish, or wildlife used for commercial, subsistence, and ceremonial purposes. For example, members of the Quinault Indian Nation and the Chehalis Tribe can harvest Pacific lamprey found in the area of the Flood Retention Facility. Access to this resource would be affected during the 2- to 3-year construction period.

Additional construction-related impacts on tribal resources are associated with loss or take of natural resources protected by tribal treaty for fishing, hunting, and gathering. As described in Section 4.2.3, direct impacts on fish or wildlife could occur during construction (including injury or mortality), as well as activities resulting in indirect impacts through habitat pathways such as sediment released into the river or construction noise-affecting behavior. Construction-related impacts would affect fish use within the immediate area of construction and habitat upstream, which would affect productivity and abundance of fish species in the area.

Additional input from the Quinault Indian Nation, Chehalis Tribe, and other potentially affected tribes will help to characterize existing tribal resources and use of the area for fishing, hunting, and gathering, and confirm the nature of potential impacts from construction-related activities. Additional coordination with affected tribes to address specific impacts on tribal resources would continue during project-level environmental review, and as part of continued government-to-government consultations.

The potential long-term impacts on tribal resources consider impacts on fishing, hunting, gathering, and other traditional cultural activities following construction. As described in Section 4.2.4.2.1, impacts on fish and fish habitat during construction that occurs over a 2- to 3-year period could become a long-term impact because reduced egg and juvenile survival in a given year would lead to reduced abundance in the subsequent generations.

Long-term impacts from the Flood Retention Facility could affect tribal resources in the following ways:

- Restricted or reduced access of tribal members to tribal resources
- Altered vegetation in the riparian and flood-affected areas due to periodic inundation, which could affect tribal fisheries
- Loss of fish habitat function within the reach of the Chehalis River inundated upstream of the dam for cool, swift water-associated fish species, including loss of salmon-spawning habitat
- Diminishment in the number of fish that would otherwise be available for tribal harvest, as well as wildlife and plants that are identified as a tribal resource

Additional potential impacts on fish and wildlife and vegetation that may directly or indirectly affect tribal resources are described in Sections 4.2.4.2 and 4.2.3.2.3, respectively. Several potential impacts have been identified, with the extent of impacts pending additional coordination with tribes and continued government-to-government consultations. Potential long-term impacts could occur to tribal resources on tribal lands, within usual and accustomed fishing areas, or other areas used for hunting and gathering. As noted by the Quinault Indian Nation, adverse impacts that impede the ability to exercise treaty rights, such as impaired access to resources or actions that harm resources directly or indirectly by affecting the habitat on which they are dependent, constitutes the take of a property right that has been guaranteed to tribes (Sharp 2016a, 2016b).

Construction of the Flood Retention Facility would occur over 2 to 3 years and, thus, could affect multiple years of salmon and steelhead adults returning to spawn in the area of construction and upstream of the construction site, as well as juveniles in the vicinity of the Flood Retention Facility site. In-water construction activities could also reduce adult passage to the upper watershed for spawning or could affect habitat, thereby affecting survival of eggs or juveniles. Together these impacts would result in fewer adult salmon and steelhead returning to the Chehalis Basin and upper watershed in future years, and would result in fewer salmon and steelhead available for harvest by tribal fishers in the lower Chehalis River. Long-term impacts on fish habitat associated with construction and operation of the Flood Retention Facility could result in a reduction in the abundance of chum salmon, Chinook salmon, coho salmon, and winter-run steelhead returning to the Chehalis Basin as predicted through habitat modeling presented in Section 4.2.4.

The Flood Retention Facility would reduce the available area for fish spawning, rearing, and migration, and would reduce upstream habitat for fish. Over the longer term, the Flood Retention Facility could affect fish population productivity and population life history diversity—both measures of population resiliency (McElhany et al. 2000). These impacts could result in greater sensitivity of the populations to variability in environmental conditions, affecting freshwater and marine survival and year-to-year variability in number of adults returning to the Chehalis Basin. Modeling is currently underway to evaluate whether sediment supply from the area above the Flood Retention Facility would result in a measurable decrease in beach sediment contribution to the Pacific Ocean (Watershed GeoDynamics and Anchor QEA 2016).

The Flood Retention Facility would be located in an area that could be used by tribal hunters and would affect access to this area. The Flood Retention Facility would affect habitat potentially used by wildlife. The dam and reservoir would remove the availability of these areas for the collection of plants and the harvesting of deer and elk by tribal hunters and gatherers.

4.2.5.2 Mitigation

The mitigation associated with potential impacts on tribal resources would be addressed directly with Quinault Indian Nation and Chehalis Tribe tribal leadership during project-level environmental review and continued government-to-government consultations.

Some potential long-term impacts on tribal fish resources could be addressed through avoidance and minimization measures developed in consultation with tribes. These may include the provision of fish passage around the dam during construction and operation, noise attenuation measures during construction, minimum instream flow release from the dam during operation, and release of cool water during operation of the FRFA facility in late spring to early fall.

Potential compensatory mitigation measures developed in consultation with tribes could include, but are not limited to, the following:

- Coordinating with tribal leaders and managers on the timing and location of construction activities that could affect tribal access
  - Coordination could result in adjustments to the timing of construction activities to avoid periods when use is the highest or provisions to provide an access point around the construction site and proposed Flood Retention Facility
- Identifying areas with significant tribal resources and coordinating with the tribes regarding access points to these areas during and after construction

Compensatory mitigation could be required for loss of fish habitat and fish habitat function, and reduced fish population performance above and below the Flood Retention Facility. Compensatory mitigation would be developed in consultation with tribes and may include fish habitat restoration, protection, or acquisition of land that presents an opportunity for in-kind compensation for fish habitat lost. Mitigation of impacts on treaty rights is subject to consideration and agreement by the Quinault Indian Nation.

4.2.6 Air Quality

4.2.6.1 Short-term Impacts

The potential short-term impacts on air quality that would occur during construction are described in Table 4.1-1. Emissions and dust would increase during the 2- to 3-year construction period, and clearing activities early in construction would cause the most increases in dust. These temporary impacts would occur in an isolated area with no permanent residents, so increased dust would not affect people. Increased dust and emissions would be localized and are not expected to violate air quality standards.

4.2.6.2 Long-term Impacts

The Flood Retention Facility would result in minor adverse impacts on air quality due to windblown particulate matter (e.g., dust). The cleared area of the FRO reservoir and FRFA reservoir flood storage pool could be a source of dust when not inundated. The dust would be limited to the dry season and during relatively high winds. Impacts would be temporary and would not affect overall regional air quality. The Flood Retention Facility would not generate emissions, and would therefore not affect air quality.

4.2.6.3 Mitigation

Potential mitigation measures to reduce short-term impacts on air quality are described in Table 4.1-1. No long-term impacts on air quality are anticipated, so no mitigation is proposed.

4.2.7 Climate Change

The evaluation of impacts related to climate change is considered from two perspectives, based on Ecology guidance (Ecology 2011c), and is as follows:

- Adverse impacts that contribute to the effects of climate change (e.g., new sources of GHG emissions)
- Adverse impacts of climate change on the proposed action element (e.g., increased sea levels, reduced snowpack, changes in water availability, changes in streamflow timing, increased forest fires, more extreme precipitation events and flooding)

Ecology's guidance (Ecology 2011c) is used for clarifying the level of analysis as follows:

- Actions that are expected to annually produce an average estimate of at least 10,000, but less than 25,000 MT carbon dioxide equivalent (CO_2e), should at least qualitatively disclose the GHG emissions caused by the action
- Actions that are expected to produce an average of 25,000 or more MT CO_2e each year should include a quantitative disclosure of GHG emissions

4.2.7.1 Short-term Impacts

4.2.7.1.1 Effects of the Flood Retention Facility Contributing to Climate Change

The potential short-term impacts that could contribute to climate change would occur during construction of the Flood Retention Facility and include additional GHG emissions from construction equipment and truck shipments of materials to and from the dam site, such as construction materials, excavated materials, cement (including GHG emissions from cement production processes), and vegetation removal. Concrete aggregate would be mined within the facility area and an on-site concrete batch plant would produce concrete at the Flood Retention Facility site. Construction of the FRFA facility would generate greater GHG emissions (270,000 MT CO_2e) than construction of the FRO facility (166,000 MT CO_2e). These effects would be above the threshold of significance established by Ecology, but would be temporary and not sustained over time.

4.2.7.1.2 Effects of Climate Change on the Flood Retention Facility

No short-term impacts of climate change on the Flood Retention Facility are anticipated during construction.

4.2.7.2 Long-term Impacts

4.2.7.2.1 Effects of the Flood Retention Facility Contributing to Climate Change

The potential adverse impacts of the Flood Retention Facility contributing to climate change would occur as a result of the permanent loss of vegetation within the Flood Retention Facility footprint, which reduces carbon sequestration (i.e., carbon storage). The loss of carbon sequestration decreases CO_2 capture, which increases the concentration of GHGs in the atmosphere. The GHG emission equivalents from lost carbon storage due to vegetation loss for both types of dams (see Section 4.2.3.2) are above the threshold of significance for evaluation of impacts (207 acres of deforestation and/or 25,000 MT CO_2e) for the Flood Retention Facility (Ecology 2011c). These effects are considered a moderate adverse impact in the immediate vicinity of the Flood Retention Facility due to the sustained impact over time of GHG emission equivalents in excess of the Ecology threshold for significance for impact evaluation. However, on a Basin-wide scale, the loss of vegetation for the dam facility represents a small percentage loss of vegetation across the watershed, which includes more than 830,000 acres of forestland.

Table 4.2-10 provides information on the loss of vegetation associated with the Flood Retention Facility, along with the corresponding annual GHG emission equivalents.

Table 4.2-10
Vegetation Loss and GHG Emission Equivalents

CATEGORY	FRO FACILITY	FRFA FACILITY
Vegetation loss in acres		
Facility footprint	6	9
Conversion of forestland to shrubland in reservoir area	405	178
Conservation pool	0	711
Total acres	**411**	**889**
GHG emission equivalents[1]	**49,731 MT CO_2e/year**	**107,569 MT CO_2e/year**

Note:
1. Based on Ecology's SEPA GHG Calculation Tool (Ecology 2011c, Attachment 2)

4.2.7.2.2 Effects of Climate Change on the Flood Retention Facility

The CIG has studied the potential effect of climate change on peak flows in the Chehalis Basin (CIG 2016). The predicted change in peak flows derived from the CIG study are listed in Table 4.2-11 (Karpack 2016a).

Table 4.2-11
Percentage Change to Chehalis Basin Peak Flows for Climate Change Conditions

EVENT	PERCENT CHANGE
2-year	+16%
10-year	+35%
20-year	+45%
100-year	+66%
500-year	+94%

The results of the CIG study were used in hydrologic modeling to estimate the effectiveness of the Flood Retention Facility in reducing peak flows under climate change conditions (Anchor QEA 2016c). The modeling found a beneficial effect of reducing flood damage in the Chehalis River Basin from the reduction in peak flows from the Flood Retention Facility under climate change conditions. Table 4.2-12 presents a comparison of peak flows for a 100-year flood, under existing and climate change conditions with the Flood Retention Facility, at Doty and at Grand Mound.

Table 4.2-12
Peak Flows During 100-year Flood Under Existing and Climate Change Conditions

	AT DAM LOCATION		AT DOTY			AT GRAND MOUND		
	EXISTING PEAK FLOW WITHOUT DAM (cfs)	PEAK FLOW WITH DAM (cfs)	PEAK FLOW WITHOUT DAM (cfs)	PEAK FLOW WITH DAM (cfs)	PERCENT DIFFERENCE	PEAK FLOW WITHOUT DAM (cfs)	PEAK FLOW WITH DAM (cfs)	PERCENT DIFFERENCE
Existing	24,200	300	36,700	12,800	-65%	75,100	62,900	-16%
With Climate Change	40,200	300	60,900	21,000	-66%	137,900	108,600	-21%

Sources: Anchor QEA 2016b; Karpack 2016b

It is predicted that the Flood Retention Facility will reduce peak flows downstream of the dam under future climate change conditions. Both the peak flow reduction and percentage reduction will be greater than under existing conditions, indicating the Flood Retention Facility could help reduce flood damage in the Chehalis River floodplain resulting from climate change. Detailed floodplain modeling of climate change conditions was not available at the time this EIS was published. The EDT model developed for the Chehalis Basin (ICF 2016) was used to predict how fish species would respond to habitat modifications resulting from climate change, both with and without the Flood Retention Facility (see Section 4.1.3 for information on forecasting climate change). The model determined that climate change would have the greatest impact on spring-run Chinook salmon and least impact on winter- and fall-run chum salmon (ASEPTC 2014c). A Flood Retention Facility would further reduce salmon abundance up to 4% on a Basin-wide scale, depending on the species. Table 4.2-13 and Figure 4.2-11 present these results for the Flood Retention Facility as a percentage increase or decrease compared to the results under current conditions with climate change.

Table 4.2-13
Potential Response in Salmonid Abundance to Habitat Change in the Chehalis Basin from Climate Change and Flood Retention Facility Types

SPECIES (CURRENT HABITAT POTENTIAL)	CHANGE FROM CURRENT CONDITION IN NUMBER OF FISH (%)			
	WITH CLIMATE CHANGE ONLY	WITH CLIMATE CHANGE AND FRFA	WITH CLIMATE CHANGE AND FR0 50	WITH CLIMATE CHANGE AND FR0 100
Coho salmon (40,642)	-22,390 (-55%)	-22,447 (-55%)	-22,560 (-56%)	-22,566 (-56%)
Fall-run Chinook salmon (25,844)	-6,969 (-27%)	-6,994 (-27%)	-7,048 (-27%)	-7,048 (-27%)
Winter/fall-run chum salmon (190,550)	-8,270 (-4%)	-9,528 (-5%)	-9,204 (-5%)	-9,204 (-5%)
Spring-run Chinook salmon (2,146)	-1,869 (-87%)	-1,897 (-88%)	-1,954 (-91%)	-1,954 (-91%)
Winter-run steelhead (6,800)	-3,741 (-55%)	-3,732 (-55%)	-3,793 (-56%)	-3,799 (-56%)

Source: ICF 2016

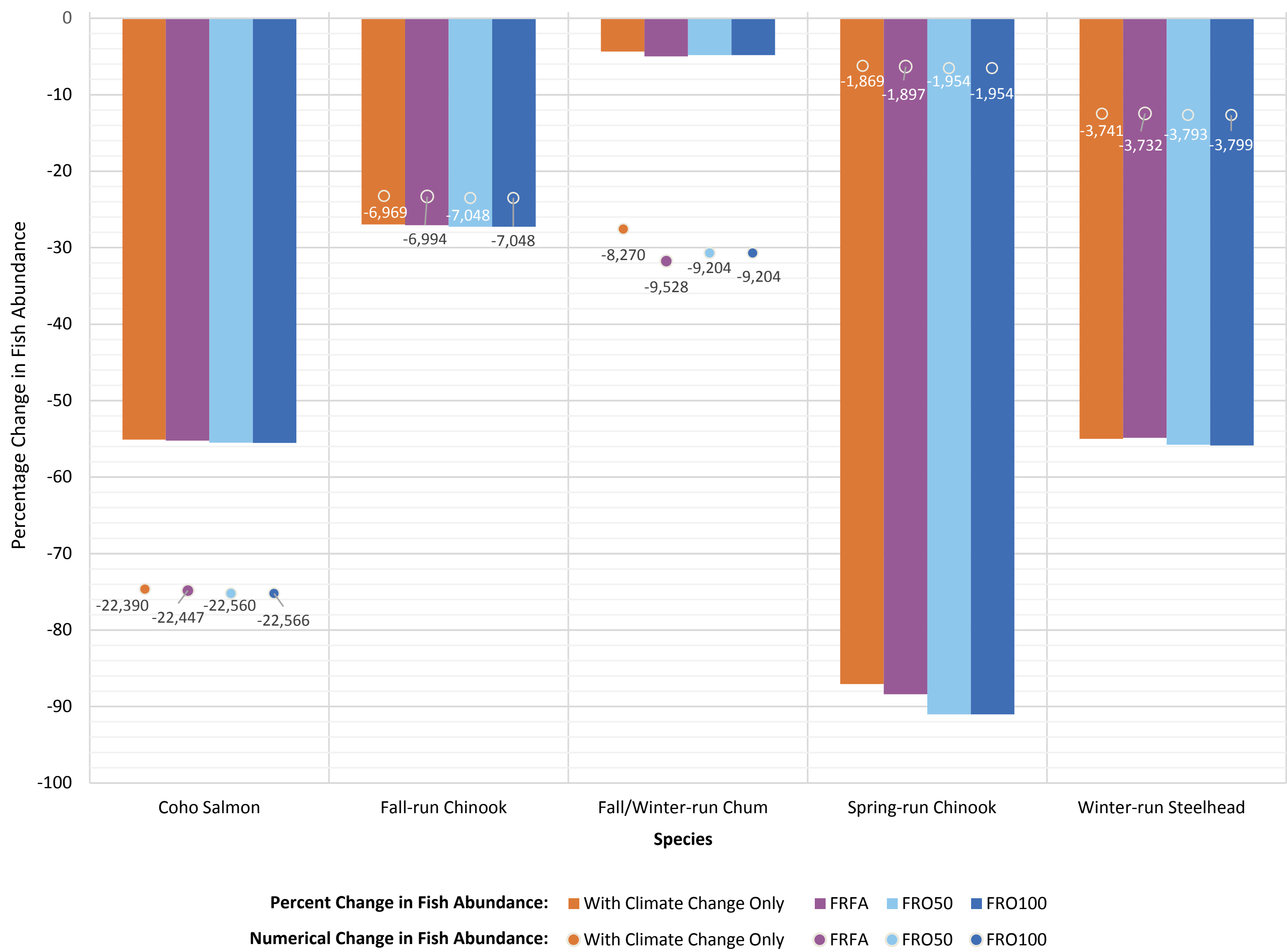
The Flood Retention Facility could worsen the adverse effects of climate change on some salmonid species, including winter/fall-run chum salmon and spring-run Chinook salmon. The FRO facility would have greater detrimental adverse impacts on the spring-run Chinook salmon population than the FRFA facility. Modeling results indicate that little or no change in populations of other salmonid populations are predicted with climate change and construction of a Flood Retention Facility.

As discussed in Section 4.2.4.2.2, decreases in salmon abundance resulting from lost freshwater habitat would have an adverse impact on wildlife species that either feed on or otherwise benefit from salmon-derived nutrients. This adverse impact would likely be most intense in areas where salmon spawning is substantially reduced or prevented, such as the reservoir footprint.

Climate change may also impact vegetation and riparian habitat upstream of the dam, as reservoir inundation patterns change with increased duration and amount of floodwater retention. Unlike the impacts associated with the immediate reservoir inundation following dam construction, the increases in these periods of inundation would likely be gradual, and the potential impacts on fish and wildlife or vegetation would be difficult to predict, but less than the initial impact after dam construction.

Figure 4.2-11

Potential Response in Salmonid Abundance to Habitat Change in the Chehalis Basin from Climate Change and Flood Retention Facility Types



Source: ICF 2016

4.2.7.3 Mitigation

4.2.7.3.1 Mitigation to Address Effects of the Flood Retention Facility Contributing to Climate Change

Potential long-term adverse impacts on climate conditions from operation of the Flood Retention Facility are associated with the loss of carbon sequestration resulting from vegetation removal. These effects could be addressed through avoidance and minimization measures, including implementing the Reservoir Operations and Management Plan, which includes vegetation management efforts to minimize increased GHG emissions (from the loss of carbon storage/vegetation removal).

The potential compensatory mitigation measures to address unavoidable adverse impacts from the operation of the Flood Retention Facility could include conservation of existing forestland to address loss of carbon storage and sequestration and increased GHG emissions.

4.2.7.3.2 Mitigation to Address Effects of Climate Change on the Flood Retention Facility

As described earlier, some of the potential long-term impacts of climate change on the Flood Retention Facility that could occur from increased intensity and frequency of storms would be mitigated by the design of the facility. Other avoidance and minimization efforts include implementation of the Reservoir Operations and Management Plan that would provide for adaptive management of dam operations to address downstream flooding. Adaptive management of the FRFA facility would also include management for instream flow and temperatures to minimize impacts on fish, in addition to downstream flooding.

4.2.8 Visual Quality

4.2.8.1 Short-term Impacts

The potential short-term impacts on visual quality that would occur during construction are described in Table 4.1-1. In addition, construction activities would substantially alter the appearance of the area near the Flood Retention Facility. Because the site is on private land, public access and views of the area are limited to Weyerhaeuser workers and occasional recreational users. Access to the area would likely be restricted during construction, further limiting the number of people exposed to construction impacts.

4.2.8.2 Long-term Impacts

Although few people would view the site of the Flood Retention Facility because of limited access, the FRO facility would result in a significant adverse impact due to the change in visual quality of the area (see Figures 4.2-12 and 4.2-13). Clearing of vegetation at the dam and reservoir sites would permanently remove forestland, as described in Section 4.2.3. The FRO dam would be approximately 226 feet high and 1,220 feet long, and would therefore be visible from adjacent hillsides. Where a free-flowing river previously existed, the FRO facility would introduce a large concrete structure with an ancillary “wing” and storage reservoir. This would greatly contrast with the existing landscape.

During floods, the FRO facility would store water and inundate 5.3 miles (on average) behind the dam (maximum area of 778 acres), creating views of open water in the foreground. Following floods, the slow release of water from the dam would leave visible mud, silt, and other residue on the edges of the storage area. During times when water is not being stored, the Chehalis River would be visible in its channel, but the riparian vegetation would be changed with the removal of trees in the reservoir area (see Section 4.2.3).

The potential adverse impacts on visual quality of the FRFA facility would be similar to the FRO facility, except the FRFA dam would be 41 feet lower (185 feet) and 1,250 feet longer (2,470 feet), and the area behind the FRFA dam would be inundated most of the year rather than just during major floods (see Figures 4.2-14 and 4.2-15). The permanent reservoir would extend up to 7.6 miles (maximum area of 1,264 acres). When reservoir water levels are high, the area behind the FRFA dam would be inundated with water, creating views of open water in the foreground. When reservoir water levels are low, the drawdown would expose areas of deciduous shrubland on the edges of the reservoir area.

4.2.8.3 Mitigation

In addition to those described in Table 4.1-1, short-term mitigation measures could include locating temporary construction access roads, staging areas, and stockpile sites within previously disturbed areas.

Long-term mitigation measures could include integrating design techniques for minimizing visual impacts, including repeating elements of form, line, color, and texture into the design and alignment of facilities. These measures could slightly reduce the visual quality impacts, but the impacts would still be significant.

Figure 4.2-12

Rendering of Existing Conditions at Potential Facility and Flood Retention Site

Figure 4.2-13

Rendering of FRO Facility (100-year Flood Stage)

Figure 4.2-14

Rendering of FRFA Facility (Permanent Reservoir)

Figure 4.2-15

Rendering of FRFA Facility (100-year Flood Stage)

4.2.9 Noise

4.2.9.1 Short-term Impacts

This section uses standard information about noise levels from typical construction equipment to present a generalized, qualitative discussion of short-term changes in noise during construction. Construction and blasting noise is exempt from regulation if conducted between 7:00 a.m. and 10:00 p.m. (daytime hours) per WAC 173-60-050. In addition, noise created by traffic (including heavy construction vehicles) on public roads is exempt from regulation under WAC 173-60-050. Therefore, there are no applicable standards to determine the significance of short-term noise impacts from construction activities. Section 4.2.4 discusses noise impacts on fish and wildlife.

The potential short-term impacts related to noise that would occur during construction are described in Table 4.1-1. Heavy equipment and construction activities associated with the Flood Retention Facility would cause short-term noise impacts. Table 4.2-14 shows noise levels of typical construction equipment at 50 feet from the source of the noise.

Table 4.2-14
Sound Levels of Common Sources and Noise Environments

CONSTRUCTION EQUIPMENT TYPES	EXAMPLES	ACTUAL MEASURED AVERAGE L_{max} AT 50 FEET (dB)
Earth moving	Compactor	83
	Front-end loader	79
	Backhoe	78
	Tractor	84
	Grader	89
	Paver	77
Materials handling	Concrete mixer truck	79
	Concrete pump truck	81
	Crane	81
Stationary	Pumps	81
	Compressor	78
	Generator	81
Hauling	Dump truck	76
Impact equipment	Pile driver	110
Impact tools	Jackhammer	81
	Rock drill	81
	Pneumatic tools	85

Note: L_{max} is the maximum value of a noise level that occurs during a single event.
Source: Reherman et al. 2006

Depending on the type of construction activity, peak noise levels from the equipment shown in Table 4.2-14 would range from 76 to 110 dBA at 50 feet from the source. Damage to hearing occurs with noise levels above 85 dBA. However, noise levels decrease with distance from the source at a rate of approximately 6 to 7.5 dBA per doubled distance. For example, noise levels from construction equipment would range from approximately 57 to 98 dBA at a distance of 200 feet; from 51 to 92 dBA at 400 feet; and from 45 to 86 dBA at 800 feet.

The location of the Flood Retention Facility is isolated, with the closest permanent residents several miles away. There are no sensitive noise receptors in the area. The area would be closed to recreational use during construction, so the only people in the area during construction would be construction workers.

Construction of the dam, as well as selective clearing of the reservoir area, would require heavy equipment and activities with high noise levels, including compactors, pile drivers, jackhammers, and rock drills. Some of this equipment would operate at noise levels high enough to cause hearing damage at very short distances (less than 50 feet), but the noise levels would dissipate to safe levels with distance. Construction would require blasting to excavate the rock footings of the dam. Blasting has an instantaneous noise level of 94 dBA at 50 feet. Blasting also causes air and ground vibrations that could be felt in surrounding areas. Because the Flood Retention Facility site is isolated and the area would be closed to recreational use during construction, few people or buildings would be exposed to the noise and vibration of blasting. Noise associated with the construction of the Flood Retention Facility would be major and would last for 2 to 3 years.

4.2.9.2 Long-term Impacts

The potential for adverse noise impacts is based on increased noise levels. Significant impacts would occur if projects generated noise that would conflict with local ordinances or increase noise levels by 5 dBA or greater at a sensitive land use. Neither the FRO or FRFA facility would generate noise, so there would be no adverse noise impacts.

4.2.9.3 Mitigation

Assuming the specifications for equipment meet the noise standards described in Table 4.1-1, no additional equipment mitigation for short-term impacts would be required. Construction workers at the site would wear hearing protectors to prevent hearing damage. A Blasting Noise Mitigation Plan would also be prepared.

No long-term impacts related to noise are anticipated, so no mitigation is required.

4.2.10 Land Use

4.2.10.1 Short-term Impacts

The potential short-term impacts on land use would occur during construction, with land use conditions returning to pre-construction status following construction. Potential short-term impacts on land use during construction include limited access to forestland and the establishment of temporary worker housing. Potential temporary impacts to vegetation associated with construction activities are addressed in Table 4.1-1 and Section 4.2.3.1.

Limited access to commercial forestland in areas immediately adjacent to the construction site could affect forestry operations in this vicinity during construction. In addition, temporary housing could be required for workers during construction, which could affect land use within the vicinity of the construction site. The specific plans for site access and temporary worker housing would be determined during the project-level environmental review associated with more detailed project design and construction specifications.

4.2.10.2 Long-term Impacts

The potential adverse impacts on land use are similar for the FRO facility and FRFA facility and include the following:

- Conversion of managed forestland to a Flood Retention Facility
- Land use changes associated with reduced flood extents and frequency of major flooding

Following the initial clearing or selective harvesting of timber during construction, the area within the Flood Retention Facility would no longer be managed as commercial forestland. The property immediately surrounding the Flood Retention Facility would remain in use as commercial forestland, and the use of the Flood Retention Facility would be compatible with surrounding land uses. No other changes in land use, including new residential or community development, are anticipated within or adjacent to the reservoir area. Such development would not be consistent with the Chehalis Basin Strategy objectives to reduce flood damage and restore habitat for aquatic species. The conversion of managed forestland to a Flood Retention Facility is considered a minor adverse effect on land use, because a substantial amount of forestry operations on 830,000 acres of forestland would continue in the Chehalis Basin.

The extent and depth of major flooding would be reduced in the Chehalis River floodplain with construction of the Flood Retention Facility, which is anticipated to reduce crop damage on agricultural land. The reduction in flooding could result in changes in the types of agricultural crops grown in the upper Chehalis Basin. Currently, an estimated 13% of the crops grown in the Chehalis Basin are vegetable crops and the remainder are field crops (e.g., pasture or hay), which are more tolerant of flooding (EES and HDR 2014). With less inundation from major floods, it is possible that some agricultural lands could be converted from field crops to higher-value vegetable crops. A reduction in the extent of major floods would likely result in fewer livestock losses as compared to major floods in the past. Less severe flooding would also provide more areas of refuge from floodwaters for livestock.

A reduction in flooding of commercial, residential, industrial, and agricultural structures is also anticipated. Modeled results for the decreased area and extent of floodplain inundation and corresponding decrease in structures damaged by flooding have been developed for the combined alternatives and are described in Chapter 5. Corresponding potential increases in development in areas protected by the Flood Retention Facility and Airport Levee Improvements are also described in the impacts analysis for Alternative 1 in Chapter 5 and Appendix L.

4.2.10.3 Mitigation

For short-term impacts, no compensatory mitigation measures are proposed.

The potential long-term adverse impacts on land use that are anticipated with Flood Retention Facility implementation are minor and are associated with the conversion of forestland. These impacts could be minimized by implementing the Reservoir Operations and Management Plan, which would include provisions to ensure that operation of the Flood Retention Facility included coordination with adjacent landowners with respect to vegetation management and site access. The need for compensatory mitigation is not anticipated.

4.2.11 Recreation

4.2.11.1 Short-term Impacts

The potential short-term impacts on recreation that would occur during construction are described in Table 4.1-1. These impacts would disrupt recreational activities in the Flood Retention Facility area. Recreational access to the area would likely be restricted during the 2- to 3-year construction period. Permits to use the Pe Ell South Permit Area on Weyerhaeuser land would likely not be issued during this time. Recreational users in nearby areas would notice construction noise and dust. Construction noise and activities could be particularly disruptive to hunters in nearby areas because wildlife would leave the area during construction.

4.2.11.2 Long-term Impacts

The Flood Retention Facility would permanently change the recreational character of the immediate area. Large areas of forestland would be cleared as described in Section 4.2.3. For the FRO facility, the area behind the dam would be inundated and unavailable for recreational activities during major floods. For the FRFA facility, the area behind the dam would be permanently inundated and unavailable for recreational activities. It is expected that Weyerhaeuser would reopen the area to recreational use (e.g., hunting) following construction. Portions of the area that would be periodically or permanently inundated could be closed to hunting, but the conversion of forestland to deciduous riparian shrubland could increase hunting opportunities. These potential adverse impacts are considered minor because the loss of access to the reservoir area for hunting and camping would affect a small area compared to the rest of the recreation opportunities in the Chehalis Basin, and recreational access is already limited by the number of passes available from Weyerhaeuser.

The Flood Retention Facility would permanently foreclose use of this reach of the Chehalis River for whitewater rafters for health and safety reasons. The American Whitewater Association lists the reach as a Class III-IV whitewater area, but the area is not used heavily by rafters (O'Keefe 2016). This change to recreation use in the area is considered a moderate adverse impact because of the permanent loss of this reach of the Chehalis River for in-water recreation.

The Flood Retention Facility would reduce flood damage at parks and other recreational facilities throughout the Chehalis Basin during a 100-year flood, including in the area of Rainbow Falls State Park and the Willapa Hills Trail. Most of the benefits of flood damage reduction would occur at recreational facilities in the upper Chehalis Basin. The Flood Retention Facility would also reduce flood damage to agricultural properties, including those used for agritourism.

4.2.11.3 Mitigation

For short-term mitigation, the area would be closed for recreational use for safety reasons. No other mitigation measures would be implemented.

No mitigation is available for the long-term impacts from changes to in-water recreation and reduction of recreation opportunities within the reservoir area. Once construction is complete, the accessible areas for activities (e.g., hunting) are likely to be re-opened to permit use.

4.2.12 Historic and Cultural Preservation

4.2.12.1 Short- and Long-term Impacts

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

The potential impacts on historic and cultural resources that could occur during construction include ground disturbance associated with new roads or access routes, building the dam, and creating the reservoir. Although no historic buildings or other cultural resources have been documented within the boundary of the Flood Retention Facility, there is a high to moderate potential for archaeological deposits to exist within the vicinity based on WSAPM.

The potential impacts on cultural resources are similar for the FRO facility and FRFA facility, but differ slightly, as the operational function of the reservoir varies between the facility types. 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. 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.

For both facility types, the initial inundation and drawdown of the flood storage reservoir and subsequent reservoir inundation as needed for flood storage, would result in the following conditions with potential long-term impacts:

- Sedimentation of submerged resources
- Stream channel changes and erosion, or streambank changes and resulting erosion—both of which could expose, damage, destroy, and/or alter as-yet undocumented cultural resources
- Increased or changed vehicular and foot traffic patterns

4.2.12.2 Mitigation

Once potential project-specific impacts of the Flood Retention Facility on cultural resources have been identified, avoidance/minimization measures may be considered that alter design or construction methods to avoid or minimize these impacts. If impacts cannot be avoided, mitigation measures to address potential impacts on cultural resources would be determined during project-specific evaluations of the Flood Retention Facility, and would include consultation with DAHP, interested and affected tribes, as well as other consulting parties.

Addressing Potential Impacts on Cultural Resources

If the Flood Retention Facility is selected to move forward into project-specific SEPA and NEPA evaluations, studies would be performed to determine if cultural resources are present within the Area of Potential Effects, and whether the action would have unavoidable significant impacts on these resources. In the case of a NEPA evaluation, a significant cultural resource is defined as any cultural resource eligible for, or listed in, the National Register of Historic Places. In the case of a SEPA evaluation, a significant cultural resource is defined as any archaeological site, or any built environment site that is eligible for the Washington Heritage Register.

The cultural resources investigative studies would include background research, field investigations, and consultation with DAHP and affected tribes. If these studies determine that significant cultural resources (including potential traditional cultural properties and designated traditional cultural properties) would be affected, the project consultation process would be used to develop and identify appropriate methods for avoiding or minimizing and mitigating impacts on significant cultural resources. This process and could include the development of a memorandum of agreement or programmatic agreement outlining the steps that would be taken to address impacts.

The potential compensatory mitigation measures could include data recovery (scientific excavation and analysis) of the archaeological sites, archaeological monitoring during construction to ensure that no (previously unknown) cultural resources are affected, development and implementation of an Inadvertent Discovery Plan, ethnographic studies, Historic American Building Survey/Historic American Engineering Record documentation, and cultural resources identification trainings for construction personnel.

4.2.13 Transportation

4.2.13.1 Short-term Impacts

The potential short-term impacts on transportation that would occur during construction are described in Table 4.1-1. In addition, road access to the Flood Retention Facility site is limited, so construction traffic would be concentrated on SR 6 to Pe Ell and local roads leading to the site. Traffic delays would be likely on these roadways. Several miles of new temporary roads would be constructed to access the Flood Retention Facility and quarry sites.

4.2.13.2 Long-term Impacts

No adverse impacts on transportation are anticipated. The Flood Retention Facility would reduce the duration of closures of I-5 during a 100-year flood. The FRO facility would reduce flooding impacts on transportation systems in the Chehalis Basin, especially in the upper Chehalis Basin. According to modeling conducted for the Flood Retention Facility, the dam would reduce flooding of roadways in the upper Chehalis Basin near the Chehalis River during a 100-year flood by approximately 1 to 3 days, including roads in Fords Prairie, south Centralia, and parallel to SR 6. Flood depths in these areas would be reduced between 1 and 11 feet, and some portions of SR 6 between Doty and Adna would no longer be inundated during a 100-year flood. In the Chehalis and Centralia area, the Flood Retention Facility would reduce flood depths by 1 to 2 feet. The Flood Retention Facility would provide some flood protection for the Chehalis-Centralia Airport during smaller floods, allowing flights to continue, but the airport would continue to flood during some floods. The Flood Retention Facility would reduce flood depths by 7 feet at the Chehalis-Centralia Airport during a 100-year flood; it would also likely decrease the frequency of rail closures. These flood damage reductions would result in beneficial effects for transportation facilities.

The completed Flood Retention Facility would not increase traffic on local roadways. Vehicle trips to the dam would be limited trips for periodic maintenance. For the FRO facility, a bypass road for FR 1000, up to 6 miles long, would provide access when the FRO facility is in operation and FR 1000 is inundated. Inundation of FR 1000 may damage the roadway, requiring maintenance following operation of the FRO facility. For the FRFA facility, a 5-mile stretch of FR 1000 would be closed and a new 7-mile bypass road would be constructed outside the reservoir area, using either a new 7-mile road or a permanent detour using existing forest roads.

4.2.13.3 Mitigation

In addition to the short-term mitigation measures described in Table 4.1-1, specific measures to mitigate short-term traffic impacts would be developed in the design phase and could include obtaining necessary permits and developing transportation plans in coordination with WSDOT, local jurisdictions, Weyerhaeuser, and other property owners. Closure of the roads around the reservoir could be coordinated with Weyerhaeuser and other property owners, if necessary.

Any damage to forest roads caused by operation of the FRO facility would be repaired. No other adverse long-term impacts on transportation are anticipated, so no additional mitigation is required.

4.2.14 Public Services and Utilities

4.2.14.1 Short-term Impacts

The Flood Retention Facility would be located in a remote area that is accessible only by a private road. Construction of the Flood Retention Facility would not hinder the access to or operation of public services; therefore, no short-term impacts on public services are anticipated. However, construction would cause short-term impacts on utilities. A new low-voltage line would be necessary for construction and operation of the dam to power pumps, gates, instruments, and other facilities. Construction would include a new transformer and electrical right-of-way to transmit electricity from local transmission lines to the Flood Retention Facility. At this time, no alignment has been identified for the potential electrical right-of-way. Constructing the new transmission line is not expected to cause adverse impacts because no services or utilities would be disrupted.

4.2.14.2 Long-term Impacts

Adverse impacts of the Flood Retention Facility would be moderate because the reservoir would inundate Pe Ell’s water supply located on Lester Creek. The small amount of electricity required for operation of the Flood Retention Facility would not affect electrical supplies. The Flood Retention Facility could require localized relocation of public utilities, resulting in minor adverse impacts.

The Flood Retention Facility would decrease the level and duration of flooding in portions of the Chehalis Basin during major floods, and therefore would reduce corresponding flood impacts on public services and utilities. Most of the benefits would occur in the Chehalis-Centralia area where public services and utilities are concentrated and where flood depths would be reduced from 1 to 2 feet during a 100-year flood. The Flood Retention Facility would reduce flooding of public services and utilities downstream of the Chehalis-Centralia area, but to a lesser extent.

4.2.14.3 Mitigation

To mitigate short-term impacts on utilities, the new electrical transmission lines would be sited according to industry best practices. Lewis County PUD provides electrical service in the area of the Flood Retention Facility. Through the permitting process, Lewis County PUD would determine how to design and place the new electrical infrastructure in a way that best avoids or minimizes impacts on exiting utilities. In addition, a Construction Sequence Plan would be developed to coordinate schedules for utility work to minimize service disruptions and provide ample advance notice when disruptions are unavoidable.

To mitigate for long-term impacts on Pe Ell's water supply, the intake could be relocated or a new water source could be provided.

4.2.15 Environmental Health and Safety

4.2.15.1 Short-term Impacts

The potential short-term impacts on environmental health and safety that would occur during construction are described in Table 4.1-1. In addition, construction traffic on local roadways could cause temporary delays to emergency response. However, construction traffic would be heading towards a more remote area on roads that are less traveled, decreasing the degree of impact. Limited emergency services are required in the remote area so disruptions would be minimal and impacts would be limited to the construction period. Construction is not likely to increase the need for emergency services.

4.2.15.2 Long-term Impacts

The Flood Retention Facility would reduce the severity of flooding in portions of the Chehalis Basin during a major flood, which would reduce the need for emergency response services in those areas. The Flood Retention Facility would also reduce the number of local roadways flooded during major floods, which would have positive impacts on emergency response and public safety within those road corridors. It could also reduce contamination of surface water by floodwaters and the release of hazardous materials, thereby reducing the potential for public exposure to hazardous materials and any health and safety effects. The Flood Retention Facility would not substantially reduce contamination of drinking water wells because most areas would continue to be inundated during a 100-year flood. Reducing the level of inundation would not prevent groundwater contamination. These potential impacts are considered beneficial because they would improve public health and safety. Overall, the Flood Retention Facility would reduce threats to public health and safety.

Over the life of the Flood Retention Facility, an earthquake on the CSZ could cause damage to the dam. If the dam sustained major damage while storing water, reservoir water could be released, causing catastrophic downstream flooding and resulting in endangered public safety. The dam would be designed to withstand shaking associated with an earthquake on the CSZ, reducing the risk of catastrophic failure. Although unlikely, the results of such an event would be considered an unavoidable significant adverse impact. Because the FRFA facility would store water continuously, there would be more potential for a failure to cause catastrophic downstream flooding compared to the FRO facility.

4.2.15.3 Mitigation

Potential measures to reduce short-term construction disruptions to environmental health and safety (e.g., encountering hazardous materials) could include coordinating construction with emergency services, scheduling construction to minimize impacts, and notifying the public of construction. Construction Traffic Control Plans would be developed to reduce impacts on emergency services and response and Worksite Safety Plans would be developed to provide emergency response for construction workers.

If the dam were to fail, emergency response would be executed in accordance with an Emergency Action Plan (EAP), as required by Ecology's Dam Safety Office. EAPs provide guidance for detecting the event, determining the emergency level, notifying the community, addressing the event, and reporting the event.

4.3 Restorative Flood Protection

4.3.1 Water Resources

4.3.1.1 Short-term Impacts

The temporary impacts described in Table 4.1-1, and their effects on water resources during construction of log and rock structures, would be relatively short in duration at each site (approximately a 4-month annual construction period), but would occur within treatment area construction sites over an approximately 10-year construction timeframe. Avoidance and minimization measures would be employed when designing, constructing and permitting each structure. Short-terms impact on water quality could also potentially occur as a result of clearing and construction associated with moving land uses out of the floodplain and relocating them in upland areas.

4.3.1.2 Long-term Impacts

The results and findings of this analysis are presented in the following study:

- *Preliminary Summary, Science and Technical Assessment of a Restorative Flood Protection Approach in the Upper Chehalis River Watershed* (Abbe et al. 2016)

Implementation of Restorative Flood Protection would have the potential to affect water resources through changes to surface water quality, surface water quantity, and groundwater. In general, floodwaters would be distributed throughout the upper Chehalis Basin watershed more evenly than at present, and during non-flood conditions surface water features would occupy more of the floodplain in treatment areas than they do at present.

Minor adverse impacts on water use and water rights are anticipated, and water right holders with groundwater rights could experience beneficial effects because of the increased groundwater recharge provided by the Restorative Flood Protection actions.

4.3.1.2.1 Surface Water Quality

No adverse impacts on surface water quality are anticipated to occur. While water quality modeling of Restorative Flood Protection actions has not been conducted for this programmatic-level analysis, the beneficial effects are expected to include cooler and less turbid stream and river flow than under current conditions. Anticipated beneficial effects are primarily related to improved stream and river corridor and riparian zone conditions from the following:

- Increased streamside vegetation to shade the stream channel and help cool the water
- Increased pools that provide places for sediment to settle rather than be transported downstream

Each of these actions would affect the water quality in the stream or river, which would in turn improve conditions for aquatic life. High summer water temperatures are a major limiting factor for fish (see Section 3.4.1). The beneficial surface water quality effects would occur at, as well as downstream of, the Restorative Flood Protection treatment areas.

Increasing streamside vegetation and associated shade along river and stream channels within the treatment areas is expected to lower water temperatures. This is the recommended approach to improving temperature conditions in Ecology's Upper Chehalis River Basin Temperature TMDL (2001), which addresses several stream reaches suitable for Restorative Flood Protection treatments. The TMDL uses streamside shade as a surrogate measure for water temperature, based on the known linkage between solar radiation reaching stream or river flow providing the energy to raise water temperature.

The extensive in-channel wood structures proposed under Restorative Flood Protection would slow streamflows, and create more channel complexity such as pools and side channels (see Section 4.3.2.2.2). These slower-water environments would result in sediments settling out of the water column, rather than being carried downstream. This would likely reduce turbidity and total suspended solid concentrations within and downstream of treatment areas.

Restorative Flood Protection actions are not expected to affect other water quality constituents, such as DO, because a decrease in water temperatures would be expected.

The potential exists for increased surface water pollution during floods from septic systems, buried fuel tanks, and stored chemicals in newly flooded areas. Restorative Flood Protection would include removal of the structures most at risk for this type of pollution, which would include decommissioning buried fuel tanks and other chemical storage. This potential water quality issue is anticipated to be addressed through implementation of this action element, in which case it would not result in an adverse impact. If not addressed, a minor adverse impact on surface water quality could occur as a result of expanded localized flooding.

Impacts on surface water quality could also occur as a result of increased development in upland areas where treatment area floodplain uses are relocated. The degree of adverse impact has not been quantitatively evaluated because specific receiving waters have not been identified. In general, long-term effects of increased sedimentation and vegetation removal from clearing, excavating, relocating transportation and utility corridors, and site development could have adverse impacts on surface water quality.

4.3.1.2.2 Surface Water Quantity

The purpose of the Restorative Flood Protection treatments is to engage floodplain storage in the watershed above Chehalis-Centralia to distribute floodwaters more evenly throughout the watershed, thereby reducing flood damage in downstream portions of the Chehalis Basin.

Within Restorative Flood Protection Treatment Areas and Upland Areas Where Relocation and Land Conversion Occurs

Anticipated impacts on surface water quality within Restorative Flood Protection treatment areas are related to the following:

- Installation of instream log structures to raise water levels and aggrade streambeds, and cause the stream to form multiple channels, which would occupy a wider strip throughout the river and stream valleys
- Reconnection of floodplain wetlands to the river and stream channels
- Creation of more sinuosity (curves) in the channels to lower the stream slope and slow the flow

Although not within the treatment areas, conversion of displaced floodplain land uses from within treatment areas to upland areas would likely generate higher runoff from those upland areas as a result of vegetation removal and increased developed surfaces.

Over time, it is anticipated that each of the actions within treatment areas would build upon each other and in turn create more surface water area for a larger portion of the year in the watershed upstream of the Newaukum River confluence with the Chehalis River. The larger surface water area would act as a temporary storage reservoir during flood periods, and could help feed summer low streamflows. These potential adverse impacts are considered moderate with regard to water quantity due to the predicted increase in the areal extent of flooding that would occur.

Restorative Flood Protection would increase surface water flooding in many valley bottom areas upstream of the Chehalis River confluence with the Newaukum River. Areas near the river and stream channels could flood annually where they do not now. Areas more distant from the river and stream channels could flood every 5 to 10 years where they now flood every 100 years on average. In addition, areas that currently flood could experience deeper flood levels. The duration of flooding would also increase, as floodplain areas work as temporary flood storage. The anticipated changes in area flooded during a 100-year flood for each treatment area sub-basin are shown in Table 4.3-1.

The Restorative Flood Protection treatments, by nature, are unlikely to result in higher velocity, more erosive flood flows; however, in some areas near the channel, the engineered log structures would cause turbulent flow that could be dangerous to life and property (see Section 4.3.15). Specific areas would be identified through site-level planning and design.

The additional runoff from converted upland areas is anticipated to be minor; many of these areas are currently in use as managed forestland and have been previously disturbed by vegetation removal and soil compaction. It is anticipated that stormwater runoff from converted upland areas could be addressed through site-level planning and design, including use of low-impact development stormwater management techniques. The land use and transportation impacts of increased flooding are described in Sections 4.3.10 and 4.3.13.

Table 4.3-1
Predicted Changes in Areal Extent of Flooding for Restorative Flood Protection in a 100-year Flood

RIVER	RIVER REACH LENGTH (MILES)	INUNDATED AREA (ACRES)		
		EXISTING 100-YEAR FLOODPLAIN	RESTORATIVE FLOOD PROTECTION 100-YEAR FLOODPLAIN	DIFFERENCE
AREAS WITH INCREASED FLOODING				
North and South Fork Newaukum, South Fork Chehalis, and mainstem Chehalis rivers; and Elk, Bunker, Deep, Stillman, Lake, Stearns creeks	140	16,530	21,130	4,600
AREAS WITH REDUCED FLOODING				
Chehalis and Centralia down to the Pacific Ocean	207	56,630	55,815	-815
Total	**347**	**73,160**	**76,945**	**3,785**

Note: All flood inundation acreages are rounded to the nearest 5 acres.

Existing surface water rights would not be impaired by Restorative Flood Protection actions. The locations of some water right intakes may need to be adjusted if there is a conflict with in-channel engineered log structures, or if structures and uses are displaced to converted upland areas. This would be a minor adverse impact as existing surface water rights and allocations would not be impaired. The water supply intake for Boistfort is located on a tributary of Stillman Creek. This is outside of the Restorative Flood Protection treatment area, and no impact is expected.

Water right changes would be needed to service consumptive water needs for homes, farms, public facilities, and businesses displaced because of Restorative Flood Protection actions. Restorative Flood Protection may require existing structures within a 16,000-acre area (including approximately 8,500 acres of farmland) to be relocated out of flood-prone and erosion risk areas. In addition, there would be more frequent flooding outside of the “river management” or “greenway” zone on approximately 5,200 acres, including 3,600 acres of farmland (see Section 4.3.10). Many of these affected lands hold water rights, which would be transferred to the owner’s new location if, or when, they were relocated.

Downstream of Restorative Flood Protection Treatment Areas

Beneficial surface water quantity effects created by the Restorative Flood Protection actions include reduced flooding in the Chehalis-Centralia area downstream of the Restorative Flood Protection treatment areas. The Restorative Flood Protection treatments would reduce the flood flows entering the mainstem Chehalis River as shown in Table 4.3-2 for a 100-year flood.

Table 4.3-2
Predicted Flow Reductions from Restorative Flood Protection Treatment Sub-basins for 100-year Flood

TRIBUTARY	PEAK FLOW		
	EXISTING CONDITION (cfs)	RESTORATIVE FLOOD PROTECTION (cfs)	CHANGE (%)
Elk Creek	7,245	6,450	-11%
Newaukum	13,957	12,279	-12%
Bunker Creek	2,290	2,106	-8%
South Fork Chehalis River	15,076	13,381	-11%

As shown in Table 4.3-3, the magnitude of this flood benefit would vary with different flood frequencies. A more pronounced effect could occur during higher-frequency floods, depending on location.

Table 4.3-3
Predicted Restorative Flood Protection Flood Level Reductions at Chehalis-Centralia for Various Flood Levels

FLOOD LEVEL	NEWAUKUM CONFLUENCE (FEET)	ALONG AIRPORT LEVEE (FEET)
500-year	-1.0	-0.4
100-year	-1.0	-0.4
20-year	-1.1	-0.3
10-year	-0.9	No change
2-year	-1.6	-0.4

4.3.1.2.3 Groundwater

No adverse impacts on groundwater are anticipated to occur with Restorative Flood Protection. The potential beneficial effects to groundwater would be a general raising of the water table in the Restorative Flood Protection treatment areas and adjacent floodplain. This effect would primarily result from increased surface water levels from higher water levels in the stream and river channels, and improved connections between floodplain wetlands and the stream channels.

The Restorative Flood Protection treatments would generally raise surface water levels, and increase the area of surface water present in treatment areas. Because shallow groundwater in the floodplain treatment areas is closely connected to surface water, it is expected that shallow groundwater levels would rise as the surface water elevation increases. This effect would be expected within the Restorative Flood Protection treatment areas and, to a lesser magnitude, in the adjacent areas that are connected hydraulically.

The effect of higher groundwater levels would be as follows:

- Higher groundwater levels would support stream and river base flows by feeding cool groundwater into the surface water system during late-summer, low-flow times
  - This would happen because of the close surface-groundwater connection, which would enable the groundwater to flow to the stream channels when water levels in the channel are lower than in the groundwater (gaining river reaches)
  - It is unknown whether this would cause summer low flows to be higher, as the more extensive streamside and riparian vegetation could transpire much of the additional shallow groundwater
- Expansion of wetlands would likely occur because soil moisture would increase in low areas where the water table would become shallower (see Section 4.3.3)

Landowners would see wetter conditions on farm fields and low areas that are influenced by the higher groundwater levels. This potential impact, including associated mitigation, is discussed in Sections 4.3.3 and 4.3.10. Relocating floodplain land uses to upland areas could result in an adverse impact on groundwater depending on the location, and associated magnitude of subsurface excavation and resulting impervious surface.

4.3.1.3 Mitigation

Potential mitigation measures for short-term impacts on water resources are described in Table 4.1-1. Potential avoidance and minimization, and compensatory mitigation measures for long-term impacts on water resources are described here.

4.3.1.3.1 Surface Water Quality

No long-term adverse impacts on surface water quality are anticipated, so no mitigation is proposed. New development in upland areas could be sited and designed to avoid adverse impacts on surface water quality through measures such as maintenance of functional riparian corridors.

4.3.1.3.2 Surface Water Quantity

Potential avoidance and minimization measures for adverse surface water quantity impacts could include treatment area design that avoids construction of Restorative Flood Protection treatments in areas that would not produce downstream flood benefits. At this point, Restorative Flood Protection has not been developed at a reach or site scale, so these areas have not been identified. Relocation of land uses that would be negatively affected by flooding from Restorative Flood Protection treatments is a critical component of this action element (see Section 4.3.10), and could be designed and sited to minimize impacts on surface water quantity by minimizing impervious surfaces and soil compaction.

4.3.1.3.3 Groundwater

No long-term adverse impacts on groundwater quantity or quality are anticipated, so no mitigation is proposed.

4.3.2 Geology and Geomorphology

4.3.2.1 Short-term Impacts

4.3.2.1.1 Geology

The potential short-term impacts on geology that would occur during construction are described in Table 4.1-1 and are primarily associated with necessary clearing and staging to gain construction access.

4.3.2.1.2 Geomorphology

The potential short-term impacts on geomorphology are described in Table 4.1-1, and are primarily limited to localized slope instabilities associated directly with the construction sites. Additional short-term impacts include the interruption of sediment and wood transport regimes throughout the construction work zone, and the loss of channel function for the river segment re-routed through the work zone. At each site, these impacts would be limited to an approximately 3- to 4-month-long active construction period.

4.3.2.2 Long-term Impacts

4.3.2.2.1 Geology

Within Restorative Flood Protection Treatment Areas and Upland Areas Where Relocation and Land Conversion Occurs

The potential impacts on geology associated with Restorative Flood Protection are related to shallow, rapid, and deep-seated landslides triggered in areas where the river encroaches on valley walls.

The Restorative Flood Protection actions would encourage more active channel migration, which could cause the river to encroach on valley walls in some areas. This encroachment has the potential to undercut landslide-susceptible slopes, and trigger slope failures. This adverse impact could be moderate as a result of potential localized increases in landslides—or could be minor because it is predictable in location and severity, thus avoidable.

A preliminary examination of potential landslide hazards was conducted by overlaying known landslides mapped by DNR with the treatment areas (see Figure 4.3-1). Although there are many areas of the Chehalis Basin with landslide-susceptible slopes, the majority of known landslide hazards are in steeper tributary drainages that are upstream of, and thus not affected by, the Restorative Flood Protection treatment areas. Results of the GIS overlay show that approximately 1% of the treatment area corridors abut known landslides in the DNR database. In the few instances where there are potential landslide hazards within treatment areas, it is anticipated that future design refinements could incorporate engineered logjams and forested riparian buffers to moderate channel migration rates, and thus limit potential for undercutting landslide-susceptible slopes in these locations.

Adverse impacts on geology could occur as a result of relocating floodplain land uses to upland areas if development included disturbance of unstable or steep slopes. These impacts are anticipated to be minor because it is expected that unstable areas could be avoided during siting and design of relocated uses.

Downstream of Restorative Flood Protection Treatment Areas
No adverse impacts on geology are expected to occur downstream of Restorative Flood Protection Treatment areas.

4.3.2.2.2 Geomorphology

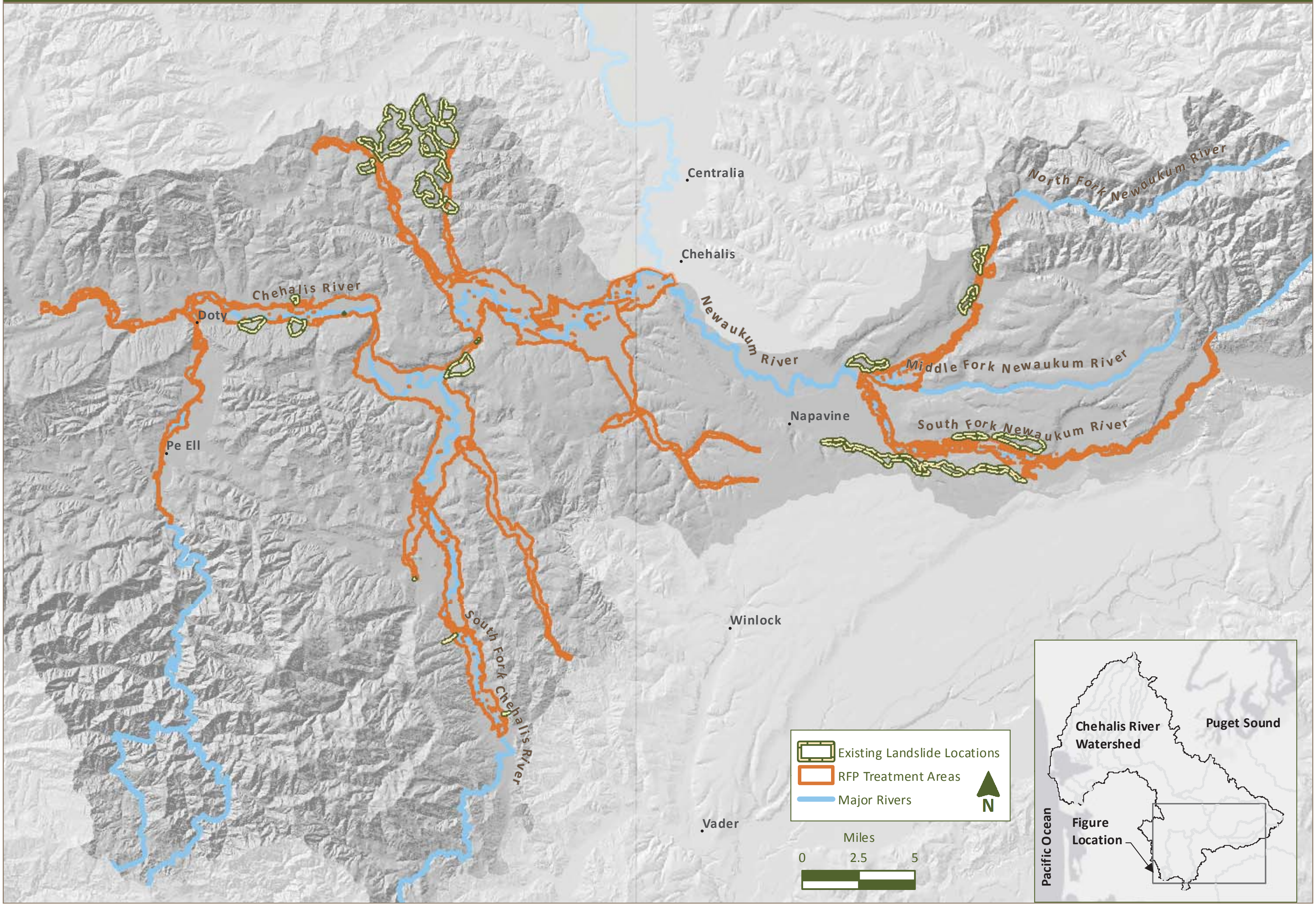
By design, the treatment actions aim to restore geomorphic processes to a condition representative of the Chehalis Basin prior to floodplain development and channel modification (pre-settlement conditions). Compared to current conditions in many of the Restorative Flood Protection treatment areas, Restorative Flood Protection treatments would result in beneficial effects on geomorphology related to the following:

- Increased channel complexity and restoration of habitat-forming processes
- Increased sediment and wood retention
- Increased floodplain connectivity (addressing effects of past channel incision)

As discussed in Section 3.2.4.1.3, channel incision has occurred over many miles of the Chehalis River mainstem, South Fork Chehalis River, and to a lesser extent in the Newaukum River. Restorative Flood Protection actions would reverse this condition, beneficially affecting geomorphology.

Figure 4.3-1

Landslides in Restorative Flood Protection Treatment Areas



Notes: Landslide data from Department of Natural Resources (2014); RFP = Restorative Flood Protection

Within Restorative Flood Protection Treatment Areas and Upland Areas Where Relocation and Land Conversion Occurs

The Restorative Flood Protection actions would increase large wood in the channels and floodplains, which would begin a series of landscape changes. For example, the channel could become more sinuous, and additional channels would also develop. Countermeasures (such as wood) to prevent active river and stream channels from migrating are not proposed with Restorative Flood Protection actions, except when active channels have the potential to encroach on landslide-susceptible, valley-side areas (see Section 4.3.2.2.1); dynamic river processes are desirable and necessary for the re-creation and maintenance of natural geomorphic processes.

During an initial period following implementation of the treatment actions, there could be localized impacts on the sediment and wood regimes of the Chehalis Basin associated with geomorphic adjustments. Increased channel roughness and energy dissipation, driven by installation of engineered logjams, would moderate the sediment transport capacity in treatment reaches. All else remaining equal, this reduction in transport capacity would be expected to result in a net deposition of sediment and aggradation of the channel bed within treatment areas. It should be noted, however, that existing channel conditions are characterized by increased sediment transport due to past removal of logjams and impairment to wood recruitment processes associated with impacts on riparian forests and ongoing removal of wood from the channel. Further, the incoming sediment supply to Restorative Flood Protection treatment areas is elevated by forest practices that can increase channel-forming flows (see Section 3.2.4.3; Perry et al. 2016). As such, providing additional storage of alluvial sediments within the Restorative Flood Protection treatment areas could result in a net benefit for the Chehalis Basin. Aggradation of the channel bed in treatment areas would provide a positive feedback mechanism that would further engage floodplain areas affected by past channel incision.

Recent inventories reported wood loadings in the upper Chehalis River that averaged only 6% of a restoration target, representing unmanaged forest conditions (Anchor QEA 2016d). The legacy of historical splash dams to flush logs downstream and intentional wood removal to clear channels of wood jams has impaired the wood regime. Restorative Flood Protection actions would greatly increase the wood loading in treatment areas, and thus create areas that would trap incoming wood recruited from upstream reaches.

At this time, the potential for adverse impacts on geomorphology as a result of relocating floodplain development to upland areas is unknown, because specific relocation areas have not been identified. Generally, many upland areas in the Chehalis Basin are currently in use as managed forestland and have been previously disturbed. However, development that interrupts sediment or wood recruitment or transport, or disconnects streams or rivers from floodplains, has the potential to adversely affect geomorphology.

Downstream of the Restorative Flood Protection Treatment Areas

In response to Restorative Flood Protection actions, the reaches immediately downstream of the treatment areas could experience a net decrease in sediment supply relative to the baseline condition due to sediment storage within the treatment area. Such impacts on supply of bedload materials are likely to be localized in extent and diminish with downstream distance resulting in a minor adverse impact. Treatment actions would not trap 100% of incoming sediment supply, and new sources of sediment would be mobilized from creation or reactivation of secondary channels in the stream corridor. The primary source of bedload material downstream of the treatment area is locally derived streambank erosion from upstream meander bends (Glancy 1971) and this process would not be affected by Restorative Flood Protection actions.

In channel segments typical of the treatment area reaches, key wood pieces that are large enough to remain stable and affect geomorphic function are generally recruited locally and remain close to the point of recruitment. As such, the effect of Restorative Flood Protection actions on wood regime of the Chehalis Basin is not anticipated to have an adverse impact on recruitment of key pieces of wood downstream of treatment areas. Pieces of smaller, mobile wood would be trapped within engineered logjams installed as part of the treatment actions. These actions would also create additional sources of wood from riparian trees planted in treatment areas, as well as additional pathways of recruitment associated with the restoration of dynamic channel processes and the creation or re-engagement of secondary channels.

4.3.2.3 Mitigation

4.3.2.3.1 Geology

Avoidance and minimization measures for potential long-term impacts on geology resulting from triggered landslides would include identifying at-risk areas during site-specific feasibility studies, and avoiding the risks during conceptual design. This could include the installation of riverbank and floodplain barriers, such as wood revetments, to prevent channel migration from encroaching on landslide-susceptible, valley-side areas.

4.3.2.3.2 Geomorphology

No long-term adverse impacts on geomorphology are anticipated, so no mitigation is proposed. Given that the scale and extent of Restorative Flood Protection actions are greater than what has been implemented to date, it would be important to evaluate project actions through the development and implementation of a detailed monitoring program to quantify geomorphic responses—both within and outside the treatment areas.

4.3.3 Wetlands and Vegetation

4.3.3.1 Short-term Impacts

The potential short-term impacts on wetlands and vegetation from construction activities such as excavation, clearing, filling, and equipment and materials staging are described in Table 4.1-1. Short-term impacts include the temporary disturbance of vegetation in the floodplain near Restorative Flood Protection treatment areas from the construction of temporary access roads and construction equipment and material staging areas.

4.3.3.2 Long-term Impacts

Adverse impacts on wetlands and vegetation from the implementation of Restorative Flood Protection actions would primarily be associated with the conversion of vegetation communities in undeveloped upland areas and managed forests to those associated with agriculture, rural residential, public services, and commercial uses, because these land uses are relocated out of the historic floodplain. Adverse impacts on wetlands from such actions are expected to be moderate because the area is large. There would also be an opportunity to avoid wetland impacts in sites selected for relocated land use. Adverse impacts from land use conversion actions on vegetation, however, would be significant, with up to 16,000 acres of managed forestland converted to other uses that primarily support cultivated herbaceous vegetation, ornamental landscaping, and impervious areas (e.g., residential and commercial development).

Anticipated beneficial effects of Restorative Flood Protection actions on wetland and vegetation within treatment areas include the following:

- Increased extent of wetland areas in the floodplain
- Improved structure and function of riparian vegetation communities associated with off-channel and slow-water habitat
- Increased diversity and extent of riparian and floodplain vegetation communities

Over the long term, each of these outcomes could in turn affect fish, amphibians, and other wildlife currently using these areas, and change the types of available habitat through the increase in floodplain connectivity, habitat structure, and habitat-shaping processes. Potential effects on fish and wildlife are discussed further in Sections 4.3.4.2.1 and 4.3.4.2.2, respectively.

4.3.3.2.1 Wetlands

Within Restorative Flood Protection Treatment Areas and Upland Areas Where Relocation and Land Conversion Occurs

Restorative Flood Protection actions are designed to reconnect the river with converted bottomlands and portions of the historic floodplain that have become isolated from flood processes over time. As proposed, Restorative Flood Protection actions would generally raise surface and groundwater levels in the treatment areas as described in Section 4.3.1. Increased surface and groundwater levels would contribute to an overall increase in wetlands by allowing some floodplain areas to maintain a surface connection to the river or an elevated water table in the upper 12 to 18 inches of the soil column throughout more of the year than current conditions. The extent of this effect has not been quantified for this programmatic-level evaluation.

Adverse impacts on wetlands could occur as a result of relocating floodplain land uses to uplands; however, this impact is anticipated to be minor because it is expected that wetland impacts can be avoided and minimized when siting and designing land uses during conversion.

Downstream of Restorative Flood Protection Treatment Areas
No adverse impacts on wetlands are anticipated to occur downstream of Restorative Flood Protection treatment areas. Direct impacts would not occur because these areas are not within Restorative Flood Protection treatment areas, and indirect impacts are not anticipated because this action element is designed to hydrologically reconnect floodplain wetlands, stream channels, and groundwater (Section 4.3.1.2.3).

4.3.3.2.2 Vegetation

Within Restorative Flood Protection Treatment Areas and Upland Relocation Land Conversion Areas
Adverse impacts from land use conversion actions on vegetation would be significant, with up to 16,000 acres of managed forestland converted to other uses that primarily support cultivated herbaceous vegetation, ornamental landscaping, and impervious areas (e.g., residential and commercial development).

Within treatment areas, restorative Flood Protection would provide improved structure and function of riparian vegetation communities associated with off-channel and slow-water habitat. This would be accomplished over time by recreating the brushy riparian conditions and wetland complexes that existed in the floodplain prior to European settlement. Such conditions would allow floodwaters to spread out over a greater portion of the floodplain, slow down the speed of flood waves, and provide additional floodwater storage in floodplain wetland depressions. The return of pre-settlement flood conditions would be expected to increase the diversity and extent of native riparian and floodplain vegetation.

Establishment of these vegetation types could occur over approximately 140 river miles for the brushy riparian corridors, with up to 21,000 acres of newly created floodplain forestland. These changes in vegetation within treatment areas, over the long term, are anticipated to positively affect water quality and create habitat for fish and wildlife that rely on these areas (see Sections 4.3.1.2.1 and 4.3.4).

Vegetation in the Restorative Flood Protection Treatment Areas

Within treatment areas, anticipated riparian vegetation would include a mosaic of native willows, red osier dogwood, red alder, and black cottonwood. Adjacent floodplain forestland would likely comprise a mix of native coniferous and deciduous trees, dominated by Douglas fir and western red cedar in the higher terraces, and black cottonwood, Sitka spruce, big-leaf maple, Oregon ash, and red alder on the lower-elevation surfaces. An extensive groundcover of shade-tolerant shrubs (salal, Cascade Oregon grape, red huckleberry and Scouler's willow) and ferns (swordfern) would likely dominate the understory vegetation. All of these vegetation types are well-adapted to the moist conditions and periodic overbank sediment deposition that would accompany the Restorative Flood Protection treatment areas.

Downstream of Restorative Flood Protection Treatment Areas

No adverse impacts on vegetation downstream of the Restorative Flood Protection treatment areas are anticipated.

4.3.3.3 Mitigation

Mitigation for long-term adverse impacts on wetland and vegetation would primarily focus on avoidance and minimization measures when siting new land uses in upland conversion areas. Avoidance measures could include avoiding sites with extensive and high-quality wetlands, designing structure and disturbance areas to avoid wetland impacts and disturbance to native vegetation, and restoring vegetation in temporarily disturbed areas.

4.3.4 Fish and Wildlife

4.3.4.1 Short-term Impacts

Short-term impacts on fish and wildlife could potentially occur during construction and would be localized to the construction footprint, with conditions returning to pre-construction status and/or function following construction.

4.3.4.1.1 Fish

The potential short-term impacts on fish related to in-water construction could primarily occur from the following:

- Reduced water quality due to turbidity increases, pollutant-laden stormwater runoff, or construction-related pollutants entering the water
- Temporarily dewatering of part of the river channels, reducing habitat available to fish in the immediate vicinity of construction

- Construction noise in or near the stream channel and removal of bank vegetation, which would reduce the function of riparian habitat for fish (e.g., shading and input of terrestrial nutrients and food)

4.3.4.1.2 Wildlife

Short-term impacts on wildlife would result from construction activities that are either site-specific, such as the clearing of vegetation from construction access and staging areas or transient, like construction and equipment-generated noise. Potential short-term impacts on wildlife related to construction activities are described in Table 4.1-1. Of the listed activities, construction noise, equipment and vehicle usage, and human presence are expected to have the greatest effects on wildlife.

4.3.4.2 Long-term Impacts

4.3.4.2.1 Fish

Within and downstream of Restorative Flood Protection treatment areas, effects on salmonids are anticipated to be beneficial, while warm-water associated species could be moderately adversely affected. The treatment actions are anticipated to reduce temperatures in rivers and streams from reduced solar radiation by increasing shade, which would provide conditions that are beneficial for cool water-associated fish—both in channels and within connected floodplain habitats—and positively affect salmon abundance within the Chehalis Basin.

The magnitude of adverse impacts on other species of fish is uncertain. The agricultural and other land uses within the floodplain areas to be treated would be relocated to areas outside the affected floodplains (up to 16,000 acres). As a result, upland areas currently having some form of forested cover would likely be converted to rural development and agricultural use, resulting in some amount of increased impervious surfaces and exposed soils. Increased rates of runoff and sediment delivery to stream channels would be expected (Beechie et al. 2013). However, these effects would be expected to be largely negated by watershed processes operating within the restored riparian forest and wetland corridors within the treated floodplain areas. Large, contiguous riparian corridors are effective at ameliorating effects of land disturbance located upstream (Naiman et al. 1992; Naiman et al. 2005). The potential benefits to salmon are primarily related to the following changes in physical attributes of the environment created by Restorative Flood Protection actions:

- Restoring normative wood loads to the stream channels to re-create a diverse mix of in-channel habitat types and provide more and well-distributed, high-quality key habitats for various salmonid species and their different life stages in all seasons of the year
- In conjunction with restored floodplain riparian corridors, wood load conditions (as described previously) could help to re-create wetlands, off-channel habitats, and side-channel networks used heavily by coho salmon, and by spring-run Chinook salmon and steelhead

- More normative wood loads could reduce bed scour at spawning sites, store spawning gravel, allow fine sediment to settle in side-channel areas, and increase egg to emergent fry survival
- Gravel could be distributed through the Restorative Flood Protection treatments and new sediment sources would be created by newly formed side channels in Restorative Flood Protection treatment areas (see Section 4.3.2.2.2)
- Stream temperatures are expected to decrease compared to current conditions, and the number, quality, and distribution of thermal refugia are anticipated to be enhanced as a result of restored riparian forests and associated wetlands, channel aggradation, higher groundwater levels, and re-creation of large, deep, main channel pools
  - These conditions are anticipated to improve survival for rearing salmonids of all species during summer
  - In particular, the conditions could improve survival of adult migrant, pre-spawner, and spawning spring-run Chinook salmon
- Peak winter flows would be reduced to characteristics more similar to a normative flow regime for the upper Chehalis River and its tributaries, which is expected to improve survival of overwintering fish, specifically coho salmon and steelhead

At the Basin-wide scale, Restorative Flood Protection is modeled to have positive effects on all salmonid species, resulting in population increases, ranging from about 26% for fall-run Chinook salmon to 473% for spring-run Chinook salmon (see Table 4.3-4 and Figure 4.3-2). Restorative Flood Protection is predicted to have positive effects on coho salmon and winter-run steelhead, a small positive effect on chum salmon, and a large positive effect on spring-run Chinook salmon. The conditions created through the Restorative Flood Protection treatments are less favorable to non-native fish species. The response of non-salmonid fishes to Restorative Flood Protection has not been modeled or quantitatively evaluated at this point.

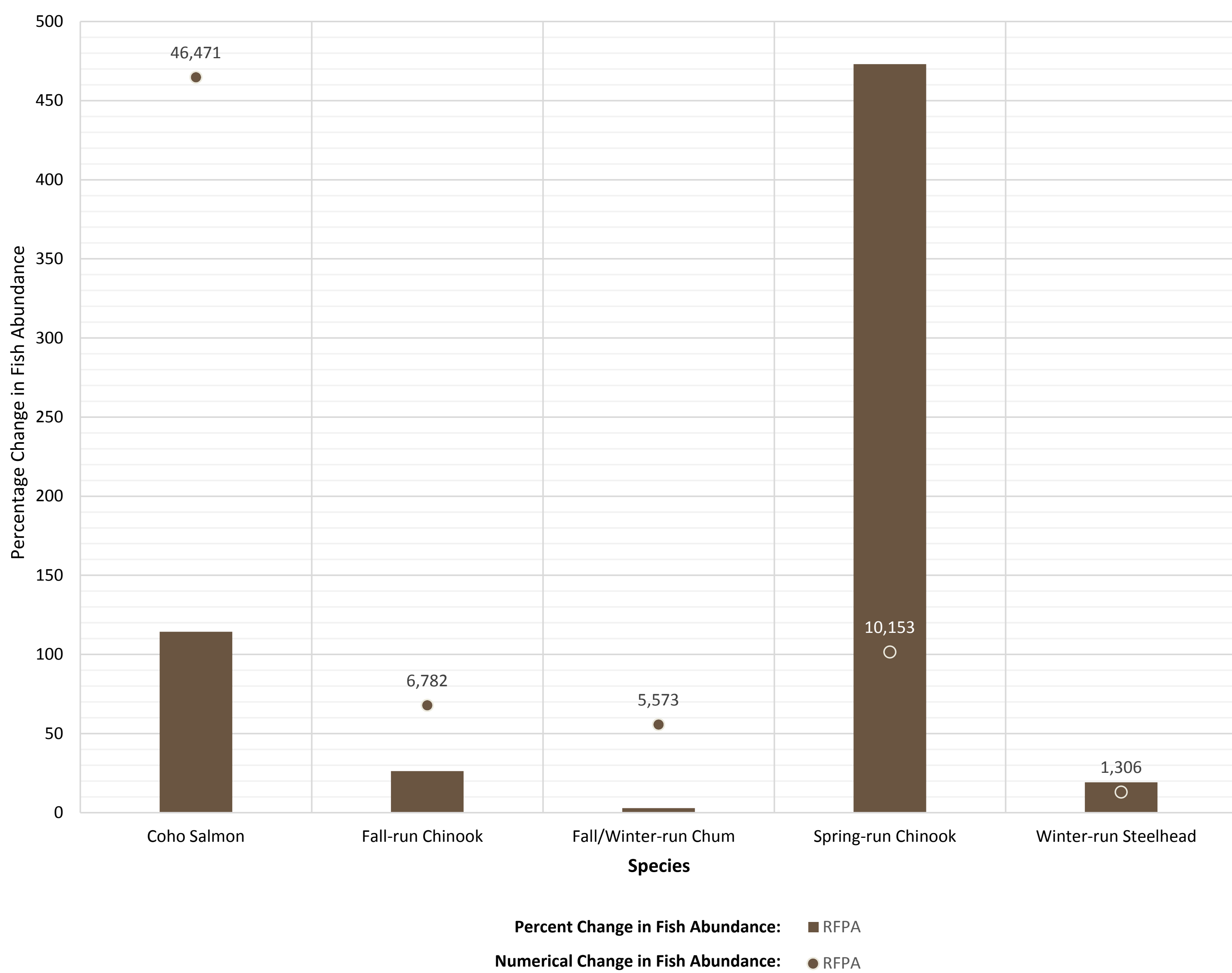
Table 4.3-4
Potential Response in Salmonid Abundance to Habitat Change in the Chehalis Basin from Restorative Flood Protection

SPECIES (CURRENT HABITAT POTENTIAL)	PRODUCTIVITY CHANGE FROM CURRENT CONDITION IN NUMBER OF FISH (%)
Coho salmon (40,642)	46,471 (114%)
Fall-run Chinook salmon (25,844)	6,782 (26%)
Winter/fall-run chum salmon (190,550)	5,573 (3%)
Spring-run Chinook salmon (2,146)	10,153 (473%)
Winter-run steelhead (6,800)	1,306 (19%)

Source: ICF 2016

Figure 4.3-2

Potential Response in Salmonid Abundance to Habitat Change in the Chehalis Basin from Restorative Flood Protection



Source: ICF 2016

4.3.4.2.2 Wildlife

Within Restorative Flood Protection Treatment Areas and Upland Areas Where Relocation and Land Conversion Occurs

The conversion of up to 16,000 acres of upland managed forestland to agriculture, rural residential, public services, and commercial land uses would affect wildlife by displacing and shrinking available habitat for upland-dependent species. Minor to moderate adverse impacts are anticipated because many of the wildlife species living and using these areas could also successfully occupy river greenways and Restorative Flood Protection treatment areas. However, direct impacts from construction of access to and new development sites, and habitat fragmentation within the displacement area (up to 16,000 acres) could be significant depending on site-specific characteristics, and there would be a temporal lag between when the river greenways and treatment areas would provide the same forest habitat as the converted uplands.

Beneficial effects for wildlife within Restorative Flood Protection treatment areas are anticipated to include the following:

- Improved structure and function of off-channel and slow-water habitat for species such as amphibians, providing high-quality habitat conditions for amphibians to breed and forage, and for wildlife species that rely on aquatic habitat for multiple life cycles, such as amphibians, western pond turtle, and North American beaver
- Improved connectivity to floodplain habitat could increase the quality of riparian vegetation and the diversity of wildlife species that occupy the habitats
- Improved connectivity between wildlife habitats, benefiting wildlife populations that are currently separated by human disturbances or activities and providing migration corridors that are less exposed to human disturbance (WHCWG 2010)
- Increased quality and quantity of habitat for native wildlife species of birds, amphibians, large and small mammals, and reptiles to breed, forage, rest, and overwinter
- Increased salmon abundance as described in Section 4.3.4.2.1 would benefit mammals and predators that feed on salmon and salmon carcasses, including multiple birds and mammal species in the Chehalis Basin, as well as the ESA-listed Southern Resident killer whale in the Pacific Ocean outside of Grays Harbor

Restoring connections among currently disconnected habitat could have an adverse impact by facilitating the spread of non-native invasive species, which could lower the quality of habitat functions; however, this is anticipated to be a potentially minor adverse impact considering the overall beneficial effect of improving connectivity between habitats for wildlife species. Invasive species dispersal could include non-native plants (e.g., reed canarygrass, purple loosestrife) or wildlife species (e.g., bullfrog) that prey on native wildlife.

4.3.4.3 Mitigation

No mitigation measures are proposed for fish and wildlife because long-term adverse impacts are minor to moderate, and will recover through maturation of the habitat within the river greenways.

4.3.5 Tribal Resources

The health and productivity of the entire Chehalis Basin affects the condition of treaty fisheries in the lower Chehalis River and its tributaries, and the non-treaty Chehalis Tribe fishery on the Chehalis Tribe reservation. The upper and middle Chehalis River and its tributaries contain valuable habitat for spawning and rearing salmonids.

Impacts on tribal resources could occur during or following construction, if tribal members could no longer access a resource or if the resource was diminished. The following potential impacts were considered:

- Access to treaty reserved usual and accustomed fishing areas, including Grays Harbor and the Chehalis River
- Access to treaty-reserved usual and accustomed areas for hunting and gathering on open and unclaimed lands
- Access to culturally significant areas for gathering of plant material or other related activities
- Injury and mortality of fish and wildlife and their habitats, and plants that are identified as a tribal resource; these impacts are detailed in Section 4.3.4 and are included in this Tribal Resources section by reference

Indirect impacts on tribal resources could occur as a result of the impacts on water resources, geology and geomorphology, wetlands and vegetation, and fish and wildlife detailed in Sections 4.3.1 through 4.3.4.

4.3.5.1 Short- and Long-Term Impacts

The potential impacts on tribal resources that would occur during construction of the Restorative Flood Protection treatments are related to the temporary disruption of access to tribal resources associated with a tribe's sovereignty or formal treaty rights, or reduced or limited access to plants, fish, or wildlife used for commercial, subsistence, and ceremonial purposes. These construction-related impacts could occur from activities associated with the in-channel wood structures and engineered-wood floodplain structures, or from relocation of floodplain land uses into upland conversion areas. Potential impacts could also include direct impacts during construction on, or loss of, natural resources protected by tribal treaties for fishing, hunting or gathering.

Additional input from the Quinault Indian Nation, the Chehalis Tribe, and other potentially affected tribes will help to characterize existing tribal resources and use of the area for fishing, hunting, and gathering, and confirm the nature of potential impacts from construction-related activities. Additional coordination with affected tribes to address specific impacts on tribal resources would continue during project-level environmental review and as part of continued government-to-government consultations.

The potential long-term impacts on tribal resources consider impacts following construction on fishing, hunting, gathering, and other traditional cultural activities. No long-term impacts on tribal resources have been identified for Restorative Flood Protection; however, beneficial outcomes are expected, primarily because of the significant improvement in self-sustaining fishery conditions that accompany the Restorative Flood Protection treatments.

Specific potential adverse impacts on fish and wildlife and vegetation that may directly or indirectly affect tribal resources have not been identified; however, all of the impacts described in Sections 4.3.4.2 and 4.3.3.2 could affect tribal resources. Potential long-term impacts would need to be identified prior to and during reach- and site-specific project development, with the extent of impacts pending additional coordination with tribes and continued government-to-government consultations. Potential long-term impacts could occur for tribal resources on tribal lands, within usual and accustomed fishing areas, or other areas used for hunting and gathering. As noted by the Quinault Indian Nation, adverse impacts that impede the ability to exercise treaty rights, such as impaired access to resources or actions that harm resources directly or indirectly by affecting the habitat on which they are dependent, constitutes the take of a property right that has been guaranteed to tribes (Sharp 2016a, 2016b).

4.3.5.2 Mitigation

The potential mitigation associated with impacts on tribal resources would be directly addressed with Quinault Indian Nation and Chehalis Tribe tribal leadership during project-level environmental review and continued government-to-government consultations.

Some potential long-term impacts on tribal fish resources could be addressed through avoidance and minimization measures developed in consultation with tribes. These may include the provision of fish passage around the dam during construction and operation, noise attenuation measures during construction, minimum instream flow release from the dam during operation, and release of cool water late spring to early fall during operation of the FRFA facility.

Potential compensatory mitigation measures developed in consultation with tribes could include, but are not limited to, the following:

- Coordinating with tribal leaders and managers on the timing and location of construction activities that could affect tribal access
  - Coordination could result in adjustments to the timing of construction activities to avoid periods when use is the highest or provisions to provide an access point around the construction site and proposed Flood Retention Facility

- Identifying areas with significant tribal resources and coordinating with the tribes regarding access points to these areas during and after construction

Compensatory mitigation could be required for loss of fish habitat and fish habitat function, and reduced fish population performance above and below the Flood Retention Facility. Compensatory mitigation would be developed in consultation with tribes and may include fish habitat restoration and protection, or acquisition of land that presents an opportunity for in-kind compensation for fish habitat lost. Mitigation of impacts on treaty rights is subject to consideration and agreement by the Quinault Indian Nation.

4.3.6 Air Quality

4.3.6.1 Short-term Impacts

The potential short-term impacts on air quality would occur during construction, including increased vehicle emissions from truck trips and mechanized construction equipment, and dust created by clearing and grading land and the transport and placement of excavation material, soils, and other materials. These impacts would be localized during the construction period and would not cause an overall decrease in regional air quality.

4.3.6.2 Long-term Impacts

No adverse impacts on air quality are anticipated because completed Restorative Flood Protection actions would not generate additional dust or emissions. Long-term emissions associated with land uses that are relocated to converted upland areas are not anticipated to increase over existing levels.

4.3.6.3 Mitigation

Potential mitigation measures to reduce short-term impacts on air quality are described in Table 4.1-1. No long-term adverse impacts on air quality are anticipated, so no mitigation is proposed.

4.3.7 Climate Change

4.3.7.1 Short-term Impacts

4.3.7.1.1 Effects of Restorative Flood Protection Contributing to Climate Change

The potential short-term effects that could contribute to climate change would occur during construction of Restorative Flood Protection treatments and include GHG emissions from construction equipment and vegetation removal. This effect is expected to be no more than 5,000 MT CO_2e—well below the 10,000 MT CO_2e threshold for qualitatively disclosing emissions established by Ecology over the construction period (this threshold equates to 6.2 million vehicle miles for a Class 7-8 truck).

4.3.7.1.2 Effects of Climate Change on Restorative Flood Protection

No anticipated short-term effects of climate change on Restorative Flood Protection actions are anticipated during construction.

4.3.7.2 Long-term Impacts

4.3.7.2.1 Effects of Restorative Flood Protection Contributing to Climate Change

There are no adverse impacts associated with Restorative Flood Protection actions that are anticipated to contribute to climate change. Overall, riparian and floodplain plantings, enhancement of floodplain wetlands, and shade to support cooler stream temperatures are expected to offset climate change impacts and forge a more resilient future floodplain, although this has not been modeled at this point. The conversion of upland areas from managed forestland to agriculture, rural residential, public services, and commercial land uses could mute any benefit; however, the overall effect is not expected to be adverse.

4.3.7.2.2 Effects of Climate Change on Restorative Flood Protection

The potential adverse impacts of climate change on Restorative Flood Protection would be considered and addressed during design of the treatment areas. In general, the increased frequency of extreme weather events and increased flow magnitudes expected under future climate change conditions could be incorporated into design criteria and treatment area designs to ensure that facilities withstand and perform their intended function under more extreme flow and weather conditions.

The EDT model developed for the Chehalis Basin (ICF 2016) was used to predict how fish species would respond to the effects of climate change on current habitat conditions when including implementation of Restorative Flood Protection actions. Table 4.3-5 and Figure 4.3-3 present the results for Restorative Flood Protection as a percentage increase or decrease compared to the results with climate change. Model results predict that Restorative Flood Protection would reduce the adverse effects of climate change on salmon abundance on a Basin-wide scale. Except for winter- and fall-run chum salmon, the adverse impacts on salmon from climate change are predicted to be partially buffered by Restorative Flood Protection actions. Benefits likely result from the substantial increase in channel and floodplain habitat size and quality, including cooler water temperatures and more refuge area.

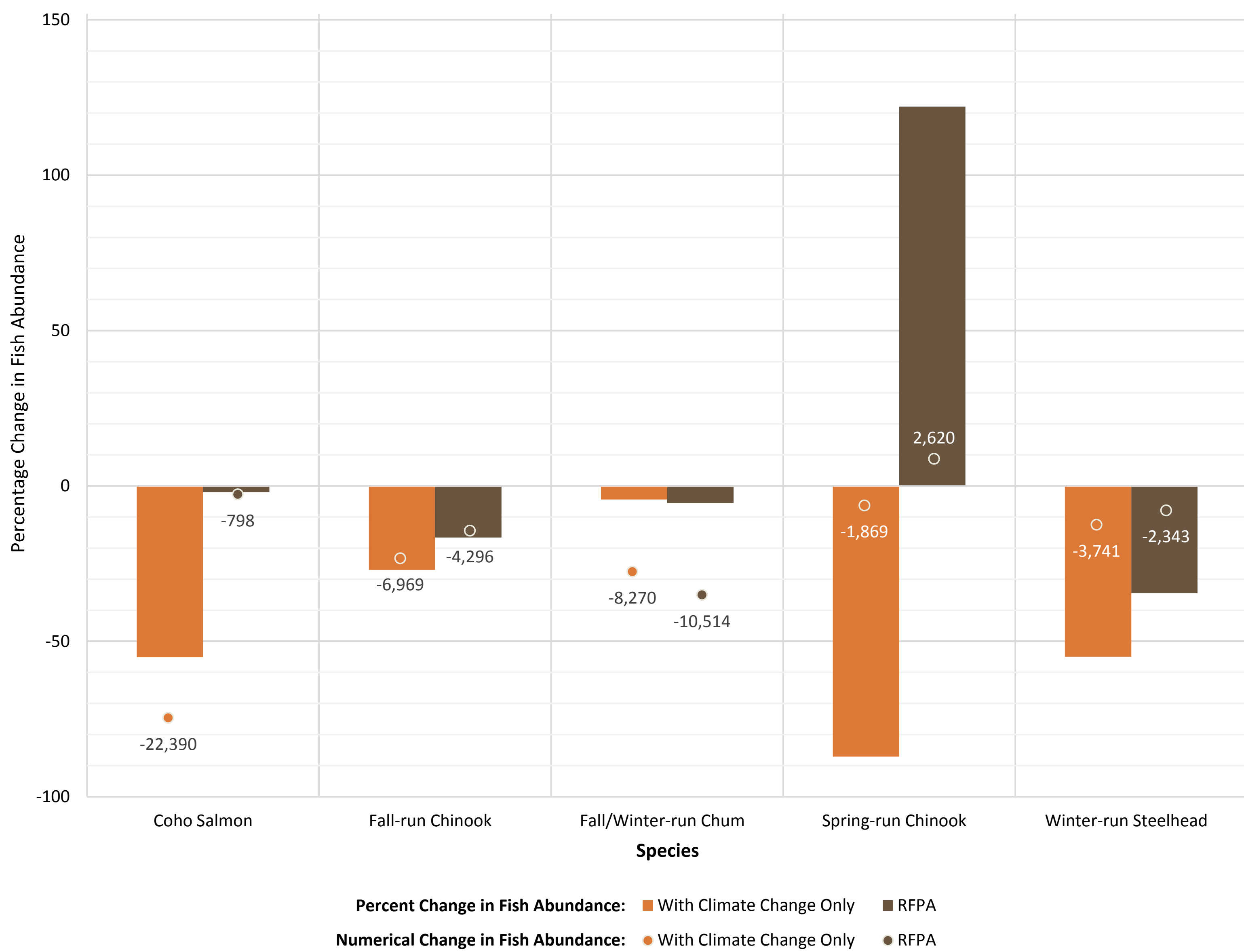
Table 4.3-5
Potential Response in Salmonid Abundance to Habitat Change in the Chehalis Basin from Climate Change and Restorative Flood Protection

SPECIES (CURRENT HABITAT POTENTIAL)	CHANGE FROM CURRENT CONDITION IN NUMBER OF FISH (%)	
	WITH CLIMATE CHANGE ONLY	WITH CLIMATE CHANGE AND RESTORATIVE FLOOD PROTECTION
Coho salmon (40,642)	-22,390 (-55%)	-798 (-2%)
Fall-run Chinook salmon (25,844)	-6,969 (-27%)	-4,296 (-17%)
Winter/fall-run chum salmon (190,550)	-8,270 (-4%)	-10,514 (-6%)
Spring-run Chinook salmon (2,146)	-1,869 (-87%)	2,620 (122%)
Winter-run steelhead (6,800)	-3,741 (-55%)	-2,343 (-34%)

Source: ICF 2016

Figure 4.3-3

Potential Response in Salmonid Abundance to Habitat Change in the Chehalis Basin from Climate Change and Restorative Flood Protection



Source: ICF 2016

4.3.7.3 Mitigation

No long-term, adverse impacts contributing to climate change are anticipated, so no mitigation is proposed.

4.3.8 Visual Quality

4.3.8.1 Short-term Impacts

The potential short-term impacts on visual quality that would occur during construction are described in Table 4.1-1. In addition, construction activities would substantially alter the appearance of the areas near the Restorative Flood Protection treatment areas. Construction activities within the channel would be largely out of view; however, construction of the engineered-floodplain elements would be visible to the community.

4.3.8.2 Long-term Impacts

Potential adverse impacts on visual quality from Restorative Flood Protection are related to a long-term change or reduction in visual quality. These impacts would occur within and within viewing distance from Restorative Flood Protection treatment areas and upland land conversion areas.

Changes that would significantly contrast with the existing visual character include the following:

- Establishment of dense floodplain vegetation that would disrupt the view that currently exists across open floodplain areas
- Engineered-floodplain log structures that would be visible across large portions of the floodplain until interplanted vegetation grows tall enough to obscure the log structures
- Conversion of upland managed forestland to other land uses

Restorative Flood Protection would require construction of engineered-floodplain structures over 85% to 90% of the future 100-year floodplain, which includes up to 21,000 acres within the treatment areas. These structures would cover a large portion of the existing floodplain, much of which is currently in pasture, hay, or other cultivated crops. The vistas that are enjoyed by people would be dramatically changed. Over a 5- to 7-year period following construction of the engineered floodplain, a densely spaced matrix of constructed wood structures would be the most visible feature. Following that, shrubs and trees would be tall enough to dominate the view, and the vista would transition to that of a forest. Because of the extent of area affected by the floodplain treatments, this is considered a significant adverse impact.

Conversion of upland managed forestland to accommodate displaced land uses from the Restorative Flood Protection treatment areas would have an adverse impact on visual quality. While in managed forestland use, the view evolves over an approximately 30-year cycle from clearcuts to young forest, and then to mature forest with large conifer trees. The converted land would permanently change this view to farms, homes, and other structures—both public and private. The views are visible from the valley, and would be noticeable from a large area within each Restorative Flood Protection treatment sub-basin. This adverse impact could range from moderate to significant, depending upon the visual quality and concentration of the new land use in contrast to managed forestland.

4.3.8.3 Mitigation

In addition to those described in Table 4.1-1, short-term mitigation measures could include locating temporary construction access roads, staging areas, and stockpile sites within previously disturbed areas.

Long-term mitigation measures could include integrating view corridors that intersperse floodplain forestland with open areas within the Restorative Flood Protection floodplain treatment areas if further analysis indicates such configurations could still achieve the desired flood attenuation and storage. These measures could slightly reduce the visual quality impacts, but the impacts would still be significant.

4.3.9 Noise

4.3.9.1 Short-term Impacts

The potential short-term impacts on noise that would occur during construction are described in Table 4.1-1. Heavy equipment and construction activities associated with the Restorative Flood Protection treatments would cause short-term noise impacts.

Depending on the type of construction activity, peak noise levels from the equipment shown in Table 4.2-10 would range from 76 to 110 dBA at 50 feet from the source. Damage to hearing occurs with noise levels above 85 dBA. However, noise levels decrease with distance from the source at a rate of approximately 6 to 7.5 dBA per doubled distance. For example, noise levels from construction equipment would range from approximately 57 to 98 dBA at a distance of 200 feet; from 51 to 92 dBA at 400 feet; and from 45 to 86 dBA at 800 feet.

Construction of Restorative Flood Protection treatments would require heavy equipment and activities with high noise levels, including earth-moving equipment and pile drivers. Some of this equipment would operate at noise levels high enough to cause hearing damage at very short distances (less than 50 feet), but the noise levels would dissipate to safe levels with distance. The locations for many of the Restorative Flood Protection treatments would be proximal to private homes, businesses, and public facilities.

4.3.9.2 Long-term Impacts

Minor adverse impacts related to noise are anticipated. These impacts would be created by potential land conversion in managed forestland. New land uses in those areas would likely create noise consistent with rural residential, farming, businesses, and public services. Significant impacts would occur if projects generated noise that would conflict with local ordinances or increase noise levels by 5 dBA or greater at a sensitive land use. Restorative Flood Protection actions would not generate noise within the treatment areas where noise would likely be less than under current conditions.

4.3.9.3 Mitigation

Assuming the specifications for equipment meet the noise standards described in Table 4.1-1, no additional equipment mitigation for short-term impacts would be required. Construction workers at the site could wear hearing protectors to reduce the risk of hearing damage.

No long-term impacts on noise are anticipated, so no mitigation is required.

4.3.10 Land Use

4.3.10.1 Short-term Impacts

Potential short-term impacts on land use would occur during construction, including disruption to use of and access to land within Restorative Flood Protection and upland relocation construction areas.

4.3.10.2 Long-term Impacts

Potential adverse impacts on land use associated with the Restorative Flood Protection would result from the following:

- Conversion of floodplain land to Restorative Flood Protection treatment areas
- Increased flooding in some areas that would affect existing high and limited value structures
- Conversion of upland commercial forestland to agriculture, rural residential, and public facilities

As described in this section, the adverse impact on existing land uses within the Restorative Flood Protection treatment areas would be significant.

Within Restorative Flood Protection Treatment Areas

Restorative flood protection actions would be incompatible with many existing land uses. Many of these areas are already at-risk for flooding and loss of land from bank erosion; Restorative Flood Protection would formally recognize that risk and address it. Figure 4.3-4 illustrates the expected range of land use impacts within the floodplain treatment areas. Based on the preliminary analysis conducted, the zone within the 10-year floodplain following Restorative Flood Protection implementation would be largely unsuitable for permanent human residents. This zone, described in the Restorative Flood Protection description as the “river management zone” or “greenway,” is expected to experience active channel migration, engagement of floodplain wetlands, and frequent flooding such that structures would be at-risk to severe flood and erosion damage. There is currently approximately 16,000 acres within this zone, including 8,500 acres of active farmland.

Outside the “river management” or “greenway” zone, but still within the Restorative Flood Protection floodplain, Restorative Flood Protection treatments are likely to cover 50% to 70% of the floodplain. It is expected that flooding would be more frequent in these areas than under current conditions. An additional 5,200 acres would be more frequently flooded within this zone, including 3,600 acres of farmland.

Under Restorative Flood Protection, willing landowners would be offered a suite of compensation options, which could include measures described below under mitigation. One option could be to relocate to suitable upland areas that would not be affected by Restorative Flood Protection treatments. This option would likely convert up to 16,000 acres of land that is currently managed forestland to agriculture, rural residential, public services, and commercial (also referred to as upland conversion areas in this EIS). If all agricultural land uses in future greenways (see Figure 4.3-4) moved to upland areas, the land conversion from managed forestland to agriculture could reach 8,500 acres in size. The location, magnitude, and concentration of these potential impacts have not yet been determined. Adverse impacts on fish and wildlife, vegetation, water quantity, visual quality, and climate change associated with this land conversion (see Sections 4.3.4, 4.3.3, 4.3.1, 4.3.8, and 4.3.7) are likely. Because upland relocation would convert managed forestland to other uses, there would also be a reduction in managed forestland in the watershed.

Approximately 462 high-value structures would be affected by increased flooding within the treatment areas. Of the 462 structures, 182 structures would be inundated under current conditions during a 100-year flood. Flood depths and frequencies would increase for these 182 structures after Restorative Flood Protection treatments. The remaining 280 structures would be subject to new flooding caused by Restorative Flood Protection treatments, and may not flood currently during a 100-year flood. Because modeling was developed to be a screening-level tool, this estimate of affected structures includes all potential affected structures, and may be reduced in number with a conceptual design-level analysis.

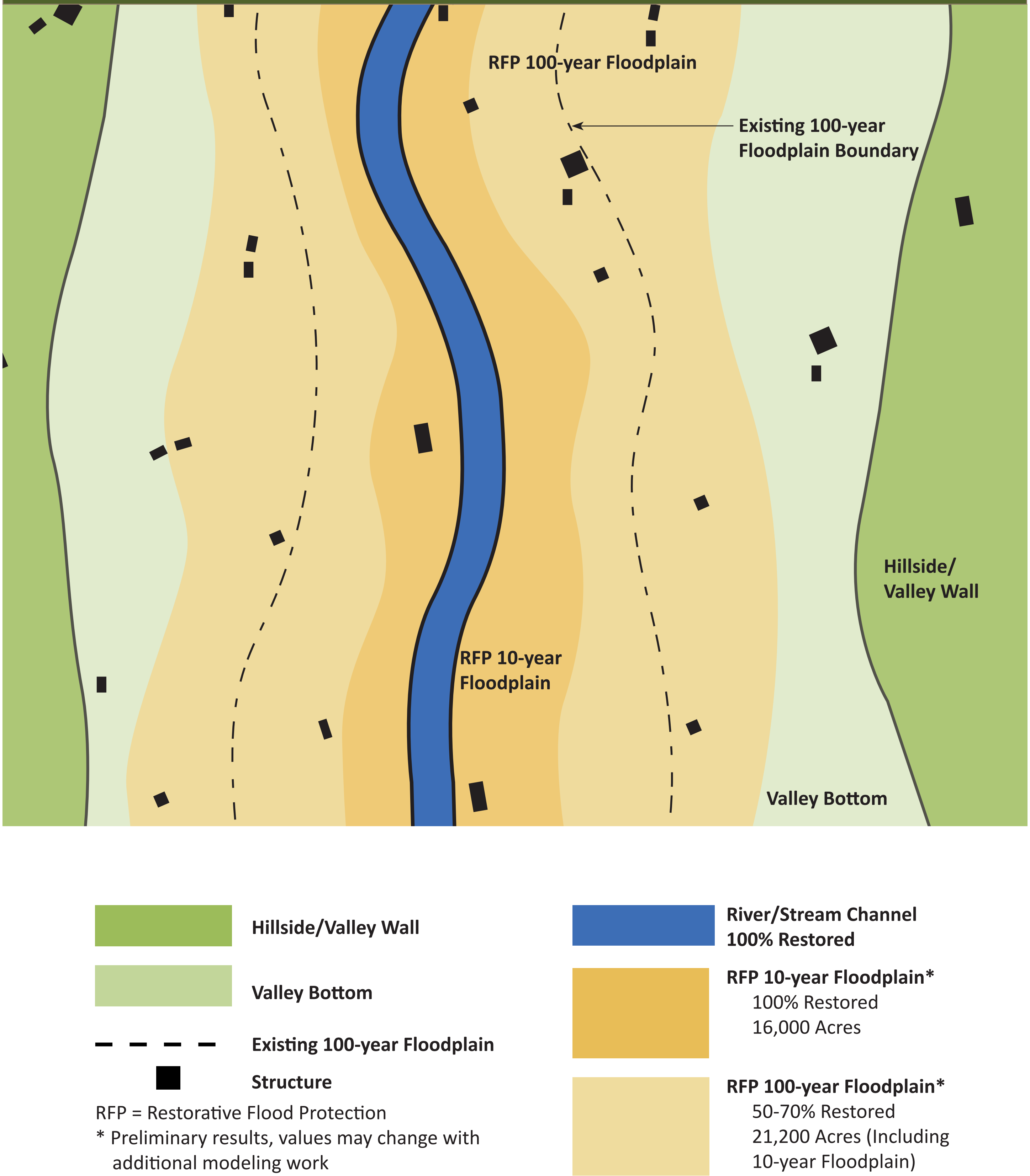
As noted above, many of the areas within Restorative Flood Protection treatment areas are already at risk from flooding and loss of land from bank erosion, and Restorative Flood Protection would formally recognize that risk and address it. If all landowners with structures that currently experience flooding, and where flooding would increase, participated, 182 fewer structures would be flooded than under current conditions. An additional 280 structures (those subject to new flooding caused by the treatments) would also be offered compensation, relocation, or adaptation assistance (see Section 4.3.10.3).

Downstream of Restorative Flood Protection Treatment Areas

Downstream of the Restorative Flood Protection treatment area, 1,197 high-value and limited-value structures are estimated to be inundated during a 100-year flood under current conditions. After implementation of Restorative Flood Protection actions, it is estimated that 1,061 structures would be inundated during a 100-year flood, for a decrease of 136 flooded structures.

Figure 4.3-4

Land Use Change Diagram



RFP = Restorative Flood Protection

* Preliminary results, values may change with additional modeling work

4.3.10.3 Mitigation

An integral part of this action element is to provide assistance to help ensure that willing property owners and residents can adapt. Adaptation strategies, intended to avoid and minimize the significant adverse impacts on land use associated with Restorative Flood Protection, could include the following:

- **Stay-in-place adaptation assistance –** Within treatment areas but outside of greenways, floodproofing, elevation of structures, farm pads, drainage and utility improvements, or relocation of homes and structures to more upland portions of the same parcel
- **Buy-outs –** If property owners prefer a simple buy-out option for property and structures
- **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 or be a strategy for parcels without structures
- **Relocation support to upland areas –** A preliminary assessment of soils in the Chehalis Basin indicates that relocation of some current floodplain land uses to upland areas could be a viable option in portions of the watershed
  - The feasibility of this concept is very preliminary and unknown; the suitability of upland areas for specific land uses would have to be further explored

4.3.11 Recreation

4.3.11.1 Short-term Impacts

Construction in the Restorative Flood Protection treatment areas would restrict access to recreation sites and river recreation. The duration of this impact would be limited to the construction period at each site, likely to span approximately 3 to 4 months. Short-term impacts on recreational activities such as hunting or fishing on managed forestlands, where currently allowed by permit, could occur from site preparation and construction associated with relocation of floodplain land uses to upland areas.

4.3.11.2 Long-term Impacts

Adverse impacts on recreation resulting from implementation of Restorative Flood Protection are anticipated to be minor to moderate because of the large area over which the impacts described in this section could occur.

Restorative Flood Protection would require construction of large wood and rock structures (engineered logjams) in the mainstem and South Fork Chehalis rivers; Bunker, Elk, Stearns, Stillman, and Lake creeks; and the North and South Fork Newaukum River channel over a total length of up to 140 river miles. Logjams can create hazardous conditions for boaters of all types, and would permanently displace recreational use of some stretches of rivers and streams. If access points are not available for boaters, rafters, and floaters to access the river in safe areas, recreational use could be further affected.

Agritourism opportunities are present in the Chehalis watershed, and depending upon their specific location, Restorative Flood Protection actions could adversely affect these recreational sites. Where current agritourism facilities are located within the Restorative Flood Protection 10-year floodplain (greenways), these recreational facilities would likely be displaced.

Some recreational facilities, such as the Chehalis-Centralia Railroad, Willapa Hills Trail, and Rainbow Falls State Park could experience more frequent flooding that would likely require modifications to existing facilities, such as floodproofing, installation of new bridges, and adjustments to trail alignments. Other recreational activities would not be affected by Restorative Flood Protection, and activities like hunting, fishing, hiking, and bird-watching could benefit (increase) as a result of more floodplain habitat area and, correspondingly, more abundant fish and wildlife.

It may not be possible to relocate some types of recreational activities or facilities from the Restorative Flood Protection floodplain to upland areas. For example, features an activity may require or depend on to operate in one location may be diminished or not exist in upland areas. For example, fishing requires access to a body of water, and this opportunity would not be available in an upland area without access to a waterbody.

4.3.11.3 Mitigation

Mitigation measures for short-term impacts on recreation during construction could include providing alternative recreational opportunities or access when treatment areas are under construction. During construction, these areas would be closed to recreational use for safety purposes.

For long-term adverse impacts on in-water recreation, compensatory mitigation could consist of identification of hazards and delineation of specific river reaches where in-water recreation is encouraged and safe. Public safety communication would also be needed to inform the public about hazards within other areas along the Chehalis River and its tributaries.

Mitigation for impacts on agritourism sites could include measures associated with the overall accommodation for relocating or compensating private landowners for displacement caused by Restorative Flood Protection (see Section 4.3.10).

4.3.12 Historic and Cultural Preservation

4.3.12.1 Short- and Long-term Impacts

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

The potential impacts on historic and cultural resources that would occur during construction include ground disturbance associated with access routes, Restorative Flood Protection construction sites, and upland conversion areas. The engineered-floodplain elements of the Restorative Flood Protection would require some ground disturbance over a large area (up to 21,000 acres). Upland conversion areas could require ground disturbance over approximately 16,000 acres. A cultural resources assessment has not yet been conducted for potential Restorative Flood Protection treatment areas or upland conversion areas, and would be required during design and project-level environmental review. 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. 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.

4.3.12.2 Mitigation

Once potential project-specific impacts of Restorative Flood Protection actions on cultural resources have been identified, avoidance and minimization measures may be considered that alter project design or construction methods to avoid or minimize these impacts. If impacts cannot be avoided, mitigation measures to address potential impacts on cultural resources would be determined during project-specific evaluations, and would include consultation with DAHP, interested and affected tribes, as well as other consulting parties (see information on addressing potential impacts on cultural resources in Section 4.2.12).

The potential compensatory mitigation measures could include data recovery (scientific excavation and analysis) of the archaeological sites; archaeological monitoring during construction to ensure that no (previously unknown) cultural resources are affected; development and implementation of an Inadvertent Discovery Plan; ethnographic studies; Historic American Building Survey/Historic American Engineering Record documentation; and cultural resources identification trainings for construction personnel.

4.3.13 Transportation

4.3.13.1 Short-term Impacts

The potential short-term impacts on transportation that would occur during construction are described in Table 4.1-1 and are related to construction traffic and temporary road closures.

4.3.13.2 Long-term Impacts

Significant adverse impacts on transportation are anticipated from implementation of Restorative Flood Protection. The potential adverse impacts on transportation include:

- Major roads that would be at risk from channel migration
- Major roads that would flood more (see Table 4.3-6)
- Roads that provide the only access route could be less accessible
- I-5, and other roads that benefit where flooding is reduced

Within Restorative Flood Protection Treatment Areas

Restorative Flood Protection would increase flooding impacts on transportation systems in the Chehalis Basin upstream of the Newaukum confluence with the Chehalis River. During a 100-year flood, Restorative Flood Protection 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.

Table 4.3-6

Increased Flooding Duration for Roads within the Restorative Flood Protection Treatment Areas

LOCATION	HOURS OF FLOODING DURING EXISTING 100-YEAR FLOOD	HOURS OF FLOODING DURING 100-YEAR FLOOD WITH RESTORATIVE FLOOD PROTECTION
SR 6 near Scheuber Road	43	70
SR 6 near Adna	33	71
SR 6 at Boistfort Road	15	35
SR 6 at Rainbow Falls State Park	17	18
Boisfort Road near SR 6	0	23
Boisfort Road at Boisfort	13	14
Wildwood Road Bridge	0	6
Main Avenue near South Fork Newaukum River crossing	0	20

A new transportation network and new transportation facilities would be necessary for upland conversion areas, which may affect current transportation facilities or patterns; the nature and magnitude of these impacts are currently unknown and would be evaluated through future development and design of this concept.

Downstream of the Restorative Flood Protection Treatment Areas

Restorative Flood Protection would reduce flooding impacts on transportation systems in the Chehalis Basin downstream of the Newaukum confluence with the Chehalis River. Restorative Flood Protection would not reduce the duration of closures of I-5 during a 100-year flood (up to 4 days of closure). In the Chehalis-Centralia area, Restorative Flood Protection would reduce flood depths by approximately

1 foot, and local roads within the area would experience reduced flood durations by up to 1 day. 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.

4.3.13.3 Mitigation

Mitigation measures for short-term impacts during construction phases of Restorative Flood Protection on transportation are described in Table 4.1-1.

Potential long-term adverse impacts on transportation could be mitigated through a combination of emergency access route planning, and road relocations and modifications to increase access during flooding.

4.3.14 Public Services and Utilities

4.3.14.1 Short-term Impacts

The potential short-term impacts on public services would occur during construction due to temporary road closures that could affect public services because access to properties would be temporarily restricted. Construction could cause a temporary disturbance of on-site and nearby utilities, including overhead utility lines.

4.3.14.2 Long-term Impacts

Restorative Flood Protection includes the relocation of agricultural, residential, and commercial land uses out of the 10-year floodplain, which would require disconnection and decommissioning of existing public utilities in these areas. This would include removal or decommissioning of overhead utilities, water lines or wells, sewer or septic systems, propane tanks, and buried fuel tanks. New public services and utilities would need to be provided to the upland areas where the displaced land uses would be relocated. The Restorative Flood Protection would not directly increase demand for public services and utilities, but relocation of those services and utilities could require extension of utilities including electricity, water supplies, and sewer services. Removal and relocation of public services and utilities throughout the 10-year floodplain would be a significant adverse impact.

Restorative Flood Protection would increase flood levels in the watershed above the confluence with the Newaukum River. Public services and utilities located in the areas of increased flood levels would experience higher inundation or longer duration of flooding. The higher flood levels would close access roads for a longer period and prevent access to public services such as public health facilities and schools for longer periods than under current conditions. Higher flood levels could inundate public utilities for a longer period of time disrupting service. Public services and utilities located in these areas include the Boistfort Elementary School, post offices, power lines, electrical substations, water wells, septic tanks, as well as numerous utilities in the small communities along the Chehalis and Newaukum rivers and their tributaries. As part of Restorative Flood Protection, public services and utilities would be relocated out of the treatment areas and the 10-year floodplain, reducing the number of public services and utilities that would be affected. These adverse impacts would be moderate.

Restorative Flood Protection would decrease the level and duration of flooding in the Chehalis Basin downstream of the Newaukum River confluence. Flooding of public services and utilities would be reduced in the Chehalis and Centralia areas where flooding would be reduced by up to 1 foot.

4.3.14.3 Mitigation

Potential measures to reduce short-term construction disruptions on public services and utilities include the following:

- Providing public notification of proposed construction activities, including the timing of construction, to all local service providers within the immediate vicinity of the construction area
- Coordinating with local utility service providers to assist in utility locations, if applicable, and to identify specific mitigation measures to minimize impacts on utility purveyors
- Coordinating with local utility purveyors to identify other specific mitigation measures to minimize impacts

Mitigation planning for utilities would require coordination with involved service providers, as well as with potentially affected residents and landowners. Where local utility system connections or installations would be affected by construction activities, alternative or relocated connections and facilities could be planned and implemented prior to construction to avoid service disruptions.

Mitigation for potential long-term adverse impacts due to relocation of public services and utilities would 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. New services and utilities would be provided to the properties where the displaced land uses are relocated in coordination with local service providers.

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.

4.3.15 Environmental Health and Safety

4.3.15.1 Short-term Impacts

The potential short-term impacts on environmental health and safety that would occur during construction are described in Table 4.1-1. In addition, construction traffic on local roadways could cause temporary delays to emergency response.

4.3.15.2 Long-term Impacts

Increased flooding could affect emergency response services in the areas upstream of the Newaukum River confluence with the Chehalis River. Higher flood levels and increased duration of flooding of SR 6 and local roadways could prevent or delay emergency service access. This would be a moderate to significant adverse impact depending on how well emergency response could be maintained. 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, but access may still be required in areas outside the 10-year floodplain. Relocation of land uses outside the 10-year floodplain would also reduce the risk of floodwater contamination by reducing the potential contaminants that could be exposed to flooding.

Restorative Flood Protection could cause a moderate to significant adverse impact on human health and safety. Higher flood levels could close roads for longer periods and prevent access for emergency response. Access to some of the rural areas within the increased flood zone is already limited, increasing the hazard of increased road closures.

4.3.15.3 Mitigation

Potential measures to reduce short-term construction disruptions to environmental health and safety could include coordinating construction with emergency services, scheduling construction to minimize impacts, and notifying the public of construction. Construction traffic control plans would be developed to reduce impacts on emergency services and response.

Potential measures to reduce long-term adverse impacts on environmental health and safety include relocating land uses out of the 10-year floodplain and providing measures to protect areas outside the 10-year floodplain that would experience increased flood levels. These measures include floodproofing structures, providing farm pads, and development plans to maintain emergency response.

4.4 Airport Levee Improvements

Improvements to the existing airport levee would be made by increasing the height by between 4 and 7 feet. If the existing levee is raised by 7 feet, a change to the extent and location of the northwest corner of the levee could be necessary to avoid interference with the glide path to the active runway; otherwise, no change to the extent or location of the levee would be proposed. In addition to raising the existing levee, 1,700 feet of Airport Road would be raised to meet the raised airport levee height along the southern extent of the airport, and all utility infrastructure would be replaced, terminating at the West Street overcrossing approach.

Short-term impacts from construction of the Airport Levee Improvements would include limited excavation, clearing, and filling required for elevating and extending the levee. No construction would occur immediately adjacent to the active channel of the Chehalis River. For a majority of the elements of the environment, the Airport Levee Improvements would result in no long-term adverse impacts. Adverse impacts would primarily be minor in nature, except for moderate impacts due to increases in the flood extent upstream and downstream of the levee, moderate impact on groundwater from disruption of the groundwater flow regime within the footprint of the levee, and the potential loss of fewer than 5 acres of wetlands and moderate to significant impacts on cultural resources. The Airport Levee Improvements would reduce flood extents in portions of the Chehalis River floodplain, resulting in beneficial effects to water resources, land use, transportation, public services and utilities, and environmental health and safety.

4.4.1 Water Resources

4.4.1.1 Short-term Impacts

The potential short-term impacts on water resources that would occur during construction are described in Table 4.1-1. No in-water work is anticipated and there would be limited subsurface excavation, which would result in limited impacts on water resources.

4.4.1.2 Long-term Impacts

4.4.1.2.1 Surface Water Quality

No adverse impacts on surface water quality are anticipated as a result of implementing the Airport Levee Improvements. Installation of the Airport Levee Improvements would reduce flood depths and extents in areas protected by the levee, which could reduce pollutant loading to nearby surface waters from sources no longer inundated. Surface water quality may not be as negatively affected during and after floods as during previous floods, if developed areas that are no longer flooded were home to pollutant-generating uses such as vehicular traffic, or on-site storage of hazardous or toxic materials. Flood levels adjacent to the Chehalis Regional Water Reclamation Facility located on Louisiana Avenue are predicted to increase by 0.5 foot during a 100-year flood. However, the Chehalis Regional Water

Reclamation Facility is elevated above the current 100-year flood levels and would not flood—with or without the Airport Levee Improvements.

Surface Water Quantity

Anticipated adverse impacts on surface water quantity include the following:

- Reduction in floodwater depths in specific locations during peak floods (e.g., 100-year flood)
- Potential for changes in flood extents and increases in floodwater elevations upstream and downstream of the Airport Levee Improvements

The Airport Levee Improvements were designed to provide flood protection in the airport vicinity in a 100-year flood. Flood depths are predicted to be reduced by as much as 15 feet at the airport within the levee (WSE 2014c), resulting in no inundation at the airport behind the levee during a 100-year flood.

The potential exists for increases in Chehalis River flood extents and flood elevations upstream and downstream of the airport levee due to changes in river hydraulics, resulting in a moderate adverse impact. Flooding could increase up to 0.9 foot in areas immediately upstream of the airport levee (north of SR 6 and west of the Chehalis River) due to backwater effects, or the displacement of floodwater that would have otherwise flooded the airport (WSE 2014c). In addition, there could be up to a 0.2-foot increase in water depth immediately downstream of the levee (WSE 2014c).

Potential beneficial effects on surface water quantity would occur in the area protected by the levee due to a reduction in the extent and depth of flooding. The acres of different land uses and number of structures that would no longer be inundated are discussed in combination with the Flood Retention Facility (Alternative 1) and I-5 Projects (Alternative 2) in Chapter 5.

No adverse impacts on water use and water rights are anticipated with the Airport Levee Improvements, because these improvements would not affect the ability of area water users to divert their water rights.

4.4.1.2.2 Groundwater

Potential adverse impacts on groundwater could result from subsurface construction (i.e., levee toe placement) that has the potential to modify the shallow groundwater flow regime. These adverse impacts are considered moderate due to their localized area of impact within the levee footprint. A potential beneficial effect on groundwater quality could result from the improved surface water quality resulting from reduced flooding of pollutant-generating surfaces or uses that store hazardous or toxic materials.

4.4.1.3 Mitigation

Potential mitigation measures for short-term impacts on water resources are described in Table 4.1-1.

Potential avoidance and minimization measures for long-term adverse impacts on surface water quality would include compliance with applicable stormwater manual requirements (i.e., the most recent version of Ecology's *Stormwater Management Manual for Western Washington*).

Potential compensatory mitigation measures for long-term adverse impacts on surface water quantity could include compensatory water storage in areas upstream of the Airport Levee Improvements where flood levels are anticipated to increase. No compensatory mitigation is proposed for shallow groundwater flow regime impacts.

4.4.2 Geology and Geomorphology

4.4.2.1 Short-term Impacts

The potential short-term impacts on geology that would occur during construction are described in Table 4.1-1. These impacts, related to excavation and filling, would increase the potential for soil erosion. There are no short-term impacts on geomorphology because all construction work would occur outside of the Chehalis River.

4.4.2.2 Long-term Impacts

Potential adverse impacts on geology would occur as a result of increased settlement of buildings and land from the Airport Levee Improvements, and are considered minor because they would be isolated to the area of the levee. No impacts on channel formation, or sediment and wood transport, in the Chehalis River are predicted to occur; therefore, no adverse impacts on geomorphology are anticipated.

4.4.2.3 Mitigation

Potential mitigation measures for short-term impacts on geology would be the same as those described in Table 4.1-1 related to excavation and filling.

Potential avoidance and minimization measures for long-term adverse impacts on geology from potential levee settlement could include engineering studies to evaluate any potential settlement by the addition of the weight (from added height) of the fill and/or levee, with such measures as staged construction and subdrainage. No long-term adverse impacts on geomorphology are anticipated, so no mitigation is proposed.

4.4.3 Wetlands and Vegetation

4.4.3.1 Short-term Impacts

The potential short-term impacts on wetlands and vegetation include temporary removal or disturbance of vegetation for activities such as excavating, clearing, filling, and construction staging. These types of impacts would occur where the levee and Airport Road are immediately adjacent to wetlands and vegetated areas, including both the north and south ends of the airport site (see Figure 4.4-1).

Disturbed wetlands and vegetated areas would be restored to pre-construction status and/or function following completion of construction.

4.4.3.2 Long-term Impacts

The potential adverse impacts on wetlands and vegetation would occur with the raising of Airport Road along the southern extent of the Airport Levee Improvements, and along the northwest corner of the levee. Both of these areas have been substantially modified by previous development and construction activities. Work here could affect existing wetlands and vegetation from activities such as land clearing, excavating, and fill placement. These activities could result in the permanent loss of wetlands and upland and wetland vegetation, and the conversion, disturbance, and/or reduction of existing wetland, riparian, and vegetation communities.

These potential adverse impacts are considered moderate for wetlands because the potential impact is less than 5 acres, and minor for vegetation because the potential loss of vegetation is less than 2 acres.

4.4.3.3 Mitigation

Some potential long-term impacts on wetlands and vegetation would be addressed through avoidance and minimization measures, including avoiding wetlands during construction access and staging efforts, and restoring vegetation in temporarily disturbed areas.

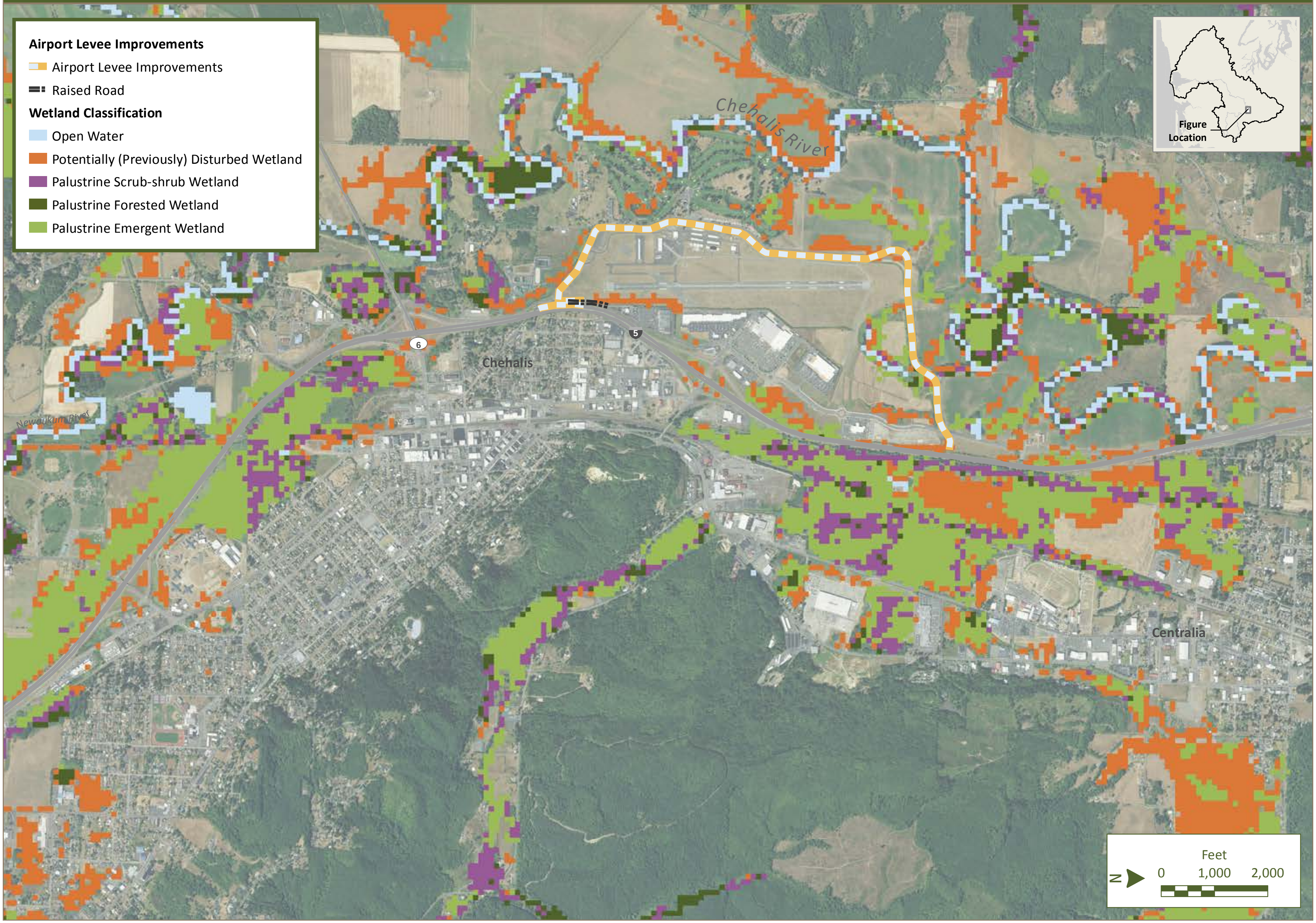
Potential compensatory mitigation measures for unavoidable adverse impacts on wetlands from the Airport Levee Improvements that could be implemented to address long-term loss of wetlands from filling and excavation could include the following:

- Creating, enhancing, or restoring wetlands in locations that would be consistent with Federal Aviation Administration (FAA) guidance, and would not create potential hazards to aircraft operations (e.g., wetlands with no standing water)
- Restoring previously disturbed wetlands in the floodplain downstream of the airport
- Completing monitoring programs for new, restored, or enhanced wetlands to ensure performance standards have been achieved
- Purchasing credits from an approved wetland mitigation bank in the same watershed

The potential compensatory mitigation measures to address unavoidable adverse impacts on vegetation from the Airport Levee Improvements would be implemented to address the loss of vegetation and habitat from land clearing. Potential compensatory mitigation for long-term impacts on vegetation could include replanting the affected area with native species, where applicable, to replace the functions and values lost from the removal and/or modification of vegetation. Revegetation efforts would be conducted in accordance with USACE levee design requirements.

Figure 4.4-1

Wetland Areas Mapped near the Airport Levee Improvements



4.4.4 Fish and Wildlife

4.4.4.1 Short-term Impacts

4.4.4.1.1 Fish

The potential short-term impacts on fish would occur during construction and would be localized to the construction footprint, with conditions returning to pre-construction status and/or function following completion of the Airport Levee Improvements. The potential short-term impacts described in Table 4.1-1 are related to construction activities, including excavation, construction of staging areas, and noise and vibration generated by equipment. There is a small potential for fish in the reach closest to the levee to be exposed to pollutant-laden runoff from the construction site.

4.4.4.1.2 Wildlife

The potential responses of wildlife to short-term impacts on habitat are similar to those described in Table 4.1-1; however, impacts would be limited in magnitude through implementation of avoidance and minimization measures during construction. The existing condition in the Airport Levee Improvements area is heavily disturbed and developed with road infrastructure. Construction activity could disturb habitat used by native wildlife species to breed, forage, rest, and overwinter.

4.4.4.2 Long-term Impacts

4.4.4.2.1 Fish

The potential adverse impacts on fish are primarily related to a change in flood extents and elevations upstream and downstream of the levee during 100-year floods. These potential adverse impacts are considered minor because of the limited extent and occurrence. Salmon and steelhead are not known to spawn or rear in the nearby reach of the Chehalis River, but adults could be affected as they migrate upstream—particularly fall-run Chinook salmon, steelhead, and coho salmon, which migrate during the fall and winter when floods are most likely to occur. Other species likely to be present in this reach and that could be affected during a flood include lamprey, largescale sucker, dace, shiner, Northern pikeminnow, and invasive non-native species.

4.4.4.2.2 Wildlife

The potential adverse impacts on wildlife species would be minor due to limited wetland and vegetation disturbance. These potential adverse impacts on composition of wildlife species currently occurring within these habitats are considered minor due to the relatively small area the action element affects, and small change in the extent of flood inundation compared to current conditions.

4.4.4.3 Mitigation

4.4.4.3.1 Fish

Mitigation measures to reduce short-term impacts on fish would not be required because construction would not occur in water.

Compensatory mitigation measures to address unavoidable adverse impacts on fish from the Airport Levee Improvements related to the redistribution of fish during a flood could potentially include acquiring and restoring affected floodplain areas of equivalent size or habitat function for fish.

4.4.4.3.2 Wildlife

Some potential short-term impacts on wildlife would be addressed through the implementation of avoidance and minimization measures, including applicable mitigation measures included in Table 4.1-1 related to excavating, clearing, filling, and construction staging.

Compensatory mitigation measures to address potential unavoidable adverse impacts on wildlife could include restoring function to sensitive habitats for wildlife after construction. Potential compensatory mitigation for long-term impacts on elements could include the following:

- Replanting native vegetation and monitoring of planted areas to ensure the success of mitigation plantings
- Implementing wetland mitigation measures described in Section 4.4.3.3 and restoring vegetation and habitat conditions that support a variety of native wildlife species

4.4.5 Tribal Resources

4.4.5.1 Short- and Long-term Impacts

Construction of the Airport Levee Improvements would not occur in water and, therefore, is not anticipated to affect access to tribal fishing areas. However, there is a small potential for release of sediments or pollutant-laden runoff from the construction site (see Table 4.1-1) to waterbodies used by tribal fish resources adjacent and downstream of the levee. This could have a negative effect on fish habitat, leading to an indirect impact on fish abundance.

Potential long-term impacts on tribal fish resources could result from changing flood extents and elevations upstream (increase in limited area) and downstream of the airport levee during floods. Although the impact of these changes on fish and fish habitat are expected to be small relative to the overall impact of a major flood or greater, there could be an indirect impact on tribal treaty rights due to reduced or impaired habitat that could affect fish populations. Elevating the airport levee would prevent the Chehalis River from breeching it during a 100-year flood, which would reduce the risk of fish stranding behind the levee. The extent of potential impacts on tribal resources from changing flood extents is pending additional consultation with tribes.

4.4.5.2 Mitigation

The potential mitigation associated with impacts on tribal resources would be addressed directly with Quinault Indian Nation and Chehalis Tribe tribal leadership during project-level environmental review and continued government-to-government consultations.

Some potential long-term impacts on tribal fish resources could be addressed through avoidance and minimization measures developed in consultation with tribes. These could include avoiding intact riparian vegetation and working in streams or other sensitive areas. Other measures outlined in Table 4.1-1 related to erosion controls would also be implemented.

Compensatory mitigation measures to address unavoidable adverse impacts on tribal resources from the Airport Levee Improvements, including impacts on tribal fish harvests, would be addressed directly with Quinault Indian Nation and Chehalis Tribe tribal leadership. In some cases, mitigation measures could be proposed to address the impacts on habitat that are important to tribal resources, including fish, wildlife, and plants. Mitigation of impacts on treaty rights is subject to consideration and agreement by the Quinault Indian Nation.

4.4.6 Air Quality

4.4.6.1 Short-term Impacts

The potential short-term impacts on air quality would occur during construction, including increased vehicle emissions from truck trips and mechanized construction equipment, and dust created by clearing and grading land and the transport and placement of excavation material, soils, and other materials. These impacts would be localized during the construction period and would not cause an overall decrease in regional air quality.

4.4.6.2 Long-term Impacts

No adverse impacts on air quality are anticipated because the Airport Levee Improvements would not generate emissions or dust.

4.4.6.3 Mitigation

Potential mitigation measures to reduce short-term impacts on air quality would be the same as those described in Table 4.1-1 related to excavating, clearing, filling, and construction staging. No long-term adverse impacts on air quality are anticipated, so no mitigation is proposed.

4.4.7 Climate Change

4.4.7.1 Short-term Impacts

4.4.7.1.1 Effects of the Airport Levee Improvements Contributing to Climate Change

The potential short-term effects of the Airport Levee Improvements that could contribute to the effects of climate change would occur during construction and include increased GHG emissions from construction equipment and truck shipments of materials to and from the Airport Levee Improvements site. GHG emissions resulting from construction activities are expected to be below the 10,000 MT CO_2e annual threshold for qualitatively disclosing emissions over the construction period. This threshold equates to 6.2 million vehicle miles for a Class 7-8 truck.

4.4.7.1.2 Effects of Climate Change on the Airport Levee Improvements

There are no anticipated short-term effects of climate change on the Airport Levee Improvements.

4.4.7.2 Long-term Impacts

4.4.7.2.1 Effects of the Airport Levee Improvements Contributing to Climate Change

No adverse impacts that would contribute to the effects of climate change are anticipated from implementation of the Airport Levee Improvements, because the potential loss of vegetation or additional GHG emissions from vehicle trips associated with airport levee operation and maintenance is below the annual threshold for qualitatively disclosing emissions. The threshold equates to 22 million vehicle miles for a large truck or sport utility vehicle.

4.4.7.2.2 Effects of Climate Change on the Airport Levee Improvements

Climate change is not anticipated to result in any adverse impacts on the Airport Levee Improvements. Even though the potential effects of climate change on the Airport Levee Improvements include an increased frequency and intensity of flooding events, the airport levee elevation would provide freeboard (i.e., distance between water surface and the height of the levee) beyond the 100-year flood level to account for potential future increases in the intensity of floods as a result of climate change. Pumps used to pump out water trapped behind the levee into the Chehalis River may be used more often as major flooding from the effects of climate change occurs more frequently. These measures would provide additional resiliency to changing climate conditions.

4.4.7.3 Mitigation

4.4.7.3.1 Mitigation to Address Effects of the Airport Levee Improvements Contributing to Climate Change

No adverse impacts contributing to climate change from the Airport Levee Improvements are anticipated, so no mitigation is proposed.

4.4.7.3.2 Mitigation to Address Effects of Climate Change on the Airport Levee Improvements

No adverse impacts from climate change are anticipated, so no mitigation is proposed.

4.4.8 Visual Quality

4.4.8.1 Short-term Impacts

Potential short-term impacts on visual quality would occur during construction of the Airport Levee Improvements, due to views of construction activities such as fugitive dust, exposed construction debris, heavy equipment, and erosion control measures. This would temporarily create an unattractive visual setting during the construction period for airport users, Riverside Golf Course and RV Park patrons, residents of surrounding properties, passing traffic, and trail users. The existing trail would be closed during construction and surrounding views would be closed off to recreational trail users for the duration of construction, which would also negatively affect existing views.

4.4.8.2 Long-term Impacts

The Airport Levee Improvements would elevate the recreational trail that runs along the airport levee by up to 7 feet. The increased elevation would generally have a positive impact on the views from the trail, except in areas where Airport Road is raised to the same grade. Because the trail along the airport levee already provides mostly open views, the increased elevation is likely to be a beneficial effect from vantage points along the trail.

The higher levee would slightly obstruct views on either side of it. Overall, however, views from properties surrounding the levee would be largely unchanged; therefore, adverse impacts would be minor. Views of the surrounding area would be improved for motorists along portions of Airport Road that are elevated to meet trail height because their vantage point would be higher, generally allowing them to see more of the landscape.

4.4.8.3 Mitigation

For short-term impacts, vegetated areas that would be temporarily affected due to clearing, grading, and other construction activities could be re-established with appropriate native vegetation following construction.

Mitigation measures to reduce long-term impacts include using earthen materials atop the existing levee to blend in with natural surroundings, and vegetating new exposed areas on the levee to the extent possible. These mitigation measures would mitigate negative visual impacts for trail users, motorists, and those observing the Airport Levee Improvements site from surrounding properties.

4.4.9 Noise

4.4.9.1 Short-term Impacts

The potential short-term impacts of noise occurring during construction would be related to heavy equipment and construction activities. Construction equipment would primarily consist of earth-moving and hauling equipment with noise levels ranging from 77 to 89 dBA (see Table 4.2-10). Some of these noise levels would be high enough to cause hearing damages at a short distance, but noise levels would decrease with distance to levels that would not cause hearing damage at adjacent properties.

Townhouses are located on the southeast corner of the Riverside Golf Club and RV Park, immediately adjacent to the airport levee. The west side of the airport levee is located adjacent to the golf course. Construction noise is likely to disturb residents as well as golfers and campers. Construction noise would be limited to allowable, daytime hours and noise levels would be reduced with distance from the construction site to levels that would not cause hearing damage.

4.4.9.2 Long-term Impacts

No adverse impacts are anticipated because the completed Airport Levee Improvements would not generate noise.

4.4.9.3 Mitigation

In addition to short-term mitigation measures described in Table 4.1-1 for noise impacts, additional measures to minimize impacts on local residents and users of the Riverside Golf Course and RV Park could include the following:

- Using equipment with mufflers or noise control
- Situating noise-generating equipment away from the townhouses and the Riverside Golf Course and RV Park
- Minimizing the need for back-up alarms
- Maintaining equipment to reduce noise
- Notifying affected property owners

No long-term adverse impacts on noise are anticipated, so no mitigation is proposed.

4.4.10 Land Use

4.4.10.1 Short-term Impacts

No short-term impacts on land use are anticipated.

4.4.10.2 Long-term Impacts

The potential adverse impacts on land use from the Airport Levee Improvements include properties and structures that would experience reduced flooding, as well those that would experience new or increased flooding in limited areas upstream and downstream of the levee. While reduced flooding would improve airport operations, a minor adverse impact on land use could occur if the existing structures or land uses in areas with new or increased flooding cannot be maintained. This effect would be minor at a Basin-wide scale because it would generally occur on the edge of the existing floodplain immediately upstream and downstream of the levee.

The decrease in acres flooded and land uses and structures that would no longer be inundated are discussed in combination with the Flood Retention Facility (Alternative 1) and I-5 Projects (Alternative 2) in Chapter 5. Areas protected by the levee that would see a reduction in flooding and are currently undeveloped could experience a corresponding increase in development. This potential is evaluated in more detail in the impacts analysis for Alternatives 1 and 2 (see Chapter 5).

4.4.10.3 Mitigation

Compensatory mitigation measures to address potential unavoidable adverse impacts on land use by increased flooding resulting from the Airport Levee Improvements could include elevating or floodproofing measures.

4.4.11 Recreation

4.4.11.1 Short-term Impacts

The potential short-term impacts on recreation that could occur during construction of the Airport Levee Improvements include the closure of the recreational trail on the top of the airport levee. Construction would be visible to users of the Riverside Golf Course and RV Park, and construction noise and dust would be disruptive to golfers. If Airport Way is used for access to the construction site, access to the golf course would likely be temporarily delayed. If the Airport Levee Improvements require bumping out the levee and locating Airport Way outside of the levee, additional construction impacts and delays could occur to users of the Riverside Golf Course and RV Park.

4.4.11.2 Long-term Impacts

The recreational trail on top of the airport levee would be rebuilt following construction, and current recreational uses would resume. The higher levee could increase flood levels at the Riverside Golf Course and RV Park, which are located between the Chehalis River and the levee. These potential adverse impacts are considered minor. Flood levels during 100-year floods would increase by up to 0.9 foot, possibly extending the time the Riverside Golf Club and RV Park are not available for use.

4.4.11.3 Mitigation

Mitigation measures related to noise, air quality, and transportation would also mitigate short-term impacts on recreation.

Long-term mitigation measures to address increased flooding at the Riverside Golf Course and RV Park could include installing compensatory flood storage upstream of the levee where flood levels are anticipated to increase.

4.4.12 Historic and Cultural Preservation

4.4.12.1 Short- and Long-term Impacts

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

The extent of impacts would depend on the nature of cultural resources that could be disturbed, which would be determined through coordination with DAHP and affected tribes during project-level environmental review, including continued government-to-government consultations. Potential impacts on tribal cultural resources or graves, Indian human remains, or traditional cultural properties could also occur and would be determined in coordination with tribes, and government-to-government consultations.

The potential impacts on cultural resources during construction are related to ground disturbance associated with excavating, filling, and construction access/hauling. Several archaeological resources have been identified in the area during studies for other projects.

Potential impacts on cultural resources following construction could occur if the improved levee exposes, damages, destroys, and/or alters cultural resources upstream or downstream of the levee through additional, increased, or changed foot traffic patterns, as well as different flood patterns that could cause flooding and sedimentation of submerged resources in affected areas.

Based on WSAPM, this area is considered to have a very high potential for archaeological deposits; therefore, potential adverse impacts are considered moderate to significant.

4.4.12.2 Mitigation

Mitigation measures for potential impacts on cultural resources would be determined during project-specific evaluations of the Airport Levee Improvements, and would include consultation with DAHP, interested and affected tribes, as well as other consulting parties (see information on addressing potential impacts on cultural resources in Section 4.2.12). The potential compensatory mitigation measures would be the same as those described for the Flood Retention Facility (see Section 4.2.12.2).

4.4.13 Transportation

4.4.13.1 Short-term Impacts

The potential short-term impacts during construction of the Airport Levee Improvements on transportation include temporary disruptions on Airport Road and adjacent roadways from construction traffic and temporary road closures. Expanding the levee to meet FAA design standards for approach and departure space would require relocating Airport Road outside of the levee, requiring additional road closures.

4.4.13.2 Long-term Impacts

The Airport Levee Improvements would provide some flood protection to I-5 during a 100-year flood, but flooding would continue to cause I-5 closures. The Airport Levee Improvements would protect the airport during 100-year floods, allowing flights to continue. The Airport Levee Improvements would provide beneficial effects on the transportation system. Some access roads to the airport would continue to flood during major floods, and the raised levee could increase flooding of SR 6 and nearby residential streets, resulting in minor adverse impacts.

4.4.13.3 Mitigation

Potential mitigation measures to reduce short-term impacts on transportation would be the same as those described in Table 4.1-1. Additional mitigation measures would include providing detours or other means to maintain access to properties along Airport Road to the extent possible.

Long-term mitigation for increased flooding of local roadways could include compensatory water storage in areas upstream of the levee where flood levels are anticipated to increase. The height and design of the Airport Levee Improvements would be coordinated with FAA to ensure compliance with FAA design standards, possibly requiring expanding the airport levee and relocating Airport Road outside the levee.

4.4.14 Public Services and Utilities

4.4.14.1 Short-term Impacts

No schools or health care facilities are located in the immediate vicinity of the airport. The potential short-term impacts on public services would occur during construction due to temporary road closures that could affect public services, such as garbage collection, because access to properties from Airport Road would be temporarily restricted. Construction could cause a temporary disturbance of on-site and nearby utilities, including overhead utility lines, underground utilities on both sides of Airport Road, and lighting in the parking lot south of the airport on Airport Road.

4.4.14.2 Long-term Impacts

The Airport Levee improvements would increase flood levels upstream (in a limited area) and downstream of the levee, potentially increasing flooding of public services and utilities. The Chehalis

Regional Water Reclamation Facility is located just upstream of the airport and could experience increased flood levels. Utilities located in the footprint of the levee would be replaced during construction. These potential adverse impacts are considered minor because increased flood levels would be limited and utility relocations would be localized to the footprint of the Airport Levee Improvements.

The Airport Levee Improvements would protect the radio tower located on the airport property (across the street from the entrance to the Riverside Golf Course and RV Park) during a 100-year flood.

4.4.14.3 Mitigation

Potential measures to reduce short-term construction disruptions on public services and utilities include the following:

- Providing public notification of proposed construction activities, including the timing of construction, to all local service providers within the immediate vicinity of the construction area
- Coordinating with local utility service providers to assist in utility locations, if applicable, and to identify specific mitigation measures to minimize impacts on utility purveyors
- Coordinating with local utility purveyors to identify other specific mitigation measures to minimize impacts

Mitigation planning for utilities would also include close coordination with involved service providers, as well as with potentially affected residents and landowners. Where local utility system connections or installations would be affected by construction activities, alternative or relocated connections and facilities could be planned and implemented prior to construction to avoid service disruptions.

Mitigation for potential long-term impacts due to limited increased flooding could be provided where flood levels are anticipated to increase. Mitigation for utility relocations would include coordination with service providers and property owners.

4.4.15 Environmental Health and Safety

4.4.15.1 Short-term Impacts

The potential short-term impacts on environmental health and safety include road closures that temporarily restrict emergency service access to businesses, single-family residences, multi-family complexes, and the Riverside Golf Course and RV Park during construction. This could result in increased emergency response time. These impacts would be limited to the construction period and access would be maintained to the extent possible.

4.4.15.2 Long-term Impacts

The potential adverse impacts on environmental health and safety are considered minor because the improved levee would cause minor increases in flood levels at the Chehalis Regional Water Reclamation

Facility, which could result in increased risk of contamination. This increased risk would be small because of the limited increase in flood levels and the existing level of flood protection at the facility. The improved levee would protect the airport and local businesses, allowing the airport to remain functional and able to provide emergency response during floods. The Airport Levee Improvements would also provide some protection to a portion of I-5 during a 100-year flood, possibly maintaining I-5 as an emergency response route for longer periods during flooding. Protection of the airport during a 100-year flood would prevent the release of hazardous or toxic materials at the airport, and reduce the risk of contamination of nearby surface waters. The Airport Levee Improvements would provide minor reductions in threats to human health and safety by allowing the airport to remain functional for emergency response.

4.4.15.3 Mitigation

Potential measures to reduce short-term impacts on environmental health and safety include those described in Table 4.1-1 related to transport of material, as well as coordinating construction with emergency services to reduce impacts on emergency response.

4.5 I-5 Projects

Short-term impacts from construction of the I-5 Projects would include impacts similar to those associated with constriction of the Airport Levee Improvements, except construction would be required within and adjacent to Dillenbaugh and Salzer creeks. This could include dewatering and/or stream diversions for bridge replacements, and construction of levees or floodwalls in and adjacent to each stream.

For a majority of the elements of the environment, the I-5 Projects would result in no long-term adverse impacts. Adverse impacts would primarily be minor in nature, except for the potential loss of less than 5 acres of wetlands (moderate impact) and moderate to significant impacts on cultural resources. Minor to moderate impacts are predicted for water quantity based on the increases in localized flood elevations and depths associated with the I-5 Projects. Groundwater impacts would be minor to moderate based on the potential for localized disruptions in the shallow groundwater flow regime from placement of action elements. I-5 Projects would result in reductions in Chehalis River floodplain extents, resulting in beneficial effects to water resources, land use, transportation, public services and utilities, and environmental health and safety.

4.5.1 Water Resources

4.5.1.1 Short-term Impacts

The potential short-term adverse impacts on water resources are described in Table 4.1-1. Although temporary, adverse impacts would occur due to an increased potential for sedimentation and turbidity, risk of contamination to surface and groundwater, and interruptions to surface water quantity and groundwater (e.g., recharge and discharge and localized hyporheic exchange alterations) in areas of dewatering. With the proposed bridge replacements at Dillenbaugh and Salzer creeks, there is an increased potential for turbidity and pH impacts due to potential work in and adjacent to the channel.

4.5.1.2 Long-term Impacts

4.5.1.2.1 Surface Water Quality

No adverse impacts on water quality are anticipated. Installation of the I-5 Projects would reduce flooding in areas protected by the levees and walls. If these areas are subject to pollutant-generating uses (e.g., vehicular traffic) or include on-site storage of hazardous or toxic materials, surface water quality could improve during and after floods in contrast to previous floods because of reduced pollutant loading to surface water from those areas.

4.5.1.2.2 Surface Water Quantity

The potential impacts of the I-5 Projects on surface water quantity would result in a beneficial effect in some locations due to reductions in flood extents, and minor adverse impacts in other locations due to increases in upstream and downstream flood levels. No adverse impacts on water use and water rights are anticipated with the I-5 Projects because they would not affect the ability of area water users to divert their water right.

With implementation of I-5 Projects, floodwaters would be shifted away from I-5 and reduced behind the levees, particularly across I-5. Bridge replacements at Salzer and Dillenbaugh creeks would alter flood extents and flood depths (0.4-foot depth decrease) within the Chehalis River floodplain in the immediate vicinity of the bridge crossings, likely as a result of less backwater occurring at and upstream of the bridge during a 100-year flood (WSE 2014a). The decreased acreage subject to flooding and land uses and structures that would no longer be inundated are discussed in combination with the Airport Levee Improvements (Alternative 2) in Chapter 5. The potential for increases in flood extents and floodwater elevations on the riverside of levees and walls, as well as upstream of the levees and walls, would be a minor to moderate adverse impact due to the local increase in floodplain extents or flood elevations.

4.5.1.2.3 Groundwater

Footings for walls and levees placed below ground have the potential to disrupt shallow groundwater flow regimes, resulting in a minor to moderate adverse impact on groundwater, depending on the extent of subsurface excavation for levee toes. Improved surface water quality from reduced flooding of pollutant-generating roadway surfaces could potentially beneficially affect groundwater quality.

4.5.1.3 Mitigation

Potential mitigation measures for short-term impacts on water resources are described in Table 4.1-1. Potential mitigation measures for long-term impacts on water resources are similar to those described for the Airport Levee Improvements (see Section 4.4.1.3).

4.5.2 Geology and Geomorphology

4.5.2.1 Short-term Impacts

The potential short-term impacts on geology and geomorphology are described in Table 4.1-1. The impacts related to excavating and filling are similar to the Airport Levee Improvements. Temporary dewatering and/or stream diversions for bridge replacement would result in loss or modification of stream function during bridge replacement.

4.5.2.2 Long-term Impacts

Adverse impacts on geology are considered minor due to the limited potential for the weight of levees and walls to cause settlement of surrounding land and adjacent buildings, which can be addressed through avoidance and minimization measures.

Potential minor adverse impacts on Basin-wide geomorphology would result from the placement of levees and floodwalls along streams and in floodplains, affecting channel movement and disconnecting streams from floodplains and off-channel areas. With any bank-hardening component, there is the potential to redirect flows downstream or to an adjacent or opposite bank, causing erosion or damage to aquatic habitats. These impacts would be local to the area of the I-5 Projects and would not have Basin-wide impacts on geomorphic function. The I-5 Projects also have the potential to improve and provide a beneficial effect to localized sediment transport processes due to improved hydraulic conditions under the replaced bridges at Dillenbaugh and Salzer creeks.

4.5.2.3 Mitigation

Potential mitigation measures for short-term impacts on geology and geomorphology are described in Table 4.1-1.

Avoidance and minimization measures for long-term impacts on geology from potential levee settlement could include such measures as staged construction and subdrainage to address potential settlement resulting from added weight (because of added height) of the levees or walls. Long-term mitigation for geomorphology could include monitoring of channel and floodplain conditions at, upstream, and downstream of the I-5 Projects. Monitoring of channel and bank conditions (i.e., areas of deposition, areas of erosion, channel widths and depths, bed substrate size) would identify any geomorphic changes resulting from the implementation of the I-5 Projects.

4.5.3 Wetlands and Vegetation

4.5.3.1 Short-term Impacts

In addition to the potential short-term impacts identified for the Airport Levee Improvements, temporary construction-related impacts on wetlands and riparian areas resulting from the construction of the I-5 Projects would occur from construction site dewatering activities. Impacts from such activities could include temporary fill placement in wetlands, removal or disturbance of existing upland and wetland vegetation, removal of bank vegetation, and temporary modification of wetland hydrology. These impacts would be limited in nature and extent, and conditions would be restored to pre-construction status and/or function following completion of the I-5 Projects.

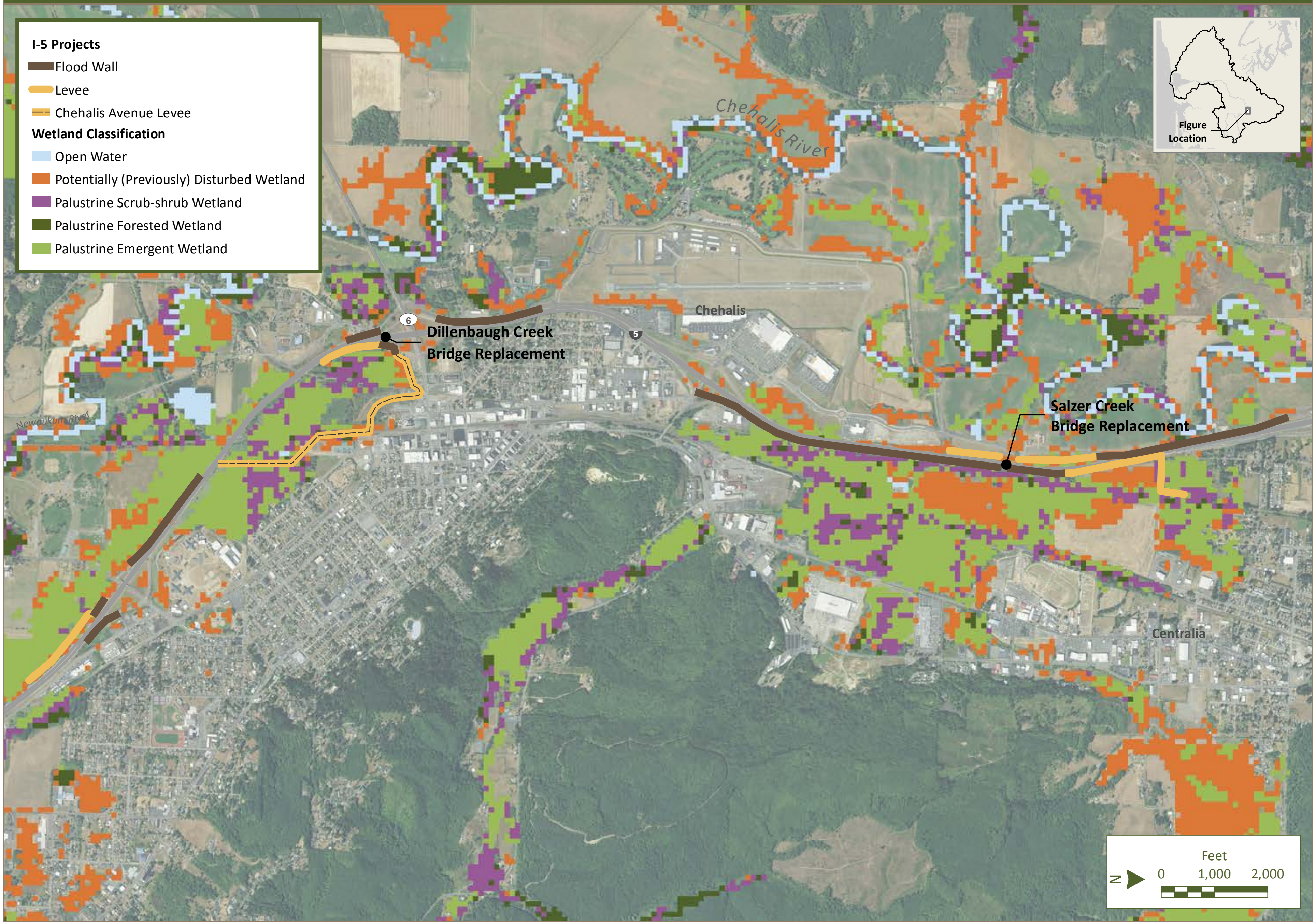
4.5.3.2 Long-term Impacts

The potential adverse impacts on wetlands and vegetation are similar to those described for the Airport Levee Improvements, except that there would be a larger footprint as well as replacement bridges over Dillenbaugh and Salzer creeks (see Figure 4.5-1). Adverse impacts on wetland and upland vegetation communities are considered moderate due to the following:

- Permanent loss of wetlands, assumed to be less than 5 acres
- Permanent loss of upland and wetland vegetation
- Constrained river migration and reduced connection to floodplain and/or riparian habitat
- Modification of wetland hydrology
- Conversion, disturbance, and/or reduction of existing wetland, riparian, and vegetation communities

Figure 4.5-1

Wetland Areas Mapped near the I-5 Projects



4.5.3.3 Mitigation

In addition to the long-term mitigation measures identified for the Airport Levee Improvements (avoidance, minimization, and compensatory mitigation), the I-5 Projects would be designed to comply with applicable stormwater manual requirements (i.e., the most recent versions of WSDOT's *Highway Runoff Manual* and Ecology's *Stormwater Management Manual for Western Washington*). Implementation of more stringent stormwater treatment requirements during design could result in improved water quality of stormwater runoff discharged to adjacent wetlands.

4.5.4 Fish and Wildlife

4.5.4.1 Short-term Impacts

4.5.4.1.1 Fish

Potential short-term impacts on fish could occur during construction of new levees along I-5, portions of which will be built immediately adjacent to the Chehalis River channel. Levee construction that occurs adjacent to the Chehalis River and bridge replacements over Dillenbaugh and Salzer creeks will involve in-water work and restructuring of adjacent streambank areas. Construction of bridge abutments would not greatly exceed the footprint of existing infrastructure. Short-term impacts would be localized to the construction footprint, with conditions returning to pre-construction status and/or function following completion of the I-5 Projects. Potential short-term impacts related to construction would primarily be from the following:

- Reduced water quality due to turbidity and pH increases or pollutants entering the water
- Temporarily dewatering of part of the river channels, potentially reducing habitat available to fish in the immediate vicinity of the I-5 Projects
- Construction noise in or near the stream channel and removal of bank vegetation, which would reduce the function of riparian habitat for fish (e.g., shading and input of terrestrial nutrients and food)

These short-term impacts have the potential result in fish injury or mortality during construction. However, they would be limited in nature and extent, and avoidance and minimization measures would be implemented during construction, as outlined below.

4.5.4.1.2 Wildlife

Similar to fish, potential short-term impacts on wildlife could occur during construction of I-5 Projects and would be localized to the construction footprint, with conditions returning to pre-construction status and/or function following completion of the I-5 Projects. Potential short-term impacts related to construction could temporarily disturb habitat used by native wildlife species to breed, forage, rest, and overwinter. These impacts would be limited in magnitude, and avoidance and minimization measures would be implemented during construction, as outlined below.

4.5.4.2 Long-term Impacts

4.5.4.2.1 Fish

No adverse impacts on fish or instream fish habitat are anticipated to occur as a result of implementing the I-5 Projects. Adverse impacts on fish are primarily related to changing flood extents and elevations upstream and downstream of the walls and levees during a 100-year flood (see Section 4.5.1.2.2) from the following:

- Redistribution of fish with the redistribution of floodwaters
- Improved water quality during and after floods if developed areas that are no longer flooded are subject to pollutant-generating uses, such as vehicular traffic, or include on-site storage of hazardous or toxic materials
- Reduced toxicity of runoff to fish with treatment of pollutant-laden stormwater from I-5

Each of these actions could affect fish migrating, rearing, and foraging in river reaches adjacent to the I-5 Projects during floods. Salzer Creek has known spawning habitat for spring-run and fall-run Chinook salmon and winter-run steelhead near the confluence with the Chehalis River and the I-5 crossing; Dillenbaugh Creek has as known spawning habitat for coho salmon near the I-5 crossing. These creeks are migratory pathways for salmon and steelhead, and many low-gradient areas could provide rearing habitat for coho salmon. Other species likely to be present include lamprey, largescale sucker, dace, shiner, Northern pikeminnow, and invasive non-native species. The numbers of fish that occur in the areas affected are unknown, but the scale of the habitat near the I-5 Projects is small relative to the fish habitat available across the entire Chehalis Basin. Adverse impacts that occur from redirection of water around the I-5 Projects during floods would be short in duration (within one season) and infrequent.

4.5.4.2.2 Wildlife

The potential adverse impacts on wildlife species would be minor due to the limited vegetation disturbance and a small change in the extent of flood inundation compared to current conditions. There could be benefits to aquatic wildlife due to improved quality of stormwater runoff discharged to adjacent habitat, which would improve conditions for wildlife species that rely on aquatic habitat for breeding, foraging, and overwintering, such as amphibians.

4.5.4.3 Mitigation

4.5.4.3.1 Fish

Some potential short-term impacts on fish could be addressed through avoidance and minimization measures, including those described in Table 4.1-1, such as avoiding intact riparian vegetation that stabilizes banks and provides cover for fish, reducing high-impact noise in water that could kill or injure fish, constructing outside of salmon migration and incubation seasons, and excluding fish from areas with nets or other temporary exclusion methods.

No long-term adverse impacts on fish would occur through implementation of the I-5 Projects, so no mitigation is proposed.

4.5.4.3.2 Wildlife

Potential mitigation measures to reduce short- and long-term impacts on wildlife would be the same as those described for the Airport Levee Improvements.

4.5.5 Tribal Resources

4.5.5.1 Short- and Long-term Impacts

The potential construction-related impacts on tribal resources are related to reduced access to tribal fish resources and diminished water quality that could affect fish production. These impacts would occur primarily where the Chehalis River is adjacent to I-5, where levee construction activities are immediately adjacent to the main channel of the Chehalis River, Dillenbaugh Creek, and other stream channels, and at bridge replacement locations over Dillenbaugh and Salzer creeks, including both in-water work and restructuring of adjacent riverbank areas.

Construction activities could also result in indirect effects to fish through the temporary degradation of habitat, including water quality through pollutant-laden stormwater runoff, pollutants spilled into the water, or increased turbidity. Areas could be temporarily dewatered, reducing available fish habitat in the immediate vicinity of the I-5 Projects. Construction noise may affect fish behavior in or near the stream channel and removal of bank vegetation would reduce the function of riparian habitat for fish (e.g., shading and input of terrestrial nutrients and food).

These impacts have the potential to increase fish injury or mortality during construction. However, they would be limited in nature and extent, and avoidance and minimization measures would be implemented during construction as described in Section 4.5.4.

The potential long-term impacts on tribal resources would be similar to those discussed for the Airport Levee Improvements.

4.5.5.2 Mitigation

The process to determine mitigation measures to address impacts of the I-5 Projects on tribal resources would be similar to those discussed under the Airport Levee Improvements, although the I-5 Projects involve in-water work, which would likely change the specific mitigation elements.

4.5.6 Air Quality

4.5.6.1 Short-term Impacts

The potential short-term impacts of construction of the I-5 Projects on air quality are similar to those described for construction of the Airport Levee Improvements, but due to the larger scale of construction activities, there would be a greater increase in vehicle emissions from truck trips and mechanized construction equipment, as well as dust. These impacts would be localized, limited to the construction period, and would not cause an overall decrease in regional air quality.

4.5.6.2 Long-term Impacts

No adverse impacts on air quality are anticipated because the I-5 Projects would not generate emissions or dust.

4.5.6.3 Mitigation

Potential mitigation measures to reduce short-term impacts on air quality would be the same as those described in Table 4.1-1 related to excavating, clearing, filling, and construction staging. No long-term impacts on air quality are anticipated, so no mitigation is proposed.

4.5.7 Climate Change

4.5.7.1 Short-term Impacts

The potential short-term impacts on climate change would be similar to those described for the Airport Levee Improvements. Although construction-related emissions and vegetation removal may be slightly greater than the Airport Levee Improvement, they would still be below the annual threshold for qualitatively disclosing emissions over the construction period. No impacts on construction resulting from climate change would occur due to the near-term, temporary nature of the construction activities.

4.5.7.2 Long-term Impacts

4.5.7.2.1 Effects of the I-5 Projects Contributing to Climate Change

No adverse impacts of the I-5 Projects contributing to climate change are anticipated, because the potential loss of vegetation or additional GHG emissions associated with the operation and maintenance of the I-5 Projects is below the annual threshold for qualitatively disclosing emissions, as described for the Airport Levee Improvements in Section 4.4.7.2.

4.5.7.2.2 Effects of Climate Change on the I-5 Projects

No adverse impacts of climate change on the I-5 Projects are anticipated, and any impacts would be similar to those described for the Airport Levee Improvements. The I-5 Project levees and walls would provide freeboard beyond the 100-year flood level. Pumps used to pump out water trapped behind the levee into the Chehalis River may be used more often as major flooding from the effects of climate change occurs more frequently. These measures would provide additional resiliency to changing climate conditions.

4.5.7.3 Mitigation

4.5.7.3.1 Mitigation to Address Effects of the I-5 Projects Contributing to Climate Change

No adverse impacts of the I-5 Projects contributing to climate change are anticipated, so no mitigation is proposed.

4.5.7.3.2 Mitigation to Address Effects of Climate Change on the I-5 Projects

No adverse impacts of climate change are anticipated, so no mitigation is proposed.

4.5.8 Visual Quality

4.5.8.1 Short-term Impacts

The potential short-term impacts of the I-5 Projects on visual quality would occur during construction activities and include fugitive dust, exposed construction debris, heavy equipment, and erosion control measures. This would temporarily create an unattractive visual setting during the construction period for motorists on I-5, users of the airport and existing airport levee trail, Riverside Golf Course and RV Park patrons, residents of surrounding properties, and passing traffic. Construction equipment and activities, including vegetation removal, would lower visual quality for the duration of construction. These impacts would be localized and limited to the construction period.

4.5.8.2 Long-term Impacts

The new I-5 floodwalls and levees would block some existing views and change views for motorists on I-5 and adjacent roadways, and potentially change the views of adjacent residences and businesses. Because the additional infrastructure would interrupt existing views, impacts on visual quality would be minor and adverse.

4.5.8.3 Mitigation

Potential mitigation measures for short-term impacts on visual quality could include limiting the area of ground disturbance, locating temporary access roads and staging areas within previously disturbed areas or co-locating them with proposed activities, and revegetating temporarily affected areas with appropriate plantings as soon as possible following construction.

Potential mitigation measures to reduce long-term impacts on visual quality could include vegetating new exposed areas on the levees to the extent possible, and using materials on the levees and floodwalls that would blend with the surroundings.

4.5.9 Noise

4.5.9.1 Short-term Impacts

The potential short-term impacts related to noise would occur during construction and include heavy equipment and construction activities. Construction equipment would primarily consist of earth-moving, materials-handling, and hauling equipment. Pile driving and impact tools could also be required for bridge replacements. Noise levels for these types of equipment range from 76 to 110 dBA at 50 feet from the source (see Table 4.2-10).

The I-5 Projects are located along the stretch of I-5 that passes through Centralia and Chehalis. Some of the proposed floodwalls, and the Dillenbaugh Creek bridge replacement, are located near residential areas and the Riverside Golf Club and RV Park. Construction noise is likely to disturb residents, golfers, and campers, but noise levels would quickly dissipate below levels that would cause hearing damage, and construction noise would be limited to daytime hours and to the duration of construction.

4.5.9.2 Long-term Impacts

No adverse impacts would occur because the completed I-5 Projects would not generate noise.

4.5.9.3 Mitigation

Potential mitigation measures for short-term impacts on noise would be the same as those described for the Airport Levee Improvements. No long-term noise impacts are anticipated, so no mitigation is proposed.

4.5.10 Land Use

4.5.10.1 Short-term Impacts

No short-term impacts on land use are anticipated.

4.5.10.2 Long-term Impacts

Reducing the length of time that I-5 is closed and the physical damage to I-5 during major floods would result in beneficial effects to land use as a result of fewer or less frequent interruptions to access for commercial or other land uses. However, increases in flood extents and floodwater elevations that would occur upstream and downstream of the levees and walls would result in a minor adverse impact on land use in areas that experience new or higher levels of flooding. The decrease in flood extents and land uses that would no longer be inundated are discussed in combination with the Airport Levee Improvements (Alternative 2) in Chapter 5.

4.5.10.3 Mitigation

Potential mitigation measures for long-term impacts on land use resulting from new or increased flooding could include installing compensatory flood storage upstream to avoid an increase in flood levels caused by the levees and floodwalls, or elevating or floodproofing those structures and uses.

4.5.11 Recreation

4.5.11.1 Short-term Impacts

Potential short-term impacts on recreation from construction of the I-5 Projects are similar to those described for the Airport Levee Improvements, but there could be a slight increase in recreational disruption (including to the Stan Hedwall Park and Recreation Park) due to the larger scale of construction activities. These impacts would be localized nature and limited to the construction period.

4.5.11.2 Long-term Impacts

The I-5 Projects are predicted to increase flooding on the riverside of the levees, which would in turn increase flood levels at the Riverside Golf Course and RV Park. These potential adverse impacts are considered minor because flood damages to the golf course and RV park would result in a limited increase in depth and duration of flooding.

4.5.11.3 Mitigation

Potential mitigation measures for short- or long-term impacts on recreation are similar to those described for the Airport Levee Improvements (see Section 4.4.11.3).

4.5.12 Historic and Cultural Preservation

4.5.12.1 Short- and Long-term Impacts

Potential impacts on historic and cultural resources associated with the I-5 Projects 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

The extent of impacts would depend on the nature of cultural resources that could be disturbed, which would be determined through coordination with DAHP and affected tribes during project-level environmental review, including continued government-to-government consultations. 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 government-to-government consultations.

The potential impacts on cultural resources that would occur during construction-related ground disturbance are associated with building new levees, structural walls, levee improvements, bridge replacements (over Dillenbaugh and Salzer creeks), and stormwater treatment areas. Several archaeological resources have been identified in the area during studies for other projects.

Some potential impacts on cultural resources from the I-5 Projects could occur following construction. The new levee could confine current transportation routes or river channels, which could expose, damage, destroy, and/or alter cultural resources at or downstream of the new levee through the following:

- Additional, increased, or changed vehicular and foot traffic patterns

- Different flood patterns, which would cause flooding and sedimentation of submerged resources in other areas and change the streambank locations and result in bank erosion

Based on WSAPM, this area is considered to have a very high potential for archaeological deposits; therefore, potential adverse impacts are considered moderate to significant.

4.5.12.2 Mitigation

Mitigation measures for potential impacts on cultural resources would be determined during project-specific evaluations of the I-5 Projects, and would include consultation with DAHP, interested and affected tribes, and other consulting parties (see information on addressing potential impacts on cultural resources in Section 4.2.12).

The potential compensatory mitigation measures would be the same as those described for the Flood Retention Facility.

4.5.13 Transportation

4.5.13.1 Short-term Impacts

The potential short-term impacts of construction of the I-5 Projects on transportation include temporary disruptions of traffic, and lane closures on I-5 and local roadways due to construction of floodwalls and levees as well as replacement of the I-5 bridges over Dillenbaugh and Salzer creeks. Construction of stormwater improvements would also require temporary lane closures. Some floodwall construction would occur near the BNSF rail line and would require coordination with BNSF. These impacts would be limited to the duration of the construction period and access would be maintained to the extent possible.

4.5.13.2 Long-term Impacts

The I-5 Projects would reduce the duration of closures of I-5 during major floods, which would be a beneficial effect. However, there could be new or increased flooding of nearby local roadways due to a limited increase in flood extents and floodwater elevation on the river side of levees and walls, as well as upstream of the levees and walls. This would result in a minor adverse impact due to the limited and localized increase in flood elevations.

4.5.13.3 Mitigation

Potential mitigation measures to reduce short-term impacts on transportation would be similar to those described for the Airport Levee Improvements. The construction and design of the I-5 Projects would be coordinated with the Federal Highway Administration and comply with federal, state, and local standards. Construction of the levee near the railroad would be coordinated with BNSF. Potential long-term mitigation measures for increased flooding of local roadways could include installing compensatory flood storage upstream to avoiding an increase in flood levels caused by the levees and floodwalls, or potentially other measures to reduce flooding on these roadways.

4.5.14 Public Services and Utilities

4.5.14.1 Short-term Impacts

The potential short-term impacts on public services and utilities would include the temporary disturbance of utilities near the levee, floodwall, and bridge replacement projects, including power lines and highway lighting during construction. These impacts would be limited to temporary disruptions of service.

4.5.14.2 Long-term Impacts

The I-5 Projects would result in a limited increase in flood extents and floodwater elevations in some locations, and would affect public services and utilities, including the Chehalis Regional Water Reclamation Facility. The I-5 Projects could require localized relocation of utilities. These adverse impacts are considered minor because the increase in flood levels would be limited and localized and utility relocations would be localized.

4.5.14.3 Mitigation

Potential mitigation measures for short-term impacts on public services and utilities would be the same as those described for the Airport Levee Improvements (see Section 4.4.14.3).

Potential impacts from increased flooding caused by the I-5 Projects could be provided through flood storage upstream of the levee, where flood levels are anticipated to increase. Mitigation for utility relocations could include coordination with service providers and property owners.

4.5.15 Environmental Health and Safety

4.5.15.1 Short-term Impacts

The potential short-term impacts on environmental health and safety would include lane closures during construction that could cause delays in emergency response. Construction of the I-5 levees and walls could cause temporary delays to emergency services that use I-5. Bridge replacements on I-5 over Dillenbaugh and Salzer creeks could require bridge closures or detours, and construction of stormwater improvements could require temporary lane closures on I-5, which would potentially delay emergency response. These impacts would be relatively short in duration and would be coordinated with emergency responders.

4.5.15.2 Long-term Impacts

Minor adverse impacts on environmental health and safety are anticipated as a result of implementation of the I-5 Projects. The I-5 levees and floodwalls would slightly increase flood elevations upstream and could cause a slight increase in risk of contamination from the Chehalis Regional Water Reclamation Facility. This risk would be minor because of the limited increase in flooding and the existing level of flood protection at the facility. Construction of the I-5 floodwalls and levees would reduce the duration of I-5 closures during major floods and maintain it as an emergency response route, which would result in moderate beneficial effects. Overall, the I-5 Projects would cause a reduction in threats to human health and safety.

4.5.15.3 Mitigation

Potential mitigation measures to reduce short-term impacts on environmental health and safety would be the same as those described for the Airport Levee Improvements. Long-term mitigation for increased flooding of the Chehalis Regional Water Reclamation Facility could include compensatory water storage in areas upstream of the levee where flood levels are anticipated to increase, or additional flood protection for the facility.

4.6 Aberdeen/Hoquiam North Shore Levee

The Aberdeen/Hoquiam North Shore Levee is larger in scale than the Chehalis-Centralia airport levee. It would be approximately 5.8 miles long, and could require in-water work within the Chehalis, Hoquiam, or Wishkah rivers. Short-term impacts from construction of this action element could include excavating, clearing, filling, and dewatering and/or water diversions to install upland earthen levees, concrete T-walls, stop-log closures, and, potentially, sheetpile walls, as well as to raise streets.

For a majority of the elements of the environment, the Aberdeen/Hoquiam North Shore Levee would not result in long-term adverse impacts. Adverse impacts would be primarily minor in nature, except for potential moderate to significant impacts on cultural resources and groundwater. The long-term beneficial effects include a reduction in coastal flooding for the Aberdeen and Hoquiam communities and a reduction in pollutant loading to surface waters from floods.

4.6.1 Water Resources

4.6.1.1 Short-term Impacts

Potential temporary impacts associated with construction of the Aberdeen/Hoquiam North Shore Levee are described in Table 4.1-1. Impacts on water resources include an increased potential for sedimentation and turbidity during upland and in-water work, risk of contamination to surface and groundwater, and interruptions to surface water quantity and groundwater (e.g., recharge and discharge and localized hyporheic exchange alterations) in areas of dewatering. Avoidance and minimization measures would be employed during construction to isolate work areas from surface waters and limit the potential for construction runoff from entering area receiving waters.

4.6.1.2 Long-term Impacts

4.6.1.2.1 Surface Water Quality

No adverse impacts on surface water quality are anticipated to occur as a result of implementing the Aberdeen/Hoquiam North Shore Levee. Installation of the levee would result in similar beneficial effects to surface water quality as the Airport Levee Improvements, due to reduced flooding of potential sources of pollution (locations that store hazardous or toxic materials and pollution-generating surfaces).

4.6.1.2.2 Surface Water Quantity

There is the potential for increases in flood extents and floodwater elevation upstream and adjacent to the levee improvements along the Wishkah, Hoquiam and Chehalis rivers, resulting in a minor adverse impact. Because this action element is in the preliminary planning and design stages, elevations and extents of changes to flooding conditions are not available.

Potential beneficial effects to surface water quantity could occur due to the reduction in the extent of flooding in Hoquiam and Aberdeen as a result of coastal floods. The levee could provide protection from flooding for up to 2,715 structures, based on estimates prepared using FEMA Hazus software (Franklin 2016). The exact extent of flood protection and number of structures protected would be determined during project-level design and environmental review.

No adverse impacts on water use and water rights are anticipated with the Aberdeen/Hoquiam North Shore Levee because this levee placement would not affect the ability of area water users to divert their water right.

4.6.1.2.3 Groundwater

The potential adverse impacts on groundwater quantity are due to shallow groundwater regime modifications with placement of the subsurface (toe) levee and sheetpile wall, and include potential impacts on the hyporheic exchange due to placement of the levee toe. These potential adverse impacts on groundwater quantity are considered moderate due to their localized area of impact. Installation of the levee would result in similar types of groundwater quality benefits as the Airport Levee Improvements, but would be increased due to the larger area of development protected from flooding. This would result in a potential beneficial effect on groundwater quality from reduced flooding of pollutant-generating land uses (e.g., roads and developed areas), which could seep into groundwater.

4.6.1.3 Mitigation

Potential mitigation measures for short-term impacts on water resources associated with construction of the Aberdeen/Hoquiam North Shore Levee are described in Table 4.1-1.

Potential mitigation measures for long-term impacts on surface water quantity would be analyzed during project-level design and environmental review. No compensatory mitigation has been identified for potential impacts on flood levels or shallow groundwater flow regime impacts.

4.6.2 Geology and Geomorphology

4.6.2.1 Short-term Impacts

The potential short-term impacts on geology and geomorphology are described in Table 4.1-1, and are similar to those described for the Airport Levee Improvements and I-5 Projects as they relate to excavating, filling, dewatering, water diversion, and isolating work areas (if in-water work were to occur).

4.6.2.2 Long-term Impacts

Similar to the Airport Levee Improvements and I-5 Projects, potential adverse impacts on geology would occur as a result of increased settlement of land, and are considered minor because they are isolated to the area of the levee. Liquefaction of the ground during an earthquake would be a concern in the area of the Aberdeen/Hoquiam North Shore Levee. The potential effects of liquefaction and earthquake-induced ground motion on the levees would need to be evaluated. Measures to accommodate the effects of liquefaction and earthquake ground motion through post-seismic event repair or to reduce the associated settlement, instability, and lateral spread could be designed into the levee and would depend on established performance criteria.

Potential moderate adverse impacts on geomorphology could result from placement of levees and floodwalls along the Wishkah, Hoquiam, and Chehalis rivers, potentially increasing the velocity in the river and restricting channel migration. With placement of the levee, there is the potential to redirect high-velocity flows downstream or to an adjacent or opposite bank, causing erosion or damage to aquatic habitats. These impacts would be local to the Aberdeen/Hoquiam North Shore Levee area, and would not have Basin-scale impacts on geomorphic function because the site is located at the bottom of the Chehalis Basin.

4.6.2.3 Mitigation

Potential mitigation measures for short-term impacts on geology and geomorphology are described in Table 4.1-1. Liquefaction of the ground during an earthquake would be a concern in the area of the Aberdeen/Hoquiam North Shore Levee (Slaughter et al. 2013). Potential avoidance and mitigation measures would be evaluated during project-level design and environmental review. Other potential mitigation measures for long-term impacts related to geology and geomorphology would be the same as those described for the I-5 Projects.

4.6.3 Wetlands and Vegetation

4.6.3.1 Short-term Impacts

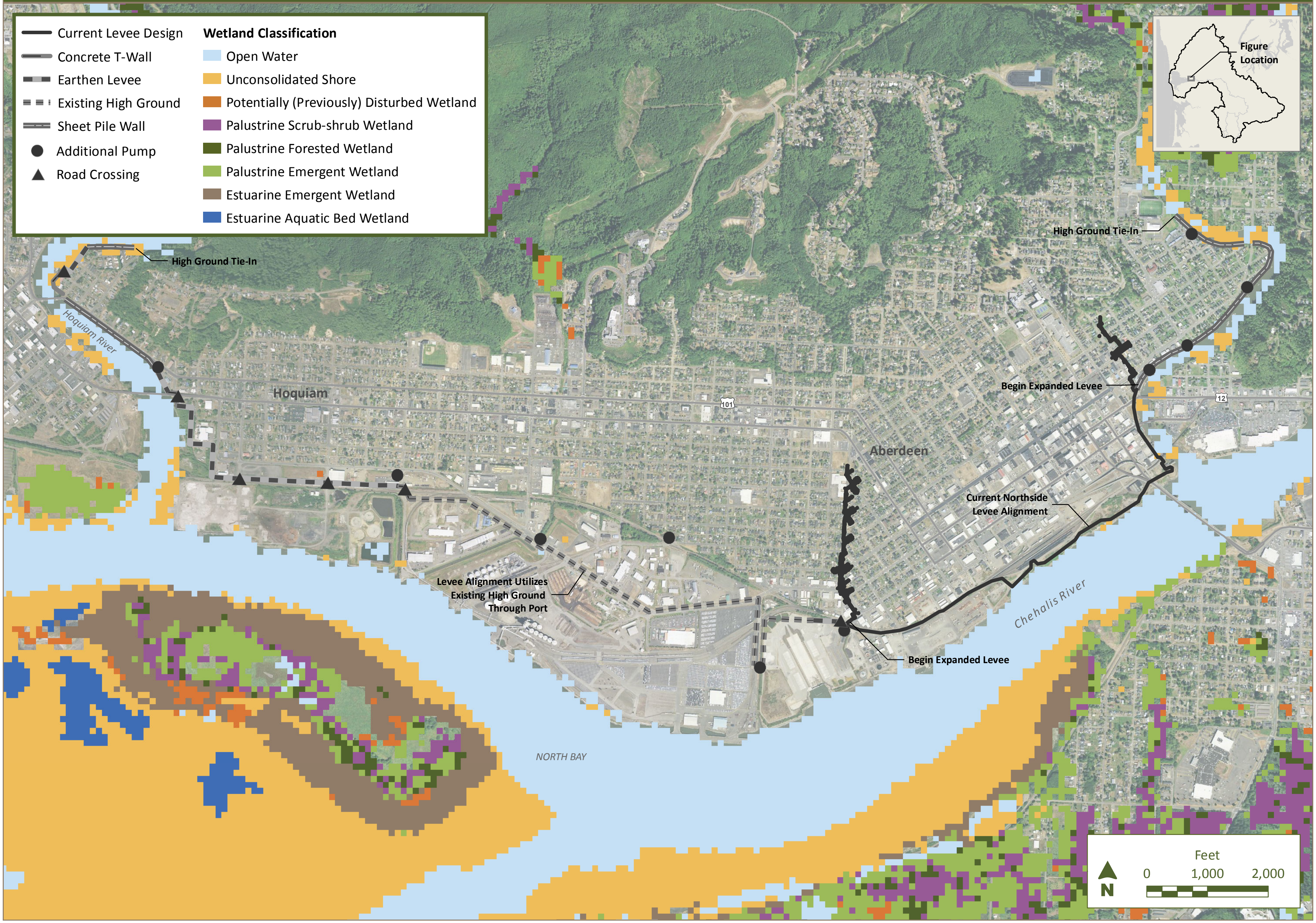
The potential short-term impacts on wetlands and vegetation would occur during construction and are similar to those described for the Airport Levee Improvements. These impacts would be limited in nature and extent given the limited existing vegetation and lack of wetlands due to previous disturbance from urban development and activities. Temporarily disturbed areas would be restored to pre-construction status and/or function following construction.

4.6.3.2 Long-term Impacts

The potential adverse impacts of implementation of the Aberdeen/Hoquiam North Shore Levee on wetlands and vegetation include the placement of fill material into potential wetlands and the removal of woody vegetation that could exist along portions of the proposed levee footprint along the Hoquiam, Chehalis, and Wishkah rivers. Following construction, adverse impacts on vegetation from the routine maintenance of the earthen portions of the levee could also occur. Impacts from such activities could include conversion, disturbance, and/or reduction of existing wetland, riparian, and vegetation communities. These potential adverse impacts of the Aberdeen/Hoquiam North Shore Levee would have a moderate effect on wetlands and a minor effect on vegetation. The proposed work is not anticipated to affect more than 0.5 acre of wetlands (see Figure 4.6-1) or native vegetation, because much of the area has already been affected by past and current development.

Figure 4.6-1

Wetland Areas Mapped near the Aberdeen/Hoquiam North Shore Levee



4.6.3.3 Mitigation

Potential mitigation measures for short-term impacts on wetlands and vegetation are described in Table 4.1-1 as they relate to excavating, clearing, filling, and construction staging. Potential mitigation measures for long-term impacts would be the same as those described for the Airport Levee Improvements and I-5 Projects.

4.6.4 Fish and Wildlife

4.6.4.1 Short-term Impacts

4.6.4.1.1 Fish

The potential short-term impacts on fish from construction of the Aberdeen/Hoquiam North Shore Levee are described in Table 4.1-1. These impacts would occur during the construction of the levee and other associated projects that are immediately adjacent to the Chehalis River and tributaries, especially if construction requires in-water work and use of barges, restructuring of adjacent riverbank areas, or water diversions. The potential short-term impacts related to construction would primarily be from the following:

- Reduced water quality due to turbidity increases, pollutant-laden stormwater runoff, or pollutants entering the water
- Temporarily dewatering of part of the river channels, reducing habitat available to fish in the immediate vicinity of the Aberdeen/Hoquiam North Shore Levee, including species like salmon and steelhead, and ESA-listed bull trout, eulachon, and Southern green sturgeon during their migrations between freshwater and saltwater.
- Construction noise in or near the stream channel and removal of bank vegetation, which would reduce the function of riparian habitat for fish (e.g., shading and input of terrestrial nutrients and food)

4.6.4.1.2 Wildlife

Construction, including noise impacts, could temporarily disturb habitat used by native wildlife species to breed, forage, rest, and overwinter. Temporary impacts would be the same as those described for the Airport Levee Improvements and I-5 Projects, and would occur in areas currently developed or that have been previously disturbed by past industrial and commercial activities.

4.6.4.2 Long-term Impacts

4.6.4.2.1 Fish

The potential adverse impacts from implementation of the Aberdeen/Hoquiam North Shore Levee on fish include reductions in coastal floodplain extents, reduction in channel migration potential, and changing flood extents and elevations upstream and downstream of the levees during coastal flooding. In addition, contaminants carried by stormwater runoff from urban areas behind the levees during large precipitation events could become concentrated at outflow areas of levee pump stations. The magnitude of these potential adverse impacts would be minor, although the impacts have not been quantified. Developed areas that would be behind the levee are not likely providing quality floodplain habitat for fish currently, due to their relatively intensively developed character. Preventing the river from inundating urbanized areas of Aberdeen and Hoquiam could result in a beneficial effect on fish, by reducing fish stranding in developed areas and by reducing pollutant loading during floods from urban-industrial areas behind the levees.

The levee would reduce flood extents in urban areas, but would shift flood extents in other areas of the lower Wishkah River, lower Hoquiam River, and lower Chehalis River estuary floodplains. The potential for river channels to migrate in these areas is already highly constrained by urban infrastructure, and further constraints on floodwater extents created by the levee are likely to increase flooding extents and force changes in the river channel upstream. Constraints on river migration and floodplain inundation in these areas reduces habitat function for fish by reducing areas of refuge from high-velocity flows. Redistribution of floodwater could result in redistribution of fish in newly flooded areas upstream, resulting in a minor adverse impact on fish.

This reach of the lower Chehalis River and estuary is a migratory pathway for salmon, steelhead, bull trout, lamprey, and eulachon (listed as threatened under ESA) in fall and winter when flooding is most likely to affect fish in the vicinity of the levees. Other saltwater-tolerant species (e.g., stickleback) and marine species (e.g., surf smelt, shiner perch, Pacific staghorn, sculpin, English sole) are likely to occur in the transition zone between freshwater and saltwater. The area adjacent to the levees could provide rearing habitat for juvenile Chinook salmon, chum salmon, and eulachon during the transition from freshwater to saltwater in spring. Southern green sturgeon (listed as threatened under ESA) occur in the lower Chehalis River and Grays Harbor during the summer. However, these life stages are not likely to be affected by impacts associated with the levees that are largely related to winter flooding events.

4.6.4.2.2 Wildlife

The potential adverse impacts on wildlife are similar to those described for the Airport Levee Improvements and I-5 Projects, and would be minor due to the limited vegetation and wetland systems in this area, as well as limited potential disturbance.

4.6.4.3 Mitigation

Potential mitigation measures for short- or long-term impacts on fish and wildlife are similar to those described for the Airport Levee Improvements and I-5 Projects (see Sections 4.4.4.3 and 4.5.4.3).

4.6.5 Tribal Resources

4.6.5.1 Short- and Long-term Impacts

The potential construction-related impacts on tribal resources would be similar to those discussed for the Airport Levee Improvements and I-5 Projects. In-water work is not anticipated, but has the potential to occur. Construction-related equipment such as cranes, barges, and tugboats could restrict the Quinault Indian Nation's treaty right of access to the Wishkah, Chehalis, and Hoquiam rivers during construction—all of which are within the Quinault Indian Nation's usual and accustomed fishing areas.

The potential long-term impacts on tribal resources are those effects to fish that result from reductions in the floodplain extent, reduction in channel migration potential, and changing coastal flood extents and elevations upstream and downstream of the levees during coastal flooding (see Section 4.6.4). This could affect estuarine habitat and functions adjacent to the Aberdeen/Hoquiam North Shore Levee. The impacts on estuarine habitat would diminish the productivity and abundance of juvenile salmon and steelhead. This impact would result in fewer fish available for harvest by tribal fishers. Access to tribal fisheries would also be affected if the Quinault Pride Seafood pier is removed as part of this action element. The extent of potential impacts on tribal resources from changing flood extents will be determined through additional coordination with tribes and continued government-to-government consultations.

The levee would be placed within the urban landscape of Aberdeen and Hoquiam and is not anticipated to affect culturally significant plants or wildlife. No long-term impacts on tribal use and availability of plants and wildlife are anticipated.

4.6.5.2 Mitigation

Avoidance and minimization measures for potential short-term impacts on tribal resources could be similar to those described for the Airport Levee Improvements and I-5 Projects. In addition, coordination on the timing and location of construction activities that could affect tribal fishers' access to boat launches or other locations (including the Quinault Pride Pier) used to access the fisheries or other treaty-reserved rights could help to avoid or minimize potential impacts on access. This coordination could result in adjustments to the timing of construction activities to avoid periods when fisheries could be open, and when access to the river is critical to target a particular opening. Other periods would include openings when multiple fish deliveries to Quinault Pride Seafood could occur in a day (e.g., during the fall salmon fishery).

The coordination process could mean establishing and communicating to the Quinault Indian Nation and Chehalis Tribe, through meetings and notices, the timing of construction activities and identification of alternative access points to the river or Bowerman Basin. Mitigation of impacts on treaty rights is subject to consideration and agreement by the Quinault Indian Nation.

4.6.6 Air Quality

4.6.6.1 Short-term Impacts

The potential short-term impacts on air quality are similar to those described for the Airport Levee Improvements, but vehicle emissions from truck trips, mechanized construction equipment, and dust would be greater due to the larger scale of construction activities. Construction would occur near residences and commercial areas; therefore, fugitive dust would be noticeable and a potential nuisance.

The impacts would be localized, limited to the construction period, and would not cause an overall decrease in regional air quality.

4.6.6.2 Long-term Impacts

No adverse impacts on air quality are anticipated because the completed Aberdeen/Hoquiam North Shore Levee would not generate dust or emissions.

4.6.6.3 Mitigation

Potential mitigation measures to reduce short-term impacts on air quality would be the same as those described in Table 4.1-1 as they relate to excavating, clearing, filling, and construction staging. No long-term adverse impacts on air quality are anticipated, so no mitigation is proposed.

4.6.7 Climate Change

4.6.7.1 Short-term Impacts

The potential short-term impacts from GHG emissions contributing to climate change would occur from construction and are the same as those described for the Airport Levee Improvements. Climate change is not anticipated to have any short-term impact on construction of the Aberdeen/Hoquiam North Shore Levee due to the temporary nature of the construction activities.

4.6.7.2 Long-term Impacts

4.6.7.2.1 Effects of the Aberdeen/Hoquiam North Shore Levee Contributing to Climate Change

The potential effects that would contribute to the effects of climate change are similar to those described for Airport Levee Improvements, and would result in no adverse impact.

4.6.7.2.2 Effects of Climate Change on the Aberdeen/Hoquiam North Shore Levee

No adverse impacts from climate change on the Aberdeen/Hoquiam North Shore Levee are anticipated. Even though the potential effects of climate change on coastal flooding include an increased frequency and intensity of flooding events, the levee design height would be increased wherever feasible to account for future potential sea level rise (City of Aberdeen 2016). More intense heavy winter rains combined with high tides could increase flooding behind the levee. Pumps used to pump out water trapped behind the levee into Grays Harbor may be used more often as major flooding from the effects of climate change occurs more frequently. These measures would provide additional resiliency to changing climate conditions.

4.6.7.3 Mitigation

4.6.7.3.1 Mitigation to Address Effects of the Aberdeen/Hoquiam North Shore Levee Contributing to Climate Change

No adverse effects of the Aberdeen/Hoquiam North Shore Levee contributing to climate change are anticipated, so no mitigation is proposed.

4.6.7.3.2 Mitigation to Address Effects of Climate Change on the Aberdeen/Hoquiam North Shore Levee

Climate change is not anticipated to have an adverse effect on the Aberdeen/Hoquiam North Shore levee, so no mitigation is proposed.

4.6.8 Visual Quality

4.6.8.1 Short-term Impacts

The potential short-term impacts on visual quality would occur during construction and include lower visual quality due to construction equipment and activities, particularly in areas where the construction activity would visually contrast with the surrounding area. Construction adjacent to residences and near existing parks, open space, and other natural settings would typically visually contrast with the construction activities. These impacts would be limited in duration.

4.6.8.2 Long-term Impacts

The Aberdeen/Hoquiam North Shore Levee would visually contrast with its location in low, flat topography where no levee currently exists. Views of Grays Harbor and the Hoquiam and Wishkah rivers could be partially blocked from areas behind the levee. These potential adverse impacts are considered minor due to their localized area.

4.6.8.3 Mitigation

Potential mitigation measures for short- and long-term impacts on visual quality are similar to those described for the Airport Levee Improvements and I-5 Projects.

4.6.9 Noise

4.6.9.1 Short-term Impacts

The potential short-term impacts on noise would occur during construction and include heavy equipment and construction activities. Construction equipment would primarily consist of earth-moving, materials-handling, hauling, and impact equipment with noise levels ranging from 76 to 110 dBA at 50 feet from the source (see Table 4.2-10). Noise levels would decrease with distance from the source and decrease to safe levels.

The Aberdeen/Hoquiam North Shore Levee is located within residential and commercial areas of Aberdeen and Hoquiam. Some construction would occur immediately adjacent to homes, and those residents would likely be disturbed by noise. Pile driving for sheetpile walls could occur along the Hoquiam and Wishkah rivers adjacent to residential areas, and would be localized and limited to daytime hours. Noise from pile driving (110 dBA) would cause impacts on residents.

4.6.9.2 Long-term Impacts

No adverse impacts are anticipated because the completed Aberdeen/Hoquiam North Shore Levee would not generate noise.

4.6.9.3 Mitigation

Potential mitigation measures for short-term noise impacts would be the same as those described for the Airport Levee Improvements and I-5 Projects. Additional mitigation measures could include noise barriers during pile-driving activities. No long-term noise impacts are anticipated, so no mitigation is proposed.

4.6.10 Land Use

4.6.10.1 Short-term Impacts

No short-term impacts on land use are anticipated as a result of construction of the Aberdeen/Hoquiam North Shore Levee.

4.6.10.2 Long-term Impacts

The potential adverse impacts on land use include the loss of access to and use of private structures, due to the placement of the levee, particularly along the Wishkah River. This adverse impact would be minor due to the anticipated limited number of properties affected.

The levee could separate existing structures from one another (e.g., homes, docks, storage buildings). If residences on these properties are included behind the levee, owners are likely to lose access to any structures located on or extending out over/into the water. If the levee is located behind those properties, no flood protection would be provided.

The levee is proposed to protect structures behind the levee from coastal flooding within Aberdeen and Hoquiam along Grays Harbor. While the exact extent of flood protection and number of structures protected would be determined during project-level design and environmental review, the increased level of protected structures would be a beneficial effect on land use.

4.6.10.3 Mitigation

Avoidance and minimization measures to address potential adverse impacts on property access and use could include locating the levee to limit the number of affected properties during design. Where adverse impacts are unavoidable, property acquisition and/or relocation efforts could be implemented.

4.6.11 Recreation

4.6.11.1 Short-term Impacts

The potential short-term impacts on recreation would occur during construction and include disruptions to parks in Aberdeen and Hoquiam that are located near the Aberdeen/Hoquiam North Shore Levee due to noise, dust, and traffic. If construction requires in-water work or barges, recreational users could temporarily experience limited or restricted access to the rivers during construction. The impacts would be temporary and localized in nature.

4.6.11.2 Long-term Impacts

The Aberdeen/Hoquiam North Shore Levee would protect parks and recreation areas behind the levee during coastal and tidally influenced flooding. This effect is considered to be beneficial because flood damage at parks and recreation areas would be reduced. The levee could block access to land and private docks along some stretches of the levee. Public access to public shoreline areas would be maintained, except during coastal floods. This adverse impact is considered to be minor because loss of access to recreational facilities would be localized.

4.6.11.3 Mitigation

Potential mitigation measures for short- or long-term impacts on recreation would be similar to those described for the Airport Levee Improvements and I-5 Projects. In addition, coordination with property owners could occur during development of project-specific design to avoid and minimize impacts on docks and other private recreational structures extending into the water.

4.6.12 Historic and Cultural Preservation

4.6.12.1 Short- and Long-term Impacts

Potential short- and long-term impacts on historic and cultural resources could occur during construction with the ground disturbance associated with building the new levee. More than 40 historic structures and selective research indicates that water-related resource procurement sites, such as fish weirs, have been found in current or historical tidal zones along the coast in areas near the levee site. Although none of these resources are currently recorded or known to exist at the Aberdeen/Hoquiam Northshore Levee site, the levee location does include current or historic tidal zones and as such, has the potential to contain these types of archaeological resources.

The extent of impacts would depend on the nature of cultural resources that could be disturbed, which would be determined through coordination with DAHP and affected tribes during project-level environmental review, including continued government-to-government consultations. 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 government-to-government consultations.

Based on WSAPM, this area is considered to have a very high to moderate potential for archaeological deposits, and potential adverse impacts are considered moderate to significant.

The potential impacts on cultural resources following construction would be similar as those described under the Airport Levee Improvements (see Section 4.4.12).

4.6.12.2 Mitigation

Mitigation measures for potential impacts on cultural resources would be determined during project-specific evaluations of the Aberdeen/Hoquiam North Shore Levee, and would include consultation with DAHP, interested and affected tribes, as well as other consulting parties (see information on addressing potential impacts on cultural resources in Section 4.2.12).

The potential compensatory mitigation measures would be the same as those described for the Flood Retention Facility (see Section 4.2.12.2).

4.6.13 Transportation

4.6.13.1 Short-term Impacts

The potential short-term impacts on transportation related to construction of the Aberdeen/Hoquiam North Shore Levee would include temporary disruptions to local roads, US 12, and US 101, including potential closures to raise the bridge approaches over the Wishkah River. Construction could also cause temporary disruptions to the Puget Sound & Pacific Railroad. These impacts would be limited to the construction period and access would be maintained to the extent possible.

4.6.13.2 Long-term Impacts

The Aberdeen/Hoquiam North Shore Levee would protect local roadways within the levee from coastal flooding on the lower (tidally influenced) reaches of the Chehalis, Wishkah, and Hoquiam rivers. The levees and walls would include stop log closures or similar devices, which would close during floods, but would open to maintain public access to roads and streets when there is no flooding. For these reasons, the potential effects are considered beneficial.

4.6.13.3 Mitigation

Potential mitigation measures for short-term impacts on transportation would be the same as those described for the Airport Levee Improvements and I-5 Projects. In addition, construction would be coordinated with WSDOT, the Puget Sound & Pacific Railroad, and local road departments.

No long-term adverse impacts on transportation are anticipated, so no mitigation is proposed.

4.6.14 Public Services and Utilities

4.6.14.1 Short-term Impacts

The potential short-term impacts on public services and utilities would occur during construction and include the following:

- Short-term disruptions to roadways, potentially affecting public services such as garbage collection if access to customers is restricted
- Temporary disruptions of utilities near the levees and floodwalls (proposed levees and floodwalls would be located within developed areas along street corridors)
- Potential effects on overhead electrical, sewer, water, and cable and internet lines

These impacts would be limited to the construction period.

4.6.14.2 Long-term Impacts

The Aberdeen/Hoquiam North Shore Levee would not increase demand for public services and utilities and would result in beneficial effects due to the protection of multiple public services and utilities inland of the levee from coastal and tidally influenced riverine flooding. Public services in the area include: Aberdeen Fire Department, Aberdeen Park Timberland Library, Aberdeen Police Department, Alexander Young Elementary School, A.J. West Elementary School, Harbor High School, Central Elementary School, Grays Harbor Beauty College, Grays Harbor Community Hospital, Grays Harbor PUD, Hoquiam Fire Department, KGHO-AM, Miller Junior High School, Polson Museum, and Techline the Technology People Computer Training School. The levee could require localized relocation of public services and utilities, resulting in minor adverse impacts.

4.6.14.3 Mitigation

Potential mitigation measures for short- and long-term impacts on public services and utilities would be the same as those described for the Airport Levee Improvements (see Section 4.4.14.3). Minor long-term impacts associated with utility relocations could be mitigated by coordination with service providers and property owners.

4.6.15 Environmental Health and Safety

4.6.15.1 Short-term Impacts

The potential short-term impacts on environmental health and safety would include disruptions to roadways, which can delay emergency response during construction. These impacts would be relatively short in duration and would be coordinated with emergency responders.

4.6.15.2 Long-term Impacts

The Aberdeen/Hoquiam North Shore Levee would reduce coastal flooding and provide flood protection along the low, tidally influenced portions of the Wishkah and Hoquiam rivers, resulting in beneficial effects on environmental health and safety through the reduced demand for emergency response and better access during floods. Reduced flooding in urban areas would also reduce the risk of contamination of floodwaters. Some local streets would be blocked when the levees are in operation, making them inaccessible for emergency response. However, the lack of access would be short term, and emergency plans would be developed for emergency response to those areas when the gates are closed. Overall, the levee would reduce threats to human health and safety in Aberdeen and Hoquiam.

4.6.15.3 Mitigation

Similar to the Airport Levee Improvements and I-5 Projects, potential mitigation measures for short-term impacts on environmental health and safety could include coordinating construction with emergency services, scheduling construction to minimize impacts, and notifying the public of construction. For long-term mitigation measures, reductions in emergency response time in the area outside the levee would be planned as part of the county's natural hazard preparedness planning process.

4.7 Local-scale Flood Damage Reduction Actions

Local-scale Flood Damage Reduction Actions include Floodproofing (and buy-outs of flood-prone properties), Local Projects (including protection of roads and infrastructure and local-scale floodplain reconnection projects), Land Use Management improvements within the Chehalis River floodplain, and Flood Warning System Improvements (see Section 2.3.3.2). Temporary ground-disturbing construction activities are limited to Floodproofing and Local Projects. The primary benefit of the Local-scale Flood Damage Reduction Actions is the reduction of flood damage to residential, commercial, industrial, public, and agricultural properties. The Local-scale Flood Damage Reduction Actions also have fewer significant adverse impacts on many elements of the natural and built environment than the Large-scale Flood Damage Reduction Actions.

For short- and long-term impacts, this section focuses on those actions that would result in adverse impacts or beneficial effects. Where no effect on an element of the environment is anticipated to result from Local-scale Flood Damage Reduction Actions, impacts are not discussed in this EIS. Short-term construction activities for Floodproofing and Local Projects could involve excavating, clearing, filling, dewatering, concrete use, in-water work, and equipment use and staging. Some of the current Local Projects (see Section 2.3.3.2) are studies and do not involve construction; because these are in the planning and preliminary feasibility phases, potential impacts are not evaluated in this EIS. Implementation of Floodproofing and Local Projects would primarily result in beneficial effects due to reduction of flood damage to structures, infrastructure and roads, and agricultural uses (including protection of livestock and farm equipment). Land Use Management actions could reduce the potential for future development within the Chehalis River floodplain. Flood Warning System Improvements would result in increased accuracy with regard to forecasting flood timing and extents, and increased public safety. Because flood warning systems are not structural, effects to the natural elements of the environment are not expected.

4.7.1 Water Resources

4.7.1.1 Short-term Impacts

Floodproofing and Local Projects

The potential short-term impacts on water resources related to Floodproofing and Local Projects are described in Table 4.1-1. Although temporary, these actions would increase the potential for sedimentation and turbidity in surface waters, risk of contamination to surface and groundwater, and interruptions to surface water quantity and groundwater (e.g., recharge and discharge and localized hyporheic exchange alterations) in areas of temporary dewatering or water diversions.

4.7.1.2 Long-term Impacts

4.7.1.2.1 Surface Water Quality

Floodproofing

Floodproofing structures within the Chehalis River floodplain would result in beneficial effects on water quality. Pollution levels in nearby waterbodies could be reduced by avoiding inundation of structures and their contents, and the corresponding exposure of floodwaters to contaminants related to residential or commercial use, such as waste, chemicals, solvents, and hazardous or toxic materials during floods.

Local Projects

Implementation of Local Projects that include bank stabilization has the potential to benefit water quality as compared to the baseline, because projects designed to protect eroding banks at specific locations would ensure WWTPs are not compromised during floods. However, Local Projects including bank stabilization are also likely to result in a loss of riparian structure where actions are implemented, which could lead to increased solar radiation and heating of surface water, resulting in a minor adverse impact.

Land Use Management

Land Use Management actions may have the potential to improve water quality during and after floods by restricting further development within the Chehalis River floodplain, thereby reducing future potential sources of pollution at risk of exposure to floodwaters and preserving natural floodplain functions that have the potential to benefit water quality. As noted in the *Build Out Analysis* (see Appendix L), Land Use Management recommendations designed to minimize creating future parcels in the Chehalis River floodplain may not be effective at limiting development due to the abundance of developable parcels that currently exist. Therefore, Land Use Management regulations that prohibit or restrict specific uses, such as restricting new on-site sewage systems, are likely to be more effective at reducing the future potential for adverse water quality impacts than those designed to limit the creation of new parcels in the floodplain.

4.7.1.2.2 Surface Water Quantity

Floodproofing

Floodproofing actions would include installation of raised fill pads for livestock and equipment, and may include small-scale walls or berms to protect residential or commercial structures. These farm pads or walls could deflect floodwaters and increase water velocities and flood depths adjacent to and slightly upstream and downstream of the project location. This is considered a minor adverse impact on water quantity due to the relatively small size, localized nature, and limited extent of these projects Basin-wide. When elevating homes, raising residential structures would generally occur in the same footprint and, therefore, would not result in an increase in flood velocities or depths in adjacent areas.

Local Projects

Some of the Local Projects are proposed to protect properties and roads from floodwaters using bank stabilization measures, which would deflect floodwaters and increase water velocities and flood depths adjacent to and slightly upstream and downstream of the project. This is considered a minor adverse impact on water quantity due to the localized nature and extent. Bank stabilization projects could deflect the river's energy downstream and increase erosion in downstream reaches. Local Projects that include reconnecting river and stream channels to floodplains have the potential to benefit surface water quantity by slowing and storing flows during floods.

Land Use Management

Changes in Land Use Management include open space preservation and restrictions on floodplain filling, which could be a beneficial effect to water quantity because it would limit future uses and activities in the floodplain that increase flood elevations upstream and downstream. Restricting further floodplain fill and maintaining open spaces would prevent downstream rises in flood levels when compared to the baseline. However as noted in the *Build Out Analysis* (see Appendix L), Land Use Management recommendations designed to minimize creating future parcels in the Chehalis River floodplain may not be effective at limiting development due to the abundance of developable parcels that currently exist. Therefore, Land Use Management regulations that prohibit or restrict specific uses, such as fill in the floodplain, are likely to more effectively minimize future water quantity impacts from continued development in the floodplain.

No adverse impacts on water use and water rights are anticipated with Local-scale Flood Damage Reduction Actions because these actions would not affect the ability of area water users to divert their water rights.

4.7.1.2.3 Groundwater

Floodproofing

Floodproofing actions may include small-scale walls or berms to protect residential, commercial, industrial, or agricultural structures. Subsurface excavation for the installation of these types of floodproofing measures has the potential to modify shallow groundwater regimes and, as a result, could have a minor adverse impact on groundwater quantity, depending on the location.

Local Projects

Subsurface excavation for the installation of bank stabilization measures associated with Local Projects has the potential to modify shallow groundwater regimes, including potential effects to hyporheic exchange. As a result of these actions, minor adverse impacts on groundwater quantity could occur due to their localized extent. Floodplain restoration projects could reconnect surface waters to groundwater and result in a benefit to groundwater quantity. No adverse impacts on groundwater quality are anticipated with Local Projects.

Land Use Management
Changes in Land Use Management include open space preservation and subdivision set asides, which could have a beneficial effect on groundwater by maintaining infiltration capacity of soils in areas within the floodplain where groundwater recharge occurs.

4.7.1.3 Mitigation

Potential mitigation measures for short-term impacts on water resources are described in Table 4.1-1. Potential mitigation measures for long-term impacts on water resources are described in this section.

4.7.1.3.1 Surface Water Quality

Floodproofing
No adverse impacts on surface water quality are anticipated related to Floodproofing, so no mitigation is proposed.

Local Projects
Potential mitigation measures for adverse impacts on surface water quality related to Local Projects could include replanting riparian areas with multi-storied vegetation to mitigate for a loss of riparian structure that provides shade and filters runoff.

Land Use Management
No adverse impacts on surface water quality are anticipated related to Land Use Management, so no mitigation is proposed.

4.7.1.3.2 Surface Water Quantity

Local Projects
Potential mitigation measures for long-term adverse impacts on surface water quantity related to Local Projects could include compensatory storage in the areas where flooding would increase as a result of any fill placed. Compensatory mitigation for bank stabilization and infrastructure protection projects would depend on site-specific conditions, but avoidance and minimization measures could include minimizing the length of stabilization to the extent necessary to protect the structure or use that is at risk, and utilizing soft shoreline stabilization approaches to the extent feasible.

Land Use Management
No long-term adverse impacts on surface water quantity are anticipated, so no mitigation is proposed.

4.7.1.3.3 Groundwater

Floodproofing and Local Projects
Mitigation for site-specific, localized effects to groundwater from Floodproofing and Local Projects would depend on the project and site conditions.

Land Use Management

No long-term adverse impacts on groundwater quality or quantity are anticipated, so no mitigation is proposed.

4.7.2 Geology and Geomorphology

4.7.2.1 Short-term Impacts

Floodproofing and Local Projects

The potential short-term impacts on geology and geomorphology related to Floodproofing and Local Projects are described in Table 4.1-1. Excavation, fill, dewatering, and water diversions could be required for raising or floodproofing structures and Local Projects, depending on the project. These impacts are anticipated to be minor and localized in nature.

4.7.2.2 Long-term Impacts

No adverse impacts on geology are anticipated as a result of Local-scale Flood Damage Reduction Actions.

Local Projects

The implementation of Local Projects could potentially result in adverse impacts on geomorphology due to localized alterations to channel morphology, and limiting channel migration from the placement of bank-stabilization structures. With any bank-hardening component of these projects, there is the potential to redirect flows downstream or to an adjacent or opposite bank, causing erosion or damage to aquatic species habitats. These impacts are anticipated to be minor based on the scale and number of projects currently on the Local Projects list; however, cumulatively hard shoreline stabilization measures could have a more significant impact on geomorphology, depending on reach conditions. Local Projects that include reconnecting river and stream channels to floodplains have the potential to benefit geomorphology.

Land Use Management

Changes in land use management regulations that protect existing floodplain areas could result in beneficial effects on geomorphology if river channels retain space in which to migrate at natural rates.

4.7.2.3 Mitigation

Potential mitigation measures for short-term impacts on geology and geomorphology are included in Table 4.1-1. No long-term adverse impacts on geology are anticipated, so no mitigation is proposed. Potential minimization and avoidance measures to reduce adverse impacts on geomorphology include minimization in the length of stabilization measures and the use of bioengineering techniques for bank stabilization associated with Local Projects.

4.7.3 Wetlands and Vegetation

4.7.3.1 Short-term Impacts

Floodproofing

The potential short-term impacts on wetlands and vegetation include the installation of Floodproofing components (e.g., farm pads, evacuation routes, floodwalls), which could affect riparian areas and/or wetlands and wetland buffers (depending on their location and proximity to construction activities). Specific impacts include temporary fill placement in wetlands and removal or disturbance of existing upland and wetland vegetation. These impacts are anticipated to be limited in nature and extent (given the limited existing wetlands and vegetation due to disturbance from previous and current land uses), and would be restored to pre-construction status and/or function following completion of Floodproofing.

Local Projects

The potential short-term impacts on wetlands and vegetation related to Local Projects include activities such as land clearing, excavation, fill placement, equipment access, and material storage. Specific impacts include temporary fill placement in wetlands, and removal or disturbance of existing upland and wetland vegetation. These impacts would be limited in nature and extent (given the limited existing wetlands and vegetation due to disturbance from previous and current activities), and would be restored to pre-construction status and/or function following completion of Local Projects.

4.7.3.2 Long-term Impacts

Floodproofing

The potential adverse impacts on wetlands and vegetation are primarily related to direct impacts from the construction of floodproofing measures. Changes in wetland hydrology could also occur if floodproofing structures alter overland flow or shallow subsurface groundwater flow paths, such that floodplain wetlands no longer receive water from overbank flooding or groundwater. The potential adverse impacts would include permanent loss of wetlands, permanent loss of upland and wetland vegetation, and modification of wetland hydrology. Overall, the potential adverse impacts on wetlands and vegetation are limited, and are therefore considered minor due to the small size of these structures and the location around existing development and in developed areas. Elevated structures are generally anticipated to maintain the same footprint as the pre-elevated structure, which would limit adverse impacts on wetlands and vegetation.

Local Projects

The construction of Local Projects could result in potential disconnection of floodplains, wetlands, and off-channel habitat from rivers, as well as direct removal of wetland or riparian vegetation. The potential adverse impacts on wetlands and vegetation from Local Projects are considered minor, based on the scale and number of projects currently on the Local Projects list and their location in relatively developed areas. Local Projects that include reconnecting river and stream channels to floodplains have the potential to benefit floodplain wetlands and native floodplain vegetation.

Land Use Management

No adverse impacts on wetlands and vegetation are anticipated. Potential beneficial effects on wetlands and vegetation could occur with preservation of floodplain open space and filling restrictions in the floodplain.

4.7.3.3 Mitigation

Potential mitigation measures for short-term impacts on wetlands and vegetation are described in Table 4.1-1. Potential mitigation measures for long-term adverse impacts on wetlands and vegetation for Floodproofing and Local Projects would be the same as those described for the Airport Levee Improvements, I-5 Projects, and Aberdeen/Hoquiam North Shore Levee.

4.7.4 Fish and Wildlife

4.7.4.1 Short-term Impacts

4.7.4.1.1 Fish

The potential responses of fish to short-term impacts on habitat as a result of the construction of Floodproofing or Local Projects actions are similar to those described in Table 4.1-1. However, impacts would be limited in magnitude because the actions are limited in number and extent, and because the areas in which these projects would occur are currently developed and habitat conditions for fish may currently be relatively impaired.

Short-term impacts on fish could occur if construction takes place immediately adjacent to the Chehalis River and tributaries, and would occur on a limited scale with actions requiring bank stabilization or in-water work. Water quality would be affected by turbidity increases, pollutant-laden stormwater runoff, or pollutants entering the water. Areas could be temporarily dewatered, reducing habitat available to fish in the immediate vicinity of the actions. Other potential impacts on fish could include construction noise in or near the stream channel and removal of bank vegetation, which would reduce the function of riparian habitat for fish (e.g., shading and input of terrestrial nutrients and food). These short-term impacts would have a limited potential for direct fish injury or mortality.

4.7.4.1.2 Wildlife

The potential responses of wildlife to short-term impacts on habitat are similar to those described in Table 4.1-1; however, impacts would be limited in magnitude since the actions are limited in number and extent and because the areas in which these actions would occur are currently developed and likely currently provide limited habitat for wildlife. These temporary impacts could disturb habitat used by native wildlife species to breed, forage, rest, and overwinter.

4.7.4.2 Long-term Impacts

4.7.4.2.1 Fish

The potential adverse impacts on fish are primarily related to changes in bank characteristics, flood extents, and improvements to water quality from bank stabilization in areas experiencing high levels of erosion, and a reduction in sedimentation and risk of wastewater contamination. Each of these actions could affect the quality of fish habitat.

Floodproofing

Floodproofing structures could result in a beneficial effect to fish by reducing potential pollutant loads to surface waters during floods. This could be accomplished as a result of elevating, or otherwise Floodproofing, structures and limiting exposure of the contents to floodwaters. However, protection measures for structures in the floodplain would allow for continuation of activities in the floodplain that are harmful to fish and fish habitat, such as preventing restoration of riparian area vegetation or preventing the creation of off-channel habitat.

Local Projects

Protecting riverbanks, roads, and infrastructure through Local Projects could benefit fish by reducing potential pollutant and sediment loads to the Chehalis River as a result of reducing erosion and improving local water quality. However, bank stabilization could also create minor adverse impacts on fish habitat by permanently altering river hydraulics, velocities, and causing bank erosion in other areas. As noted previously, bank stabilization impacts on fish habitat cumulatively could be more significant, depending on the project setting. In addition, some Local Projects could affect local riparian structure, which could impair fish habitat quality by increasing water temperatures and pollutant runoff, and result in impacts on refugia. Local Projects that include reconnecting river and stream channels to floodplains have the potential to benefit fish by improving habitat.

Land Use Management

Revising land use regulations and practices could limit future development in the floodplain to some extent, preserving open space and potentially floodplain habitat for fish. Fish like juvenile coho salmon and Olympic mudminnow rely on off-channel habitat, which could be preserved in present open spaces. The potential effects on fish from Land Use Management are considered beneficial. The magnitude of the benefit would depend on the amount of open area preserved, and the efficacy of development restrictions in the floodplain—that is, preventing development in the Chehalis River floodplain rather than allowing development where structures are protected during a 100-year flood by added freeboard.

4.7.4.2.2 Wildlife

Anticipated adverse impacts on wildlife are primarily related to changes in flood extents and potential improvements to water quality during floods. Each of these actions could affect the quality of wildlife habitat used for breeding, foraging, resting, and overwintering.

Floodproofing and Local Projects

Minor adverse impacts could result from potential changes in wildlife habitats, such as wetlands and riparian areas, from the alteration of overland flow paths by floodproofing structures, or direct impacts on wetlands or vegetation during construction of Local Projects. Additionally, clearing existing vegetation would result in minor adverse impacts on native wildlife by reducing the quantity and quality of habitat available. Non-native invasive wildlife species could also populate disturbed areas, creating competition with or displacement of native species.

Aquatic or semi-aquatic wildlife species may benefit from improved water quality if WWTPs, roads and infrastructure, and other potential sources of pollutants are not inundated in future floods. These benefits would be most important to species such as amphibians that rely on high-quality aquatic habitat for breeding and foraging. Local Projects that include reconnecting river and stream channels to floodplains have the potential to benefit floodplain wetlands and native floodplain vegetation, and therefore wildlife that use these habitats.

Land Use Management

Open space preservation may avoid future impacts on floodplain habitat, which would be considered a beneficial effect for wildlife.

4.7.4.3 Mitigation

4.7.4.3.1 Fish

Some potential long-term impacts on fish would be addressed through mitigation measures outlined in Table 4.1-1. The potential compensatory mitigation measures to address unavoidable minor adverse impacts on fish from Floodproofing and Local Projects would be the similar those identified for the Airport Levee Improvements, I-5 Projects, and Aberdeen/Hoquiam North Shore Levee. Mitigation for bank stabilization projects would generally be site- and project-specific; however, to address the loss of riparian structure, compensatory mitigation could include replanting affected riparian vegetation or restoring floodplain areas of equivalent size or habitat function for fish.

4.7.4.3.2 Wildlife

Some potential long-term impacts on wildlife would be addressed through the avoidance and minimization measures outlined in Table 4.1-1. The potential compensatory mitigation measures to address unavoidable minor adverse impacts on wildlife from Floodproofing and Local Projects would be the same as those identified for the Airport Levee Improvements, I-5 Projects, and Aberdeen/Hoquiam North Shore Levee.

4.7.5 Tribal Resources

4.7.5.1 Short- and Long-term Impacts

The potential construction-related impacts on tribal resources are associated with Local Projects and would be similar to those discussed for the Airport Levee Improvements and I-5 Projects. Construction of Local Projects could involve in-water work and/or could restrict the treaty right of access to tribal fishing areas or other tribal resources. Potential impacts on tribal resources following construction of Local Projects are not anticipated with the exceptions of ongoing maintenance or similar project-related activities. Local Projects that include reconnecting river and stream channels to floodplains have the potential to benefit fish by improving habitat, and therefore may potentially benefit tribal resources.

Protection measures like floodproofing structures in the floodplain would allow for continuation of activities in the floodplain that, cumulatively, are harmful to fish and fish habitat. Land Use Management actions that include development restrictions—that is, prevent rather than allow development, but require protection for structures—are more likely to benefit fish (see Section 4.7.4.2.1), and may therefore benefit tribal resources. The extent of potential impacts on tribal resources from restricted access to tribal fishing areas will be determined through additional coordination with tribes and continued government-to-government consultations.

4.7.5.2 Mitigation

The potential mitigation associated with impacts on tribal resources would be addressed directly with Quinault Indian Nation and Chehalis Tribe tribal leadership during project-level environmental review and continued government-to-government consultations.

Some potential long-term impacts on tribal fish resources could be addressed through avoidance and minimization measures developed in consultation with tribes. These could include avoiding intact riparian vegetation and working in streams or other sensitive areas. Other measures outlined in Table 4.1-1 and related to erosion controls would also be implemented.

Compensatory mitigation measures to address unavoidable adverse impacts on tribal resources from Local Projects should be addressed directly with Quinault Indian Nation and Chehalis Tribe tribal leadership. In some cases, mitigation measures could be proposed to address the impacts on habitat that are important to tribal resources, including fish, wildlife, and plants. Mitigation of impacts on treaty rights is subject to consideration and agreement by the Quinault Indian Nation.

4.7.6 Air Quality

4.7.6.1 Short-term Impacts

Floodproofing and Local Projects

The potential short-term impacts on air quality related to Floodproofing and Local Projects would vary and would likely last a few weeks to a few months depending on the scale of the individual project. The impacts would be localized, limited to the construction period, and would not cause an overall decrease in regional air quality.

4.7.6.2 Long-term Impacts

No adverse impacts on air quality are expected because, once completed, it is not anticipated that the Local-scale Flood Damage Reduction Actions would generate emissions above current levels. Any cleared areas could be revegetated to avoid providing future sources of dust.

4.7.6.3 Mitigation

Potential mitigation measures for short-term impacts on air quality would be the same as those described in Table 4.1-1. No long-term impacts on air quality are anticipated, so no mitigation is proposed.

4.7.7 Climate Change

4.7.7.1 Short-term Impacts

4.7.7.1.1 Effects of Local-scale Flood Damage Reduction Actions Contributing to Climate Change

Floodproofing and Local Projects

The potential short-term effects of Floodproofing and Local Projects that would contribute to climate change include additional GHG emissions from construction equipment. GHG emissions resulting from construction activities are expected to be below the annual threshold for qualitatively disclosing emissions and are considered negligible.

4.7.7.1.2 Effects of Climate Change on the Local-scale Flood Damage Reduction Actions

Floodproofing and Local Projects

No short-term effects from climate change on Floodproofing or Local Projects are anticipated.

4.7.7.2 Long-term Impacts

4.7.7.2.1 Effects of Local-scale Flood Damage Reduction Actions Contributing to Climate Change

Floodproofing and Local Projects

The potential effects that contribute to climate change are due to GHG emissions during operation and maintenance activities that could require the periodic use of trucks and/or heavy equipment. The anticipated GHG emission equivalents from operation of equipment are below the annual threshold for qualitative disclosure of emissions as described in Section 4.4.7; therefore, no adverse impacts are anticipated.

4.7.7.2.2 Effects of Climate Change on Local-scale Flood Damage Reduction Actions

Floodproofing and Local Projects

The effects of climate change on Floodproofing and Local Projects are increased frequency and intensity of flooding events. More intense heavy winter rains could increase flood elevations beyond anticipated levels, and compromise Floodproofing and Local Projects. Floodproofing actions and Local Projects could be designed to consider climate change (e.g., additional freeboard when raising homes), and similar measures could provide resiliency to changing climate conditions. Therefore, no adverse impacts are anticipated. Local Projects that include reconnecting river and stream channels to floodplains are likely to improve floodplain function, and therefore provide resiliency under future climate change conditions.

4.7.7.3 Mitigation

4.7.7.3.1 Mitigation to Address Effects of Local-scale Flood Damage Reduction Actions Contributing to Climate Change

It is not anticipated that Local-scale Flood Damage Reduction Actions would contribute to climate change over the long term; therefore, no mitigation is proposed.

4.7.7.3.2 Mitigation to Address Effects of Climate Change on Local-scale Flood Damage Reduction Actions

Local-scale Flood Damage Reduction Actions could be designed to be resilient to changing climate conditions, such as more intense winter rains and projected increases in peak flood flows.

4.7.8 Visual Quality

4.7.8.1 Short-term Impacts

Floodproofing and Local Projects

The potential short-term impacts on visual quality related to Floodproofing and Local Projects include construction equipment and activities that would lower visual quality for the duration of construction, particularly in areas where the construction activity would visually contrast with the surrounding area. Parks, open space, and other natural settings visited by the public would be particularly sensitive to visual impacts associated with construction. These impacts would be relatively small and limited in duration.

4.7.8.2 Long-term Impacts

Floodproofing

Elevating existing structures would change the appearance of the buildings and could interrupt views. Purchasing (and removing) homes in the Chehalis River floodplain would potentially result in more open area. Constructing flood barriers, floodwalls, and farm pads would introduce human-made structures where they currently do not exist. Their impact on the existing viewshed would depend on the degree to which they contrast with it; however, because they would be auxiliary to existing structures, these potential adverse impacts are considered minor.

Local Projects

Protection of roads and infrastructure would cause localized changes to views in the areas. The potential adverse impacts from Local Projects are considered minor because of their small scale. Bank protection activities could cause minor adverse impacts on the limited changed views along the Wynoochee and Chehalis rivers.

4.7.8.3 Mitigation

Potential mitigation measures for short-term impacts on visual quality are similar to those described for the Airport Levee Improvements, I-5 Projects, and Aberdeen/Hoquiam North Shore Levee. Potential mitigation measures for long-term impacts on visual quality related to Floodproofing and Local Projects include buffering visual impacts with native trees, shrubs, and other vegetation.

4.7.9 Noise

4.7.9.1 Short-term Impacts

Floodproofing and Local Projects

The potential short-term noise impacts related to Floodproofing and Local Projects include construction activities and equipment. Construction equipment likely to be used for construction would include earth-moving, materials-handling, and hauling equipment with peak noise levels ranging from 81 to 89 dBA at 50 feet from the source (see Table 4.2-10). Construction noise would likely be a disturbance to nearby residents, but the impacts would not be significant because noise levels would decrease to safe levels before reaching homes and would be limited to daytime hours.

4.7.9.2 Long-term Impacts

No adverse impacts are anticipated because none of the completed projects would generate noise in excess of current conditions.

4.7.9.3 Mitigation

Potential mitigation measures for short-term noise impacts would be the same as those described for the Airport Levee Improvements and I-5 Projects. No long-term noise impacts are anticipated with the Local-scale Flood Damage Reduction Actions, so no mitigation is proposed.

4.7.10 Land Use

4.7.10.1 Short-term Impacts

Floodproofing

No potential short-term impacts on land use are anticipated as a result of Floodproofing.

Local Projects

No potential short-term impacts on land use are anticipated as a result of Local Projects.

4.7.10.2 Long-term Impacts

Floodproofing

This action element estimates that 75% of residential structures in the Chehalis River floodplain could be elevated above BFE. If elevation of a structure is more expensive than the value of the land and structure combined, the structure and land could be purchased. The potential effects on land use from Floodproofing are beneficial and include reductions in flood damage for residential land uses. Floodproofing also would be employed to reduce flood damages to other land uses, where approximately 25% of residential structures and 75% of commercial, industrial, government, school structures have the potential to be floodproofed. The installation of farm pads that provide refuge from floodwaters and the creation of livestock evacuation routes would benefit agricultural land uses.

Local Projects

No adverse impacts on land use are anticipated. The potential effects on land use associated with Local Projects primarily include the reduction in the risk of flood damage to structures and key infrastructure or priority areas, reducing the risk of flood damage or disruption to land uses.

Land Use Management

Land Use Management actions are intended to affect patterns of development within the floodplain. Floodplain protection and construction standards proposing to minimize development in flood-prone locations, protect natural floodplain functions, and more effectively protect buildings in the floodplain could be enacted, with the goal of effecting a long-term impact on land use. This would be considered a beneficial effect on land use in the context of reducing flood damage. A *Build Out Analysis* was conducted to evaluate the potential effectiveness of Land Use Management actions in the floodplain of this type (see Appendix L). Due to the abundance of existing developable parcels in the Chehalis River floodplain, the results indicated that subdivision set asides, and low density or large lot zoning, would be unlikely to significantly limit further development in the Chehalis River floodplain. While Land Use Management actions could have an effect on land use, regulations that more directly restrict floodplain development could be more effective at preventing potential future flood damage. Land use changes that restrict development potential on existing parcels could be considered minor adverse impacts from the perspective of individual property owners. More information on the potential effectiveness of Land Use Management actions in the floodplain is included in Appendix L.

4.7.10.3 Mitigation

No short-term impacts on land use are anticipated as a result of implementing Floodproofing or Local Projects, so no mitigation is proposed.

Floodproofing and Local Projects

No long-term adverse impacts on land use are anticipated with Floodproofing and Local Projects, so no mitigation is proposed.

Land Use Management

Land Use Management changes that represent a departure from a community's current comprehensive plan or development regulations would need to demonstrate that such standards continue to provide sufficient suitable land for development to accommodate allocated housing and employment growth, per the provisions of GMA. Significant adverse impacts on land use are not anticipated under the proposed floodplain protection and construction standards.

4.7.11 Recreation

4.7.11.1 Short-term Impacts

Floodproofing and Local Projects

Potential short-term impacts on recreation related to Floodproofing or Local Projects would occur during construction, and include construction noise and dust on properties located adjacent to parks or other recreational facilities. These impacts would be limited to the construction period, which would likely be several weeks to several months.

4.7.11.2 Long-term Impacts

Floodproofing and Local Projects

Floodproofing would not affect any recreational areas and would therefore have no adverse impact. Floodproofing could result in a beneficial effect on recreation if farm pad projects protect livestock and equipment for farms used for agritourism. Some Local Projects could result in benefits to recreation because they could help maintain access to parks or other recreational areas by reducing flooding of access roads.

4.7.11.3 Mitigation

No short- or long-term adverse impacts on recreation are anticipated with Local-scale Flood Damage Reduction Actions, so no mitigation is proposed.

4.7.12 Historic and Cultural Preservation

4.7.12.1 Short- and Long-term Impacts

Floodproofing and Local Projects

The potential impacts on cultural resources related to Floodproofing and Local Projects that could occur during construction are related to ground disturbance and filling to floodproof (raise or make other alterations) frequently flood-damaged properties or farm pads. The purchase and demolition of frequently flood-damaged properties, or infrastructure improvements implemented under Local Projects, could also affect cultural resources during construction. Potential impacts 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

The extent of impacts would depend on the nature of cultural resources that could be disturbed, which would be determined through coordination with DAHP and affected tribes during a project-level environmental review, including continued government-to-government consultations. 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 government-to-government consultations.

The potential impacts on cultural resources associated with Floodproofing and Local Projects that could occur following construction are associated with the alteration or removal of existing frequently flood-damaged properties, which could expose, damage, destroy, and/or alter cultural resources through additional, increased, or changed vehicular and foot traffic patterns. Different flood patterns, which could cause flooding and sedimentation of any submerged resources in different areas, change stream channels and cause erosion, and change the streambank locations, which results in bank erosion. These changes could expose, damage, destroy, and/or alter cultural resources downstream of the Local Projects. Potential adverse impacts are considered minor for Floodproofing, as these actions are not anticipated to require substantial ground disturbance that could affect significant archaeological materials. Potential adverse impacts for Local Projects are considered moderate to significant due to the potential to affect cultural resources due to different flood patterns, although as described previously, this would be determined during coordination and consultation with DAHP and affected tribes under the project-level environmental review.

4.7.12.2 Mitigation

Mitigation measures for potential impacts on cultural resources would be determined during project-specific evaluations, and would include consultation with DAHP, interested and affected tribes, as well as other consulting parties (see information on addressing potential impacts on cultural resources in Section 4.2.12). The potential compensatory mitigation measures would be the same as those described for the Flood Retention Facility (see Section 4.2.12.2).

4.7.13 Transportation

4.7.13.1 Short-term Impacts

Floodproofing and Local Projects

The potential short-term impacts on transportation related to Floodproofing and Local Projects include temporary disruptions to local roadways. These impacts would be limited in duration and access to properties would be maintained to the extent possible.

4.7.13.2 Long-term Impacts

Local Projects

Local Projects that protect roadways would reduce road closures in specific locations during major floods, resulting in beneficial effects.

Land Use Management

Limitations on the construction of new roads in the floodplain would reduce the number of roads inundated during floods, and limitations on residential development in the floodplain would reduce incidences of blocked access to residential areas during floods. Therefore, Land Use Management would result in beneficial effects.

4.7.13.3 Mitigation

Mitigation measures for short-term impacts would be similar to those for the Airport Levee Improvements and I-5 Projects. No long-term impacts on transportation are anticipated with Local-scale Flood Damage Reduction Actions, so no mitigation is proposed.

4.7.14 Public Services and Utilities

4.7.14.1 Short-term Impacts

Floodproofing and Local Projects

The potential short-term impacts on public services and utilities related to Floodproofing and Local Projects include reduced accessibility and temporary disruption of public services that rely on having consistent access to their customers (e.g., garbage collection). However, impacts would be limited through proper mitigation (i.e., use of detours or maintain property access). Local Projects to protect WWTPs would be designed so that operations are not disrupted during construction; therefore, no disruption of services is anticipated. Short-term impacts would occur due to implementation of construction mitigation measures and limited construction periods.

4.7.14.2 Long-term Impacts

Floodproofing

Floodproofing structures in the floodplain would reduce flood impacts and help maintain public services and utilities structures and uses during floods. These potential effects are considered beneficial because they would protect a limited number of public services and utilities. Any utility relocations would be localized, causing minor adverse impacts.

Local Projects

Local Projects would result in beneficial effects where such projects protect specific WWTPs and other utilities during floods. Local Projects could require utility relocations, either on the current site or to nearby areas off site, resulting in minor to moderate adverse impacts.

Land Use Management

Changes to land use regulations would positively affect public services and utilities by restricting the placement of public service facilities and utilities in the floodplain, reducing flood damage and the need to repair utilities in the future.

4.7.14.3 Mitigation

Potential mitigation measures for short-term impacts on public services and utilities would include measures to maintain access and public services similar to those described for the Airport Levee Improvements. The minor to moderate long-term adverse impacts associated with utility relocations would be mitigated by coordination with service providers and property owners.

4.7.15 Environmental Health and Safety

4.7.15.1 Short-term Impacts

Floodproofing and Local Projects

The potential short-term impacts on environmental health and safety related to Floodproofing and Local Projects would occur during construction and include temporary disruptions to local roadways, causing minor delays to emergency response during construction. These impacts would be limited to the construction period.

4.7.15.2 Long-term Impacts

Floodproofing

Floodproofing could reduce the demand for emergency response services during a flood because residences and commercial buildings would no longer be inundated, or inundated to a lesser extent, and the risks to health and safety of inhabitants of those structures would be reduced as a result. Floodproofing residences and commercial buildings could reduce floodwater contamination from hazardous materials. These effects would be beneficial at the locations in which they are applied.

Local Projects

Local Projects could somewhat reduce the demand for emergency response services through localized flood damage reduction and maintaining road access. Flood protection of WWTPs would reduce the potential for floodwater contamination by keeping the WWTPs operable during major floods. Minor reductions in threats to human health and safety would create a beneficial effect to the community.

Land Use Management

Updated regulatory standards would require a higher level of protection for critical facilities (facilities that are vital to flood response activities or public health and safety, as well as those that could release hazardous materials into the environment during flooding). New facilities would either be prohibited from locating within the 500-year floodplain, or be protected from damage and loss of access during a 500-year flood through more stringent construction standards. Regulatory standards that minimize new development in the floodplain would reduce risks to public safety and potential impacts on emergency services. Therefore, beneficial effects on public health and safety could result from improvements to Land Use Management.

Flood Warning System

Implementing improvements to the flood warning system would improve flood forecasts and increase the lead time for flood warning, resulting in a beneficial effect on environmental health and safety.

4.7.15.3 Mitigation

No short- or long-term adverse impacts on environmental health and safety are anticipated, so no mitigation is proposed.

improve populations of salmon and steelhead from 2% (for fall-run Chinook salmon) up to 13% (for coho salmon), depending on the species. Coho salmon would experience the greatest gains because of their tendency to be distributed across many sub-basins and in smaller tributaries that are often impaired by undersized culverts (see Table 3.4-4 for existing salmon and steelhead run sizes by species).

The reconnection of off-channel habitat across large areas of the Chehalis Basin could result in a minor adverse impact if it facilitates the dispersal of invasive species, such as bass and bullfrogs, that prey on or compete with native fish species. However, reconnection of off-channel areas to main channel streams and rivers may restore seasonal flow patterns that reduce the abundance of invasive predators.

Salmon abundance would be increased by actions in two different geographic areas of the Chehalis Basin: areas that are in active timber management (managed forestland), which are generally located in the upper Chehalis Basin and fall under the Washington FPA and Habitat Conservation Plans, and areas downstream of the managed forestlands in lowland areas of the basin where active habitat restoration is proposed under the Aquatic Species Habitat Actions. Under current Forest Practice rules, changes to improve the conditions of the riparian corridor and reduce impacts from road building and fish barriers (such as culverts) have taken place on publicly and privately managed forestland. In the lowland areas, restoration measures would include active riparian restoration and other habitat actions described in Section 2.3.3.3.

There is uncertainty as to the long-term effectiveness of riparian maturation in managed forestland. As a result, the effectiveness of riparian maturation in managed forestland was reduced from 100% to a range from 20% to 60% effective in the model to account for this uncertainty. Managed forestland was studied and modeled along with the Aquatic Species Habitat Actions to account for the overall habitat improvement in the Chehalis Basin as fish use both managed forestland and downstream areas for spawning, rearing and migrating.

While other species that are as widely distributed as salmon in the Chehalis Basin are likely to benefit, the magnitude of the benefit to other native fishes will depend on restoration that focuses on restoring ecological processes that support all species, as well as the overlap of chosen restoration areas with the distributions of the other native fishes. The modeled current habitat potential for the Chehalis Basin to support each salmon species is depicted as the number of potential spawners, along with estimated total run size and escapement provided by WDFW over the past 10 years. The modeled change in salmon and steelhead abundance for the entire Chehalis Basin predicted to result from a change in habitat potential due to implementation of the low and high restoration scenarios is shown in Table 4.8-1 and Figure 4.8-1 for each species.

Table 4.8-1
Potential Response in Salmonid Abundance to Habitat Change in the Chehalis Basin from Aquatic Species Habitat Actions

SPECIES (CURRENT HABITAT POTENTIAL)	CHANGE IN ABUNDANCE IN NUMBER OF FISH (%)			
	LOW RESTORATION; 20% OF REACHES	HIGH RESTORATION; 20% OF REACHES	LOW RESTORATION; 60% OF REACHES	HIGH RESTORATION; 60% OF REACHES
Coho salmon (40,642)	22,908 (56%)	39,258 (97%)	51,785 (127%)	96,165 (237%)
Fall-run Chinook salmon (25,844)	2,781 (11%)	9,124 (35%)	5,437 (21%)	19,350 (75%)
Winter/fall-run chum salmon (190,550)	18,596 (10%)	29,080 (15%)	30,626 (16%)	56,970 (29%)
Spring-run Chinook salmon (2,146)	2,051 (96%)	4,590 (214%)	5,583 (260%)	15,357 (715%)
Winter-run steelhead (6,800)	2,147 (32%)	3,133 (46%)	4,738 (70%)	7,751 (114%)

Source: ICF 2016

The contribution of managed forestlands to salmon habitat potential varies, with a range of 5% (fall-run Chinook salmon) to 26% (steelhead) and 31% (coho salmon) benefit for the low restoration scenario, and a range of 10% (fall-run Chinook salmon) to 54% (steelhead) and 57% (coho salmon) benefit for the high restoration scenario, compared to current conditions (see Figure 4.8-2). The low restoration scenario is focused on spring-run Chinook salmon spawning reaches, with habitat potential primarily located in the upper Chehalis Basin in managed forestland, with some reaches in the middle and upper mainstem Chehalis River. The high restoration scenario would result in a larger proportion of restoration benefit from active restoration in lowland areas outside managed forestlands, due to an increased level of restoration in a wider array of reaches throughout the Chehalis Basin[1].

The response of salmon populations to habitat restoration was also modeled by sub-basin. The results assume distribution of restoration widely across sub-basins. Those sub-basins that show the largest response in numbers of increased fish tend to be those with the most river miles of stream that would be restored. The sub-basins that would provide the greatest increase in numbers of salmon and steelhead within the overall Chehalis Basin population are shown in Table 4.8-2 for each species.

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

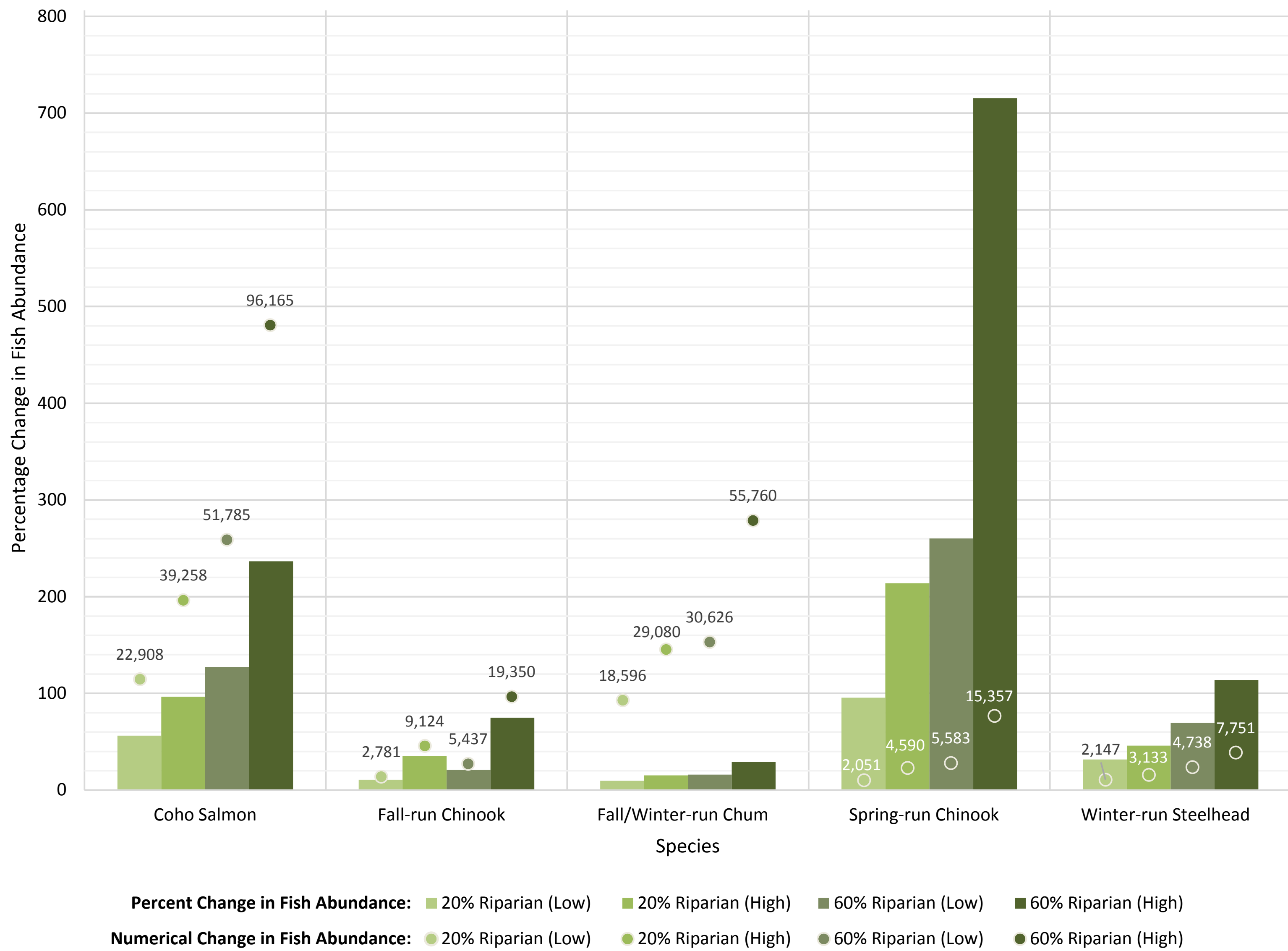
Table 4.8-2
Sub-basins with the Largest Potential Increase in Chehalis Basin Salmonid Abundance by Species from Aquatic Species Habitat Actions

SPECIES	RESTORATION LEVEL[1]	SUB-BASIN	CURRENT SUB-BASIN HABITAT POTENTIAL	CHANGE IN SUB-BASIN ABUNDANCE IN NUMBER OF FISH (%)[2]
Coho salmon	Low (20%)	Mainstem Chehalis from Satsop to Skookumchuck	5,764	4,437 (77%)
	Low (60%)			8,803 (153%)
	High (20%)			6,835 (119%)
	High (60%)			16,088 (279%)
Fall-run Chinook salmon	Low (20%)	Mainstem Chehalis from Satsop to Skookumchuck	3,401	842 (25%)
	Low (60%)			1,536 (45%)
	High (20%)			2,404 (71%)
	High (60%)			5,466 (161%)
Fall/winter-run chum salmon	Low (20%)	Mainstem Chehalis from Satsop to Skookumchuck	52,103	10,261 (20%)
	Low (60%)			14,456 (28%)
	High (20%)			13,419 (26%)
	High (60%)			22,387 (43%)
Spring-run Chinook salmon	Low (20%)	Newaukum River	812	912 (112%)
	Low (60%)			2,026 (250%)
	High (20%)			2,127 (262%)
	High (60%)			6,341 (781%)
Winter-run steelhead	Low (20%)	Newaukum River	1,022	397 (39%)
		Low (60%)		**598 (59%)**
		High (20%)		**819 (80%)**
		High (60%)		**1,451 (142%)**

Notes:
1. Low and high scenarios are shown in combination with 20% or 60% of spawning reaches restored
2. Percentage change shows change in size of the given sub-basin population
Source: ICF 2016

Figure 4.8-1

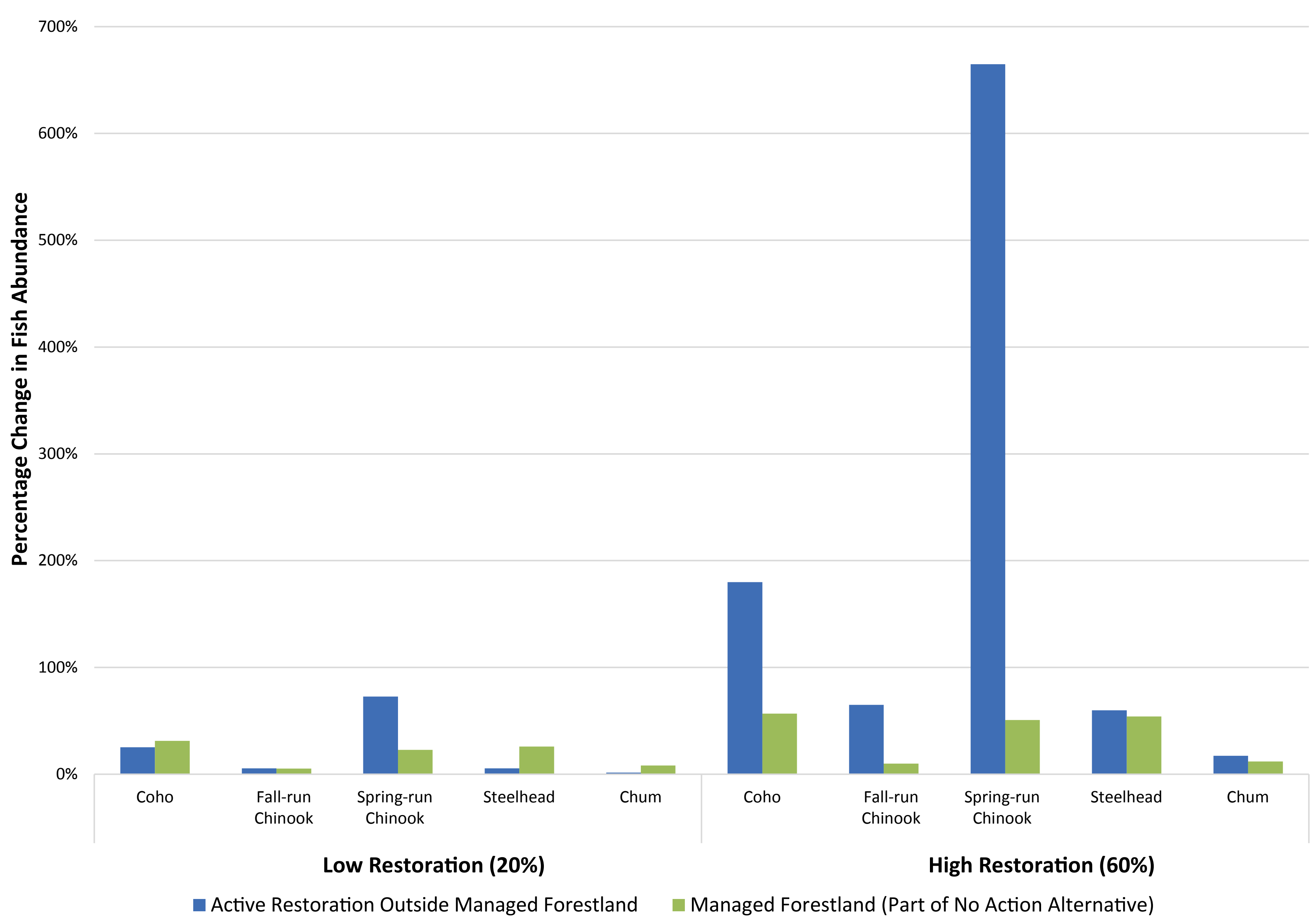
Potential Response in Salmonid Abundance to Habitat Change in the Chehalis Basin from Aquatic Species Habitat Actions



Source: ICF 2016

Figure 4.8-2

Potential Response in Salmonid Abundance to Habitat Change in the Chehalis Basin from Active Restoration Outside Managed Forest Compared to Managed Forestland



Aquatic Species Habitat Actions under the high restoration scenario would occur in 356 river miles across the entire Chehalis Basin. If the high restoration scenario were undertaken, salmonid species would benefit across the entire Chehalis Basin—ranging from an increase in abundance of 16% for fall- and winter-run chum salmon if 20% of reaches were restored, up to an increase of 715% for spring-run Chinook salmon if 60% of reaches were restored (see Table 4.8-2).

If low restoration scenario were undertaken, restoration would be focused on 104 river miles of spring-run Chinook salmon spawning reaches; however, all salmon species that use these reaches would benefit. Based on model results, increases in total Chehalis Basin abundance under the lowest restoration scenario would range from 10% for fall- and winter-run chum salmon to 11% for fall-run Chinook salmon if 20% of reaches were restored, up to 260% for spring-run Chinook salmon if 60% of reaches were restored (see Table 4.8-2).

Restoration of the Newaukum and the middle mainstem Chehalis River sub-basins between the confluences of the Skookumchuck River up to Elk Creek would increase salmon numbers the most across all five species; however, restoration of the lower Chehalis, Wynoochee, Satsop, Skookumchuck, and South Fork Chehalis River sub-basins would also provide benefits of slightly smaller magnitudes. The smallest change in salmon abundance would be observed with restoration of the South Bay, Humptulips, Hoquiam, and Wishkah rivers; however, the magnitude of change within these tributaries could still be sizeable, with sub-basin populations increasing up to nearly 200% for coho salmon in the Wishkah River.

It should be noted that the benefits described here do not take climate change in to account, which is projected to cause increases in water temperature and change seasonal precipitation patterns. The benefit of the low Aquatic Species Habitat Actions scenario would not offset losses to salmon abundance predicted under a climate change scenario (see Section 4.8.7 for further discussion).

4.8.4.2.2 Wildlife

The potential beneficial effects on wildlife include habitat improvements and protection, and restoration of vegetation communities and wetlands that are of high value to fish and wildlife. Anticipated effects are primarily related to increases in habitat quantity, quality, and connectivity from the following:

- Increase in wildlife habitat through improvements in wetland and riparian habitats and associated functions through restoration or creation of habitat
- Improved habitat connectivity and corridors for wildlife
- Increased fish production described in Section 4.8.4.2.1 would benefit mammals and predators that feed on salmon and salmon carcasses including multiple birds and mammal species in the Chehalis Basin, as well as the ESA-listed Southern Resident killer whale in the Pacific Ocean outside of Grays Harbor

Each of these actions could affect habitat quality by increasing the area of habitat functioning as it would have historically for aquatic and semi-aquatic wildlife such as amphibians, reptiles, North American beaver, and waterfowl. In the low restoration scenario, 21 to 63 river miles (1,150 to 2,900 acres) of riparian habitat could be treated with restoration or protection activities; whereas in the high restoration scenario, 71 to 214 river miles (3,900 to 9,750 acres) of riparian habitat could be restored or protected.

The potential effects on wildlife habitat and native wildlife species, in particular species that rely on aquatic habitat for multiple stages of their life cycle such as amphibians, are considered beneficial. Key restoration activities that benefit wildlife would include the following:

- Improvement of habitat processes, habitat complexity, and connectivity throughout the Chehalis Basin that is self-maintaining, high-value habitat for wildlife
- Creation, restoration, and enhancement of wetlands for use by semi-aquatic species
- Creation and improvement of habitat features achieved through increased plant species diversity and complexity, the addition of snag and woody material habitat features, increased wetland and riparian habitat functions, and the establishment of hydrologic features with diverse characteristics in depth, width, and sinuosity
- Restoration and improvement of riparian habitat features could improve connectivity between wildlife habitats, creating a benefit by connecting wildlife populations that are currently separated by human disturbances or activities and providing migration corridors that are less exposed to human disturbances (WHCWG 2010)

Establishing these features would provide quality habitat for native wildlife species of birds, amphibians, large and small mammals, and reptiles to breed, forage, rest, and overwinter.

Restoring connections among currently disconnected habitat could have an adverse impact by facilitating the spread of non-native invasive species, which could lower the quality of habitat functions; however, this would be a potentially minor adverse impact compared to the overall beneficial effect of improving connectivity between habitats for wildlife species. Invasive species dispersal could include non-native plants (e.g., reed canarygrass and purple loosestrife) or wildlife species (e.g., bullfrog) that prey on native wildlife.

4.8.4.3 Mitigation

4.8.4.3.1 Fish

Potential mitigation measures to reduce short-term impacts on fish could include those described in Table 4.1-1, as well as the following:

- Avoiding intact riparian vegetation that stabilizes banks and provides cover for fish

- Excluding fish from areas with nets or other temporary exclusion methods

No long-term adverse impacts on fish are anticipated, because Aquatic Species Habitat Actions would be beneficial to fish species in the long term, so no mitigation is proposed.

4.8.4.3.2 Wildlife

Potential mitigation measures for short-term impacts on wildlife are described in Table 4.1-1. No long-term adverse impacts on wildlife are anticipated, because Aquatic Species Habitat Actions would be beneficial to wildlife species in the long term, so no mitigation is proposed.

4.8.5 Tribal Resources

4.8.5.1 Short- and Long-term Impacts

Potential adverse impacts on tribal resources could occur during construction and would result in the following disturbances to aquatic habitat and tribal fish resources:

- Impairment or elimination of fish habitat used by adults, eggs, and juveniles
- Effect on survival of adult, eggs, and juveniles
- Affected 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

While Aquatic Species Habitat Actions would focus on self-maintaining restoration and protection, structural habitat actions would likely require intervention during the 100-year life span of this action element. In particular, culvert maintenance would be required over the long term, which likely would involve instream work, however on a small temporal and spatial scale.

Tribal fishers could be temporarily delayed or restricted from accessing the Chehalis River or its tributaries during some construction activities. The potential to affect access depends on where and when construction would occur. Access to traditional plants and hunting of wildlife could also be affected by short-term construction activities.

The extent of potential impacts is pending additional coordination with tribes and continued government-to-government consultations. The potential impacts on tribal resources following construction of the projects implemented as part of Aquatic Species Habitat Actions are improvements to productivity and capacity of natural populations of salmon and steelhead.

Under the high restoration scenario, improvements in riparian vegetation would also provide wildlife habitat for elk and deer. These potential long-term effects are considered beneficial due to the appreciable improvement in overall population performance of all populations.

Habitat improvements are anticipated to benefit tribal fisheries by improving population productivity, abundance, and life history diversity; and proving greater resiliency to periods of adverse freshwater and marine environmental conditions. The modeled change in salmon abundance for the low and high restoration scenarios is described in Section 4.8.4.

4.8.5.2 Mitigation

The potential mitigation associated with impacts on tribal resources would be addressed directly with Quinault Indian Nation and Chehalis Tribe tribal leadership during project-level environmental review and continued government-to-government consultations.

In some cases, mitigation measures would be proposed to address the short- and long-term impacts on habitat that are important to tribal resources, including fish, wildlife, and plants. Mitigation of impacts on treaty rights is subject to consideration and agreement by the Quinault Indian Nation.

4.8.6 Air Quality

4.8.6.1 Short-term Impacts

The potential short-term impacts on air quality would vary and would likely last a few weeks to a few months depending on the scale of the individual restoration project. These impacts would be localized, limited to the construction period, and would not cause an overall decrease in regional air quality.

4.8.6.2 Long-term Impacts

No adverse impacts on air quality are anticipated because Aquatic Species Habitat Actions would not generate emissions once completed. Cleared areas would be revegetated and would not provide a source of dust.

4.8.6.3 Mitigation

Potential mitigation measures for short-term impacts on air quality would be the same as those described in Table 4.1-1. No long-term adverse impacts on air quality are anticipated with Aquatic Species Habitat Actions, so no mitigation is proposed.

4.8.7 Climate Change

4.8.7.1 Short-term Impacts

4.8.7.1.1 Effects of Aquatic Species Habitat Actions Contributing to Climate Change

The potential short-term effects of Aquatic Species Habitat Actions that could contribute to climate change would occur during construction and include additional GHG emissions from construction equipment and truck shipments of materials to and from the site, such as construction and excavated/demolished materials for fish barrier removals, and materials for vegetation re-establishment and aquatic species habitat restoration sites. Restoration activities are expected to be implemented over a multi-year timeframe, and the anticipated GHG emission equivalents from all restorative elements are below the annual threshold for qualitative disclosure of emissions (Ecology 2011b).

4.8.7.1.2 Effects of Climate Change on Aquatic Species Habitat Actions

No short-term effects of climate change on Aquatic Species Habitat Actions are anticipated.

4.8.7.2 Long-term Impacts

4.8.7.2.1 Effects of Aquatic Species Habitat Actions Contributing to Climate Change

No adverse impacts that contribute to climate change are anticipated. However, beneficial effects could occur with increased vegetation and the associated increase in carbon storage and reduction in GHG emission equivalents, ranging between 140,000 to 350,000 MT CO_2e/year (low restoration) and 470,000 to 1.18 million MT CO_2e/year (high restoration).

4.8.7.2.2 Effects of Climate Change on Aquatic Species Habitat Actions

The potential impacts of climate change on Aquatic Species Habitat Actions could reduce the effectiveness of restoration for salmonid populations. However, these effects are considered minor adverse impacts because the improved habitat-forming processes, habitat complexity, and self-maintaining connectivity associated with implementation of Aquatic Species Habitat Actions are expected to help buffer the effects of climate change on salmonids and aquatic species.

Several actions within both the high and low restoration scenarios serve to moderate the effects that are predicted with climate change forecasts, including providing the following:

- Floodplain reconnection to moderate the effects of increased stream temperatures on aquatic species by increasing hyporheic flow, which provides cool groundwater to surface water during the summer
- Restored riparian habitat, reduced erosion and sediment delivery, and restored instream conditions to moderate the effects of climate change on stream temperatures
- An increase in thermal refugia to moderate the impacts of climate change on salmonids

The EDT model developed for the Chehalis Basin (ICF 2016) was used to predict how fish species would respond to varying effects of climate change under the high and low restoration scenarios. Table 4.8-3 and Figure 4.8-3 present these results, as compared to current conditions with climate change.

Table 4.8-3
Potential Response in Salmonid Abundance to Habitat Change in the Chehalis Basin from Climate Change and Aquatic Species Habitat Actions

SPECIES (CURRENT HABITAT POTENTIAL)	CHANGE IN ABUNDANCE IN NUMBER OF FISH (%)				
	WITH CLIMATE CHANGE ONLY	WITH CLIMATE CHANGE AND LOW RESTORATION; 20% OF REACHES	WITH CLIMATE CHANGE AND HIGH RESTORATION; 20% OF REACHES	WITH CLIMATE CHANGE AND LOW RESTORATION; 60% OF REACHES	WITH CLIMATE CHANGE AND HIGH RESTORATION; 60% OF REACHES
Coho salmon (40,642)	-22,390 (-55%)	-3,865 (-10%)	4,728 (12%)	27,684 (68%)	61,395 (151%)
Fall-run Chinook salmon (25,844)	-6,969 (-27%)	-4,602 (-18%)	-566 (-2%)	-2,236 (-9%)	8,654 (33%)
Winter/fall-run chum salmon (190,550)	-8,270 (-4%)	15,445 (8%)	28,232 (15%)	29,261 (15%)	59,272 (31%)
Spring-run Chinook salmon (2,146)	-1,869 (-87%)	-1,075 (-50%)	-452 (-21%)	1,088 (51%)	5,467 (255%)
Winter-run steelhead (6,800)	-3,741 (-55%)	-894 (-13%)	194 (3%)	2,711 (40%)	6,347 (93%)

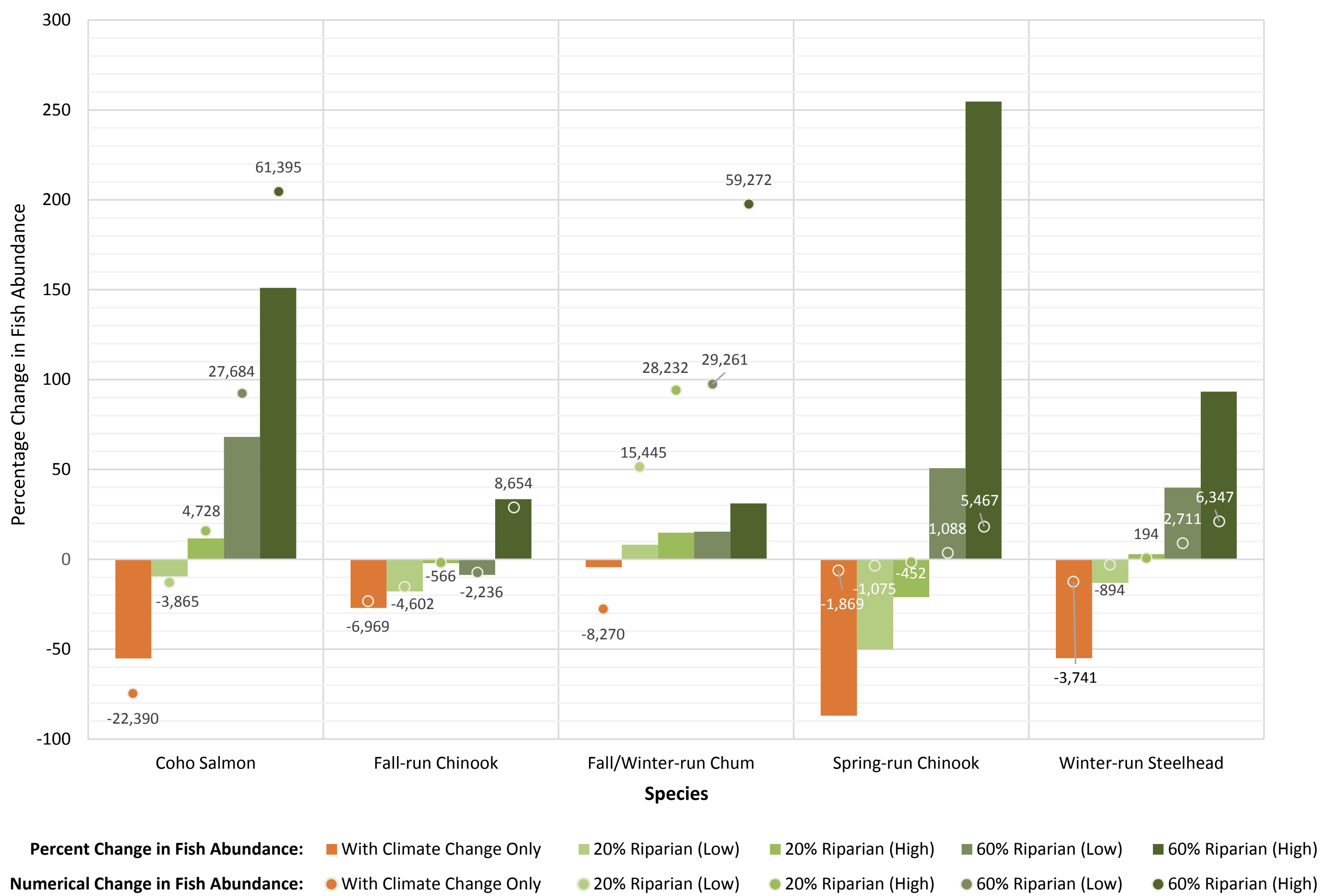
Source: ICF 2016

Future climate conditions in the Chehalis Basin are expected to appreciably reduce the habitat potential for salmon. However, active restoration in lowland areas is anticipated to moderate these changes, especially when considering the high restoration scenario. Figure 4.8-4 shows the increase in benefit from managed forestlands and active restoration in lowland areas outside of managed forestlands[2].

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

Figure 4.8-3

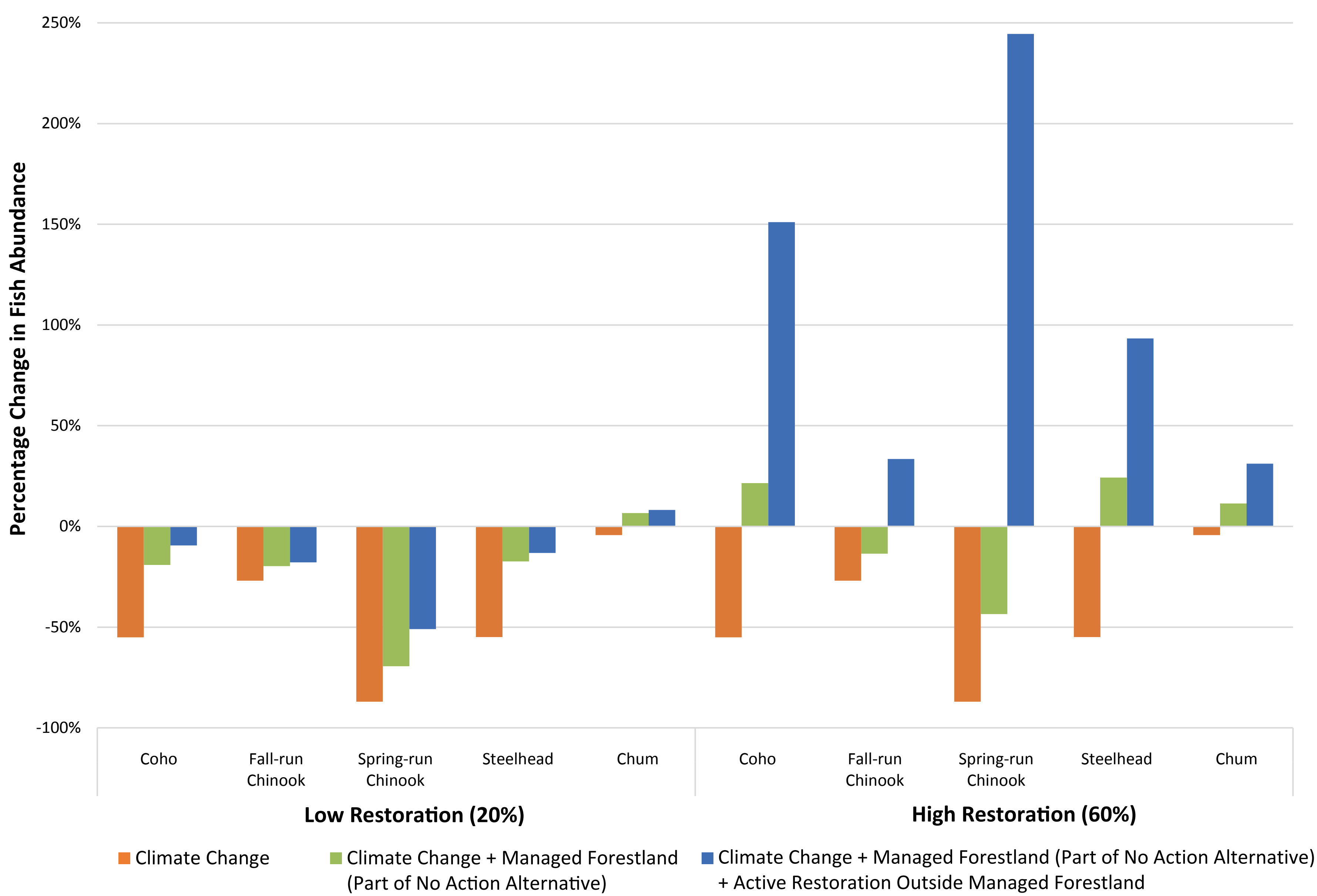
Potential Response in Salmonid Abundance to Habitat Change in the Chehalis Basin from Climate Change and Aquatic Species Habitat Actions



Source: ICF 2016

Figure 4.8-4

Potential Response in Salmonid Abundance to Habitat Change in the Chehalis Basin from Climate Change (Active Restoration Outside Managed Forest Compared to Managed Forestland)



All of the low and high restoration scenarios with climate change would result in the increased abundance of salmonids compared to climate change only.

The high restoration scenarios with climate change would result in the following:

- Significantly greater percentage increase in abundance (more than 75%) than the low restoration scenario for coho salmon and spring-run Chinook salmon when applied to either 20% or 60% of the reaches, as well as winter-run steelhead when applied to 60% of the reaches
- Exceedance of habitat potential for coho salmon and spring-run Chinook salmon with 60% of reaches addressed

The low restoration scenarios with climate change would result in the following:

- A reduction in predicted losses of salmonid abundance due to climate change only under current conditions for all species
- Avoidance of a loss in abundance for coho salmon and winter-run steelhead when applied to 60% of reaches and for winter/fall-run chum salmon when applied to both 20% and 60% of reaches

4.8.7.3 Mitigation

4.8.7.3.1 Mitigation to Address Effects of Aquatic Species Habitat Actions Contributing to Climate Change

No adverse effects of Aquatic Species Habitat Actions contributing to climate change are anticipated, so no mitigation is proposed.

4.8.7.3.2 Mitigation to Address Effects of Climate Change on Aquatic Species Habitat Actions

The design of the actions within Aquatic Species Habitat Actions are intended to moderate the effects of climate change and provide resiliency to these changing conditions. The vulnerability of specific types of restoration actions in the Chehalis Basin would be evaluated in order to identify those actions that would maintain the largest degree of effectiveness under future projected climatic and hydrologic conditions. No additional mitigation measures are anticipated.

4.8.8 Noise

4.8.8.1 Short-term Impacts

The potential short-term impacts on noise would occur during construction and would include construction equipment, such as graders and dump trucks that would have peak noise levels ranging from 79 to 89 dBA at 50 feet from the source (see Table 4.2-10). Aquatic Species Habitat Actions would range in scale, and larger actions, such as restoring off-channel habitat, would last longer and require heavier equipment. These impacts would be localized and limited to daytime hours.

4.8.8.2 Long-term Impacts

No adverse impacts are anticipated because implementation of Aquatic Species Habitat Actions would not generate noise.

4.8.8.3 Mitigation

Potential mitigation measures for short-term noise impacts would be the same as those described for the Airport Levee Improvements and I-5 Projects. No long-term noise impacts are anticipated with Aquatic Species Habitat Actions, so no mitigation is proposed.

4.8.9 Visual Quality

4.8.9.1 Short-term Impacts

The potential short-term impacts on visual quality would occur during construction and include unmanaged dust, exposed construction debris, heavy equipment, and temporary installations, depending on the individual activity, which would generally create an unattractive visual setting. These impacts would occur in relatively small areas and would be limited to the construction period.

4.8.9.2 Long-term Impacts

Aquatic Species Habitat Actions could cause changes in views in local areas toward more natural conditions and vegetation. Depending on personal preference, these changes could be considered beneficial to visual quality. All potential adverse impacts would be minimal because they would not involve large-scale changes or large structures that block views.

4.8.9.3 Mitigation

Potential mitigation measures for short-term impacts on visual quality include limiting the area of ground disturbance through appropriate site design; locating staging and stockpiling areas within previously disturbed areas or co-locating them with proposed activities; and revegetating temporarily affected areas with appropriate plantings following construction.

Long-term impacts on visual quality would be minimal and dependent on personal preference, so no mitigation is proposed.

4.8.10 Land Use

4.8.10.1 Short-term Impacts

No short-term impacts on land use are anticipated.

4.8.10.2 Long-term Impacts

The potential adverse impacts on land use are related to the conversion of land from other uses into habitat restoration areas, which could be between 1,150 and 9,750 acres. Impacts are most likely to occur on existing agricultural land, with impacts on residential, commercial, or industrial land uses occurring to a lesser degree. The land use conversion would be completed through property acquisition or pursuing a conservation easement on the portion of the land where restoration would take place (i.e., restoration of a narrow riparian corridor would not necessitate conversion of the entire property). If implemented at the highest level, habitat restoration actions could cumulatively result in minor to moderate adverse impacts to land use.

4.8.10.3 Mitigation

No short-term impacts on land use are is anticipated, so no mitigation is proposed. Potential mitigation measures to address long-term adverse impacts on land use are associated with individual projects that permanently convert or alter the existing land use. Where an easement or property acquisition is necessary, the type and level of mitigation would be determined during project-level environmental review, and coordination with affected property owners.

4.8.11 Recreation

4.8.11.1 Short-term Impacts

The potential short-term impacts on recreation would occur during construction and include construction noise, dust, access, and transportation impacts in or adjacent to recreation areas, which could disturb recreational users. Access to recreation areas could also be restricted during construction. These impacts would be limited to the construction period, which would be a few weeks to a few months for most projects.

4.8.11.2 Long-term Impacts

The restoration actions would increase the abundance of fish species in the Chehalis Basin, improving opportunities for recreational fishing and causing beneficial effects. In-water structures (e.g., LWM) installed in the river or its tributaries could create a hazard for kayakers and other recreational boaters. This would result in a minor adverse impact because the area affected would be limited and signage would warn boaters. Restoration actions could cause some minor, localized reductions in flooding, but the effects on recreation would be limited because these reductions are unlikely to reduce flood damage at recreational facilities or agritourism sites. It is possible that some restoration sites would be closed to public access after construction. If these sites were previously used for undeveloped recreation, this would be a minor adverse impact because it is likely that other opportunities for undeveloped recreation would remain nearby.

4.8.11.3 Mitigation

In addition to restoring access to recreation areas following construction, mitigation measures for short-term impacts on recreation are described in Table 4.1-1. Potential mitigation measures for long-term adverse impacts on recreation associated with in-water structures could include signage to notify boaters of potential hazards.

4.8.12 Historic and Cultural Preservation

4.8.12.1 Short- and Long-term Impacts

The potential impacts on cultural resources are related to ground disturbance and filling to restore habitat, reduce bank erosion, and remove or improve fish passage obstructions. Potential impacts 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

The resulting changes to the landscape could expose, damage, destroy, and/or alter cultural resources through the following:

- Additional, increased, or changed vehicular and foot traffic patterns
- Different flood patterns, which would 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

The extent of impacts would depend on the nature of cultural resources that could be disturbed and could range from minor to significant, depending on the location. Impacts would be determined through coordination with DAHP and affected tribes during a project-level environmental review, including continued government-to-government consultations. 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 government-to-government consultations.

4.8.12.2 Mitigation

Mitigation measures for potential impacts on cultural resources could be determined during project-specific evaluations of Aquatic Species Habitat Actions, and could include consultation with DAHP, interested and affected tribes, as well as other consulting parties (see information on addressing potential impacts on cultural resources in Section 4.2.12).

The potential compensatory mitigation measures would be the same as those described for the Flood Retention Facility (see Section 4.2.12.2).

4.8.13 Transportation

4.8.13.1 Short-term Impacts

The potential short-term impacts on transportation would include limited temporary disruptions to local roadways to access construction areas and temporary road closures or detours for removal of fish passage barriers. These impacts would be limited in duration and access would be maintained to the extent possible.

4.8.13.2 Long-term Impacts

Aquatic Species Habitat Actions would not affect the duration of I-5 closures. Aquatic Species Habitat Actions could cause localized increased in flooding of some roadways, resulting in minor adverse impacts due to the limited scale.

4.8.13.3 Mitigation

Potential mitigation measures for short-term impacts on transportation include maintaining access to properties to the extent possible, installing signs, marking detour routes, flagging and providing information to the public, including notifications in advance of construction activities. Culvert replacements on state roadways would be coordinated with WSDOT and local transportation departments.

Long-term adverse impacts on transportation would be limited to small areas of increased flooding on local roadways, so no mitigation is proposed.

4.8.14 Public Services and Utilities

4.8.14.1 Short-term Impacts

The potential short-term impacts on public services and utilities would occur during construction and include temporary disruptions to roadways, delays to public services, and disruptions of utilities. These impacts are limited because services and utilities would be maintained through proper mitigation, and impacts would be limited to the construction period.

4.8.14.2 Long-term Impacts

Aquatic Species Habitat Actions would not change demand for public services and utilities, but could require localized relocation of utilities, which would result in minor adverse impacts. Aquatic Species Habitat Actions could cause minor increases in flooding, but the increases are unlikely to affect public services and utilities.

4.8.14.3 Mitigation

Potential mitigation measures for short-term impacts on public services and utilities could include measures to maintain access and public services similar to those described for the Airport Levee Improvements. Mitigation for minor long-term adverse impacts associated with utility relocation could include coordination with local service providers and property owners.

4.8.15 Environmental Health and Safety

4.8.15.1 Short-term Impacts

The potential short-term impacts on environmental health and safety would include disruptions to local roadways, causing temporary delays to emergency services during construction. These impacts would be limited to the construction duration and access would be coordinated with emergency services.

4.8.15.2 Long-term Impacts

No adverse impacts on environmental health and safety would occur with implementation of the Aquatic Species Habitat Actions. Restoration actions could cause some increased flooding in local areas, but would not increase the demand for emergency response services or increase the risk of contamination of floodwaters.

4.8.15.3 Mitigation

Potential mitigation measures for short-term impacts on environmental health and safety could include those described in Table 4.1-1 as they relate to the transport of material, as well as coordinating construction with emergency services to reduce impacts on emergency response. No long-term adverse impacts on environmental health and safety are anticipated with Aquatic Species Habitat Actions, so no mitigation is proposed.

occurring to a lesser degree. The land use conversion would be completed through property acquisition or pursuing a conservation easement on the portion of the land where restoration would take place (i.e., restoration of a narrow riparian corridor would not necessitate conversion of the entire property). If implemented at the highest level, habitat restoration actions could cumulatively result in minor to moderate adverse impacts to land use.

4.8.10.3 Mitigation

No short-term impacts on land use are is anticipated, so no mitigation is proposed. Potential mitigation measures to address long-term adverse impacts on land use are associated with individual projects that permanently convert or alter the existing land use. Where an easement or property acquisition is necessary, the type and level of mitigation would be determined during project-level environmental review, and coordination with affected property owners.

4.8.11 Recreation

4.8.11.1 Short-term Impacts

The potential short-term impacts on recreation would occur during construction and include construction noise, dust, access, and transportation impacts in or adjacent to recreation areas, which could disturb recreational users. Access to recreation areas could also be restricted during construction. These impacts would be limited to the construction period, which would be a few weeks to a few months for most projects.

4.8.11.2 Long-term Impacts

The restoration actions would increase the abundance of fish species in the Chehalis Basin, improving opportunities for recreational fishing and causing beneficial effects. In-water structures (e.g., LWM) installed in the river or its tributaries could create a hazard for kayakers and other recreational boaters. This would result in a minor adverse impact because the area affected would be limited and signage would warn boaters. Restoration actions could cause some minor, localized reductions in flooding, but the effects on recreation would be limited because these reductions are unlikely to reduce flood damage at recreational facilities or agritourism sites. It is possible that some restoration sites would be closed to public access after construction. If these sites were previously used for undeveloped recreation, this would be a minor adverse impact because it is likely that other opportunities for undeveloped recreation would remain nearby.

4.8.11.3 Mitigation

In addition to restoring access to recreation areas following construction, mitigation measures for short-term impacts on recreation are described in Table 4.1-1. Potential mitigation measures for long-term adverse impacts on recreation associated with in-water structures could include signage to notify boaters of potential hazards.

4.8.12 Historic and Cultural Preservation

4.8.12.1 Short- and Long-term Impacts

The potential impacts on cultural resources are related to ground disturbance and filling to restore habitat, reduce bank erosion, and remove or improve fish passage obstructions. Potential impacts 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

The resulting changes to the landscape could expose, damage, destroy, and/or alter cultural resources through the following:

- Additional, increased, or changed vehicular and foot traffic patterns
- Different flood patterns, which would 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

The extent of impacts would depend on the nature of cultural resources that could be disturbed and could range from minor to significant, depending on the location. Impacts would be determined through coordination with DAHP and affected tribes during a project-level environmental review, including continued government-to-government consultations. 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 government-to-government consultations.

4.8.12.2 Mitigation

Mitigation measures for potential impacts on cultural resources could be determined during project-specific evaluations of Aquatic Species Habitat Actions, and could include consultation with DAHP, interested and affected tribes, as well as other consulting parties (see information on addressing potential impacts on cultural resources in Section 4.2.12).

The potential compensatory mitigation measures would be the same as those described for the Flood Retention Facility (see Section 4.2.12.2).

4.8.13 Transportation

4.8.13.1 Short-term Impacts

The potential short-term impacts on transportation would include limited temporary disruptions to local roadways to access construction areas and temporary road closures or detours for removal of fish passage barriers. These impacts would be limited in duration and access would be maintained to the extent possible.

4.8.13.2 Long-term Impacts

Aquatic Species Habitat Actions would not affect the duration of I-5 closures. Aquatic Species Habitat Actions could cause localized increased in flooding of some roadways, resulting in minor adverse impacts due to the limited scale.

4.8.13.3 Mitigation

Potential mitigation measures for short-term impacts on transportation include maintaining access to properties to the extent possible, installing signs, marking detour routes, flagging and providing information to the public, including notifications in advance of construction activities. Culvert replacements on state roadways would be coordinated with WSDOT and local transportation departments.

Long-term adverse impacts on transportation would be limited to small areas of increased flooding on local roadways, so no mitigation is proposed.

4.8.14 Public Services and Utilities

4.8.14.1 Short-term Impacts

The potential short-term impacts on public services and utilities would occur during construction and include temporary disruptions to roadways, delays to public services, and disruptions of utilities. These impacts are limited because services and utilities would be maintained through proper mitigation, and impacts would be limited to the construction period.

4.8.14.2 Long-term Impacts

Aquatic Species Habitat Actions would not change demand for public services and utilities, but could require localized relocation of utilities, which would result in minor adverse impacts. Aquatic Species Habitat Actions could cause minor increases in flooding, but the increases are unlikely to affect public services and utilities.

4.8.14.3 Mitigation

Potential mitigation measures for short-term impacts on public services and utilities could include measures to maintain access and public services similar to those described for the Airport Levee Improvements. Mitigation for minor long-term adverse impacts associated with utility relocation could include coordination with local service providers and property owners.

4.8.15 Environmental Health and Safety

4.8.15.1 Short-term Impacts

The potential short-term impacts on environmental health and safety would include disruptions to local roadways, causing temporary delays to emergency services during construction. These impacts would be limited to the construction duration and access would be coordinated with emergency services.

4.8.15.2 Long-term Impacts

No adverse impacts on environmental health and safety would occur with implementation of the Aquatic Species Habitat Actions. Restoration actions could cause some increased flooding in local areas, but would not increase the demand for emergency response services or increase the risk of contamination of floodwaters.

4.8.15.3 Mitigation

Potential mitigation measures for short-term impacts on environmental health and safety could include those described in Table 4.1-1 as they relate to the transport of material, as well as coordinating construction with emergency services to reduce impacts on emergency response. No long-term adverse impacts on environmental health and safety are anticipated with Aquatic Species Habitat Actions, so no mitigation is proposed.